WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

EXTRAORDINARY SESSION

CAIRNS, 4–12 DECEMBER 2002

ABRIDGED FINAL REPORT WITH RESOLUTIONS AND RECOMMENDATIONS

WMO-No. 955

Secretariat of the World Meteorological Organization - Geneva - Switzerland

REPORTS OF RECENT WMO SESSIONS

Congress and Executive Council

883 — **Executive Council**. Fiftieth session, Geneva, 16–26 June 1998.
902 — **Thirteenth World Meteorological Congress**. Geneva, 4–26 May 1999.
903 — **Executive Council**. Fifty-first session, Geneva, 27–29 May 1999.
915 — **Executive Council**. Fifty-second session, Geneva, 16–26 May 2000.
929 — **Executive Council**. Fifty-third session, Geneva, 5–15 June 2001.
932 — **Thirteenth World Meteorological Congress**. Proceedings, Geneva, 4–26 May 1999.
945 — **Executive Council**. Fifty-fourth session, Geneva, 11–21 June 2002.

Regional associations

924 — **Regional Association II** (Asia). Twelfth session, Seoul, 19–27 September 2000.
927 — **Regional Association IV** (North and Central America). Thirteenth session, Maracay, 28 March–6 April 2001.
934 — **Regional Association III** (South America). Thirteenth session, Quito, 19–26 September 2001.
942 — **Regional Association VI** (Europe). Thirteenth session, Geneva, 2–10 May 2002.
944 — **Regional Association V** (South–West Pacific). Thirteenth session, Manila, 21–28 May 2002.
954 — **Regional Association I** (Africa). Thirteenth session, Mbabane, 20–28 November 2002.

Technical commissions

893 — **Commission for Basic Systems**. Extraordinary session, Karlsruhe, 30 September–9 October 1998.
921 — **Commission for Hydrology**. Eleventh session, Abuja, 6–16 November 2000.
923 — **Commission for Basic Systems**. Twelfth session, Geneva, 29 November–8 December 2000.
931 — **Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology**. First session, Akureyri, 19–29 June 2001.
938 — **Commission for Climatology**. Thirteenth session, Geneva, 21–30 November 2001.
941 — **Commission for Atmospheric Sciences**. Thirteenth session, Oslo, 12–20 February 2002.
947 — **Commission for Instruments and Methods of Observation**. Thirteenth session, Bratislava, 25 September–3 October 2002.
951 — **Commission for Agricultural Meteorology**. Thirteenth session, Ljubljana, 10–18 October 2002.
953 — **Commission for Aeronautical Meteorology**. Twelfth session, Montreal, 16–20 September 2002.

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Regional Association III	—	English, Spanish
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NOTE

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GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING OF THE SESSION (agenda item 1)

1.1 The extraordinary session (2002) of the Commission for Basic Systems was held in Cairns, Australia from 4 to 12 December 2002 at the invitation of the Government of Australia. The session which took place at Cairns Convention Centre, was opened at 10 a.m. on 4 December 2002 by the acting president of the Commission, Mr A. Gusev.

1.2 Mr J. W. Zillman, Permanent Representative of Australia with WMO, on behalf of the Government of Australia, extended a warm welcome to all participants of the session. He made important remarks on the work of the Commission and on challenges that it faced in designing, implementing and operating the global meteorological infrastructure of the future. Mr Zillman pointed out that the role of CBS was absolutely fundamental to the operation of the entire global monitoring, research and service systems. He mentioned, inter alia, that CBS should be cautious of establishing too sharp a distinction between weather and climate and should design and operate basic synoptic and climatological networks as a single integrated network. He also stressed that the meteorological community must be prepared to reaffirm the fundamental importance of free and unrestricted exchange of basic data and products. In conclusion, Mr Zillman urged CBS to take the broadest view of its role in guiding the development of the global meteorological infrastructure as the foundation for better public and private meteorological service provision.

1.3 On behalf of the Department of the Premier and Cabinet of the State of Queensland, Mr R. Nargar, Regional Manager for Far North Queensland Regional Communities, welcomed the participants and expressed his state's pleasure to host the CBS session for the first time in Australia. He emphasized the importance of the work of the Commission with respect to weather observing and forecasting for his state.

1.4 On behalf of the City of Cairns, Mrs M. Gill, Councillor and Deputy Mayor of the City of Cairns, welcomed all the participants of the session. Mrs Gill briefed the session on 125 years of history of Cairns. She noted that Cairns was affected to a large extent by various weather phenomena such as tropical cyclones, storm surges and high tides. Mrs Gill stressed therefore the importance of the studies and prediction of weather phenomena for her native city. She wished the participants an enjoyable stay in Cairns.

1.5 The Deputy Secretary-General of WMO, Mr M. J. Jarraud, presented the statement of the Secretary-General of WMO, Professor G.O.P. Obasi, who due to unavoidable circumstances, was unable to attend the opening of the session. In his statement, Professor Obasi welcomed the participants of the session on behalf of the Organization, and expressed appreciation to the Government of Australia for hosting the session, as well as the Technical Conference on Data-processing and Forecasting Systems held prior to the session. He also extended his thanks to the Australia Bureau of Meteorology for the excellent arrangements made to ensure the success of the session.

1.6 The Secretary-General noted several major events and developments of importance to CBS which had taken place since the last session, including the World Summit on Sustainable Development. High priority was given to weather, climate and water-related issues, and in particular, to the need to strengthen observational networks and to ensure the provision of related information in support of sustainable development. The challenge for CBS was therefore, to ensure the subsequent development of the basic systems infrastructure that supported all other WMO and international programmes. Professor Obasi noted that in the light of those requirements, the Commission made substantial progress in recent years with respect to the redesign of GOS, the introduction of advanced data communication techniques and services that brought early benefits to the whole GTS, the development of the Future WMO Information System concept, the introduction of EPS and improvement of the PWS, including establishing the Severe Weather Information Centre and the World Weather Information Centre which would provide authoritative weather warnings and forecasts to the media and public.

1.7 Mr Jarraud expressed sincere thanks, on behalf of Professor Obasi and his own, to the State of Queensland for hosting the CBS session and wished the participants every success in their deliberations.

1.8 The acting president of CBS welcomed the participants and guests and expressed his gratitude to previous speakers for their kind and commendable words. He emphasized the leading role of the Commission in the provision data and products needed for the implementation of other WMO Programmes. He noted with satisfaction that the Commission was a pioneer in the process of restructuring of the WMO technical commissions, and its experience was used by other commissions in their restructuring process. The acting president recalled that the recent session of the Executive Council again underlined that WWW had the highest priority in the WMO activities and that was also related to CBS activities. The acting president expressed his strong belief that the high potential of CBS would permit it to continue to play the leading role in WMO activities.

1.9 There were 93 participants at the session which included representations of 47 Members of WMO and four international organizations. A complete list of participants is given in Appendix A to this report.

2. ORGANIZATION OF THE SESSION (agenda item 2)

2.1 CONSIDERATION OF THE REPORT ON CREDENTIALS (agenda item 2.1)

The Commission decided that in accordance with General Regulation 22, it was not necessary to establish a Credentials Committee. The Commission approved the report of the representative of the Secretary-General.

2.2 ADOPTION OF THE AGENDA (agenda item 2.2)

The provisional agenda was adopted by the session. The final agenda is reproduced in Appendix B to this report.

2.3 ESTABLISHMENT OF COMMITTEES (agenda item 2.3)

2.3.1 One working committee was established to examine the various agenda items in detail. Following proposals by the acting president, the following chairpersons were appointed for consideration of the individual items:

Mr R. Brook (Australia) for item 6.1;

Mr A. H. M. Al-Harthy (Oman) for items 6.2 and 10.1;

Dr J. Mukabana (Kenya) for items 6.3, 6.4, 9, 10.2.

2.3.2 Items 3, 4, 5, 7 and 8 were considered in a Committee of the Whole, chaired by Mr S. Mildner (Germany), and the remainder of the items were considered in Plenary, chaired by the acting president.

2.3.3 The session nominated Mr T. Quayle (New Zealand) as Rapporteur on previous resolutions and recommendations of the Commission and relevant resolutions of the Executive Council (agenda item 9).

2.3.4 In accordance with General Regulations 24 and 28, a Coordination Committee was established. It comprised the acting president of the Commission, the representative of the Secretary-General, the chairpersons of the working committee and a representative of the host country.

2.4 OTHER ORGANIZATIONAL QUESTIONS (agenda item 2.4)

It was agreed that summarized minutes of the plenary meetings would not need to be prepared. The session agreed upon the working hours for the duration of the session. A complete list of documents presented at the session is contained in Appendix B to this report.

3. REPORT BY THE ACTING PRESIDENT OF THE COMMISSION (agenda item 3)

3.1 The Commission noted with appreciation the report of the acting president, Mr Alexander Gusev (Russian Federation), which provided information on the activities of the Commission since its twelfth session in November/December 2000. Mr A. Gusev, the former vice-president of the Commission, became acting president of CBS as from 10 May 2002 when the former president, Mr Geoff Love, relinquished that office.

3.2 The Commission expressed its gratitude to Mr G. Love for his many years of work in the Commission and for his excellent leadership as vice-president and later as president of the Commission. It wished him all the best for his new career.

3.3 The Commission recalled with satisfaction that both the Expert Teams and the Implementation Coordination Teams, which together included more than 160 experts, had accomplished a great deal of work. There had been more than 60 meetings, workshops and seminars during the period on matters falling under the Commission's purview or otherwise related to WWW. Further details of the activities and accomplishments were provided in the reports of the chairpersons of the working groups and discussed under the relevant agenda items.

3.4 The Commission noted that during the intersessional period the president was actively involved in many activities dealing with matters of general importance to WMO, representing CBS and the WWW Programme in numerous meetings and providing input to the discussions in various forums dealing with issues like the exchange of meteorological data and products, high-level policy on satellites matters, the AMDAR programme and many other items.

3.5 The Commission expressed its appreciation for the extensive guidance provided by the three sessions of the CBS Management Group, which had kept under review the follow-up to the decisions of CBS, and for the various actions taken by the president especially as regarded the participation of the Commission in the work of other constituent bodies and for representing the Commission at two sessions of the Executive Council.

3.6 The Commission recognized the substantial progress made in challenging the major issues and questions to which the Commission was confronted. When considering its work programme, the Commission agreed to emphasize the following issues and questions:

(*a*) Redesign of the GOS;

(*b*) Refinement of the concept of the FWIS and its impact on the evolution of the WWW Programme;

(*c*) Implementation of the migration to binary codes, in particular the development of pilot projects;

(*d*) Development of severe weather forecasting and issue of severe weather warning;

(*e*) Support to natural disaster reduction activities;

(*f*) Development of quality management processes within the existing framework of the WWW procedures.

3.7 The acting president expressed his sincere appreciation to all CBS members who had participated in the activities of the Commission for their enthusiastic cooperation. In particular, he thanked the chairpersons of the OPAGs and the Expert Teams as well as the Rapporteurs for their outstanding work. On behalf of CBS, the acting president also thanked the Secretary-General of WMO and the staff of the Secretariat, in particular the WWW Basic Systems and Applications Departments, for their support and cooperation.

INNOVATIVE COLLABORATION

3.8 The Commission considered the report of the Rapporteur on Innovative Collaboration, Ms R. Patton

(United Kingdom), and thanked the Rapporteur for her very comprehensive and valuable contribution. The Rapporteur's complete report was available at http://www.wmo.ch/web/www/reports/Innovative-collaboration.html. It noted that the report concluded that there were very many ways of collaborating and that different approaches had been tried, with varying degrees of success. The report further noted that there was no right or wrong way to collaborate internationally. Each venture had its own unique set of variables that would determine how its membership should best organize itself in order to meet its objectives.

3.9 The Commission agreed that collaborative ventures did not need to be overly formal to meet their objectives. It encouraged members to consider all available options for working with one another for mutual benefit and to strive to keep arrangements as simple as practicable. It noted that lateral thinking as well as flexibility and a continued focus on the benefits to be gained were the most probable contributors to a successful international collaboration.

3.10 The Commission noted that an informal network for discussions about non-technical aspects of international collaborations would be a useful way of learning from the experience of others. An Internet newsgroup or a similar other e-mail exchange mechanism, where collaborators could informally exchange ideas and ask for input from others, would be an effective way of implementing such a network.

3.11 The Commission noted the comprehensive findings that had been compiled and analysed in the report, and the wide range of ventures' objectives. It agreed to refer the report to the OPAGs with a view to identifying the subjects that were relevant to their respective programme areas and to taking benefit of the relevant findings. The Commission invited the Secretariat to develop a project for an Internet newsgroup, which might be hosted on the WMO Web server, and to submit it to the Management Group for consideration and possible follow-up action.

4. REVIEW OF DECISIONS OF THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION (agenda item 4)

4.1 The outcome of the discussions held at the fifty-third and fifty-fourth sessions of the Executive Council relevant to CBS were reviewed, with particular emphasis being placed on those decisions that would have an impact on the future work programme of the Commission. The Commission was pleased to note that the Executive Council had devoted a fair amount of time to the WWW and the other Programmes under CBS's responsibility and reconfirmed, in particular at its fifty-fourth session when preparing the fourteenth financial period (2004–2007), the crucial importance of WWW in support of the operations of the NMHSs and of many other programme activities.

4.2 The Commission noted that the Executive Council had confirmed its supportive comments on the new CBS structure, including the new CBS Management Group, and encouraged the other technical commissions to consider using it as a model. The Executive Council was also pleased that CBS placed much emphasis on regional involvement and capacity building, and took steps to encourage participation and contributions of other technical commissions and relevant international organizations. It also supported the practice of holding technical conferences in conjunction with sessions of CBS that had, inter alia, helped more developing countries to participate in CBS sessions.

4.3 At its fifty-third session, the Executive Council requested CBS to carry out a study of the concept of quality management and of ISO 9000. The Commission was informed of the follow-up action taken and its outcome that had been reviewed by the CBS Management Group, and were submitted to the Executive Council Advisory Group on the Role and Operation of NMHSs with a view to their consideration by the Executive Council, at its fifty-fourth session.

4.4 The Executive Council, at its fifty-third session, noted with interest that CBS was developing a concept of an FWIS, and agreed that it was essential that WMO develop an information system that could serve cost-effectively all WMO Programmes. The Executive Council asked CBS, in cooperation with the other technical commissions, to develop further the concept, taking into account the need for helping to narrow, rather than widen, the technological gap between developed and developing countries, the need for system support and training and for a secure, stable and reliable system. It also noted that the advantages presented by the current WMO information system that was organized, operated and controlled by NMHSs, needed to be considered in a future information system.

4.5 At its fifty-fourth session, the Executive Council was pleased that further progress had been made in the development of the concept of an FWIS. It considered that a window of opportunity existed now to arrive at an agreed standard for FWIS and that any delay in necessary coordination could result in multiple incompatible systems. The Executive Council, recognizing that the proposed system would likely require changes in operational and institutional arrangements, agreed that there were several technical and policy-level issues that needed further consideration. The Commission noted that it was requested to refine further the concept, to develop more detailed technical information on specific requirements for FWIS and to look at how the proposed system would function and address those requirements. CBS should also specify how the existing WWW system and centres would evolve into the new structure while, at the same time, ensuring a smooth transition with no interruption in essential services. The Commission addressed the request of the Executive Council under agenda item 6.2 and invited the Secretary-General to submit the outcome of its work to the Executive Council Advisory Group on the Role and Operation of NMHSs.

4.6 The Commission noted that the Executive Council had also raised policy issues, namely:

(*a*) The possible impact of the introduction of FWIS on Members' responsibilities and resources;

(*b*) The extent to which the functions and responsibilities of existing infrastructure and centres should be used or revised.

The Council had requested that a study be undertaken to explore those and other policy-level implications of the FWIS, based on the outcome of CBS at its present extraordinary session. It requested the Executive Council Advisory Group on the Role and Operation of NMHSs to consider the results of the study, to analyse the relevant policy issues and to report its findings to Fourteenth Congress.

4.7 The Commission noted the Council's decisions related to the Sixth WMO Long-term Plan which were addressed under agenda item 7.2.

4.8 The Commission also noted that, with respect to lead responsibilities assigned to technical commissions, the Council had recognized the need for them to have greater involvement relating to resources associated with their programmes of responsibility. That would facilitate their making recommendations on necessary programme and/or resource allocation adjustments. The commissions should be able to report to the Executive Council on the achievement of objectives of the programmes under their responsibilities, including reporting on measures for assessing implementation. The Council further agreed that it should make better use of the technical commissions by delegating to them certain tasks for the implementation and monitoring of the WMO scientific and technical programmes.

4.9 The Commission further noted that the Council had urged the enhanced use of modern information technology for the dissemination of WMO publications and other material, and had requested the Secretary-General to explore the possibility of adopting the procedure where electronic versions of WMO material would be provided in the first instance (by default) while printed versions should be considered as optional, and would be provided upon request, bearing in mind the particular situation of developing countries. The Commission was pleased to recognize that as regarded the WWW and PWS Programmes, the use of electronic publication and dissemination of documents, reports and regulatory materials was already a well established practice.

4.10 The remaining decisions of the Executive Council related to the Commission were addressed under the relevant agenda items.

TOTAL QUALITY MANAGEMENT

4.11 The Commission noted with appreciation that the CBS Management Group, at its second session (December 2001), reviewed both the preliminary report of the CBS Rapporteur on Total Quality Management, Mr P. Van Grunderbeeck (France), as well as an additional report from Ms C. Richter (Germany) on the applicability of total quality management to NMSs in developing countries.

4.12 The Commission further noted that the CBS Management Group considered all the options presented by the rapporteurs that appeared to be relevant to the WWW in connection with ISO 9000 and determined that the development of quality management processes within the existing framework of the WWW procedures and practices would be the most appropriate. The report of the CBS Rapporteur on Total Quality Management as it applied to the WWW was submitted to the Executive Council Advisory Group on the Role and Operation of NMHSs. The Commission felt that the above reports constituted a valuable input to understand better the goals and impacts of setting up a quality management system in NMHSs and requested the Secretary-General to make those reports available to Members.

4.13 The fifty-fourth session of the Executive Council took into account the views of the technical commissions and agreed that WMO should work towards its own quality management framework by making use of the already developed comprehensive system of documented WMO procedures and practices in the *Technical Regulations* (WMO-No. 49), *Manuals*, *Guides*, Guidelines and Technical Publications. It also requested the Secretary-General to make information material on ISO 9000 and related quality management systems available to Members.

4.14 The Commission noted that the fifty-fourth session of the Executive Council had recognized that WMO standards, elements of quality control, performance monitoring and training standards of professionals, among others, were found in a number of those publications, but that additional work needed to be done to update and/or revise those materials. In the development of the WMO quality management framework, the technical review needed to be performed for the assessment of available documentation with respect to conformity with quality management procedures. The Council requested the technical commissions, through their presidents, to develop additional documentation which should describe the quality management procedures and practices to be followed and the resources required for implementation. The additional documentation would be adopted by WMO Members through established WMO mechanisms.

4.15 The Council agreed that in the preparation of the WMO quality management framework, a certification (registration) process should be developed and that the following elements needed to be studied further:

(*a*) Monitoring of the performance of elements of the system;

(*b*) Assessment of conformity to the WMO established procedures and recommended practices;

(*c*) The need for an independent "certification" or "registration" body or mechanism.

The Council emphasized the importance of an independent auditing component.

4.16 The Commission appreciated the information provided by the president of the Commission (Mr Neil

Gordon (New Zealand)), on recent developments relating to quality management for aviation meteorological services. It noted that the conjoint WMO CAeM/ICAO Meteorology Divisional Meeting, held in Montreal in September 2002, had retained as recommended practices the provisions related to quality management in ICAO Annex 3/WMO Technical Regulation [C.3.1], and had recommended the joint development of guidance material by ICAO and WMO, to assist Members in the development of quality management systems for the provision of meteorological services for international air navigation. It further noted that the part of the Aeronautical Meteorology programme in the draft 6LTP included a specific component relating to quality management systems, with intended key benefits of helping aviation meteorological service providers and their staff to raise the quality of their service to aviation users and to improve efficiency.

4.17 The Commission acknowledged the request from the Council to develop, through its OPAGs responsible for IOS, ISS, DPFS and PWS, additional documentation that described the quality management procedures and practices to be followed, and the resources to be allocated in the provision of WWW functionality, which would enable the overall quality, in particular, of the WWW outputs to be monitored and continuously improved. That documentation, to be adopted by WMO Members, would be a part of the implementation of all activities that contributed to the delivery of the WWW and the PWS.

4.18 The Commission also acknowledged that the Council noted the views expressed by the president of CBS that development of additional documentation to incorporate specific quality management procedures into the Technical Regulations, at a level of detail similar to the ISO 9000 procedures, would amount to a challenging task because the operational *Manuals*, such as those *on the GOS* (WMO-No. 544), *on the GTS* (WMO-No. 386) and *on the GDPS* (WMO-No. 485), had evolved over decades and would need fundamental revision and restructuring. Other more recently produced guidance material, such as the *Guide to Public Weather Services* (WMO-No. 834) and the *Guide on World Weather Watch Data Management* (WMO-No. 788), contained elements of quality management which would need to be adjusted or expanded for that purpose. If CBS was requested to carry out that work, it would need additional resources for that purpose.

4.19 Through that process, WWW could advance further the implementation of quality management systems at the national level without committing Members to the costs of implementation of more general systems developed for application outside meteorology. The integration of quality management procedures and processes within the WWW *Manuals* and *Guides* would also benefit those Members that chose to implement ISO 9000, possibly serving as component of the latter. While WMO guidance was provided, it was clear that Members would need to consider their options on the basis of their particular situations.

4.20 The Council had recognized that quality standards were set for the assessment, as well as for enhancement, of products and services delivered. In that connection, it was important to recall that the users' perspective should be taken into account and that the assessment and/or enhancement of products and services should be considered also from the point of view of the level of usefulness of those products and services.

4.21 The Commission noted that the Council had emphasized that there were also relevant contributions from the other WMO Programmes. The Council had agreed with the recommendation of the 2002 Meeting of Presidents of Technical Commissions for the establishment of an intercommission task group on quality to develop an overall approach for the WMO quality management framework referred to earlier.

4.22 The Commission agreed that the nature of the task to implement the Council's directives on that issue was to design a modification to existing relevant regulatory material that would assist NMSs to meet increasing user expectations for more effective service delivery. That would require a balanced and careful approach that would assist NMSs, especially in developing countries, to strengthen their quality management systems for end-to-end service delivery without incurring the overhead burden possibly associated with the ISO quality management standard. It was also essential that that be available to all NMSs and that it be complemented by appropriate training of relevant NMS staff and support in the implementation of those improved systems.

4.23 Noting the guidelines provided by the Council, the Commission also recognized that there was still a diversity of opinions regarding ways and means of introducing a quality management system. Some Members expressed concern at the high cost involved, especially in developing countries. Some Members felt that it would be best to implement ISO 9000 procedures directly, while others were of the opinion that WMO should concentrate on updating and improving the existing WMO quality management standards in the context of the WMO management framework (see general summary paragraph 4.15).

4.24 Regarding the possibility of developing a WMO specific quality management framework, the view was expressed by some delegations that there was a real risk that such an approach might be too inward looking and might in the end be even more expensive overall than ISO 9000.

4.25 The Commission agreed that it may be appropriate for WMO to develop a quality management framework that could be used by NMHSs as a model for establishing quality management systems. The implementation of such a framework in NMHSs would be an opportunity for innovative collaboration.

5. STATUS OF WORLD WEATHER WATCH IMPLEMENTATION AND OPERATION (agenda item 5)

5.1 The Commission was informed of the results of the monitoring of the operation of the WWW. The

Commission noted with appreciation that the detailed monitoring results were posted on the WMO server at http://www.wmo.ch/web/www/ois/monitor/monitor-home.htm. The monitoring activities included two types of monitoring exercises: the AGM and SMM. About 100 WWW centres provided monitoring results for the AGM exercises, which were carried out from 1–15 October each year. Eight MTN centres from Regions I, II, V and VI participated in the SMM exercises, which were carried out from 1–15 February, April, July and October.

5.2 The percentage of SYNOP reports available at MTN centres in comparison with the number of reports required from RBSN stations remained at the same level (about 75 per cent) during the period 2000–2002. There were still deficiencies in the availability of SYNOP reports from areas in Regions I (51 per cent in July 2002), III (62 per cent) and V (68 per cent).

5.3 The percentage of TEMP reports available at MTN centres decreased from 65 per cent to 57 per cent during the period 1992–1999 but increased from 57 per cent to 63 per cent since 1999. That evolution was mainly due to changes in the operation of the upper-air observation network in the northern part of Region II. The availability of TEMP reports was relatively satisfactory for the eastern and southern parts of Region II, the northern part of Region IV, some countries in Region V and the western part of Region VI. The availability of TEMP reports was generally insufficient for most of the other parts of the world.

5.4 The Commission noted that the deficiencies in the availability of SYNOP and TEMP reports were mostly attributed to serious economic difficulties, including a prohibitive cost of consumables (in particular radiosondes), infrastructure shortcomings and lack of personnel. The relevant issues were considered under the relevant parts of agenda item 6. Taking into account that all the monitoring results were calculated with reference to the number of reports required from RBSN stations, the Commission noted that several regional associations were in the process of reviewing the RBSNs and relevant stations observing programmes to reflect better actual Members' commitment taking into account priorities in light of available resources. The Commissioin requested its OPAGs on IOS and on ISS, in coordination with the Secretariat, to take into account those developments and to adapt the calculation of monitoring results to the new definitions of RBSNs, in a coordinated global approach.

5.5 There was no major evolution in the availability of SHIP and TEMP SHIP reports during the period 1996-2002. The numbers of AMDAR and BUOY reports had doubled since 1996. The availability of AIREP reports, which had been constant during the period 1996–2000, decreased in 2001 and 2002. Except for BUOY reports, a large part of the reports from mobile stations were issued from the northern hemisphere. In the case of AMDAR reports, 60 per cent of the reports were from Europe.

6. WORLD WEATHER WATCH PROGRAMME, SUPPORT FUNCTIONS AND PUBLIC WEATHER SERVICES, INCLUDING THE REPORTS BY THE CHAIRPERSONS OF THE OPEN PROGRAMME AREA GROUPS (agenda item 6)

TECHNICAL COOPERATION AND SYSTEM SUPPORT ACTIVITIES

6.0.1 The Commission reviewed the technical cooperation and system support activities related to the WWW Basic Systems and Public Weather Services and agreed on guidelines for the allocation of priorities for technical cooperation support as given below.

INTEGRATED OBSERVING SYSTEMS

6.0.2 In 2001–2002, 40 countries received support for a total of 50 projects concerning observing systems. Thirty projects aimed at strengthening surface observing stations, 19 at strengthening upper-air observing stations and one project at establishing a radar network. There remained 115 VCP projects for observing systems, which had not yet been fully supported.

6.0.3 Following the decisions of Thirteenth Congress, technical cooperation projects related to the implementation of basic components of the WWW should be carried out as priority activities. The Commission noted RA VI recommended that the highest priority should be given to the realization of projects which would have the greatest impact on the WWW implementation on the regional and global scales. To follow up those decisions related to the GOS and also in accordance with the Strategic Plans adopted in RAs I and II, the Commission agreed on the following guidelines for the allocation of the priorities for technical cooperation activities for the IOS:

(*a*) The highest priority should be given to the projects aimed at improving, restoring, replacing and building the upper-air observational capacities of the RBSNs. The activities should focus on the activation of silent upper-air observing stations comprised in the RBSNs;

(*b*) A high priority should be given to the activities related to the improvement of data quality and coverage of surface observations of the RBSNs. The activities should focus on activation of silent surface observing stations comprised in the RBSNs;

(*c*) A high priority should be given to projects related to the deployment and/or use of new and cost-effective observing systems like surface-based AWSs, AMDAR, ASAP and drifting buoys;

(*d*) A high priority should be given to the projects related to the improvement of the data quality and coverage provided by newly established RBCNs.

INFORMATION SYSTEMS AND SERVICES

6.0.4 Fifty countries received support for 61 projects concerning information systems and services in 2001–2002. Twelve projects aimed at strengthening the MSS at GTS centres, 34 at providing satellite receiving systems, 10 at connecting WWW centres to the Internet and five at strengthening the national meteorological telecommunication networks. Forty-four VCP projects had not yet been fully supported.

6.0.5 As regarded technical cooperation activities for the ISS, the Commission agreed on the following guidelines for the allocation of the priorities:

(*a*) The highest priority should be given to the implementation of the connection of each NMC to the GTS for the exchange of observational data and processed information (at a minimum speed of 16 Kbits s^{-1} using TCP/IP procedures);

(*b*) The highest priority for the exchange of data between RTHs at a minimum speed of 64 Kbits s^{-1} using TCP/IP procedures;

(*c*) The highest priority for the implementation of the project for an improved MTN;

(*d*) The highest priority for the collection of data from RBSN stations at NMCs or centres with similar functions;

(*e*) A high priority for a backup connection of each WWW centre to the GTS, such as the reception of satellite distribution systems;

(*f*) A high priority for the implementation of virtual private network connections via the Internet as a backup for the exchange of data, in particular for RTHs.

6.0.6 The WMO goals for Members equipped with meteorological satellite receiving equipment were 100 per cent for polar-orbiting satellite data receivers (either APT or HRPT) and 100 per cent for geostationary satellite data receivers (either WEFAX or HR). To date, the overall level of implementation was 87 per cent. With regard to each category, the WMO Regions had achieved an implementation of 90 per cent and 89 per cent for polar-orbiting and geostationary satellite receivers, respectively. The expected change from analogue to digital low resolution imagery coupled with improved capability to utilize satellite data by all WMO Members indicated that a strategy towards implementation of low and high resolution digital receivers should be pursued by WMO Members as well as through assistance programmes. The commencement of the new digital broadcast services was expected in 2003 with the first LRIT service. The Commission agreed on the following guidelines for the allocation of priorities:

(*a*) The highest priority for satellite receivers for those Members without any receiver;

(*b*) A high priority for satellite receivers for those Members without a polar-orbiting receiver or a geostationary receiver;

(*c*) A medium priority for satellite high resolution receivers for those Members with only low resolution polar-orbiting receiver or only low resolution geostationary receivers;

(*d*) A low priority for satellite receivers for those Members already exceeding the WWW goal.

DATA-PROCESSING AND FORECASTING SYSTEMS

6.0.7 Thirteen countries received support for projects concerning data-processing and forecasting systems in 2001–2002. SADC and IGAD countries in Africa also received support for computing systems, including training. Twenty-three VCP projects had not yet been fully supported.

6.0.8 With regard to technical cooperation activities for DPFS, the session agreed on the following guidelines for the allocation of priorities:

(*a*) The highest priority for cooperation activities in establishing access, processing and forecasting functions of NMHSs for NWP and transport modelling, application of seasonal to interannual prediction and linkages with disaster management agencies to assure effective community response to severe weather forecasts and warnings;

(*b*) The highest priority for activities contributing to the improvement of the dissemination and application of weather and climate products;

(*c*) The highest priority for activities on capacity building facilities and use of Internet and implementation of related facilities in developing countries for improving the access to forecast products and for exchanging meteorological and environmental information;

(*d*) The highest priority should be given to workshops on EPS, including the interpretation of probabilistic products and case studies that were relevant to the trainees and a high priority to cooperation for training in EPS for those who intended to make their own products and/or who would need more specific training about products or the methodology of the forecast;

(*e*) The highest priority in training on data processing, modelling, and applications support and development;

(*f*) A high priority in training activities on computer operation and maintenance;

(*g*) A high priority in setting up remote support, maintenance and distance training.

PUBLIC WEATHER SERVICES

6.0.9 Seventeen countries received support for the provision/upgrading of media weather presentation systems in 2001–2002. There were 12 unsupported projects related to public weather services.

6.0.10 WMO Members, especially those in small and developing countries, needed assistance for the acquisition, replacement and upgrading of computing and communications systems in order to satisfy the increased demand for high quality public weather services as well as to keep up with the rapid advances in technology. As regarded technical cooperation activities for PWS, the Commission agreed on the following guidelines for the allocation of priorities:

(*a*) The highest priority for television/media presentation systems comprising high performance computing and communications hardware, peripherals and software, video equipment for television production, as well as the related training of staff;

(*b*) The highest priority for computer-based meteorological workstations that enabled, through forecaster interaction, the creation of new or enhanced products for users, based on satellite imagery and processed products (inputs);

(*c*) The highest priority for enhanced Internet access for NMHSs as a communications tool to improve their data access, as well as expand the dissemination methods of their public weather services, and promote the use of official consistent information;

(*d*) The highest priority for training related to national PWS plans, including training in media skills (writing and presentation), product design, and public education and awareness;

(*e*) A high priority for fixed and mobile communications systems for the dissemination of public weather services, preferably modern telephone and communication services (e.g., mobile telephones, pagers/short message system and fax-on-demand);

(*f*) A medium priority for VHF radios to provide radio broadcast and warning alert systems.

6.1 **INTEGRATED OBSERVING SYSTEMS** (agenda item 6.1)

6.1.1 The Commission noted with appreciation the comprehensive report of Mr J. Purdom (United States), chairperson of the OPAG on IOS, which covered essential areas on the GOS including observational data requirements and redesign of the GOS, satellite system utilization and products, requirements and representation of data from AWSs and GOS regulatory material.

STATUS OF IMPLEMENTATION AND OPERATION OF THE SURFACE-BASED GOS

6.1.2 The Commission took note that in the past two years, the overall implementation of surface and upper-air stations in the RBSNs had shown stability but the most recent monitoring still showed weakness over certain areas in Regions I, II, III and V.

6.1.3 It noted that the availability of SYNOP reports at MTN centres during 2001–2002 remained unchanged globally, constituting 75 per cent of the reports expected from stations included in the RBSNs. According to the results of the monitoring operation of the WWW (SMM exercise, July 2002), the percentage of SYNOP reports received daily at MTN centres of the GTS continued to show insufficient data availability in RA I (51 per cent), in RA III (62 per cent) and in RA V (68 per cent). The data availability for the same period of monitoring was 90 per cent for RA VI, 84 per cent for RA IV and 81 per cent for RA II. The deficiencies in the surface data coverage were caused to a large degree by inadequate funds to rehabilitate and operate both observational and telecommunication equipment.

6.1.4 The Commission was informed that the availability of upper-air reports at MTN centres remained unchanged as compared with 2000, giving a global average of 63 per cent of the reports expected from RBSN stations. It further noted with satisfaction that since 1999 the percentage of TEMP reports available at MTN centres had increased from 57 to 63 per cent. That positive trend was due primarily to the successful replacement of obsolete OMEGA-based observing technology in certain regions and the continued efforts to reactivate RBSN performance in the northern part of Region II. However, the percentage of expected reports in the 2002 monitoring results still showed a noticeable difference in data coverage in various regions. The range was from 27 per cent in Region I to 36 per cent in Region III, 63 per cent in Region II and Region V, 75 per cent in Region VI and 84 per cent in Region IV. The greatest cause of missing reports continued to be the lack of trained staff and or consumables in countries where financial difficulties existed, notably in Regions I and III, but also in some parts of the other four regions. The Commission agreed that some proposals, as contained in the reports from the various Expert Teams and Working Groups, could potentially contribute markedly to alleviating deficiencies in the surface and upper-air data coverage provided by the RBSN. The Commission was also pleased to note the development of the Strategic Plan for Implementation and Improvements of the WWW Basic Systems in Region I. Special fact finding missions had been accomplished to analyse the problems in the implementation of GOS in Region I and achievable solutions, which could be translated into fundable projects, had been proposed. The Strategic Plan covered the Eastern Africa and Southern Africa subregions, the English-speaking North Africa subregion, the West Africa and Central Africa subregions and the French-speaking North Africa subregion.

OTHER NETWORKS, INCLUDING SEA STATIONS

6.1.5 The Commission noted the statistics prepared by JCOMM reflecting the status of the various observational networks supporting the international marine programme. In particular, it noted with satisfaction that marine networks had recovered from the loss of reporting stations and were at the level achieved in 1996. The greatest achievement had been the significant increase in the number and quality of reports transmitted over the GTS. Those positive results were attributable to the excellent interaction between CBS and JCOMM. The Commission also noted that there was more work to be done in developing greater interaction between some regional Co-rapporteurs on Marine Meteorological Services and on the GOS. That point was clearly stated in the reports of the regional associations. The Commission was informed concerning the status of marine programmes, as followed:

(*a*) The VOS programme: Volunteer ship data, despite a decline in the total number of reporting ships to around 6 000 reports per day, as well as the quality and total number of reports had stabilized at around 160 000 per month. A VOS Climate Project was being implemented to provide a subset of high quality VOS data for various applications, including global climate studies and the calibration of satellite observations. Developments in the services provided by Inmarsat, including new systems with greatly enhanced bandwidth, would benefit ship operators;

(*b*) Data buoy programme: The number of drifter buoys was currently around 900, of which slightly over half provided pressure observations. The number of monthly pressure reports received over the GTS had increased from 40 000 to 200 000 and continued to increase, as did the quality of the reports, thus providing a significant impact over data-sparse areas;

(*c*) The SOO programme: The SOO programme network in 2001 was providing 24 000 reports a year over the GTS;

(*d*) Argo programme: The Argo network had 535 floats deployed and operational in August 2002, with a planned network of 3 000 floats by the end of 2005;

(*e*) ASAP: After several years of decline, the ASAP network had increased to a level just under 6 000 and that increase was projected to continue as a result of the introduction of new lines. Three new ASAP lines were initiated in 2001/2002, two under the European ASAP project of EUMETNET, the other under the worldwide recurring ASAP project of the ASAP Panel. All were essentially operational;

(*f*) Data distribution: GTS distribution of drifting and moored buoy data through Argo in the BUFR code would commence in 2003. Work was also under way to initiate GTS distribution of Argo float data in BUFR. Due to the need for new hardware, the migration to BUFR would take some time and the need to transmit in traditional character codes would need to continue for some time;

(*g*) Instrument evaluation, calibration and system performance: The evaluation and calibration of operational marine instrumentation was undertaken within the context of specific platform-based groups. The JCOMM-I Ship Observations Team was investigating various possibilities, including a formal JCOMM instrument programme, was providing expertise to CIMO to allow the Commission to undertake evaluation and calibration of marine instruments; or was continuing those activities within specialist groups. In the short term, the third option was most likely. Most marine observing system components presently had performance metrics, which allowed for the assessment of sensor performance to facilitate remedial actions and future enhancements. The Observations Coordination Group within JCOMM was developing a coherent approach to assessing and reporting the overall performance of the integrated observing system against multiple user requirements.

6.1.6 The Commission reaffirmed the importance of the AMDAR programme and its contribution in establishing an effective upper-air observing system. The Commission noted that the fifty-fourth session of the Executive Council was aware that all the achievements of the AMDAR Panel were due to the financial contributions provided by a few Members. Furthermore, it recognized that continued development of a coordinated global programme was dependent on those voluntary contributions.

6.1.7 The Commission noted that the positive impact of AMDAR data on the ongoing improvement to the GOS had been well established through a number of important OSEs. It was noted that the number of observations exchanged daily on the GTS had increased from 78 000 in 2000 to about 140 000 in 2002 and that that was expected to increase to 200 000 over the next few years. Although a large proportion of those AMDAR data were obtained over Europe and North America, and to a lesser extent over Australasia, Asia, and Southern Africa, the Commission was pleased to note that work was proceeding to develop new operational programmes or programmes of targeted observations in data-sparse regions. Of interest were a series of newly planned or developing programmes such as the targeted programme in Region I, in collaboration with ASECNA, and the extension of the Southern Africa operational programme. In Region II, the Saudi Arabian programme was nearing operational status and the developments by three additional countries in the Middle East and four countries in eastern Asia were anticipated. Plans to develop or complete programme development by several countries in the eastern part of Region VI, including the Russian Federation and three countries in Region III, were also noted as was the interest in Region V to extend AMDAR into the South-West Pacific island countries of Region V. It was also noted that collaboration was continuing with ICAO in regard to aircraft dependent surveillance system meteorological reports over the North Atlantic and Pacific regions since observations were being passed to the WAFCs in London and Washington.

6.1.8 The Commission was informed of the commencement of a trend to use smaller regional aircraft operating from more remote airports not serviced by existing AMDAR equipped aircraft. That trend would result in more data in the low to mid-troposphere in data-sparse areas. The work of the AMDAR Panel was recognized by its accomplishment of several important steps in providing the *AMDAR Reference Manual* and in establishing improvements in the exchange of data on the GTS through the development of additional code forms and new smaller regional AMDAR bulletins. The Commission was also informed of continuing work on the development of a reliable humidity sensor with new operational trials to commence during 2004.

Status of implementation and operation of the space-based GOS

6.1.9 The Commission noted with appreciation the following:

(*a*) Research satellite operators providing data for operational utilization:

- (i) NASA providing MODIS Direct Readout from Terra and Aqua, Quikscat winds data, and AIRS data for NWP centres from Aqua;
- (ii) Altimetry data being provided by ESA;
- (iii) Plans existed for NASA, ESA, NASDA and Roshydromet to provide data for Members;

(*b*) Operational satellite data available to Members from four polar satellites and six geostationary satellites;

(*c*) Satellite operators had agreed to global contingency plans for both polar and geostationary constellations;

(*d*) In coordination with the Expert Team on Satellite System Utilization and Products, the Virtual Laboratory for Education and Training in Satellite Meteorology and the IPWG had been formed and were active.

6.1.10 The Commission appreciated the contribution made by satellite operators during the past two years, by providing valuable data, products and services from the space-based component of the GOS. Continuation of a EUMETSAT satellite over the data-sparse Indian Ocean had provided increased coverage and reliability as had the recent launch and commissioning of China's polar orbiting satellite, FY-1D, the United State's NOAA-16 and NOAA-17, and the Russian Federation's METEOR-3M-N1 in a Sun-synchronous orbit.

6.1.11 The Commission noted that the present geostationary satellite constellation consisted of Meteosat-7 at 0° longitude and Meteosat-5 at 63°E (operated by EUMETSAT), GOMS-1 at 76°E (operated by the Russian Federation), FY-2B at 105°E (operated by China), GMS-5 at 140°E (operated by Japan), and GOES-10 at 135°W and GOES-8 at 75°W (operated by the United States). The polar-orbiting constellation consisted of METEOR-2 and -3 series satellites operated by the Russian Federation, NOAA-16 and -17 operated by NOAA/NESDIS and FY-1C & D operated by China. The Commissioin was also informed by the Republic of Korea of its plans for multi-purpose geostationary and polar-orbiting satellites as a potential contribution to the space-based component of the GOS. The Commission suggested that the Republic of Korea should approach CGMS for appropriate consultations.

GROUND SEGMENT OF THE SPACE-BASED COMPONENT OF THE GOS

6.1.12 Improvements were noted throughout the ground segment. However, the changes in the space-based component of the GOS — starting in the first decade of the new millennium — as a result of digital information services and improved capability to utilize satellite data, suggested a strategy towards implementation of high-resolution receivers by WMO Members as well as through assistance programmes.

GLOBAL CONTINGENCY PLANNING

6.1.13 The Commission was informed that in geostationary contingency planning, the satellite operators had agreed to follow the principles of "help your neighbour." Furthermore, nominal configurations for most satellite operators included either an "in-orbit spare" or an "on-demand launch." For the polar system, contingency planning called for a constellation of four polar-orbiting satellites optimally distributed in time with two in AM orbits, each capable of serving as backup to the other, and two in PM orbits also capable of serving as backup to the other.

OBSERVATIONAL DATA REQUIREMENTS AND REDESIGN OF THE GLOBAL OBSERVING SYSTEM

6.1.14 The Commission was pleased to note the work carried out by the relevant Expert Team on Observational Data Requirements and Redesign of the GOS:

(*a*) User requirements and observing system capabilities were charted in 10 application areas, the rolling requirements review was pursued and statements of guidance were issued in all 10 areas (available in several WMO technical documents and summarized in the final report of the meeting of the Expert Team, held in July 2002);

(*b*) Several OSEs were pursued to test possible reconfigurations of the GOS;

(*c*) Candidate observing systems (space-based and ground-based) for the coming decade were studied and a WMO Technical Document was published;

(*d*) Recommendations for evolution of space- and surface-based components of GOS were developed which summarized the most pressing observational needs and recommendations for the most cost-effective actions for meeting them in the near term and the next 10–15 years;

(*e*) A vision for the GOS in 2015 and beyond was drafted.

6.1.15 The Commission noted in particular the following significant findings of that Expert Team:

(*a*) The rolling requirements review was readily applied to a diversity of application areas, provided the database of user requirements and observing system capabilities was accurate;

(*b*) Working with the Rapporteurs of Scientific Evaluation of OSEs (Regional and Global), it was found that hypothetical changes to the GOS could be explored in OSEs with NWP centre assistance, provided data assimilation procedures were well understood and impact studies were conducted in a statistically significant way. Furthermore it was made apparent that the OSSEs required huge human and computer resources and were beyond the available resources;

(*c*) The future GOS should build upon existing components, both surface and space based, and capitalize on existing and new observing technologies not presently incorporated or fully exploited; each incremental addition to the GOS would be reflected in better data, products and services from the NMHSs;

(*d*) The impact of the changes to the GOS in the next decades was anticipated to be so massive that new revolutionary approaches for science, data handling, product development, training, and utilization would be required. There was an urgent need to study comprehensive strategies for anticipating and evaluating changes to the GOS.

6.1.16 The evolution of the GOS had been framed in 42 recommendations found in the final report of CBS/IOS/ICT-2 (14–18 October 2002). Those recommendations reflected:

(*a*) Statements of guidance in 11 application areas (available in *Preliminary Statement of Guidance Regarding How Well Satellite Capabilities Meet WMO User Requirements in Several Application Areas* (WMO/TD-No. 913, SAT-21) in the *Statement of Guidance Regarding How Well Satellite Capabilities Meet WMO User Requirements in Several Application Areas* (WMO/TD-No. 992, SAT-22) and in the *Statement of Guidance Regarding How Well Satellite and In Situ Sensor Capabilities Meet WMO User Requirements in Several Application Areas* (WMO/TD-No. 1052, SAT-26) and summarized in the meeting report of the Expert Team on Observational Data Requirements and Redesign of the GOS (1–5 July 2002);
(*b*) Results from regional programmes such as COSNA, EUCOS and NAOS;
(*c*) Conclusions from the Toulouse Workshop on Impact of Various Observing Systems on NWP (March 2000; see the *Proceedings of the Second CGC/WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction* (WMO/TD-No. 1034, World Weather Watch Technical Report No. 19);
(*d*) OSEs prompted by suggested changes to the GOS (see final report of the CBS/IOS/ICT-2, 14–18 October 2002).

6.1.17 The 22 recommendations for the surface-based component of the GOS included more complete and timely data distribution; enhanced AMDAR especially over data-sparse areas; optimized rawinsonde launches; targeted observations; inclusion of ground-based GPS, radars and wind profilers; increased oceanic coverage through expanded ASAP observations, drifting buoys and ARGOS; and possible use of unmanned aerial vehicles. The Commission also noted with appreciation the activities to optimize data coverage over Europe carried out by EUCOS/EUMETNET and recommended use of the experience gained in cooperation and joint funding in other Regions.

6.1.18 The 20 recommendations for the space-based component of the GOS (nine for operational geostationary and polar orbiting, 11 for R&D satellites) built upon the known plans of the operational and R&D satellite operators and called for rigorous calibration of remotely-sensed radiances as well as improved spatial, spectral, temporal and radiometric accuracies. The wind profiling and global precipitation measurement missions were singled out for their importance to the GOS.

6.1.19 The vision for the evolution of the GOS to 2015 and beyond included:

(*a*) For the space-based component:
  - (i) Six operational GEOs:
    - a. All with multispectral imager (IR/VIS);
    - b. Some with hyperspectral sounder (IR);
  - (ii) Four operational LEOs:
    - a. Optimally spaced in time;
    - b. All with multispectral imager (MW/IR/VIS/UV);
    - c. All with sounder (MW);
    - d. Three with hyperspectral sounder (IR);
    - e. All with RO;
    - f. Two with altimeter;
    - g. Three with conical scanning MW or scatterometer;
  - (iii) Several R&D satellites serving WMO Members and comprised of:
    - a. A constellation of small satellites for RO;
    - b. LEO with wind lidar;
    - c. LEO with active and passive microwave precipitation instruments;
    - d. LEO and GEO with advanced hyperspectral capabilities;
    - e. GEO lightning;
    - f. Possibly GEO microwave;
  - (iv) Improved inter-calibration and operational continuity;

(*b*) For the surface-based component:
  - (i) Automation to enable:
    - a. Targeted observations in data-sensitive areas;
    - b. Optimal operation of:
      - i. Rawinsondes;
      - ii. ASAP systems;
      - iii. Aircraft in flight;
  - (ii) Rawinsondes:
    - a. Optimized utilization;
    - b. Stable GUAN;
    - c. Supplemented by:
      - i. AMDAR ascent/descent;
      - ii. Ground-based GPS water vapour measurements;
      - iii. Wind profilers;
      - iv. Satellite soundings (MW, GPS-OS, advanced IR);
    - d. Rawinsondes automatically launched;
    - e. Computerized data processing;
    - f. Real-time data transmission;
    - g. High vertical resolution;
  - (iii) Commercial aircraft observations:
    - a. Of temperature and wind plus humidity on some aircraft;
    - b. In-flight and ascent/descent data;
    - c. High temporal resolution;
    - d. Availability from most airports including currently data void airports in Asia, Africa and South America;
    - e. Possibly supplemented with unmanned aerial vehicles;
  - (iv) Surface observations:
    - a. Automated systems;
    - b. Land sensors at high spatial resolution, supporting local applications such as road weather;
    - c. Ocean platforms (ship, buoys, profiling floats, moorings) in adequate number to complement satellite measurements;
  - (v) Radar observing systems, measuring:
    - a. Radial winds;
    - b. Hydrometeor distribution and size;

c. Precipitation phase and rate;
d. Multiple cloud layers, including cloud base and cloud top height;

(vi) Data collection and transmission:
a. Digital in a highly compressed form;
b. Entirely computerized data processing;
c. Role of humans in observing chain reduced to minimum;
d. Information technology in all areas of life to provide new opportunities for obtaining and communicating observations;
e. For satellite data in particular:
i. Use of ADM including regional/special DCPC in the context of FWIS;
ii. DB for special local applications in need on minimal time delay and as backup.

With regard to polar orbiting satellites, the Commission agreed that four operational LEOs were required and should be reflected in the update to the *Manual on the Global Observing System* (WMO-No. 544).

6.1.20 The Commission agreed to the following actions as part of its future work programme:

(*a*) Given the massive changes anticipated for the GOS, to develop as soon as possible an infrastructure and implementation plan including a detailed time schedule within WMO to assure full utilization of the evolving GOS;
(*b*) Given the urgent need to study comprehensive strategies for anticipating and evaluating changes to the GOS, to support a focused funded activity for the study of observing system design should be started;
(*c*) Given the importance of system and user characterization, to continue updating the database of user requirements and observing system capabilities and include user reviewed R&D expected performances;
(*d*) Given the success of the rolling requirements review to guide GOS evolution, to continue the rolling requirements review process in application areas already started and expand into new areas relevant to missing disciplines;
(*e*) Given the importance of NWP OSE implications for GOS evolution, to facilitate organization of the next Workshop on Impact of Various Observing Systems on NWP during the first quarter of 2004;
(*f*) Given the urgency of many recommendations for the GOS, to pursue early implementation (with particular attention to the developing countries).

6.1.21 With regard to the impact of the redesign of the GOS on developing countries, the Commission agreed that the major issues reported to CBS-XII were still valid. They included: (*a*) difficulties facing some RBSNs in receipt and/or production of data and products; (*b*) deficiencies in the current RBSNs due to a variety of infrastructure related issues; and (*c*) underutilization of satellite systems.

6.1.22 The Commission recognized that the redesign of the GOS envisioned over the next 15 years should have a positive impact on developing countries. For example, PUMA and its follow-up, and similar activities in other regions with respect to satellite data reception, analysis and communications could provide a major step forward in capability. PUMA was a European Union funded project to provide RA I Members with high resolution satellite ground receiving stations for the reception of MSG data including appropriate training for satellite data use and applications. The Commission expressed its gratitude for the European Union's support, which would enhance the capabilities in RA I. Training to ensure full utilization of those data including from R&D satellites was being addressed through the Virtual Laboratory for Education and Training in Satellite Meteorology. The proposed integration of ADM into the FWIS vision would allow for the rapid dissemination of satellite information together with other data sets to developing countries. That would provide information that could be used to improve forecasts for daily and seasonal to interannual time frames.

6.1.23 It was noted that a stable GUAN/GSN in the context of the redesign presented above would allow for optimization in rawinsonde utilization. Some developing countries were implementing radar systems to improve the measurement of precipitation and for improved warnings. AMDAR regional projects should provide badly needed data on winds and temperature profiles for use by NMHSs. Improvements in automatic weather stations, other remote data collection platforms, and marine observational programmes would allow for data in inaccessible regions to be available for a variety of applications.

6.1.24 The Commission stressed that the realization of the redesign would also require the implementation of strategic plans within the various WMO Regions. Those implementation plans should address the needs of developing countries and should include capacity building and support of basic infrastructure through upgrading, restoring and substitution of applicable WWW systems. It was noted that such implementation plans were currently under development in RAs I and II.

RAPPORTEURS ON SCIENTIFIC EVALUATION OF OSEs AND OSSEs

6.1.25 The Commission was pleased to note that the Rapporteurs on Scientific Evaluation of OSEs and OSSEs had worked closely with the Expert Team on Observational Data Requirements and Redesign of the GOS in carrying out their work plan. The Commission noted that the Rapporteurs monitored and summarized the results of OSEs being carried out in the major European NWP centres, the EUCOS Programmes, the High Resolution Limited Area Model Consortium, Australia, Canada, Japan, the Russian Federation, the United States and others. They included (with initial results):

(*a*) Impact of hourly versus six-hourly surface pressures. Using four-dimensional variational analysis assimilation, the ECMWF found positive impact especially over the North Atlantic and Southern Oceans;

(*b*) Impact of denial of radiosonde data globally above the tropopause. The Canadian Atmospheric Environment Service report was anticipated in late 2002;

(*c*) Information content of the Siberian radiosonde network and its changes during the last decades. Roshydromet's Main Geophysical Observatory in St Petersburg found that information content was ascending until 1985 and descending thereafter with downstream and upstream impacts. The NCEP related a decrease in performance of 500 hPa height analysis over North America to a decrease in Siberian radiosondes;

(*d*) Impact of AMDAR data over Africa through data denial in a four-dimensional variational analysis and forecasting system. ECMWF showed that denial over the northern hemisphere for observations below 350 hPa had large significant impact in summer and winter. Investigation of African AMDAR impact was pending at *Météo-France*;

(*e*) Impact of tropical radiosonde data. The UK Met Office varied the density of South-East Asia radiosondes used in assimilation and produced high impact on winds at all levels with occasional propagation of impact to mid-latitudes. Temperature and wind information were the most important potential measurements from AMDAR in less well observed tropical areas (e.g. Africa, Central America);

(*f*) Impact of three LEO AMSU-like sounders (NOAA-15, -16, and -17 plus the NASA R&D satellite, AQUA). ECMWF showed large positive impact from two AMSUs compared to one MSU and stressed the importance of the timely reception of the data streams. The ECMWF and the UK Met Office showed positive impact of three over two AMSU when NOAA-17 was added to the GOS;

(*g*) Impact of AIRS data. The ECMWF, the UK Met Office, NCEP, the Australian Bureau of Meteorology Research Centre, and the Japan Meteorological Agency would report on that in late 2002;

(*h*) Impact of better than three-hourly ascent/descent AMDAR data. Preliminary northern hemisphere AMDAR ascent/descent impact suggested positive effect for higher frequency data. EUCOS would arrange for higher frequency observations in 2003 to enable that study by the UK Met Office and ECMWF;

(*i*) Impact of polar winds from moderate resolution imaging spectroradiometer water vapour imagery. A 30-day impact study at ECMWF and NASA showed that forecasts of the geopotential height for the Arctic, northern hemisphere extratropics, and Antarctica were improved significantly.

6.1.26 The Commission reiterated the great value of experiments in the redesign process and encouraged leading NWP centres and relevant scientific groups to continue their efforts in that area.

SATELLITE SYSTEM UTILIZATION AND PRODUCTS

6.1.27 The Commission noted with appreciation the work carried out by the Expert Team on Satellite System Utilization and Products, namely:

(*a*) From the biennial questionnaire 2001, it made recommendations, derived strategic goals for 2002–2003 and enhanced the questionnaire with respect to the Virtual Laboratory for Education and Training in Satellite Meteorology;

(*b*) With the Ad Hoc Task Force on Integrated Strategy for Data Dissmenation for Meteorological Satellites, it reviewed the concept of direct broadcast with respect to future systems and sensors;

(*c*) It identified the need for alternative ADM for satellite data;

(*d*) The IPWG was formed;

(*e*) The Virtual Laboratory for Satellite Data Utilization was functioning;

(*f*) It published two WMO Satellite Activities Technical Documents: *Migration of Satellite Receiving Stations to the New Meteorological Satellite Digital Data Broadcast Services* (WMO/TD-No. 1057, SAT-27) and *Status of the Availability and Use of Satellite Data and Products by WMO Members* (WMO/TD-No. 1119, SAT-30);

(*g*) It reviewed and updated the *Guidelines for the Education and Training of Personnel in Meteorology and Operational Hydrology* (WMO-No. 258).

6.1.28 The Commission noted in particular the following accomplishments resulting from the work of the Expert Team:

(*a*) The Expert Team analysed the 2001 Biennial Questionnaire on the Availability and Use of Satellite Data and Products by WMO Members (*Status of the Availability and Use of Satellite Data and Products by WMO Members* (WMO/TD-No. 1119, SAT-30)) and also compared it to the analysis for 1999. It enhanced the utilization of the Questionnaire with respect to the Virtual Laboratory for Education and Training in Satellite Meteorology. Strategies derived from the evaluation addressed three areas: data access; data use; and education and training;

(*b*) The Expert Team reviewed the direct broadcast concept from meteorological satellites and held a joint meeting with a CGMS Task Team dealing with that matter. Tasked by CBS-XII and the fifty-fourth session of the Executive Council, based on current and planned satellite systems, and taking into account the evolving telecommunication technology and having regard to NMHSs' requirements for a cost-optimized access to all necessary meteorological data/products, the Expert Team developed a proposal to complement the direct broadcast concept with ADM. Access to satellite data and products by WMO Members should be through a composite data access service comprised of both direct broadcast from satellite systems and ADM. ADM would be the baseline while direct broadcast reception would serve as back up as well as for providing data for those WMO Members unable to take advantage of ADM;

(*c*) As concerned direct broadcast, while recognizing that future satellite systems would not have duplicate instruments nor provide identical data, there would be a need for a direct broadcast capability as part of a global dissemination service based on the already approved CGMS global specification for advance high-rate picture transmission, i.e., a WMO standard. The global service should be provided by all satellite operators with near-polar-orbiting satellites. The global service should have a common frequency in the 1 698–1 710 MHz band and common bandwidth. Finally, the global service should have a comparable data content with Metop, considered as a benchmark;

(*d*) The ADM branches would be open to merging with other meteorological data streams. ADM would allow for a seamless inclusion of data/product sets from near-polar and geostationary operational satellites as well as from relevant R&D satellites. The concept was welcomed by CGMS as well as by the second session of the Consultative Meetings on High-level Policy on Satellite Matters. The CBS Inter-programme Task Team on FWIS was informed of the ADM concept and included it in its FWIS vision;

(*e*) The Expert Team appreciated the excellent progress made by the Virtual Laboratory Focus Group (belonging to the Virtual Laboratory for Education and Training In Satellite Meteorology) towards achieving the assigned actions. All core actions had already been completed. The formation of the Virtual Laboratory Focus Group was agreed by WMO and CGMS, held its first meeting in 2001 and had been very active since then;

(*f*) The Expert Team also recommended enhancement of the transfer of satellite applications from research to operations, and CGMS agreed to establish the IPWG. IPWG convened an organizational meeting in 2001, followed by the first IPWG Workshop in 2002.

6.1.29 There were significant findings and recommendations from the evaluation of the 2001 Biennial Questionnaire (*Status of the Availability and Use of Satellite Data and Products by WMO Members*, WMO/TD-No. 1119, SAT-30) regarding:

(*a*) Data availability;

(*b*) Personnel;

(*c*) Use of satellite data at the NMHSs;

(*d*) Most important and required parameters (which matched with findings of the Expert Team on Observational Data Requirements and Redesign of the GOS although based on a different approach);

(*e*) Limiting factors in the use of satellite data and products;

(*f*) Education and training.

6.1.30 The Commission endorsed the following recommendations and strategies as contained in the *Status of the Availability and Use of Satellite Data and Products by WMO Members* (WMO/TD-No. 1119, SAT-30):

(*a*) Recommendations

(i) NMHSs were strongly encouraged to increase the number of staff active in satellite meteorology in order to be able to benefit from the unique capabilities of satellite systems;

(ii) NMHSs should be informed on alternative means for access to satellite data and products, including R&D missions;

(iii) NMHSs should be encouraged to establish communication systems with appropriate capacity based on the planned data volumes to be disseminated from future satellite systems. Members should seek special status for NMHSs with relevant telecommunications authorities including support for communication software and data exchange;

(iv) Relevant WMO Members should be encouraged to consider alternative solutions to achieve their computer programming requirements. Such an alternative could be, for example, the formation of networks or consortia with shared responsibilities, activities and services;

(v) Appropriate strategies should be developed and implemented in order to improve the availability of application software and methods;

(vi) The next Questionnaire should be issued for completion by April 2003;

(vii) Coordination with the Task Team on FWIS and further evolution of FWIS should be continued.

(*b*) Strategies

(i) Data access:

a. WMO should inform CGMS of the ADM concept and should seek CGMS endorsement including agreement to converge on appropriate standards as well as the establishment of appropriate facilities in every WMO Region in order to allow an adequate response to the meteorological and environmental data requirements;

b. The ADM concept and principles should be further refined including matters related to R&D satellite missions. Additionally, the ATOVS retransmission service should be considered for expansion towards a complete global service;

(ii) Data use:

a. Operational space agencies were encouraged to provide space systems with more frequent observations of atmospheric instability parameters and develop capabilities for cloud base height observations;

b. Space agencies were encouraged to develop the capability to provide wind profiles and fly operational sensors for the observation of precipitation rate that met WMO observational requirements;

(iii) Education and training:

a. A feedback mechanism should be developed between the Centres of Excellence including their cosponsoring satellite operator and the WMO Members they served to provide information on training activities;

b. Centres of Excellence and their corresponding sponsoring satellite operators should participate in responding to the Questionnaire as well as to providing information to WMO Members within their regions that may assist in responding to the Questionnaire;

c. The Virtual Laboratory Focus Group should consider preparing a periodic newsletter that would be distributed electronically via appropriate list-servers.

REQUIREMENTS AND REPRESENTATION OF DATA FROM AWSS

6.1.31 The Commission noted with appreciation the work carried out by the Expert Team on Requirements for Data from Automatic Weather Stations in developing functional specifications for AWSs and accompanying BUFR/CREX descriptors. It noted that the Expert Team reviewed current AWS operational practices, reviewed and developed AWS BUFR descriptor and templates and found them suitable to facilitate the exchange of AWS data, and addressed the need for AWS quality control standards and procedures. It was also informed that during the intersessional period the majority of the Expert Team members changed and the loss of continuity due to those changes placed a heavy burden on the new Expert Team members. The Commission noted the findings of the Expert Team regarding simplifying meteorological tables; clarifying for data users how instrument reported values were derived; and addressing quality control guidelines and procedures for AWSs. The modification of several meteorological tables had been accomplished and appropriate recommendations for the implementation of new methods for calculating meteorological elements, such as cloudiness, were made. Another item of importance deliberated by the Expert Team was the need to provide the users of AWS data with sufficient information to understand how the data were being produced. The importance of standardization of basic quality control and its application to all AWS was also underlined.

6.1.32 The Commission agreed that the following practical recommendations of the Expert Team should be implemented as a matter of urgency:

(*a*) Provide a consistent definition of radiation;

(*b*) Maintenance of accurate metadata for all AWS installations;

(*c*) Include water vapour measurements as a requirement for AWS reporting;

(*d*) BUFR/CREX should support the reporting of both nominal and instrument values;

(*e*) Links should be provided in documentation (metadata) so that data users might understand the specific algorithm(s) used in deriving AWS output;

(*f*) In the *Manual on the Global Observing System* (WMO-No. 544), introduce the optical extinction profile of the atmosphere as a basic parameter to be reported by principal AWS. WMO regulations should note that both cloud base height and cloud extent could be derived directly from that profile without further measurement, using one-minute time series.

***MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-NO. 544)**

6.1.33 The Commission considered the proposed changes to the *Manual on the Global Observing System* (WMO-No. 544), Volume I submitted by the Rapporteur on Regulatory Material and reviewed by the ICT on IOS. The Commission noted that the revision to the *Manual on the Global Observing System* had followed the procedure recommended by CBS-XII. The revised text of the *Manual* was reviewed by the Task Team on Regulatory Material (Geneva, 26–30 November 2001) and then posted on the WMO Web site with an invitation for comments by WMO Members by 15 June 2002. The revised *Manual* was also considered at the session of the Expert Team on the Observational Data Requirements and Redesign of the GOS (July 2002) which recommended adding to the draft *Manual* a description of the rolling requirements review process. Recommendations of the Expert Team, together with comments received from CBS members, were discussed in detail at the second session of the CBS OPAG on IOS/Implementation Coordination Team on IOS (Geneva, 14–18 October 2002). Updated in October and based on Members' review and ICT recommendations, it was provided in CD-ROM format at CBS-Ext.(02). The Commission thanked the Rapporteur and the many experts who had been involved in preparing and reviewing the comprehensive revision of the *Manual on the GOS* and asked the Secretary-General to publish the revised document at the earliest practical time. Accordingly, Recommendation 1 (CBS-Ext.(02)) was adopted.

IMPROVEMENTS TO *WEATHER REPORTING* (WMO-NO. 9), VOLUME A

6.1.34 The Commission considered the revisions to *Weather Reporting* (WMO-No. 9), Volume A, submitted by the Rapporteur on the Improvement of Volume A and reviewed by the ICT on IOS. The Commission also noted that version 5 of the report was published in February 2002 on the WMO Web page and valuable comments from the OPAG on IOS were received, resulting in the latest version of the report. The Commission noted in particular, the main topics and proposed recommendations of the Rapportuer on the Improvement of Volume A, namely:

(*a*) Definition, purpose and scope, in particular with a view to climatological users;

(*b*) The procedures for communication between Member States and the Secretariat;

(*c*) The linking to monitoring results;

(*d*) Revision of the contents and readability for automated systems;

(*e*) The problems caused by the limitations of the index numbering system.

6.1.35 The Commission discussed the analysis and conclusions of the Report and agreed with the resulting recommendations. However, with regard to the index numbering system and recognizing that that change would be necessary, the Commission requested the OPAG on IOS to describe clearly the consequences of those changes. The Commission thanked the Rapporteur on the Improvement of Volume A and the many experts who had been involved in preparing the comprehensive revision of Volume A. It requested the Secretariat to initiate the implementation of the proposed changes.

RAPPORTEUR ON GCOS MATTERS

6.1.36 The Commission appreciated the report of the Rapporteur on GCOS Matters and noted with satisfaction the enhanced cooperation that raised between CBS and GCOS in the implementation of GSN and GUAN. In particular, the Commission noted with satisfaction that the first CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (Offenbach, Germany, May 2002) developed 15 specific recommendations concerning the improvement of climate data availability which were submitted for consideration through existing CBS and GCOS procedures. It also welcomed the monitoring results of the availability of observations from GSN and GUAN. It noted that while there had been some modest improvement in the reporting of climate messages, the current level of performance remained far from ideal (approximately 60 per cent of expected CLIMAT reports and 70 per cent of expected CLIMAT TEMP reports for the most recent monitoring periods). It noted with concern the drop in availability of CLIMAT reports from the Antarctic since February 2001.

6.1.37 The Commission recognized the difficulties encountered in bringing results of monitoring the GSN and GUAN networks to the attention of station operators in order that remedial action could be taken in a timely manner. The Commission agreed with recommendations developed by the first meeting of the Expert Meeting on Coordination of the GSN and GUAN and requested that CBS Lead Centres for GCOS data (one for GUAN and one for GSN) be established on a trial basis to facilitate the exchange of that information directly with the NMHSs involved, with the terms of reference as presented in the final report of the Expert Meeting. The Commission was pleased to note that Japan would assume responsibility for the CBS Lead Centre for GSN as from 2003 on a trial basis. The Commission also expressed its gratitude to the United States for funding the data rescue project in RA I on recovering paper archives holding surface and upper-air data.

6.1.38 The Commission further requested that Points of Contact be nominated by each NMHS, who could be contacted directly by the Lead Centres and who would be tasked by the Permanent Representative to follow up with appropriate action within the NMHS concerned. Terms of reference for the Points of Contact were also given in the final report of the Expert Meeting.

6.1.39 The Commission expressed its appreciation for a briefing on the current GCOS activities provided by Mr M. Manton, Chairperson of the Atmosphere Observation Panel for Climate. It noted an increased collaboration between CBS and GCOS and valuable support provided by the *Deutscher Wetterdienst*, the Japan Meteorological Agency, the UK Met Office, ECMWF and NCDC in the monitoring and archiving data from GCOS baseline (GSN and GUAN) networks. The Commission re-affirmed the importance of those backbone observing networks that should be operated according to the GCOS climate monitoring principles (in response to Decision 5/CP.5 — Research and systematic observation, of the UNFCCC COP-5). The Commission re-emphasised that GCOS CLIMAT and CLIMAT TEMP messages should be produced and distributed globally on the GTS.

6.1.40 The Commission urged all Members concerned to assure that network operators, monitoring centres, telecommunication centres, CBS Lead Centres for GCOS Data and the GCOS Data and Analysis Centres adhere to the guidelines given in the *Guide to the GCOS Surface and Upper-Air Networks: GSN and GUAN* (WMO/TD-No. 1106, GCOS-73).

AVAILABILITY OF CLIMAT AND CLIMAT TEMP REPORTS

6.1.41 The Commission noted with appreciation the recent developments in the establishment of RBCNs. In particular, it noted that the sessions of XII-RA II (September 2000), XIII-RA III (September 2001), XIII-RA IV (March/April 2001), XIII-RA V (May 2002) and XIII-RA VI (May 2002) had considered and agreed to the concept of defining a separate RBCN for their regions and adopted appropriate resolutions. Based on the approved list of RBCN stations (as of July 2002) and pending approval of XIII-RA I, all regions, including the Antarctic, comprised a total of 3 086 stations, constituting the following regional breakdown:

RBCN	RA I	RA II	RA III	RA IV	RA V	RA VI	ANTARCTIC	TOTAL
CLIMAT	616	593	344	242	188	520	72	2 575
CLIMAT TEMP	19	194	49	72	74	91	12	511

6.1.42 More recent WWW monitoring results based on the approved lists of RBCN stations showed that the availability of CLIMAT and CLIMAT TEMP reports was not satisfactory, providing the global average of only 49 and 53 per cent, respectively. The density of reports was particularly low in Regions I and III. The Commission reiterated its view that the establishment of RBCN provided a valuable justification for maintaining a minimum number of CLIMAT reporting stations, and those RBCN stations could serve as a target list for WWW monitoring. In order to increase the availability of CLIMAT messages, further efforts by Members should be made to ensure that their operational observing stations compiled and transmitted the CLIMAT/CLIMAT TEMP messages according to existing regulations.

WMO SATELLITE ACTIVITIES

6.1.43 The Commission noted three important areas with regard to WMO Satellite Activities since CBS-XII. In particular, it was informed of the development of a set of guidelines for requirements for observational data from operational and R&D satellite missions, the expansion of the space-based component of the GOS to include appropriate R&D satellite missions, and the establishment of a WMO Space Programme.

GUIDELINES FOR REQUIREMENTS FOR OBSERVATIONAL DATA FROM OPERATIONAL AND R&D SATELLITE MISSIONS

6.1.44 The Commission was informed that Guidelines for requirements for observational data from operational and R&D satellite missions had been agreed upon by the fifty-third session of the Executive Council. The Guidelines served to provide operational users with a measure of confidence in the availability of operational and R&D observational data, and data providers with an indication of its utility. The Guidelines were subsequently sent to R&D space agencies for their consideration to include appropriate R&D satellite missions as part of the space-based component of the GOS.

EXPANSION OF THE SPACE-BASED COMPONENT OF THE GOS

6.1.45 The Commission noted that the fifty-third session of the Executive Council had also reviewed the support provided by the present R&D satellite missions to WMO Programmes. The review highlighted the significant contributions already made by R&D satellite missions in support of WMO Programmes. Of critical importance were the streamlining of the transition from R&D to operations, as well as the development of a broader service orientation. The Executive Council had also reviewed possible configurations for the space-based component of the GOS that included R&D missions as well as the existing constellations of environmental geostationary and near-polar-orbiting satellites. The configurations were based on the assumption that the Guidelines, as cited above, would be agreed upon by the space agencies. The Executive Council had felt that the most appropriate manner to satisfy the full suite of present requirements, while recognizing the capabilities of both operational meteorological and R&D satellites, was to expand the present definition of the space-based GOS to include R&D satellites, complementing the existing two operational meteorological satellite constellations (geostationary and near-polar orbiting). Enhancements to the overall space-based component of the GOS would be incremental as new contributions from the R&D satellites were realized. The Executive Council agreed that the expansion of the definition should be reflected in the *Guide on the GOS* (WMO-No. 488) and the *Manual on the GOS* (WMO-No. 544).

6.1.46 The Commission was informed that several R&D space agencies had responded positively to the Guidelines. NASA confirmed its commitment to WMO and to the world community to make observations available without restriction. It further indicated that the policy would apply to all relevant missions. Therefore, since data from NASA's Earth observation missions were readily available, its satellites could be considered de facto as part of the space-based component of the GOS. ESA confirmed that it was establishing dialogue aimed at developing information for WMO Members concerning the availability of specific data and products from ESA's Earth observation satellite missions, and in particular from the ENVISAT mission launched in March 2002. ESA further indicated that it would propose to its Programme Board for Earth Observation, to organize jointly a dedicated, specific Announcement of Opportunity to foster the use of ESA Earth Observation data by the WMO community. NASDA of Japan indicated that its future satellite missions, including ADEOS II and the GCOM series, were candidate systems to contribute to the new R&D constellation for the space-based component of the GOS. Finally, the Russian Aviation and Space Agency (Rosaviakosmos) confirmed that experimental and R&D instruments on board its operational METEOR 3M N1 satellite as well as on its future Ocean series and other missions could be considered as a potential contribution to the space-based component of the GOS.

WMO SPACE PROGRAMME

6.1.47 The Commission noted that the fifty-fourth session of the Executive Council had reviewed the assessment of WMO Satellite Activities to ensure that it was optimum for the present and perceived future needs. The WMO Satellite Activities Programme should provide for an appropriate framework for efficient interaction both internally within WMO as well as with external coordination mechanisms such as CGMS and CEOS. The assessment took into consideration the emphasis that WMO placed on the contribution environmental satellite systems were making to WMO and its supported programmes and the large expenditures by those space agencies contributing to the space-based component of the GOS. The Executive Council had agreed that the present Satellite Activities Programme was insufficient to respond to the new demands resulting from the expansion of the space-based component of the GOS to include the R&D constellation and that increased emphasis was required. In order for WMO to take advantage of the new technologies to serve its Members better, it was of primary importance to enhance coordination. The assessment clearly demonstrated a significant growth during the last decade in all areas for which WMO Satellite Activities had responsibilities. The recent agreement by the Executive Council at its fifty-third session to expand the space-based component of the GOS to include appropriate R&D environmental satellite missions was a landmark decision, with significant implications to WMO Members with a corresponding increase in responsibility for the WMO Satellite Activities.

6.1.48 The fifty-fourth session of the Executive Council agreed that it was appropriate to establish a WMO Space Programme as a matter of priority. The scope, goals and objectives of the new programme should respond to the tremendous growth in the utilization of environmental satellite data, products and services within the expanded space-based component of the GOS that now included appropriate R&D environmental satellite missions. Thus, the Executive Council asked the Secretary-General to make appropriate proposals in the 6LTP and in the programme and budget (2004–2007) to be submitted for consideration by Congress. In considering the important contributions made by environmental satellite systems to WMO and its supported programmes as well as the large expenditures by the space agencies, the Executive Council felt that it was appropriate that the overall responsibility for the new WMO Space Programme should be assigned to CBS and institutionalized Consultative Meetings should be held on High-Level Policy on Satellite Matters in which CBS should be represented by its president. Since the Consultative Meetings were attended by the Directors of agencies operating environmental satellite, the Council felt that the assignment of joint lead responsibility could be conducive to support the WMO Space Programme by the satellite operating agencies. Such support on the part of the satellite operators could complement the WMO commitment established by a WMO Space Programme and assist the new Space Office with specific projects and initiatives, as appropriate.

FUTURE CBS ACTIVITIES WITH REGARD TO THE WMO SPACE PROGRAMME

6.1.49 The Commission noted the implications of expansion of the space-based component of the GOS and of establishing the new WMO Space Programme. In order to maximize the impacts of the now greatly expanded GOS, the Commission felt that relevant tasks should be formulated for the OPAGs (including both IOS and ISS) and that the membership of appropriate Expert Teams and Implementation Coordination Teams should include representatives from the R&D space agencies. Additionally, the tasks should clearly integrate the transition of R&D data, products and services including standardization of formats within the future CBS work programmes.

COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

6.1.50 The Commission was briefed on results from the thirtieth session of CGMS held in Bangalone, India in November 2002. The Commission noted that CGMS had agreed to expand its membership to include R&D space agencies contributing to the space-based component of the GOS. It was also informed of CGMS's plans to meet the WMO TCP requirements. With regard to global contingency planning, Japan informed the Commission of the GMS-5/GOES-9 back up scheduled to become effective in April 2003. GOES-9 data for secondary data user stations would be broadcast by GMS-5. High resolution data from GOES-9 would be available on an Internet server of the Japan Meteorological Agency. The Commission thanked Japan and the United States for their efforts to continue the coverage over the western Pacific. With regard to the Indian Ocean coverage, the Commission expressed its appreciation to EUMETSAT for the availability of Meteosat-5 data expected to continue until at least 2005 and encouraged CGMS satellite operators to provide for permanent coverage in that important region. With regard to the availability of ocean surface wind data, the Commission noted the present availability of QuickSCAT data and the plans to continue such valuable data with the scatterometers on the Metop, the WINDSAT/CORIOLIS and the NPOESS series. The Commission also requested that WMO Members be kept informed of the need to convert satellite ground receiving stations as and when new satellite systems become available.

SCIENTIFIC EVALUATION GROUP OF THE COORDINATION GROUP ON THE COMPOSITE OBSERVING SYSTEM FOR THE NORTH ATLANTIC

6.1.51 The Commission recalled that Resolution 5 (EC-XLII) — Composite Observing System for the North Atlantic (COSNA), endorsed the organization of the CGC having as its primary goal the efficient management of the environmental data from the North Atlantic to ensure that they met the established standards for timeliness, quality, coverage and utility. CGC, through its SEG, had encouraged and, as appropriate, had sponsored scientific evaluations and studies, which assisted in establishing and maintaining the acceptable performance for COSNA, and had guided its future development. The Commission noted that although SEG focused on the North Atlantic, the impact studies were mainly undertaken on a global scale. The SEG also organized or co-sponsored workshops on data-impact studies (Geneva, April 1997 and Toulouse, March 2000).

6.1.52 The Commission was informed by CGC that COSNA would be absorbed by EUCOS in 2003. The Commission noted that that issue was discussed at the XIII-RA VI (Geneva, May 2002). As regarded SEG, the Association noted the view of CGC that it could develop into a group which monitored and partially coordinated the work being carried out worldwide on observing system impact studies and observing system evaluation projects, which made recommendations to relevant WMO bodies for future work and which provided input to CBS expert teams on the further development of an integrated observing system. The Association recommended to incorporate activities of the group in an appropriate way into the working structure of CBS, if possible.

6.1.53 The Commission further noted that CGC-XIII (Reykjavik, August 2002) supported the views of RA VI and expressed the hope that they would be considered favourably by CBS, so that continuation of the scientific evaluation work would be assured within the framework of the OPAG on IOS.

6.1.54 The Commission noted with appreciation the comments on SEG activities provided by Mr H. Böttger (ECMWF), chairperson of SEG. The Commission underlined that the data-impact study work of the SEG and the related workshops were considered to be valuable contributions towards the monitoring and development of the GOS. The Commission was pleased to note that CGC agreed to co-sponsor another workshop on impact studies in 2004. It also recognized that global NWP centres together with GDPS centres were best placed to assess the relative contribution and value of various components of the GOS and to provide feedback on data requirements and input for the redesign of the GOS. In particular, the evolution of the satellite observing system capabilities and the utilization of those data in skilful data assimilation systems should be monitored and supported through a well-organized programme of OSEs involving the major NWP and GDPS centres of the WMO Members from all Regions. The Commission felt that the OPAG on IOS — through the Expert Team on Observational Data Requirements and Redesign of the GOS and its rapporteurs on global and regional NWP — appeared to be best placed to organize, in close collaboration with the OPAG on DPFS, the OSE work and arrange future NWP impact study workshops. That would enable more effective exchange of results from OSE studies and would provide feedback to the operators and managers of the GOS on the performance of their systems and future data requirements.

6.1.55 In light of the above, the Commission reconfirmed in principle its current working structure dealing with OSE/OSSEs and requested its Management Group to review the working arrangements of the OPAG on IOS with respect to retaining in the OPAG the tasks and expertise of the SEG, which were carried out by global NWP centres.

6.1.56 The Commission expressed its deep appreciation to the Members implementing the AMDAR programme for providing data from automated aircraft observations that supplement upper-air data received from the global upper-air network. It noted with satisfaction that the number of AMDAR observations exchanged daily on the GTS had increased from 2000 observations in 1980 to 140 000 in 2002. The main areas covered by AMDAR were North America, Europe, Southern Africa, West Pacific and Australasia while there were large gaps in data coverage over most parts of Africa, Asia and South America.

6.1.57 The Commission noted with appreciation the activities of the members of the AMDAR Panel in developing and coordinating the AMDAR programme. It was also noted that the Panel had recognized the fundamental principle of WMO to broaden and enhance the free and unrestricted international exchange of data and promoted the exchange and dissemination of all appropriate AMDAR data through the GTS.

6.1.58 The Commission emphasized the need for further extension of AMDAR coverage through the development of regional AMDAR projects. It noted with satisfaction that upon the initiative of the AMDAR Panel, two demonstration projects were under way in Southern Africa and the Middle East. The Commission also noted that additional regional projects were launched by ASECNA; Hong Kong, China; and Japan in close collaboration with the AMDAR Panel. It felt that similar regional projects in the Russian Federation, other parts of Africa and South America would be highly desirable.

6.1.59 The Commission expressed concern that there was a lack of knowledge both in some NMSs and the airline industry regarding the benefits provided by the AMDAR programme. That caused some difficulties in the promotion of the AMDAR programme in certain areas. It felt that training activities in that respect would be necessary.

6.1.60 The Commission drew attention to shortcomings in the management of AMDAR data flow on a global basis resulting in a redundancy of AMDAR data in some areas. It felt that better coordination in that field as well as the implementation of procedures for targeted observations would be necessary in that regard.

6.1.61 Recognizing the high potential of AMDAR observations as a supplement to the global upper-air network, the Commission felt that AMDAR activities were considered more and more as an operational component of the GOS. It expressed the view that such a development required more close cooperation between CBS and CAeM and the two Commissions could find an appropriate mechanism to integrate more fully AMDAR activities in the WWW. In view of the importance of that issue for the meteorological community, the Commission decided to address that issue at Fourteenth Congress and adopted Recommendation 2 (CBS-Ext.(02)).

6.2 INFORMATION SYSTEMS AND SERVICES (agenda item 6.2)

6.2.1 The Commission thanked Mr G.-R. Hoffmann, chairperson of the OPAG on ISS for his report. It noted with satisfaction the significant progress made and the achievements attained, covering a wide range of tasks. It noted that the proposals and recommendations developed by the Expert Teams had been reviewed and consolidated by the Implementation Coordination Team on ISS. The Commission expressed its thanks to the many experts who had served on the various Expert and Implementation Coordination Teams.

STATUS OF IMPLEMENTATION AND OPERATION OF THE GTS

6.2.2 All but one of the 23 MTN circuits were in operation and all MTN centres were automated. Most of the MTN circuits were using digital links at speeds from 64 to 256 kbit s^{-1} (14 circuits), and all but one currently operated with X.25, TCP/IP or a combination of both. Ten circuits operated with TCP/IP, making use of FTP or sockets, and the migration to TCP/IP firmly continued. However, the Commission noted that one circuit (Sofia-Moscow) was no longer implemented and that one circuit (New Delhi-Cairo) remained using very low speed characteristics. The Commission noted that the implementation of computer-based systems for GTS/GDPS functions in WWW centres were making important progress, in particular through the introduction of cost-effective PC-based data handling systems in several developing countries. The Commission was pleased with the significant progress made in the implementation of

RMTNs, but it also noted that serious shortcomings still existed in some Regions at the regional and national levels.

6.2.3 In Region I, despite serious economic difficulties, continuous efforts had enabled some improvement of GTS circuits via leased lines, satellite-based telecommunications (in particular SATCOM) or public data networks, including the Internet. Satellite-based data-distribution systems (MDD, RETIM and SADIS as part of the ICAO aeronanutical fixed service) and data-collection systems (METEOSAT/DCS) would continue to play a crucial role, taking into account the planned upgrades (MSG and RETIM 2000 Africa). There were still serious shortcomings, in particular at the national level. The RA I Strategy for enhancing WWW basic systems was developed to enable sustainable development, in particular of meteorological data communications. The PUMA project for the implementation of MSG receiving stations (funded by the European Commission under the ACP-Lomé IV Convention of 1995) and the RETIM Africa system (planned by France for the first half of 2003), were essential contributions to the strategy.

6.2.4 The observational data collection system in Region II was in general quite satisfactory, except in a few countries where serious shortcomings still existed. Most of Region II GTS circuits were operating at medium or high speed, but there were still a number of low-speed connections. The RMTN in Region II, particularly in its eastern and southern parts, was being improved by the continued implementation of improved data communication services, including frame relay services, complemented by satellite-based distribution systems and the use of the Internet. A plan for an improved RMTN was developed.

6.2.5 In South America, the RA III RMDCN project was entering its implementation phase, with the finalized technical specifications and the planned international tender. Despite the current economic difficulties that were slowing down the process, important efforts were made towards a progressive implementation, including upgraded interconnection between the three RTHs. All 13 NMCs were also equipped with systems receiving WAFS and OPMET information via ISCS operated by the United States. In Region IV, the two-way satellite-based network RMTN that was integrated in the ISCS continued to be fully operational, but the replacement of GTS/GDPS PC-based terminal equipment at NMCs was becoming a high priority. The Commission noted in that regard the planning for upgrading the ISCS including migration to TCP/IP procedures as from August 2003, and actions towards the replacement of NMCs' workstations.

6.2.6 Significant progress was made in the Region V RMTN with the implementation of frame relay services, the inclusion of additional GTS circuits, in particular in the Pacific, and the expansion and planned upgrades of satellite-based communications, including the ISCS operated by the United States, the DCS of the GMS and GOES satellites and the GOES emergency managers weather information network. There was also an increasing use of the Internet, in particular for the collection of observational reports and for linking small nations in the Pacific.

6.2.7 The RA VI RMDCN, based on a shared managed network service managed by the ECMWF, was interconnecting 33 RTHs and NMCs. The RMDCN met the RA VI GTS requirements as well as data exchange requirements between ECMWF and its Member States and Cooperating States. Provisions were agreed to extend the RMDCN services, in particular to include interregional GTS circuits. The other RA VI Members were operating leased point-to-point GTS circuits and were expected to join the RMDCN as soon as possible. Satellite-based distribution systems (FAX-E, RETIM and MDD) were also playing an important role, taking account of the planned upgrades.

6.2.8 The Commission emphasized that the data-communications network services used for the Region VI RMDCN had proven to be an excellent example of a cost-effective implementation of the GTS, with a very high reliability and full security, a guaranteed quality of service and an easy scalability of capacity, while its cost-effectiveness had significantly increased (more than 25 per cent in 2003). It also noted that the use of standard data-communication techniques and procedures for the GTS had greatly facilitated the utilization of cost-effective telecommunication services.

6.2.9 The Commission noted the extensive implementation of satellite-based multipoint telecommunications systems that were operating as integrated components of the GTS for the distribution of large volume of information, in complement to the dedicated connections. Each WMO Region was completely covered by at least one satellite-based data-distribution system. The Commission expressed its appreciation for the planned upgrades of several of the satellite-based data-distribution systems. The Commission particularly noted the RETIM-2000 satellite-based system using DVB techniques operated by France, that was recently put into operation, and its planned extension over Africa by mid-2003. EUMETSAT had also started its EUMETSAT ATOVS Retransmission Service via DVB satellite-based services in its pilot operational phase.

REVIEW OF THE ORGANIZATION OF THE GTS

6.2.10 The Commission was informed of the proposal from the United Kingdom to include the GTS interregional circuit Bracknell-Melbourne in the MTN. It noted that the circuit was operational for several years and was efficiently contributing to the global data exchange; its inclusion into the MTN would effectively complement the single MTN circuit Melbourne-Tokyo that was currently connecting both WMC Melbourne and Region V, and would significantly improve the overall MTN interconnectivity. It further noted that the circuit Bracknell-Melbourne was also included in the implementation plan of the improved MTN (see also general summary paragraphs 6.2.31 and 6.2.32). The Commission agreed that the GTS circuit Bracknell-Melbourne be included in the MTN.

6.2.11 The Commission noted that Bulgaria had submitted a proposal to the Secretary-General to include the circuit Sofia-Toulouse into the MTN. It noted that the thirteenth session of RA VI (Geneva, May 2002) agreed upon the inclusion of the circuit Sofia-Toulouse into the regional meteorological telecommunication plan of Region VI as a main regional circuit. The circuit Sofia-Toulouse was implemented through the RMDCN. RTH Sofia was connected on the MTN to RTH Prague. The Commission emphasized that the essential function of the MTN was to support the global and interregional exchange of information. In that regard, it recalled that, at its twelfth session, it had underlined that the "interregional" MTN element was crucial and should be addressed with the highest priority. It noted that the proposed new MTN circuit would not contribute to the global and interregional information exchange, since the MTN centres in Region VI that operated interregional MTN circuits were already efficiently interconnected. It was also underlined that Region VI had already the largest number of intraregional MTN circuits. While acknowledging the importance of the circuit at the regional level, the Commission concluded that the circuit Toulouse-Sofia should not be included in the MTN.

6.2.12 Noting that the MTN circuit Cairo-New Delhi was still implemented as a 100 baud telegraphic circuit and was not capable of meeting the MTN requirements, the Commission was pleased to learn that an upgrade of the circuit was planned for 2003, including in the framework of the IMTN project (see paragraphs 6.2.31 to 6.2.35).

DATA-COMMUNICATION SYSTEMS AND TECHNIQUES

TCP/IP AND RELATED PROTOCOLS ON THE GTS

6.2.13 The Commission noted that the Expert Team on Data-communication Systems and Techniques was keeping under review the procedures and implementation guidance for the use of TCP/IP and related protocols on the GTS, as described in the *Manual on the GTS* (WMO-No. 386), Volume I, Part II, Attachment II-15. In compliance with those procedures, the WMO Secretariat coordinated the assignments of IP addresses and AS numbers for GTS connections upon request from GTS centres. The Commission noted, however, that obtaining the complementary official IP addresses from Internet service providers required for centres' systems (MSS, hosts, etc.) might be extremely difficult in several countries, in particular in Asia and Africa. It concurred that a set of addresses that had been hardly used, originally allocated for IP over X.25, could be used for assigning IP addresses to NMCs' systems (MSS, host) experiencing serious difficulties, on a case-by-case basis and upon request. Noting the particular shortage of IP addresses in Asia, the Commission invited NMHSs to check if they could help by giving some unused part of their address space to NMHSs in need.

6.2.14 The Commission noted that the Expert Team had reviewed the current recommended practices for the FTP transfer of files containing accumulated messages and endorsed the amendments it had developed to eliminate possible different interpretations and to cancel options which revealed to be unnecessary or impractical.

6.2.15 The Expert Team had agreed that the provisional file naming conventions for new types of data (no current AHL) as described in Attachment II-15 were not appropriate and should be cancelled. While noting with interest and appreciation the development of a WMO metadata standard based on both ISO standards and XML formats, it had emphasized that metadata alone could not permit any efficient mechanism for the operational routeing and distribution of files. The Commission noted that the Expert Team had strongly emphasized the need for file names containing sufficient information on the content of the file to enable operational routeing and distribution. Metadata provided the detailed data format and content descriptions for displaying, using and processing the file. The open, flexible and forward-looking general file naming convention that was developed, facilitating a smooth transition from AHL, was based on a mandatory part and a free format part. The mandatory part, which was essential to basic routeing, was kept simple and general, with clear field delimiters, so that countries with existing systems could readily convert to the new file name convention without much trouble. The optional free format part allowed centres to include some additional content description in the file names as well. The Commission endorsed the recommended file naming convention as a replacement for the "File naming conventions for new message types (no existing AHL)" of Attachment II.15, Chapter 4. The Commission recognized, however, that a transition period of a maximum of five years was required to implement that new recommended practice. It requested the OPAG on ISS to assess a practical implementation date by its thirteenth session (2003). It also requested the OPAG on ISS to develop urgently the detailed complementary procedures for the applications of the file naming convention. It furthermore requested the OPAG on ISS to address, in that respect, both the requirements of the distribution mode (data push) and of the downloading mode (data pull), with a view to developing consistent and streamlined practices.

6.2.16 The Commission endorsed the recommended consequent revision to Attachment II-15, to the *Manual on the GTS*, Volume I, Part II.

GUIDANCE FOR USING THE INTERNET BETWEEN GTS CENTRES

6.2.17 The Commission recognized that, for several small NMHSs, the Internet was the only affordable telecommunication means for transmitting meteorological information, despite its possible shortcomings (availability, reliability, delays). With respect to data exchange via e-mail over the Internet, the Commission endorsed recommended practices for collecting observational bulletins, which covered the format of the message and arrangements limiting the security risks, that were developed from the experience gained by several GTS centres. The recommended practices were included in Annex I to this report. The Commission noted that some RTHs also use e-mail, including request-reply mechanisms, for providing data and products to NMCs, and it requested the OPAG on ISS to study further that matter in the more general framework of delivery of information upon request.

6.2.18 Recognizing that the establishment of Internet-based connections between GTS centres was an opportunity, the Commission noted with satisfaction that the Expert Team had developed a guidance document on virtual private networks via the Internet between GTS centres. The document described the most appropriate procedures and implementation options that would minimize the operational and security risks. It noted that those guidelines would be further refined in the light of the experience gained in implementation, and expressed its appreciation to the ECMWF for contributing to the validation of the best option(s) for GTS centres through operational tests. It also invited all WWW centres to report and share their own experience. The Commission underlined that the guidance document on virtual private networks was strongly influenced by the rapidly changing technology, and it recommended that the document be published in an electronic form on the WMO Web server and be provided in printed form to NMHSs that requested it. The guidance document on virtual private networks via the Internet between GTS centres should eventually also be made available in at least English, French, Spanish and Russian.

6.2.19 The Commission also recalled that online information resources on data communication systems and techniques were available on the WMO Web server for providing all Members with practical information and guidance on the actual implementation of data communication systems and techniques. It invited all WWW centres to continue contributing to, and making use of, those information resources.

GTS OPERATION AND INFORMATION EXCHANGE

6.2.20 The Commission agreed to amend the functions and responsibilities of RTHs included in the *Manual on the GTS* which related to the correction of bulletins by RTHs, with a view to avoiding the transmission of multiple bulletins with the same abbreviated headings and different contents. It also invited RAs I, II, III and IV to consider aligning, accordingly, the corresponding text in their respective parts of Volume II.

6.2.21 In view of the requirements for information exchange in binary forms, the Commission agreed to recommend that the maximum length of meteorological messages be extended to 500 Koctets for messages containing data in binary presentation forms (T_1 = H, I, J, O, P, Q and Y). The Commission recognized that a transition period was needed to implement the recommendation and agreed upon a maximum period of five years. It invited the OPAG on ISS to assess a realistic implementation date, and the Secretariat to carry out an enquiry to RTHs.

6.2.22 The Commission recalled that, at its twelfth session, it had agreed that all observational data, with the exception of radar and satellite data, available from WMO Members, should be globally exchanged on the MTN, and noted that a modification of the definition and use of the group ii of the data designator of abbreviated headings would therefore be needed. It had also agreed that "essential data", as defined in Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities, should be compiled into bulletins with ii in the series 01 to 19 and that other types of data, including "additional data", should be compiled in the ii series above 19, as a goal for the future.

6.2.23 The Commission recognized that any change to the allocation of ii would lead to changes of abbreviated headings of a large number of bulletins and would be a burden for a number of RTHs. It underlined that since all RTHs were using the full AHL in routeing directories, group ii was not used any longer as the sole indicator for routeing purposes. The Commission therefore agreed that the use of ii to differentiate the global, interregional, regional and national distribution was no longer needed, and recommended to change, accordingly, the ii specifications to allow more flexibility.

6.2.24 The Commission noted that the expanded MTN routeing experiment conducted by an ad hoc group was highly valuable in identifying problems and deficiencies on the MTN and GTS, especially those involving duplicate elimination and routeing mechanisms, and in implementing improvements at some participating RTHs. It noted with appreciation that the ad hoc group would carry on further testing of MTN routeing, with an improved methodology to avoid the impacts identified in the first experiment.

6.2.25 The Commission noted that some WWW centres were using different location indicators CCCCs to differentiate bulletins containing processed information (e.g. issued from different NWP models, or different satellites). The Commission agreed upon the use of different CCCCs for centres (WMC, RTH, RSMC or meteorological satellite centre) preparing a large number of bulletins to extend usefully the allocation of abbreviated headings in compliance with the current provisions (tables of Attachment II-5 of the *Manual on the GTS*). The Commission also agreed that a different CCCC could be an effective mechanism for differentiating bulletins containing "additional" from "essential" data as defined in Resolution 40 (Cg-XIII). The Commission adopted the subsequent amendments to the specifications for the international location indicator CCCC.

6.2.26 The Commission reviewed the provisions for the allocation of abbreviated headings (Tables of Attachment II-5 of the *Manual on the GTS*). Noting that the transmission of GRID bulletins should progressively stop, being superseded by GRIB, it agreed that the designators T_1 = D, G and X should be deleted from Table A when possible. The Commission endorsed the following changes:

(*a*) Allocation of designators for WAVEOB reports and float data;
(*b*) Deletion of designator T2 = L from Table B1 (T_1 = S), as a duplicate for ozone CREX bulletins ;
(*c*) Split of the current Table B2 into two tables, a revised Table B2 for GRIB/GRID bulletins (T_1 = D, G, H, X or Y) and a new Table B6 for pictorial information (T_1 = P, Q);
(*d*) Additional entries into Table C6 for satellite-derived wind motion vectors, satellite-derived tropospheric humidity and ozone data.

6.2.27 The Commission emphasized that, in the context of migration to table-driven code forms, the GTS must be able to distribute "migrated" data from traditional alphanumerical codes encoded into BUFR and CREX. Adequate abbreviated headings were therefore required, taking into account that for traditional alphanumeric codes, many headings were already in use under six different T_1 radices (T_1 = S, U, F, C, A, T), while only three were available for table-driven code forms (T_1 = I (observations) and T_1 = J (forecasts) for BUFR and T_1 = K for CREX). Furthermore, a parallel heading scheme was required between the BUFR and CREX versions of data for most cases. The Commission agreed upon a scheme of allocations of abbreviated headings as contained in Annex II to this report, which provided for the reservations required to facilitate the migration to table-driven code forms. It further agreed that the relevant Tables (B3, C6 and C7) of Attachment II-5 of the *Manual on the GTS* should be reviewed and revised accordingly as soon as the actual need for exchanging the various type of "migrated data" arose, and it requested the OPAG on ISS to keep the matter under continuous review.

AMENDMENTS TO THE MANUAL ON THE GTS, VOLUME I, GLOBAL ASPECTS

6.2.28 Subsequent to the conclusions reflected above, the Commission adopted Recommendation 3 (CBS-Ext.(02)) concerning amendments to the *Manual on the GTS*, Volume I, Global aspects, Parts I and II.

IMTN PROJECT

6.2.29 The IMTN, as agreed by the Commission at its twelfth session, would be implemented through data-communication network services from a small number of providers. A first implementation phase would mix network services and point-to-point circuits; a second phase would provide the full MTN connectivity through the network services. The project facilitated a progressive implementation, which could be adapted to the needs and resources of the Members concerned and could respond to changing requirements. The IMTN project was agreed to be the best solution taking into account MTN requirements, technical efficiency, cost-effectiveness, implementation feasibility and early benefits for the whole GTS; it was also expected to permit savings for most centres on recurrent costs in comparison with the current leased circuits, while enabling capacity upgrades.

6.2.30 The Commission noted that the Executive Council, at its fifty-third session (June 2001), endorsed the principles and concepts of the IMTN project, as agreed upon by CBS-XII. Furthermore, the Executive Council, at its fifty-fourth session (June 2002), emphasized the importance of pursuing the development and upgrade of the regional and global components of the GTS in order to meet the increasing data exchange requirements. It noted that the IMTN project was making some progress and it encouraged Members concerned to facilitate effective multilateral cooperation, with the assistance of the Secretariat, as necessary, in particular with respect to the procurement, contractual and financial framework to foster its early implementation.

6.2.31 The Commission endorsed the IMTN project, as consolidated by the Expert Team on the IMTN and GTS, into two parts:
(*a*) The implementation of a "cloud I" providing the interconnectivity between RTH/WMCs Washington and Melbourne and RTHs Tokyo, Bracknell, Brasilia and Buenos Aires, including RTH/WMC Moscow in a further step;
(*b*) The implementation of a "cloud II" as an extension of the Region VI RMDCN, providing the interconnectivity between RTHs Bracknell, Toulouse, Offenbach, RTH/WMC Moscow and other adjacent RTHs, i.e. RTHs Nairobi, Dakar, Algiers, Cairo, Jeddah, New Delhi and Beijing. The inclusion of the Tokyo-Beijing and Tokyo-New Delhi circuits would also provide an effective interconnectivity between both "clouds".

NOTE: RTHs Tokyo and Bracknell and WMC/RTH Moscow, connected to the two "clouds" would ensure the effective interconnection between the two "clouds".

6.2.32 With respect to "cloud I", the Expert Team had consolidated the technical requirements, analysed the competitive quotations obtained from potential providers, and identified the best offers. Individual contractual and billing arrangements should be made for each RTH, and sharing between RTHs of the recurrent cost of respective links should be based on the inbound data-communication capacity. The Expert Team had reached the conclusion that all required preconditions were met towards implementation of the part of "cloud I" interconnecting RTH/WMCs Washington and Melbourne and RTHs Tokyo and Bracknell. The inclusion of RTHs Brasilia and Buenos Aires and of RTH/WMC Moscow in a further step, should be further analysed. A letter from the Secretary-General was sent to the Members concerned to encourage them to proceed with the implementation of the relevant part of the IMTN project. The Commission noted with much appreciation that positive replies were notified and that the portion Washington, Melbourne, Tokyo and Bracknell was firmly planned to be implemented as from 18 December 2002.

6.2.33 With respect to "cloud II", the Expert Team consolidated the technical requirements and analysed the quotations and services provided by Equant Network

Services Limited "Equant", which was the contractor for the Region VI RMDCN-managed data-communication services, selected upon an International Invitation to Tender. In the framework of the WMO/ECMWF agreement on the RMDCN as part of the GTS, the ECMWF managed the RMDCN and monitored, on behalf of all participating centres, the quality of service and the contractor's adherence to the Service Level Agreements. RA VI and the ECMWF Council agreed that the RMDCN could be extended, in particular by the addition of GTS connections between RA VI RTHs/NMCs and RTHs/NMCs in other Regions. Those connections included interregional GTS circuits and circuits of the IMTN project. The Equant master RMDCN contract was revised accordingly. The ECMWF Council also agreed upon the incurred additional management and monitoring workload for the ECMWF.

6.2.34 The Commission concurred with the conclusion that the extension of the RMDCN was the best opportunity for "cloud II" and that it would lead to significant savings for several MTN and interregional circuits, taking into account the adaptation of the committed information rates to the actual throughput requirements. The importance of the network management services and the monitoring and control undertaken by the ECMWF was also emphasized. The Expert Team had agreed that all required preconditions were met towards implementing by the end of 2002 the part of "cloud II" comprising the MTN circuits Beijing-Offenbach, Nairobi-Offenbach and also including the interregional circuit Nairobi-Toulouse. Consideration of the implementation of other circuits should be pursued in coordination with centres concerned, noting in particular that the Tokyo-Beijing, Tokyo-New Delhi and Moscow-New Delhi MTN circuits could be planned for next year. A letter from the Secretary-General was sent to all Members concerned to encourage them to proceed with the implementation of the relevant part of the IMTN project. The Commission was pleased to note that RTH Beijing had concluded the required arrangements to join "cloud II", and that Tokyo was firmly planning implementation by mid-2003 and New Delhi in 2003.

6.2.35 The Commission noted with satisfaction the progress made in the implementation of the IMTN project and expressed its great appreciation for the collaborative effort made by the NMHSs concerned that would contribute to the upgrade of the GTS as a whole.

TELECOMMUNICATION TECHNIQUES AND SERVICES

6.2.36 The Commission recommended satellite-based DVB and DAB data-communication techniques for improving the implementation of GTS data-distribution systems. DVB, as a digital high-capacity transmission system, could transmit data files and supported standard procedures (IP, FTP). Several satellite-based telecommunication providers provided DVB services via satellite (DVB-S). The two satellite-based data-distribution systems of Region VI RMTN, RETIM and FAX-E were being upgraded based on DVB-S transmission techniques. The Commission was pleased to note that the services were inter-operable. DVB-S services were a highly cost-effective solution in terms of recurrent and investment costs for meteorological data-distribution with large capacity (multiple 10 Mbit s^{-1}).

6.2.37 DAB, as a digital transmission system, could transmit other data as well as audio. Satellite-based digital audio broadcast services, such as those provided by WorldSpace, also included commercial "datacasting" services. Current services covered Africa and Asia, and were planned for the Americas. The WorldSpace radio and Internet (RANET) experiment over Africa was based on DAB services. DAB datacasting services were a cost-effective solution in terms of recurrent and investment costs for meteorological data-distribution with moderate capacity (multiple 10 kbit s^{-1}), in particular for replacing RTH radiobroadcasts, taking account of the service area of coverage (satellite beams footprints) and the required access to the satellite uplink sites. The Commission noted that India was replacing the radiobroadcast from RTH New Delhi with satellite-based DAB services as from March 2003.

RADIO FREQUENCIES FOR METEOROLOGICAL ACTIVITIES

6.2.38 The Commission emphasized that the pressure on radio-frequency bands allocated for meteorology (meteorological aids, meteorological satellites, radars and wind profilers, space-borne passive remote sensing) would continue with the increasing development and expansion of new radiocommunication systems. It noted that the agenda for the forthcoming World Radiocommunication Conference (WRC-03) included items of importance for meteorology, and that the fifty-fourth session of the Executive Council requested CBS and the Secretariat to pursue as a matter of high priority the related preparatory activities to secure adequate radio-frequency allocations for meteorology. The Commission noted with appreciation the effective activities undertaken by the Steering Group on Radio-Frequency Coordination and the fruitful contributions from several NMHSs, meteorological satellite agencies, in particular EUMETSAT, and the Secretariat to the relevant ITU-R Sector activities. It further noted with satisfaction that the joint ITU/WMO *Handbook on Use of Radio Spectrum for Meteorology* was published and that the WMO Workshop on Radio Frequencies for Meteorology was held in Geneva (7–8 October 2002) with participants from many NMHSs, including developing countries.

6.2.39 With regard to the WRC-03 agenda, the Commission noted with concern the threat on portions of the 1 675–1 690 MHz band (agenda item 1.31), which might seriously hamper the development of meteorological satellites and operation of radiosondes, in particular in Regions II, III, IV and V. However, the ITU-R preparatory work, as reflected in the report of the Conference Preparatory Meeting, recognized and supported the meteorological requirements in the band and meteorological operations were likely to be safeguarded by WRC-03. The possible sharing of the portion 1 670–1 675 MHz with the mobile satellite service, including adequate measures for the protection of the few main MetSat Earth stations and of radiosonde operation in some countries, was an acceptable compromise that would not be detrimental to meteorological services. The Commission, however, reaffirming the fundamental importance for the WWW programme of radiosonde operation, stressed the need to preclude in the countries concerned the sharing of the band 1 670–1 675 MHz with the mobile satellite service, as long as radiosonde operation would continue to require the band 1 670–1 675 MHz.

6.2.40 The Commission noted that allocations to space-borne passive sensing, which had an increasing importance in meteorology (e.g. observation, NWP, climatology), included protection of space-borne passive sensors that were extremely sensitive to interference, with in many cases exclusive allocations. Noting that several WRC-03 agenda items (1.8.2, 1.13, 1.16) involved Earth exploration-satellite (passive) and space research (passive) service allocations, the Commission emphasized that the utmost importance should be attached to safeguarding the adequate protection of space-borne passive sensing and to pursuing the detailed studies on adequate protection criteria. As regarded space-borne passive sensing, the Commission noted with much concern that there was a serious risk that anti-collision radars for cars be authorized to use the 23.6–24 GHz band. That band was crucial for water vapour measurement. The operation of car radars in that band would have a serious detrimental impact on sounding measurements, thus on the quality of NWP products. The Commission urged all Members to make all efforts to ensure the protection of the radio-frequency bands for passive microwave radiometry, that were a unique natural resource for the atmospheric measurements.

6.2.41 The Commission noted that WRC-03 was also expected to decide upon the inclusion in the next WRC (2005/2006) agenda the feasibility of sharing the 2 700–2 900 MHz band, which was worldwide allocated to meteorological radars, with the IMT-2000 operation (third generation of mobile phones). ITU-R studies showed incompatibility between IMT-2000 operation and meteorological radar operations. The Commission emphasized the crucial importance of meteorological radars, in particular for forecasting and warning heavy rain and floods, and strongly supported that the 2 700–2 900 MHz band be safeguarded for sustainable meteorological radar operation.

6.2.42 The Commission urged Members to ensure that their respective national Radiocommunication Authorities were fully aware of the impact of the relevant WRC-03 issues for meteorological operations and to seek their support for issues relevant to meteorology.

METADATA STANDARDS

6.2.43 The Commission emphasized that technical data exchange was the key to the success of the WMO Programmes. As the variety and volume of data increased, the need for describing those data in an unambiguous way became essential if best use was to be made of data within and between different Programmes. A standard approach to describing data was central to the concepts behind the proposals for the future WMO information system. “Metadata” was the technical term used for the information that described data.There were three stages in making use of data; a different level of detail was required for metadata at each stage:

(*a*) “Discovery level.” The first step in using data was to find out (“discover”) where the data of interest might be obtained;

(*b*) “Request level.” Once potential sources of data had been identified, the user could approach one of the data providers with a more specific request;

(*c*) “Usage and management level.” The third level of metadata was more detailed, describing not only the general aspects of the data but also specific details (such as the precision and units).

6.2.44 The Commission endorsed the conclusions of the report of the Expert Team on Integrated Data Management that the ISO standard for geographic metadata was suitable for use within WMO (ISO DIS 19115). Using an existing standard as the basis for metadata within WMO permitted to have access to skills and tools from communities outside WMO. The Commission noted the WMO core minimum set of information that was considered to be essential for exchanging data for WMO purposes. That was intended to be adequate for the “discovery” level.

6.2.45 The Commission recognized that the information in the WMO core metadata would not itself meet all the requirements for describing data for all WMO Programmes. A far more comprehensive standard would be required for that. The Commission recommended that each WMO Programme use the WMO core metadata as a starting point to develop more detailed metadata standards in response to its own requirements. Those more-detailed programme-specific standards should, to the extent possible, be based on the ISO standard with any necessary extensions. Reliance on the ISO standard as a common starting point would reduce the effort required by the Programmes and would greatly enhance the compatibility between the various Programme-specific standards and with the WMO core metadata standard.

6.2.46 Noting that there were many possible ways of representing WMO metadata, the Commission endorsed the recommendation that XML be adopted as the common language (or format) for exchange. It noted that a framework for mapping the proposed metadata standard into XML was developed as an XML schema to ensure interoperability. The Commission recognized that several further actions were required before WMO could adopt the metadata standard for operational use. Key among those was to apply the draft standard to data held by several Programmes, so that practical problems with using the standard could be identified and corrected before the standard was finalized. The second action needed was to publicize the standard, both within WMO technical commissions and elsewhere (for example, registering the interpretation of the standard with ISO). The third major action was to work with other expert teams to implement the detailed metadata required to provide the "management and usage" layer and also the technical mechanisms to transfer metadata with the data they described.

6.2.47 The Commission requested its OPAG on ISS to pursue the development of the WMO metadata standard, and tasked its chairperson to involve, to the largest extent possible, members of other technical commissions in assessing the proposal and in testing the standard by applying it to their data. It also invited its president to address that important matter at a future meeting of presidents of technical commissions.

WMO *GUIDE ON WWW DATA MANAGEMENT* (WMO-NO. 788)

6.2.48 Noting the speed at which details of information technology were changing and the fact that including outdated technical information within WMO publications would be misleading, the Commission decided that the content of the WMO Guide on WWW Data Management should be revised substantially by the OPAG on ISS. The Commission asked that the Guide should be designed for electronic publication and that only those aspects of the *Guide* that described best practices should be maintained by WMO in the official languages. Guidance on other aspects of data management should be included indirectly through references to other sources of information available on the Web. It recognized the implication that some of the more technical information might not be available in all the official languages. The Commission also asked the OPAG on ISS to establish a process to verify and update the references at an appropriate frequency.

INTEGRATED WWW MONITORING

6.2.49 The project on integrated WWW monitoring, as agreed by the Commission at its twelfth session, comprised two parts: an operational trial of the proposed integrated monitoring and an extension of the SMM.

6.2.50 With respect to the relevant extension of the SMM, the Commission noted that all participating RTHs on the MTN had been invited to implement the following extensions, as from October 2002, if feasible:

(*a*) To monitor all bulletins with indicators ii=01-39;

(*b*) To monitor the SYNOP bulletins with T_1T_2 = SI and T_1T_2 = SN, and the SHIP bulletins with T_1T_2 = SI;

(*c*) To monitor the SYNOP bulletins containing observations designated as "additional" as defined in Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities. The Secretariat was tasked to prepare the list of the bulletins containing "additional" data for the next SMM exercises.

6.2.51 Noting the development of the use of the BUFR code, in particular through the migration from traditional alphanumeric codes to table-driven code forms, the Commission stressed the importance of monitoring data presented in the BUFR code. It invited RTHs on the MTN, in particular RTHs Melbourne, Offenbach, Tokyo and Toulouse, to consider participating with high priority in the preparation of a pilot study and in preliminary tests for the monitoring of BUFR bulletins.

6.2.52 The Commission also noted the change of dates of the SMM from 1–15 February to 1–15 January as from January 2003, at the same time as for the specific monitoring of the exchange of Antarctic data. It was concerned that the change of the period from 1–15 February to 1–-15 January could lead to certain difficulties in implementing the specific monitoring on the exchange of Antarctic data at some centres, in particular with respect to 1 January. The Commission requested the Secretariat to consider further that issue with respect to all monitoring activities.

6.2.53 The Commission recalled that it had agreed, at its twelfth session, that an operational trial of the proposed integrated monitoring should include at least one MTN centre, one associated RTH and two associated NMCs, with a view to assessing the implementation impact, in particular as regarded the resources needed at RTHs and NMCs vis-à-vis the resulting benefits. It noted that a tentative project was developed, involving RTH Toulouse and two associated NMCs, as well as one RTH and an associated NMC in Region I. The Commission was informed that a workshop was planned to be held by mid-2003 at RTH Toulouse for the centres that would participate in the trial, with a view to developing all the detailed arrangements for the trial. It also noted that the trial should also serve, as far as possible, as a benchmark for the specifications and test of a PC dedicated for monitoring applications. It requested the OPAG on ISS to analyse the results of the trial, and, in light of the outcome, consolidate and submit the procedures for the integrated monitoring to the Commission, at its next session.

DATA REPRESENTATION AND CODES

6.2.54 The Commission noted with appreciation the work of the Expert Team on Data Representation and Codes and thanked Mr J. Clochard (France), who chaired the Team.

MODIFICATIONS TO DATA REPRESENTATION TABLES APPROVED DURING THE INTERSESSIONAL PERIOD

6.2.55 The Commission recalled Recommendation 9 (CBS-01), implemented on 7 November 2001, after approval during the intersessional period by the president of CBS and the President of WMO, concerning additions to table-driven code tables:

(*a*) Adding a note under GRIB edition 2 Data presentation templates 5.1 and Data template 7.1;

(*b*) Adding new entries for Code table 3.2 — Shape of the Earth;

(*c*) Representing in a better manner icing in BUFR/CREX Code table 0 20 021;

(*d*) Adding entries in Code table 0 02 163 — Height assignment method;

(*e*) Adding new significance qualifiers;
(*f*) Adding entries for the representation of buoy last known position;
(*g*) Adding entires for the representation of satellite "ascending vs. descening" orbit;
(*h*) Adding new elements for oceanographic data.

MODIFICATIONS TO THE *MANUAL ON CODES* (WMO-NO. 306)

6.2.56 Noting further tests and experimental exchanges with the new FM 92 GRIB edition 2, the Commission recommended additional templates for the exchange of EPS fields and entries to support additional products of atmospheric transport model output, namely time-integrated airborne concentrations, and to support cloud mask products (see Annex 1 to Recommendation 4 (CBS-Ext.(02)). The Commission noted also the need for increasing the maximum bulletin size (up to 500 K octets) on the GTS to accommodate the higher resolution fields and ensemble products formatted in GRIB edition 2.

6.2.57 Noting the stated requirements for improving the transmission of data from AWS, XBT/XCTD and subsurface floats, and CLIMAT stations as well as the resulting proposals developed by expert groups and CBS teams, the Commission recommended additions related to metadata and capability of sensors to FM 94 BUFR and FM 95 CREX tables (see Annex 2 to Recommendation 4 (CBS-Ext.(02)).

6.2.58 The Commission further recommended additions to BUFR/CREX tables (see Annex 3 to Recommendation 4 (CBS-Ext.(02)) for:

(*a*) Exchanging geostationary satelite radiance data;
(*b*) Transmission of ensemble tropical cyclone tracks;
(*c*) Transmission of AMDAR data and AMDAR vertical profile (ascent/descent of aircraft);
(*d*) New monitoring information;
(*e*) New Common table C-11 for Originating centres;
(*f*) New Table B descriptors for use with AMSU A/B satellite data;
(*g*) Clarifying a regulation on replication operation in BUFR;
(*h*) New Table B descriptors for use with next generation rawindsonde data (from the United States);
(*i*) Descriptors used in reporting certain types of AIRS satellite data;
(*j*) Supporting JASON satellite data;
(*k*) Coding certain types of altimeter data;
(*l*) For representation of ground-based global navigation satellite system data in BUFR format.

6.2.59 At the request of CBS-XII, the modifications for reporting zero and 24-hour precipitation in synoptic reports were finalized and the Commission recommended their implementation in November 2003. The Commission recommended also an addition to one regulation for improving the coding of CLIMAT TEMP and CLIMAT TEMP SHIP reports (see Annex 4 to Recommendation 4 (CBS-Ext.(02)).

6.2.60 After the clarifications of the requirement by ICAO, the Commission agreed that the names METAR, SPECI or TAF should only be required at the beginning of each report, and should not be inserted at the beginning of the bulletin. The Commission recommended the new format and other changes due to Amendments 72 to ICAO Annex 3/WMO Technical Regulation [C.3.1], with a view to their operational implementation in November 2004 (see Annex 5 to Recommendation 4 (CBS-Ext.(02)). The Commission agreed that, in order to ensure a coordinated implementation, the dates for implementation of amendments to the aeronautical codes should be conditioned by operational constraints and should be simultaneous with the dates of implementation of all other code changes. The Commission recommended that those modifications to aeronautical codes should be implemented on the first Wednesday following 1 November 2004.

6.2.61 The ICAO observer informed the session about future changes to the METAR/SPECI, TAF and WINTEM code forms, which would have to be made as a consequence of Amendment 73 to Annex 3 (applicable in November 2004). Since Amendment 73 was still, in principle, subject to changes, which might result from the consultation with States, the Commission agreed not to include the corresponding amendment to the codes. It was concluded in that regard that, before approving any amendments to the *Manual on Codes* (WMO-NO. 306) which were consequential to ICAO Annex 3, the Annex 3 amendment must have been first finalized (i.e. reviewed by ICAO Air Navigation Commission). It was realized that that approach could delay the applicability date of the amendment to the *Manual on Codes*. The Commission noted that that would be the case with the code changes consequential to Amendment 73 to Annex 3.

6.2.62 The Commission adopted Recommendation 4 (CBS-Ext.(02)).

6.2.63 The Commission appreciated that the Expert Team on Data Representation and Codes had finalized templates for the transmission in BUFR or CREX of AWS data, of SYNOP, SYNOP MOBIL, SHIP, PILOT, PILOT SHIP, PILOT MOBIL, TEMP, TEMP DROP, TEMP SHIP, TEMP MOBIL, XBT/XCTD, sub-surface profiling floats, BUOY, AMDAR, AIREP, METAR/SPECI, CLIMAT, CLIMAT SHIP, CLIMAT TEMP and CLIMAT TEMP SHIP, as well as of new AMDAR, extracted AMDAR vertical profiles and tropical cyclone tracks. The Commission agreed that those templates should be made available on the WMO Web server and as an Attachment to Volume I.2 of the *Manual on Codes*. The Commission also agreed that new reporting practices linking observations with BUFR or CREX formats should also be listed as an Attachment to Volume I.2 of the *Manual on Codes*.

6.2.64 The Commission was pleased that the new *Guide on BUFR and CREX* had been completed and made available on the WMO server. The Commission recommended, as suggested by Hong Kong, China, the development of a suite of computer programs for encoding and decoding the different types of data mentioned in the previous paragraph in BUFR and CREX codes to facilitate migration. Those programs should be made available on the Web. The Commission was also expecting the finalization of the *Guide on GRIB Edition 2* at the beginning of 2003.

6.2.65 The Commission noted with appreciation that the CBS Management Group had requested the nomination of national focal points for matters relative to WMO codes and data representation, including the migration to table-driven code forms. The Commission was pleased that almost 100 countries had so far nominated a focal point. The Commission requested the Secretariat to keep the focal points informed of the code changes recommended by the Expert Team. The Commission took note that the CBS Management Group had recommended that the fast-track mechanism for modifications to table-driven codes should be reserved for urgent operational problems.

6.2.66 The Commission agreed on the new three-step mechanism proposed by the Expert Team, with a view to accommodate user needs, as followed:

(*a*) Approval (by the chairperson of the Expert Team on Data Representation and Codes, OPAGs and the CBS president) of allocated entries after expression of requirements. The list was kept on-line in the WMO server;

(*b*) After validation, declaration of pre-operational use (approval by the chairpersons of the Expert Team on Data Representation and Codes, OPAGs and the CBS president). The list was kept on-line in the WMO server;

(*c*) Approval by CBS and the Executive Council and insertion in the *Manual on Codes*.

USE OF XML FORMAT TO EXCHANGE METEOROLOGICAL INFORMATION

6.2.67 The Commission noted that the Expert Team on Data Representation and Codes concluded that the inherent characteristic of XML was making it unfit to translate bulky data such as satellite, GRIB, or a large number of BUFR encoded observations. Manipulating GRIB or BUFR data in XML would be possible only as objects of the XML data set. The use of XML could be appropriate to exchange a limited number of observations, in particular XML could be used to exchange documents or to pass information such as METNO, forecast information, warnings, etc. XML would also be appropriate for exchanging metadata. The Commission agreed that there was a requirement to standardize the exchange of meteorological observations in XML. The Commission recommended the organization of a workshop on the use of XML in meteorology to elaborate further on requirements, problems and solutions and to develop standards for describing meteorological parameters and objects; experts on XML from outside WMO should be invited to attend that workshop.

MIGRATION TO TABLE-DRIVEN CODE FORMS

6.2.68 The Commission considered the draft plan for migration to table-driven code forms developed in response to the request of its twelfth session. The summary of the plan is given in Annex III to this report. The Commission found that the plan was thorough and that it addressed all aspects of the migration known so far. The Commission thanked the chairperson of the Expert Team on Migration to Table-driven Code Forms, Mr Fred Branski (United States), and the team members for their excellent work.

6.2.69 The Commission stressed that in order to achieve a successful migration, the data users would need decoding software and support for that software early in the process. The NMCs would also have to analyse the possible impacts on data processing that might result from the availability of new BUFR or CREX reports, new parameters and new metadata. Immediate fixes for maintaining operations and adjustments to database management systems and application programs might be necessary. Manually-operated NMCs should seriously consider the introduction of automation as soon as possible and should plan for training manual operators in the use of CREX as an interim solution. Data-processing software developed or provided from elsewhere would need to include universal BUFR and CREX decoders, as well as GRIB 1 and GRIB 2 decoders. Manufacturers of meteorological systems should strive to support those formats in their products. The Commission agreed that the services of volunteering software support centres that would provide free-of-charge well documented, validated, universally applicable encoder/decoder computer programs, would be essential for the broad acceptance and implementation of the migration plan. The Commission stressed that the encoding and decoding software should be user friendly and able to run under different types of operating systems, such as UNIX, LINUX and Windows.

6.2.70 The Commission was very pleased that ECMWF would make software running under UNIX and LINUX for encoding/decoding BUFR, CREX and GRIB 1 and GRIB 2 available free of charge for WMO Members. Starting in 2003, the software could be downloaded from their Web site with appropriate documentation. ECMWF would upgrade the Code tables and the programs on the Web site, when necessary, and would provide some limited remote assistance after e-mail queries. The Commission was informed that the Russian Hydro-meteorological Service was currently developing an encoding/decoding software under Windows, that could be made available free to other NMHS. The delegate from the United Kingdom also indicated that their encoding/decoding software was available free of charge upon request for WMO Member countries. The Commission expressed its appreciation and thanks for those contributions.

6.2.71 The Commission, noting that it was possible to exchange BUFR and CREX data via the Internet, requested the OPAG on ISS to promote the development of a turn key software package in a PC-Windows environment to decode and encode BUFR and CREX data via the Internet.

6.2.72 The Commission recognized that costs would be involved in the implementation of the migration plan, but agreed that they would be compensated by the benefits to be gained, noting that the migration plan allowed sufficient time and flexibility for implementation. It stressed that training was a fundamental prerequisite of the migration process, for which trainers should be trained first and a training methodology and material would need to be developed. The Commission felt that relevant manufacturers should also be included in the training, preferably in the form of a workshop to be held in 2003 at no cost to WMO.

6.2.73 The Commission recommended to carry out pilot projects beginning in 2003, which should reveal the real problems that a developing country would have to face in implementation of the migration to table-driven code forms. That should help every country in formulating its own national migration plan with an analysis of impacts, costs, sources of funding, training measures, technical solutions and schedules. The Commission noted with interest the report on a case study on the impacts and requirements for the migration to table-driven code forms in the NMHS of Uzbekistan. The Commission appreciated that the implications of the migration were described for the whole meteorological data flow including the production of observations, the national and international telecommunications and data processing. It stressed that priorities should be established for the development and implementation of national migration plans. In particular, the first action should be the development of the capability to receive and process incoming table-driven code form data from the GTS. The generation of table-driven code form data, which might be a more complex issue, should be addressed in a second phase.

6.2.74 Japan informed the Commission that, with respect to the responsibility of RTH Tokyo as a collecting centre for SHIP reports, it planned to transmit in BUFR format the collected reports for insertion into the GTS, with dual dissemination during a transition period. The Commission invited Members operating collection centres for SHIP reports, buoys, XBT/XCTD, sub-surface floats and AMDAR reports, to provide also data in BUFR format.

6.2.75 To avoid any undue disruptions in the operations, the Commission felt that an effective mechanism must be put in place for monitoring and coordination. Each national focal point on code matters should be actively involved in the national migration plan. He/she would ensure coordination of the transition process with the regional association and other relevant WMO groups in the Region. The Commission, through its OPAG on ISS and the specific teams it might set up, would provide the central coordination and reporting essential to the success of code migration. The Commission stressed the importance for every Member country to develop as soon as possible a national migration plan, derived from the international plan, with analysis of impacts, costs, solutions, sources of funding (as necessary), national training, technical planning and schedule.

6.2.76 The Commission was informed by the president of CAeM that the conjoint WMO/CAeM/ICAO Meteorology Divisional Meeting (Montreal, September 2002) had recommended that WMO, in close coordination with ICAO, undertake with a dedicated expert team the development of a migration plan for aeronautical codes within the realm of the WWW as well as in the realm of specific aeronautical networks and operations.

6.2.77 The Commission endorsed the migration plan and requested that the final version of that plan be made available in the WMO Web server as guidance for the Members. It invited Members to consult the related material available on the WMO Web server, such as the detailed migration plan or the newly written *Guide on BUFR and CREX*. The Commission agreed to submit the migration plan to Fourteenth Congress for consideration and approval.

FUTURE WMO INFORMATION SYSTEM

6.2.78 The Commission, was pleased to note the progress made by the Inter-programme Task Team on FWIS in its refinement of the FWIS concept. It noted that the Team — taking into consideration the views of other CBS expert teams, the Executive Council and the other technical commissions — had reviewed the FWIS vision that had been proposed at the Commission's twelfth session. The Team determined that, while no significant changes to the concept itself were required, much work was needed to clarify and improve the document that described it. Consequently the Team developed an improved vision that:

(*a*) Included an introduction to define clearly the concept and the reasons for its development;

(*b*) Expanded and improved the text to clarify the relationship with existing centres;

(*c*) Included a new diagram illustrating the relationship of FWIS to existing WMO Programmes;

(*d*) Improved the figures to ensure that they illustrated more clearly the concept.

The Commission also noted with interest an analysis of potential technical and operational issues related to the transition of the current WWW information system to the FWIS. It noted that the analysis was available on the WMO Web site at http://www.wmo.ch/web/www.

6.2.79 The Commission noted that the current WMO information systems had been developed to meet a diverse set of requirements. The principal system was the GTS along with the related data-processing and management functions that had been developed to serve the WWW. The GTS had a number of significant strengths: it was an operational private network that mainly provided for the exchange of real-time high-priority data, and it was mature, well tested, regularly upgraded and operated according to well-defined procedures and shared responsibilities.

6.2.80 Other information systems that had been developed to meet the needs of other programmes and Commissions had their own advantages. Given the diversity of those systems, it was difficult to provide a concise summary. However, most shared a common strength — they had been developed by individual programmes to meet their specific requirements. Thus, the systems were generally focused in their approach and did not suffer from compromises and inefficiencies that could sometimes result from the development of generalized systems.

6.2.81 The multiplicity of systems operated for different programmes had, however, resulted in incompatibilities, inefficiencies, duplication of effort and higher overall costs for Members. Continuing to develop systems in that uncoordinated manner would exacerbate those problems and would further isolate the WMO Programmes from each other and from the wider environmental community. It would increase the difficulty in sharing information between programmes, which was essential for them to fulfil their requirements. As a consequence, other organizations, environmental programmes or commercial concerns might assume responsibility for providing essential data and services and WMO would thus lose its leadership role.

6.2.82 The Commission noted that the Task Team recognized that one option to address those problems might be to enhance and extend the GTS in such a way as to generalize the services to all Programmes. However, the Team felt that the specificity of the GTS, dedicated to real-time high-priority data exchange between NMHSs, would prevent it from meeting cost-effectively all of the requirements of WMO Programmes.

6.2.83 The Commission noted the overarching approach that had been proposed: a single coordinated global infrastructure, the FWIS. It was envisioned that FWIS would be used for the collection and sharing of information for all WMO and related international programmes. The FWIS vision provided a common roadmap to guide the orderly evolution of the information system functions performed by current WMO Programmes into an integrated system that met efficiently all of the requirements of Members for the relevant international environmental information. The Commission noted that the FWIS concept was consistent with the WWW structure.

6.2.84 The Commission emphasized that the implementation of FWIS should build upon the most successful components of existing WMO information systems in an evolutionary process. The Commission agreed that, with respect to the requirements for highly reliable delivery of time-critical data and products, and in particular for the WWW, the concept should clarify that the FWIS would build upon the GTS. It particularly noted that the MTN, taking into account its current evolution into the improved MTN, would be the basis for the core communication network interconnecting the GISCs. The FWIS should also identify and acknowledge the national level of the WMO information systems, that were currently included in the GTS structure and were of crucial importance for national data collection. Taking into account that information systems technology was evolving rapidly, and strengthening further the current trend of the current GTS development, the FWIS should utilize international industry standards for protocols, hardware and software. Use of those standards would reduce costs and allow exploitation of the ubiquitous Internet and Web services.

6.2.85 The Commission noted that, in order to clarify the concept of FWIS and differentiate its elements from the current WWW system, three functional components were defined: NCs, DCPCs and GISCs. The functions of those components and related flow of information are described in Annex IV to this report.

6.2.86 The Commission noted that the information and communication responsibilities of existing WWW and other WMO Programme centres could be mapped into the corresponding functions within FWIS as illustrated in the table below. The FWIS functions would be an evolution of the existing functions and responsibilities of the participating centres, with respect to information and communication services. The Commission noted that the FWIS functions would entail, in most cases, additional functions and responsibilities in comparison with the current WWW centres. It noted, however, that some centres were already performing most of the FWIS functions. The Commission requested the Task Team to develop into more detail the comparison and mapping of the respective functions and responsibilities of FWIS and WWW centres.

Current WWW centres	*FWIS functions*
NMC (as regarded information and communication)	NC
RSMC (as regarded information and communication)	DCPC and/or GISC
WMC (as regarded information and communication)	DCPC and/or GISC
RTH	DCPC
RTH on MTN	DCPC and/or GISC
Other programme centres	NC and/or DCPC

6.2.87 Noting that NMHSs spanned a range of responsibilities and capabilities, the Commission recognized that FWIS would provide a flexible and extensible structure that would allow NMHSs to enhance their capabilities as their national and international responsibilities grew. CBS noted that centres considering participation in FWIS might be concerned that that would entail additional costs and replacement of equipment. However, FWIS would be built upon existing systems and those systems could continue to carry out their current tasks without modification. Additional equipment would probably be required if centres chose to provide the enhanced services offered by FWIS, but additional facilities would have been required anyway to meet increasing requirements and responsibilities. Overall, cost savings would likely be realized since FWIS would provide a coordinated framework and structure for those developments.

6.2.88 The Commission recognized that, as the objective of the FWIS was to support the information exchange requirements of all WMO Programmes, a comprehensive assessment of the requirements as regarded information types and volumes, timeliness, sources and users, security, etc. was needed in order to consolidate the FWIS concept and to develop design and implementation plans. The Commission therefore requested the OPAG on ISS and its Task Team to compile and consolidate urgently the requirements from the relevant WMO Programmes. CBS emphasized that the design, implementation and operation of FWIS would require the participation of many programmes and centres. Since all WMO Programmes stood to benefit, each must actively participate and contribute its own expertise and resources in all phases of the development of the FWIS. The support and involvement of many members of the WMO community, including especially regional associations and technical commissions was needed, as early as possible, in all phases of the FWIS development in order to ensure a full and shared ownership of the project, and its effective implementation.

6.2.89 The Commission agreed that further development of FWIS should be pursued towards the refinement and consolidation of the concept and the design and implementation planning phases. The evaluation of enabling technologies by means of pilot projects and prototypes was recognized to play an essential role. Successful prototypes should then be expanded to serve additional communities and/or be distributed to other Members and centres for wider implementation. In that way, the enhanced functions provided by FWIS should be gradually introduced and expanded, while ensuring the required international coordination and compliance to international standards. The Commission also emphasized that additional GTS expertise should be involved in the further phases of development of the FWIS.

6.2.90 The Commission noted the requests of the fifty-fourth session of the Executive Council related to the FWIS (see general summary paragraphs 4.5 and 4.6). It agreed that although further refinement and consolidation of the concept was required as noted above, the technical background and orientations for the FWIS concept, that were required to support a study on policy-level implications, were now available from the outcome of the session. The Commission was of the view that the policy-level study requested by the Executive Council, to be submitted to the Executive Council Advisory Group on the Role and Operation of NMHSs, was beyond the Commission's mandate and should be carried out by (a) consultant(s), with the technical assistance and support of the chairperson of the OPAG on ISS, as required.

6.3 DATA-PROCESSING AND FORECASTING SYSTEMS (agenda item 6.3)

6.3.1 The Commission thanked Ms Angele Simard (Canada), chairperson of the OPAG on DPFS who also served as chairperson of the ICT on DPFS, for her report. It noted with satisfaction the significant progress made and the achievements attained by the OPAG Teams and Rapporteurs in addressing the requirements of the WWW and other programmes and in accomplishing their tasks in collaboration with experts of other Commissions working under the auspices of OPAG. The Commission expressed its thanks to all experts who served on the subsidiary bodies of the OPAG on DPFS. The relevant bodies were the Expert Team on Ensemble Prediction Systems, the Emergency Response Activities Coordination Group, the Expert Team on the Infrastructure for Long-range Forecasting, the Expert Team to Develop a Verification System on Long-range Forecasting, and the Rapporteurs on the Application of NWP to Severe Weather Forecasting and on the Impact of Changes to GOS on NWP.

ENSEMBLE FORECASTING METHODOLOGY AND PROGRESS

6.3.2 Short- and medium-range ensemble forecasting were viewed as integral in a seamless suite of products. Those systems enabled estimates in the forecast confidence of specific weather threats, first, in the context of the larger-scale circulation pattern and associated weather at medium range and, then, in the details of the weather system and sensible weather in the short range. There was a growing interest in EPS and the numbers of EPS producers and users had been increasing. The focus of targeted meteorological phenomena in use of EPS products now included extratropical systems, tropical phenomena and mesoscale features. The application of short-range regional model EPS was being used on a quasi-operational basis and medium-range model EPS for national early warning systems were operational in many centres. The Commission agreed with the assessment of the Technical Conference on Data-processing and Forecasting System (Cairns, Australia, 2–3 December 2003) that EPS products clearly had the potential to benefit forecasting services in all areas and in particular for high impact weather and seasonal prediction and application in environmental prediction, hydrological modelling and environmental emergency response by providing probability forecasts for specific environmental variables dependent on atmospheric drivers (see also general summary paragraph 6.3.48).

6.3.3 The Commission encouraged Members to implement measures so that:

(*a*) Derived EPS products for short-range and medium-range forecasting recommended for routine dissemination including direct model fields of the EPS were made available to requesting WMO Members;

(*b*) Where GTS would not be able to handle the amount of EPS data, fields could be transmitted by other available means such as FTP services on the Internet, dedicated lines or satellite distribution systems;

(*c*) The FM-92 GRIB edition 2 format, the most practical code for the exchange of gridded EPS data, should be used for that purpose;

(*d*) In the Web site of the EPS producer, a catalogue of EPS fields and products should be available. Documentation on the EPS system should be provided, i.e. time of availability of products, version number of EPS system, last modifications, perturbation method, etc. Verification scores should also be provided;

(*e*) Verification procedures and the exchange of results of EPS products were carried out as a simple extension of current NWP scores defined in the *Manual on the Global Data-processing System* (WMO-No. 485) for short and medium range.

6.3.4 The Commission recommended updates to the *Manual on the Guide on the Global Data-processing System* to include EPS, but considered it should be limited to products covering medium to extended ranges. It agreed that a new chapter in the *Guide on the Global Data-processing System* (WMO-No. 305) was also required and recommended that a consultant should gather and write the necessary material. It adopted modifications to Parts I and II of the *Manual on the GDPS* and an expanded Appendix II.6 as given in Annexes 1 and 2, respectively, to Recommendation 5 (CBS-Ext.(02)).

6.3.5 The Commission noted that EPS products were already available from several centres and welcomed those initiatives. It encouraged other centres producing EPS products to consider making those available also. It endorsed the high priority given in user requirements to EPS products.

6.3.6 The Commission also emphasized the need for centres providing EPS products to verify also those products and to make verification statistics available to NMHSs. It encouraged Members who used EPS products to access verification statistics and to gain experience in interpreting those statistics. It adopted EPS verification procedures as given in Annex 3 to Recommendation 5 (CBS-Ext.(02)).

SEVERE WEATHER FORECASTING

6.3.7 The Commission noted with appreciation the report of the Rapporteur on the Application of NWP to Severe Weather Forecasting, and the results of the survey on operational practices. It was noted that current arrangements for the provision of forecasts for tropical cyclone gave a good example of the benefits which could be derived from a more structured approach with different levels of responsibilities.

6.3.8 The Commission recalled the other phenomena, which could be classified as severe weather events:

(*a*) Enhance extratropical storms over ocean or over land;

(*b*) Large-scale heavy precipitation and high intensity precipitation over small areas for short duration (heavy rainfall or snowstorm);

(*c*) Active convective events with associated phenomena (heavy precipitation, hail, lightning, gusts, tornadoes);

(*d*) Persistence of extreme temperatures (cold or heat spells);

(*e*) Phenomena lowering dramatically the visibility or disrupting transportation (fog, duststorm, black ice).

6.3.9 The Commission recognized that extreme temperatures such as heat waves or cold outbreak over rather large areas could be forecast with some success from the current NWP model fields. It also recognized that several categories of meteorological phenomena such as fog or black ice, which had high impact on transportation were often linked to local conditions and could be better handled by NMSs rather than by regional specialized centres producing large scale general guidance. The Commission, therefore agreed to give priority to the first three categories. It further agreed to encourage the implementation of forecast guidance related to tropical cyclones and to follow-up the new development in that area.

6.3.10 The Commission encouraged NMSs, without an adequate technical environment and relying on valuable information and guidance provided by other centres, to develop the necessary good knowledge about the possibilities and the limitations of the automatic systems which were used and the products which were made available from NWP centres.

6.3.11 The Commission encouraged NWP centers to produce additional or specific products that could bring valuable assistance to locate better the various forcings and to assess the synoptic conditions in which severe convection was likely to take place. Such products were, for example:

(*a*) Potential vorticity maps;

(*b*) Parameters on isentropic or iso potential vorticity surfaces;

(*c*) Isotaches contouring to locate jet streams and jet streaks;

(*d*) Stability indices, wind shear, helicity.

6.3.12 The Commission noted that, especially in the case of severe weather events, the evolution of the current models was very sensitive to model physics as well as the initial conditions so that it was not possible to completely rely on the solution given by the model. There was the need to increase further the resolutions of regional models to below 10 km to capture mesoscale features, to improve further data assimilation, and to enhance data availability in data-sparse areas in the tropics and southern hemisphere. That was the reason why automated forecasts produced by NWP models had to be carefully examined by the forecasters before warnings of the occurrence of severe weather events were issued. The forecasters had to acquire a good knowledge of the meteorological concepts that led to severe weather in order to be able to recognize it with the help of model outputs. The survey indicated that several countries did not yet make use of EPS products, and other NWP guidance, because they were not yet aware of the products, or they did not have sufficient bandwidth to access products, or they lacked education and training in the use of those products. The survey also noted the importance of remote sensing and nowcasting systems to enable detection of outbreaks of severe weather events, which were not well captured by current NWP systems, and to anticipate their development. It was important to promote cooperative actions to help NMSs set up or improve such systems, and to participate in training.

6.3.13 The Commission agreed that the improvement of severe weather forecasting would be facilitated by products, which were generated by three categories of systems:

(*a*) EPS information about the probability of the occurrence of severe weather events;
(*b*) NWP current products (wind, temperature, humidity, vertical velocity, etc.) and some additional ones (potential vorticity, stability indices, wind shear, helicity) which provided useful information about the synoptic environment favourable to strong convective events and to identify conceptual models;
(*c*) Products issued by nowcasting tools based on extrapolation techniques which required all available real-time data.

The Commission emphasized the need for collaboration between Meteorological and Hydrological Services to optimize the use of meteorological forecasts and warnings on intense precipitation in assessing and predicting severe hydrological events such as floods.

EMERGENCY RESPONSE ACTIVITIES AND ATMOSPHERIC TRANSPORT PRODUCTS

6.3.14 The Commission noted that while emergency response activities were highly focused on the support to NMSs in nuclear emergencies, there was interest that the underlying science and methodologies of atmospheric transport models should be applied to non-nuclear emergency situations. Noting that the capacity and capabilities (non-nuclear) varied across the RSMCs, it was agreed, in principle, that requests should be made and that the RSMC could consider such requests on a case-by-case basis.

6.3.15 The Commission noted that while new approaches were being sought for the distribution of (or access to) specialized product, the facsimile was still the official operational means. Distribution by Web-based approaches, via the Internet, needed to be carefully considered and designed so that operational time-critical distribution and availability were assured, e.g. with operational redundancy.

6.3.16 The Commission, as a means of validating model performance (e.g. new models) before implementation, encouraged the adoption of standard data sets from field experiments for model intercomparisons and calibration.

6.3.17 The Commission recognized the benefits of collaboration with CTBTO, and noted that meteorological data from CTBTO were available to WMO Members via the GTS.

6.3.18 The Commission agreed for the future work programme in that specific area should include the following:
(*a*) Continue to develop the overall framework and plans to implement a reliable operational distribution system for specialized products;
(*b*) Explore and test EPS including multimodel/poor person’s ensemble approach for atmospheric transport modelling.

6.3.19 The Commission identified as issues to be further explored, the verification of transport models, for example model-related intercomparison using monitoring data and adherence to the agreed operations standards in the overall quality management of the response services.

6.3.20 The Commission agreed on further activities that should be pursued, in particular the need to continue as present, but with more involvement of the NMHSs; further clarify the roles and procedures; implement Web technologies with appropriate Internet back-up facility for the dissemination of products; identify clearly additional observation requirements for emergency response; enhance the role of NMSs and contribute to their capacity building through sharing of software and training; develop further the framework for cooperation with CTBTO; enhance guidance and procedures for response to non-nuclear dispersion problems and develop networks in the area.

6.3.21 The Commission endorsed the desire of Members that the broad environmental issues such as transboundary air pollution, chemical spills, etc. should be investigated in the context of environmental emergency responses. It agreed on the need for NMSs to explore the application of atmospheric transport models to air quality, propagation of airborne diseases and other hazards or consequences related to natural disasters, with the cooperation of RSMCs with specialization in emergency response. It invited the Coordination Group on ERA to explore expansion of modelling applications and response procedures to non-nuclear incidents including potential incidents that a Member(s) might consider imminent and for which RSMC transport model output support was required.

6.3.22 The Commission considered and endorsed some modifications to the text of the *Manual on the GDPS* and to the *Documentation on RSMC Support for Environmental Emergency Response* (WMO/TD-No. 778), as given in Annex 4 to Recommendation 5 (CBS-Ext.(02)), that clarified the following issues:
(*a*) In order to inform timely NMSs about nuclear incidents, the GTS messages would be distributed for site area emergency and general emergency;
(*b*) For a general emergency where products were requested, distribute the basic products to IAEA and all national Meteorological Services in the Region;
(*c*) IAEA only wanted products from the RSMCs whose responsibility included the country of the accident, while the other RSMCs were to send their products only to the NMSs in their region (not including IAEA) and WMO;
(*d*) RSMCs were only required to respond upon the receipt of the form “Request for WMO RSMC Support”;
(*e*) Initial run should be based on information provided on the request form and not necessarily on default values;
(*f*) Current products: The incorporation of a time/date of issue in UTC on all products (i.e. individual charts and faxes), was agreed to as it would save valuable time in collating the various products;
(*g*) A separate request form for RSMC products was prepared for IAEA use (to be included with the

Documentation on RSMC Support for Environmental Emergency Response (WMO/TD-No. 778) and in cooperative arrangements with IAEA).

SEASONAL TO INTERANNUAL FORECASTING

6.3.23 The Commission was pleased to note that the Science Steering Committee for the WWRP, the CAS/JSC Working Group on Numerical Experimentation and appropriate bodies of the WCRP had prepared a WMO Statement on the scientific basis for, and limitations of, weather and climate forecasting which was adopted by the fifty-fourth session of the Executive Council. The Statement gave scientific explanation of the long-range predictability in the atmosphere beyond the average limit of deterministic predictability of individual synoptic-scale weather systems and the clear difference between weather forecasting, prediction at seasonal to interannual timescales and projection of future climate. It was primarily intended to assist NMHSs in their dealing with Governments, the media, the general public and users.

6.3.24 The problem of the infrastructure for the provision of long-range forecasts was of great importance for several WMO Programmes. The problem had been discussed extensively at many meetings of both the WMO working and constituent bodies. Based on that consideration, the Commission noted that the reliable operational global long-range forecast system should include three different types of centres:

(*a*) The Global Producing Centres;
(*b*) The Regional Climate Centres;
(*c*) The National Meteorological and/or Climate Centres.

6.3.25 The Commission noted with appreciation that the Expert Team on the Infrastructure for Long-range Forecasting considered and upgraded the infrastructure needs and requirements for long-range forecasts developed by the Intercommission Task Team on RCCs and other relevant bodies. A list of global products was defined to be made available by global-scale producing centres as given in Annex V to this report. It agreed that that list of global seasonal to interannual products was a good targeting point for the experimental exchange of long-range forecasts but indicated that some centres might only produce a subset of products initially. The Commission noted the conclusions of the Intercommission Task Team on RCCs endorsed by the Executive Council, in particular with regard to the assigned responsibilities to CBS for providing infrastructure for producing global seasonal to interannual forecasts. The Commission recorded its decision on future activities related to the provision of infrastructure for producing global seasonal to interannual forecasts under agenda item 8.

6.3.26 The Commission noted that the WMCs and RSMCs with geographical specialization were expected to produce long-range forecasts according to the *Manual on the GDPS*. Thus they could be the global producing centres in the framework of the WWW. The ECMWF and some institutes such as IRI (United States), the Max Planck Institute for Meteorology (Germany) and some advanced meteorological organizations outside WMO could also serve as global-scale long-range forecast producing centres. The Commission noted with satisfaction that following the decision of the fifty-fourth session of the Executive Council, a workshop of potential global producing centres was being organized in February 2003 to facilitate the early commencement of the experimental sharing of the products.

6.3.27 The Commission also concurred with the recommendations of the Intercommission Task Team on RCCs that functions of the RCCs should be flexible in order to reflect the regional needs and that regional associations might chose among several options for the creation of RCC functionalities where those were required — for example the establishment of a centralized RCC versus the establishment of an RCC with distributed functionalities.

VERIFICATION OF LONG-RANGE FORECASTS

6.3.28 The Commission was informed that experience at several centres with the experimental standardized verification scheme adopted at CBS-XII had shown that the large number of area-averaged statistics did not provide a proportionate amount of information on the quality of the forecasts to either system developers or users.

6.3.29 The Commission noted the conclusion of the Intercommission Task Team on RCCs, in particular with regard to the responsibilities for verification, where the CBS verification team was to develop and implement verification schemes for seasonal to interannual forecasts in collaboration with CAS, while the CCl team would provide leadership in the development and implementation of verification of post-processed products to end users.

6.3.30 The aim of the standardized verification scheme was to provide estimates of the skill of the global-scale products in support of NMHSs and RCCs in their use of those products to provide long-range forecasts to end-users.

6.3.31 The Commission considered the revised procedures for a standard verification system for long-range forecasts as the basis for operational use to focus on providing information on the spatial variability of the forecast skill and an emphasis on measures appropriate to probabilistic forecasts. The statistics were quite basic and could feed in to more advanced measures of utility such as calculations of economic value.

6.3.32 The Commission noted that a basic principle for exchanging verification information was that a multifaceted view of performance could be possible. To that end, and to accommodate a broad range of needs, it was recommended that three levels of information be presented:

(*a*) Summary scores for broad geographic areas;
(*b*) Maps of those and additional scores;
(*c*) Contingency tables.

6.3.33 The Commission noted with appreciation that the new proposal clearly recognized that the timescales for assessing the quality of long–range forecasts were much longer than for NWP. Consequently, most of the emphasis was on making available the statistics from hindcast periods. Centres were encouraged to present comparisons of recent forecasts with the verified observations as a limited monitoring of ongoing performance.

6.3.34 The Commission endorsed the continuing need for a Lead Centre. It acknowledged the work done in WMC Melbourne so far and encouraged the Centre to continue to develop its capabilities. However, the Commission also considered that, in those early stages of the implementation of an operational verification system, it would be beneficial if one or two other centres could assume such a role also. The Commission accepted the offer of Canada and designated RMSC Montreal as a co-lead Centre for verification of long-range forecasts. It noted with appreciation that a few major centres have successfully implemented or are in the process of implementing the Standard Verification System for long-range forecasts, and have agreed to make the results available.

6.3.35 The Commission recognized that there was still considerable work to be done in the commencement of implementation of a standardized verification scheme for long-range forecasts. It considered and adopted Annex 5 to Recommendation 5 (CBS-Ext.(02)).

6.3.36 The Commission considered the future work programme regarding verification of long-range forecasts under agenda item 8.

Operational infrastructure and procedures for the exchange of long-range forecasts and their access by NMHSs and other users

6.3.37 Global long-range forecast products were currently available on the Web sites of many institutions. Those products were key inputs used routinely by agencies including NMHSs in preparing long-range forecast products. The distribution of long-range forecast products had already begun using the widely available systems and formats of the World Wide Web.

6.3.38 That current sharing of products was based on Web sites where many products were available to users, rather than through a formal "exchange" of products. Web products had the advantage of being accessible by widely available standard technology. Evolving technology was likely to facilitate distributed database information and make the products even more accessible.

6.3.39 In order to make available either gridded-derived products or full sets or subsets of model fields, the Intercommission Task Team considered and agreed that FM-92 GRIB edition 2 (GRIB 2) should be used for products posted on FTP sites or disseminated through the GTS. The Commission requested the OPAG on ISS to monitor the use of GRIB 2 for EPS and long-range forecast products and move quickly to remedy any deficiencies or omissions in the formulation of GRIB 2, so that there was no impediment to the exchange of long-range forecast products.

6.3.40 The Commission encouraged global producing centers to participate in multimodel prediction system developments. Such pilot projects would provide experience in the exchange of long-range forecast products. That experience should be reviewed in order to develop improved procedures and infrastructure to facilitate such exchanges.

Workstations

6.3.41 The Commission recalled the conclusions and recommendations developed by the Rapporteur on Workstations. It encouraged Members to cooperate and participate in the sharing of information and software development activities, as a cost effective way of developing workstation applications to benefit all WMO Members. It was noted that requirements for workstations were becoming increasingly acute as a lot of information, such as NWP and remote-sensed data, needed proper tools available on workstations to integrate and visualize forecasts. It urged developed Members to provide proven systems to developing countries through technical cooperation with the support of relevant development funding agencies. Such support should be coupled with strong technical transfer needed to develop the required skills to operate and maintain the systems.

Update of procedures for quality control and exchange of results

6.3.42 The Commission noted with satisfaction the outcome of the CBS Expert Meeting on GDPS Solutions for Data Quality Monitoring hosted by ECMWF in June 2002. It agreed that paragraph 1.2 of the current Attachment II.8 (new version re-numbered II.10) restricting wide dissemination of suspect lists to users was counterproductive and recommended its deletion. It also recommended that all participating centres provide their monitoring reports to participating centres and post them on their Web sites. Real-time information about daily availability and biases should be included.

6.3.43 The Commission noted with satisfaction that the WMO Secretariat, as a follow-up to the recommendation of the Meeting, established a data quality monitoring Index Page on the WMO Web site with links to lead centres and other participating data quality monitoring centres' monitoring reports Web sites. The participating centres were requested to provide the relevant URL addresses and their subsequent updates to the WMO Secretariat.

6.3.44 The Commission adopted updates to current quality monitoring procedures and formats for the exchange of monitoring results for surface and upper-air data including marine, aircraft and satellite data as given in Annex 6 to Recommendation 5 (CBS Ext.(02)).

Training needs related to data-processing and forecasting systems

6.3.45 The Commission agreed that implementation of coherent education and training was critical for realizing the benefits of EPS and for strengthening the capability of developing NMCs in that specific area. It strongly endorsed the recommendation that one- or two-week seminars entirely devoted to EPS should be organized. Priority should be given to the development of a workshop on EPS, including the interpretation of probabilistic products and case studies that were relevant to the trainees. It also endorsed the need for the production of guidance material on the use of ensemble prediction products by forecasters. The Commission noted with appreciation the offer of ECMWF to organize training courses on the use of medium-range forecast products in particular from the EPS to be open to WMO Members with the understanding that WMO would consider some forms of co-sponsorship arrangements.

6.3.46 The Commission emphasized the importance of the training activities that should essentially focus on common techniques and models used in severe weather forecasting. The need to develop a capacity building training policy using approaches such as that pursued for satellite activities was suggested.

6.3.47 The Commission noted that several Members in all Regions were interested in the development of a NWP system on workstations or PCs and agreed on the need for more training on NWP modelling as a means to promote technical transfer from advanced GDPS centres to the developing NMCs. Technical assistance through technical and bilateral cooperation was required. It noted the need for training and education in the use of model transport products. It endorsed the need for a training workshop on the techniques, the models available for providing trajectory and dispersion forecasting.

FUTURE WORK PROGRAMME

6.3.48 The Commission considered the future work programme of the OPAG on DPFS under agenda item 8.

TECHNICAL CONFERENCE ON DATA-PROCESSING AND FORECASTING SYSTEMS

6.3.49 The Commission expressed its appreciation for the convening of the CBS Technical Conference on Data-processing and Forecasting Systems, which was held over the two days immediately preceding the session of the Commission. It was attended by 87 participants from 46 countries and four international organizations. The Commission specifically thanked the Conference Director, Ms Angèle Simard (Canada), the organizing committee and the Secretariat for their excellent preparatory work. It also expressed special thanks to the four session chairpersons and to the authors of papers accepted for oral and poster presentations for the high quality of their papers and presentations, which had generated lively discussions. The Commission reviewed and endorsed the statement and recommendations of the Technical Conference given in Annex VI to this report.

6.4 PUBLIC WEATHER SERVICES (agenda item 6.4)

6.4.1 The Commission noted with appreciation the report of the chairperson of the OPAG on PWS, Mr K. O'Loughlin (Australia). It was informed that the work of the OPAG on PWS was coordinated through three Expert Teams and an Implementation Coordination Team, and that each Team met once since CBS-XII. The Commission expressed satisfaction with the progress and development of the PWS Programme since the last session, noting that the competence and efficiency of the respective teams reflected in the completed tasks that were delivered according to the decisions of Congress.

6.4.2 The Commission recalled that the main purpose of the PWS Programme was to assist WMO Members to provide comprehensive public weather services to the community with particular emphasis on public safety and welfare, and to assist with guidance on educating the public on how best to use those services. The Programme had made important strides over the past two years consistent with that purpose, but much more work remained to be done. Many Members, especially developing countries, needed urgent assistance to develop their capabilities to deliver public weather services effectively against the backdrop of changing global and national economics, and to address issues affecting the status and visibility of NMSs, dwindling government support, and the adverse effects of natural disasters on sustainable development. In that regard, the Commission strongly endorsed the need for the PWS Programme to respond effectively and with sensitivity to the situation and to provide assistance to NMSs so that they could demonstrate the usefulness and indispensability of their services to users in order to fulfil their role in national development.

THE WORK OF THE EXPERT TEAMS

EXPERT TEAM ON MEDIA ISSUES (ET/MI)

6.4.3 The Commission recalled that tasks allotted to ET/MI derived from the response of CBS to Congress requests for the PWS Programme to focus on promotion of better partnerships between NMSs and the media. The Commission strongly endorsed the need for preserving the authority of NMSs as the single official voice for issuing forecasts and warnings and for increasing media access to NMSs' warnings, forecasts and information.

6.4.4 The Commission was informed that a meeting of ET/MI was held in Minneapolis, United States from 26 to 30 June 2001, in conjunction with the American Meteorological Society's thirtieth Conference on Broadcast Meteorology. It appreciated the outcome of the conjoint meeting, noting that co-location facilitated discussions with international media representatives.

6.4.5 The Commission welcomed the development of two sets of guidelines on media issues. The first elaborated on strategies for addressing the need for enhanced use of official and consistent information by the media. Those included improving coordination and communication with the media, designing appropriate user-friendly public weather services products, making the media aware of the availability of those special products and having media-skilled personnel available to interface with the media. The second set aimed at improving relations between the NMS and the media and included specific recommendations on best practices. Those guidelines encourage NMSs to strengthen partnership and coordination with the media for transmission of vital warnings and information to the public. They also emphasized that interaction with the media would facilitate dissemination of daily weather forecasts and seasonal climate outlooks, participation in joint seminars and workshops, and importantly, could lead to a joint approach for public education and awareness. As a result, the *Guidelines on the Improvement of NMSs — Media Relations and Ensuring the Use of Official and Consistent Information* (PWS-1, WMO/TD-No. 1088) was published.

6.4.6 The Commission appreciated the development of Guidelines on weather on the Internet and other new technologies. Those Guidelines elaborated on NMSs' policies on public, commercial and specialized access of weather information through the Internet, and provided advice on the technical, design and content aspects of high-quality NMSs' Web sites, with hyperlinks providing additional background information. As a result, *Weather on the Internet and Other New Technologies* (PWS-2, WMO/TD-No. 1084) was published. The Commission stressed that national forecasts appearing on the NMSs' Web site must be reviewed by experienced forecasters before posting, and Web pages needed to be updated frequently and consistently. It acknowledged that high-quality and user-friendly NMSs' Web sites would enhance the image of NMSs and encouraged Members to give priority to that task. The Commission noted with interest that workshops on designing Web sites and training Web masters had been organized in the Netherlands through ACMAD for Members in RA I, which had proved highly useful. It urged that more training workshops be organized on that subject. In view of the resources and expertise necessary for establishing and maintaining such sites, the Commission noted that such activity was suitable for inclusion in technical cooperation projects aimed at boosting the capacity of NMSs' in developing countries.

6.4.7 While appreciating the work done so far on that issue, the Commission emphasized that more work needed to be done to ensure that, through partnerships and better coordination between NMSs and the media, the use of official and consistent information by the media was promoted and that the unique authority of the NMS as the single official voice in particular in issuing warnings of severe weather was reinforced. It was also stressed that the media should both broadcast official weather information more frequently and identify the official source of that information. The Commission requested that the PWS Programme strengthen its work on those important issues.

6.4.8 The Commission expressed appreciation for the training seminars and workshops on improving presentation and communication skills of forecasters and requested that the PWS Programme should continue to organize such training events. In that connection, the Commission appreciated the assistance by the UK Met Office to a number of countries through the provision of television studios and training facilities to improve forecast presentations on the television.

Expert Team on Product Development and Service Assessment (ET/PDSA)

6.4.9 The Commission recalled that the rationale for having established ET/PDSA included the need for provision of assistance to Members in the application of research and new technologies in the context of PWS and the requirements for new and improved products and service assessment.

6.4.10 The Commission noted with satisfaction that the Team, at its meeting in Honolulu, in December 2001, had prepared a set of guidelines to assist NMSs to make beneficial use of advances in technology and meteorological research in the provision of public weather services. The guidelines provided a comprehensive review of the latest available technology including workstation systems, integration and packaging of weather information, communication and dissemination mechanisms and Internet communications, and their impact on public weather services. As a result, the *Guidelines on Application of New Technology and Research to Public Weather Services* (PWS-6, WMO/TD-No. 1102) was published and included sections on computer-aided learning and updates on plans for the modernized WMO information system.

6.4.11 The Commission recalled that earlier guidelines on performance evaluation had been prepared by the previous Expert Team, and welcomed the current Team's development of a supplementary set of guidelines on service assessment that integrated scientific verification with user-based assessment for specific applications. As a result, the *Supplementary Guidelines on Service Assessment* (PWS-7, WMO/TD-No. 1103) was published. The Commission expressed the opinion that such guidelines provided much-needed assistance to Members to enhance the quality and effectiveness of their services to the public through meeting the end-user requirements. In identifying the need for further work in that area, the Commission emphasized that a customer service culture should be created among the NMSs to ensure that the users of public weather services were correctly identified and that their specific needs were responded to in the most effective manner. Furthermore, the Commission was of the view that in the context of the current debate on the need for more formally defined quality management processes, those guidelines complemented other WMO *Guides* on operational practices and standards and would assist Members to monitor, document and improve continuously their public weather services. The Commission requested the OPAG on PWS to continue to work on that important issue and develop additional material to describe quality management procedures and practices in the delivery of public weather services.

6.4.12 The Commission expressed satisfaction with the progress made by the ET/PDSA, but stressed the importance of the PWS Programme to continue to assist Members to keep abreast of new research and technologies and their application in the preparation, dissemination and presentation of new PWS products.

EXPERT TEAM ON WARNINGS AND FORECAST EXCHANGE, UNDERSTANDING AND USE (ET/WFEU)

6.4.13 The Commission was informed that a meeting of the ET/WFEU was held in Hong Kong, China from 25 February to 1 March 2002. The Commission welcomed progress reports on the status of implementation of two pilot Web sites, namely the SWIC and WWIS Web sites, related to media issues. In that connection, the Commission noted with appreciation the presentations made by Hong Kong, China and Oman on the English and Arabic versions of those Web sites. Both Web sites were developed by Hong Kong, China under the auspices of WMO (both projects are discussed in general summary paragraphs 6.4.20 to 6.4.27). In considering those reports, the Commission agreed with the Team's view that WMO Members should strive to have their own Web sites to serve better the public and the media. It further endorsed the recommendation that city forecasts should remain the focus of forecast exchange activities and noted that the preferred means of transmission of forecasts was the Internet, according to a 2001 survey of Members taking part in the pilot project on city forecasts. The Commission noted with appreciation that Team experts had developed a framework for a draft message format for WWIS, which was expected to evolve further as the pilot project progressed. The Commission felt that work should continue on that project in collaboration, as required, with the OPAG on ISS/Expert Team on Data Representation and Codes, which was gaining wide support among Members.

6.4.14 With respect to cross-border exchange of warnings, the Commission acknowledged that the exchange should be on a cooperative basis between neighbouring countries. Such exchange agreements between countries would take into consideration the significance of the impact of a weather event in a particular country, the thresholds for warning parameters and the message content, format, frequency and delivery. The Commission noted that exchanges of warnings were taking place among several NMSs in RA VI and, in view of the importance of such information exchange at times of severe weather, encouraged other Regions to consider undertaking similar exchanges. The Commission recommended that in addition to exchanging warnings of short timescale hazards, cross-border dialogue on longer timescale hazards should be encouraged. The Commission expressed appreciation that the Team had developed a set of guidelines on cross-border warnings exchange.

6.4.15 The Commission was pleased that in order to assist Members to improve public understanding of, and response to, warnings, the Team also developed guidelines that included emphasis on the warning process and on the accuracy, timeliness, language content and credibility of the sources of warning messages. The Commission was of the opinion that that task was a complex challenge that required a multidisciplinary approach due to the wide range of skills needed to develop and implement appropriate programmes. It agreed that input from social science and human behavioural experts was important in analysing user response to warning products, and welcomed the recent shift in focus by many NMSs, to ensure a balance between a science-oriented approach and a more user-oriented philosophy.

6.4.16 The Commission considered the need for improving the capacity of NMSs to provide users and the public with high quality warning products by having a cadre of capable warning meteorologists. In that regard, the Commission urged that forecasters receive specific training in severe weather forecasting, in issuing warnings of severe weather, in developing appropriate communication skills, and in familiarizing with practices and procedures of neighbouring NMSs.

IMPLEMENTATION COORDINATION TEAM ON PWS

6.4.17 The Commission appreciated the work of the ICT in examining the activities of the other OPAG on PWS Expert Teams and in providing overall guidance for the future work of OPAG, as well as in reviewing a number of general issues that were not allocated to Expert Teams. It noted that a meeting of the ICT on PWS had been held in Athens from 11 to 15 November 2002. As part of its terms of reference, the Team developed a draft framework for a set of guidelines on relationships between NMSs and emergency management authorities with a view to expanding them into full guidelines for publication as a WMO technical document. The Commission also noted that the ICT had maintained contact with other technical commissions and OPAGs within CBS. A further task of the ICT had called for monitoring the PWS training activities. Based on the results of a survey by the Team of participants in past training events, the Commission strongly recommended that PWS training component should be maintained and strengthened to develop and improve skills and competencies of NMSs' staff involved in service delivery.

6.4.18 In noting the results of the review undertaken by the ICT on user assessment activities, the Commission identified that those activities were an important part of an NMS's overall service assessment programme and a key component in the NMS's ability to identify customer requirements and user satisfaction with PWS. The Commission agreed that further work in that area included possible development of a set of recommended core user assessment criteria and questions for NMSs and the exploitation of Internet-based feedback mechanisms. Finally, as regarded the overall improvements in national PWS implementation, the Commission agreed that a number of case studies should be prepared based on particular known improvements in national PWS practices. The information gathered from those case studies would be collated with a view to publication and should assist NMSs in the greater use of the existing guidelines produced under the PWS Programme.

6.4.19 The Commission noted that in addition to the above work areas, the ICT had also been tasked with reviewing a number of issues which were emerging as potentially significant PWS matters. Those included the economic valuation of PWS, a possible PWS reference system, environmental and bio-meteorological information in PWS, quality management issues, standardized formats for warnings and forecasts exchange, and communication issues related to probability forecasts. The Commission agreed that all of those issues needed to be addressed further since there was clearly a role for PWS in all of those areas. On the subject of the provision of weather and climate support for the Olympic Games, the Commission was pleased that more detailed draft guidelines for such support would be produced by the ICT for consideration and eventual adoption by the International Olympics Committee. It also welcomed the proposed collaboration with the Hellenic National Meteorological Service involving Web site links in connection with the Athens 2004 Olympics.

PILOT PROJECTS ON THE INTERNATIONAL EXCHANGE OF PUBLIC FORECASTS AND WARNINGS THROUGH THE INTERNET

PILOT WEB SITE ON SEVERE WEATHER WARNINGS

6.4.20 The Commission recalled that the previous ET/MI established in 1998 had proposed a centralized Web site to facilitate access by the international media to official NMS warnings. CBS-XII had requested Hong Kong, China to take the lead in developing and managing a pilot Web site catering for tropical cyclones warnings in the western North Pacific, in the first instance. The Web site, the SWIC, was launched as an operational trial in September 2001 and the current version provided advisories from the RSMC Tokyo Typhoon Centre and local warnings from nine Members of the ESCAP/WMO Typhoon Committee. The address of the Web site was http://severe.worldweather.org.

6.4.21 The Commission noted that the basic design was to gather dynamic information from the Web sites of participating NMSs. In order to let participants decide how to present information in the pilot Web site, an automated system was in place to read regularly relevant metafiles in an agreed format, and automated checking routines looked for updated information on particular tropical cyclones in participants' Web sites. Warning information from the GTS was also used. The Web site also provided static information such as the warning areas of respective centres, tropical cyclone names and hyperlinks to participants' Web sites.

6.4.22 The Commission was pleased that the SWIC Web site was thoroughly tested during the 2002 typhoon season and that further liaison with Typhoon Committee members had led to enrichment of the Web site information. The Web site, in English only for the time being, received over 4 000 visits daily during the peak of the tropical cyclone season in 2002. The Commission strongly advised that the language issue should be studied to enhance the usefulness of the Web site to non-English speaking communities and their media. Noting concerns about possible confusion arising from different track forecasts by some NMSs in respect of the same storm, the Commission appreciated that an explanatory note had been put on the SWIC Web site and urged further consideration of that matter.

6.4.23 The Commission recommended that efforts be concentrated on the further development of the SWIC Web site, hoping that participation in the pilot project would increase as more Members got their own Web sites. The Commission was informed that plans were under way to incorporate tropical cyclones in the southwest Pacific.

PILOT WEB SITE FOR THE INTERNATIONAL EXCHANGE OF OFFICIAL CITY FORECASTS

6.4.24 The Commission recalled that CBS-XII had endorsed a pilot project for the development of a Web site to provide official city forecasts to the public and had authorized Hong Kong, China to take the lead. The Commission noted that the Web site, the WWIS, was being implemented on a phased basis, with climatological information for selected cities in Phase I and city forecasts in Phase II. A demonstration Web site was developed for comments in September 2001 and the operational trial of Phase I was launched in December 2001. The address of the Web site was http://www.worldweather.org. The Commission was pleased to note that climatological information of 826 cities from 150 Members as well as hyperlinks to the Web sites of 70 Members were represented on the Web site and that it attracted about 6 400 visits per day in October 2002.

6.4.25 The Commission noted that Phase II, completed in December 2002, would allow posting of medium-term city forecasts. Nearly 70 Members had supplied forecasts for 680 cities, with more Members planning to join. The Web site supported communication through the GTS nodes, FTP and e-mail, as well as the use of a Web-based form to enable participation of all Members. The Commission welcomed the efforts to ensure Web site reliability and credibility through use of a resilient system with dependable service delivery, and anticipated the use of graphic icons in addition to forecasts, in the next stage.

6.4.26 As in the case of the SWIC Web site, the language problem presently limited audience size, but the Commission was of the opinion that that could be overcome if Members were to offer to host other language versions. In that regard, the Commission appreciated the work by Oman to host the Arabic version and appreciated that the Russian Federation had created an open-access Web site containing weather information and forecasts for Russia and other regions.

6.4.27 The Commission commended the diligent work of the Expert Team in developing the pilot projects and expressed appreciation to Hong Kong, China for hosting and maintaining both Web sites. Noting that international media organizations as well as the public would welcome and benefit from the Web sites, the Commission urged Members not only to cooperate by supplying more forecasts and warnings, but also to follow the example of Oman to host other language versions of WWIS as well as the initiative of the Russian Federation.

SUPPORT FOR CAPACITY BUILDING AND TRAINING

6.4.28 The Commission noted that capacity building activities within the PWS Programme were given the high priority mandated by CBS and Congress. The Commission appreciated the Programme's sensitivity to the stringency of budgetary limits through optimum use of available resources by organizing training events in collaboration with other WMO Programmes. Since CBS-XII, PWS workshops and seminars had been held in conjunction with TCP during the annual RA IV Workshop on Hurricane Forecasting and Warning in Miami, as well as workshops in La Réunion and Melbourne. In addition, two PWS/GDPS joint regional training seminars were held in Bahrain and Peru.

6.4.29 The Commission reaffirmed that future needs of Members to enhance their capabilities to deliver high quality public weather services would continue to increase, especially in developing NMSs and requested the PWS Programme to continue efforts to assist Members to strengthen and improve their national public weather services. In that connection, the Commission especially appreciated the production of the substantial amount of guidance material produced under the PWS Programme and requested that every effort be made to translate those materials into other WMO languages besides English so as to enhance their utilization by all NMSs. The Commission was pleased to learn that the PWS guidelines would be posted on the PWS Web site so that they would be more widely available. That would also facilitate updating them to incorporate new material as required.

DISASTER REDUCTION ACTIVITIES

6.4.30 In acknowledging that natural disaster mitigation was now a major concern to WMO Members, the Commission reiterated the important role that the PWS Programme should play in assisting Members to ensure the application of science and technology in the protection of life and property and to reduce losses caused by natural disasters. The Commission noted that for many NMSs, their public weather services were the main channel of communication to both the public and the emergency management community and that often required an integrated message covering climatology, recent events, actions that could be taken for personal safety, current weather, short- and medium-range forecasts, and seasonal outlooks. It was therefore important that the PWS Programme assist Members to develop their capability to deliver such integrated messages. The Commission expressed appreciation that the services of a Junior Professional Officer seconded by the Government of Japan, and attached to the PWS Division of WMO, had been engaged to enhance further WMO's efforts in that area.

LINKS WITH WWRP

6.4.31 The Commission noted with satisfaction that the links that had been established with WWRP through the attendance of the chairperson of the OPAG on PWS at meetings of the Science Steering Committee of the WWRP had proven mutually beneficial to the WWRP and to CBS. That had been particularly useful in the context of the Sydney 2000 Olympics Forecast Demonstration Project which featured interaction among researchers, operational and end-users and was influencing the design of future operational nowcasting systems, service delivery and user-based evaluation. The Commission noted that interaction on the CAS Statement on the scientific basis for, and limitations of, weather and climate forecasting had also been valuable.

6.4.32 The Commission noted that the future work of the WWRP included a planned hemispheric experiment (THORPEX), ensemble forecasting, quantitative rainfall prediction, urban meteorology, and a further Forecast Demonstration Project in connection with the Athens 2004 Olympics. All were of interest to the Commission and the PWS Programme in particular. It asked that the chairperson of the OPAG on PWS maintain close links with WWRP.

TRENDS, CHANGES AND CHALLENGES

6.4.33 The Commission acknowledged that important changes of both socio-economic and technological nature were taking place, which would be of consequence to the plans, programmes, activities and future functioning of WMO and NMSs. Those changes presented both challenges and opportunities to NMSs, in particular as regarded the provision of public weather services. Among them were globalization and commercialization, which promoted free trade, competition and new product sources, resulting in a growing tendency of Governments to reduce public expenditure in its institutions, including NMSs. Such reductions in available resources placed NMSs under increasing pressure to review, rationalize and optimize their activities and to highlight their role as providers of the most needed services such as severe weather warnings and forecasts, and other public weather services products.

6.4.34 The Commission stressed that as part of responding to that challenge, NMSs must demonstrate to Governments and the public how weather, climate and environmental issues impacted everyday life and sustainable development. NMSs should seek opportunities to emphasize the economic value of weather services and the public good by their wide availability and use. Furthermore, NMSs should promote user awareness of the indispensable value of their products and ensure that they were provided in a timely manner and disseminated in conformity with the users' requirements.

6.4.35 In terms of advantages, the Commission was of the view that the increased availability of data and technological advances in areas such as numerical model prediction and the availability of powerful PC-based computer systems, coupled with advanced information technology, enabled provision of services to users at the local and regional levels in a more direct and user-oriented way.

6.4.36 In view of the many diverse ongoing and emerging issues to be addressed under the PWS

Programme, the Commission agreed to organize a technical conference on public weather services to be held in conjunction with its next session.

EVOLVING NEEDS OF MEMBERS

6.4.37 Prior to deciding on the detailed implementation components of the PWS Programme, the Commission advised that the following issues, which related closely to the Programme, should kept in mind:

(*a*) Ongoing improvement of products and services and better coordination between NMSs and the associated RSMCs in order to provide a greater range of services to address the growing number of national applications and users;

(*b*) Increased demand for dissemination of more accurate, timely and effective warnings of severe weather, and need for guidance on how to mitigate weather disasters and manage the associated risks effectively, through working with other disciplines and authorities, and how to use that information to secure extra funding from innovative sources;

(*c*) Increased need for involvement in, and contribution to, sustainable development through the provision of widely disseminated weather forecasts and information;

(*d*) Increased need for the development of standard and/or recommended practices and procedures for exchange of weather forecasts, and international formats for the texts of forecasts and warnings issued by NMSs, with the result being more reliable forecasts;

(*e*) Increasing need to strengthen Members' capability to deliver high quality services, to monitor and identify training requirements of Members, and to develop flexible training programmes and activities that could be modified as appropriate to cater for the transfer of knowledge, research and technology.

FUTURE DIRECTIONS

6.4.38 In acknowledging the current trends, changes and challenges facing NMHSs and the evolving needs of Members, the Commission requested that high priority be given to the following implementation components, ensuring appropriate collaboration with the OPAGs on IOS, on ISS and on DPFS:

(*a*) Provision of assistance to Members on the use of tools and techniques to achieve widespread availability of information, through the application of technological advances in communications, dissemination systems and improved graphics display capability to the delivery of more effective public weather services;

(*b*) Provision of guidance on the economic valuation of meteorological services including public weather services;

(*c*) Provision of assistance to Members in keeping abreast of scientific research and technological developments especially related to remote-sensing systems, advanced numerical prediction models, ensemble forecasting and new data assimilation and analysis schemes to improve the quality and timeliness of public weather services;

(*d*) Provision of assistance to Members in their efforts to improve their public weather services, including:
   - (i) Guidance on effective formulation and content of warnings and forecasts;
   - (ii) Guidance on effective and improved dissemination, communication and presentation techniques and methods, for use by the mass media;
   - (iii) Methodologies for assessing the level of service provided, the degree of user requirements and satisfaction, and quality control of defined services and products including verification of warning and forecast products;

(*e*) Provision of advice on regional and global exchange and coordination of hazardous and routine weather information including warnings, and establishment of appropriate agreements and procedures for such exchanges;

(*f*) Provision of assistance in capacity building in NMSs, including:
   - (i) Organizing training events with emphasis on public safety and effective service delivery;
   - (ii) Development of training programmes for technical users such as emergency managers, the media and local officials;

(*g*) Provision of guidance and advice on quality management issues and practices to monitor the quality of the public weather services and products;

(*h*) Study and promote the application of standardized approaches to end-user oriented forecasts and warnings, especially severe weather forecasts and warnings;

(*i*) Provision of guidance on the application of numerical modelling to air quality forecasting services developed in collaboration with environmental protection authorities.

6.4.39 The Commission reviewed the progress made in the PWS Programme since its twelfth session. Taking into consideration the discussions held under the present agenda item, it adopted the tasks for the Expert Teams and the Implementation Coordination Team of the OPAG on PWS as given in agenda item 8.

7. LONG-TERM PLANS (agenda item 7)

7.1 MONITORING AND EVALUATION OF THE FOURTH AND FIFTH WMO LONG-TERM PLANS (agenda item 7.1)

7.1.1 The Commission recalled that, according to Resolution 12 (EC-LIII) — Guidelines on monitoring and evaluation of the implementation of the Fifth WMO Long-term Plan, the president of the Commission and the Secretary-General had submitted their independent monitoring and evaluation reports to the Executive Council Working Group on Long-term Palnning, which had analysed those reports and prepared an assessment of the level of implementation of the 5LTP, which was adopted by the fifty-fourth session of the Executive Council (see agenda item 14 in the *Abridged Final Report with Resolutions of the Fifty-fourth Session of the Executive Council* (WMO-No. 945)).

7.1.2 The Commission considered and concured with the assessment of the Executive Council of the implementation of the 5LTP as regarded the programmes under its technical responsibility.

7.2 **PREPARATION OF THE SIXTH WMO LONG-TERM PLAN** (agenda item 7.2)

7.2.1 The Commission considered the sections of the draft 6LTP that were relevant to the WWW and PWS Programme and noted that the fifty-fourth session of the Executive Council had endorsed the draft 6LTP in general and had requested that several improvements be taken into account prior to its submission to Fourteenth Congress.

7.2.2 The Commission noted the request of the fifty-fourth session of the Executive Council that, in further revising the 6LTP, attention should be given to the formulation of the new Natural Disaster Prevention and Mitigation Programme as a major, cross-cutting Programme to ensure linkage to various programmes that would contribute to it. In particular, the contribution of the GDPS and ERA should be explicitly recognized. In that connection, the Commission reviewed and endorsed for inclusion in Chapter 6 under the new Natural Disaster Prevention and Mitigation Programme of the 6LTP the text on the contribution of GDPS and ERA as given in Annex VII to this report.

7.2.3 The Commission noted that the fifty-fourth session of the Executive Council agreed that consideration should be given to greater use of technical commissions in lieu of Executive Council Working Groups or Panels. In particular, consideration should be given to transferring the Executive Council Working Group on Antarctic Meteorology to CBS. The Commission studied the current terms of reference of that Group as given in Resolution 10 (EC-LI) — Executive Council Working Group on Antarctic Meteorology, and recommended that as regarded the possible transfer to CBS of the activities of that Group, the Commission, taking into account the standing terms of reference of that Working Group, felt that that matter should be further considered by the Executive Council in the context of a new WMO structure.

7.2.4 The Commission noted that the Council reiterated the need for strengthening collaboration between technical commissions and regional associations and encouraged arrangements for the involvement of experts from Regions in the activities of the subsidiary bodies of technical commissions. The Commission was satisfied with its current arrangements, which comprised the regular participation of the chairpersons of the Regional Working Groups on the WWW in sessions of the Commission, the inclusion of the Regional Rapporteurs on the component programmes of the WWW in the corresponding Implementation Coordination Teams as *ex officio* members, the regional balance in the composition of the CBS Management Group, the organization of technical conferences together with sessions of the Commission, and a strong information policy of CBS that reached out to all members in all Regions.

7.2.5 The Commission noted with particular interest that the Council had requested the president of CBS to consider a proposal to rename CBS to reflect more clearly the services aspect of the work of the Commission. The Commission had a lively discussion with most delegations supporting that issue. A number of delegations was in favour of the proposal to re-name the Commission as "Commission for Basic Systems and Services", and a number of delegations was in favour of re-naming the Commission as "Commission for Basic Services and Systems". The implications of such changes were discussed and it was felt that the latter option might impinge on responsibilities of existing application commissions that also provided basic application services. It was noted that a change of name of the Commission might or might not require a revision of the terms of reference of CBS. Other delegations were not in favour of changing the name of the Commission at the present time. The Commission requested the CBS Management Group to study further the issue and to develop a proposal for consideration by the next session of the Commission.

7.2.6 In a related context, as discussed by the fifty-fourth session of the Executive Council, the Commission agreed on the need to include the word "forecasting" in the definition of GDPS so that it would read "Global Data-processing and Forecasting System" (GDPFS). It noted that that was already implemented within the Commission's new structure by the creation of the OPAG on DPFS. The Commission recommended to Fourteenth Congress that the GDPS programme be named as GDPFS programme.

7.2.7 The Commission recommended that in the draft 6LTP, Chapter 5, Strategy 4, paragraphs 5.4.1 and 5.4.2 be amended as followed:

"5.4.1 The key result areas for this strategy are:
- Public information;
- Public weather services;

....

5.4.2 Through the WMO Information and Public Affairs and Public Weather Services Programmes, WMO will provide advice on ways and means of educating the public and users of services on the role of the NMHSs, services they can provide, as well as information about severe weather and actions that can be taken for personal safety.

It also recommended that Chapter 6, paragraph 6.1.14 be amended to read:

"6.1.14 A number of constituent and other bodies will participate in the planning and future implementation of the GOS.

Among these bodies, the leading role will belong to CBS and in particular with the collaboration of CIMO for the action 6.1.11(*b*), that participating bodies will undertake:"

The Commission further considered that there was a need to give more emphasis to the link between the GOS and GCOS. It therefore recommended to modify Chapter 5, paragraph 5.6.2 to read:

"5.6.2 Crucial to the realization of Strategy 6 is the further development of the three basic components of WWW — GOS, GTS and GDPS. In particular, GCOS depends on the long-term sustainability and performance of the GOS. There will also be emphasis on the enhancement of related systems such as GOOS, GAW and WHYCOS."

In the same context, the Commission recommended to amend the first main long-term objective of the GOS (Chapter 6, paragraph 6.1.11(*a*)) to read:

"6.1.11 To improve and optimize global systems for observing the state of the atmosphere and the ocean surface to meet the requirements, in the most effective and efficient manner, for the preparation of increasingly accurate weather analysis, forecasts and warnings, and for climate and environmental monitoring activities, in particular GCOS, carried out under programmes of WMO and other relevant international organizations."

8. FUTURE WORK PROGRAMME (agenda item 8)

8.1 The Commission reviewed the progress made since its twelfth session and consolidated its two-year work programme based on the relevant sections of the 5LTP and draft 6LTP and on relevant decisions of the Executive Council, and taking into account the detailed discussions held under agenda item 6.

8.2 To carry out its two-year work programme, the Commission reviewed and adapted, as necessary, the terms of reference and tasks of the Expert Teams and Rapporteurs of each OPAG that were established by CBS-XII. The specific tasks that were identified in complement or adjustment of the current terms of reference of Expert Teams and Rapporteurs, or revised terms of reference, as appropriate, are listed in the Annex VIII to this report. The Commission requested each OPAG chairperson to ensure that the specific tasks be adequately addressed. It further requested its Management Group to keep under review the work programme and make arrangements, as necessary, on the proposals of OPAG chairpersons.

8.3 With respect to total quality management (see also agenda item 4), the Commission requested its Management Group to make necessary arrangements, including within the OPAGs, for carrying out efficiently the tasks that would stem from the relevant decisions and directives of Congress.

9. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND RELEVANT RESOLUTIONS OF THE EXECUTIVE COUNCIL (agenda item 9)

In accordance with established practice, the Commission examined those resolutions and recommendations adopted prior to the present session which were still in force and adopted Resolution 1 (CBS-Ext.(02)) and Recommendation 6 (CBS-Ext.(02)).

10. OTHER BUSINESS (agenda item 10)

10.1 OPERATIONAL INFORMATION SERVICE (agenda item 10.1)

10.1.1 The Commission recalled that the objective of OIS was to collect from, and distribute to, WMO Members and WWW Centres detailed and up-to-date information on facilities, services and products made available in the day-to-day operation of the WWW. It agreed that an important goal was to make available the updated information on the WMO server and to provide interactive on-line access services.

10.1.2 The Commission noted with appreciation that the WMO Secretariat posted the updated versions of Volumes A, C1, C2 and D of *Weather Reporting* (WMO-No. 9) as well as the *International List of Selected, Supplementary and Auxiliary Ships* (WMO-No. 47) on the WMO server at http://www.wmo.ch/web/www/ois/ois-home.htm. That OIS home page also included links to other operational information such as the catalogue of radiosondes, the lists of RBSN and RBCN stations, the routeing catalogues of bulletins, monitoring reports, and information on additional data and products as defined in Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities. The Commission also invited the Secretariat to post on the WMO server the content of the *Manuals on Codes* (WMO-No. 306) and *on the GTS* (WMO-No. 386), in order to facilitate access to reference information on the WWW operations.

10.1.3 The production and dispatch of *Weather Reporting* and the *International List of Selected, Supplementary and Auxiliary Ships* were much more cost effective on CD-ROM than in paper format. The Commission was pleased to note that the Secretariat had initiated the distribution of both publications (except Volume B of *Weather Reporting*) on CD-ROM once a year as from 2002, which superseded the distribution of the publications on diskette. The Secretariat continued to provide paper copies upon the request of WMO Members, but Members were invited to examine carefully the requirements for a paper copy in light of the high cost of production and dispatch. The Commission also noted that the WWW and Marine Meteorological Services *Operational Newsletter* was distributed electronically only since its May–June 2002 edition.

10.1.4 The Commission recognized that the use of database applications for the maintenance of the operational information in quasi-real-time, in which the information was presented in code forms and keywords, precluded the possibility of using several languages. The Commission agreed however, that the expanded introductory and explanatory texts related to *Weather Reporting* and the *International List of Selected, Supplementary and Auxiliary Ships* should be made available in English, French, Spanish and Russian.

10.1.5 Most changes to Volume A — Observing stations, were currently sent to the Secretariat on paper which it then had to enter manually into Volume A. That was not efficient and was a possible source of errors. The Commission noted that the development of procedures for updating and distributing Volume A in quasi-real-time by using electronic media was part of the study carried out by the Rapporteur on Improvement of Volume A.

10.1.6 Information on the data-processing and forecasting systems was provided on a yearly basis in the WWW Technical Progress Report on the GDPS. Further information on the processed information exchanged on the GTS was available in Volume C1 — Catalogue of meteorological bulletins. The Secretariat did not receive updates of Volume B — Data processing, since 1993. The Commission agreed that there was no requirement to maintain Volume B and recommended the deletion of that publication from the list of WMO mandatory publications. It also recommended to distribute the WWW Technical Progress Report on the GDPS on a CD-ROM instead of paper format.

10.1.7 With respect to the improved Volume C1 — Catalogue of meteorological bulletins, the Commission noted that nine MTN centres (Bracknell, Melbourne, Moscow, Nairobi, Offenbach, Prague, Sofia, Tokyo and Toulouse) had implemented the new database procedures for the maintenance of their own parts of Volume C1. The Commission urged all MTN centres to implement those procedures with a view to achieving a complete catalogue.

10.1.8 Volume C2 — Transmissions schedules, contained the transmission programmes of the distribution systems of the GTS (satellite distribution systems, RTT and radio-facsimile broadcasts). In order to avoid unnecessary duplication of information, in particular with Volume D — Information for shipping, and with the routeing catalogues of RTHs, the Commission agreed that Volume C2 should contain the identification and the technical specifications of each data distribution system and a summary of the transmission programmes. It invited Members operating GTS Centres concerned to include the lists of bulletins transmitted through distribution systems in their routeing catalogues and to continue providing updates on data distribution systems as well as a summary of the transmission programmes in electronic format, to be then included in Volume C2.

10.1.9 The Commission was pleased to note that a project for the interactive on-line access to Volume C1 was being developed by the Secretariat. The Commission agreed that the development of interactive on-line access services to all components of the OIS should be considered with the highest priority within the framework of the development of the OIS.

10.2 DEMONSTRATION OF REGIONAL SPECIALIZED METEOROLOGICAL CENTRE CAPABILITIES (agenda item 10.2)

BROADENING THE FUNCTIONS OF AN RSMC

The Commission noted the invitation of XIII-RA VI to the *Deutscher Wetterdienst* to continue research and development efforts in the area of ultraviolet forecasts and to make those forecasts available with a view to establishing an RSMC on ultraviolet-index forecasts for the Region. The Commission was informed of the formal commitment of Germany that the existing RSMC in Offenbach, would fulfil those RSMC functions. The Commission expressed appreciation for the presentation made on the capability of that Centre, and agreed that the Centre had fulfilled the relevant provisions of the procedures for broadening the functions of existing RSMCs. The Commission therefore recommended the broadening of the functions of the RSMC Offenbach, to include the provision of ultraviolet-index forecasts for Region VI (Europe). In that connection, the Commission adopted Recommendation 7 (CBS-Ext.(02)).

11. DATE AND PLACE OF THE THIRTEENTH SESSION (agenda item 11)

The Commission noted with appreciation the kind offer by the Government of Kenya to host the thirteenth session of CBS in Nairobi, Kenya in the second half of 2004.

12. CLOSURE OF THE SESSION (agenda item 12)

12.1 In his closing remarks, the acting president of the Commission, Mr A. Gusev, recalled the special role of CBS in providing support to all WMO Programmes and the view of the fifty-fourth session of the Executive Council, which underlined the highest priority of WWW Programme, and, consequently, that of the corresponding CBS activities. Again, the new working structure of the Commission had continued to demonstrate its effectiveness. The session had taken decisions and made recommendations on a number of operational issues and had held lively discussions on some conceptual and even controversial questions. The Commission had reaffirmed its ability to approach issues in an open-minded and balanced manner and develop objective solutions. In particular, he mentioned in that connection the progress achieved in determining the role of the future WMO information system, the very encouraging exchange of views on the quality management framework, and the discussion on the terms of reference and the name of Commission. Fourteenth Congress would present to the Commission new and challenging tasks. Mr Gusev felt that all Expert Teams and the Management Group would do the utmost to accomplish those tasks and wished success to everyone involved in the work of the Commission. Her thanked all those who had contributed to the smooth running of the session and, particularly, to the co-chairpersons of the working committees. He thanked Messers G. Love and S. Mildner, the former presidents of the Commission, for their dedicated work and leadership, especially during the initial phase of restructuring the Commission. On behalf of the Commission, he extended special thanks to the Government of Australia and to the city of Cairns for their generous hospitality. He concluded by recognizing the excellent work done by both the WMO and the local Secretariats.

12.2 Mr S. Milder explained that that was the last session of the Commission in which he would be able to participate. He took the opportunity to thank everybody for the cooperation and friendship he experienced over the many years he was involved with WWW and CBS, as a staff member of the WMO Secretariat, as a member of the Commission, and during the years of his CBS presidency. He wished the Commission and its officers all be the best for the future.

12.3 On behalf of the Permanent Representative of Australia with WMO, Mr J. Zillman, Mr R. Brook of the Australian Bureau of Meteorology emphasized the continuing high priority which the WMO Programmes, and in particular the WWW, had in the Bureau and pointed to the importance of the international cooperation on which meterological work depended so much. Mr Brook thanked the Secretary-General of WMO and his staff for their excellent support and advise in the preparation phase and during the session. He also thanked the co-chairpersons of the working committee, the local support staff and the Cairns Convention Centre for having facilitated the smooth and effective conduct of the session of the Commission.

12.4 Mr D. Schiessl, representative of the Secretary-General, addressed the session on behalf of Professor G.O.P. Obasi and on his own. He thanked the delegates for the hard work and the support staff for their untiring efforts during the session. He said that the Commission had made impressive progress in areas which would have far-reaching consequences in the future for the entire meteorological community, in particular the FWIS and the migration strategy to table-driven code forms. He felt that the Commission had well positioned itself to respond effectively to the policy directives of the forthcoming Congress in all areas of the Commission's responsibility, and including the quality management framework. The session had demonstrated once again that the new working structure of the Commission was effective and successful in producing substantive working results. He thanked specifically the acting president of the Commission for his excellent leadership and the OPAG chairperson and co-chairpersons, and the Expert Team chairpersons and members for their hard and dedicated work during the intersessional period. Mr Schiessl concluded by thanking the Australian Bureau of Meteorology, and through it the Government of Australia, for having hosted the present session of the Commission and for the great hospitality provided to the delegates.

12.5 The extraordinary session (2002) of the Commission for Basic Systems closed at 12:10 p.m. on 12 December 2002.

RESOLUTIONS ADOPTED BY THE SESSION

RESOLUTION 1 (CBS-Ext.(02))

REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

NOTING the action taken on the resolutions and recommendations adopted by the Commission prior to its extraordinary session (2002),

DECIDES:

(1) To keep in force Resolution 1 (CBS-Ext.(98)) and Resolutions 1, 2 and 3 (CBS-XII);

(2) Not to keep in force recommendations adopted before its extraordinary session (2002).

RECOMMENDATIONS ADOPTED BY THE SESSION

RECOMMENDATION 1 (CBS-Ext.(02))

REVIEW OF THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-No. 544), VOLUME I, GLOBAL ASPECTS

THE COMMISSION FOR BASIC SYSTEMS,

RECALLING the need for a major review of the *Manual on the Global Observing System* (WMO-No. 544), Volume I, Global aspects, as agreed by CBS-XII (*Abridged Final Report with Resolutions and Recommendations of the Twelfth Session of the Commission for Basic Systems* (WMO-No. 923), general summary paragraphs 6.1.48–6.1.52),

NOTING:

(1) The work carried out by the CBS Task Team on Regulatory Material, the OPAG on IOS Expert Team on Observational Data Requirements and Redesign of the GOS, and the OPAG on IOS Implementation Coordination Team on Integrated Observing Systems, in this respect,

(2) That the comprehensive review process on the revised draft *Manual on the Global Observing System* was completed in accordance with the decision of CBS-XII (*Abridged Final Report with Resolutions and Recommendations of the Twelfth Session of the Commission for Basic Systems* (WMO-No. 923) general summary paragraph 6.1.52),

RECOMMENDS that the revised draft *Manual on the Global Observing System*, Volume I, Global aspects, be published;

REQUESTS the Secretary-General to make arrangements for publishing the revised *Manual* as soon as possible.

RECOMMENDATION 2 (CBS-Ext.(02))

AMDAR ACTIVITIES

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The priority given to the WWW by the fifty-fourth session of the Executive Council and relevant discussion held at that session of the Executive Council and at CAeM-XII regarding the value of AMDAR activities,

(2) The importance of AMDAR in an integrated Global Observing System as a supplement to the upper-air network,

CONSIDERING:

(1) The value of AMDAR data not only in numerical weather prediction but also in local forecasting and aeronautical meteorological services,

(2) The need for improved coverage by AMDAR in data-sparse areas,

(3) The need to promote AMDAR implementation as a good example of innovative collaboration,

(4) The need for management of AMDAR data flow and implementation of procedures for targeted observations,

RECOGNIZING:

(1) The requirement to provide training to promote the benefits of the AMDAR programme,

(2) The activity of the AMDAR Panel in developing and coordinating the AMDAR programme and the generous contributions of Panel members in funding AMDAR activities to date,

RECOMMENDS:

(1) That CBS and CAeM should develop an appropriate mechanism to integrate more fully AMDAR activities into the WWW Programme;

(2) That specific activities are initiated under WWW and Aeronautical Meteorology Programmes, including training to facilitate the availability and use of AMDAR data in areas where they are currently not available, in particular in developing countries;

ENCOURAGES WMO Members to contribute to the AMDAR Trust Fund on a voluntary basis.

RECOMMENDATION 3 (CBS-Ext.(02))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I, GLOBAL ASPECTS, PARTS I AND II

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) Resolution 2 (Cg-XIII) — World Weather Watch Programme for 2000–2003,

(2) The *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I, Global aspects, Parts I and II,

RECOMMENDS that the *Manual on the Global Telecommunication System*, Volume I, Global aspects, Parts I and II, be amended as given in the annex to this recommendation, with effect from 3 November 2003;

REQUESTS the Secretary-General to make the amendments, as given in the annex to this recommendation, to the *Manual on the Global Telecommunication System*, Volume I, Global aspects, Parts I and II;

AUTHORIZES the Secretary-General to make any consequent purely editorial amendments of the *Manual on the Global Telecommunication System*, Volume I, Global aspects, Parts I and II.

ANNEX TO RECOMMENDATION 3 (CBS-Ext.(02))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I

PART I

Replace in section 2, paragraph 2.1(*e*) to read:

(*e*) Before relaying a message issued from their zones of responsibility (as an RTH in a Region and/or as an RTH located on the MTN) on the GTS, checking the parts related to the telecommunications of the message in order to maintain standard telecommunication procedures. The RTH informs the associated centre originating or compiling the message of any correction to be made to the message. The RTH and its associated centres make arrangements for the insertion of the message without telecommunication errors on the GTS. Messages issued from outside the zone of responsibility of an RTH shall not be corrected by the RTH except in case of special arrangements for inserting data into the GTS.

Amend Attachment I-2 — Configuration of the MTN, to include the circuit Bracknell-Melbourne.

PART II

Replace in paragraph 2.3.2.2 the part related to ii to read:

ii It shall be a number with two digits. When an originator or compiler of bulletins issues two or more bulletins with the same $T_1T_2A_1A_2$ and CCCC the ii shall be used to differentiate the bulletins and will be unique to each bulletin.

Bulletins containing reports prepared at the main synoptic hours for the stations included in the Regional Basic Synoptic Networks or stations included in the Regional Basic Climatological Networks shall be compiled into bulletins with ii in the series 01 to 19. This does not apply to bulletins compiled in BUFR or CREX code.

Bulletins containing "additional" data as defined in Resolution 40 (Cg-XII) shall be compiled into bulletins with ii above 19. This does not apply to bulletins compiled in BUFR or CREX code.

For some bulletins, such as those compiled in GRIB code or containing pictorial information, the use of ii is defined in the tables contained in Attachment II-5. Originators or compilers of bulletins shall use the ii values from these tables when they are defined for the purpose for which a bulletin is being intended.

Replace in paragraph 2.3.2.2 the part related to CCCC to read:

CCCC International four-letter location indicator of the station or centre originating or compiling the bulletin, as agreed internationally, and published in WMO-No. 9, Volume C1, *Catalogue of Meteorological Bulletins*.

In order to differentiate sets of bulletins that cannot be distinguished using the $T_1T_2A_1A_2$ii allocations, a centre may establish additional CCCCs where the final two characters differ from its original CCCC. The two first letters of any additional CCCCs established by a centre shall remain the same as the original CCCC. For instance, the additional CCCCs could be used to indicate different satellites, different models or to differentiate between bulletins containing "additional" or "essential" data as defined in Resolution 40 (Cg-XII)). All CCCCs established by any centre shall be published and defined in the (Publication No. 9, Volume C1, *Catalogue of Meteorological Bulletins*.

Once a bulletin has been originated or compiled, the CCCC must not be changed. If the contents of a bulletin is changed or recompiled for any reason, the CCCC should be changed to indicate the centre or station making the change.

Replace in paragraph 2.3.2.2 the last sub-paragraph to read:

Bulletins containing observational or climatic data (surface or upper-air) from land stations will be compiled from a defined list of stations. This does not apply to bulletins compiled in BUFR or CREX code.

The abbreviated headings and the contents of bulletins shall be published in Publication No. 9, Volume C1, *Catalogue of Meteorological Bulletins*.

Replace paragraph 2.7.1 to read:

The length of messages should be determined according to the following guidelines:

(*a*) Alphanumerical messages for transmission on the GTS shall not exceed 15 000 octets;

(*b*) Sets of information, transmitted using segmentation into a series of bulletins, shall not exceed 250 000 octets;

(*c*) The existing limit of 15 000 octets on messages presented in binary code forms shall be increased to 500 000 octets as from 9 November 2007;

(*d*) Sets of information may be exchanged using the file transfer technique described in Attachment II-15, particularly where sets larger than 250 000 octets are concerned.

Amend in Attachment II-5, Table B1, for T_1 = S Surface data, the following rows to read:

T_2 Designator	*Data type*	*Code form (name)*
L	–	–
O	Oceanographic data	FM 63 (BATHY)/ FM 64 (TESAC)/ FM 62 (TRACKOB)
W	Wave information	FM 65 (WAVEOB)

Replace in Attachment II-5, Table B2 to read:

Table B2

Data type designator T_2 (when T_1 = D, G, H, X or Y)

Instructions for the proper application of the data type designator

1. The designator specified in this table should be used to the greatest extent possible to indicate the type of data contained within the text of the bulletin.
2. Where more than one type is contained in the text, the designator for one of the data types should be used.
3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

Designator	*Data type*
A	Radar data
B	Cloud
C	Vorticity
D	Thickness (relative topography)
E	Precipitation
F	–
G	Divergence
H	Height
I	–
J	Wave height + combinations
K	Swell height + combinations
L	–
M	For national use
N	Radiation
O	Vertical velocity
P	Pressure
Q	Wet bulb potential temperature
R	Relative humidity
S	–
T	Temperature
U	Eastward wind component
V	Northward wind component
W	Wind
X	–
Y	–
Z	Not assigned

Add in Attachment II-5, new Table B6:

Table B6

Data type designator T_2 (when T_1 = P, Q)

Instructions for the proper application of the data type designator

1. The designator specified in this table should be used to the greatest extent possible to indicate the type of data contained within the text of the bulletin.
2. Where more than one type is contained in the text, the designator for one of the data types should be used.
3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

Designator	*Data type*
A	Radar data
B	Cloud
C	Clear air turbulence
D	Thickness (relative topography)
E	Precipitation
F	Aerological diagrams (ash cloud)
G	Significant weather
H	Height
I	Ice flow
J	Wave height + combinations
K	Swell height + combinations

L	Plain language
M	For national use
N	Radiation
O	Vertical velocity
P	Pressure
Q	Wet bulb potential temperature
R	Relative humidity
S	Snow cover
T	Temperature
U	Eastward wind component
V	Northward wind component
W	Wind
X	Lifted index
Y	Observational plotted chart
Z	Not assigned

Insert in Attachment II-5, Table C2, paragraph 1:

For floats (T_1T_2 = S0): F

Replace in Attachment II-15, section 4, the part "FTP procedures" to read:

FTP Procedures

INTRODUCTION

File Transfer Protocol (FTP) is a convenient and reliable method for exchanging files, especially large files. The protocol is defined in RFC 959.

The main issues to be considered are:

1. Procedures for accumulating messages into files so as to minimize FTP overheads with short messages (applies only to existing message types);
2. File naming conventions for existing message types (existing AHL);
3. General file naming conventions;
4. File renaming;
5. Use of directories;
6. Account names and passwords;
7. FTP sessions;
8. Local FTP requirements;
9. File compression.

ACCUMULATING MESSAGES INTO FILES

One of the problems with using FTP to send traditional GTS messages is the overhead if each message is sent in a separate file. To overcome this problem, multiple messages in the standard GTS message envelope should be placed in the same file according to the rules set out below. This method of accumulating multiple messages applies only to messages for which AHLs have been assigned. Centres have the option of including or deleting the starting line and end of message strings and indicating which option they are using via the format identifier (refer to points 2 and 4 below).

1. Each message should be preceded by an 8-octet message length field (8 ASCII characters). The length includes the starting line (if present), AHL, text and end of message (if present).
2. Each message should start with the currently defined starting line and AHL as shown in Figure 4.2.
3. Messages should be accumulated in files thus:
   (*a*) Length indicator, message 1 (8 characters);
   (*b*) Format identifier (2 characters);
   (*c*) Message 1;
   (*d*) Length indicator, message 2 (8 characters);
   (*e*) Format identifier (2 characters);
   (*f*) Message 2;
   (*g*) And so on, until the last message;
   (*h*) If necessary, and subject to bilateral agreement, a 'dummy' message of zero length may be inserted after the last real message, to assist with end of file detection in certain MSS systems. This requirement does not exist in most cases and needs only to be implemented where necessary, and agreed between centres.
4. Format identifier (2 ASCII characters) has the following values:
   (*a*) 00 if starting line and end of message strings present;
   (*b*) 01 if starting line and end of message strings absent (not preferred, to be discontinued).
5. The sending centre should combine messages in the file for no more than 60 seconds to minimize transmission delays; this limit should be set to a value depending upon the characteristics of the link.
6. The sending centre should limit the number of messages in a file to a maximum of 100; this limit should be set to a value depending upon the characteristics of the link.
7. The format applies regardless of the number of messages, i.e. it applies even if there is only one message in the file.

FILE NAMING CONVENTIONS FOR EXISTING MESSAGE TYPES (EXISTING AHL)

The file naming convention is:

CCCCNNNNNNNN.ext

where:

CCCC is the international four-letter location identifier of the sending centre, as defined in WMO-No. 9, Volume C;

NNNNNNNN is a sequential number from 1 to 99999999 generated by the sending Centre for each data type determined by ext; 0 is used for (re-) initialization; through bilateral agreement, Centres may use NNNN instead of NNNNNNNN in case of limitation on filename length.

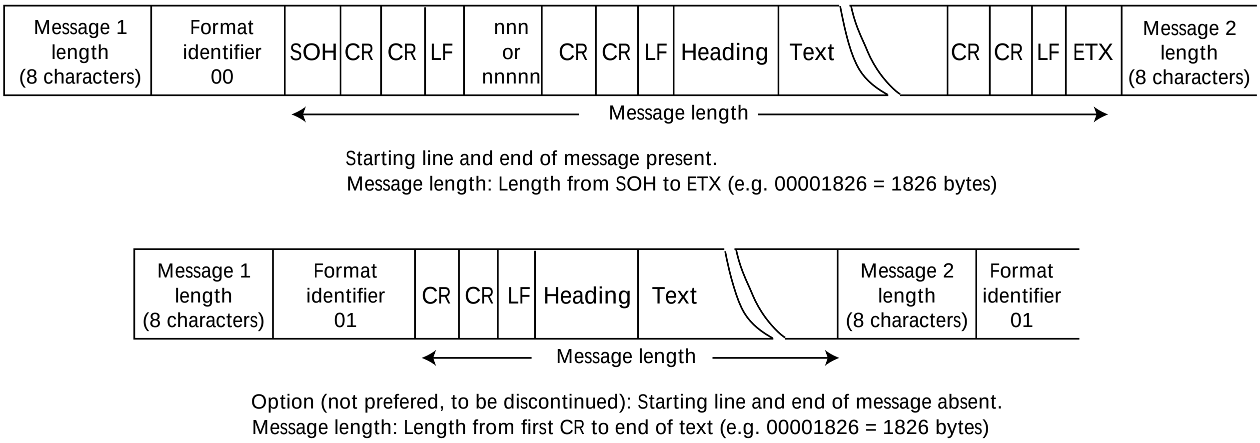

Figure 4.2 Structure of a typical message in a file.

ext is:

‘ua’ for urgent alphanumeric information
‘ub’ for urgent binary information
‘a’ for normal alphanumeric information
‘b’ for normal binary information
‘f’ for facsimile information

NOTE: Where, through bilateral agreement, Centres allow alphanumeric and binary data in the one file, the b or ub extent shall be used.

GENERAL FILE NAMING CONVENTIONS

The following file naming convention should be implemented with a transition period not exceeding 2007. The implementation date is subject to review by CBS. The procedure is based on transmission of file pairs, one file being the information file and the other being the associated metadata file. The concept of file pairs allows the communications function to be implemented independently of data management requirements for structure of metadata, yet provides for the carriage of whatever metadata is required. It is not compulsory to always have a ‘.met’ file, such as when the information file itself is self-specifying or when a single ‘.met’ file can describe several information files (for example as in the case of same data type for different times). There is always however a clear relation between the information file name and the metadata file name, which should only differ from their extension field and possible wildcards.

File names for new message types (no existing AHL) shall follow the following format. It should be noted that file names for existing message types (existing AHL) can also follow the following format.

The file name format is a predetermined combination of fields, delimited by the _ (underscore) character except for the last 2 fields, which are delimited by the . (period) character.

Each field can be of variable length, except for the date/time stamp field which is predetermined.

The order of the fields is mandatory.

The file name fields are as follows:

pflag_productidentifier_oflag_originator_yyyyMMddhhmmss[_freeformat].type[.compression]

where the mandatory fields are:

pflag is a character or combination of characters indicating how to decode the productidentifier field. At this time, the pflag field has only the following acceptable value:

Table 4.1 – Accepted pflag values

pflag	*Meaning*
T	The productidentifier field will be decoded as a standard $T_1T_2A_1A_2$ii data designator (the WMO standard data designators are given in Attachment II-5)
A	The productidentifier field will be decoded as a standard abbreviated heading, including BBB as appropriate, space characters being discarded, e.g. $T_1T_2A_1A_2$iiCCCCYYGGgg[BBB]
W	Planned WMO product identifier
Z	Originating centre’s local product identifier

productidentifier is a variable length field containing information that describes the nature of the data in the file. The productidentifier field should be decoded according to the pflag.

oflag is a character or combination of characters indicating how to decode the originator field. At this time, the oflag field has only the following acceptable value:

Table 4.2 – Accepted oflag values

oflag	*Meaning*
C	The originator field will be decoded as a standard CCCC country code

Originator is a variable length field containing information that states where the file originated from. The originator field should be decoded according to the oflag.

yyyyMMddhhmmss is a fixed length date and time stamp field. The interpretation of this field should be in accordance with the standard rules set for specific data description and types. Therefore it may have various significance such as date of creation or the file, or date of collection of data. If a particular date and time stamp field is not specified, it should be replaced by a '-' (minus) character. For example: ------311500-- represents a stamp that specifies only the day (31st), hours (15) and minutes (00). If there are no rules for a specific data type, this field should represent the date and time of creation of the file by the originator.

Type is a variable length field that describes the general format type of the file. Although this information could be considered somewhat redundant to the productidentifier field, it is kept as such for industry accepted standard compatibility. It should be noted that the delimiter before the type field is a '.' (period). This is to help parse the file name for fields, since the freeformat field could make use of further '_' (underscore) to delimit subfields.

Table 4.3 – Accepted type values

Type	*Meaning*
met	The file is a metadata file pair which describes the content and format of the corresponding information file with the same name
tif	TIFF file
gif	GIF file
png	PNG file
ps	Postscript file
mpg	MPEG file
jpg	JPEG file
txt	text file
htm	HTML file
bin	a file containing data encoded in a WMO binary code form such as GRIB or BUFR
doc	a Microsoft Word file
wpd	a Corel WordPerfect file

The non-mandatory fields are:

freeformat is a variable length field containing further descriptors as required by a given originator. This field can be further divided in sub-fields. Originating countries should strive to make their freeformat descriptions available to others.

compression is a field that specifies if the file uses industry standard compression techniques.

Table 4.4 – Accepted compression values

Compression	*Meaning*
Z	The file has been compressed using the Unix COMPRESS technique
zip	The file has been compressed using the PKWare zip technique
gz	The file has been compressed using the Unix gzip technique
bz2	The file has been compressed using the Unix bzip2 technique

Maximum file name length: Although no maximum length is specified for the entire file name, the mandatory fields shall not exceed 63 characters (including all delimiters) to allow processing by all international systems.

Character set: The file names shall be composed of any combination of the standard character set (ITU-T Rec. X.4) with the exceptions noted in Table 4.5.

Table 4.5 – Symbols for file names

<table>
<tr><th>Symbol</th><th>Allowed</th><th>Meaning</th></tr>
<tr><td>_</td><td>yes</td><td>The underscore symbol is used has a delimiter symbol. To be used only as a delimiter of fields. The underscore is also accepted in the freeformat field, but not in other fields.</td></tr>
<tr><td>.</td><td>yes</td><td>The period symbol is used has a delimiter symbol. To be used only before the type and compression fields.</td></tr>
<tr><td>/</td><td>no</td><td>Forward stroke often has special meaning for the full path specification of a file name in some operating systems</td></tr>
<tr><td>\</td><td>no</td><td>Backward stroke often has special meaning for the full path specification of a file name in some operating systems</td></tr>
<tr><td>></td><td>no</td><td>Greater than symbol shall not be used since it often represents special file manipulation in some operating systems</td></tr>
<tr><td><</td><td>no</td><td>Less than symbol shall not be used since it often represents special file manipulation in some operating systems</td></tr>
<tr><td>|</td><td>no</td><td>Vertical bar (pipe) symbol shall not be used since it often represents special file manipulation in some operating systems</td></tr>
<tr><td>?</td><td>no</td><td>Question mark symbol shall not be used</td></tr>
<tr><td>‘</td><td>no</td><td>Single quote shall not be used</td></tr>
<tr><td>“</td><td>no</td><td>Double quotes shall not be used</td></tr>
<tr><td>*</td><td>no</td><td>The star symbol is often used for wildcard specification in procedures that process file names</td></tr>
<tr><td>Space</td><td>no</td><td>The space symbol shall not be used</td></tr>
</table>

,	yes	The comma symbol can be used in the freeformat field
A-Z a-z 0-9	yes	

The structure of the '.met' file, related to the WMO Metadata standard, is not defined in this *Guide*.

Examples

A possible imagery file (significant weather chart) that would have originated from the United States:
T_PGBE07_C_KWBC_20020610180000_D241_SIG_WEATHER_250-600_VT_06Z.tif

A possible model output file from France:
A_HPWZ89LFPW131200RRA_C_LFPW_20020913160300.bin

A possible image from Australia:
Z_IDN60000_C_AMMC_20020617000000.gif

Note that this shows that the date and time stamp is to be interpreted to be 00 hours, 00 minutes and 00 seconds.

A possible compressed TOVS satellite data file from the United Kingdom:
Z_LWDA_C_EGRR_20020617000000_LWDA16_0000.bin.Z

A possible image (radar) from Canada:
T_SDCN50_C_CWAO_200204201530--_WKR_ECHOTOP,2-0,100M,AGL,78,N.gif

A possible single-record GRIB file from Canada:
Z__C_CWAO_2002032812----_CMC_reg_TMP_ISBL_500_ps60km_2002032812_P036.bin

A possible multiple record batch file from China:
Z_SM_C_BABJ_20020520101502.txt

FILE RENAMING

The method used by receiving centres to detect the presence of a new file may depend on the type of machine used. However most centres will do this by scanning a directory for new files.

To avoid problems with the receiving centre processing a file before it has completely arrived, all sending centres must remotely rename the files they send.

The file shall be sent with the added extent '.tmp' and then renamed to the appropriate extent defined above when the transfer is completed, e.g.

(*a*) Put xxxxx RJTD00220401.a.tmp (xxxxx = local file name)
rename RJTD00220401.a.tmp RJTD00220401.a

(*b*) Put xxxxx AMMC09871234.ub.tmp
rename AMMC09871234.ub.tmp AMMC09871234.ub

USE OF DIRECTORIES

Some receiving centres may wish the files to be placed in specific sub-directories. This should be limited to require only that all files of the same type be delivered to the same directory. It is recommended that a separate directory be used for each host system which is initiating FTP sessions to avoid the possibility of file name duplication.

ACCOUNT NAMES AND PASSWORDS

Using FTP the sender "logs in" to a remote machine using a specific account name and password. The receiving centre defines the account name and the password. There are potential security implications for centres so care needs to be taken.

The following general rules should however apply.

1. The receiving centre defines the user account and password for the sending centre.
2. Anonymous FTP may be used or a specific account may be created. (If anonymous FTP is used, each sending centre must have its own sub-directory on the FTP server).

FTP SESSIONS

To limit the load on both the sending and receiving systems, no more than one FTP session per file type should exist at the same time. If for example, Centre A wishes to send two files to Centre B of the same type (say .ua), the second file must not be sent until the first is finished. Centres should limit the number of concurrent sessions with a particular centre to five maximum.

The idle timer for closing the FTP session should be set to a value between the cut-off time for accumulating messages (max. 60 seconds) and a maximum of 3 minutes.

LOCAL FTP REQUIREMENTS

All sending centres will need to allow for additional "static" FTP commands to be included in the FTP commands that they issue. For example, some MVS centres may require the inclusion of "SITE" commands to define record and block lengths. Centres should support FTP commands as specified in RFC 959 unless some are excluded by bilateral agreement. There may also need to be bilaterally-agreed procedures and commands.

It is the responsibility of receiving centres to delete files after they have been processed.

USE OF FILE COMPRESSION

If large files are to be sent then it is often desirable to compress them first.

Centres should only use compression by bilateral agreement.

RECOMMENDATION 4 (CBS-Ext.(02))

AMENDMENTS TO THE *MANUAL ON CODES* (WMO-No. 306), VOLUME I.1, ALPHANUMERIC CODES AND VOLUME I.2, BINARY CODES AND COMMON FEATURES

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The report of the Expert Team on Data Representation and Codes (22–26 April 2002),

(2) The report of the Implementation Coordination Team on Information Systems and Services (9–13 September 2002),

CONSIDERING the requirement:

(1) For additional parameters exchanged in EPS fields, atmospheric transport model output and satellite cloud mask products,

(2) To report metadata and capability of sensors to improve the transmission of data from AWSs, of XBT/XCTD and subsurface floats profiles, and of CLIMAT data,

(3) For new additions to BUFR/CREX tables,

(4) For reporting zero and 24-hour precipitation in synoptic reports and for improving the coding of CLIMAT TEMP reports,

(5) For amendments to aeronautical codes resulting from corresponding changes in ICAO Annex 3/WMO Technical Regulation [C.3.1],

RECOMMENDS that the following amendments be adopted for use as from 5 November 2003:

(1) Additions to FM 92-XII GRIB defined in Annex 1 to this recommendation;

(2) Additions to FM 94-XII BUFR and FM 95-XII CREX tables, defined in Annexes 2 and 3 to this recommendation;

(3) Amendments to FM 12-XI Ext. SYNOP, FM 13-XI Ext. SHIP, FM 14-XI Ext. SYNOP MOBIL, FM 75-XII CLIMAT TEMP and FM 76-XII CLIMAT TEMP SHIP, defined in Annex 4 to this recommendation;

RECOMMENDS that the following amendments be adopted for use as from 3 November 2004:

Amendments to FM 15-XII METAR, FM 16-XII SPECI and FM 51-XII TAF, defined in Annex 5 to this recommendation;

REQUESTS the Secretary-General to arrange for the inclusion of these amendments in Volumes I.1 and I.2 of the *Manual on Codes* (WMO-No. 306).

ANNEX 1 TO RECOMMENDATION 4 (CBS-Ext.(02))

ADDITIONS TO FM 92-XII GRIB

Product definition template 4.11: Individual ensemble forecast, control and perturbed, at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Octet No.	*Contents*
10	Parameter category (see Code table 4.1)
11	Parameter number (see Code table 4.2)
12	Type of generating process (see Code table 4.3)
13	Background generating process identifier (defined by originating centre)
14	Forecast generating process identifier (defined by originating centre)
15–16	Hours after reference time of data cut-off (see Note 1)
17	Minutes after reference time of data cut-off
18	Indicator of unit of time range (see Code table 4.4)
19–22	Forecast time in units defined by octet 18 (see Note 2)
23	Type of first fixed surface (see Code table 4.5)
24	Scale factor of first fixed surface
25–28	Scaled value of first fixed surface
29	Type of second fixed surface (see Code table 4.5)
30	Scale factor of second fixed surface
31–34	Scaled value of second fixed surface
35	Type of ensemble forecast (see Code table 4.6)
36	Perturbation number
37	Number of forecasts in ensemble
38–39	Year of end of overall time interval
40	Month of end of overall time interval
41	Day of end of overall time interval

42	Hour of end of overall time interval
43	Minute of end of overall time interval
44	Second of end of overall time interval
45	n — number of time range specifications describing the time intervals used to calculate the statistically-processed field
46–49	Total number of data values missing in statistical process
	50–61 Specification of the outermost (or only) time range over which statistical processing is done
50	Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
51	Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
52	Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
53–56	Length of the time range over which statistical processing is done, in units defined by the previous octet
57	Indicator of unit of time for the increment between the successive fields used (see Code table 4.4)
58–61	Time increment between successive fields, in units defined by the previous octet (see Note 3)
	62–nn These octets are included only if n>1, where nn = 49 + 12 × n
62–73	As octets 50 to 61, next innermost step of processing
74–nn	Additional time range specifications, included in accordance with the value of n. Contents as octets 50 to 61, repeated as necessary

NOTES:

(1) Hours greater than 65534 will be coded as 65534.

(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.

(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs, and the rainfall measured by a raingauge. The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets 51, 63, 75 ...). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

Product definition template 4.12: derived forecasts based on all ensemble members at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Octet No.	*Contents*
10	Parameter category (see Code table 4.1)
11	Parameter number (see Code table 4.2)
12	Type of generating process (see Code table 4.3)
13	Background generating process identifier (defined by originating Centre)
14	Forecast generating process identifier (defined by originating Centre)
15–16	Hours after reference time of data cut-off (see Note 1)
17	Minutes after reference time of data cut-off
18	Indicator of unit of time range (see Code table 4.4)
19–22	Forecast time in units defined by octet 18 (see Note 2)
23	Type of first fixed surface (see Code table 4.5)
24	Scale factor of first fixed surface
25–28	Scaled value of first fixed surface
29	Type of second fixed surface (see Code table 4.5)
30	Scale factor of second fixed surface
31–34	Scaled value of second fixed surface
35	Derived forecast (see Code table 4.7)
36	Number of forecasts in the ensemble (N)
37–38	Year of end of overall time interval
39	Month of end of overall time interval
40	Day of end of overall time interval

41	Hour of end of overall time interval
42	Minute of end of overall time interval
43	Second of end of overall time interval
44	n — number of time range specifications describing the time intervals used to calculate the statistically-processed field
45–48	Total number of data values missing in statistical process
	49–60 Specification of the outermost (or only) time range over which statistical processing is done
49	Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
50	Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
51	Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
52-55	Length of the time range over which statistical processing is done, in units defined by the previous octet
56	Indicator of unit of time for the increment between the successive fields used (see Code table 4.4)
57–60	Time increment between successive fields, in units defined by the previous octet (see Notes 3 and 4)
	61–nn These octets are included only if n>1, where nn = 48 + 12 × n
61–72	As octets 49 to 60, next innermost step of processing
73–nn	Additional time range specifications, included in accordance with the value of n. Contents as octets 49 to 60, repeated as necessary

NOTES:

(1) Hours greater than 65534 will be coded as 65534.

(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.

(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs, and the rainfall measured by a raingauge.

(4) The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets 50, 62, 74 ...). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

Product definition template 4.13: derived forecasts based on a cluster of ensemble members over a rectangular area at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Octet No.	*Contents*
10	Parameter category (see Code table 4.1)
11	Parameter number (see Code table 4.2)
12	Type of generating process (see Code table 4.3)
13	Background generating process identifier (defined by originating centre)
14	Forecast generating process identifier (defined by originating centre)
15–16	Hours after reference time of data cut-off (see Note 1)
17	Minutes after reference time of data cut-off
18	Indicator of unit of time range (see Code table 4.4)
19–22	Forecast time in units defined by octet 18 (see Note 2)
23	Type of first fixed surface (see Code table 4.5)
24	Scale factor of first fixed surface
25–28	Scaled value of first fixed surface
29	Type of second fixed surface (see Code table 4.5)
30	Scale factor of second fixed surface
31–34	Scaled value of second fixed surface
35	Derived forecast (see Code table 4.7)
36	Number of forecasts in the ensemble (N)
37	Cluster identifier
38	Number of cluster to which the high resolution control belongs

39	Number of cluster to which the low resolution control belongs
40	Total number of clusters
41	Clustering method (see Code table 4.8)
42–45	Northern latitude of cluster domain
46–49	Southern latitude of cluster domain
50–53	Eastern longitude of cluster domain
54–57	Western longitude of cluster domain
58	NC – Number of forecasts in the cluster
59	Scale factor of standard deviation in the cluster
60–63	Scaled value of standard deviation in the cluster
64	Scale factor of distance of the cluster from ensemble mean
65–68	Scaled value of distance of the cluster from ensemble mean
69–70	Year of end of overall time interval
71	Month of end of overall time interval
72	Day of end of overall time interval
73	Hour of end of overall time interval
74	Minute of end of overall time interval
75	Second of end of overall time interval
76	n — number of time range specifications describing the time intervals used to calculate the statistically-processed field
77–80	Total number of data values missing in statistical process
	81–92 Specification of the outermost (or only) time range over which statistical processing is done
81	Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
82	Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
83	Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
84–87	Length of the time range over which statistical processing is done, in units defined by the previous octet
88	Indicator of unit of time for the increment between the successive fields used (see Code table 4.4)
89–92	Time increment between successive fields, in units defined by the previous octet (see Notes 3 and 4)
	93–nn These octets are included only if n>1, where nn = 80 + 12 × n
93–104	As octets 81 to 92, next innermost step of processing
105–nn	Additional time range specifications, included in accordance with the value of n. Contents as octets 81 to 92, repeated as necessary
(nn+1)–(nn+ N_C)	List of N_C ensemble forecast numbers (N_C is given in octet 58)

NOTES:

(1) Hours greater than 65534 will be coded as 65534.

(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.

(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs, and the rainfall measured by a raingauge.

(4) The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets 82, 94, 106,....). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

In existing Product definition template 4.3: Insert and change after octet 57:

58	N_C – number of forecasts in the cluster
59	Scale factor of standard deviation in the cluster
60–63	Scaled value of standard deviation in the cluster
64	Scale factor of distance of the cluster from ensemble mean
65–68	Scaled value of distance of the cluster from ensemble mean
69–(68+N_C)	List of N_C ensemble forecast numbers (N_C is given in octet 58)

Product definition template 4.14: derived forecasts based on a cluster of ensemble members over a circular area at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Octet No.	*Contents*
10	Parameter category (see Code table 4.1)
11	Parameter number (see Code table 4.2)
12	Type of generating process (see Code table 4.3)
13	Background generating process identifier (defined by originating centre)
14	Forecast generating process identifier (defined by originating centre)
15–16	Hours after reference time of data cut-off (see Note 1)
17	Minutes after reference time of data cut-off
18	Indicator of unit of time range (see Code table 4.4)
19–22	Forecast time in units defined by octet 18 (see Note 2)
23	Type of first fixed surface (see Code table 4.5)
24	Scale factor of first fixed surface
25–28	Scaled value of first fixed surface
29	Type of second fixed surface (see Code table 4.5)
30	Scale factor of second fixed surface
31–34	Scaled value of second fixed surface
35	Derived forecast (see Code table 4.7)
36	Number of forecasts in the ensemble (N)
37	Cluster identifier
38	Number of cluster to which the high resolution control belongs
39	Number of cluster to which the low resolution control belongs
40	Total number of clusters
41	Clustering method (see Code table 4.8)
42–45	Latitude of central point in cluster domain
46–49	Longitude of central point in cluster domain
50–53	Radius of cluster domain
54	N_C – Number of forecasts in the cluster
55	Scale factor of standard deviation in the cluster
56–59	Scaled value of standard deviation in the cluster
60	Scale factor of distance of the cluster from ensemble mean
61–64	Scaled value of distance of the cluster from ensemble mean
65–66	Year of end of overall time interval
67	Month of end of overall time interval
68	Day of end of overall time interval
69	Hour of end of overall time interval
70	Minute of end of overall time interval
71	Second of end of overall time interval
72	n — number of time range specifications describing the time intervals used to calculate the statistically-processed field
73–76	Total number of data values missing in statistical process
	77–88 Specification of the outermost (or only) time range over which statistical processing is done
77	Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
78	Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
79	Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
80–83	Length of the time range over which statistical processing is done, in units defined by the previous octet
84	Indicator of unit of time for the increment between the successive fields used (see Code table 4.4)
85–88	Time increment between successive fields, in units defined by the previous octet (see Notes 3 and 4)
	89–nn These octets are included only if n>1, where nn = 76 + 12 × n

89–110	As octets 77 to 88, next innermost step of processing
111–nn	Additional time range specifications, included in accordance with the value of n. Contents as octets 77 to 88, repeated as necessary
(nn+1)–(nn+N_C)	List of N_C ensemble forecast numbers (N_C is given in octet 54)

NOTES:

(1) Hours greater than 65534 will be coded as 65534.

(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.

(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs, and the rainfall measured by a raingauge.

(4) The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets 78, 90, 112...). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

In existing Product definition template 4.4: Insert and change after octet 53:

54	N_C – Number of forecasts in the cluster
55	Scale factor of standard deviation in the cluster
56–59	Scaled value of standard deviation in the cluster
60	Scale factor of distance of the cluster from ensemble mean
61–64	Scaled value of distance of the cluster from ensemble mean
65–(64+N_C)	List of N_C ensemble forecast numbers (N_C is given in octet 54)

Add note to Product definition template 4.30:

NOTE:

For “satellite series of band number”, “satellite numbers of band number” and “instrument types of band number”, it is recommended to encode the values as per BUFR code tables 0 02 020, 0 01 007 (common Code table C-5) and 0 02 019 (common Code table C-8), respectively.

Add in Code table 4.0 — Product definition template number:

Code figure	*Meaning*
11	Individual ensemble forecast, control and perturbed, at a horizontal level or in a horizontal layer, in a continuous or non-continuous interval
12	Derived forecasts based in all ensemble members at a horizontal level or in a horizontal layer, in a continuous or non-continuous interval
13	Derived forecasts based on a cluster of ensemble members over a rectangular area, at a horizontal level or in a horizontal layer, in a continuous or non-continuous interval
14	Derived forecasts based on a cluster of ensemble members over a circular area, at a horizontal level or in a horizontal layer, in a continuous or non-continuous interval
15–19	Reserved

Add in Code table 4.2:

Product discipline 0 — Meteorological products, parameter category 18: Nuclear/radiology

Number	*Parameter*	*Units*
6	Time-integrated air concentration of caesium pollutant	Bq s m^{-3}
7	Time-integrated air concentration of iodine pollutant	Bq s m^{-3}
8	Time-integrated air concentration of radioactive pollutant	Bq s m^{-3}
9–191	Reserved	

Product discipline 3 — Space products, parameter category 0: Image format products

Number	*Parameter*	*Units*
7	Cloud mask	Code table (4.217)
8–191	Reserved	

Add in Code table 4.217 — Cloud mask type

Code figure	*Meaning*
0	Clear over water
1	Clear over land
2	Cloud
3	No data
4–191	Reserved
192–254	Reserved for local use
255	Missing

Add in Code table 4.7 – Derived forecast

Code figure	*Meaning*
4	Spread of all members
5	Large anomaly index of all members (see Note)
6	Unweighted mean of the cluster members
7–191	Reserved
192–254	Reserved for local use
255	Missing

NOTE: Large anomaly index is defined as {number of members whose anomaly is higher than 0.5xSD) – (number of members whose anomaly is lower than –0.5xSD)} / {number of members} at each grid point, where SD is defined as observed climatological standard deviation.

ANNEX 2 TO RECOMMENDATION 4 (CBS-Ext.(02))

ADDITIONS TO 94-XII BUFR AND FM 95-XII CREX Tables

Introduce the following new descriptors:

0 07 030	Height of station ground above mean sea level	m	1	–4000	17
0 07 031	Height of barometer above mean sea level	m	1	–4000	17
0 07 032	Height of sensor above local ground (or deck of marine platform)	m	2	0	16
0 07 033	Height of sensor above water surface	m	1	0	12

with notes added under Table B, Class 7, referring to 0 07 030, 0 07 031, 0 07 032 and 0 07 033:

- Height of station ground above mean sea level is defined as the height above mean sea-level of the ground on which the raingauge stands or, if there is no raingauge, the ground beneath the thermometer screen. If there is neither raingauge nor screen, it is the average level of terrain in the vicinity of the station (Reference: *Guide to Meteorological Instruments and Methods of Observation*, WMO-No. 8).
- Height of barometer above mean sea level, referring to the location of the barometer of a station, does not redefine the descriptor 0 07 030.
- Height of sensor above local ground (or deck of marine platform) is the actual height above ground (or deck or marine platform) at the point where the sensor is located. This descriptor does not redefine the descriptor 0 07 030 or 0 07 033.
- Height of sensor above water surface is the height of sensor above water surface of sea or lake. This descriptor does not redefine the descriptor 0 07 030 or 0 07 032.

Add a note to the existing descriptor 0 07 001:

This descriptor should be used for archived data only. Descriptors 0 07 030 and 0 07 031 should be used and preferred to represent ground elevation and elevation of barometer, respectively, as defined in *Weather Reporting* (WMO-No. 9), Volume A – Observing stations.

Add descriptors (needed particularly for automatic weather stations)

0 02 175	Method of precipitation measurement	Code table	0	0	4
0 02 176	Method of state of ground measurement	Code table	0	0	4
0 02 177	Method of snow depth measurement	Code table	0	0	4
0 02 178	Method of liquid content measurement of precipitation	Code table	0	0	4
0 02 179	Type of sky condition algorithm	Code table	0	0	4
0 02 180	Main present weather detecting system	Code table	0	0	4
0 02 181	Supplementary present weather sensor	Flag table	0	0	21

0 02 182	Visibility measurement system	Code table	0	0	4
0 02 183	Cloud detection system	Code table	0	0	4
0 02 184	Type of lightning detection sensor	Code table	0	0	4
0 02 185	Method of evaporation measurement	Code table	0	0	4
0 02 186	Capability to detect precipitation phenomena	Flag table	0	0	30
0 02 187	Capability to detect other weather phenomena	Flag table	0	0	18
0 02 188	Capability to detect obscuration	Flag table	0	0	21
0 02 189	Capability to discriminate lightning strikes	Flag table	0	0	12
0 08 010	Surface qualifier (temperature data)	Code table	0	0	5
0 26 020	Duration of precipitation	Minute	0	0	11
0 33 005	Quality information (AWS data)	Flag table	0	0	30
0 33 006	Internal measurement status information (AWS)	Code table	0	0	3

Add and amend in the Flag Table 0 20 021:

Bit No.	
23	White dew
24–29	Reserved

Add new sequence descriptors in Table D:

3 01 004 **Surface station identification**

0 01 001	WMO block number
0 01 002	WMO station number
0 01 015	Station or site name
0 02 001	Type of station

3 01 090 **Surface station identification: time, horizontal and vertical coordinates**

3 01 004	Surface station identification
3 01 011	Year, month, day
3 01 012	Hour, minute
3 01 021	Latitude, longitude (high accuracy)
0 07 030	Height of station ground above mean sea level
0 07 031	Height of barometer above mean sea level

3 01 091 **Surface station instrumentation**

0 02 180	Main present weather detecting system
0 02 181	Supplementary present weather sensor
0 02 182	Visibility measurement system
0 02 183	Cloud detection system
0 02 184	Type of lightning detection sensor
0 02 179	Type of sky condition algorithm
0 02 186	Capability to detect precipitation phenomena
0 02 187	Capability to detect other weather phenomena
0 02 188	Capability to detect obscuration
0 02 189	Capability to discriminate lightning strikes

3 02 069 **Visibility data**

0 07 032	Height of sensor above local ground
0 33 041	Attribute of following value
0 20 001	Horizontal visibility

3 02 070 **Wind data**

0 07 032	Height of sensor above local ground
0 11 001	Wind direction
0 11 002	Wind speed
0 11 043	Maximum wind gust direction
0 11 041	Maximum wind gust speed
0 11 016	Extreme counterclockwise wind direction of a variable wind
0 11 017	Extreme clockwise wind direction of a variable wind

3 02 071		**Wind data from one-hour period**
	0 07 032	Height of sensor above local ground
	0 08 021	Time significance (= 2 (time averaged))
	0 04 025	Time period (= –10 minutes, or number of minutes after a significant change of wind, if any)
	0 11 001	Wind direction
	0 11 002	Wind speed
	0 08 021	Time significance (= missing value)
	1 03 002	Replicate next 3 descriptors 2 times
	0 04 025	Time period (= –10 minutes in the first replication, = –60 minutes in the second replication)
	0 11 043	Maximum wind gust direction
	0 11 041	Maximum wind gust speed
	0 04 025	Time period (= –10 minutes)
	0 11 016	Extreme counterclockwise wind direction of a variable wind
	0 11 017	Extreme clockwise wind direction of a variable wind
3 02 072		**Temperature and humidity data**
	0 07 032	Height of sensor above local ground
	0 12 101	Temperature/dry-bulb temperature (scale 2)
	0 12 103	Dew-point temperature (scale 2)
	0 13 003	Relative humidity
3 02 073		**Cloud data**
	0 20 010	Cloud cover (total)
	1 05 004	Replicate 5 descriptors 4 times
	0 08 002	Vertical significance
	0 20 011	Cloud amount
	0 20 012	Cloud type
	0 33 041	Attribute of following value
	0 20 013	Height of base of cloud
3 02 074		**Present and past weather**
	0 20 003	Present weather
	0 04 025	Time period
	0 20 004	Past weather (1)
	0 20 005	Past weather (2)
3 02 075		**Intensity of precipitation, size of precipitation element**
	0 08 021	Time significance (= 2 (time averaged))
	0 04 025	Time period (= –10 minutes)
	0 13 055	Intensity of precipitation
	0 13 058	Size of precipitation element
	0 08 021	Time significance (= missing value)
3 02 076		**Precipitation, obscuration and other phenomena**
	0 20 021	Type of precipitation
	0 20 022	Character of precipitation
	0 26 020	Duration of precipitation
	0 20 023	Other weather phenomena
	0 20 024	Intensity of phenomena
	0 20 025	Obscuration
	0 20 026	Character of obscuration
3 02 077		**Extreme temperature data**
	0 07 032	Height of sensor above local ground
	0 04 025	Time period

	0 12 111	Maximum temperature (scale 2) at height and over period specified
	0 12 112	Minimum temperature (scale 2) at height and over period specified
	0 07 032	Height of sensor above local ground (for ground temperature)
	0 04 025	Time period
	0 12 112	Minimum temperature (scale 2) at height and over period specified (for ground temperature)
3 02 078		**State of ground and snow depth measurement**
	0 02 176	Method of state of ground measurement
	0 20 062	State of ground (with or without snow)
	0 02 177	Method of snow depth measurement
	0 13 013	Total snow depth
3 02 079		**Precipitation measurement**
	0 07 032	Height of sensor above local ground
	0 02 175	Method of precipitation measurement
	0 02 178	Method of liquid water content measurement of precipitation
	0 04 025	Time period
	0 13 011	Total precipitation/total water equivalent of snow
3 02 080		**Evaporation measurement**
	0 02 185	Method of evaporation measurement
	0 04 025	Time period
	0 13 033	Evaporation/evapotranspiration
3 02 081		**Total sunshine data**
	0 04 025	Time period
	0 14 031	Total sunshine
3 02 082		**Radiation data**
	0 04 025	Time period
	0 14 002	Long-wave radiation, integrated over period specified
	0 14 004	Short-wave radiation, integrated over period specified
	0 14 016	Net radiation, integrated over period specified
	0 14 028	Global solar radiation (high accuracy), integrated over period specified
	0 14 029	Diffuse solar radiation (high accuracy), integrated over period specified
	0 14 030	Direct solar radiation (high accuracy), integrated over period specified
3 02 083		**First order statistics of P, W, T, U data**
	0 04 025	Time period
	0 08 023	First-order statistics
	0 10 004	Pressure
	0 11 001	Wind direction
	0 11 002	Wind speed
	0 12 101	Temperature/dry-bulb temperature (scale 2)
	0 13 003	Relative humidity
	0 08 023	First-order statistics (= missing value)

New Code tables or Flag tables

Code figure	0 02 175 Method of precipitation measurement
0	Manual measurement
1	Tipping bucket method
2	Weighing method
3	Optical method
4	Pressure method
5	Float method
6	Drop counter method
7–13	Reserved
14	Others
15	Missing value

Code figure	0 02 176 Method of state of ground measurement
0	Manual observation
1	Video camera method
2	Infra-red method

3	Laser method
4–13	Reserved
14	Others
15	Missing value

Code figure	0 02 177
	Method of snow depth measurement
0	Manual observation
1	Ultrasonic method
2	Video camera method
3–13	Reserved
14	Others
15	Missing value

Code figure	0 02 178
	Method of liquid content measurement of precipitation
0	Manual observation
1	Optical method
2	Capacitive method
3–13	Reserved
14	Others
15	Missing value

Code figure	0 02 179
	Type of sky condition algorithm
0	Manual observation
1	VAISALA algorithm
2	ASOS (FAA) algorithm
3	AWOS (Canada) algorithm
4–13	Reserved
14	Others
15	Missing value

Code figure	0 02 180
	Main present weather detecting system
0	Manual observation
1	Optical scatter system combined with precipitation occurrence sensing system
2	Forward and/or backscatter system of visible light
3	Forward and/or backscatter system of infrared light
4	Infrared light emitting diode (IRED) system
5	Doppler radar system
6–13	Reserved
14	Others
15	Missing value

Bit No.	0 02 181
	Supplementary present weather sensor
1	Rain detector
2	Freezing rain sensor
3	Ice detection sensor
4	Hail and ice pellet sensor
5–19	Reserved
20	Others
All 21	Missing value

Code figure	0 02 182
	Visibility measurement system
0	Manual measurement
1	Transmissometer system (base ≥ 25 m)
2	Transmissometer system (base < 25 m)
3	Forward scatter system
4	Back scatter system
5–13	Reserved
14	Others
15	Missing value

Code figure	0 02 183
	Cloud detection system
0	Manual observation
1	Ceilometer system
2	Infrared camera system
3	Microwave visual camera system
4	Sky imager system
5	Video time-lapsed camera system
6	Micro pulse lidar (MPL) system
7–13	Reserved
14	Others
15	Missing value

Code figure	0 02 184
	Type of lightning detection sensor
0	Manual observation
1	Lightning imaging sensor
2	Electrical storm identification sensor
3	Magnetic finder sensor
4	Lightning strike sensor
5	Flash counter
6–13	Reserved
14	Others
15	Missing value

Code figure	0 02 185
	Method of evaporation measurement
0	Manual measurement
1	Balanced floating method
2	Pressure method
3	Ultrasonic method
4	Hydraulic method
5–13	Reserved
14	Others
15	Missing value

Bit No.	0 02 186
	Capability to detect precipitation phenomena
1	Precipitation-unknown type
2	Liquid precipitation not freezing
3	Liquid freezing precipitation
4	Drizzle
5	Rain
6	Solid precipitation
7	Snow
8	Snow grains

9	Snow pellets
10	Ice pellets
11	Ice crystals
12	Diamond dust
13	Small hail
14	Hail
15	Glaze
16	Rime
17	Soft rime
18	Hard rime
19	Clear ice
20	Wet snow
21	Hoar frost
22	Dew
23	White dew
24–29	Reserved
All 30	Missing value

Bit No.	0 02 187 Capability to detect other weather phenomena
1	Dust/sand whirl
2	Squalls
3	Sand storm
4	Dust storm
5	Lightning – cloud to surface
6	Lightning – cloud to cloud
7	Lightning – distant
8	Thunderstorm
9	Funnel cloud not touching surface
10	Funnel cloud touching surface
11	Spray
12–17	Reserved
All 18	Missing value

Bit No.	0 02 188 Capability to detect obscuration
1	Fog
2	Ice fog
3	Steam fog
4–6	Reserved
7	Mist
8	Haze
9	Smoke
10	Volcanic ash
11	Dust
12	Sand
13	Snow
14–20	Reserved
All 21	Missing value

Bit No.	0 02 189 Capability to discriminate lightning strikes
1	Manual observation
2	All lightning strikes without discrimination
3	Lightning strikes cloud to ground only
4	All lightning strikes with discrimination between cloud to ground and cloud to cloud
5–11	Reserved
All 12	Missing value

Code figure	0 08 010 Surface qualifier (temperature data)
0	Reserved
1	Bare soil
2	Bare rock
3	Land grass cover
4	Water (lake, sea)
5	Flood water underneath
6	Snow
7	Ice
8	Runway or road
9	Ship or platform deck in steel
10	Ship or platform deck in wood
11	Ship or platform deck partly covered with rubber mat
12–30	Reserved
31	Missing value

Bit No.	0 33 005 Quality information (AWS data)
1	No automated meteorological data checks performed
2	Pressure data suspect
3	Wind data suspect
4	Dry-bulb temperature data suspect
5	Wet-bulb temperature data suspect
6	Humidity data suspect
7	Ground temperature data suspect
8	Soil temperature (depth 1) data suspect
9	Soil temperature (depth 2) data suspect
10	Soil temperature (depth 3) data suspect
11	Soil temperature (depth 4) data suspect
12	Soil temperature (depth 5) data suspect
13	Cloud data suspect
14	Visibility data suspect
15	Present weather data suspect
16	Lightning data suspect
17	Ice deposit data suspect
18	Precipitation data suspect
19	State of ground data suspect
20	Snow data suspect
21	Water content data suspect
22	Evaporation/evapotranspiration data suspect
23	Sunshine data suspect
24–29	Reserved
All 30	Missing value

Code figure	0 33 006 Internal measurement status information (AWS)
0	Self-check OK
1	At least one warning active, no alarms
2	At least one alarm active
3	Sensor failure
4–6	Reserved
7	Missing value

Add new entries for coding of XBT/XCTD and subsurface floats

0 08 080	Qualifier for GTSPP quality flag	Code Table	0	0	6
B 08 080			0		2
0 33 050	Global GTSPP quality flag	Code Table	0	0	4
B 33 050			0		2

Code figure 0 08 080
Qualifier for GTSPP quality flag

0	Total water pressure profile
1	Total water temperature profile
2	Total water salinity profile
3	Total water conductivity profile
4–62	Reserved
63	Missing

Code figure 0 33 050
Global GTSPP quality flag

0	Unqualified
1	Correct value (all checks passed)
2	Probably good but value inconsistent with statistics (differ from climatology)
3	Probably bad (spike, gradient, if other tests passed)
4	Bad value, impossible value (out of scale, vertical instability, constant profile)
5	Value modified during quality control
6–7	Reserved
8	Interpolated value
9–14	Reserved
15	Missing

Add new descriptors for coding CLIMAT data:

0 12 151	Standard deviation of daily mean temperature	K	2	0	12
0 12 118	Maximum temperature at height specified, past 24 hours	K	2	0	16
0 12 119	Minimum temperature at height specified, past 24 hours	K	2	0	16
0 04 051	Principal time of daily reading of maximum temperature	Hour	0	0	5
0 04 052	Principal time of daily reading of minimum temperature	Hour	0	0	5
0 08 050	Qualifier for number of missing values in calculation of statistic	Code table	0	0	4
0 04 059	Times of observation used to compute the reported mean values	Flag table	0	0	6

Code figure 0 08 050
Qualifier for number of missing values in the calculation of statistic

0	Reserved
1	Pressure
2	Temperature
3	Extreme temperature
4	Vapour pressure
5	Precipitation
6	Sunshine duration
7	Maximum temperature
8	Minimum temperature
9	Wind
10–14	Reserved
15	Missing value

Bit No. 0 04 059
Times of observation used to compute the reported mean values

1	0000 UTC
2	0600 UTC
3	1200 UTC
4	1800 UTC
5	Other hours
All 6	Missing value

ANNEX 3 TO RECOMMENDATION 4 (CBS-Ext.(02))

FURTHER ADDITIONS TO 94-XII BUFR AND FM 95-XII CREX TABLES

New common sequences descriptors:

3 10 023 **Geostationary multi-channel satellite radiance data**

3 01 072	Satellite identification
0 30 021	Number of pixels per row
0 30 022	Number of pixels per column
0 08 012	Land/sea qualifier
0 07 024	Satellite zenith angle
0 07 025	Solar zenith angle

	0 10 002	Height
	1 01 012	Replicate next descriptor 12 times
	3 04 032	Cloud fraction
	1 05 002	Replicate next 5 descriptors 2 times
	0 02 152	Satellite instrument used in data processing
	0 02 024	Integrated mean humidity computational method
	0 07 004	Pressure
	0 07 004	Pressure
	0 13 003	Relative humidity
	1 01 012	Replicate next descriptor 12 times
	3 04 033	Radiance
3 10 024		**Geostationary three-channel satellite radiance data**
	3 01 072	Satellite identification
	0 30 021	Number of pixels per row
	0 30 022	Number of pixels per column
	0 08 012	Land/sea qualifier
	0 07 024	Satellite zenith angle
	0 07 025	Solar zenith angle
	0 10 002	Height
	1 01 003	Replicate next descriptor 3 times
	3 04 032	Cloud fraction
	1 05 002	Replicate next 5 descriptors 2 times
	0 02 152	Satellite instrument used in data processing
	0 02 024	Integrated mean humidity computational method
	0 07 004	Pressure
	0 07 004	Pressure
	0 13 003	Relative humidity
	1 01 003	Replicate next descriptor 3 times
	3 04 033	Radiance

Add new descriptors for tropical cyclone tracks derived from EPS:

0 01 090	Technique for making up initial perturbations	Code table	0	0	8
0 01 091	Ensemble member number	Numeric	0	0	10
0 01 092	Type of ensemble forecast	Code table	0	0	8
B 01 090		Code table	0	3	
B 01 091		Numeric	0	4	
B 01 092		Code table	0	3	

Add new Code tables:

Code figure	0 01 090 Technique for making up initial perturbations
0	Lagged-average forecasting (LAF)
1	Breeding
2	Singular vectors
3	Multiple analysis cycles
4–191	Reserved
192–254	Reserved for local use
255	Missing value

Code figure	0 01 092 Type of ensemble forecast
0	Unperturbed high-resolution control forecast
1	Unperturbed low-resolution control forecast
2	Negatively perturbed forecast
3	Positively perturbed forecast
4–191	Reserved
192–254	Reserved for local use
255	Missing value

PROPOSED ADDITIONS TO BUFR TABLE B FOR AMDAR:

Table reference	*Table element*	*BUFR*				*CREX*		
F X Y	*Name*	*Unit*	*Scale*	*Reference value*	*Data width (Bits)*	*Unit*	*Scale*	*Data width (characters)*
0 01 023	Observation sequence number	Numeric	0	0	9	Numeric	0	3
0 08 009	Detailed phase of flight	Code table	0	0	4	Code table	0	2
0 07 010	Flight level	m	0	–1024	16	ft	1	5
0 11 039	Extended time of occurrence of peak eddy dissipation rate	Code table	0	0	6	Code table	0	2
0 11 077	Reporting interval or averaging time for eddy dissipation rate	s	0	0	12	s	0	4
0 20 042	Airframe icing present	Code table	0	0	2	Code table	0	1
0 20 043	Peak liquid water content	Kg m^{-3}	4	0	7	Kg m^{-3}	4	2
0 20 044	Average liquid water content	Kg m^{-3}	4	0	7	Kg m^{-3}	4	2
0 20 045	Supercooled large droplet (SLD) conditions	Code table	0	0	2	Code table	0	2

Add new Code tables:

Code figure	0 08 009 Detailed phase of aircraft flight
0	Level flight, routine observation, unsteady
1	Level flight, highest wind encountered, unsteady
2	Unsteady (UNS)
3	Level flight, routine observation (LVR)
4	Level flight, highest wind encountered (LVW)
5	Ascending (ASC)
6	Descending (DES)
7	Ascending, observation intervals selected by time increments
8	Ascending, observation intervals selected by time increments, unsteady
9	Ascending, observation intervals selected by pressure increments
10	Ascending, observation intervals selected by pressure increments, unsteady
11	Descending, observation intervals selected by time increments
12	Descending, observation intervals selected by time increments, unsteady
13	Descending, observation intervals selected by pressure increments
14	Descending, observation intervals selected by pressure increments, unsteady
15	Missing value

0 11 039
Extended time of occurrence of peak eddy dissipation rate

Code figure	Minutes prior to observation time (min)
0	min < 1
1	1 <= min < 2
2	2 <= min < 3
3	3 <= min < 4
4	4 <= min < 5
5	5 <= min < 6
6	6 <= min < 7

7	7 <= min < 8
8	8 <= min < 9
9	9 <= min < 10
10	10 <= min < 11
11	11 <= min < 12
12	12 <= min < 13
13	13 <= min < 14
14	14 <= min < 15
15–59	As above to 59 <=min < 60
60	No timing information available
61–62	Reserved
63	Missing value

Code figure	0 20 042
	Airframe icing present
0	No icing
1	Icing present
2	Reserved
3	Missing value

Code figure	0 20 045
	Supercooled large droplet (SLD) conditions
0	No SLD conditions present
1	SLD conditions present
2	Reserved
3	Missing value

PROPOSED ADDITIONS TO BUFR TABLE D

Table references F	*X*	*Y*	*Table reference*			*Element name*
						(Standard AMDAR reports)
3	11	005	0	01	008	Aircraft identification
			0	01	023	Sequence number
			3	01	021	Latitude and longitude
			3	01	011	Year, month and day
			3	01	013	Hour, minute and second
			0	07	010	Flight level
			0	08	009	Detailed phase of flight
			0	11	001	Wind direction
			0	11	002	Wind speed
			0	11	031	Degree of turbulence
			0	11	036	Derived equivalent vertical gust speed
			0	12	101	Temperature/dry-bulb temperature
			0	33	025	ACARS interpolated values
						(AMDAR sounding data)
3	11	006	0	07	010	Flight level
			0	11	001	Wind direction
			0	11	002	Wind speed
			0	02	064	Roll angle quality
			0	12	101	Temperature/dry-bulb temperature
			0	12	103	Dew-point temperature

Add new Class 35 BUFR/CREX descriptors:

Bulletin being monitored (CCCC)				
0 35 023	CCITT IA5	0	0	32
B 35 023	Character	0		4
Bulletin being monitored (BBB)				
0 35 024	CCITT IA5	0	0	24
B 35 024	Character	0		3

Change units of the following descriptors currently existing in BUFR/CREX Class 35:

Bulletin being monitored (TTAAii)				
0 35 021	CCITT IA5	0	0	48
B 35 021	Character	0		6
Bulletin being monitored (YYGGgg)				
0 35 022	CCITT IA5	0	0	48
B 35 022	Character	0		6

New common Code table C-11 — Originating centres

CREX B 01 035 (5 characters)	*Sect.1/ Octets 6-7 in GRIB edition 2 BUFR 0 01 035 (16 bits)*	
0 to 254	0 to 254	See Common table C-1
255 to 10000	255 to 10000	Reserved for centres in Region I which are not in the list above
10001 to 20000	10001 to 20000	Reserved for centres in Region II which are not in the list above
20001 to 30000	20001 to 30000	Reserved for centres in Region III which are not in the list above
30001 to 40000	30001 to 40000	Reserved for centres in Region IV which are not in the list above
40001 to 50000	40001 to 50000	Reserved for centres in Region V which are not in the list above
50001 to 65534	50001 to 65534	Reserved for centres in Region VI which are not in the list above
65535	65535	Missing value
65536 to 99999	n.a.	Not used

PROPOSED NEW ENTRY FOR COMMON TABLE TABLE C-1 AND (C-11)

161 US NOAA Office of Oceanic and Atmospheric Research

Subcentres:

1. Great Lakes Environmental Research Laboratories
2. Forecast Systems Laboratory

Add list of subcentres for originating centre 7 (NCEP) within Common Code Table C-1 (and C-11):

1. NCEP Reanalysis Project
2. NCEP Ensemble Products
3. NCEP Central Operations
4. Environmental Modeling Center
5. Hydrometeorological Prediction Center
6. Marine Prediction Center
7. Climate Prediction Center
8. Aviation Weather Center
9. Storm Prediction Center
10. Tropical Prediction Center
11. NWS Techniques Development Laboratory
12. NESDIS Office Research and Applications
13. Federal Aviation Administration
14. NWS Meteorological Development Laboratory

Add descriptor in Class 1:

0 01 035	Originating centre	Common Code table C-11	0	0	16
B 01 035				0	5

Add note under Common table C-1:

(4) In case all entries of a band reserved to a specific Region have been allocated, it will be allowed to attribute an entry in another Region band, if necessary.

Add new BUFR/CREX descriptors:

Emissivity				
0 14 050	%	1	0	10
B 14 050	%	1		4
Snow cover				
0 20 065	%	0	0	7
B 20 065	%	0		3

NOTES:

(1) Emissivity is the ratio of the amount of energy emitted from a particular object compared to the amount that would be emitted by a blackbody at the same temperature (i.e. the Planck function). Multiplying by 100 gives a per cent (and provides 2 digits of precision at the same time).

(2) Snow cover will be reported for each satellite pixel as a percentage of coverage of the pixel. It does not seem feasible to try to use existing descriptor 0 20 062 for such a purpose because the use of that descriptor additionally implies details on, e.g. snow drifts, wet compared to dry snow, etc. that a satellite obviously cannot accurately detect.

Add a note to regulation 94.5.4.1 in BUFR:

NOTE: Where a replication operation includes delayed replication(s) within the scope of its replication, the replication (or repetition) factor descriptor(s) from class 31 shall be counted for X, except the one (if any) located immediately after the replication descriptor for which X is being calculated, as in the following example:

106000 031001 008002 103000 031001 005002 006002 010002

Add a sub-note (ix) to note 2 of regulation 94.6.3:

(ix) When delayed replication is present, it is required that the number of replications shall be identical for each data subset if data compression is to be used. In such cases, sub-note (vii) shall apply when coding the number of replications.

Add new BUFR/CREX descriptors for new rawinsonde data:

Radiosonde serial number	0 01 081	CCITT IA5	0	0	160
	B 01 081	Character	0		20
Radiosonde ascension number	0 01 082	Numeric	0	0	14
	B 01 082	Numeric	0		4
Radiosonde release number	0 01 083	Numeric	0	0	3
	B 01 083	Numeric	0		1
Balloon lot number	0 01 093	CCITT IA5	0	0	96
	B 01 093	Character	0		12
WBAN number	0 01 094	Numeric	0	0	17
	B 01 094	Numeric	0		5
Observer identification	0 01 095	CCITT IA5	0	0	32
	B 01 095	Character	0		4
Radiosonde configuration	0 02 016	Flag table	0	0	5
	B 02 016	Flag table	0		2
Radiosonde ground receiving system	0 02 066	Code table	0	0	6
	B 02 066	Code table	0		2
Radiosonde operating frequency	0 02 067	Hz	-5	0	15
	B 02 067	Hz	-5		5
Balloon manufacturer	0 02 080	Code table	0	0	6
	B 02 080	Code table	0		2
Type of balloon	0 02 081	Code table	0	0	5
	B 02 081	Code table	0		2
Weight of balloon	0 02 082	Kg	3	0	12
	B 02 082	Kg	3		4
Type of balloon shelter	0 02 083	Code table	0	0	4
	B 02 083	Code table	0		2
Type of gas used in balloon	0 02 084	Code table	0	0	4
	B 02 084	Code table	0		2
Amount of gas used in balloon	0 02 085	Kg	3	0	13
	B 02 085	Kg	3		4
Balloon flight train length	0 02 086	m	1	0	10
	B 02 086	m	1		4
Type of pressure sensor	0 02 095	Code table	0	0	5
	B 02 095	Code table	0		2
Type of temperature sensor	0 02 096	Code table	0	0	5
	B 02 096	Code table	0		2
Type of humidity sensor	0 02 097	Code table	0	0	5
	B 02 097	Code table	0		2
Type of surface observing equipment	0 02 115	Code table	0	0	5
	B 02 115	Code table	0		2
Flight level significance	0 08 040	Code table	0	0	6
	B 08 040	Code table	0		2
Data significance	0 08 041	Code table	0	0	5
	B 08 041	Code table	0		2
Relative humidity	0 13 009	%	1	-1000	12
	B 13 009	%	1		4
Software identification	0 25 061	CCITT IA5	0	0	96
	B 25 061	Character	0		12

Orientation correction (azimuth)	0 25 065	Degree	2	-1000	11
	B 25 065	Degree	2		4
Orientation correction (elevation)	0 25 066	Degree	2	-1000	11
	B 25 066	Degree	2		4
Radiosonde release point pressure correction	0 25 067	Pa	0	-8000	14
	B 25 067	Pa	0		4
Number of archive recomputes	0 25 068	Numeric	0	0	7
	B 25 068	Numeric	0		3
Flight level pressure corrections	0 25 069	Flag table	0	0	8
	B 25 069	Flag table	0		3
Data quality check indicator	0 33 015	Code table	0	0	6
	B 33 015	Code table	0		2
Reason for termination	0 35 035	Code table	0	0	5
	B 35 035	Code table	0		2

Add note under BUFR/CREX Class 1:

(12) Descriptor 0 01 082 is to be used for reporting the sequential number of the current radiosonde reporting period (e.g. synoptic cycle) within a given year or other similar locally-defined length of time. Descriptor 0 01 083 is to be used in the case of multiple sequential radiosonde releases during a single reporting period (e.g. synoptic cycle), in order to indicate which particular release generated the corresponding data values.

Add new code and flag tables:

Bit No.	0 02 016 Radiosonde configuration
1	Train regulator
2	Light unit
3	Parachute
4	Rooftop release
All 5	Missing value

Code figure	0 02 066 Radiosonde ground receiving system
0	ART-1
1	ART-2
2	VIZ GPS
3	Vaisala GPS
4	ATIR
5	Sippican GPS
6	IMS GPS
7–61	Reserved
62	Other
63	Missing value

Code figure	0 02 080 Balloon manufacturer
0	Kaysam
1	Totex
2	KKS
3-61	Reserved
62	Other
63	Missing value

Code figure	0 02 081 Type of balloon
0	GP26
1	GP28
2	GP30
3	HM26
4	HM28
5	HM30
6	SV16
7–29	Reserved
30	Other
31	Missing value

Code figure	0 02 083 Type of balloon shelter
0	High bay
1	Low bay
2	BILS
3	Roof-top BILS
4–13	Reserved
14	Other
15	Missing value

Code figure	0 02 084 Type of gas used in balloon
0	Hydrogen
1	Helium
2	Natural gas
3–13	Reserved
14	Other
15	Missing value

Code figure	0 02 095 Type of pressure sensor
0	Capacitance aneroid
1	Derived from GPS
2	Resistive strain gauge
3–29	Reserved
30	Other
31	Missing value

Code figure	0 02 096 Type of temperature sensor
0	Rod thermistor
1	Bead thermistor
2	Capacitance bead

3–29	Reserved
30	Other
31	Missing value

Code figure	0 02 097
	Type of humidity sensor
0	VIZ Mark II carbon hygristor
1	VIZ B2 hygristor
2	Vaisala A-humicap
3	Vaisala H-humicap
4	Capacitance sensor
5	Vaisala RS90
6	Sippican Mark IIA carbon hygristor
7–29	Reserved
30	Other
31	Missing value

Code figure	0 02 115
	Type of surface observing equipment
0	PDB
1	RSOIS
2	ASOS
3	Psychrometer
4	F420
5–29	Reserved
30	Other
31	Missing value

Code figure	0 08 040
	Flight level significance
0	High-resolution data sample
1	Within 20 hPa of surface
2	Pressure less than 10 hPa (i.e., 9, 8, 7, etc.) when no other reason applies
3	Base pressure level for stability index
4	Begin doubtful temperature, height data
5	Begin missing data (all ele-ments)
6	Begin missing relative humidity data
7	Begin missing temperature data
8	Highest level reached before balloon descent because of icing or turbulence
9	End doubtful temperature, height data
10	End missing data (all elements)
11	End missing relative humidity data
12	End missing temperature data
13	Zero degrees C crossing(s) for RADAT
14	Standard pressure level
15	Operator added level
16	Operator deleted level
17	Balloon re-ascended beyond previous highest ascent level
18	Significant relative humidity level
19	Relative humidity level selection terminated
20	Surface level
21	Significant temperature level
22	Mandatory temperature level
23	Flight termination level
24	Tropopause(s)
25	Aircraft report
26	Interpolated (generated) level
27	Mandatory wind level
28	Significant wind level
29	Maximum wind level
30	Incremental wind level (fixed regional)
31	Incremental height level (gener-ated)
32	Wind termination level
33	Pressure 100 to 110 hPa, when no other reason applies
34–39	Reserved
40	Significant thermodynamic level (inversion)
41	Significant relative humidity level (according to NCDC criteria)
42	Significant temperature level (according to NCDC)
43-61	Reserved
62	Other
63	Missing value

Code figure	0 08 041
	Data significance
0	Parent site
1	Observation site
2	Balloon manufacture date
3	Balloon launch point
4	Surface observation
5	Surface observation displacement from launch point
6	Flight level observation
7	Flight level termination point
8–30	Reserved
31	Missing value

Bit No.	0 25 069
	Flight level pressure corrections
1	Smoothed
2	Baseline adjusted
3	Normalized time interval
4	Outlier checked
5	Plausibility checked
6	Consistency checked
7	Interpolated
All 8	Missing value

Code figure	0 33 015
	Data quality check indicator
0	Passed all checks
1	Missing data check
2	Descending/reascending balloon check
3	Data plausibility check (above limits)
4	Data plausibility check (below limits)
5	Superadiabatic lapse rate check
6	Limiting angles check
7	Ascension rate check
8	Excessive change from previous flight
9	Balloon overhead check
10	Wind speed check
11	Wind direction check
12	Dependency check

13	Data valid but modified
14	Data outlier check
15–62	Reserved
63	Missing value

Code figure 0 35 035
Reason for termination

0	Balloon burst
1	Balloon forced down by icing
2	Leaking or floating balloon
3	Weak or fading signal
4	Battery failure
5	Ground equipment failure
6	Signal interference
7	Radiosonde failure
8	Loss of GPS signal
9	Limiting angles
10	Excessive missing data frames
11	Excessive missing temperature
12	Excessive missing pressure
13	User terminated
14	Software error
15–29	Reserved
30	Other
31	Missing value

Add the following new entries to existing descriptor 0 33 035 (Manual/automatic quality control):

Code figure	*Meaning*
6	Automatic quality control flagged data as questionable and not manually checked
7	Automatic quality control flagged data as questionable and manually checked and failed
8	Manually checked and failed
9–14	Reserved

FOR REPRESENTATION OF SSMIS TEMPERATURE DATA RECORD (TDR) DATA

New table B entries:

F	*XX*	*YYY*	*Name*	*Unit*	*Scale*	*Reference value*	*Data with*
0	12	070	Warm load temperature	K	2	0	16
0	13	040	Surface flag	code table	0	0	4
0	20	029	Rain flag	code table	0	0	2
0	21	083	Warm target calibration	numeric	0	0	16
0	21	084	Cold target calibration	numeric	0	0	16
0	25	054	SSMIS subframe ID number	numeric	0	0	5
0	25	055	Multiplexer housekeeping	K	2	0	16

Code tables:

013040 Surface flag

0	Land
1	Reserved
2	Near coast
3	Ice
4	Possible ice
5	Ocean
6	Coast
7–14	Reserved
15	Missing

020029 Rain flag

0	No rain
1	Rain
2	Reserved
3	Missing value

New table D entry:

3 10 025 SSMIS temperature data record

0 01 007	Satelllite identification
0 08 021, 0 04 001, 0 04 002, 0 04 003	Scan start, year, month, day
0 04 004, 0 04 005	Hour, minute
2 01 138, 2 02 131, 0 04 006, 2 02 000, 2 01 000	Millisecs
2 01 132, 0 05 041, 2 01 000	Scan number
2 01 129, 0 05 043, 2 01 000	Scene number
0 05 002, 0 06 002, 0 13 040, 0 20 029	Latitude, longitude, surface flag, rain flag
1 04 024, 0 05 042, 0 12 163	24 times (channel number, temperature, warm,
0 21 083, 0 21 084	cold target calibration)
1 15 003	Replicate ephemeris data *3
0 04 001, 0 04 002, 0 04 003	Ephemeris year, month, day
2 01 142, 2 02 131, 0 04 026, 2 02 000, 2 01 000	Ephemeris millisecs
0 05 001, 0 06 001	Ephemeris lat, long
2 01 138, 2 02 129, 0 07 001, 2 02 000, 2 01 000	Ephemeris height

0 08 021, 0 04 001, 0 04 002, 0 04 003	Orbit start, year, month, day
0 04 004, 0 04 005, 0 05 040	Hour, minute, orbit number
1 01 003, 0 12 070	3 times warm load temperature
0 25 054	SSMIS subframe identification number
1 01 004, 0 250 55,	4 times MUX HK values
0 08 007	Dimensional significance (line)
1 04 028, 0 05 002, 0 06 002, 0 02 111, 0 05 021	28 times (latitude, longitude, Earth angle, azimuth)

FOR USE WITH CERTAIN TYPES OF ALTIMETER DATA

In existing table Common Code Table C-5: Satellite identifier (BUFR 0 01 007), add new entries:
720 = TOPEX and 721 = GFO

Add new Table B entry: Cycle number
0 05 044, Cycle number, Unit = numeric, Scale = 0, Reference value = 0,
Data width = 11 (BUFR) 4 (CREX)

REPRESENTATION OF GROUND-BASED GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS) DATA IN BUFR FORMAT

Observations at each ground-based station are made at regular intervals, typically 15 minutes, and consist of measurements of several global positioning systems (GPS) or other GNSS satellites observable from the station at that time. The Global Navigation Satellite System (GNSS) is a generic term which includes the United States, the GPS satellites, the corresponding Russian GLONASS satellites and the proposed European GALILEO satellites.

The instruments measure the phase shift of the satellite signal relative to what would have been expected if the entire signal path were a vacuum. Using the wavelength, this is converted into an atmospheric path delay (typically 2–3 metres).

Data are processed locally to generate estimates of the path delays for a zenith view and for limb views in the main geographic directions. The processing also generates estimates of errors for these quantities.

New Table D entry for the representation of ground-based GNSS data

The table gives the expansion for the proposed new sequence 3 07 022 for ground-based GNSS data. New descriptors and Code table entries are marked in italics and are fully described in subsequent tables.

Descriptor	*Element name*	*Unit*	*Notes*
3 07 022	*(Ground-based GNSS data)*		
0 01 015	Station or site name	CCITT IA5	
3 01 011	Year	Year	
	Month	Month	
	Day	Day	
3 01 012	Hour	Hour	
	Minute	Minute	
3 01 022	Latitude (high accuracy)	Degrees	
	Longitude (high accuracy)	Degrees	
	Height of station	m	
0 08 021	Time significance	Code table	23 = monitoring period
0 04 025	Time period or displacement	Minutes	
0 10 004	Pressure	Pa	
0 12 001	Temperature	K	
0 13 003	Relative humidity	%	
0 33 038	*Quality flags for ground-based GNSS data*	*Flag table*	*New descriptor*
0 08 022	Total number	Numeric	Number of GNSS satellites used
1 06 025	Replication		6 descriptors 25 times
0 02 020	Satellite classification	Code table	*New table entries*
0 01 050	Platform transmitter identification number	Numeric	
0 05 021	Azimuth	Degree true	
0 07 021	Elevation	Degree	
0 15 031	*Atmospheric path delay in satellite signal*	*m*	*New descriptor*
0 15 032	Estimated error in atmospheric path delay	m	New descriptor
0 08 060	Sample scanning mode significance	Code table	*=5 for north/south*

0 15 033	*Difference in path delays for limb views at extremes of scan*	*m*	*New descriptor*
0 15 034	*Estimated error in path delay difference*	*m*	*New descriptor*
0 08 060	Sample scanning mode significance	Code table	*=6 for east/west*
0 15 033	*Difference in path delays for limb views at extremes of scan*	*m*	*New descriptor*
0 15 034	*Estimated error in path delay difference*	*m*	*New descriptor*
0 15 035	*Component of zenith path delay due to water vapour*	*m*	*New descriptor*
2 01 131	Change bit width		
2 02 129	Change scale		
0 13 016	Precipitable water	Kg m^{-2}	
2 02 000	Reset scale		
2 01 000	Reset bit width		
0 15 011	Log_{10} of integrated electron density	$Log_{10}(m^{-2})$	

New Table B entries:

Table reference F XX YYY	*Element name*	*Unit*	*Scale*	*Reference value*	*Data with*
0 15 031	Atmospheric path delay in satellite signal	m	4	10000	15
0 15 032	Estimated error in atmospheric path delay	m	4	0	10
0 15 033	Difference in path delays for limb views at extremes of scan	m	5	–10000	15
0 15 034	Estimated error in path delay difference	m	5	0	14
0 15 035	Component of zenith path delay due to water vapour	m	4	0	14
0 33 038	Quality flags for ground-based GNSS data	Flag table		0	0 10

New code figures for Satellite Classification in Code Table 0 02 020

Code figure	*Meaning*
401	GPS
402	GLONASS
403	GALILEO

New code figures for Sample Scanning Mode Significance in Code Table 0 08 060

Bit No.	*Meaning when set*
5	North/South
6	East/West

New Flag Table: 0 33 038

Quality Flags for ground-based GNSS data

Bit No.	*Meaning when set*
1	Total zenith delay quality is considered poor
2	GALILEO satellites used
3	GLONASS satellites used
4	GPS satellites used
5	Meteorological data applied
6	Atmospheric loading correction applied
7	Ocean tide loading applied
8	Climate quality data processing
9	Near-real time data processing
All 10	Missing value

New entries for Originating/Generating Sub-Centre in 0 01 034 — Common Code Table C-1

Centre		*Sub-centre*	
Code figure	*Name*	*Code figure*	*Name*
		21	Agenzia Spaziale Italiana (Italy)
		22	Centre National de la Recherche Scientifique (France)
74	UK Meteorological Office, Bracknell (RSMC)	23	GeoForschungsZentrum (Germany)
		24	Geodetic Observatory Pecny (Czech Republic)
		25	Institut d'Estudis Espacials de Catalunya (Spain)
		26	Swiss Federal Office of Topography
		27	Nordic Commission of Geodesy

New descriptor for use in reporting certain types of AIRS satellite data:

Principal component score	0 25 050	Numeric	4	–131072	18
	B 25 050	Numeric	4		6

Additional entries in BUFR code tables to support JASON satellite data:

Append an asterisk to the element name for existing descriptor 0 25 060 in order to indicate that the actual meaning may be obtained from the originator of the data.

Additional Table B descriptors:

		Unit	Scale	Ref	Bits
0 02 173	Square of the off-nadir angle	Square degrees	4	0	10
0 04 007	Seconds within a minute	s (microsecond accuracy)	6	0	26
0 08 029	Remotely-sensed surface type	Code table	0	0	8
0 08 074	Altimeter echo type	Code table	0	0	2
0 08 076	Type of band	Code table	0	0	6
0 13 090	Radiometer water vapour content	kg m^{-2}	0	0	7
0 13 091	Radiometer liquid content	kg m^{-2}	0	0	7
0 21 128	Number of valid points per second used to derive previous parameters	Numeric	0	0	8
0 25 095	Altimeter state flag	Flag table	0	0	2
0 25 096	Radiometer state flag	Flag table	0	0	5
0 25 097	Three-dimensional error estimate of the navigator orbit	Code table	0	0	4

Additional entries in existing Code tables:

Common Code table C-5:

260	JASON-1
261	JASON-2

Code and flag tables:

0 02 020	Satellite classification
261	JASON
0 02 048	Satellite sensor indicator
9	POSEIDON altimeter
10	Jason microwave radiometer (JMR)
0 08 023	First-order statistics
13	Root-mean-square

Additional code and flag tables:

0 08 029 Remotely-sensed surface type

Value	*Meaning*
0	Open ocean or semi-enclosed sea
1	Enclosed sea or lake
2	Continental ice
3	Land
4–254	Reserved
255	Missing value

0 08 074 Altimeter echo type

Value	*Meaning*
0	Open ocean or semi-enclosed sea
1	Non-ocean like
2	Reserved
3	Missing value

0 08 076 Type of band

Value	*Meaning*
0	Ku
1	C
2–62	Reserved
63	Missing value

0 25 095 Altimeter state flag

Bit No.	*Indicator*
1	Altimeter operating (0 if nominal, 1 if backup)
All 2	Missing value

0 25 096 Radiometer state flag

Bit No.	*Indicator*
1	Mode indicator (0 if mode 2, 1 if mode 1)
2	Mode 1 calibration sequence indicator (0 if normal data taking either mode 1 or 2, 1 if mode 1 calibration sequence)
	Bits 3 and 4 indicate active 23.8 GHz channel(s):
3	Channel 2 (0 if on, 1 if off)
4	Channel 3 (0 if on, 1 if off)
All 5	Missing value

0 25 097 Three-dimensional error estimate of the navigator orbit

Value	*Meaning*
0	Ranges between 0 and 30 cm
1	Ranges between 30 and 60 cm
2	Ranges between 60 and 90 cm
3	Ranges between 90 and 120 cm
4	Ranges between 120 and 150 cm
5	Ranges between 150 and 180 cm
6	Ranges between 180 and 210 cm
7	Ranges between 210 and 240 cm
8	Ranges between 240 and 270 cm
9	Ranges larger than 270 cm
10–14	Reserved
15	Missing value

ANNEX 4 TO RECOMMENDATION 4 (CBS-Ext.(02))

AMENDMENTS TO FM 12-XII SYNOP, FM 13-XII SHIP AND FM 14-XII SYNOP MOBIL FOR REPORTING PRECIPITATION AND ITS GLOBAL HARMONIZATION

Change regulation 12.2.5.4 to read:

This group shall be:

(*a*) Coded with RRR = 000, (3 zeros) when precipitation is measured but no precipitation occurred during the reference period;

(*b*) Coded with RRR = ///, (3 solidi) when precipitation is normally measured but is not available for the current report;

(*c*) Omitted when precipitation is not normally measured. In this case, i_R should be coded as 4.

(*d*) Existing automated weather stations (AWS) may continue to report no precipitation with i_R coded as 3 and the $6RRRt_R$ group omitted. New systems and human observer should report the $6RRRt_R$ group with RRR = 000, (3 zeros) to indicate no precipitation occurred during the reference period.

Change regulation 12.4.1 to read:

The inclusion of groups with indicator figures 1 up to 6, and 8 and 9 shall be decided regionally. However group $7R_{24}R_{24}R_{24}R_{24}$ shall be included by all stations (with the exception of stations situated in the Antarctic) capable of doing so, once a day at one appropriate time of the main standard times (0000, 0600, 1200 or 1800 UTC).

Add for correct encoding in FM 75-XII CLIMAT TEMP and FM 76-XII CLIMAT TEMP SHIP a next sentence at the end of regulation 75.4 to read:

Solidi (/////) shall be reported for any missing value in the groups of a level for which any element or all are not available. No group shall be omitted at any level. Any missing element shall be reported by solidi.

ANNEX 5 TO RECOMMENDATION 4 (CBS-Ext.(02))

AMENDMENTS TO FM 15-XII METAR, FM 16-XII SPECI

Amend the titles to read "FM 15-XII Ext. METAR Aerodrome routine meteorological report (with or without trend forecast)" and "FM 16-XII Ext. SPECI Aerodrome special meteorological report (with or without trend forecast)". Reason: the term "selected special reports" has been deleted from ICAO Annex 3/WMO Technical Regulation [C.3.1]. The proposal would also align the titles used for METAR and SPECI with the one used for TAF aerodrome forecast (Amendment 72 to ICAO Annex 3).

Amend regulation 15.1.1 to read as follows: "The code name METAR or SPECI shall be included at the beginning of each individual report." (Amendment 72 to ICAO Annex 3).

FM 51-XII TAF

Add in code form "AMD" after "TAF": there is an aeronautical requirement to identify amended aerodrome forecasts (Amendment 72 to ICAO Annex 3).

Add at the end of NOTE (3): The code words "AMD" shall be included as appropriate for ammended forcasts.

Amend regulation 51.1.1 to read as follows: "The code name TAF shall be included at the beginning of each individual aerodrome forecast" (Amendment 72 to ICAO Annex 3).

Amend regulation 51.1.5 last sentence to read as follows: "However, in case of significant change of the clouds, all cloud groups including any significant layer(s) or masses not expected to change shall be given". Reason: to align the *Manual on Codes* with ICAO Annex 3/WMO Technical Regulation [C.3.1]).

RECOMMENDATION 5 (CBS-Ext.(02))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The report of the Meeting of the Emergency Response Activities Coordination Group (September 2001),

(2) The report of the Meeting of the CBS Expert Team on Ensemble Prediction Systems (October 2001),

(3) The report of the Meeting of the CBS Expert Team on the Infrastructure for Long-range Forecasting (November 2001),

(4) The report of the Meeting of the CBS Expert Team to Develop a Verification System for Long-range Forecasts (April 2002),
(5) The report of the Meeting of the CBS Implementation Coordination Team on Data-processing and Forecasting Systems (June 2002),
(6) The report of the Expert Meeting on GDPS Solutions for Data Quality Monitoring Procedures (June 2002),
(7) The *Manual on the Global Data-processing System* (WMO-No. 485),

CONSIDERING:
(1) That there is a need, in the light of experience, to update further current procedures for the provision of transport model products for environmental emergency response,
(2) That there is a need to specify requirements for ensemble prediction products and standards for their verification,
(3) That there is a need to adopt standards and recommended practices for the verification of long-range forecasts,
(4) That there is a need to adopt complementary procedures and formats for the exchange of data quality monitoring results,

RECOMMENDS that the amendments to the *Manual on the Global Data-processing System* (WMO-No. 485), Parts I and II, Appendices I-1, I-3, II-6 and II.7, and Attachments II.7, II.8 and II.9, given in the annexes to this recommendation be adopted for inclusion in the *Manual on the Global Data-processing System* to take effect from 1 July 2003;

REQUESTS the Secretary-General, to make appropriate changes, as given in the annexes to this recommendation in the *Manual on the Global Data-processing System*;

AUTHORIZES the president of CBS, in consultation with the Secretary-General to make any consequential purely editorial amendments with respect to the *Manual on the Global Data-processing System*.

ANNEX 1 TO RECOMMENDATION 5 (CBS-Ext.(02))

MODIFICATIONS TO PARTS I AND II OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM*

PART I

1. PURPOSE OF THE GDPS

The main purpose of the GDPS shall be to prepare and make available to Members in the most cost-effective way meteorological analyses and forecast products. The design, functions, organizational structure and operations of the GDPS shall be in accordance with Members' needs and their ability to contribute to, and benefit from, the system.

2. FUNCTIONS OF THE GDPS

2.1 The real-time functions of the GDPS shall include:

(*a*) Pre-processing of data, e.g. retrieval, quality control, decoding, sorting of data stored in a database for use in preparing output products;
(*b*) Preparation of analyses of the three-dimensional structure of the atmosphere with up-to-global coverage;
(*c*) Preparation of forecast products (fields of basic and derived atmospheric parameters) with up-to-global coverage;
(*d*) Preparation of ensemble prediction products;
(*e*) Preparation of specialized products such as limited area very-fine mesh short-, medium-, extended- and long-range forecasts, tailored products for marine, aviation, environmental quality monitoring and other purposes;
(*f*) Monitoring of observational data quality;
(*g*) Post-processing of NWP data using workstation and PC-based systems with a view to producing tailored value-added products and generation of weather and climate forecasts directly from model output.

2.2 The non-real-time functions of the GDPS shall include:

(*a*) Preparation of special products for climate-related diagnosis (i.e. 10-day or 30-day means, summaries, frequencies and anomalies) on a global or regional scale;
(*b*) Intercomparison of analysis and forecast products, monitoring of observational data quality, verification of the accuracy of prepared forecast fields, diagnostic studies and NWP model development;
(*c*) Long-term storage of GOS data and GDPS products, as well as verification results for operational and research use;
(*d*) Maintenance of a continuously-updated catalogue of data and products stored in the system;
(*e*) Exchange between GDPS centres of ad hoc information via distributed databases;
(*f*) Conduct of workshops and seminars on the preparation and use of GDPS output products.

3. ORGANIZATION OF THE GDPS

The GDPS shall be organized as a three-level system of World Meteorological Centres (WMCs), Regional Specialized Meteorological Centres (RSMCs) and National Meteorological Centres (NMCs), which carry out GDPS functions at the global, regional and national levels, respectively. The GDPS shall also support other WMO Programmes and relevant programmes of other international organizations in accordance with policy decisions of the Organization.

4. FUNCTIONS OF GDPS CENTRES

4.1 The general functions of GDPS centres shall be as follows:

4.1.1 World Meteorological Centres (WMCs)

These shall consist of centres applying sophisticated high-resolution global NWP models (including ensemble prediction system) and preparing for distribution to Members and other GDPS centres the following products:

(*a*) Global (hemispheric) analysis products;

(*b*) Short-, medium-, extended- and long-range forecasts and products with a global coverage, but presented separately, if required, for:
  - (i) The tropical belt;
  - (ii) The middle and high latitudes or any other geographical area according to Members' requirements;

(*c*) Climate-related diagnostic products, particularly for tropical regions.

WMCs shall also carry out verification and intercomparison of products, support the inclusion of research results into operational models and their supporting systems, and provide training courses on the use of WMC products.

PART II

1. Functions of WMCs, RSMCs and NMCs

1.1 GDPS products and services

Each Member or group of Members(s) responsible for a GDPS Centre should ensure that its centre performs the relevant category of the following functions:

1.1.1 Real-time products and services for middle latitudes and subtropical areas

For middle latitudes and subtropical areas, the GDPS should provide the following products derived from deterministic and ensemble NWP systems and services in real time:

(*a*) Surface and upper-air analyses;

(*b*) Prognoses one to three days in advance, including:
  - (i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind in map or other form;
  - (ii) Diagnostic interpretation of numerical weather prediction (NWP) products to give:
    - a. Areal distribution of cloudiness;
    - b. Precipitation location, occurrence, amount and type;
    - c. Sequences at specific locations (time diagrams), at the surface and aloft, of temperature, pressure, wind, humidity, etc., subject to agreement between Members where appropriate;
    - d. Vorticity advection, temperature/thickness advection, vertical motion, stability indices, moisture distribution, and other derived parameters as agreed by Members;
    - e. Jet-stream location and tropopause/layer of maximum wind;
    - f. Numerical products providing sea-state or storm-surge forecasts;

(*c*) Prognoses four to 10 days in advance, including:
  - (i) Surface and upper-air prognoses of pressure (geopotential), temperature, humidity and wind;
  - (ii) Outlooks of temperature, precipitation, humidity and wind in map or other form;

(*d*) Extended- and long-range forecasts of averaged weather parameters as appropriate, including sea-surface temperature, temperature extremes and precipitation;

(*e*) Interpretation of numerical products using relations derived by statistical or statistical/dynamical methods to produce maps or spot forecasts of probability of precipitation or precipitation type, maximum and minimum temperature, probability of thunderstorm occurrence, etc.;

(*f*) Sea-state and storm-surge forecasts using models driven by winds from global NWP models;

(*g*) Environmental quality monitoring and prediction products;

(*h*) Independent real-time quality control of the Level II and Level III data defined in Note (3) to paragraph 1.5.2.

1.1.2 Real-time products and services for tropical areas

For tropical areas, the GDPS should provide the following products from deterministic and ensemble NWP systems and services in real time:

(*a*) Surface and upper-air analyses;

(*b*) Prognoses one to three days in advance, including:
  - (i) Surface and upper-air prognoses, particularly of wind and humidity in map or other form;
  - (ii) Diagnostic interpretation of NWP products to give:
    - a. Areal distribution of cloudiness;
    - b. Precipitation location/occurrence/amounts;
    - c. Time sequence of weather parameters at specific locations, subject to agreement between Members, where appropriate;
    - d. Vorticity, divergence, velocity potential, vertical motion, stability indices, moisture distribution and other derived parameters as agreed by Members;
    - e. Jet stream and layer of maximum wind locations;

f. Numerical products providing sea-state or storm-surge forecasts;

(iii) The use of special NWP-nested models or diagnostic interpretation of fine-mesh global models to give:

a. Tropical storm positions and tracks;

b. Tropical depression and easterly wave positions and movement;

(*c*) Prognoses four to 10 days in advance, including:

(i) Surface and upper-air prognoses, particularly of wind and humidity;

(ii) Outlooks of precipitation, wind, cloudiness and wet and dry periods;

(iii) Life cycle of tropical storms;

(*d*) Extended- and long-range forecasts of averaged weather parameters, as appropriate, including sea-surface temperature, temperature range and precipitation;

(*e*) Interpretation of numerical products, using relations derived by statistical/dynamical methods to produce maps or at specific location of forecast probability of cloudiness, temperature range, precipitation, thunderstorm occurrence, tropical cyclone tracks and intensitities, etc.;

(*f*) Environmental quality monitoring and prediction products;

(*g*) Sea-state and storm-surge forecasts using models driven by winds from global NWP models;

(*h*) Independent real-time quality control of the Level II and Level III data defined in Note (3) to paragraph 1.5.2.

1.1.3 Non-real-time products and services

The GDPS should also provide the following products and services in non-real time:

(*a*) Long-range weather and climate monitoring products when operationally useful;

(*b*) Climate-related diagnoses (10- or 30-day mean charts, summaries, anomalies, etc.) particularly for the tropical/subtropical belt;

(*c*) Intercomparison of products, verification and diagnostic studies, as well as NWP model development;

(*d*) Access to data, products and intercomparison results using internationally-accepted formats and media;

(*e*) Provision of continuously updated catalogues of data and products;

(*f*) Regional and global analyses (circulated by Members or research institutions) of the atmosphere and oceans, including means and anomalies of surface and upper-air pressure, temperature, wind and humidity, ocean currents, sea-surface temperature, and ocean surface layer temperature; derived indices, including blocking and teleconnection indices;

(*g*) Satellite remote sensing products distributed by Members; including outgoing long-wave radiation, sea-surface elevation, and normalized vegetation indices;

(*h*) Monthly and annual means or totals for each year of a decade (e.g. 1971–1980, etc.) and the corresponding decadal (10-year) averages of pressure (station level and mean sea level), temperature and precipitation, principally from CLIMAT reporting stations;

(*i*) Climatological standard normals (for the periods 1931–1960, 1961–1990, etc.) of selected elements, principally from CLIMAT reporting stations;

(*j*) Guidelines on the operational use of GDPS centre products; and

(k) Carrying out periodic monitoring of the operation of the WWW.

1.2 Functions of Members responsible for GDPS centres

1.2.1 Interpretation at NMCs

National Meteorological Centres (NMCs) should be able to use, interpret and interact fully with GDPS products in order to reap the benefits of the WWW system. Appropriate guidance on the methods for the interpretation of the GDPS output to end-user products should be made available to Members, as well as methods for the verification and intercomparison of forecasts.

1.2.2 Accessibility of products

GDPS products should be accessible through a system of World Meteorological Centres (WMCs) and Regional Specialized Meteorological Centres (RSMCs)* with functions and responsibilities as defined in the Manual and according to agreements among Members when appropriate.

1.2.3 Data management

The WWW data management function shall be used to coordinate the real-time storage, quality control, monitoring and handling of GDPS data and products.

1.3 WMC responsibilities

1.3.1 Output products

1.3.1.1 Each WMC applying sophisticated high-resolution global NWP models including ensemble prediction systems should prepare for distribution to Members and other GDPS centres the following products, based on the list in paragraphs 1.1 to 1.1.3 above:

(*a*) Global (hemispheric) analysis products;

(*b*) Short-, medium-, extended- and long-range weather forecasts based on deterministic and ensemble NWP system with global coverage presented separately, if required, for:

(i) The tropical belt;

(ii) The middle and high latitudes or any other geographical area according to Members' requirements;

(*c*) Climate-related diagnostic products, particularly for tropical regions;

(*d*) Environmental quality monitoring, analyses, forecasts and prediction products.

* The present structure of the GDPS is given in Appendix I-1.

1.3.1.2 Global model products required to meet the needs of all WMO Programmes should be made available to national and regional centres at the highest possible resolution given technological and other constraints.

1.3.2 Use of products

WMCs should also carry out verification and inter-comparison of products and make results available to all Members concerned, support the inclusion of research results into operational models and their supporting systems and provide training courses on the use of WMC products.

1.3.3 The functions of a WMC should also include the following non-real-time activities:

(*a*) Carrying out the development of research in support of large- and planetary-scale analyses and forecasting;
(*b*) Exchanging technical information with other centres;
(*c*) Providing opportunities for training personnel in data processing;
(*d*) Managing non-real-time data involving:
  (i) Collection and quality control of data not available from the GOS in real-time, via mail or other means;
  (ii) Storage and retrieval of all basic observational data and processed information needed for large- and planetary-scale research and applications;
  (iii) Making non-real-time data available to Members or research institutes upon request;
(*e*) Continuously updating and providing, on request, catalogues of available products.

Add in Appendix I-1 the following at the end of paragraph 2:

Broadened RSMC functions:
Offenbach — Provision of ultraviolet-index forecasts for Region VI (Europe)

Replace the following in Appendix I-3:

REGIONAL AND GLOBAL ARRANGEMENTS FOR THE PROVISION OF TRANSPORT MODEL PRODUCTS FOR ENVIRONMENTAL EMERGENCY RESPONSE

SUPPORT FOR NUCLEAR ENVIRONMENT EMERGENCY RESPONSE

IAEA notification of WMO

In the framework of the Convention on Early Notification of nuclear accidents, the IAEA informs the WMO Secretariat and the RTH Offenbach (Germany) of the status of the emergency. If needed, the IAEA will request support from the WMO RSMCs. Beginning with a site area emergency, RTH Offenbach will disseminate the EMERCON messages on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs (see also WMO *Manual on the Global Telecommunication System*, WMO-No. 386).

When the IAEA no longer requires WMO RSMC support, the IAEA will send an EMERCON termination message to the RSMCs, WMO Secretariat and RTH Offenbach. RTH Offenbach will disseminate the EMERCON termination message on the GTS in the form of an alphanumeric bulletin in plain-text English language under the abbreviated heading WNXX01 IAEA for global distribution to the NMCs/RSMCs.

Regional arrangements

The RSMCs designated by WMO for the provision of atmospheric transport model products for nuclear environmental emergency response shall:

1. Provide products only when either the delegated authority[1] of any country in the RSMC region of responsibility or the International Atomic Energy Agency (IAEA) requests RSMC support. Upon receipt of a request from the delegated authority[2] or from the IAEA, the RSMC shall provide basic information to the National Meteorological Service of that country or to the IAEA, respectively. If multiple requests are received, highest priority will be given to IAEA requests.
2. Upon receipt of a first request for products related to a nuclear incident and in the absence of a prior notification by the IAEA, inform the WMO Secretariat, all designated RSMCs and IAEA of the request.
3. For an IAEA request sent to the RSMCs to produce and distribute products, the requested RSMCs will distribute the basic products to the IAEA, and all RSMCs will distribute to National Meteorological Services in the region[3] and WMO. For a request for support from a Delegated Authority and without notification by IAEA, basic information provided to the National Meteorological Service of the requesting country will not be disclosed to the public in that country nor distributed by RSMCs to other National Meteorological Services.
4. Provide, on request, support and advice to the IAEA and WMO Secretariats in the preparation of public and media statements.

1 The person authorized by the Permanent Representative of the country to request RSMC support.
2 The RSMC products will be provided to the NMS Operational Contact Point designated by the Permanent Representative.
3 The basic information will normally be provided by the NMS to the IAEA national contact point.

5. Determine the standard set of basic products and the method of delivery in consultation with users and the IAEA.
6. Provide product interpretation guidelines to users.
7. Provide support and technology transfer to national and regional meteorological centres that want to become designated RSMCs.
8. Make arrangements to provide backup services. These would normally be between the two designated centres in a region. Interim arrangements should be made by centres in regions with a single designated RSMC.

Global arrangements

Until such time as new RSMCs have been designated, it is proposed that Regional Association VI-designated RSMCs be responsible to provide services for radiological emergencies to Regional Association I; Regional Association IV-designated RSMCs be responsible to provide services to Regional Association III; while the Regional Association V-designated RSMC, in collaboration with Regional Association IV-designated RSMCs, will be responsible to provide services to Regional Association V.

In cases of radiological emergencies where coordination is required between RSMCs of different regions, the RSMCs of the region where the emergency has occurred will provide this coordination.

Support for non-nucler environmental emergy response

If support is required for response to a non-nuclear environmental emergency, related to atmospheric transport of pollutants, the Permanent Representative with WMO of the affected country may direct its request for support to the operational contact point of the designated RSMC(s) for its Regional Association.

1. Due to the potentially broad range of environmental emergencies, the RSMC shall consider each request with regard to its capabilities and the suitability of its products to address the emergency requirements and will then respond accordingly.
2. The RSMC shall inform all other designated RSMCs and the WMO Secretariat of the request and the agreed actions.

ANNEX 2 TO RECOMMENDATION 5 (CBS-Ext.(02))

MODIFICATIONS TO APPENDIX II-6 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM*

Add the following after paragraph 3:

4. FORECASTS

Surface (including synoptic features)

925 hpa
850 hpa
700 hpa
500 hpa
400 hpa
300 hpa
250 hpa
200 hpa
150 hpa
100 hpa
70, 50, 30, 20 10 hpa

} Parameters: P/H, T, W and R, as appropriate and applicable

Jet-stream location and tropopause/layer of maximum wind
Significant weather
Relative topography, thickness 500/1 000 hPa

NOTE: The above list includes products which are required as part of the ICAO World Area Forecast System in accordance with requirements determined by ICAO.

Freezing level
Vorticity
Vertical motion
Areal distribution of cloudiness
Precipitation location, occurrence, amount and type
Sequences at specific locations (time diagrams) at the surface and aloft of T, P, W and R
Vorticity advection, temperature/thickness advection, vertical motion, stability indices, moisture distribution and other derived parameters
Tropical storm positions and intensities
River stage, discharge and ice phenomena
Tropical depression and easterly wave positions and movement
Four-to-10-day outlook for T, W, R and precipitation
Forecasts of probability of precipitation and temperature extremes for mid-latitudes and subtropical areas or forecasts of cloudiness, temperature range and precipitation probability for tropical areas
State of sea
Storm surge
Sea-surface temperature
Thermoclines
Sea ice
Superstructure icing
Three-dimensional trajectories with particle locations at synoptic hours for EER

Time integrated pollutant concentration within the 500 m layer above ground in three time periods up to 72 hours for EER
Total deposition up to 72 hours

4.1 Ensemble prediction system products

4.1.1 Products for dhort-range and medium-range

(*a*) Global products for routine dissemination

(Period for all fields: forecast D+0 to D+10 (12-hour intervals) at highest resolution possible)
Probabilities of:

(i) Precipitation exceeding thresholds 1, 5, 10, 25 and 50 mm/24 hours
(ii) 10 m sustained wind and gusts exceeding thresholds 10, 15 and 25 m s^{-1}
(iii) T850 anomalies with thresholds -4, -8, +4 and +8 K with respect to a reanalysis climatology specified by the producing Centre

ensemble mean (EM) + spread (standard deviation) of Z500, PMSL, Z1000, vector wind at 850 and 250 hPa
Tropical storm tracks (lat/long locations from EPS members)

(*b*) Model fields

Full set or subset of EPS members variables and levels for requesting WMO Members for specific applications.

Extended range forecasts (levels and parameters as appropriate five, 10, 15 or 30 day) and applicable mean values

Long-range forecasts (monthly, three-month or 90-day, seasonal to multi-seasonal outlook

4.1.2 Products for extended range

Ensemble means anomalies/spread

One week averages and the monthly mean (all anomalies with respect to model climate):

Tropical SST
Standard ENSO indices
Z500 and Z1000, precipitation, T850 and surface temperature

Probabilities:

Terciles: above, below, normal (with respect to model climate)

Precipitation
Z500
Z1000
T850 and surface temperature

Model fields:

(*a*) Full set or subset of EPS members variables and levels for requesting WMO Members for specific applications.
(*b*) Relevant post-processed fields from sequence of daily output (e.g. indices of monsoon onset, droughts, tropical storm activity, extratropical storm track activity)

NOTE: The list of long range products for distribution as developed by the CBS Expert Team on the Infrastructure for Long-range Forecasting is being validated prior to being adopted as part of the appendix to this *Manual*.

ANNEX 3 TO RECOMMENDATION 5 (CBS-Ext.(02))

ATTACHMENT II.7, TABLE F OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM*

Add the following at the end of Table F:

III — Standard verification measures of EPS

EXCHANGE OF SCORES

Monthly exchanges:

ENSEMBLE MEAN

For verification of ensemble mean, the specifications in this table of the attachment for variables, levels, areas and verifications should be used.

SPREAD

Ratio of standard deviation over RMS error of the ensemble mean averaged over the same regions and variables as used for the ensemble mean.

PROBABILITIES

The reliability table of the same format as defined for the SVS for long-range forecasts should be exchanged.

List of parameters

PMSL ± 1, ± 2 standard deviation with respect to centre's own climatology
Z500 with thresholds as for PMSL.
850 hPa wind speed with thresholds of 10, 15, 25 m s^{-1}.
T850 anomalies with thresholds ± 4, ± 8 degrees with respect to a centre specified climatology.
Verified for areas defined for verification against analysis.
Precipitation with thresholds 1, 5, 10, and 25 mm/24 hours every 24 hours verified over areas defined for deterministic forecast verification against observations.
Observations for EPS verification should be based on the GCOS list of surface network (GSN).

Scores

Brier Skill Score (with respect to climatology) (see definition below*)

Relative economic value (C/L) diagrams

Reliability diagrams with frequency distribution

NOTE: Annual and seasonal averages of the Brier Skill Score at 24, 72, 120, 168 and 240 hours for Z500 and T850 should be included in the yearly Technical Progress Report on the Global Data-processing System.

* The Brier Score is most commonly used for assessing the accuracy of binary (two-category) probability forecasts. The Brier Score is defined as:

$$PS = \frac{\sum_{ij}\left(F_{ij} - O_{ij}\right)^2}{N}$$

where the observations O_{ij} are binary (0 or 1) and N is the verification sample size. The Brier Score has a range from 0 to 1 and is negatively-oriented. Lower scores represent higher accuracy.

The Brier Skill Score (BSS) is in the usual skill score format, and may be defined by:

$$BSS = \frac{PS_C - PS_F}{PS_C} \times 100 = \left[1 - \frac{\sum_{ij}\left(F_{ij} - O_{ij}\right)^2}{\sum_{ij}\left(C_{ij} - O_{ij}\right)^2}\right] \times 100$$

where C refers to climatology and F refers to the forecast.

ANNEX 4 TO RECOMMENDATION 5 (CBS-Ext.(02))

MODIFICATIONS TO APPENDIX II-7 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM*

USERS INTERPRETATION GUIDE FOR ATMOSPHERIC TRANSPORT MODEL PRODUCTS PROVIDED BY RSMCs

Standards in the provision of international services by RSMCs for nuclear environmental emergency response

The Delegated Authority requests support from WMO Regional Specialized Meteorological Centres (RSMC) for atmospheric transport modelling products by using the form entitled "Environmental Emergency Response — Request for WMO RSMC Support by Delegated Authority". The Delegated Authority then sends the completed form immediately to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. This will initiate a joint response from the RSMCs in their region of responsibility.

The International Atomic Energy Agency (IAEA) requests support from WMO RSMCs for atmospheric transport modelling products by using the form agreed between WMO and IAEA. The IAEA then sends the completed form immediately to the RSMCs as per the regional and global arrangements and ensures receipt of the form by phone. This will initiate a joint response from the RSMCs in their region of responsibility.

The designated RSMCs shall implement agreed standard procedures and products by:

(*a*) The provision of the following standard set of basic products within two to three hours of reception of a request and according to the general rules for displaying results;

(*b*) The adoption of the following forecast periods for the numerical calculations;

(*c*) The adoption of a joint response approach;

(*d*) The adoption of the general rules for displaying results.

1. Default values to be used in response to a request for products for the unspecified source parameters[1]

(*a*) Uniform vertical distribution up to 500 m above the ground;

(*b*) Uniform emission rate during six hours;

(*c*) Starting date/time: date/time specified at "START OF RELEASE" on request form or, if not available, then the "date/time of request" specified at the top of the request form;

(*d*) Total pollutant release 1 Bq (Becquerel) over six hours;

(*e*) Type of radionuclide ^{137}Cs.

2. Basic set of products

Five maps consisting of:

(*a*) Three-dimensional trajectories starting at 500, 1 500 and 3 000 m above the ground, with particle locations at six-hour intervals (main synoptic hours up to the end of the dispersion model forecast);

(*b*) Time-integrated airborne concentrations within the layer 500 m above the ground, in Bq s m^{-3} for each of the three forecast periods;

(*c*) Total deposition (wet + dry) in Bq m^{-2} from the release time to the end of the dispersion model forecast.

A joint statement that will be issued as soon available.

1 The adoption of default values is based on the understanding that some runs of the transport/dispersion models need to be carried out with default parameters because little or no information (except location) will be available to the RSMC at an early stage. RSMCs are, however, requested to conduct and propose subsequent model runs with more realistic parameters as they become available (products based upon updated parameters will be provided on request only or confirmed from IAEA or a Delegated Authority). This may, for example, refer to a more precise assumption of the vertical distribution or the need to conduct a model run for the release of noble gases.

3. Forecast periods for numerical calculations

The initial set of products will cover the period from T, the start time of the release, through a forecast of 72 hours from t, the start time of the current output from the operational NWP model.

The first 24-hour period for integrated exposures in the dispersion model will start at the nearest synoptic time (0000 or 1200 UTC) prior to or equal to T. Subsequent 24-hour integrations of the dispersion model will be made up to, but not exceeding, the synoptic time nearest to t+72.

If T is earlier than t, the first response will use hindcasts to cover the period up to t.

4. Joint response and joint statements

A joint response means that the collaborating RSMCs shall immediately inform each other of any request received; initially both should produce and send the basic set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a "joint statement" to describe a synopsis of the current and forecast meteorological conditions over the area of concern, and the results from the transport models, their differences and similarities and how they apply to the event.

5. General rules for displaying results

In order to make the interpretation of the maps easier, the producing centres should adopt the following guidelines:

General guidelines for all maps:

(*a*) Provide labelled latitude and longitude lines at 10° intervals and sufficient geographic map background (shore lines, country borders, etc.) to be able to locate precisely the trajectories and contours;

(*b*) Indicate the source location with a highly visible symbol (●, ▲, ✕, ✻, ■, etc.);

(*c*) Indicate the source location in decimal degrees (latitude — N or S specified, longitude — E or W specified, plotting symbol used), date/time of release (UTC), and the meteorological model initialization date/time (UTC);

(*d*) Each set of maps should be uniquely identified by at least product issue date and time (UTC) and issuing centre;

(*e*) Previously transmitted products from the dispersion model need not be re-transmitted;

(*f*) Indicate with a legend if this is an exercise, requested services, or an IAEA notified emergency.

Specific guidelines for trajectory maps:

(*a*) Distinguish each trajectory (500, 1 500, 3 000 m) with a symbol (▲, ●, ■, etc.) at synoptic hours (UTC);

(*b*) Use solid lines (darker than map background lines) for each trajectory;

(*c*) Provide a time-height (m or hPa) diagram, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

Specific guidelines for concentration and deposition maps:

(*a*) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10;

(*b*) A legend should indicate that contours are identified as powers of 10 (i.e. –12 = 10^{-12}). If grey-shading is used between contours, then the individual contours must be clearly distinguishable after facsimile transmission and a legend provided on the chart;

(*c*) Use solid dark lines (darker than map background lines) for each contour;

(*d*) Indicate the following input characteristics: (i) source assumption (height, duration, isotope, amount released); (ii) the units of time integrated concentration (Bq s m^{-3}) or deposition (Bq m^{-2}). In addition, charts should specify: (i) "Time integrated surface to 500 m layer concentrations"; (ii) "Contour values may change from chart to chart", and if the default source is used; (iii) "results based on default initial values";

(*e*) Indicate, if possible, the location of the maximum concentration/deposition with a symbol on the map and include a legend indicating the symbol used and the maximum numerical value;

(*f*) Indicate the time integration starting and ending date/time (UTC).

The RSMCs will normally provide the products in the ITU-T T4 format suitable for both group 3 facsimile machines and transmission on parts of the GTS. The RSMC may also make use of other appropriate technologies.

(ANNEX 3 TO TD/778)

ENVIRONMENTAL EMERGENCY RESPONSE ALERT

REQUEST FOR WMO RSMC SUPPORT BY DELEGATED AUTHORITY

This form should be sent by fax to the RSMC. At the same time, the Delegated Authority must immediately call the RSMC to confirm the transmission of this request for RSMC support

(This section must be completed in full)

STATUS: . . . .(EVENT OR EXERCISE) Date/time of request: ....(UTC)

NAME OF DELEGATED AUTHORITY: . . . .

COUNTRY: . . . .

DELEGATED AUTHORITY TELEPHONE/FAX NUMBERS: (......) . . . .(Tel)

(......) . . . .(Fax)

REPLY TELEPHONE/FAX NUMBERS FOR NMS OF REQUESTING COUNTRY: (......) . . . .(Tel)

(......) . . . .(Fax)

NAME OF RELEASE SITE: . . . .(facility and place)

GEOGRAPHICAL LOCATION OF RELEASE: . . . .(lat./long. decimal degrees N or S; E or W)

(essential accident information for model simulation — if not available, model will execute with standard default values)

RELEASE CHARACTERISTICS:

START OF RELEASE: . . . .(date/time, UTC)

DURATION: . . . .(hours), or end of release . . . .(date/time, UTC)

RADIONUCLIDE SPECIES: . . . .

TOTAL RELEASE QUANTITY: . . . .(Becquerel)

OR POLLUTANT RELEASE RATE: . . . .(Becquerel/hour)

EFFECTIVE HEIGHT OF RELEASE: Surface: . . . . .or

Stack height: . . . .(m), or

Aloft: top . . . .(m), base . . . .(m)

(helpful information for improved simulation)

SITE ELEVATION: . . . .(m)

LOCAL METEOROLOGICAL CONDITIONS NEAR ACCIDENT: . . . .

. . . .

. . . .

. . . .(wind speed and direction/weather/cloudiness, etc.)

OTHER INFORMATION: . . . .

. . . .

. . . .

. . . .(nature of accident, cause, fire explosion, controlled release,

. . . . .foreseeable development, normal activity, projected conditions, etc.)

(to be completed by RSMC)

DATE/TIME OF RECEIPT OF REQUEST: . . . .(UTC)

DATE/TIME OF RETURN CONFIRMATION OF RECEIPT: . . . .(UTC)

NOTE: All times in UTC.

ENVIRONMENTAL EMERGENCY RESPONSE
REQUEST FOR WMO RSMC SUPPORT BY IAEA

STATUS: ❒ EMERGENCY ❒ EXERCISE Date/Time of Request: - - / : (UTC)

REQUESTED RSMCs: (indicate the lead RSMCs by a checkmark below)

❒ BRACKNELL ❒ TOULOUSE ❒ MELBOURNE ❒ MONTREAL ❒ WASHINGTON
❒ BEIJING ❒ TOKYO ❒ OBNINSK

SENDERS NAME: INTERNATIONAL ATOMIC ENERGY AGENCY

COMMUNICATION DETAILS:	Tel.: +43 1 2600 22023	use to confirm receipt of request
	Fax: +43 1 26007 29309	use to confirm receipt of request
	Email: eru3@iaea.org	use to confirm receipt of request

NAME OF RELEASE SITE AND COUNTRY (facility and place)

GEOGRAPHICAL LOCATION OF RELEASE:
(MUST BE COMPLETED) . decimal degrees ❒ N ❒ S
. decimal degrees ❒ E ❒ W

DECLARED EMERGENCY CLASS:
❒ NONE ❒ other, specify:

ACTION REQUIRED:
- ❒ NONE
- ❒ GO ON STANDBY (request for products or for assistance on weather conditions is to be expected)
- ❒ GENERATE STANDARD PRODUCTS AND SEND TO IAEA ONLY
- ❒ GENERATE STANDARD PRODUCTS FOR THE IAEA AND REGIONAL DISTRIBUTION
- ❒ OTHER ACTION:

(essential accident information for model simulation — if not available, model will execute with standard default values)
RELEASE CHARACTERISTICS:
START OF RELEASE: . . . .(date/time, UTC)
DURATION: . . . .(hours), or end of release . . . .(date/time, UTC)
RADIONUCLIDE SPECIES: . . . .
TOTAL RELEASE QUANTITY: . . . .(Becquerel)
OR POLLUTANT RELEASE RATE: . . . .(Becquerel/hour)
EFFECTIVE HEIGHT OF RELEASE: Surface: . . . . .or
Stack height: . . . .(m), or
Aloft: top . . . .(m), base . . . .(m)

(helpful information for improved simulation)
SITE ELEVATION: . . . .(m)
LOCAL METEOROLOGICAL CONDITIONS NEAR ACCIDENT: . . . .
. . . .
. . . .
(wind speed and direction/weather/cloudiness, etc.)
OTHER INFORMATION: . . . .
. . . .
. . . .
(nature of accident, cause, fire explosion, controlled release, foreseeable development, normal activity, projected conditions, etc.)

(to be completed by RSMC)
DATE/TIME OF RECEIPT OF REQUEST: . . . .(UTC)
DATE/TIME OF RETURN CONFIRMATION OF RECEIPT: . . . .(UTC)

NOTE: All times in UTC.

ANNEX 5 TO RECOMMENDATION 5 (CBS-Ext.(02))

NEW ATTACHMENTS II.8 AND II.9 TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM,* VOLUME I

ATTACHMENT II.8

VERIFICATION SYSTEMS FOR LONG-RANGE FORECASTS — REVISED EXPERIMENTAL SCORES TO BE EXCHANGED

1. FORMULATION

The standardized verification system (SVS) is formulated in four parts:

1.1 Diagnostics. Diagnostic information required incorporates derived diagnostic measures and contingency tables. Three diagnostic measures are included and are closely defined. Estimates of the statistical significance of the scores achieved are also required. Additional diagnostic measures are suggested but are not incorporated into the core SVS as yet. Use of the additional diagnostics is optional.

1.2 Parameters. Key variables and regions are proposed. However producers are not limited to these key parameters. Thus all producers can contribute regardless of the structure of individual forecast systems. The parameters to be verified are defined on three levels:

- Level 1: Diagnostic measures aggregated over regions,
- Level 2: Diagnostic measures evaluated at individual grid-points,
- Level 3: Contingency tables provided for individual grid-points.

The SVS makes provision for a staged implementation of the three levels of information and the inclusion estimates of skill significance over a two-year period (Section 4).

1.3 Verification data sets. Key data sets of observations against which forecasts may be verified are proposed.

1.4 System details. Details of forecast systems employed.

2. DIAGNOSTICS

Three diagnostic measures are incorporated in the core SVS; relative operating characteristics; reliability diagrams and accompanying measure of sharpness; and mean square skill scores with associated decomposition. Estimates of the statistical significance in the diagnostic scores are also included in the core SVS. The three diagnostics permit direct intercomparison of results across different predicted variables, geographical regions, forecast ranges, etc. They may be applied in verification of most forecasts and it is proposed that, except where inappropriate, all three diagnostics are used on all occasions. Tabulated information at grid-point resolution is also part of the core SVS. The tabulated information will allow reconstruction of scores for user-defined areas and calculation of other diagnostic measures such as economic value.

2.1 Relative operating characteristics (ROC). To be used for verification of probability forecasts, calculation details are discussed in Attachment II-9. For Level 1 information (measures aggregated over regions), the ROC curve and the standardized area under the curve (such that perfect forecasts give an area of 1 and a curve lying along the diagonal gives 0.5) should be provided. Probability values should be labelled on any ROC curves. For Level 2 information (gridded values), the standardized area under the ROC curve should be provided, both in rendered map format and in digital format (see Section 3).

2.2 Reliability diagrams and frequency histograms. To be used in assessment of probability forecasts, the construction of these diagrams and histograms is discussed in Attachment II-9. They are required as part of the Level 1 information only.

2.3 Mean square skill score (MSSS) and decomposition. To be used in verification of deterministic forecasts, calculation details are discussed in Attachment II-9. For Level 1, an overall bulk MSSS value is required and will provide a comparison of forecast performance relative to "forecasts" of climatology. The three terms of the MSSS decomposition provide valuable information on phase errors (through forecast/observation correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias. For Level 2, quantities pertaining to the three decomposition terms (see Attachment II-9) should be provided as rendered maps for selected seasons. Additional terms relating to MSSS and its decomposition are required as tabulated information.

2.4 Contingency tables. In addition to the derived diagnostic measures, contingency table information provided at grid-points for both probability and categorical deterministic forecasts form part of the core SVS. This information constitutes Level 3 of the exchange and will allow RCCs and NMHSs (and in some cases end-users) to derive ROC, reliability, other probability-based diagnostics and scores for categorical deterministic forecasts for user-defined geographical areas.

A number of recommended contingency table-based diagnostics are listed in the Annex. The Hanssen-Kuiper score is the deterministic equivalent to the area under the ROC curve, and thus provides a useful measure for comparing probabilistic and deterministic skill. The Gerrity score is one recommended score for overall assessment of forecasts using two or more categories. Calculation details for the Hanssen-Kuipers and Gerrity scores are provided in Attachment II-9.

3. PARAMETERS

The key list of parameters in the core SVS is provided below. Any verification for these key parameters should be assessed using the core SVS techniques wherever possible. Many long-range forecasts are produced which do not include parameters in the key list (for example, there are numerous empirical systems that predict seasonal rainfall over part of, or over an entire, country). The core SVS diagnostics should be used to assess these forecasts also, but full details of the predictions will need to be provided.

3.1 Diagrams and scores to be produced for regions

3.1.1 Atmospheric parameters. Predictions for:

T2m screen temperature with standard regions:

Tropics 20°N to 20°S
Northern extratropics >=20°N
Southern extratropics <=20°S

Precipitation with standard regions:

Tropics 20°N to 20°S
Northern extratropics >=20°N
Southern extratropics <=20°S

3.1.2 Scores and diagrams to be produced for probabilistic forecasts

Reliability diagram and frequency histograms
The ROC curve and the standardized area under the curve
Estimations of error (significance) in the scores

The above scores and diagrams to be produced for equi-probable tercile categories.

3.1.3 Scores to be used for deterministic forecasts

MSSS with climatology as standard reference forecast

3.1.4 Stratification by season

Four conventional seasons: March/April/May (MAM), June/July/August (JJA), September/October/November (SON), December/January/February (DJF)

3.1.5 Lead time

Preferred minimum: two lead times, one preferably to be two weeks or greater, with a lead time not greater than four months.

3.2 Verification to be produced in map format on 2.5° × 2.5° grid

3.2.1 Verification maps to be produced for each of the following variables

T2m
Precipitation
Sea-surface temperature

3.2.2 Scores to be calculated for probabilistic forecasts

ROC area for three tercile categories
Significance of the ROC scores should also be calculated and shown on the ROC area map, or on an accompanying map

3.2.3 Scores to be calculated for deterministic forecasts

The three terms of the Murphy decomposition of MSSS, produced with climatology as standard reference forecast. As a second, optional, control it is recommended that damped persistence be used.

Significance estimates for each of the three Murphy decomposition terms should also be calculated and shown on the relevant map or an accompanying map.

3.2.4 Stratification by season

Four conventional seasons: MAM, JJA, SON, DJF

3.2.5 Lead time

Preferred minimum: two lead times, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.2.6 Stratification according to the state of *El Niño*/Southern Oscillation (ENSO)

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;
(*b*) Seasons with *El Niño* active;
(*c*) Seasons with *La Niña* active.

3.3 Tabulated information to be exchanged

Tabular information to be provided for grid-points of a 2.5 × 2.5 grid.

3.3.1 Contingency tables

Contingency tables to be produced for each of the following variables:

T2m
Precipitation
Sea-surface temperature

3.3.2 Tables to be produced for probabilistic forecast verification.

The number of forecast hits and false alarms to be recorded against each ensemble member or probability bin for each of three equi-probable categories (terciles). It is recommended that the number of bins remains between 9 and 20. The forecast providers can bin according to percentage probability or by individual ensemble members as deemed necessary. No latitude weighting of the numbers of hits and false alarms is to be applied in the contingency tables.

The user is encouraged to aggregate the tables over grid-points for the region of interest and to apply methods of assessing statistical significance of the aggregated tables.

3.3.3 Tables to be produced for deterministic forecasts

3 × 3 contingency tables comparing the forecast tercile with the observed tercile, over the hindcast period.

3.3.4 Stratification by season

If available 12 rolling three-month periods (e.g. MAM, AMJ, MJJ). Otherwise four conventional seasons (as specified in Section 3.1.4).

3.3.5 Leadtime

Preferred minimum: two leadtimes, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.3.6 Stratification according to the state of ENSO

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;

(*b*) Seasons with *El Niño* active;

(*c*) Seasons with *La Niña* active.

3.4 Grid-point data for mapping

The information requested in this section is the digital data required to produce the maps described in Section 3.2, with some additional information associated with the MSSS diagnostic. This will allow maps to be generated by users (or the lead centre) in a consistent format and allow access to maps for 12 rolling seasons rather than the four conventional seasons specified in Section 3.2.

3.4.1 Grid-point verification data to be produced for each of the following variables

T2m

Precipitation

Sea-surface temperature

3.4.2 Verification parameters to be produced for deterministic verification

The necessary parameters for reconstructing the MSSS decomposition, the number of forecast/observation pairs, the mean square error of the forecasts and of climatology and the MSSS are all part of the Core SVS (as specified in Attachment II-9). Significance estimates for the correlation, variance, bias, MSE and MSSS terms should also be supplied.

3.4.3 Verification to be provided for probability forecasts

ROC area for three tercile categories.

Significance of the ROC scores should also be provided.

3.4.4 Stratification by season

If available 12 rolling three-month periods (e.g. MAM, AMJ, MJJ). Otherwise four conventional seasons (as in specified in Section 3.1.4).

3.4.5 Leadtime

Preferred minimum: two leadtimes, one preferably to be two weeks or greater, with a leadtime not greater than four months.

3.4.6 Stratification according to the state of ENSO

Stratification by the state of ENSO should be provided if sufficient ENSO events are contained within the hindcast period used. Scores should be provided for each of three categories:

(*a*) All hindcast seasons;

(*b*) Seasons with *El Niño* active;

(*c*) Seasons with *La Niña* active.

3.5 Verification for indices

3.5.1 Indices to be verified

NIÑO3.4 region SST anomalies. Other indices may be added in due course.

3.5.2 Scores to be calculated for probabilistic forecasts

ROC area for three tercile categories. Where dynamical forecast models are used, scores should be aggregated over all grid-points of the verification data set in the NINO3.4 region. It is recommended that significance of the ROC scores should also be calculated.

3.5.3 Scores to be calculated for deterministic forecasts

The three terms of the Murphy decomposition of MSSS, produced with climatology as standard reference forecast. As a second, optional, control it is recommended that damped persistence be used.

Where dynamical models are used, the MSSS decomposition should be calculated for the grid-point averaged NIÑO3.4 anomaly.

Significance estimates should accompany each of the three terms.

3.5.4 Stratification by month

Verification should be provided for each calendar month.

3.5.5 Lead time

Verification for each month should be provided for six lead times. Namely zero-lead and leads of 1, 2, 3, 4 and 5 months. Additional lead times are encouraged if available.

4. STAGED IMPLEMENTATION

In order to ease implementation, producers may stage the provision of the elements of the core SVS according to the following recommendation:

(*a*) Initial exchange: verification at Levels 1 and 2;

(*b*) Six-months after initial exchange: verification at Level 3;

(*c*) Twelve-months after initial exchange: inclusion of estimates of skill significance for verification at Levels 1 and 2.

5. VERIFICATION DATA SETS

The key list of data sets to be used in the core SVS for both climatological and verification information is provided below. The same data should be used for both climatology and verification, although the centre's analysis (where available) and the ECMWF and NCEP/NCAR Reanalyses and subsequent analyses may be used when other data are not available. Many seasonal forecasts are produced that may not use the data in either the key climatology or verification data sets (for example, there are numerous systems which predict seasonal rainfall over part of, or over an entire, country). Appropriate data sets should then be used with full details provided.

5.1 Sea-surface temperature

Reynolds OI, for the period 1981 to present. The data set of Smith, *et al.* (1996) for the period 1971–1980.

5.2 Precipitation

Xie-Arkin and/or the Global Precipitation Climatology Project.

5.3 T2m screen temperature

UKMO/CRU T2m data set.

When gridded data sets are used, a 2.5° × 2.5° grid is recommended.

6. SYSTEM DETAILS

Information will be requested for the exchange of scores concerning the following details of the forecast system:

1. Is the system numerical/hybrid/empirical?
2. Is the system deterministic/probabilistic?
3. List of parameters being assessed.
4. List of regions for each parameter.
5. List of forecast ranges (lead times) and periods (e.g. seasonal average) for each parameter.
6. The number of hindcasts/predictions incorporated in the assessment and the dates of these hindcasts/predictions.
7. Details of climatological and verification data sets used (with details of quality controls when these are not published).
8. If appropriate, resolution of fields used for climatologies and verification.

References

Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions, Journal of Climate, Volume 9, Number 6, June 1996, pp. 1403–1420.

ANNEX
ADDITIONAL DIAGNOSTICS

1. Categorical forecasts
   Linear error in probability space for categorical forecasts (LEPSCAT)
   Bias
   Post agreement
   Per cent correct
2. Probability forecasts of binary predictands
   Brier score
   Brier skill score with respect to climatology
   Continuous rank probability score
3. Probability of multiple category predictands
   Ranked probability score
   Ranked probability skill score with respect to climatology
4. Continuous forecasts in space
   Murphy-Epstein decomposition (phase error, amplitude error, bias error) including the anomaly correlation

ATTACHMENT II.9

Standardized verification system (SVS) for long-range forecasts (LRF)

1. INTRODUCTION

The WMO Commission for Basic Systems (CBS) noted that there has been considerable progress in the development of long-range forecasting activities but that no comprehensive documentation of skill levels measured according to a common standard was available. It was noted that assessments of the scientific quality of long-range forecasts were not generally made available to users, apart from simple measures of skill and warning provided along with Internet products from some issuing centres/institutes.

Long-range forecasts are being issued from several centres/institutes and are being made available in the public domain. Forecasts for specific locations may differ substantially at times, due to the inherent limited skill of long-range forecast systems. The Commission acknowledged the scientific merit of those differences and encouraged the various approaches as a means to spur progress on the research front. However, concerns were raised that this situation tended to lead to confusion amongst users, and ultimately was reflecting back on the science behind long-range forecasts.

There was agreement on the need to have a more coherent approach to verification of long-range forecasts. The Commission agreed that its role was to develop procedures for the exchange of verification results, with a particular focus on the practical details of producing and exchanging appropriate verification scores.

This document presents the detailed specifications for the development of a standardized verification system (SVS) for long-range forecasts (LRF) within the framework of a WMO exchange of verification scores. The SVS for LRF described herein constitutes the basis for long-range forecast evaluation and validation, and for exchange of verification scores. It will grow as more requirements are adopted.

2. DEFINITIONS

2.1 Long-range forecasts

LRF extend from 30 days up to two years and are defined in Table 1.

Seasons have been loosely defined in the northern hemisphere as December–January–February (DJF) for winter (summer in the southern hemisphere), March–April–May (MAM) for spring (fall in the southern hemisphere), June–July–August (JJA) for summer (winter in the southern hemisphere) and September–October–November (SON) for fall (spring in the southern hemisphere). In the Tropical areas, seasons may have different definitions. Outlooks over longer periods such as multi-seasonal outlooks or tropical rainy season outlooks may be provided.

Table 1
Definition of long-range forecasts

Monthly outlook:	Description of averaged weather parameters expressed as departures from climate values for that month
Three-month or 90-day outlook:	Description of averaged weather parameters expressed as departures from climate values for that three-month or 90-day period
Seasonal outlook:	Description of averaged weather parameters expressed as departures from climate values for that season

It is recognized that in some countries, long-range forecasts are considered to be climate products.

This document is mostly concerned with the three-month or 90-day outlooks and the seasonal outlooks.

2.2 Deterministic long-range forecasts

Deterministic LRF provide a single expected value for the forecast variable. The forecast may be presented in terms of an expected category (referred to as categorical forecasts, e.g. equiprobable terciles) or may take predictions of the continuous variable (non-categorical forecasts). Deterministic LRF can be produced from a single run of a numerical weather prediction (NWP) model or a general circulation model (GCM), or can be produced from the grand mean of the members of an ensemble prediction system (EPS), or can be based on an empirical model.

The forecasts are either objective numerical values such as departure from normal of a given parameter or expected occurrences (or non-occurrences) of events classified into categories (above/below normal or above/near/below normal for example). Although equi-probable categories is preferred for consistency, other classifications can be used in a similar fashion.

2.3 Probabilistic long-range forecasts

Probabilistic LRF provide probabilities of occurrences or non-occurrences of an event or a set of fully inclusive events. Probabilistic LRF can be generated from an empirical model, or produced from an EPS.

The events can be classified into categories (above/below normal or above/near/below normal for example). Although equi-probable categories are preferred for consistency, other classifications can be used in a similar fashion.

2.4 Terminology

There is no universally accepted definition of forecast period and forecast lead time. However, the definition in Table 2 will be used in this document.

Figure 1 presents the definitions of Table 2 in graphical format.

Table 2
Definition of forecast period and lead time

Forecast period:	Forecast period is the validity period of a forecast. For example, long-range forecasts may be valid for a 90-day period or a season.
Lead time:	Lead time refers to the period of time between the issue time of the forecast and the beginning of the forecast validity period. Long-range forecasts based on all data up to the beginning of the forecast validity period are said to be of lead zero. The period of time between the issue time and the beginning of the validity period will categorize the lead. For example, a winter seasonal forecast issued at the end of the preceding summer season is said to be of one season lead. A seasonal forecast issued one month before the beginning of the validity period is said to be of one month lead.

Forecast range determines how far into the future LRF are provided. Forecast range is thus the summation of lead time and forecast period.

Persistence, for a given parameter, stands for persisting the anomaly which has been observed over the period of time with the same length as the forecast period and immediately prior to the LRF issue time (see Figure 1). It is important to realize that only the anomaly of any given parameter can be persisted. The persisted anomaly is added to the background climatology to retrieve the persisted parameter. Climatology is equivalent to persisting a uniform anomaly of zero.

3. SVS FOR LONG-RANGE FORECASTS

3.1 Parameters to be verified

The following parameters are to be verified:

(*a*) Surface air temperature (T2m) anomaly at screen level;

(*b*) Precipitation anomaly;

(*c*) Sea-surface temperature (SST) anomaly.

In addition to these three parameters, the Niño3.4 Index, defined as the mean SST anomaly over the Niño-3.4 region from 170°W to 120°W and from 5°S to 5°N, all inclusive, is also to be verified.

It is recommended that three levels of verification be done:

(*a*) Level 1: large scale aggregated overall measures of forecast performance (see section 3.1.1).

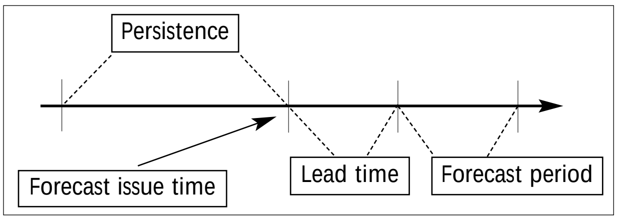

Figure 1 — Definition of forecast period, lead time and persistence as applied in a forecast verification framework

(*b*) Level 2: verification at grid-points (see section 3.1.2).
(*c*) Level 3: grid-point by grid-point contingency tables for more extensive verification (see section 3.1.3).

Both deterministic and probabilistic forecasts are verified if available. Level 1 is applicable to T2m anomaly, Precipitation anomaly and Niño3.4 Index. Levels 2 and 3 are applicable to T2m anomaly, precipitation anomaly and SST anomaly.

3.1.1 Aggregated verification (level 1)

Large-scale verification statistics are required in order to evaluate the overall skill of the models and ultimately for assessing their improvements. These are bulk numbers calculated by aggregating verification at grid-points and should not be used to assess regionalized skill. This aggregated verification is performed over three regions:
(*a*) Tropics: from 20°S to 20°N all inclusive;
(*b*) Northern extratropics: from 20°N to 90°N, all inclusive;
(*c*) Southern extratropics: from 20°S to 90°S, all inclusive.

The verification of Niño3.4 Index is also part of level 1 verification.

3.1.2 Grid-point verification (level 2)

The grid point verification is recommended for a regionalized assessment of the skill of the model. The appropriate way to make these verifications available is by visual rendering. The verification latitude/longitude grid is recommended as being 2.5° × 2.5°, with origin at 0°N, 0°E.

3.1.3 Contingency tables (level 3)

It is recommended to make available the raw verification material used for the grid-point verification in section 3.1.2. This data is provided in contingency tables to allow users to perform more detailed verifications and generate statistics that are relevant for localized regions. The contingency tables are defined in sections 3.3.2 and 3.3.3. It is recommended to code all contingency tables at all grid-points into a single file. Forecasts producers are required to provide a complete description of the format to ensure proper decoding of these contingency table files.

3.1.4 Summary of the core SVS

The following chart gives a summary of what is part of the core SVS:

Level 1			
Parameters	*Verification regions*	*Deterministic forecasts*	*Probabilistic forecasts*
T2m anomaly Precipitation anomaly	Tropics Northern extratropics Southern extratropics (section 3.1.1)	MSSS (bulk number) (section 3.3.1)	ROC curves ROC areas Reliability diagrams Frequency histograms (sections 3.3.3 and 3.3.4)
Niño3.4 Index	N/A	MSSS (bulk number) (section 3.3.1)	ROC curves ROC areas Reliability diagrams Frequency histograms (sections 3.3.3 and 3.3.4)
Level 2			
T2m anomaly Precipitation anomaly SST anomaly	Grid-point verification on a 2.5° by 2.5° grid (section 3.1.2)	MSSS and its three-term decomposition at each grid-point in graphic representation number of forecast-observation pairs mean of observations and forecasts variance of observations and forecasts correlation of forecasts and observations (section 3.3.1)	ROC areas at each grid-point in graphic representation (section 3.3.3)
Level 3			
T2m anomaly Precipitation anomaly SST anomaly	Grid-point verification on a 2.5° by 2.5° grid (section 3.1.2)	3 by 3 contingency tables at each grid-point (section 3.3.2)	ROC reliability tables at at each grid-point (section 3.3.3)

The number of realizations of LRF is far smaller than in the case of short-term numerical weather prediction forecasts. Consequently it is mandatory as part of the core SVS, to calculate and report error bars and level of significance (see section 3.3.5).

In order to ease implementation, participating LRF producers may stage the introduction of the core SVS according to the following priorities:

(*a*) Verification at levels 1 and 2 in the first year of implementation;

(*b*) Verification at level 3 by the middle of the year following implementation of levels 1 and 2;

(*c*) Level of significance by the end of the year following implementation of levels 1 and 2.

Other parameters and indices to be verified as well as other verification scores can be added to the core SVS in future versions.

3.2 Verification strategy

LRF verification should be done on a latitude/longitude grid, and at individual stations or groups of stations representing grid boxes or local areas as defined in section 3.1.1. Verification on a latitude/longitude grid is performed separately from the one done at stations.

The verification latitude/longitude grid is recommended as being 2.5° × 2.5°, with origin at 0°N, 0°E. Both forecasts and the gridded verifying data sets are to be interpolated onto the same 2.5° × 2.5° grid.

In order to handle spatial forecasts, predictions for each point within the verification grid should be treated as individual forecasts but with all results combined into the final outcome. The same approach is applied when verification is done at stations. Categorical forecast verification can be performed for each category separately.

Similarly, all forecasts are treated as independent and combined together into the final outcome, when verification is done over a long period of time (several years for example).

Stratification of the verification data is based on forecast period, lead time and verification area. For example, seasonal forecast verification should be stratified according to season, meaning that verification results for different seasons should not be mixed. Forecasts with different lead times are similarly to be verified separately. It is also recommended to stratify verification according to warm and cold ENSO events (see Section 7 for definitions).

3.3 Verification scores

The following verification scores are to be used:

(*a*) Mean square skill score (MSSS);

(*b*) Relative operating characteristics (ROC).

MSSS is applicable to deterministic forecasts only, while ROC is applicable to both deterministic and probabilistic forecasts. MSSS is applicable to non-categorical forecasts (or to forecasts of continuous variables), while ROC is applicable to categorical forecasts either deterministic or probabilistic in nature.

Verification methodology using ROC, is derived from signal detection theory. This methodology is intended to provide information on the characteristics of systems upon which management decisions can be taken. In the case of weather/climate forecasts, the decision might relate to the most appropriate manner in which to use a forecast system for a given purpose. ROC is applicable to both deterministic and probabilistic categorical forecasts and is useful in contrasting characteristics of deterministic and probabilistic systems. The derivation of ROC is based on contingency tables giving the hit rate and false alarm rate for deterministic or probabilistic forecasts. The events are defined as binary, which means that only two outcomes are possible, an occurrence or a non-occurrence. It is recognized that ROC as applied to deterministic forecasts is equivalent to the Hanssen and Kuipers score (see section 3.3.2).

The binary event can be defined as the occurrence of one of two possible categories when the outcome of the LRF system is in two categories. When the outcome of the LRF system is in three (or more) categories, the binary event is defined in terms of occurrences of one category against the remaining ones. In those circumstances, ROC has to be calculated for each possible category.

3.3.1 MSSS for non-categorical deterministic forecasts

Let x_{ij} and f_{ij} (i=1,...,n) denote time series of observations and continuous deterministic forecasts, respectively, for a grid-point or station j over the period of verification (POV). Then, their averages for the POV, $\overline{x}_j$ and $\overline{f}_j$ and their sample variances s_{xj}^2 and s_{fj}^2 are given by:

$$\overline{x}_j=\frac{1}{n}\sum_{i=1}^{n}x_{ij},\quad \overline{f}_j=\frac{1}{n}\sum_{i=1}^{n}f_{ij}$$

$$s_{xj}^2=\frac{1}{n-1}\sum_{i=1}^{n}\left(x_{ij}-\overline{x}_j\right)^2,\quad s_{fj}^2=\frac{1}{n-1}\sum_{i=1}^{n}\left(f_{ij}-\overline{f}_j\right)^2$$

The mean squared error of the forecasts is:

$$MSE_j=\frac{1}{n}\sum_{i=1}^{n}\left(f_{ij}-x_{ij}\right)^2$$

For the case of cross-validated (see section 3.4) POV climatology forecasts where forecast/observation pairs are reasonably temporally independent of each other (so that only one year at a time is withheld), the mean squared error of climatology forecasts (Murphy, 1988) is:

$$MSE_{cj}=\frac{n-1}{n}s_{xj}^2$$

The MSSS for j is defined as one minus the ratio of the squared error of the forecasts to the squared error for forecasts of climatology:

$$MSSS_j = 1 - \frac{MSE_j}{MSE_{cj}}$$

For the three domains described in section 3.1.1 it is recommended that an overall MSSS be provided. This is computed as:

$$MSSS = 1 - \frac{\sum_j w_j MSE_j}{\sum_j w_j MSE_{cj}}$$

where w_j is unity for verifications at stations and is equal to $\cos(\theta_j)$, where θ_j is the latitude at grid point j on latitude-longitude grids.

For either $MSSS_j$ or MSSS a corresponding root mean square skill score (RMSSS) can be obtained easily from:

$$RMSSS = 1 - (1 - MSSS)^{1/2}$$

$MSSS_j$ for forecasts fully cross-validated (with one year at a time withheld) can be expanded (Murphy, 1988) as:

$$MSSS_j = \left\{ 2\frac{s_{fj}}{s_{xj}} r_{fxj} - \left(\frac{s_{fj}}{s_{xj}}\right)^2 - \left(\frac{\left[\bar{f}_j - \bar{x}_j\right]}{s_{xj}}\right)^2 + \frac{2n-1}{(n-1)^2} \right\} \Bigg/ \left\{ 1 + \frac{2n-1}{(n-1)^2} \right\}$$

where r_{fxj} is the product moment correlation of the forecasts and observations at point or station j.

$$r_{fxj} = \frac{\frac{1}{n}\sum_{i=1}^{n}\left(f_{ij} - \bar{f}_j\right)\left(x_{ij} - \bar{x}_j\right)}{s_{fj} s_{xj}}$$

The first three terms of the decomposition of $MSSS_j$ are related to phase errors (through the correlation), amplitude errors (through the ratio of the forecast to observed variances) and overall bias error, respectively, of the forecasts. These terms provide the opportunity for those wishing to use the forecasts for input into regional and local forecasts to adjust or weight the forecasts as they deem appropriate. The last term takes into account the fact that the climatology forecasts are cross-validated as well.

Note that for forecasts with the same amplitude as that of observations (second term unity) and no overall bias (third term zero), $MSSS_j$ will not exceed zero (i.e. the forecasts squared error will not be less than for climatology) unless r_{fxj} exceeds approximately 0.5.

It is recommended that maps of the correlation, the ratio of the square roots of the variances, and the overall bias be produced for all forecast parameters and leads for each of the conventional seasons:

Map: $r_{fxj}, \frac{s_{fj}}{s_{xj}}, \left[\bar{f}_j - \bar{x}_j\right]$, all parameters, leads, and target months and seasons.

In addition to the bulk measures of MSSS and the maps of the three quantities just described, it is recommended that a table be produced for every parameter, lead, and target containing for every station or grid point j the following quantities:

$$n, \bar{f}_j, \bar{x}_j, s_{fj}, s_{xj}, r_{fxj}, MSE_j, MSE_{cj}, MSSS_j$$

As an additional standard against which to measure forecast set performance, cross-validated damped persistence (defined below) should be considered for certain forecast sets. A forecast of ordinary persistence, for a given parameter and target period, stands for the persisted anomaly (departure from cross-validated climatology) from a period immediately preceding the start of the lead time for the forecast period (see Figure 1). This period must have the same length as the forecast period. For example, the ordinary persistence forecast for a 90-day period made 15 days in advance would be the anomaly of the 90-day period beginning 105 days before the target forecast period and ending 16 days before. Ordinary persistence forecasts are never recommended as a standard against which to measure other forecasts if the performance or skill measures are based on squared error, like herein. This is because persistence is easy to beat in this framework.

Damped persistence is the optimal persistence forecast in a least squared error sense. Even damped persistence should not be used in the case of extratropical seasonal forecasts, because the nature of the interannual variability of seasonal means changes considerably from one season to the next in the extratropics. For all other cases, damped persistence forecasts can be made in a cross-validated mode (section 3.4) and the skill and performance diagnostics based on the squared error described above (bulk measures, maps, and tables) can be computed and presented for these forecasts.

Damped persistence is the ordinary persistence anomaly $x_{ij}(t - \Delta t) - \bar{x}_{ij}^m(t - \Delta t)$ damped (multiplied) towards climatology by the cross-validated, lagged product moment correlation between the period being persisted and the target forecast period.

Damped persistence forecast: $r^m_{\Delta,j}\left[x_{ij}(t-\Delta t) - \bar{x}^m_{ij}(t-\Delta t)\right]$

$$r^m_{\Delta,j} = \frac{\frac{1}{m}\sum_m \left[x_{ij}(t-\Delta t) - \bar{x}^m_{ij}(t-\Delta t)\right]\left[x_{ij}(t) - \bar{x}^m_{ij}(t)\right]}{s^m_{xj}(t-\Delta t)\, s^m_{xj}(t)}$$

where t is the target forecast period, t-Δt the persisted period (preceding the lead time), and m denotes summation (for $r^m_{\Delta,j}$, $\bar{x}^m_{ij}$, s^m_{xj}) at each stage of the cross-validation over all i except those being currently withheld (section 3.4).

⇒ MSSS, provided as a single bulk number, is mandatory for level 1 verification in the core SVS. MSSS, together with its three-term decomposition, are also mandatory for level 2 verification in the core SVS.

3.3.2 Contingency tables and scores for categorical deterministic forecasts

For two- or three-category deterministic forecasts, it is recommended that full contingency tables be provided (digitally not graphically), because it is recognized that they constitute the most informative way to evaluate the performance of the forecasts. These contingency tables then form the basis for several skill scores that are useful for comparisons between different deterministic categorical forecast sets (Gerrity, 1992) and between deterministic and probabilistic categorical forecast sets (Hanssen and Kuipers, 1965), respectively.

The contingency tables should be provided for every combination of parameter, lead time, target month or season, and ENSO stratification (when appropriate) at every verification point for both the forecasts and (when appropriate) damped persistence. The definition of ENSO events is provided in Section 7.

If xi and fi now denote an observation and corresponding forecast of category i (i = 1,...,3), let n_{ij} be the count of those instances with forecast category i and observed category j. The full contingency table is defined as the nine n_{ij}. Graphically, the nine-cell counts are usually arranged with the forecasts defining the table rows and the observations the table columns:

Table 3
General three by three contingency table

		Observations			
		Below normal	*Near normal*	*Above normal*	
Forecasts	Below normal	n_{11}	n_{12}	n_{13}	$n_{1\bullet}$
	Near normal	n_{21}	n_{22}	n_{23}	$n_{2\bullet}$
	Above normal	n_{31}	n_{32}	n_{33}	$n_{3\bullet}$
		$n_{\bullet 1}$	$n_{\bullet 2}$	$n_{\bullet 3}$	T

In Table 3, $n_{i\bullet}$ and $n_{\bullet i}$ represent the sum of the rows and columns respectively; T is the total number of cases. Generally about at least 90 forecast/observation pairs are required to estimate properly a three-by-three contingency table. Thus it is recommended that the provided tables be aggregated by users over€windows of target periods, like several adjacent months or overlapping three-month periods, or over verification points. In the case of the latter, the weights W_i should be used in summing nij over different points i (see discussion on Table 4). W_i is defined as:

W_i = 1 when verification is done at stations or at single grid-points within a 10 degree box; $W_i = \cos(\theta_i)$ at grid point i, when verification is done on a grid and θ_i the latitude at grid-point i.

On a 2.5 degree latitude-longitude grid, the minimally acceptable sample is easily attained even with a record as short as n = 10 by aggregating over all grid points with a 10 degree box. Or alternatively in this case, an adequate sample can be achieved by aggregation over three adjacent months or overlapping three-month periods and within a 5 degree box. Regardless, scores derived from any contingency table should be accompanied by error bars, confidence intervals or level of significance.

Contingency tables such as the one in Table 3 are mandatory for level 3 verification in the core SVS.

The relative sample frequencies p_{ij} are defined as the ratios of the cell counts to the total number of forecast/observation pairs N (n is reserved to denote the length of the POV):

$$p_{ij} = n_{ij}/N$$

The sample probability distributions of forecasts and observations, respectively, then become:

$$p(f_i) = \sum_{j=1}^{3} p_{ij} = \hat{p}_i \;;\; i = 1, ..., 3$$

$$p(x_i) = \sum_{j=1}^{3} p_{ji} = p_i \;;\; i = 1, ..., 3$$

A recommended skill score for the three-by-three table which has many desirable properties and is easy to compute is the Gerrity skill score (GSS). The definition of the score uses a scoring matrix s_{ij} (i = 1,...,3), which is a tabulation of the reward or penalty every forecast/observation outcome represented by the contingency table will be accorded:

$$GSS = \sum_{i=1}^{3}\sum_{j=1}^{3} p_{ij} s_{ij}$$

The scoring matrix is given by:

$$s_{ii} = \frac{1}{2}\left(\sum_{r=1}^{i-1} a_r^{-1} + \sum_{r=i}^{2} a_r\right)$$

$$s_{ij} = \frac{1}{2}\left[\sum_{r=1}^{i-1} a_r^{-1} - (j-1) + \sum_{r=j}^{2} a_r\right];\; 1 \le i < 3,\; i < j \le 3$$

where:

$$a_i = \frac{1 - \sum_{r=1}^{i} p_r}{\sum_{r=1}^{i} p_r}$$

Note that GSS is computed using the sample probabilities, not those on which the original categorizations were based (i.e. 0.33, 0.33, 0.33).

The GSS can be alternatively computed by the numerical average of two of the three possible two-category, unscaled Hannssen and Kuipers scores (introduced below) that can be computed from the three-by-three table. The two are computed from the two two-category contingency tables formed by combining categories on either side of the partitions between consecutive categories: (*a*) above normal and a combined near and below normal category; and (*b*) below normal and a combined near and above normal category.

The GSS's ease of construction ensures its consistency from categorization to categorization and with underlying linear correlations. The score is likewise equitable, does not depend on the forecast distribution, does not reward conservatism, utilizes off diagonal information in the contingency table, and penalizes larger errors more. For a limited subset of forecast situations it can be manipulated by a forecaster to his/her advantage (Mason and Mimmack, 2002), but this is not a problem for objective forecast models that have not been trained to take advantage of this weakness. For all these reasons it is the recommended score.

An alternative score to the GSS for consideration is LEPSCAT (Potts, *et al.*, 1996).

Table 4 shows the general form for the three possible two-by-two contingency tables referred to above (the third is the table for the near normal category and the combined above and below normal category). In Table 4, T is the grand sum of all the proper weights applied on each occurrence and non-occurrence of the events.

Table 4
General ROC contingency table for deterministic forecasts

		Observations		
		Occurrences	*Non-occurrences*	
Forecasts	Occrrences	O_1	NO_1	O_1+NO_1
	Non-occurrences	O_2	NO_2	O_2+NO_2
		O_1+O_2	NO_1+NO_2	T

The two-by-two table in Table 4 may be constructed from the three-by-three table described in Table 3 by summing the appropriate rows and columns.

In Table 4, O_1 represents the correct forecasts or hits:

$$O_1 = \sum W_i \, (OF)_i$$

(OF) being 1 when the event occurrence is observed and forecast; 0 otherwise. The summation is over all grid-points or stations.

NO_1 represents the false alarms:

$$NO_1 = \sum W_i \, (NOF)_i$$

(NOF) being 1 when the event occurrence is not observed but was forecast; 0 otherwise. The summation is over all grid-points or stations.

O_2 represents the misses:

$$O_2 = \sum W_i \, (ONF)_i$$

(ONF) being 1 when the event occurrence is observed but not forecast; 0 otherwise. The summation is over all grid-points or stations.

NO_2 represents the correct rejections:

$$NO_2 = \sum W_i \, (NONF)_i$$

(NONF) being 1 when the event occurrence is not observed and not forecast; 0 otherwise. The summation is over all grid-points or stations.

W_i = 1 when verification is done at stations or at single grid-points; $W_i = \cos(\theta_i)$ at grid-point *i*, when verification is done on a grid and θ_i the latitude at grid-point *i*.

When verification is done at stations, the weighting factor is one. Consequently, the number of occurrences and non-occurrences of the event are entered in the contingency table of Table 4.

However, when verification is done on a grid, the weighting factor is $\cos(\theta_i)$, where θ_i is the latitude at grid point *i*. Consequently, each number entered in the contingency table of Table 5, is, in fact, a summation of the weights properly assigned.

Using stratification by observations (rather than by forecast), the hit rate (HR) is defined as (referring to Table 4):

$$HR = {}^{O_1}/(O_1 + O_2)$$

The range of values for HR goes from 0 to 1, the latter value being desirable. An HR of one means that all occurrences of the event were correctly forecast.

The false alarm rate (FAR) is defined as:

$$FAR = {}^{NO_1}/(NO_1 + NO_2)$$

The range of values for FAR goes from 0 to 1, the former value being desirable. A FAR of zero means that in the verification sample, no non-occurrences of the event were forecast to occur.

Hanssen and Kuipers Score (see Hanssen and Kuipers, 1965 and Stanski, *et al.*, 1989) is calculated for deterministic forecasts. The Hanssen and Kuipers Score (KS) is defined as:

$$KS = HR - FAR$$
$$= \frac{O_1 NO_2 - O_2 NO_1}{(O_1 + O_2)(NO_1 + NO_2)}$$

The range of KS goes from -1 to +1, the latter value corresponding to perfect forecasts (HR being 1 and FAR being 0). KS can be scaled so that the range of possible values goes from 0 to 1 (1 being for perfect forecasts):

$$KS_{scaled} = \frac{KS+1}{2}$$

The advantage of scaling KS is that it becomes comparable to the area under the ROC curve for probabilistic forecasts (see section 3.3.3) where a perfect forecast system has an area of 1 and a forecast system with no information has an area of 0.5 (HR being equal to FAR).

⇒ Contingency tables for deterministic categorical forecasts (such as in Table 3) are mandatory for level 3 verification in the core SVS. These contingency tables can provide the basis for the calculation of several scores and indices such as the Gerrity Skill Score, the LEPSCAT or the scaled Hanssen and Kuipers Score and others.

3.3.3 ROC for probabilistic forecasts

Tables 5 and 6 show contingency tables (similar to Table 4) that can be built for probabilistic forecasts of binary events.

Table 5
General ROC contingency table for probabilistic forecasts of binary events with definitions of the different parameters. This contingency table applies when probability thresholds are used to define the different probability bins

Bin number	*Forecast probabilities*	*Observed occurrences*	*Observed non-occurrences*
1	$0–P_2$ (%)	O_1	NO_1
2	$P_2–P_3$ (%)	O_2	NO_2
3	$P_3–P_4$ (%)	O_3	NO_3
•••	•••	•••	•••
n	$P_n–P_{n+1}$ (%)	O_n	NO_n
•••	•••	•••	•••
N	P_N–100 (%)	O_N	NO_N

In Table 5, n = number of the nth probability interval or bin n; n goes from 1 to N; P_n = lower probability limit for bin n; P_{n+1} = upper probability limit for bin n; N = number of probability intervals or bins.

$$O_n = \sum W_i\,(O)_i$$

(O) being 1 when an event corresponding to a forecast in bin n, is observed as an occurrence; 0 otherwise. The summation is over all forecasts in bin n, at all grid points or stations.

$$NO_n = \sum W_i\,(NO)_i$$

(NO) being 1 when an event corresponding to a forecast in bin n, is not observed; 0 otherwise. The summation is over all forecasts in bin n, at all grid-points i or stations i.

W_i = 1 when verification is done at stations or at single grid points; $W_i = \cos(\theta_i)$ at grid-point i, when verification is done on a grid; θ_i the latitude at grid-point i.

Table 6
General ROC contingency table for probabilistic forecasts of binary events with definitions of the different parameters. This contingency table applies when the different probability bins are defined as function of the number of members in the ensemble

Bin number	*Member distribution*	*Observed occurrences*	*Observed non-occurrences*
1	F=0, NF=N	O_1	NO_1
2	F=1, NF=N–1	O_2	NO_2
3	F=2, NF=N–2	O_3	NO_3
•••		•••	•••
n	F=n–1, NF=N–n+1	O_n	NO_n
•••		•••	•••
N+1	F=N, NF=0	O_{N+1}	NO_{N+1}

In Table 6, n = number of the n^{th} bin; n goes from 1 to N+1; N = number of members in the ensemble; F = the number of members forecasting occurrence of the event; NF = the number of members forecasting non occurrence of the event. The bins may be aggregated:

$$O_n = \sum W_i\,(O)_i$$

(O) being 1 when an event corresponding to a forecast in bin n is observed as an occurrence; 0 otherwise. The summation is over all forecasts in bin n, at all grid-points i or stations i.

$$NO_n = \sum W_i\,(NO)_i$$

(NO) being 1 when an event corresponding to a forecast in bin n is not observed; 0 otherwise. The summation is over all forecasts in bin n, at all grid points i or stations i.

W_i = 1 when verification is done at stations or at single grid points; $W_i = \cos(\theta_i)$ at grid-point i, when verification is done on a grid and θ_i the latitude at grid-point i.

To build the contingency table in Table 6, probability forecasts of the binary event are grouped in categories or bins in ascending order, from 1 to N, with probabilities in bin n-1 lower than those in bin n (n goes from 1 to N). The lower probability limit for bin n is P_{n-1} and the upper limit is P_n. The lower probability limit for bin 1 is 0%, while the upper limit in bin N is 100%. The summation of the weights on the observed occurrences and non-occurrences of the event corresponding to each forecast in a given probability interval (bin n for example) is entered in the contingency table.

Tables 5 and 6 outline typical contingency tables. It is recommended that the number of probability bins remains between 9 and 20. The forecast providers can bin according to per cent thresholds (Table 5) or ensemble members (Table 6) as deemed necessary. Table 6 gives an example of a table based on ensemble members.

Hit rate and false alarm rate are calculated for each probability threshold P_n (see Tables 5 and 6). The hit rate for probability threshold P_n (HR_n) is defined as (referring to Tables 5 and 6):

$$HR_n = \sum_{i=n}^{N} O_i \Big/ \sum_{i=1}^{N} O_i$$

and the false alarm rate (FAR_n) is defined as:

$$FAR_n = \sum_{i=n}^{N} NO_i \Big/ \sum_{i=1}^{N} NO_i$$

where n goes from 1 to N. The range of values for HR_n goes from 0 to 1, the latter value being desirable. The range of values for FAR_n goes from 0 to 1, zero being desirable. Frequent practice is for probability intervals of 10% (10 bins, or N=10) to be used. However the number of bins (N) should be consistent with the number of members in the EPS used to calculate the forecast probabilities. For example, intervals of 33% for a nine-member ensemble system could be more appropriate.

Hit rate (HR) and false alarm rate (FAR) are calculated for each probability threshold P_n, giving N points on a graph of HR (vertical axis) against FAR (horizontal axis) to form the ROC curve. This curve, by definition, must pass through the points (0,0) and (1,1) (for events being predicted only with >100% probabilities (never occurs) and for all probabilities exceeding 0%, respectively). No-skill forecasts are indicated by a diagonal line (where HR=FAR); the further the curve lies towards the upper left-hand corner (where HR=1 and FAR=0) the better.

The area under the ROC curve is a commonly used summary statistics representing the skill of the forecast system. The area is standardized against the total area of the figure such that a perfect forecast system has an area of one and a curve lying along the diagonal (no information) has an area of 0.5. The normalized ROC area has become known as the ROC score. Not only can the areas be used to contrast different curves, but they are also a basis for Monte Carlo significance tests. It is proposed that Monte Carlo testing should be done within the forecast data set itself. The area under the ROC curve can be calculated using the Trapezium rule. Although simple to apply, the Trapezium rule renders the ROC score dependent on the number of points on the ROC curve, and care should be taken in interpreting the results. Other techniques are available to calculate the ROC score (see Mason, 1982).

⇒ Contingency tables for probabilistic forecasts (such as in Tables 5 and 6) are mandatory for level 3 verification in the core SVS. ROC curves and ROC areas are mandatory for level 1 verification in the core SVS while ROC areas only are mandatory for level 2 verification in the core SVS.

3.3.4 Reliability diagrams and frequency histograms for probabilistic forecasts

It is recommended that the construction of reliability curves (including frequency histograms to provide indications of sharpness) be done for the large-sampled probability forecasts aggregated over the tropics and, separately, the two extratropical hemispheres. Given frequency histograms, the reliability curves are sufficient for the ROC curve, and have the advantage of indicating the reliability of the forecasts, which is a deficiency of the ROC. It is acknowledged that the ROC curve is frequently the more appropriate measure of forecast quality than the reliability diagram in the context of verification of long-range forecasts because of the sensitivity of the reliability diagram to small sample sizes. However, because measures of forecast reliability are important for modellers, forecasters, and end-users, it is recommended that in the exceptional cases of the forecasts being spatially aggregated over the tropics and over the two extratropical hemispheres, reliability diagrams be constructed in addition to ROC curves.

The technique for constructing the reliability diagram is somewhat similar to that for the ROC. Instead of plotting the hit rate against the false alarm rate for the accumulated probability bins, the hit rate is calculated only from the sets of forecasts for each probability bin separately, and is plotted against the corresponding forecast probabilities. The hit rate for each probability bin (HR_n) is defined as:

$$HR_n = \frac{O_n}{O_n + NO_n}$$

This equation should be contrasted with the hit rate used in constructing the ROC diagram.

Frequency histograms are constructed similarly from the same contingency tables as those used to produce reliability diagrams. Frequency histograms show the frequency of forecasts as a function of the probability bin. The frequency of forecasts (F_n) for probability bin n is defined as:

$$F_n = \frac{O_n + NO_n}{T}$$

where T is the total number of forecasts.

⇒ Reliability diagrams and frequency histograms are mandatory for level 1 verification in the core SVS.

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3.3.5 Level of significance

Because of the increasing uncertainty in verification statistics with decreasing sample size, significance levels and error bars should be calculated for all verification statistics. Recommended procedures for estimating these uncertainties are detailed below.

ROC area

In certain special cases, the statistical significance of the ROC area can be obtained from its relationship to the Mann–Whitney U-statistic. The distribution properties of the U-statistic can be used only if the samples are independent. This assumption of independence will be invalid when the ROC is constructed from forecasts sampled in space because of the strong spatial (cross) correlation between forecasts (and observations) at nearby grid-points or stations. However, because of the weakness of serial correlation of seasonal climate anomalies from one year to the next, an assumption of sequential independence may frequently be valid for long-range forecasts, and so Mann–Whitney U-statistic may be used for calculating the significance of the ROC area for a set of forecasts from a single point in space. An additional assumption for using the Mann–Whitney U-test is that the variance of the forecast probabilities (not that of the individual ensemble predictions themselves) for when non-events occurred is the same as those for when events occurred. The Mann–Whitney U-test is, however, reasonably robust to violations of homoscedasticity which means that the variance of the error term is constant across the range of the variable, and so significance tests in cases of unequal variance are likely to be only slightly conservative.

If the assumptions for the Mann–Whitney U-test cannot be held, the significance of the ROC area should be calculated using randomization procedures. Because the assumptions of permutation procedures are the same as those of the Mann–Whitney U-test, and because standard bootstrap procedures assume independence of samples, alternative procedures such as moving block bootstrap procedures (Wilks, 1997) should be conducted to ensure that the cross- and/or serial-correlation structure of the data is retained.

ROC curves

Confidence bands for the ROC curve should be indicated, and can be obtained either by appropriate bootstrap procedures, as discussed above, or, if the assumption of independent forecasts is valid, from confidence bands derived from a two-sample Kolmogorov-Smirnov test comparing the empirical ROC with the diagonal.

MSSS

Appropriate significance tests for the MSSS and the individual components of the decomposition again depend upon the validity of the assumption of independent forecasts. If the assumption is valid, significance tests could be conducted using standard procedures (namely the F-ratio for the correlation and for the variance ratio, and the t-test for the difference in means), otherwise bootstrap procedures are recommended.

⇒ Level of significance is mandatory in the core SVS. A phased-in introduction of level of significance in the SVS may be used (see section 3.1.4).

3.4 Hindcasts

In contrast to short- and medium-range dynamical NWP forecasts, LRF are produced relatively few times a year (for example, one forecast for each season or one forecast for the following 90-day period, issued every month). Therefore the verification sampling for LRF may be limited, possibly to the point where the validity and significance of the verification results may be questionable. Providing verification for a few seasons, or even over a few years only may be misleading and may not give a fair assessment of the skill of any LRF system. LRF systems should be verified over as long a period as possible in hindcast mode. Although there are limitations on the availability of verification data sets and in spite of the fact that validating numerical forecast systems in hindcast mode requires large computer resources, the hindcast period should be as long as possible. Because of verification data availability, it is recommended to do hindcast over the period from 1981 to present. If data is available, it is recommended to extend the period back to 1971.

Verification in hindcast mode should be achieved in a form as close as possible to the real-time operating mode in terms of resolution, ensemble size and parameters. In particular, dynamical/empirical models must not make any use of future data. Validation of empirical models, dynamical models with post-processors (including bias corrections), and calculation of period of verification means, standard deviations, class limits, etc. must be done in a cross-validation framework. Cross-validation allows the entire sample to be used for validation (assessing performance, developing confidence intervals, etc.) and almost the entire sample for model and post-processor building and for estimation of period of verification climatology. Cross-validation proceeds as follows:

1. Delete 1, 3, 5, or more years from the complete sample;
2. Build the statistical model or compute the climatology;
3. Apply the model (e.g. make statistical forecasts or post-process the dynamical forecasts) or the climatology for one (usually the middle) year of those deleted and verify;
4. Replace the deleted years and repeat 1–3 for a different group of years;

5. Repeat 4 until the hindcast verification sample is exhausted.

Ground rules for cross-validation are that every detail of the statistical calculations be repeated, including redefinition of climatology and anomalies, and that the forecast year predictors and predictands are not serially correlated with their counterparts in the years reserved for model building. For example, if adjacent years are correlated but every other year is effectively not, three years must be set aside and forecasts made only on the middle year (see Livezey, 1999 for estimation of the reserved window width).

The hindcast verification statistics should be updated once a year based on accumulated forecasts.

⇒ Verification results over the hindcast period are mandatory for the exchange of LRF verification scores.

3.5 Real-time monitoring of forecasts

It is recommended that there be regular monitoring of the real-time long-range forecasts. It is acknowledged that this real-time monitoring is neither as rigorous nor as sophisticated as the hindcast verification; nevertheless it is necessary for forecast production and dissemination. It is also acknowledged that the sample size for this real-time monitoring may be too small to assess the overall skill of the models. However, it is recommended that the forecast and the observed verification for the previous forecast period be presented in visual format to the extent possible given the restrictions on availability of verification data.

4. VERIFICATION DATA SETS

The same data should be used to generate both climatology and verification data sets, although the forecasts issuing centres/institutes own analyses or ECMWF reanalyses and subsequent operational analyses may be used when other data are not available. Use of NCEP reanalysis data is also another option.
Many LRF are produced that are applicable to limited or local areas. It may not be possible to use the data in either the recommended climatology or verification data sets for validation or verification purposes in these cases. Appropriate data sets should then be used with full details provided.

It is recommended to use:

1. UKMO/CRU for surface air temperature anomaly at screen level (T2m).
2. Xie-Arkin and/or GPCP for precipitation anomaly.
3. Reynolds OI for sea-surface temperature (SST) anomaly. Prior to 1981, the reconstructed SST database using EOF of Smith, *et al.*, 1996 can be used.

4.1 Status of the verification data sets

The following paragraphs give the status of the various proposed verification data sets:

4.1.1 Xie-Arkin

Availability:	• NOAA
Period:	• 1979–1998
Type:	• Rain gauges, satellites and model precipitation amount values • Choice of grids with missing values in the polar regions or completed with model data • Monthly means
Grid:	• 2.5° by 2.5°
Update frequency:	• Every 3 to 6 months
Climatology:	• None
Reference:	• Xie, Pingping, Phillip A. Arkin, 1997: Global precipitation: a 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. *Bulletin of the American Meteorological Society*. Volume 78, Number 11, pp. 2539–2558.
Web site:	• http://www.cdc.noaa.gov/cdc/data.cmap.html

4.1.2 GPCP

Availability:	• NASA
Period:	• 1987–1999
Type:	• Similar to Xie-Arkin data
Grid:	• 2.5° by 2.5°
Update frequency:	• Unknown
Climatology:	• None
Reference:	• Huffman, George J., Robert F. Adler, Philip Arkin, Alfred Chang, Ralph Ferraro, Arnold Gruber, John Janowiak, Alan McNab, Bruno Rudolf, Udo Schneider, 1997: The Global Precipitation Climatology Project (GPCP) combined orecipitation dataset. *Bulletin of the American Meteorological Society*. Volume 78, Number 1, pp. 5–20.
Web site:	• http://orbit-net.nesdis.noaa.gov/arad/gpcp/

4.1.3 UKMO/CRU

Availability:	• UKMO/Hadley Centre
Period:	• 1851–1998
Type:	• Monthly surface air temperature (T2m) anomalies from 1961–1990 climate
Grid:	• 5° by 5°
Update frequency:	• Monthly
Climatology	• 1961–1990
Reference:	• Jones, P. D., M. New, D. E. Parker, S. Martin and I. G. Rigor, 1999: Surface air temperature and its changes over the past 150 years. *Review of Geophysics*, 37, pp. 173–199.
Web site:	• http://www.cru.uea.ac.uk/cru/data/temperature/

These data sets are available for use in scientific research upon the signing of a short license agreement.

4.1.4 Reynolds OI

Availability:	• NOAA/CDC
Period:	• 1981–1998
Type:	• Weekly or monthly sea-surface temperature (SST) means
Grid:	• 1° by 1° • 2° by 2°
Update frequency:	• 2–4 times a year
Climatology:	• None
Reference:	• Reynolds, R. W. and T. M. Smith, 1994: Improved global sea surface temperature analyses using optimum interpolation. *Journal of Climate*, 7, pp. 929–948. • Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions. *Journal of Climate*, pp. 1403–1420.
Web site:	• http://www.cdc.noaa.gov/cdc/data.reynolds_sst.html

5. SYSTEM DETAILS

Information must be provided on the system being verified. This information should include (but is not restricted to):

1. Whether the system is numerical, empirical or hybrid.
2. Whether the system is deterministic or probabilistic.
3. Model type and resolution.
4. Ensemble size.
5. Boundary conditions specifications.
6. List of parameters being assessed.
7. List of regions for each parameter.
8. List of forecast ranges (lead times) and periods for each parameter.
9. Period of verification.
10. The number of hindcasts or predictions incorporated in the assessment and the dates of these hindcasts or predictions.
11. Details of climatological and verification data sets used (with details on quality control when these are not published).
12. If appropriate, resolution of fields used for climatologies and verification.

Verification data for the aggregated statistics and the grid-point data should be provided on the Web. The contingency tables should be made available by the Web or anonymous FTP. The lead centre will take responsibility for defining a common format for displaying the verification scores. Real-time monitoring should be done as soon as possible and made available on the Web.

6. REFERENCES

Gerrity, J. P. Jr., 1992: A note on Gandin and Murphy's equitable skill score. *Monthly Weather Review*, 120, pp. 2707-2712.

Hanssen A. J. and W. J. Kuipers, 1965: On the relationship between the frequency of rain and various meteorological parameters. *Koninklijk Nederlands Meteorologist Institua Meded*. Verhand, 81-2-15.

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Potts J. M., C. K. Folland, I. T, Jolliffe and D. Sexton, 1996: Revised "LEPS" scores for assessing climate model simulations and long-range forecasts, *Journal of Climate*, 9, pp. 34-53.

Smith M. T., R. W. Reynolds, R. E. Livezey and D. C. Stokes, 1996: Reconstruction of historical sea-surface temperatures using empirical orthogonal functions, *Journal of Climate*, pp. 1403-1420.

Stanski H. R., L. J. Wilson and W. R. Burrows, 1989: Survey of common verification methods in meteorology. *World Weather Watch Technical Report No. 8*, WMO/TD-No. 358, 114 pp.

Wilks, D. S., 1997: Resampling hypothesis tests for autocorrelated fields. *Journal of Climate*, 10, pp. 65-92.

7. DEFINITIO OF ENSO EVENTS

The following table gives the definition of the ENSO events. The following list of cold (*La Niña*) and warm (*El Niño*) episodes has been compiled to provide a season-by-season breakdown of conditions in the tropical Pacific. The data underlying the following table have been taken from NOAA/NCEP/CPC at www.cpc.ncep.noaa.gov and have been subjectively interpolated to fit the conventional seasons DJF, MMA etc.

Years	*DJF*	*MAM*	*JJA*	*SON*
1950	C	C	C	C
1951	C	N	N	N
1952	N	N	N	N
1953	N	N	N	N
1954	N	N	N	C
1955	C	N	N	C
1956	C	C	C	N
1957	N	N	N	W
1958	W	W	N	N

Years	*DJF*	*MAM*	*JJA*	*SON*	*Years*	*DJF*	*MAM*	*JJA*	*SON*
1959	N	N	N	N	1981	N	N	N	N
1960	N	N	N	N	1982	N	N	W	W
1961	N	N	N	N	1983	W	W	N	N
1962	N	N	N	N	1984	N	N	N	N
1963	N	N	N	W	1985	N	N	N	N
1964	N	N	N	C	1986	N	N	N	W
1965	N	N	W	W	1987	W	W	W	W
1966	W	N	N	N	1988	N	N	N	C
1967	N	N	N	N	1989	C	N	N	N
1968	N	N	N	N	1990	N	N	N	N
1969	W	N	N	N	1991	N	N	W	W
1970	N	N	N	C	1992	W	W	N	N
1971	C	N	N	N	1993	N	W	W	N
1972	N	N	W	W	1994	N	N	W	W
1973	W	N	N	C	1995	W	N	N	N
1974	C	C	N	N	1996	N	N	N	N
1975	N	N	C	C	1997	N	W	W	W
1976	C	N	N	N	1998	W	W	N	C
1977	N	N	N	N	1999	C	C	N	C
1978	N	N	N	N	2000	C	N	N	N
1979	N	N	N	N	2001	N	N	N	N
1980	N	N	N	N					

ANNEX 6 TO RECOMMENDATION 5 (CBS-Ext.(02))

ATTACHMENT II.10
MODIFICATIONS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM*

PROCEDURES AND FORMATS FOR EXCHANGE OF MONITORING RESULTS

1. GENERAL REMARKS

1.1 Centres participating in the exchange of monitoring results will implement standard procedures and use agreed formats for communicating the information both to other centres and to the data providers. The following list is incomplete and requires further development in the light of practical experience. Guidance will be given through the initiative of the lead centres in their corresponding fields of responsibility.

1.2 Recognizing the fact that the monthly lists of suspect stations could be misinterpreted if the methods of compilation are not completely understood, they should be circulated only to those centres participating in the monitoring programme. In addition, they should contain a clear explanation of the criteria used and the limitations o the system.

1.3 Lead centres who are informed of remedial actions being taken should provide this information to all participating centres. The WMO Secretariat shall forward, every six months, the information it receives to the relevant lead centres. All lead centres shall produce for the WMO Secretariat a yearly summary of information made available to them and/or of those actions taken within their area of responsibility.

2. UPPER-AIR OBSERVATIONS

2.1 Monthly exchange for upper-air observations should include lists of stations/ships with the following information.

Month/year
Monitoring centre
Standard of comparison (first-guess/background field)

Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST THREE LEVELS WITH 10 OBSERVATIONS DURING THE MONTH AND 100 M WEIGHTED RMS DEPARTURE FROM THE FIELD USED FOR COMPARISON BETWEEN 1 000 hPa AND 30 hPa.

The gross error limits to be used for observed minus reference field are as follows:

Level	*Geop*
1 000 hPa	100 m
925 hPa	100 m
850 hPa	100 m
700 hPa	100 m
500 hPa	150 m

400 hPa	175 m
300 hPa	200 m
250 hPa	225 m
200 hPa	250 m
150 hPa	275 m
100 hPa	300 m
70 hPa	375 m
50 hPa	400 m
30 hPa	450 m

Weights to be used at each level are as follows:

Level	*Weight*
1 000 hPa	3.70
925 hPa	3.55
850 hPa	3.40
700 hPa	2.90
500 hPa	2.20
400 hPa	1.90
300 hPa	1.60
250 hPa	1.50
200 hPa	1.37
150 hPa	1.19
100 hPa	1.00
70 hPa	0.87
50 hPa	0.80
30 hPa	0.64

Data to be listed for each station/ship should include:

- WMO identifier
- Observation time
- Latitude/longitude (for land stations)
- Pressure of the level with largest weighted RMS departure
- Number of observations received (including gross errors)
- Number of gross errors
- Percentage of observations rejected by the data assimilation
- Mean departure from reference field
- RMS departure from reference field (unweighted)

Gross errors should be excluded from the calculation of the mean and RMS departures. They should not be taken into account in the percentage of rejected data (neither the numerator nor denominator).

2.1.1 List 1: Geopotential height

- Month/year
- Monitoring centre
- Standard of comparison (first-guess/background field)

Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST THREE LEVELS WITH 10 OBSERVATIONS DURING THE MONTH AND 100 M WEIGHTED RMS DEPARTURE FROM THE FIELD USED FOR COMPARISON BETWEEN 1 000 hPa AND 30 hPa.

The gross error limits to be used for observed minus reference field are as follows:

Level	*Geop*
1 000 hPa	100 m
925 hPa	100 m
850 hPa	100 m
700 hPa	100 m
500 hPa	150 m
400 hPa	175 m
300 hPa	200 m
250 hPa	225 m
200 hPa	250 m
150 hPa	275 m
100 hPa	300 m
70 hPa	375 m
50 hPa	400 m
30 hPa	450 m

Weights to be used at each level are as follows:

Level	*Weight*
1 000 hPa	3.70
925 hPa	3.55
850 hPa	3.40
700 hPa	2.90
500 hPa	2.20
400 hPa	1.90
300 hPa	1.60
250 hPa	1.50
200 hPa	1.37
150 hPa	1.19
100 hPa	1.00
70 hPa	0.87
50 hPa	0.80
30 hPa	0.64

Data to be listed for each station/ship should include:

- WMO identifier
- Observation time
- Latitude/longitude (for land stations)
- Pressure of the level with largest weighted RMS departure
- Number of observations received (including gross errors)
- Number of gross errors
- Percentage of observations rejected by the data assimilation
- Mean departure from reference field
- RMS departure from reference field (unweighted)

Gross errors should be excluded from the calculation of the mean and RMS departures. They should not be taken into account in the percentage of rejected data (neither the numerator nor denominator).

2.1.2 List 2: Temperature

Besides the geopotential height, temperature monitoring should be included at standard levels. As an initial criteria, the gross error thresholds to be considered could be:

- 15 (K) for p>700 hPa
- 10 (K) for 700>=p>50 hPa
- 15 (K) for p <= 50 hPa

2.1.3 List 3: Wind
Month/year
Monitoring centre
Standard of comparison (first-guess/background field)
Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST ONE LEVEL WITH 10 OBSERVATIONS DURING THE MONTH AND 15 m s-1 RMS VECTOR DEPARTURE FROM THE FIELD USED FOR COMPARISON, BETWEEN 1 000 hPa AND 100 hPa.
The gross error limits to be used are as follows:

Level	*Wind*
1 000 hPa	35 m s^{-1}
925 hPa	35 m s^{-1}
850 hPa	35 m s^{-1}
700 hPa	40 m s^{-1}
500 hPa	45 m s^{-1}
400 hPa	50 m s^{-1}
300 hPa	60 m s^{-1}
250 hPa	60 m s^{-1}
200 hPa	50 m s^{-1}
150 hPa	50 m s^{-1}
100 hPa	45 m s^{-1}

Data to be listed for each selected station/ship should include:
WMO identifier
Observation time
Latitude/longitude (for land stations)
Pressure of the level with largest RMS departure
Number of observations received (including gross errors)
Number of gross errors
Percentage of observations rejected by the data assimilation
Mean departure from reference field for u-component
Mean departure from reference field for v-component
RMS vector departure from reference field
Gross errors should be handled in the same way as for List 1.

2.1.4 List 4: Wind direction
The method used for computing the wind direction bias should be included in the reports (clockwise or aniclockwise)
Month/year
Monitoring centre
Standard of comparison (first-guess/background field)
Selection criteria: FOR 0000 AND 1200 UTC SEPARATELY, AT LEAST FIVE OBSERVATIONS AT EACH STANDARD LEVEL FROM 500 hPa TO 150 hPa, FOR THE AVERAGE OVER THAT LAYER, MEAN DEPARTURE FROM REFERENCE FIELD AT LEAST +/- 10 DEGRESS, STANDARD DEVIATION LESS THAN 30 DEGREES, MAXIMUM VERTICAL SPREAD LESS THAN 10 DEGREES.
Same limits for gross errors as above. Data for which the wind speed is less than 5 m s^{-1}, either observed or calculated, should also be excluded from the statistics. Data to be listed for each selected station/ship should include:
WMO identifier
Observation time
Latitude/longitude (for land stations)
Minimum number of observations at each level from 500 hPa to 150 hPa (excluding gross errors and data with low wind speed)
Mean departure from reference field for wind direction, averaged over the layer
Maximum spread of the mean departure at each level around the average
Standard deviation of the departure from reference field, aveaged over the layer
(To be completed with information from other lead centres)

NOTES:
(1) The responsiblity for updating this attachment rests with the lead centres.
(2) Urgent changes to this attachment recommended by the lead centres shall be approved, on behalf of the Commission for Basic Systems, by the president of the Commission.

2.1.5 The profilers should be monitored (suspect platforms) using the same criteria as for the radiosondes.

3. LAND SURFACE OBSERVATIONS

3.1 The criteria for the production of monthly list of suspect stations are as follows:

3.1.1 List 1: Mean sea level pressure
Element: MSL pressure, surface synoptic observations at 0000, 0600, 1200 or 1800 UTC compared to the first-guess field of a data assimilation model (usually a six-hour forecast).
Number of observations: at least 20 for at least one observation time, without distinguishing between observation times.
One or more of the following:
Absolute value of the mean bias ≥ 4 hPa
Standard deviation ≥ 6 hPa
Percentage gross error ≥ 25 per cent (gross error limit: 15 hPa).

3.1.2 List 2: Station level pressure
The criteria for station-level pressure monitoring is the same as for MSL pressure above.

3.1.3 List 2: Geopotential height
Element: geopotential height, from surface synoptic observations or derived from station-level pressure, temperature and published station elevations

at 0000, 0600, 1200 or 1800 UTC compared to the first-guess field of a data assimilation model (usually a six-hour forecast).

Number of observations: at least five for at least one observation time, without distinguishing between observation times.

One or more of the following:

Absolute value of the mean bias ≥30 m
Standard deviation ≥40 m
Percentage gross error ≥25 per cent (gross error limit: 100 m).

3.1.4 Precipitaiton

General guidance reflecting Global Precipitation Climatology Centre (GPCC) procedures for precipitation quality monitoring is given in section 6.3.3.1 of the *Guide on the Global Data-processing System*.

NOTES:

(1) All monitoring centres are asked to conform to the above specified criteria. These monthly lists should be prepared for at least the regional association of the lead centres and, if possible, for other regional associations. Consolidated lists of suspect stations should be produced every six months by the lead centres (January–June and July–December) and forwarded to the WMO Secretariat for further action.

(2) The stations on these consolidated lists should be those appearing on all six-monthly lists of the lead centres. Other stations could be added to the consolidated list if the lead centres judges that there is sufficient evidence for their inclusion. Each centre should send its proposed consolidated list to all participating monitoring centres for comment. The final list would then be forwarded to the WMO Secretariat.

4. SURFACE MARINE OBSERVATIONS

4.1 Monthly exchange for surface marine observations should include lists of 'suspect' ships/buoys/platforms with the following additional information:

Month/year
Monitoring centre
Standard of comparison: first-guess/background field of a global data assimilation model — often a six-hour forecast, but the background values may be valid at the observation time for non-main hour data using 4-D VAR or time-interpolation of T+3, T+6, T+9 forecasts; for SST, the first-guess/background field may be from a previous analysis.

All surface marine data may be included, not just observations at the main hours of 0000, 0600, 1200 and 1800 UTC.

4.2 The elements to be monitored should include:

Mean sea level pressure
Wind speed
Wind direction
and, where possible:
Air temperature
Relative humidity
Sea-surface temperature

4.3 Data to be listed for each ship/buoy/platform and each element should include:

WMO identifier observation times (if not all times latitude/longitude (for buoys and platforms)
Number of observations received (including gross errors)
Number of gross errors
Percentage of observations rejected by the data assimilation quality control
Mean departure from reference field (bias)
RMS departure from reference field

Gross errors should be excluded from the calculation of the mean and RMS departures. They should not be taken into account in the percentage of rejected data (neither the numerator nor denominator).

4.4 The criteria for the production of the monthly list of suspect stations are as follows:

4.4.1 List 1: Mean sea-level pressure

Number of observations: at least 20
One or more of the following:

Absolute value of the mean bias ≥ 4 hPa
Standard deviation ≥ 6 hPa
Percentage gross error ≥ 25% (gross error limit: 15 hPa)

4.4.2 List 2: Wind speed

Number of observations: at least 20
One or more of the following:

Absolute value of the mean bias ≥ 5 m s^{-1}
Percentage gross error ≥ 25% (25 m s^{-1} vector wind)

4.4.3 List 3: Wind direction

Data for which the wind speed is less than 5 m s^{-1}, either observed or calculated, should be excluded from the statistics.

Number of observations: at least 20
One or more of the following:

Absolute value of the mean bias ≥ 30°
Standard deviation ≥ 80°
Percentage gross error ≥ 25% (gross error limit: 25 m s^{-1} vector wind)

4.4.4 List 4: Air temperature

Number of observations: at least 20
One or more of the following:

Absolute value of the mean bias ≥ 4°C
Standard deviation ≥ 6°C
Percentage gross error ≥ 25% (gross error limit: 15°C)

4.4.5 List 5: Relative humidity

Number of observations: at least 20
One or more of the following:

Absolute value of the mean bias ≥ 30%
Standard deviation ≥ 40%
Percentage gross error ≥ 25% (gross error limit: 80%)

4.4.6 List 6: Sea surface temperature
Number of observations: at least 20
One or more of the following:
Absolute value of the mean bias ≥ 3°C
Standard deviation ≥ 5°C
Percentage gross error ≥ 25% (gross error limit: 10°C)

5. AIRCRAFT DATA

5.1 The criteria for the production of the monthly list of suspect aircraft temperatures and winds observations are as follows:

5.1.1 Automated aircraft observations, both AMDAR and ACARS, will separately be listed as suspect for temperatures and winds in three pressure categories if the data statistics exceed the criteria defined in paragraph 5.1.2. The three pressure categories are: low surface to 701 hPa; mid to 700 to 301 hPa; and high to 300 hPa and above. To be considered suspect, the number of observations must meet minimal counts and the data statistics versus the guess must exceed at least one criterion or the gross rejection rate must exceed 2 per cent. Thus, if the magnitude of the temperature or speed bias exceed the criterion or the RMS differences to the guess exceed the limit for the pressure category, then the aircraft is listed as suspect for that pressure category. Observations differing from the guess by amounts larger than gross check limits will be considered gross and not used in computing bias and RMS differences. If the number of gross observations (NG) for a pressure category exceeds 2 per cent of the total number of checked observations, then the aircraft will be listed as suspect. After data thinning for assimilation, the remaining number of observations is NT. The number of rejected observations excluding thinning (NR) is an optional statistic for information, and for which operational practice should be documented.

List: Temperature and wind
Month/year
Monitoring centre
Standard of comparison (first guess/background field)

Each aircraft that is suspect will be listed as follows in one line:
Aircraft ID
Pressure category
Total number of available observations (NA)
NG
NT
NR
Bias
RMS difference to the guess
For wind reports, the number of exactly calm winds (NC).

5.1.2 Suspect automated aircraft temperatures and winds observations criteria

Variable	*Low*	*Mid*	*High*
Gross temperature (K)	15.0	10.0	10.0
Temperature bias (K)	3.0	2.0	2.0
Temperature RMS (K)	4.0	3.0	3.0
Minimum count	20	50	50
Gross wind (m s^{-1})	30.0	30.0	40.0
Wind speed bias (m s^{-1})	3.0	2.5	2.5
Wind RMS (m s^{-1})	10.0	8.0	10.0
Minimum count	20	50	50

5.1.3 AIREP

Monthly exchange for AIREP observations should include lists of airlines with the following information:
Month/year
Monitoring centre
Standard of comparison (first guess/background field)
Selection criteria
Number of observations>=20
Levels monitored
300 hPa and above
Elements monitored
Wind and temperature
Data to be listed for each airline
Airline ID
Number of observations
Number of rejected observations
Number of gross errors
Number of calm winds (<5 m s^{-1})
RMS excluding gross errors
Bias excluding gross errors (wind speed and temperature)
Gross error limits are:
Wind 40 m s^{-1}
Temperature 10 degrees °C

6. SATELLITE DATA

6.1 Satellite data monitoring criteria are as specified in the following table:

Geostationary satellite wind (SATOB or BUFR code, as assimilated, centres must clarify this and channels shown)	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring layers	Upper (101–400 hPa) Middle (401–700 hPa) Lower (701–1 000 hPa)
Minimum observation count	20 (in 10 deg box), 10 (in 5 deg box)
Gross error limit ($m\ s^{-1}$)	60
Availability map (averaged observation number in 24 hours)	10degX10deg OR 5degX5deg for all levels
Map: wind observed value	10degX10deg OR 5degX5deg for each layer
Map: O-FG wind vector difference (bias)	10degX10deg OR 5degX5deg for each layer
Map: O-FG wind speed difference (bias)	10degX10deg OR 5degX5deg for each layer
Map: O-FG RMS of wind vector difference	10degX10deg OR 5degX5deg for each layer
Table: Statistics as defined in the *Proceedings of the Third International Winds Workshop* (1996), Menzel, p. 17. EUMETSAT, Darmstadt, EUMP18, with reference to the first guess	The following statistics for all levels, high, medium and low in all regions, N and S extratropics and tropics for satellite in use and selected channels: MVD = Mean vector difference RMSVD = Vector difference RMS BIAS = Speed bias SPD = FG/background wind speed NCMV = Number of disseminated SATOB winds

Orbital satellite SATEM	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring parameters	Thickness layers (850–1 000, 100–300, 30–50) hPa
Gross error limit (m)	150 (1 000–850), 400 (300–100), 500 (50–30) hPa
Availability map (averaged observation number in 24h)	5degx5deg OR 10degX10deg for each layer
Map: O-FG thickness difference (bias)	5degx5deg OR 10degX10deg for each layer
Map: O-FG RMS of thickness difference	5degx5deg OR 10degX10deg for each layer

Orbital satellite Atmospheric soundings	*Recommended criteria*
Monitoring satellites	Current operational satellites
Monitoring parameters	Uncorrected brightness temperatures primarily, plus corrected
Monitoring channels	The lead centre will recommend a selection of channels to be monitored
Availability map (averaged observation number in 24 hours)	5degx5deg OR 10degX10deg for each satellite
Map: O-FG difference (bias)	5degx5deg OR 10degX10deg for each satellite
Map: O-FG SD of difference	5degx5deg OR 10degX10deg for each satellite

	Recommended criteria
Sea-surface wind (e.g. scatterometers, SSM/I)	Follow guidelines as above for satellite winds where possible, but applied to surface only

Geostationary satellite wind (SATOB or BUFR code, as assimilated, centres must clarify this and channels shown)	*Recommended criteria*
Any other satellite product	The pioneering centre can set the initial standard, based on the above guidelines for similar parameters, or a new standard for a new product. Report back to the lead centre for information

RECOMMENDATION 6 (CBS-Ext.(02))

REVIEW OF RESOLUTIONS OF THE EXECUTIVE COUNCIL BASED ON PREVIOUS RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS OR RELATED TO THE WORLD WEATHER WATCH

THE COMMISSION FOR BASIC SYSTEMS,

NOTING with satisfaction the action taken by the Executive Council on the previous recommendations of the Commission for Basic Systems or related to the World Weather Watch in general,

CONSIDERING that some of the previous Executive Council resolutions are still valid,

RECOMMENDS that the following Executive Council resolutions be kept in force:

Resolutions 1 and 2 (EC-XXXVI) and 5 (EC-XLII).

RECOMMENDATION 7 (CBS-Ext.(02))

BROADENING OF THE FUNCTIONS OF A REGIONAL SPECIALIZED METEOROLOGICAL CENTRE TO INCLUDE THE PROVISIONS OF ULTRAVIOLET INDEX FORECASTS FOR EUROPE

THE COMMISSION FOR BASIC SYSTEMS,

NOTNG:

(1) The requirements stated by XIII-RA VI for the establishment of an RSMC for the provision of ultraviolet index forecasts for Europe,

(2) Appendix I.2 of the *Manual on the Global Data-processing System* (WMO-No. 485) — Procedures for broadening the functions of existing RSMCs and for designation of new RSMCs,

CONSIDERING that the RSMC Offenbach (Germany) provides ultraviolet index forecasts on an operational basis and has fulfilled the relevant procedures for broadening the functions of existing RSMCs,

RECOMMENDS broadening the functions of the RSMC Offenbach (Germany) to include provision of ultraviolet index forecast for Europe with effect from 1 July 2003;

REQUESTS:

(1) The Member operating the designated RSMC to make available its specialized products, as required, to Members concerned on a regional basis and to coordinate such activities with the relevant Programmes of WMO;

(2) The Secretary-General to arrange for the inclusion of the newly agreed RSMC function in the *Manual on the Global Data-processing System* (WMO-No. 485) as soon as the Executive Council has approved this recommendation.

ANNEXES

ANNEX I

Annex to agenda item 6.2.17 of the general summary

PROCEDURES FOR OBSERVATIONAL DATA COLLECTION USING E-MAIL OVER THE INTERNET

The document provides guidelines for using electronic mail as a complementary communication system for collecting meteorological data bulletins over the Internet. The purpose of this proposal is not to replace the existing data collection systems, but to serve as a complementary system to be used in test and special cases, or when a GTS link is unavailable.

Background

Electronic mail (e-mail) can be a very simple and cost effective way to exchange GTS messages. It should be noted however that e-mail is not an end-to-end service and there is no guarantee of the timely delivery of messages.

The following guidelines describe practices for sending both data collection bulletins and binary GTS messages via e-mail.

Guidelines for sending GTS messages via electronic mail on the Internet:

1. E-mail messages shall be sent in ASCII (plain text) with possible attachments. HTML shall not be used.
2. The GTS message(s) can be sent either as text in the body of the e-mail, or in the attachment(s) of the e-mail, but not in both. Binary data should only be included in e-mail attachment(s).
3. The body of an e-mail shall follow the following format:

   <security string>
   <GTS message>
   …
   <GTS message>
   where,
   <security string> is a bilaterally-agreed word or series of words to help in the validation of the e-mail. The security string is optional.
   <GTS message> is a standard GTS message starting with the abbreviated header line, such as:

   TTAAii CCCC YYGGgg [BBB]
   message text

   Each line of the GTS message should not exceed 69 characters.

   No other information should be included in the body of the e-mail unless agreed by the receiving centre.

   NOTE: If the GTS message(s) are included in the attachment(s), then the body only contains the <security string>.
4. The structure and filename (to be verified to validate) of an attachment shall be identical to that of a file transferred by FTP. The length of an attachment shall not exceed 2 MBytes or as specified in a bilateral agreement. Attachments shall be coded in Base64 (MIME standard).
5. The e-mail header “Subject:” field either:
   (*a*) May contain the AHL if the e-mail contains a single GTS message;
   (*b*) Is empty; or
   (*c*) By bilateral agreement, contains a <security string>.

   Security considerations:
6. The e-mail is inherently insecure. To minimize security issues, the receiving centre should only process GTS-related e-mails from a pre-defined list of e-mail addresses. That is, the receiving centre should validate the e-mail header “From:” field. To avoid problems with e-mails containing manipulated “From”-fields, centres may bilaterally agree in <security strings> as described in the above rules.
7. It is recommended to use specific mail accounts for GTS data transfer with bilaterally-agreed names and not to receive GTS data in personal mailboxes.
8. A problem with some mail exchangers is that by default they operate as an “open-relay”. An open-relay occurs, for example, if you are on site A.COM, and you accept mail from B.NET destined for C.ORG. This means that spammers can use your mail system to distribute their e-mails. Centres should ensure that they do not operate as an open-relay. For centres using “sendmail” as the mail exchanger it is recommended that they use version 8.9 or later which by default denies unauthorized relaying.

ANNEX II

Annex to paragraph 6.2.27 of the general summary

RESERVED $T_1T_2A_1A_2$ ABBREVIATED HEADING ALLOCATIONS FOR FACILITATING THE MIGRATION TO TABLE-DRIVEN CODE FORMS

(T_1 = I (observations) or T_1 = J (forecasts) for BUFR, and T_1 = K for CREX)

Introduction

The reserved allocations for the abbreviated heading line were developed with a view to facilitating the migration to table-driven code forms, in accordance with the following general principles:

1. The existing Tables C3, C6 and C7 of Attachment II-5 were used as the basis for abbreviated heading allocations to table-driven code form data.
2. For observational data, abbreviated heading allocations were corresponding between data in BUFR with T_1 = I and data in CREX with T_1 = K (although with a few differences).
3. For forecast information, abbreviated heading allocations were mapped between observational data in BUFR with T_1 = J and in CREX with T_1 = K (e.g. T_1T_2 = JS with T_1 = KF).
4. For most real-time oriented data, T_1 allocations for traditional alphanumeric codes are used as T_2 allocations for table-driven code forms.
5. In most cases, the geographical indicator A_1A_2 for traditional alphanumeric codes is reduced to a single A_2 for table-driven code forms. This was an acceptable compromise since the CCCC location indicator contributes to the identification of the origin of the data. The ii indicator could also ensure the required differentiation.

Surface observations (T_1T_2 = [I/K]S):

- Remove buoy observation from A_1 = S (to distinguish from ship observations);
- Allocate A_1 = D for radiological observation;
- Allocate A_1 = F for source of atmospherics;
- Allocate A_1 = W for aviation routine weather observation.

Upper-air observations (T_1T_2 = [I/K]U):

- Allocate A_1 = F for radio soundings (parts C and D);
- Allocate A_1 = K for radio soundings (parts A and B); Note: A_1 = M is currently allocated in Table C6;
- Allocate A_1 = U for monthly statistics of data from upper-air station;
- Allocate A_1 = G for upper wind (part B);
- Allocate A_1 = J for upper wind (part C);
- Allocate A_1 = O for profiles of aircraft observations in ascending/landing phases;
- Allocate A_1 = Q for upper wind (part D);
- Allocate A_1 = W for upper wind (part A).

NOTE: A_1 = P is allocated in Tables C6/C7.

Oceanographic observations (T_1T_2 = [I/K]O):

- Allocate A_1 = B for buoy observations;
- Allocate A_1 = P for sub-surface profiling floats.

Forecast (T_1T_2 = JS/KF):

- Clarify rules for use of A_1 = A/P/S/T
- Allocate A_1 = D for radiological forecast
- Allocate A_1 = O for maritime forecast

NOTE: Additional entries might be allocated to support migration of ARFOR/ROFOR/WINTEM forms, noting that there were no longer requirements from ICAO for ARFOR and WINTEM.

ANNEX III

Annex to paragraph 6.2.68 of the general summary

SUMMARY OF THE DRAFT PLAN FOR MIGRATION TO TABLE-DRIVEN CODE FORMS

(The full text of the draft plan is available on the WMO Web server at: http://www.wmo.ch/web/www/WDM/wdm.html#Documents)

Acknowledgements

This draft plan is the result of the work of CBS Expert Team on Migration to Table-driven Code Forms. Chairperson: Fred Branski (United States). Team members: Jean Clochard (France, chairperson, Expert Team on Data Representation and Codes), Seid Amedie (Ethiopia), Heinrich Knottenberg (Germany), Keiichi Kashiwagi (Japan), Dick Blaauboer (Netherlands), Vladimir Antsypovich (Russia), Milan Dragosavac (ECMWF), Simon Elliott (EUMETSAT), Etienne Charpentier (JCOMMOPS); other contributors: Geerd R. Hoffmann (Germany, chairperson, Open Programme Area Group on Information Systems and Services), Jaap van der Plank (Netherlands), Jeffrey Ator (United States); WMO Secretariat: Joël Martellet.

I. INTRODUCTION: ADVANTAGES OF, AND REASONS FOR, MIGRATION TO TDCF

1.1 Observational data are the lifeblood of the meteorological activities of WMO. Standardization of the formatting of the data has always been a fundamental requirement. The self-description, flexibility and expandability of TDCF, BUFR, CREX and GRIB, are the only solution to the demands of the rapidly evolving science and technology for representation of new data types, metadata, higher resolution data in time or space dimensions and higher precision of data. BUFR and CREX offer great advantages in comparison with TAC. In addition, BUFR offers condensation (packing) of data. The alphanumeric code CREX provides human readability, but not packing. BUFR has mainly been used for satellite, aircraft and wind profiler observations, and also for tropical cyclone information and archival of all types of observational data. CREX is used for the exchange of ozone data, radiological, hydrological, tide gauge, and soil temperature data, as well as for tropical cyclone information. The TDCF will easily permit to satisfy existing as well as future needs. The reliability of binary data transmission provides for an increase in data quality and quantity received at meteorological centres. In addition, the systematic exchange of metadata in every report is easily performed with TDCF. This alleviates the difficulties currently experienced in acquiring this metadata and simplifies archival of data. Since all BUFR and CREX messages include the respective code table edition and version numbers, the correct retrieval of parameters from archives for any historical post-processing application is safer and simpler. Increased data quantity and quality will lead to the generation of better products. Less development and maintenance work and reduced associated costs will be additional operational benefits. The universal use of TDCF will reduce the diversity of data formats that need to be processed, consequently reducing software and other operational requirements. BUFR and CREX can satisfy all needs for coding observations and are recommended for all present and future WMO applications. They are the ideal codes for observations and the best adapted to the fast scientific and technological evolution of the twenty-first century.

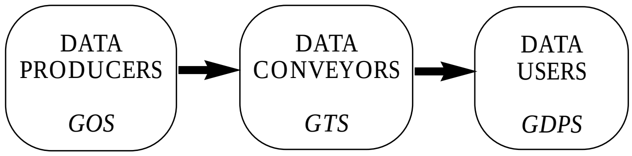
1.2 The impact the migration may have on financial resources is a legitimate concern of WMO Members. There will be significant changes to systems, which will require many staff-hours of work. However, many Members feel this is manageable and outweighed by the advantages of migration as long as sufficient time and flexibility is allowed for in the plan.

II. POTENTIAL IMPACTS OF THE MIGRATION TO TDCFs ON THE WWW

The concepts of data producers, data conveyors and data users

2.1 The migration to TDCF will have implications at every step of the WWW data flow. Technical impacts and possible solutions must be identified. The concepts of data producers, data conveyors and data users are introduced to explain the WWW data flow. The GOS and similar systems are the data producers; the data conveyors are elements of the GTS, and the GDPS and others, who utilize the data, are the data users. Entities making up the GOS, GTS and GDPS are all located within the NMHSs.

THE WORLD WEATHER WATCH DATA FLOW



Impact on data producers of WMO observations

2.2 Most NMCs and other data producers encode traditional observations using alphanumeric codes such as SYNOP, TEMP and PILOT. A number of specialized data producers provide other observations such as satellite data (the majority already encoded in BUFR), aircraft data (AIREP, AMDAR [some already encoded in BUFR]), SHIP data, BUOY data, XBT/CTD and sub-surface profiling floats data (soon to be encoded in BUFR).

WMO Members' observing stations and platforms

2.2.1 Most countries still take many observations manually. Migration to BUFR will require automation, either by an automatic weather station generating BUFR messages or by an observer entering the observations into a system (possibly a Web-based interface) that encodes them into BUFR. Migration to CREX would allow manual encoding by a human observer to continue; however, the observers will need to be trained.

2.2.2 Most of the current automated observing systems encode data in TAC. It will take several years to convert or replace these systems before observations will be encoded in BUFR at these observation sites. Where human observers enter data into a computer, the encoding is de-coupled from the measurement. In these cases, encoding of BUFR or CREX could be done through modification to the encoding software. The choice of BUFR or CREX would be made based on telecommunication issues. For instance, experience with some data-collection platforms indicates that CREX may be preferred because of potentially lower error rates (better error detection through the use of CREX check digits). One country estimated the work associated with the implementation of new encoding software to be about six staff-months per observing system. Implementation costs would depend on the details of each system, but in most cases would be reasonable if performed as part of normal life cycle maintenance.

National collection

2.2.3 Data collected at observational sites are usually sent to a central site for placement onto the GTS. Adjustments to the related systems and software at these sites may need to be made to add or enhance the capability to compile bulletins of BUFR or CREX-encoded reports. It will be difficult for voluntary ships to encode observations in BUFR or CREX and will require a lengthy transition period. A similar situation exists for data that are encoded in TAC by producers outside of NMHSs, such as aircraft data.

Impact on data conveyors of WMO observations

2.3 For some observation types, there will likely be periods during the transition to TDCF when the same data will be exchanged in both TAC and TDCF — a period of "dual dissemination". This will facilitate migration between the code forms. Dual dissemination should not cause serious problems with computer system hardware or bandwidth of telecommunication lines because of the rapid progress of information technology and services. While dual dissemination is occurring, there will be a temporary increased load on GTS switching systems. The volume of data that would be candidates for dual dissemination is small. Hence, the additional bandwidth required is also small and partially offset by the compressibility of BUFR-ncoded data. RTHs on the MTN can handle binary data, as can managed data communication networks and most satellite dissemination systems.

Impact on data users of WMO observations

2.4 The GDPS centres are dependent on meteorological observations. These centres have to extract the information contained in the observations from the formats in which they are exchanged. This usually involves separating out the individual observations from within the bulletins that contain them. Many centres use software to achieve this. For TAC, the software is complex and often much of the program is for detecting and correcting errors in the data due to manual coding errors or transmission failures. Use of TDCF will drastically reduce formatting errors resulting in more observations being available for all meteorological applications, especially data assimilation systems. Additionally, multiple programs are required today for decoding the different TAC formats. A single BUFR and/or CREX decoder would replace these.

2.4.1 Some applications may also need to be changed as a result of migrating to TDCF. Except where a data user wishes to modify an application to take advantage of new parameters that may be available, changes will be mainly in the pre-processing layer. Where a change only affects pre-processing, the work is estimated to be about one staff-month for each observation type. As a result, the impact on resources at an individual centre will vary depending on the type and number of applications concerned. Provision of, and support for, encoding and decoding software for TDCF will be necessary for successful migration. It will take significant time for many NMHSs to introduce computer systems to process binary data at their local offices and to implement a national telecommunication network which can disseminate binary data even if their NMCs and GTS Centres can handle binary data. Furthermore, even some advanced NMCs use application software directly linked to TAC for data plotting, data display and databases simply because most conventional observations are encoded in TAC. Introducing or modifying software for migration to TDCFs will have a financial impact on many NMHSs.

2.4.2 The final result of the migration on data users will be beneficial since data assimilation programs, forecasters, climate, marine and aviation databases will all have more data of higher quality with additional useful parameters.

Impact of migration to TDCF on other programmes or organizations

2.5 The advantages of migration to TDCF are becoming known to programmes and organizations outside the WWW community. BUFR and CREX decoders will be needed by those who receive meteorological observations. Some programmes are already using TDCF or are planning to do it soon. For example, satellite data producers have been using BUFR for a long time. SADC-HYCOS and MED-HYCOS use CREX for meteorological and hydrological observations. ARGOS, DBCP and the SOO programme are planning and developing systems for the transmission of observations in BUFR beginning in 2003. Dual dissemination could be performed during a transition period. However, some ACARS and AMDAR are already transmitted in BUFR. The WAFS centres have started disseminating some weather data in BUFR and plans are in place for further migration to occur. Aviation data users, such as pilots, will certainly need a presentation in clear character formats, but data transmission could be done in BUFR with automated decoding and display.

Impact for decision makers

2.6 There will be implications due to the migration process on WMO Members' resources for development and operation. One has to be aware of the financial impact of the various steps of the migration process on NMHSs´ budgets. There will be costs for:

(*a*) Training of personnel who generate or use data;
(*b*) Training of system and software personnel;
(*c*) Project management for transition;
(*d*) Documentation updates;
(*e*) Infrastructure, hardware and system changes (e.g. for automation);
(*f*) Software development;
(*g*) Operational procedure changes.

III. SOLUTIONS AND PLAN OF ACTIONS

Basic principles of the plan

3.1 The goal of the plan is the elimination of TAC for observational data exchange by the migration to BUFR.

(*a*) The goal of the plan is the eventual complete replacement of TAC by BUFR in the exchange of observational data;
(*b*) The migration process will be flexible. Within the target dates defined in the plan, WMO Members can choose their own timetable for the migration;
(*c*) The use of CREX is seen as an interim step in the migration to BUFR;
(*d*) The data producer, not the user, is the initiator of the migration process;

(*e*) Data producers should not be constrained in using BUFR or CREX;

(*f*) Data users must have access to new data produced in BUFR or CREX and be able to receive data exchanged in BUFR or CREX;

(*g*) Data users should have first priority for training;

(*h*) Data users should implement BUFR and CREX decoders as soon as possible;

(*i*) Dual dissemination (initially in BUFR and TAC, later in BUFR and CREX) should be provided, where data users are unable to receive or process BUFR or CREX;

(*j*) The successful migration in developing countries depends on capacity building. Assistance to developing countries in the form of pilot and specific projects will be necessary for implementation of new coding procedures, new software and possibly hardware for automation.

Training in parallel with actions

3.2 All WMO Members will be affected by the migration to TDCF. It is important that they understand the benefits and implications of TDCF. Training is essential for Members to realize fully the benefits. The training programme will be defined for the international level and training actions will be suggested for the national level. CBS-XII has recommended that such training be completed by October 2005.

3.2.1 Three levels of training should be addressed:

(*a*) Level 1 – General understanding of the philosophy of TDCF and a migration overview;

(*b*) Level 2 – Deeper understanding of TDCF and introduction and use of TDCF software including debugging and the interaction with data-processing applications;

(*c*) Level 3 – Total understanding of the TDCF, for programming of encoders and decoders (only needed if the software project is not implemented).

3.2.2 To implement the three levels of training, two WMO training courses are proposed for two categories of trainees:

(*a*) P1: Trainers, data managers, general users (meteorologists) and decision makers for technical matters;

(*b*) P2: Technical users involved in operational software development.

3.2.3 WMO proposes to organize training seminars that would cover handling of software packages for decoding and visualization software for decoded data. The seminars would include P1 and P2 courses for technical users involved in operational software development and trainers from RMTCs. The seminars would be provided in all WMO Regions over the period 2003–2005. The total cost to WMO has been estimated at CHF 500 000.

National training

3.2.4 Currently, there is little or no training on TDCFs within the NMHSs. Level 1 and Level 2 training should be given. Level 3 should be considered if the software project is not implemented. Information on the general philosophy of BUFR and CREX codes should be included in meteorological training institutions of all countries for all technical staff. However, most staff does not need instruction on the "physical" structure of the code(s). Level 1 training is sufficient for most staff.

Information for manufacturers

3.2.5 Information should be provided to manufacturers of automatic observing systems, processing systems and workstations. It could be delivered in a seminar where documentation was also provided. The seminar would cover general principles of the codes along with examples. The WMO Secretariat may be able to arrange for such a seminar at no cost for WMO via registration fees paid by the manufacturers.

Software house project

3.3 CBS recognized that provision of, and support for, encoding and decoding software for the TDCF is an indispensable part of any migration plan. A software house project is a new paradigm for WMO but is a critical need for a successful migration to TDCFs. A centralized unit developing and supporting application program interface software is a valuable and necessary step to ensure that standard data representation forms, developed and coordinated by WMO, are used by the widest possible user community. This will be of particular use to those users with very limited computer programing resources. The implementation of a software house project in a technologically advanced State or through an international organization will favour and help migration to TDCF. It should be noted that the first beneficiaries of such a project would be the technologically advanced States themselves, and all their meteorological applications, in particular their operational forecasting systems, with the prospect of receiving more data and better quality data, leading to better products.

Pilot project(s)

3.4 Assistance in the form of pilot projects is urgently required for the automation of NMCs, for the introduction of information and communication technology, and for the training of their technical staff. Pilot migration projects should be identified, developed and implemented, as a test and precursor to the migration, to show the benefits, and to show any difficulties. This will also allow for better solutions to problems to be identified.

Actions recommended: tasks of WMO Members for producing TDCF

3.5 Data producers will have the freedom to switch to BUFR when they need. However, they have to ensure that their users have access to the data. In some cases, dual dissemination in BUFR and CREX will be necessary for users who cannot receive or process binary data. Dual dissemination in BUFR and TAC is discouraged since users will not be able to benefit from new parameters and the greater precision provided by BUFR and

CREX, but users should have the capacity to understand CREX.

Manufacturers of automated platforms

3.5.1 Some NMHSs will need to plan for replacement of their automated systems and others may plan to introduce automation. Financial considerations may make it necessary for Members to do this over a long time. Members should begin planning for the introduction of systems with software to encode observations in BUFR (or CREX). Automatic platform manufacturers have to be aware of the BUFR and CREX formats for developing their new systems. Manufacturers of observing systems should be solicited for the development of systems that comply with the migration strategy.

3.5.2 Development and implementation of software to generate BUFR messages (BUFR encoding software) is needed at all places where messages are currently generated in TAC. The software project could take care of the software development itself. However, the specific site implementation would require special attention and work. NMHSs should be encouraged to start special migration projects to implement new encoding software in all operational observation systems, which currently produce TAC.

Need for double dissemination

3.5.3 As some countries begin to migrate to TDCF, double encoding, dual dissemination or translation back to TAC will need to be done to cater for countries not equipped to receive or process BUFR. Data flows and user requirements have to be analysed. So far, satellite data transmitted in BUFR have been used by a limited number of Centres running global numerical models; other users did not need these data. To decide on dual dissemination or not, producers will have to consider their users and analyse requirements for dual dissemination perhaps based on a geographical basis.

National concentration and dissemination on GTS

3.5.4 It may not be practical and cost-effective to encode observations in both TAC and TDCF at observation sites and to send them to a collecting centre. Observation sites could transmit reports to a concentration site or to their NMC in a format, which could be national or non-standard, TAC, CREX or BUFR. The NMC or concentration site could convert the TAC or national/non-standard format to BUFR or CREX and transmit the observations onto the GTS. During a transition period, observations in TAC could be transmitted in TAC as needed. The NMC or concentration site could convert observations reported in BUFR to TAC and transmit both formats (double-dissemination) if there is a need for non-binary compatible users. Eventually, when all NMCs can understand CREX, double dissemination BUFR and CREX would be preferable. All NMCs should have BUFR decoder and CREX encoder software to perform this conversion. Testing of encoded BUFR or CREX observations with an independent decoder preferably by some other WMO Member will be a pre-requisite before starting to disseminate operationally these observations in TDCF. A WMO Member producing a new bulletin containing observations in BUFR or CREX should notify the Secretariat in advance of its transmission, in order to pass the information to all other Members. Producers should give warning (through the WMO Secretariat) at least one or two years in advance of the date they will stop the dissemination of observations in TAC or CREX.

Non-automated stations

3.5.5 For the long term, automation should be considered. When contracting with manufacturers of automatic platforms, encoding in BUFR or CREX, not TAC, should be specified. Level 1 training for observers (if still used for entering data) will be required for explaining the new technology and TDCF. An intermediate step could be migration to CREX, which can be handled manually. This should be done if new parameters or new data types have to be transmitted despite manual encoding. This migration would require the training of staff: the observers to encode observations in CREX and the staff at NMCs to understand the CREX code coming from their national stations, from the GTS or from other means.

Tasks of WMO Members for conveying TDCF

3.6 Since different centres on the GTS have varying capabilities to accomplish migration, and since message switching directories have to be changed throughout the world, it is recognized that the pace of migration will be different from centre to centre and that completion of the project will take significant time. Since format translation is not a role of an RTH and many RTHs would not have the processing power to be able to do this, dual dissemination should be the primary mechanism utilized for migration. However, some RTHs or centres may have the capability to do format translation and may decide to convert message formats for their national needs or as regionally agreed. If centres have to convert BUFR messages received from the GTS into character code, it is recommended that they use CREX instead of TAC.

Tasks of WMO Members using TDCF

3.7 To achieve a successful migration, the data users will need decoding software and support for this software early in the process. The Software House can assist centres with this. The NMCs will also have to analyse the possible impacts on data processing resulting from the availability of new BUFR or CREX reports, new parameters and new metadata. Some immediate fixes may be required to maintain operation. Further adjustments to their database management systems and application programs may also be necessary.

3.7.1 As BUFR is the preferred format for the future, manually operated NMCs should seriously consider automation at this time. However, they may consider training manual operators to receive CREX as an interim solution. Training to receive and understand CREX is a relatively simple task. An NMC considering automation should ensure that the data-processing software developed includes universal BUFR and CREX decoders, as well as GRIB 1 and GRIB 2 decoders. Manufacturers of meteorological systems should strive to support these formats in their products.

Use of the Internet

3.7.2 The use of the Internet may help to solve some migration problems. For some NMCs, the Internet could allow earlier access to data in binary formats if they did not have a GTS link or if this data are not available over their GTS link. This assumes that these meteorological observations are made available on the Internet by some GDPS centres in their Web or FTP servers.

Actions by WMO Members — decision makers

3.8 Every WMO Member should:

(*a*) Define a Migration Contact Point (about 100 Members have nominated one already);

(*b*) Establish a national Migration to TDCF Steering Group (MTSG);

(*c*) Identify impacts of migration on national operation;

(*d*) Produce a national migration plan;

(*e*) Plan their requests for equipment and software (resources commitment);

(*f*) Start a national training programme on TDCF;

(*g*) As needed, modify or replace software used for observation, encoding, data concentration, dissemination systems, input data processing, message switching, decoding, visualization and archiving;

(*h*) Evaluate the implications, due to the migration process, on WMO Members' resources for development and operation;

(*i*) Reserve the budget resources necessary to implement the migration.

Schedule

3.9 The following actions should occur in parallel:

(*a*) Training (2003 to 2005): organized by WMO and nationally;

(*b*) Installation of universal BUFR/CREX decoders as soon as possible, if necessary, provided by the Software House, starting the second half of 2003;

(*c*) Every country should formulate their own national migration plan, derived from the international plan, with analysis of impacts, costs, solutions, sources of funding (if necessary), national training, technical planning and schedule.

Code migration schedule

3.9.1 Even if the majority of the GTS Centres could support binary data early on, it would still take a long time for many NMHSs to introduce automated observing systems with the software to encode data in BUFR at the source sites, as well as implement their national telecommunication network capable of handling binary data. Based on a survey of code usage and considering constraints and factors linked to each type of TAC, the TACs have been grouped into six categories that share common characteristics that would allow migration to proceed in parallel. Considering established traditions and various factors (internal or external to the WWW) affecting each of these categories, three target dates have been set. They are the start of experimental exchange, the start of operational exchange and the end of operational exchange (see the table).

IV. RECOMMENDATIONS FOR COORDINATION AND REVIEW MECHANISMS

4.1 To ensure minimum impact to Members from the migration to TDCF, an effective mechanism must be put in place to provide implementation monitoring and coordination. It is critical to the process that information on the timing of changes, the availability of data and the identification of both requirements and problems be made available to Members' managers and decision makers as well as to appropriate groups within WMO and other relevant organizations.

4.2 Members should provide national focal points for migration issues, preferably the National Focal Point for Code Matters. The national focal point should have direct knowledge of national migration implementation plans. The national focal point would provide coordination with the regional association and other relevant WMO groups, as needed, regarding national plans for migration, impacts of migration on national operations and status of implementation. The national focal point would define requirements to the Expert Team on Data Representation and Codes for code changes. They would provide notification of planned implementation dates. The national focal point would also provide a channel to make Members aware of activities and critical information from other Members or organizations, such as implementation dates or changes in availability data planned by other Members.

4.3 The regional associations will need to play an active role in the coordination of the migration in their Regions, including the identification of the most effective mechanisms for management and monitoring.

4.4 Central planning and coordination of the migration will be performed by the OPAG on Information Systems and Services and its teams. There should be a mechanism for collecting, recording and reporting implementation dates, changes in data availability and any other migration issues which have an extranational impact including information on past and future changes. Technical guidance should be developed in the form of a WMO code migration guide.

Code migration schedule

	Category					
	Category 1: common	*Category 2: satellite observations*	*Category 3: aviation* (1)	*Category 4: maritime*	*Category 5*(2)*: miscellaneous*	*Category 6*(2)*: almost obsolete*
Lists of traditional code forms	SYNOP SYNOP MOBIL PILOT PILOT MOBIL TEMP TEMP MOBIL TEMP DROP CLIMAT CLIMAT TEMP	SAREP SATEM SARAD SATOB	METAR SPECI TAF CODAR AMDAR WINTEM ARFOR ROFOR	BUOY TRACKOB BATHY TESAC WAVEOB SHIP CLIMAT SHIP PILOT SHIP TEMP SHIP CLIMAT TEMP SHIP	RADOB RADREP IAC IAC FLEET GRID (to GRIB) MAFOR HYDRA HYFOR RADOF	ICEAN GRAF NACLI etc. SFAZI SFLOC SFAZU ROCOB ROCOB SHIP

	Schedule					
Start experimental exchange(3)	November 2002 for some data (AWS SYNOP, TEMP USA)	Current at some centres	2007 2002 at some centres for AMDAR	2005 2003 for Argos data (BUOY, sub-surface floats, XBT/XCTD)	2004	Not applicable
Start operational exchange(3)	November 2005	Current at some centres	2008 2003 for AMDAR	2007 2003 for Argos data (BUOY, sub-surface floats, XBT/XCTD)	2006	Not applicable
Migration complete	November 2010	November 2006	2015 2005 for AMDAR	2012 2008 for Argos data (BUOY, sub-surface floats, XBT/XCTD)	2008	Not applicable

NOTES:

(1) METAR, SPECI, TAF and ROFOR codes require ICAO coordination and approval. Experimental exchange may start in 2007 in line with amendment 74 to ICAO Annex 3/WMO Technical Regulations.

(2) Category 5 codes will need to be reviewed to determine if there is a final requirement to be migrated to BUFR/CREX. If not, they will be moved to category 6. Codes in category 6 are not to be migrated.

(3) All dates above are meant as “not later than”. However, Members and organizations are encouraged to start experimental exchange, and, if all relevant conditions (see below) are satisfied, to start operational exchange as soon as possible:

(*a*) Start of experimental exchange: data will be made available in BUFR (CREX if needed) but not operationally, i.e. in addition to the current alphanumeric codes, which are still operational;

(*b*) Start of operational exchange: data will be made available in BUFR (CREX if needed) whereby some (but not all) Members rely on them operationally. Some distribution of the current alphanumeric codes will still be done;

(*c*) Migration complete: at this date the BUFR (CREX if needed) exchange becomes the standard WMO practice. Distribution of the current alphanumeric codes is terminated. For archiving purposes and where BUFR or CREX exchange still causes problems, the alphanumeric codes may be used on a local or national.

Relevant conditions to be satisfied before experimental exchange may start:

(*a*) Corresponding BUFR/CREX tables and templates are available;

(*b*) Training of exchanging parties has been completed;

(*c*) Required software of exchanging parties (encoding, decoding, viewing) is implemented.

Relevant conditions to be satisfied before operational exchange may start:

(*a*) Corresponding BUFR/CREX tables and templates are fully validated;

(*b*) Training of all concerned parties has been completed;

(*c*) ll required, software (encoding, decoding, viewing) is operational.

ANNEX IV

Annex to paragraph 6.2.85 of the general summary

FUNCTIONS AND RESPONSIBILITIES OF FUNCTIONAL CENTRES IN THE FUTURE WMO INFORMATION SYSTEM CONCEPT

National Centres (NCs)

1. FWIS NCs would serve data and product needs of their country. Most NCs would be part of an NMHS. However, there might be others within the same country having national responsibility for functions falling within WMO Programmes but located outside of the NMHS. The participation of the centres would be coordinated through the national Permanent Representative to WMO. NCs would:

(*a*) Collect observational data from within their country;

(*b*) Provide observations and products intended for global dissemination to their responsible GISC;

(*c*) Provide observations and products intended for regional distribution to the responsible DCPC;

(*d*) Collect, generate and disseminate products for national use;

(*e*) Participate in monitoring the performance of the system.

Data Collection or Product Centres (DCPCs)

2. Several dozen centres would serve as DCPCs. An existing RSMC would fulfil the function of a DCPC but many additional centres would also serve as DCPCs. This would include suppliers of special observations (e.g. ARGOS, ARINC, field experiments) and centres producing products related to a specific discipline (e.g. ECMWF, NESDIS). As appropriate, DCPCs would:

(*a*) Collect information intended for dissemination to NCs within its area of responsibility (i.e. regional collections);

(*b*) Collect special programme-related data and products;

(*c*) Produce regional or specialized data and products;

(*d*) Provide information intended for global exchange to their responsible GISC;

(*e*) Disseminate information not intended for global exchange;

(*f*) Support access to their products via WMO request/reply (“pull”) mechanisms in an appropriate manner;

(*g*) Describe their products according to an agreed WMO standard and provide access to this catalogue of products or provide this information to another centre with this responsibility (e.g. a GISC);

(*h*) Ensure that they have procedures and arrangements in place to provide swift recovery or backup of their essential services in the event of an outage (due to, for example, fire or a natural disaster);

(*i*) Participate in monitoring the performance of the system.

Global Information System Centres (GISCs)

3. Several (perhaps four to 10) centres would serve as GISCs. Each GISC would have a defined area of responsibility. GISCs would usually be located within or closely associated with a centre running a global data assimilation system or having some other global commitment, such as a WMC. However, the proposed architecture does not dictate that this be a requirement. The responsibilities of a GISC can be summarized as follows. Each GISC would:

(*a*) Receive observational data and products that are intended for global exchange from NCs and DCPCs within their area of responsibility, reformat, as necessary, and aggregate into products that cover their responsible area;

(*b*) Exchange information intended for global dissemination with other GISCs;

(*c*) Disseminate, within its area of responsibility, the entire set of data and products agreed by WMO for routine global exchange (this dissemination can be via any combination of the Internet, satellite, multicasting, etc. as appropriate to meet the needs of Members that require its products);

(*d*) Hold the entire set of data and products agreed by WMO for routine global exchange and make it available via WMO request/reply (“pull”) mechanisms;

(*e*) Describe its products according to an agreed WMO standard and provide access to this catalogue of products;

(*f*) Provide around-the-clock connectivity to the public and private networks at a bandwidth that is sufficient to meet its global and regional responsibilities;

(*g*) Ensure that they have procedures and arrangements in place to provide swift recovery or backup of their essential services in the event of an outage (due to, for example, fire or a natural disaster);

(*h*) Participate in monitoring the performance of the system, including monitoring the collection and distribution of data and products intended for global exchange.

4. The flow of information between these centres is illustrated in Figures 1 and 2. Figure 1 outlines the collection of observations and products. It is not considered necessary to standardize the physical links to be used between all of the suppliers and collectors. These could instead be decided by bilateral agreement to best match the requirements and capabilities of the parties involved. However, Members would be encouraged to use standard protocols recommended by WMO.

5. Figure 2 illustrates the dissemination of products (both routine and non-routine). Routine (i.e. scheduled) dissemination of observed data and products would be accomplished through an automatic broadcast or “push” system that could be implemented via a variety of technologies, including the existing GTS. Ad hoc

(non-scheduled) and special requests for data and products would be satisfied by a request/reply ("pull") system. The "push" and "pull" systems, operating in parallel, should be available to all users of WMO data and products.

6. NMHSs span a range of responsibilities and capabilities. FWIS services of less developed NMHSs with less demanding requirements, could be successfully implemented with PCs and dial-up Internet connections, provided they receive basic products via satellite broadcast (e.g. EMWIN, MDD, RETIM 2000, etc.). As resources and requirements increase, NMHSs could be equipped with increased capabilities as illustrated in Figure 3.

7. Increased capabilities at an affordable cost could be provided using one or more PCs, a permanent connection to the Internet and, possibly, satellite communications for assured and timely receipt of WMO products. Centres with these facilities would have the capabilities to function as an NC or small DCPC.

8. Further capacity could be provided by PCs, workstations or servers, a broadband Internet connection, and connection to the WMO communication system (GTS with a dedicated message switch, UNIDART, and/or Internet data distribution). A centre with this infrastructure could serve as a fully functional NC or DCPC.

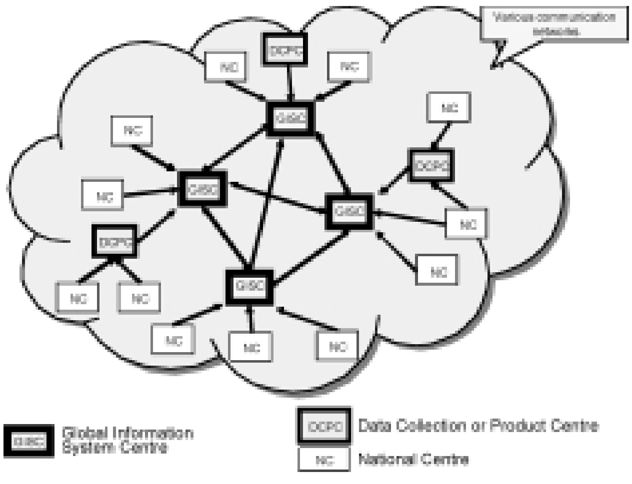


Figure 1 — Information collection data flow
(Arrows indicate data flows; no physical links are implied)

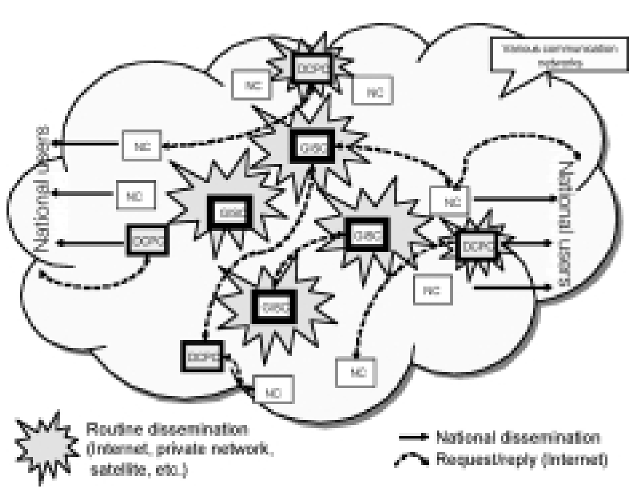


Figure 2 — Information distribution
(Arrows indicate data flows; no physical links are implied)

9. A full capacity centre would be equipped with a large computer system (mainframe, multiple interconnected servers, workstations and PCs), a very broadband Internet connection, and a high-speed connection (or multiple connections) to the WMO communication system. A fully equipped centre with these capabilities could provide the services of a sophisticated NC, DCPC, GISC or any combination of these three centres.

10. For the near future, transmission of the current suite of global products will continue to be distributed to WMO Centres via the existing GTS infrastructure. However, implementation of request/reply systems and exchange of high volume datasets cannot be easily supported by the existing GTS. Realization of the FWIS vision would require that the existing GTS dedicated communication links and message switches be augmented by additional communication capabilities such as those provided by the Internet.

11. The current GTS can be extremely costly to several WMO Members (in particular developing countries) and can inhibit participation in WMO data exchange, due to high costs associated with dedicated connections. The Internet is likely to become eventually the default communication carrier for WMO FWIS data exchange; dedicated circuits and networks would be used when the data exchange requirements of WMO Programmes (e.g., secure, permanent and reliable real-time) could not be

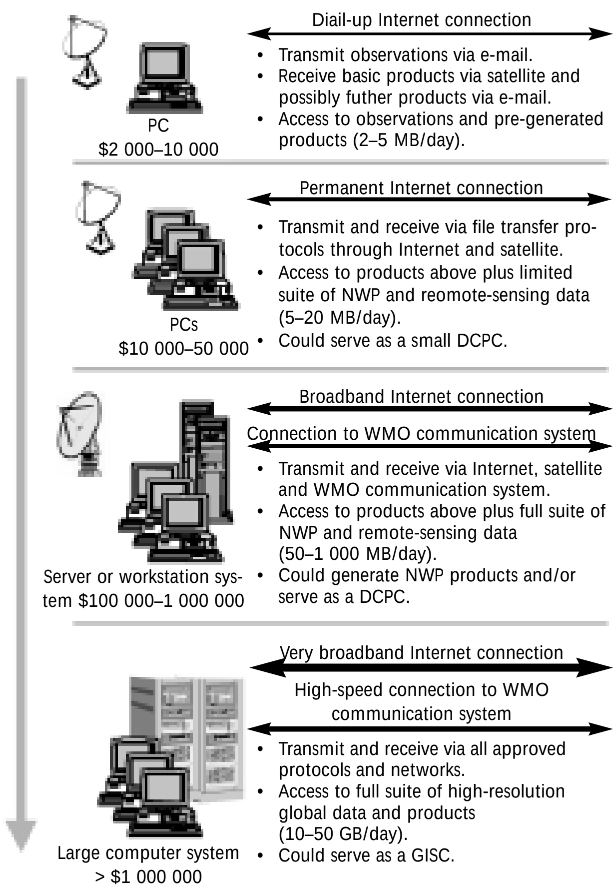


Figure 3 — Capabilities of centres in response to increasing requirements
(The approximate value of computer hardware and software performing FWIS functions is provided for each level in US dollars)

met. The current capabilities of the Internet raised concerns for Members' requirements for:

(*a*) Reliable and continuous connectivity;

(*b*) Sufficient bandwidth to handle peak-period data transmission;

(*c*) Responsive delivery of time-critical information at all times;

(*d*) A secure networking environment.

These concerns would be addressed through long-term testing of Internet capabilities and advanced methodologies (e.g. IPv6, VPN, QoS) that were likely to provide a secure network environment and predictable performance.

12. Alternative communication pathways and software to facilitate data exchange can lower costs, can simplify operational management of basic data exchange between Members and can provide flexible and scalable solutions to meet changing data exchange requirements. Alternative methodologies to communicate messages include the automatic file distribution system developed by the *DWD* and the Internet data distribution developed by the UNIDATA Program Center. While these systems take different approaches to the transmission of data products, they both have a proven history of operation and offer cost-effective alternatives to message switches. Additionally, these methodologies can coexist on dedicated or public communication pathways to provide maximum flexibility for data exchange in a store and forward (push) environment.

ANNEX V

Annex to paragraph 6.3.25 of the general summary

LIST OF RECOMMENDED LONG-RANGE FORECAST PRODUCTS TO BE MADE AVAILABLE BY GLOBAL-SCALE PRODUCING CENTRES

Requirements that have attracted a significant consensus by both the Intercommission Task Team on RCCs and the CBS Infrastructure Team on Long-range Forecasts are shown in bold.

1. Forecast products

NOTE: It is recognized that some centres may provide subsets of the product list, according to their long-range forecast capacity.

Basic properties

Temporal resolution: Monthly and seasonal (three-month) averages/accumulations/incidences.

Spatial resolution: 2.5° × 2.5° (NOTE: selected to match resolution of current verification data).

Spatial coverage: Global (separate areas of interest to users, down to subregions of a continent or ocean basin, may be provided on special request from Members).

Lead time: 0–six months for monthly forecasts and 0-four months for seasonal forecasts. This reflects the six-month requirement regarding products to be issued to end-user. Some end-user requirements extend to 15 months. Note the end-user requirement of three months minimum for warnings of high amplitude and abnormal events, such as increase in tropical storm frequency or change in phase of ENSO. (Forecast range determines how far into the future long-range forecasts are provided. Forecast range is thus the summation of lead time and forecast period.)

Note on definition of lead time: for example, a monthly forecast issued on 31 December has a lead time of 0 months for a January forecast, and a lead time of one month for February forecast, etc.; a three-monthly forecast issued on 31 December has a lead time of 0 months for a January-to-March forecast, and a lead time of one month for February-to-April forecast, etc.

Issue frequency: Monthly

Output types: Gridded numerical values, area-averaged values and indices, and/or images.

Indications of skill must be provided (see "skill and confidence levels" in section 2), in accordance with recommendations from CBS on the standardized verification system.

Content of basic forecast output: (some products are intended as directly meeting NMS requirements with regard to information needed for end-user applications (direct or further processed); others are to assist the contributing global centres in product comparison and in the development of multimodel ensembles. These products are regarded as feasible from current systems).

A. Calibrated outputs from ensemble prediction system showing the mean and spread of the distribution for:
   - (i) Two-metre temperature over land;
   - (ii) Sea-surface temperature;
   - (iii) Precipitation;
   - (iv) Z500, MSLP, T850;
   - (v) Sea-surface temperature area averages for the principal *El Niño* areas (Niño3, Niño3.4, Niño4), including ensemble plumes of monthly values;
   - (vi) Surface pressure field indices including the Southern Oscillation Index (e.g. inferred Tahiti-Darwin pressure difference) and the North Atlantic Oscillation (Iceland-Azores difference), including ensemble plumes of monthly values.

NOTES:

1. These fields are to be expressed as departures from normal model climate.

2. SST used as boundary conditions for (two-tiered) atmospheric general circulation model predictions should be made available.

B. Calibrated probability information for forecast categories. Tercile categories should be provided, consistent with present capabilities. Information for larger numbers of categories (e.g. deciles) is foreseen, however, as capabilities increase in order to match better the anticipated end-user requirements. These targets are implied also for forecasts from statistical/empirical models.

NOTE: information on category boundaries should be included.

(i) Two-metre temperature over land;
(ii) SST;
(iii) Precipitation;
(iv) Z500, MSLP, T850.

(NOTE: "Calibrated" implies correction based on past performance for systematic errors in anomaly predictions, using at least 15 years of retrospective forecasts.)

The Expert Team noted the following issues regarding uniformity of products to be addressed in the implementation of the experimental accessibility:

(*a*) Use of a common grid;
(*b*) Reference climatology;
(*c*) Resolution of the probability distribution;
(*d*) Definition of period for terciles;
(*e*) Category boundaries for terciles;
(*f*) Indication of uncertainty (is spread sufficient?);
(*g*) Timing of issue of forecasts.

Other requirements, as adapted from the Intercommission Task Team on RCCs

Some requirements are not as well established or may not be achievable at present. The predictability associated with some products is not yet established.

(*a*) As in A and B for sunshine, solar radiation and cloudiness;
(*b*) As in A and B for 850 hPa wind, Z200;
(*c*) SST area averages for the tropical Atlantic and specified sectors of the North Atlantic and Indian Oceans;
(*d*) Ensemble related predictions of the equatorial zonal wind average at heights of 30 and 50 hPa, as an indicator of the quasi-biennial oscillation;
(*e*) Likely seasonal tropical cyclone activity (may be inferred from proxy mean fields);
(*f*) Likelihood of within-season activity of wet (including heavy rain) and dry spells, hot and cold (including frost) spells, to provide indications of whether the frequencies and severity will be above normal (NOTE: these may be inferred from mean fields);
(*g*) Ensemble output related to heating/cooling and growing degree-days using regionally-supplied thresholds (NOTE: these may be inferred from proxy mean fields) (details will depend on regionally-supplied requirements, such as thresholds and averaging periods);
(*h*) Ensemble output to indicate onset and duration of rainy and monsoon seasons;
(*i*) Non-ensemble outputs of all the above variables/events where models are not operated in ensemble mode (e.g. statistical models);
(*j*) Threshold value for the category boundary, e.g. "above/near/below normal";
(*k*) Related input from centres without global LRF capability.

NOTE: For some of these quantities (e.g. monsoon onset), provision of daily model fields for all ensemble members for selected areas may be necessary.

2. Skill and confidence levels

(*a*) Skill information must accompany each product, with corresponding spatial and temporal detail, to indicate predictability levels (e.g. a gridded map product should have skill information for the same grid, averaging period and lead time). The skill measures should follow the recommendations of CBS on the standardized verification system (e.g. ROC values), should be based on at least 15 years of retrospective forecasts, and should also include a widely-understandable form (such as per cent correct) suitable for direct communication to end-users if required;
(*b*) An indication (text statement and/or quantitative indicator) of the confidence in each forecast, for example based on model ensemble characteristics, uncertainties in initial conditions, model uncertainties, and degree of consensus and intrinsic lack of predictability;
(*c*) An alert, to accompany forecasts, of significant changes in models or practices used to generate the forecasts. Examples are changes to analysis schemes for surface wind stress and sea-surface temperature changes in assimilation techniques and model resolution;
(*d*) Regions where probabilities are close to climatology level reflect either a lack of predictability demonstrated for the region, or no clear forcing on the climate for the particular forecast period, even though predictability on the average has been demonstrated for the region. It may be useful to distinguish between the two in map format;
(*e*) Verification to discriminate between seasons and lead times.

Verification of issued forecasts

(*a*) With each statistical and dynamical model output (single forecast and ensembles), and each consensus forecast, a time series of verification data describing the model and consensus performance. Such data to include outputs from the WMO standardized verification system for long-range forecasts including ROC catering for flexible event definitions;
(*b*) Verification-based skill masks to be applied to forecasts for areas where there is little skill, to be developed using criteria agreed with users.

Documentation

(*a*) Description of statistical and dynamical models including scope and limitations;
(*b*) Description of forecast and hindcast processes;
(*c*) Description of consensus procedures;
(*d*) Description of calibration and validation procedures with provision of forecast systematic error fields;
(*e*) Notifications of intention to upgrade or change models and procedures.

ANNEX VI

Annex to paragraph 6.3.49 of the general summary

CBS TECHNICAL CONFERENCE ON DATA-PROCESSING AND FORECASTING SYSTEMS (CAIRNS, 2–3 DECEMBER 2002)

1. During its four sessions, the conference covered two main topics: EPS and severe weather forecasting. The conference documented advances in EPS and their increasing range of applications over time-scales covering short-, medium- and long-range forecasts. EPS products clearly have the potential to benefit forecasting services in all areas, and in particular for high impact weather, e.g. forecasting of tropical cyclone movement, heavy precipitation and seasonal to inter-annual predictions. There is also a potential for applications in environmental prediction, hydrological modelling and environmental emergency response, by providing probabilistic forecasts of specific environmental variables dependent on atmospheric drivers. In addition, the conference also considered user requirements and approaches for severe weather forecasting, including the need for nowcasting systems and techniques. Nowcasting products are especially valuable in the case of fine-scale, hazardous weather phenomena associated with severe convection and intense cyclones (tornadoes, hail, downbursts, hailstorms).

2. A traditional numerical weather forecast provides a single best-estimate prediction of the future weather. However, uncertainties in initial conditions and in the formulation of the weather prediction models generate errors that may grow non linearly in time, thus reducing the accuracy and usefulness of forecasts. A deterministic high resolution forecast provides a unique solution to the future evolution of the atmosphere and hence gives no indication of the sensitivity to these uncertainties — how likely is a given forecast to be correct? To take into account the stochastic nature of the forecast problem and to provide forecast guidance that allows an objective quantification of the uncertainty in forecasts, EPS have been introduced to complement the high resolution deterministic forecasts. Individual forecasts within an ensemble progressively diverge from one another during the forecast period, in a similar way as forecasts from different centres have been known to differ from each other, thereby making up another type of multi-models ensemble, the so-called “poor-man’s ensemble”. The rationale for the ensemble approach is based on sampling the uncertainties in numerical weather predictions, coming from sources such as specification of the initial state of the atmosphere (analysis) and numerical forecast model uncertainties. The ensemble approach aims to provide indications on the “dispersion” of NWP models solutions of possible future states of the atmosphere as time evolves and, hence on the atmospheric predictability in these conditions. Ensemble forecasting therefore provides information on the range of possible future weather states consistent with our knowledge of the current state: the larger and the faster the ensemble members’ solutions differ from each other, the more uncertainty is associated to forecasts. From the distribution of ensemble members, information on practical probabilities of particular forecast events can be derived. This can be done simply by considering the proportion of ensemble members that predicts these events, or some high level statistical interpretation techniques can be applied to arrive at these probabilistic forecasts. Whereas a single high resolution deterministic forecast may indicate a predicted occurrence of a high impact weather event, it provides the user with no information on the confidence one can put in such a forecast. With an ensemble prediction system, such a “confidence” index may be obtained. Not only high probability events have a value, but those involved in risk assessment can make judicious use of low probabilities of high impact events which may have very large economical and societal impacts.

3. Ensemble prediction has become an established part of operational global weather prediction at many operational centres. Ensemble prediction systems have been used for a wide variety of applications such as providing measures of predictability and alternative developments; local probabilistic forecasts of weather elements; economic value of forecasts, etc. More recently there has been increasing interest in applying EPS to high impact weather. EPS can provide, for example, information on possible tropical cyclone tracks and on the strike probability associated with them. The combined use of guidance from the EPS and the high-resolution deterministic forecasting system is particularly beneficial for high impact weather prediction. Whereas the high resolution deterministic system can usually provide indications on the intensity and severity of specific events, the EPS provides information on the

probability of these events occurring and allows an objective risk assessment with respect to user applications.

4. High impact weather events receive more and more attention due to the damages they cause to life and property and their induced costs. So the principal aim of NMSs is to make use of the available scientific and technical means to produce and issue accurate forecasts and be able to provide Civil Protection Services and the public with efficient warnings and advice. Forecasters need means to recognize early the meteorological situations leading to dangerous phenomena. A cascading approach is well suited for providing information on high impact weather. Some preliminary EPS-based guidance should be given for the medium range by Centres able to operate EPS and provide probabilistic information. Then the Centres running their own NWP model or having access to comprehensive model output should provide greater details at shorter ranges and indicate potential risks. Finally, as soon as the phenomenon has been actually detected, National Centres have to track it carefully by using the available nowcasting systems in order to predict its evolution and to issue regularly updated information. The implementation of this cascading process involving the responsibilities of several Meteorological Centres belonging to a given geographical area, according to their resources and capabilities, implies a close co-operation between them.

5. For the case of high impact weather events, it is possible to forecast the probability for a given meteorological parameter to exceed a specified threshold (intensity of the wind gusts, cumulative precipitation during a given time frame). In order to produce such ensemble forecasts, lower resolution models are used, making it more difficult to represent severe weather events of finer horizontal scale. In some cases, conditions conducive to severe convective events (such as thunderstorms and phenomena associated with them) can be anticipated with some accuracy with the development of mesoscale models. For the moment, their operational use is hampered by the computing cost. Furthermore, there are some serious science issues yet to be resolved with respect to assimilating mesoscale data in high resolution systems, the lack of data for properly initializing the dynamic, humidity and surface fields, and how best to model the physics and to generate perturbations. To detect the outbreak of fine-scale severe weather events such as tornadoes, and to anticipate their development, it is important to stress the importance of mesoscale prediction systems and nowcasting techniques. The mesoscale model can be used to assess the potential for severe weather. Thus methods are being developed that combine extrapolation techniques of observed meteorological fields with NWP, through improved blending of the two products and through improved assimilation of detailed mesoscale observations. Significant research is still required to improve forecasts (location and timing) of fine-scale severe weather such as severe thunderstorms, tornadoes, hailstorms, downbursts.

6. The Conference agreed that ensemble forecasting is becoming increasingly important and will evolve as a future vital tool for weather forecasting on all time scales from short range to seasonal range and beyond (ensembles are also valuable in assessing the uncertainty in climate change predictions). The Conference noted that a few Centres are making available EPS products, including medium-range products, and welcomed these initiatives. The Conference also noted the strong interest in EPS products and the high priority given in expressions of user requirements, particularly for medium-range products. The Conference encouraged other Centres producing EPS products to consider making these available also. The Conference noted, however, that EPS products are still unfamiliar to many users and training in the interpretation of products is required for forecasters and other users of the products in order for them to be used profitably in forecasting services. It is important to stress here the key-role of well-trained forecasters in order to interpret the vast range of products coming from various sources. The forecasters have to be familiar with probabilistic forecasting and know well how to use it, to be able to deliver reliable information toward the end users. It is also important that suitable verification statistics are made available so that users are aware of the applicability of the products.

7. The Conference recommended that:

(*a*) Centres running EPS systems be encouraged to make products available for use in other NMHSs;

(*b*) Centres running EPS systems be encouraged to undertake routine verification of the products, participate in intercomparison studies and make the performance statistics available to NMHSs;

(*c*) Training opportunities be organized by WMO for forecasters on a regional basis and nationally for end users. The training should include information on EPS approach and on the interpretation of the products. The documentation and training material should be made available (e.g. by publicising links to documentation on the web sites of producing centres);

(*d*) Centres involved in EPS be encouraged to work with NMCs to explore ways to implement EPS for short-range mesoscale forecasting models, to evaluate its skill and feasibility;

(*e*) Centres continue to expand the range of diagnostics and fields available from their NWP systems to assist Members in their provision of severe weather forecasting services;

(*f*) Nowcasting and forecast systems techniques continue to be developed and implemented in support of severe weather forecasting in the short range. There is a need to promote cooperation and training in this area.

ANNEX VII

Annex to paragraph 7.2.2 of the general summary

GDPS AND ERA CONTRIBUTION TO THE NEW NATURAL DISASTER PREVENTION AND MITIGATION PROGRAMME

The GDPS and ERA, in support of the Natural Disaster Prevention and Mitigation Programme, will focus on:

(*a*) Enhancing the application of GDPS products of all forecast time scales for warnings and advisories of hydrometeorological disasters, and linkages with disaster management agencies to assure effective delivery of services;

(*b*) Building GDPS capability to detect, simulate and forecast atmospheric features that lead to severe weather and extreme, or anomalous events including development and implementation of suitable tools for diagnostics of NWP results;

(*c*) Provision of advance NWP guidance on up to medium-range forecast of severe tropical phenomena, including cyclone strike probability, for improved and coordinated warning services;

(*d*) The further development and capacity building of facilities and human resources of NMCs in transport modelling and provision and the exchange of observational data and specialized products to respond effectively to nuclear emergencies, volcanic ash/gas eruptions and haze smoke from wildland fires. This will include the enhancement of local capabilities to respond to chemical and biological agents, air-borne diseases and other pollution incidents;

(*e*) Developing techniques further for using NWP output as input to application models to forecast extreme hydrological events, in particular floods;

(*f*) Promoting capacity in using the Internet to disseminate products and warnings regarding the safety of life and the protection of property.

ANNEX VIII

Annex to paragraph 8.2 of the general summary

TASKS FOR OPAG TEAMS AND RAPPORTEURS

OPAG ON INTEGRATED OBSERVING SYSTEMS

Specific future tasks (in complement/adjustment of terms of reference of the OPAG teams and rapporteurs):

Expert Team on Observational Data Requirements and Redesign of the GOS

(*a*) Given the massive changes anticipated for the GOS, to develop an implementation and infrastructure plan, with proposed time schedules within WMO to assure full utilization of the evolving GOS, while continuing to evaluate redesign options for CBS consideration and paying particular attention to developing countries and the southern hemisphere;

(*b*) Given the urgent need to study comprehensive strategies for anticipating and evaluating changes to the GOS, to support a focused funded activity for the study of observing system design should be started;

(*c*) Given the importance of system and user characterization, to continue updating the database of user requirements and observing system capabilities and include user reviewed R&D expected performances;

(*d*) Given the success of the rolling requirements review to guide GOS evolution, to continue the rolling requirements review process in application areas already started and expand into new areas relevant to missing disciplines;

(*e*) Given the importance of NWP OSE implications for GOS evolution, to facilitate organization of the next Workshop on Impact of Various Observing Systems on NWP during the first quarter of 2004, while continuing to study hypothetical changes to the GOS with the assistance of NWP centres.

Rapporteurs on Scientific Evaluation of Observing System Experiments (OSEs) and Observing System Simulation Experiments (OSSEs)

In coordination with the Expert Team on Observational Data Requirements and Redesign of the GOS to continue reviews of regional and global OSEs and OSSEs that are being undertaken by various NWP Centres. Take the leading part in the organization of the next Workshop on Impact of Various Observing Systems on NWP during the first quarter of 2004.

Expert Team on Satellite System Utilization and Products

(*a*) Analyse the biennial questionnaire, compile a list of recommended actions based on that analysis and prepare a new Technical Document, including a summary analysis from the Virtual Laboratory for Satellite Data Utilization's Centres of Excellence;

(*b*) Refine the ADM concept and principles for operational and R&D satellites, in close coordination with the CGMS standing Working Group on this issue and with WMO's FWIS activities aimed at harmonizing the services to the maximum extent possible;

(*c*) Refine requirements for comparable data content for near-polar orbiting satellites, in close coordination with CGMS. Compile a list of applications effected by the comparable data content and identify needs for new operational data sets and products, including those from R&D satellites;
(*d*) Represent WMO Member needs to the Virtual Laboratory for Satellite Data Utilization in relevant areas, including:
 (i) Training events aiming at increasing further the number of staff and their skills in full utilization of satellite data, from both operational and R&D satellite data;
 (ii) Help ensure that Members have access to training materials and courses, as well as provide advice on ways to access data, products, and algorithms from both operational and R&D satellites;
 (iii) With the Virtual Laboratory for Satellite Data Utilization focus group, evaluate the success and needs of the Virtual Laboratory components and suggest strategies for improving its performance.
(*e*) Prepare documents to assist Members, summarizing the results from the above activities.

Rapporteur on GCOS Matters

To follow up, in coordination with the Secretariat, the establishment, on a trial basis, of the CBS Lead Centres for GCOS (GSN and GUAN) data and to establish working contact with national Points of Contact.

Expert Team on Requirements for Data from Automatic Weather Stations

(*a*) To provide a consistent definition of radiation;
(*b*) To accomplish the maintenance of accurate metadata for all AWS installations;
(*c*) To include water vapor measurements as a requirement for AWS reporting;
(*d*) To investigate the possibility of reporting both nominal and instrument values in BUFR/CREX;
(*e*) To provide links in documentation so that data users might understand the specific algorithm(s) used in deriving AWS output;
(*f*) To develop improved guidelines on extended quality control procedures for data from AWSs as a standard for publication;
(*g*) To amend the *Manual on the Global Observing System* (WMO-No. 544), introducing the optical extinction profile of the atmosphere as a basic parameter to be reported by principal AWS. WMO regulations should note that both cloud base height and cloud extent could be derived directly from that profile without further measurement, using one-minute time series.

OPAG ON INFORMATION SYSTEMS AND SERVICES

Specific future tasks (in complement/adjustment of the terms of reference of the OPAG teams and rapporteurs):

Data-communication systems, techniques and operation:

(*a*) To develop urgently the detailed complementary procedures related to file naming convention, including for data push and data pull modes;
(*b*) To refine further guidance on virtual private networks via the Internet;
(*c*) To assess a realistic implementation date for 500 Koctets maximum length of meteorological messages;
(*d*) To assess a realistic implementation date for the new file naming convention;
(*e*) To keep GTS operational matters under continuous review, in particular AHL allocations related to the codes migration;
(*f*) To foster and coordinate the further implementation of the IMTN.

Data management:

(*a*) To pursue the development of the WMO metadata standard, involving other Commissions' expertise, and carry out testing;
(*b*) To revise the WMO *Guide on WWW Data Management* (WMO-No. 788) for electronic publication.

Data representation and codes:

(*a*) Maintain all WMO data representation forms, in particular table-driven codes BUFR, CREX and GRIB edition 2;
(*b*) Invite and assist Members to participate in the experimental exchange of data encoded in BUFR, CREX and GRIB edition 2;
(*c*) Define standards for meteorological information using XML, as appropriate;
(*d*) Organize a Workshop on the use of XML in meteorology;
(*e*) Finalize the production of a guide on GRIB edition 2;
(*f*) Define new templates for the transmission of traditional observations in TDCF as required, to facilitate the migration and define corresponding common sequence descriptors;
(*g*) Finalize the reporting practices related to observations encoded in TDCF;
(*h*) Facilitate the development of a suite of computer programs for encoding and decoding the different types of data in BUFR and CREX.

Migration:

(*a*) Monitoring the implementation of the migration plan by:
 (i) Collecting information;
 (ii) Sending questionnaires;
(*b*) Ensuring that training requirements are met;
(*c*) Promoting the implementation of the software house project;
(*d*) Collecting information on national migration plans;
(*e*) Maintaining a record of experimental or operational migration by countries or agencies and by data types;

(*f*) Prepare a workshop for manufacturers;
(*g*) Liaise with regional Working Groups on the WWW on the implementation of migration strategy;
(*h*) Liaise with CAeM and ICAO with respect to a migration plan for aeronautical codes;
(*i*) Promote the development of a free decoder software package running in the Windows environment including the exchange, encoding and decoding of BUFR via the Internet.

WWW monitoring:
(*a*) To organize the trial of the integrated monitoring;
(*b*) To analyse the results of the trial and consolidate the integrated monitoring procedures.

Future WMO Information System:
(*a*) To compile and consolidate WMO Programmes requirements as regards information types and volumes, timeliness, sources and users, security, etc. (through questionnaires and analysis);
(*b*) To refine and consolidate the FWIS concept in close coordination with the other OPAGs;
(*c*) To develop the design and implementation plans, taking into account the experience gained by pilot projects.

OPAG ON DATA-PROCESSING AND FORECASTING SYSTEMS

Specific future tasks (in complement/adjustment of the terms of reference of the OPAG teams and rapporteurs):
(*a*) The Expert Team on the Infrastructure for Long-range Forecasting will continue to develop procedures for the exchange of long-range forecasting products;
(*b*) The Expert Teams to Develop a Verification System on Long-range Forecasts and on EPS still have some tasks to continue in order to develop the verification system for long-range forecasts and implementation of EPS;
(*c*) The task for verification and long-range forecasts should include:
 (i) Coordinate the provision of long-range forecast verification scores and related information to NMHSs and RCCs, real-time monitoring of forecasts and relevant exchange between participating centres and institutes;
 (ii) Encourage and monitor feedback from NMHSs and RCCs on the usefulness of verification information provided by producing centres under the scheme;
 (iii) Review the effectiveness of the verification scheme in assisting NMHSs and RCCs to use the global-scale products to provide end-user services;
 (iv) Contribute to the further development of the activities of Lead Centres' on their Web sites with links to producing centres and the development and provision of relevant software to NMHSs and RCCs as capacity building measures to access information from producing centres to produce user-friendly verification information;
 (v) Recommend updates to operational practices to be followed in terms of the information on validation results to be attached to the long-range forecast products in the light of the experience and progress in research on verification activities;
 (vi) Develop relevant standards for representation and presentation of verification information in maps and contingency tables;
 (vii) In consultation with CAS (CLIVAR/Working Group on Seasonal to Interannual Prediction) and CCl, propose recommendations for improvements to CBS;
(*d*) A small working group should be tasked to develop an outline plan for the development of a workshop on EPS, build on the available documentation and develop components on the interpretation of EPS;
(*e*) The EPS aspects should include:
 (i) Developing education and training material for forecasters including rationale of concepts and strategies of EPS, and on the nature, interpretation and application of EPS products;
 (ii) Reviewing progress on EPS and its application to severe weather forecasting including progress on regional model-based EPS, and preparing ways to make best operational usage of these developments;
 (iii) Enhancing verification of EPS products;
 (iv) Reporting on verification measures for EPS, and skill of available products;
(*f*) There is a need for NMSs to explore the application of atmospheric transport models to air quality, propagation of airborne diseases, other hazards or consequences related to natural disaster, with the cooperation of RSMCs with specialization in emergency response. The expansion of modelling applications beyond emergency response for nuclear incidents should be given consideration in relation to how best to organize them as well as in terms of additional funding requirements (e.g. meetings, training, documentation etc.);
(*g*) Another issue that will need attention in the future is the need to run models on massive parallel processor systems or clusters and modern technology and related transfer of know-how issues. Many Members will need help in developing such an expertise. The benefits will be significant as Members, in keeping pace with new technology, will be in a better position to take action in severe weather or other natural disasters;
(*h*) Nowcasting is a growing activity that will need some attention in the future. Activities such as a review of operational requirements for nowcasting, of technology and products available, will be required to raise awareness among Members, and to help them develop a nowcasting system;
(*i*) Computer-aided learning modules should also be developed;
(*j*) Finally there is an ongoing need for capacity building, such as the development of applications,

training and the interpretation of products, and for developing expertise to run models on workstations/PCs.

OPAG ON PUBLIC WEATHER SERVICES

Revised terms of reference of the OPAG teams and rapporteurs:

Implementation Coordination Team on Public Weather Services

(*a*) Coordinate and keep under review the work of the PWS expert teams;
(*b*) Continue with appropriate arrangements for consultation and collaboration with relevant technical commissions on cross-cutting issues, and with other CBS OPAGs to ensure coordination of services and systems;
(*c*) Promote awareness of the information and guidance material produced by the PWS Programme among NMSs and relevant media and user groups;
(*d*) Monitor and report on the effectiveness of PWS training activities;
(*e*) Monitor and report on the improvements in national PWS programmes as a result of activities under the WMO PWS Programme;
(*f*) Develop the concept of a Web-based reference system on PWS to complement the existing guidance material;
(*g*) Continue to review and report on the results of service assessment activities undertaken by NMSs;
(*h*) Develop material on the economic aspects of PWS;
(*i*) Develop guidelines on weather and climate support for the Olympic Games to be provided by the International Olympic Committee to national organizing committees, and provide guidance to relevant NMSs as required.

Expert Team on Product Development and Service Assessment

(*a*) Make available on the Internet the guidance material on new technologies and research, in the context of PWS, and update it as required;
(*b*) Continue to monitor emerging needs and opportunities for new and improved PWS products and services;
(*c*) Study and report on the possibility of applying increasingly integrated approaches to forecast production and service delivery;
(*d*) Study and report on the need for standardized formats for publicly disseminated forecasts, warnings and information;
(*e*) Explore and advise on methods of incorporating air quality forecasts and bio-meteorology information into PWS delivery;
(*f*) Take steps to share information with appropriate WWW experts on the needs of PWS in the exchange of products and the delivery of services, especially in relation to the FWIS;
(*g*) Develop a set of recommended core service assessment criteria and questions to be used by NMSs in service assessment and promote awareness of the existing guidance material on service assessment among NMSs;
(*h*) Supplement existing WMO guidance on PWS, develop additional documentation on quality management procedures and practices that would allow the overall quality of the outputs and delivery of PWS to be monitored and improved continuously.

Expert Team on Media Issues

(*a*) Promote awareness and use in the media of the sources (SWIC and WWIC Web sites) of authorized and official meteorological information provided by NMSs;
(*b*) Continue to advise and report on the demand by national and local media for information on meteorologically-related disasters;
(*c*) Continue to monitor trends and technology in the media and the consequent implications for the provision of public weather products and services;
(*d*) Promote awareness and provide advice on the importance of communication skills in the effective delivery of PWS by NMSs;
(*e*) Promote awareness of the importance of the impact of high quality, well delivered public weather services on the image and visibility of the NMS;
(*f*) Make available on the Internet the guidance material on media issues, and expand and update it as required, with particular attention to the development of appropriate guidelines on the delivery of weather information by radio;
(*g*) Monitor the growing use of probabilistic forecast techniques, such as EPSs and report on the development of communicating effectively the concepts of uncertainty and confidence in PWS products and services.

Expert Team on Warnings and Forecast Exchange, Understanding and Use

(*a*) Develop further the concept and conduct pilot tests on the improved international availability and access of NMSs' official severe weather information via the Internet (SWIC);
(*b*) Continue to develop the official city forecast Web site (WWIS) and explore its potential both for conveying other information and for developing the Web site in other languages, in addition to English;
(*c*) Promote awareness of, and provide guidance to, Members on the exchange of public weather forecasts on the Internet;
(*d*) Provide guidance to Members on the implementation of cross-border exchange of forecasts and warnings;
(*e*) Make available on the Internet the guidance material on improving public understanding of, and response to, warnings;
(*f*) Develop guidance for Members on the application of risk management principles in the provision of severe weather warnings, and use of this approach in efforts to secure extra funding from innovative sources.

APPENDIX A

LIST OF PERSONS ATTENDING THE SESSION

1. Officers of the session

A.I. Gusev	Acting president
(vacant)	Vice-president

2. Representatives of WMO Members

Member	*Name*	*Capacity*
Argentina	M.A. Rabiolo	Principal delegate
Australia	R. R. Brook	Principal delegate
	K. J. O'Loughlin	Alternate
	M. J. Manton	Delegate
	P. A. Gigliotti	Delegate
	J. T. Davidson	Delegate
	V. K. Tsui	Delegate
	D. Gunasekera	Delegate
	L. M. Farrell	Delegate
	A. Forbes	Delegate
Belgium	E. De Dycker	Principal delegate
Canada	P. Dubreuil	Principal delegate
	A. Simard (Ms)	Alternate
	R. Verret	Delegate
China	Yu Jixin	Principal delegate
	Shen Min	Delegate
	Shi Peiliang	Delegate
	Liang Xin	Delegate
	Wen Kegang	Delegate
	Zheng Yunjie	Delegate
Croatia	K. Pandzic	Principal delegate
Czech Republic	E. Cervená (Ms)	Principal delegate
Denmark	N. J. Pedersen (4–5.XII.2002)	Principal delegate
	F. Jensen (7–12.XII.2002)	Principal delegate
Egypt	A. A. M. Faris	Principal delegate
Fiji	R. Prasad	Principal delegate
	Raj Rishi	Delegate
Finland	M. J. Heikinheimo	Principal delegate
France	F. Duvernet	Principal delegate
	J. Coiffier (part-time)	Delegate
Germany	S. Mildner	Principal delegate
	G.-R. Hoffmann	Delegate
	G. Steinhorst	Delegate
Hong Kong, China	H. K. Lam	Principal delegate
	E. W. L. Ginn	Alternate
Hungary	M. Buránszkyné Salllai (Ms)	Principal delegate
Iceland	G. Hafsteinsson	Principal delegate
	H.-B. Baldursdóttir (Ms)	Delegate
India	R. P. Rao	Principal delegate
Iran, Islamic Republic of	A. M. Noorian	Principal delegate
	M. Jabbari (Ms)	Delegate
	B. Sanaei	Delegate
	A. Sardari	Delegate
Ireland	P. Halton	Principal delegate
Italy	G. Tarantino	Principal delegate
Japan	K. Kashiwagi	Principal delegate
	T. Matsumura	Delegate
	T. Deshimaru	Delegate
Kazakhstan	O. Abramenko (Ms)	Principal delegate
Kenya	J. R. Mukabana	Principal delegate
Macao, China	L. Weng Kun	Principal delegate
Madagascar	A. S. Razafimahazo	Principal delegate
Mexico	M. R. Moshinsky	Prinicipal delegate
Mongolia	P. Gomboluudev	Principal delegate
Netherlands	T. L. Van Stijn	Principal delegate
New Zealand	T. Quayle	Principal delegate
Nigeria	T. Obidike	Principal delegate
Norway	J. Sunde	Principal delegate
	K. Bjorheim	Alternate
Oman	A. H. M. Al Harthy	Principal delegate
Pakistan	N. Shah	Principal delegate
Portugal	M. Almeida	Principal delegate
Repbulic of Korea	S. K. Chung	Principal delegate
	J. S. Chung	Delegate
	S. H. Kim	Delegate
	B. H. Lim	Delegate
Romania	E. Cordoneanu (Ms)	Principal delegate
Russian Federation	V. Dyadyuchenko	Prinicipal delegate
	A. Gusev	Delegate
	V. Khan	Delegate
	L. Bezruk	Delegate

Member	*Name*	*Capacity*
Saudi Arabia	O. M. K. H. Daftardar	Principal delegate
Slovak Republic	I. Zahumenský	Principal delegate
Sweden	S. Nilsson	Principal delegate
Switzerland	J. Ambühl T. Frei	Principal delegate Delegate
Uganda	E. Bazira	Principal delegate
United Kingdom of Great Britain and Northern Ireland	R. Hunt K. Groves A. M. Radford	Principal delegate Alternate Delegate
United Republic of Tanzania	P. F. Tibaijuka	Principal delegate
United States of America	J. Jones J. L. Fenix W. C. Bolhofer J. F. W. Purdom S. Tracton	Principal delegate Delegate Delegate Advisor Advisor
Uzbekistan	I. Zaytseva	Principal delegate
Yugoslavia	V. Barjaktarovic	Principal delegate

3. INVITED EXPERTS

W. Nyakwada	Chairperson, RA I/WG on WWW
R. P. Rao	Chairperson, RA II/WG on WWW
M. A. Rabiolo	Chairperson, RA III/WG on WWW
T. Hart	Chairperson, RA V/WG on WWW
G. Steinhorst	Chairperson, RA VI/WG on WWW

4. REPRESENTATIVES OF OTHER WMO CONSTITUENT BODIES

N. Gordon	President, Commission for Aeronautical Meteorology (CAeM)

5. REPRESENTATIVES OF INTERNATIONAL ORGANIZATIONS

Organization	*Name*
Agency for Air Safety in Africa and Madagascar (ASECNA)	M. Sissako F. L. Fictime
European Centre for Medium-range Weather Forecasts (ECMWF)	H. Böttger
European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)	T. Mohr
International Civil Aviation Organization (ICAO)	O. M. Turpeinen

APPENDIX B

AGENDA

Agenda item		Document No.	PINK No. and person submitting	Resolutions and recommendations adopted
1.	OPENING OF THE SESSION		1, acting president of CBS	
2.	ORGANIZATION OF THE SESSION		2, acting president of RA V	
2.1	Consideration of the report on credentials			
2.2	Adoption of the agenda	2.2(1); 2.2(2)		
2.3	Establishment of committees			
2.4	Other organizational questions			
3.	REPORT BY THE ACTING PRESIDENT OF THE COMMISSION	3(1)	3(1), chairperson, Committee of the Whole	
	Report on innovative collaboration	3(2)	3(2), chairperson, Committee of the Whole	
4.	REVIEW OF DECISIONS OF THE EXECUTIVE COUNCIL RELATED TO THE COMMISSION	4(1); 4(2)	4(1), chairperson, Committee of the Whole	
	Report on total quality management		4(2), chairperson, Committee of the Whole	
5.	STATUS OF WORLD WEATHER WATCH IMPLEMENTATION AND OPERATION	5	5, chairperson, Committee of the Whole	
6.	WORLD WEATHER WATCH PROGRAMME, SUPPORT FUNCTIONS AND PUBLIC WEATHER SERVICES, INCLUDING THE REPORTS OF THE CHAIRPERSONS OF THE OPEN PROGRAMME AREA GROUPS	6(1)	6(1), chairperson, Committee of the Whole	
6.1	Integrated observing systems	6(1)		Rec. 1; 2
	Report of the chairperson of the OPAG on IOS	6.1	6.1, chairperson, Working Committee	
	WMO Satellite Activities	6.1(3)	6.1(3), chairperson, Working Committee	
	Future role of the Scientific Evaluation Group of the Coordination Group on the Composite Observing System for the North Atlantic	6.1(4)	6.1(4), chairperson, Working Committee	
	The role of AMDAR in the WWW	6.1(5)	6.1(5), chairperson, Working Committee	
6.2	Information systems and services	6(1); 6.2(2)	6.2(2), chairperson, Working Committee	Rec. 3; 4
	Report of the chairperson of the OPAG on ISS	6.2(1)		
	Data representation and codes	6.2(3)	6.2(3), chairperson, Working Committee	
	Migration to table-driven codes	6.2(4)	6.2(4), chairperson, Working Committee	
	Assessment of the problems and requirements of NMS Uzbekistan related to the migration to TDCF	6.2(4), ADD. 1		
	Future WMO Information System	6.2(5); 6.2(5), ADD. 1	6.2(5), chairperson, Working Committee	
6.3	Data-processing and forecasting systems	6(1); 6.3; 6.3, ADD. 1	6.3; 6.3, ADD. 1; 6.3, ADD. 2, chairperson, Working Committee	Rec. 5

	Agenda item	*Document No.*	*PINK No. and person submitting*	*Resolutions and recommendations adopted*
	Report of a survey on the use of NWP for improving severe weather forecasts	6.3(2)		
6.4	Public weather services	6(1); 6.4(1)	6.4(1), chairperson, Working Committee	
	Results of the ICT on PWS Meeting	6.4(2); 6.4(2), ADD. 1		
7.	LONG-TERM PLANS			
7.1	Monitoring and evaluation of the Fourth and Fifth WMO Long-term Plans		7.1, chairperson, Committee of the Whole	
	Report on the assessment of progress in the implementation of the 5LTP for the period 2000-2001	7.1		
7.2	Preparation of the Sixth WMO Long-term Plan Development of the 6LTP	7.2 7.2, ADD. 1	7.2; 7.2(1), chairperson, Committee of the Whole	
8.	FUTURE WORK PROGRAMME	8	8, chairperson, Committee of the Whole	
9.	REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND RELEVANT RESOLUTIONS OF THE EXECUTIVE COUNCIL	9	9, chairperson, Working Committee	Res. 1; Rec. 6
10.	OTHER BUSINESS			
10.1	Operational information service	10.1	10.1, chairperson, Working Committee	
10.2	Demonstration of Regional Specialized Meteorological Centre capabilities	10.2(2)	10.2(1), convenor, Ad Hoc Group on Review of Capabilities of RSMC Offenbach	Rec. 7
	Designation of an RSMC	10.2(1)		
11.	DATE AND PLACE OF THE THIRTEENTH SESSION		11, acting president of CBS	
12.	CLOSURE OF THE SESSION		11, acting president of CBS	

APPENDIX C

LIST OF ABBREVIATIONS

ACARS	Automated Communications Addressing and Reporting System
ACMAD	African Centre of Meteorological Applications for Development
ADM	Alternative Dissemination Method
AGM	Annual Global Monitoring
AHL	Abbreviated Header Line
AIRS	Advanced Infrared Sounder
AMDAR	Aircraft Meteorological Data Relay
AMSU	Advanced Microwave Sounding Unit
APT	Automatic Picture Transmission
ARGOS	Data Relay and Platform Location System
ASAP	Automated Shipboard Aerological Programme
ASECNA	Agency for Air Safety in Africa and Madagascar
ATOVS	Advanced TIROS Operational Vertical Sounder
AWS	Automatic Weather Station
CAeM	Commission for Aeronautical Meteorology
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems
CCl	Commission for Climatology
CEOS	Committee on Earth Observation Satellites
CGC	Coordination Group for the Composite Observing System for the North Atlantic
CGMS	Coordination Group for Meteorological Satellites
CIMO	Commission for Instruments and Methods of Observation
CLIVAR	Climate Variability and Predictability
COP	Conference of the Parties
COSNA	Composite Observing System for the North Atlantic
CTBTO	Comprehensive Nuclear Test Ban Treaty Organization
DAB	Digital Audio Broadcasting
DB	Data collection
DBCP	Data Buoy Cooperation Panel
DCPC	Data Collection or Product Centres
DCS	Data Collection System
DPFS	Data-processing and Forecasting Systems
DVB	Digital Video Broadcasting
DWD	*Deutscher Wetterdienst*
ECMWF	European Centre for Medium Range Weather Forecasts
ENSO	El Niño/Southern Oscillation
EPS	Ensemble Prediction System
ERA	Emergency Response Activities
ESA	European Space Agency
ESCAP	Economic and Social Commission for Asia and the Pacific
ET/MI	Expert Team on Media Issues
ET/ODRRGOS	Expert Team on Observational Data Requirements and Redesign of the GOS
ET/PDSA	Expert Team on Product Development and Service Assessment
ET/WFEU	Expert Team on Warnings and Forecast Exchange, Understanding and Use
EUCOS	European Composite Observing System
EUMETNET	European Meteorological Network
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
4DVAR	Four-dimensional Variational Analysis
5LTP	Fifth WMO Long-term Plan
FTP	File Transfer Protocol
FWIS	Future WMO Information System

GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GDIN	Global Disaster Information Network
GDPFS	Global Data-processing and Forecasting System
GDPS	Global Data-processing System
GEO	Geosynchronous Orbit
GISC	Global Information System Centre
GOOS	Global Ocean Observing System
GOS	Global Observing System
GPS	Global Positioning System
GSN	GCOS Surface Network
GTS	Global Telecommunication System
GUAN	GCOS Upper-air Network
HR	High Resolution
HRPT	High Resolution Picture Transmission
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organization
ICT	Implementation/Coordination Team
IGAD	Intergovernmental Authority on Development
IMT	International Mobile Telecommunication
IMTN	Improved Main Telecommunication Network
INMARSAT	International Maritime Satellite System
IOS	Integrated Observing Systems
IPWG	International Precipitation Working Group
IR	Infrared
IRI	International Research Institute for Climate Prediction
ISCS	International Satellite Communication System
ISO	International Organization for Standardization
ISS	Information Systems and Services
ITU-R	ITU Radiocommunication Sector
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM In Situ Observing Platform Support Centre
JSC	Joint Scientific Committee
LEO	Low Earth Orbit
LRIT	Low Rate Information Transmission
MED-HYCOS	Mediterranean Hydrological Cycle Observing System
MODIS	Moderate Resolution Imaging Spectroradiometer
MSG	Meteosat Second Generation
MSS	Message Switching System
MSSS	Multi-satellite Support System
MSU	Microwave Sounding Unit
MTDC	Migration to Table-driven Code Forms
MTN	Main Telecommunication Network
MTSG	Migration to TDCF Steering Group
NAOS	North Atlantic Ocean Stations
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency
NC	National Centre
NCDC	National Climatic Data Centre
NCEP	National Centres for Environmental Predictions
NESDIS	National Environmental Satellite, Data and Information Service
NMC	National Meteorological Centre
NMHS	National Meteorological and Hydrological Service
NMS	National Meteorological or Hydrometeorological Service

NOAA	National Oceanic and Atmospheric Administration
NWP	Numerical Weather Prediction
OIS	Operational Information Service
OPAG	Open Programme Area Group
OSE	Observing System Experiment
OSSE	Observing Systems Simulation Experiment
PUMA	Preparation for the Use of Meteosat Second Generation in Africa
PWS	Public Weather Services
R&D	Research and Development
RBCN	Regional Basic Climatological Network
RBSN	Regional Basic Synoptic Network
RCC	Regional Climate Centre
RMDCN	Regional Meteorological Data Communication Network
RMTC	Regional Meteorological Training Centre
RMTN	Regional Meteorological Telecommunication Network
RO	Radio Occulation
ROC	Relative Operating Characteristics
RSMC	Regional Specialized Meteorological Centre
RTH	Regional Telecommunication Hub
RTT	Radio Teletype
6LTP	Sixth WMO Long-term Plan
SADC	Southern African Development Community
SADC-HYCOS	Southern African Development Community-Hydrological Cycle Observing System
SEG	Scientific Evaluation Group
SMM	Special MTN Monitoring
SOO	Ship-of-opportunity
SST	Sea-surface Temperature
SSUP	Satellite System Utilization and Products
SWIC	Severe Weather Information Centre
TAC	Traditional Alphanumeric Code
TCP	Tropical Cyclone Programme
TCP/IP	Transmission Control Protocol/Internet Protocol
TDCF	Table-driven Code Form
THORPEX	The Hemispheric Observing System Research and Predictability Experiment
UNFCCC	United Nations Framework Convention on Climate Change
VCP	Voluntary Cooperation Programme
VHF	Very High Frequency
VOS	Voluntary Observing Ship
WAFC	World Area Forecast Centre
WAFS	World Area Forecast System
WCRP	World Climate Research Programme
WEFAX	Weather Facsimile
WHYCOS	World Hydrological Cycle Observing System
WMC	World Meteorological Centre
WMO	World Meteorological Organization
WRC	World Radiocommunication Conference
WWIC	World Weather Information Centre
WWIS	World Weather Information Service
WWRP	World Weather Research Programme
WWW	World Weather Watch

XBT	Expendable Bathythermograph
XCDT	Expendable Conductivity Temperature Probe
XML	Extensible Markup Language