GLOBAL CLIMATE OBSERVING SYSTEM

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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

REPORT OF THE EIGHTH SESSION OF THE

GCOS/WCRP ATMOSPHERIC OBSERVATION PANEL FOR CLIMATE (AOPC)

(Wokingham, UK, 20 – 24 May 2002)

October 2002

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REPORT OF AOPC-VIII

1. OPENING OF THE MEETING

The Eighth Session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) began at 09:00 on Monday 20 May 2002 at the Easthampstead Park Conference Centre in Wokingham, UK. Dr Mike Manton, AOPC Chairman, welcomed participants to the meeting (see Annex I for list) and reviewed the proposed agenda, inviting proposals for any changes or additions. The final version is presented as Annex II and the list of relevant documents as Annex III. Dr Hans Teunissen then reviewed the operating procedures and logistics for the meeting on behalf of the GCOS Secretariat.

2. REPORT FROM THE CHAIRMAN

Dr Manton briefly reviewed the achievements of the Panel since the previous meeting, most of which would be elaborated during this meeting. He noted the progress in implementation of the GCOS Surface Network (GSN) and GCOS Upper-Air Network (GUAN) baseline systems which, albeit slower than desired, would clearly benefit from the positive developments at the CBS/GCOS Expert Meeting[1] which had been held during the previous week at the Deutscher Wetterdienst in Offenbach, Germany. He was pleased to note that the GCOS Steering Committee (SC) had recommended to GCOS sponsors that a dedicated project office for GCOS baseline systems be established as soon as possible, and looked forward to the improvements that such an action would bring. He also noted the positive developments that had resulted from cooperation between AOPC and the CBS Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS) which had resulted in the development of a refined Statement of Guidance (SOG) for Seasonal-to-Interannual Forecasts for producers of observational data. This had been presented to the Second Session of the WMO Consultative Meetings on High-Level Policy on Satellite Matters in February 2002, along with a draft set of climate monitoring principles for satellite observations which would be refined during the current AOPC session for eventual formal adoption by GCOS sponsors. Dr Manton also noted the positive outcomes of several other meetings and initiatives, including the Boulder Workshop on Historical Marine Climate Data (Jan/Feb 2002), START/IPCC initiatives on Data Recovery and Analysis, and the meeting at NOAA/OGP in late April to finalize the AOPC Plan. Dr Manton had presented these activities and outcomes to the GCOS SC at its Tenth Session in Farnham, UK, in April 2002. The SC had welcomed them and adopted a number of decisions and action items directly related to AOPC (see Section 4 of Annex IV to this report for list).

Dr Manton then highlighted the priority issues for AOPC in the coming year, most of which would also be discussed at this meeting. These included the development and distribution of identifiable products from the baseline systems; extension of surface and satellite baseline systems; definition of reanalysis requirements and synthetic data needs; development of a work plan for the Sea-Level Pressure Working Group; refinement of large-scale indicators of climate change; data assimilation in coupled systems (in cooperation with WCRP/CLIVAR); development of additional SOGs for climate applications; completion of the AOPC Plan; contributing to the development of the second adequacy report on the global climate observing systems; and possibly organizing, with WCRP, an international conference on atmospheric observations for climate.

[1] CBS/GCOS Expert Meeting on the GSN and GUAN, Offenbach, Germany 15-17 May 2002

3. REPORT FROM THE DIRECTOR

Dr Alan Thomas, Director of the GCOS Secretariat, reviewed the activities of the GCOS programme since the last meeting of the AOPC, highlighting the progress in implementation of the various networks and presenting a broad overview of GCOS interactions with the UN Framework Convention on Climate Change (UNFCCC). He noted the results of a number of meetings that had taken place in the preceding year, in particular the Tenth Session of the GCOS SC and several meetings relating to the UNFCCC. Dr Thomas also noted the change in chairmanship for both the Ocean Observations Panel for Climate (OOPC) and Terrestrial Observation Panel for Climate (TOPC) and looked forward to working with the new chairmen (Dr Ed Harrison and Dr Alan Belward, respectively). With respect to the TOPC, he noted that considerable discussion of the weakness in many of the terrestrial observing systems had taken place at SC-X, and that the possibility of establishing an improved international framework for terrestrial observations had been raised, perhaps along the line of the highly-successful establishment of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) in the ocean domain. Details of Dr Thomas's presentation are given in Annex IV to this report.

Following extensive discussions on the issues raised in the presentations of both Dr Manton and Dr Thomas, the meeting approved the following decisions:

1. **The AOPC recognized the need to strengthen the interactions between GCOS/AOPC and the atmospheric constituents community and requested that the Chairman communicate with the Global Atmosphere Watch (GAW) infrastructure to augment their collaboration in this regard.**

2. **The AOPC recognized the need for improving the definition of the science requirements for climate observations in the terrestrial domain and requested that the Chairman initiate increased collaboration with TOPC to assist in fulfilling this need.**

3. **The AOPC recognized the potential benefits of an improved international framework for terrestrial observations and requested that the Chairman initiate discussions with TOPC to explore the possibilities for establishing such a framework.**

4. **The AOPC concurred with the need expressed by the GCOS SC for increased involvement of the GCOS Science Panels in the Regional Workshop Programme. The Panel agreed on a number of possible topics and presentations which could be included in the workshops which would focus on AOPC and other Panels' issues and which could involve Panel members directly in many cases.**

4. UNFCCC AND THE SECOND ADEQUACY REPORT

Dr Paul Mason, Chairman of the GCOS SC, presented details of the current activity to develop a Second Report on the Adequacy of the Global Climate Observing Systems for submission to the Conference of the Parties (COP) to the UNFCCC (see Annex V for background and schedule). Dr Mason reviewed the strategy to be followed in developing the report, which involved focussing on the capability to monitor the key parameters needed for trend detection rather than on the observing networks *per se*. These key parameters are a large subset of those needed for the broader problems of understanding and describing the climate system and its inherent variability; attribution of climate change; determination of climate forcings and feedbacks resulting from anthropogenic causes; validation of models and prediction of future climates; and determination of the impacts of climate and climate change on human and natural systems.

Dr Mason summarized the key parameters identified to date (see list below) and explained that the analysis for each parameter would assess its main climate application; the baseline GCOS and related observations contributing to measuring the parameter; significant data management issues and analysis products related to each parameter; current capability to observe the parameter; and provide a summary of the issues and priorities associated with the key parameter. The assessment would be carried out by leading scientific experts in the field, including those previously engaged in the work of the Intergovernmental Panel on Climate Change (IPCC), counting on strong input and advice from the GCOS Science Panels. In the latter context, the Panel Chairs were directly involved in the overall process and input was being sought from the Panels at their various sessions, including the present AOPC session. Dr Mason therefore requested that the Panel (a) provide comments on the proposed list of key parameters and (b) carry out initial assessments on several of the parameters in the atmospheric and/or oceanic domain, to be used as preparation for, and input to, the series of meetings planned from July to October.

KEY PARAMETERS FOR TREND DETECTION

ATMOSPHERE:

- **SURFACE**
  - air temperature
  - sea level pressure
  - precipitation
  - radiation budget
  - ?wind
  - ?humidity
- **UPPER AIR**
  - temperature
  - humidity
  - wind
- **AEROSOLS**
  - airborne dust
  - volcanic ash
  - sulfate particles
  - by tropo/strato?
- **OZONE (tropo? strato ?)**
- **TRACE GASES**
  - NO_2
  - HF
  - HCl
  - CH_4
  - BrO, ClO, N_2O (above 100 hPa)
- **RADIATION BUDGET (TOA)**
  - downwelling solar
  - outgoing longwave
  - outgoing shortwave

Oceanographic:

- **SURFACE**
  - sea surface temperature
  - sea surface salinity
  - sea level
  - sea ice
  - ocean currents
  - ocean wave heights
  - ocean colour?
- **SUB-SURFACE**
  - ocean temperature
  - ocean salinity
  - ?biology
  - ?nutrients

Terrestrial:

- **GLACIERS**
  - mass balance
  - length
- **PERMAFROST**
  - borehole temperature
- **HYDROLOGY**
  - snow cover extent, depth
  - streamflow
  - landwater reservoirs
  - groundwater, soil moisture
- **ECOLOGY**
  - Flux net
  - surface vegetative cover
  - albedo (or AOPC)

In response to this request, several small groups of participants were established and tasked to prepare draft assessments of some key parameters, including surface-air temperature, precipitation, upper-air temperature, sea-surface temperature, upper-ocean temperature, ocean surface winds and sea level. In summary:

5. **The AOPC reviewed the draft list of climate parameters proposed as the basis for preparing the Second Adequacy Report to the UNFCCC/SBSTA and provided suggestions to the SC Chairman for a next draft. The Panel also reviewed the parameter summary template, completed the summaries for several sample parameters and agreed on a list of potential authors for completing summaries for the remaining parameters, as initial steps in its participation in the process to develop the report.**

5. AOPC PLAN

Dr Manton reported on the status of finalization of the AOPC Implementation Plan for Atmospheric Observations. A meeting had recently been hosted by the University of Maryland to review the latest draft and prepare the needed updates before submitting the plan to external sources for final review. Panel members were asked to provide comments on specific sections that still needed additional tuning prior to this external review. It was agreed that the external reviewers should include the OOPC and TOPC Chairmen, representatives of WCRP, the WMO (e.g. GAW, CCl, CBS) and the IGBP.

6. **The AOPC expressed its appreciation to the University of Maryland Earth System Science Interdisciplinary Center (ESSIC) and the NOAA Office of Global Programs for supporting the recent meeting (29 April - 2 May 2002) to complete the draft of the AOPC Implementation Plan for Atmospheric Observations (the 'AOPC Plan').**

7. **The AOPC revised and approved the draft AOPC Plan and requested the Chairman to carry out final editing prior to submitting it to external sources for further review.**

6. STATEMENTS OF GUIDANCE

Dr Manton reviewed the ongoing cooperative activities between AOPC and the 'ET-ODRRGOS' (CBS Open Programme Area Group (OPAG) on the Integrated Observing System (IOS) Expert Team on Observational Data Requirements and Redesign of the Global Observing System) in ensuring that the needs of climate applications for observations from the Global Observing Systems (GOS) were adequately taken into account in the process to redesign the GOS. The work of the ET included the so-called Rolling Review of Requirements (RRR) process where observational needs were compared with availability from existing and planned observing system components to identify gaps and overlaps and develop Statements of Guidance (SOGs) which could be used by data providers to guide system development. The ET had developed an initial draft of an SOG on Seasonal-to-Interannual (SIA) Forecasts which had been updated by the AOPC through Dr Manton, with input from WCRP and CCl representatives, and presented to the recent Fourth Session of the ET-ODRRGOS (28 January - 1 February 2002), which Dr Manton had attended. The ET had then requested that the climate representatives identify other climate application areas that could be addressed through the RRR process and participate with the ET in their development.

The Panel discussed the issue of additional application areas for climate and agreed that SOGs on 'Monitoring Climate Variability' and 'Monitoring Climate Change' would be appropriate, with the latter area to include the needs for both climate change detection and climate change

attribution. Sub-groups were tasked to develop initial drafts of such statements, which would be finalized by the Chairman.

8. **The AOPC noted the revised Statement of Guidance (SOG) for Seasonal-to-Interannual Forecasts that had been presented to the CBS OPAG/IOS ET-ODRRGOS on behalf of the climate community, and thanked the Chairman for having led its development. It agreed that additional SOGs should be prepared for the two applications of Monitoring Climate Variability and Monitoring Climate Change, and requested that the Chairman finalize the drafts that had been developed at the meeting for submission to the ET-ODRRGOS. The Panel also agreed that completion of the SOG on Monitoring Climate Change should be delayed until a draft of the Second Adequacy Report had been drafted, in view of the commonality involved in the two exercises. The Panel welcomed the increased cooperation between GCOS/AOPC and CBS in the area of observational requirements for climate applications and looked forward to the continuing strengthening of this important relationship.**

7. GSN AND GUAN

7.1 Outcomes of Offenbach Meeting

Dr Manton reported on the main outcomes of the CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (EMCGG), which had been held in Offenbach, Germany from 15-17 May 2002. The main objectives were to review the World Weather Watch (WWW) and GCOS monitoring activities for GSN and GUAN, to identify problems and potential solutions in providing monitoring results to station operators, and to develop a joint strategy for improving the network performance for submission to the WMO Commission for Basic Systems (CBS). The meeting was extremely useful and provided a number of recommendations (see Annex VI) which would be presented to the CBS at its next meeting in December 2002. Of particular importance were the recommendations to establish CBS Lead Centres for GCOS data and to nominate points-of-contact in each country who could be contacted directly by the Lead Centres to take the actions needed to correct deficiencies.

9. **The AOPC expressed its appreciation to the WMO Commission for Basic Systems and the Deutscher Wetterdienst (DWD) for their support in organizing and hosting the recent CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (EMCGG, Offenbach, Germany, 15-17 May 2002). The Panel welcomed the excellent progress made in assessing the status of, and identifying procedures to improve, the performance of the networks as demonstrated by the positive results from the meeting. The AOPC expressed its full support for those conclusions and recommendations, welcoming in particular the proposal to establish CBS Lead Centres for GCOS Data on a trial basis and the acceptance of the GSN Monitoring Centre (DWD and JMA) and GSN/GUAN Analysis Centre (NCDC) to fulfil those roles.**

7.2 Activities of the AGG and GCOS Secretariat

Dr Teunissen presented an overview of recent activities of the AOPC Advisory Group on GSN and GUAN (AGG) and the GCOS Secretariat relating in particular to the composition of the networks. He noted the significant number of requests for additions or deletions of stations that were routinely received by the GCOS Secretariat. These were being reviewed for appropriateness by the AGG prior to responding to the WMO Member concerned, or further submission to AOPC if deemed necessary. He noted also the ongoing exercise of harmonization of the official GSN and GUAN lists of stations with the new lists of Regional Basic Climatological Networks (RBCNs). The RBCNs were being developed through the WMO

Regional Associations and were to include by definition all GSN and GUAN stations, as designated by the WMO Member concerned. These activities were producing unavoidable modifications to the GSN and GUAN lists, but would clearly lead to more realistic designations of the network composition. As of April 2002, the GSN had 969 stations, of which as many as 300 still had serious problems insofar as providing the required CLIMAT reports. The GUAN was made up of 150 stations, of which 40 to 50 were deficient in reporting of CLIMAT TEMP messages. Dr Teunissen noted that a letter had been sent to all WMO Members in June of 2001, informing them of the routine availability of performance monitoring results from all GSN and GUAN stations and requesting that they take the action needed to address the deficiencies being observed. He also noted the recognition by the GCOS SC of the performance problems in the GSN and GUAN and their recommendation from GCOS SC-X to the GCOS Sponsors that a dedicated project office for GSN and GUAN be established as soon as possible to coordinate resolution of these difficulties on a continuing and dedicated basis.

Dr Teunissen also reported on the welcome support being received from the US National Weather Service in identifying specific problems at individual GUAN and GSN stations and developing project proposals which, when implemented, would restore the stations to full operation. This was an ongoing exercise based on stations identified by the AGG as being of particular geographical importance and for which the necessary funding support would subsequently be sought. He also noted the current efforts within the US under its Climate Change Research Initiative which could lead to the establishment of some of this support.

The AGG met several times as a breakout group during the session and agreed on a number of recommendations concerning the operation and composition of the GSN and GUAN, which were subsequently approved by the Panel as a whole (see Annex VII).

7.3 GSN Monitoring and Performance Results

Dr Bruno Rudolf, on behalf of the GSN Monitoring Centre, summarized the latest GSN performance results as presented in the Monitoring Report for July – December 2001. A distinct improvement had been observed in the percentage of reports received (62%) compared with the previous six-month period (58%) and the first formal monitoring period from January to June 1999 (54%), although the current level of reporting was obviously still disappointing. It was still the case that the reporting from GSN CLIMAT stations was lower than that from the entire CLIMAT network of about 2500 stations (66%, 64% and 60%, respectively). There were still a significant number of errors in coding of messages and some of the station metadata, and it was intended of course that the decisions from the Offenbach Expert Meeting would lead to resolving such problems. One very disturbing trend was a decrease in the reports being received from the Antarctic Region during 2001, from about 70% in January to about 45% in the latter half of the year. There was no obvious explanation for this decrease, and further investigation was clearly required.

7.4 GSN Historical Data

Dr Tom Peterson reported that the historical dataset at the GSN Archive now contained data from a total of 321 (of the 969) GSN stations, representing 32 countries. Data for additional stations were being submitted, albeit at a disappointingly slow rate. Quality control of those data that had been submitted was mixed. It was expected that improvements in the historical database could be achieved through direct contact between the GSN Analysis Centre (NCDC) and the countries concerned in the former's new role as a CBS Lead Centre for GCOS Data.

The meeting noted the great importance of including daily (as well as monthly) data in the GSN archive. Long-term records of daily surface climate are currently available for only a few regions of the world and should be distributed through the archive as soon as they become available. In the case of monthly data, it was noted that differences could be encountered

between the values archived for the same stations at different centres (e.g. WDC-Asheville/NCDC, CRU/East Anglia), for example as a result of differing homogeneity adjustments applied at the centres and/or time-varying changes in the methods of calculating monthly and daily averages. It was agreed that it would be very useful to make direct comparisons of appropriate data held by these centres to determine and document the scale of any such differences.

The meeting further noted that the history of instrumental recording varies not only through time but also from country to country. During the twentieth century, a number of scientific papers have led to recommendations on standards in some countries for the number of observations required per day and the method for calculating monthly averages. Although the objectives were to improve the accuracy of absolute temperatures (measuring the 'true' temperature), the effects of implementing such recommendations were generally to introduce discontinuities in the long-term records. The Panel was of the opinion that rather than specifying a specific method for all countries, it would be preferable that all homogeneity exercises, both national and international, adjust all series to be consistent with practices currently used for the monthly data which are internationally exchanged. This was very important in view of the fact that a number of countries were releasing current data through the CLIMAT network which required adjustments to make them consistent with long, recently-homogenized historic series.

7.5 GUAN Monitoring and Performance Results

Mr David Parker presented a status report from the GUAN Analysis Centre (Hadley Centre, UK) indicating that about 70% of the 150 GUAN stations were submitting the expected CLIMAT TEMP messages on a consistent basis. The most serious problems existed in WMO Regions I (Africa) and III (South America) and it was expected that planned activities discussed at this meeting would help to overcome these difficulties. Mr Parker's detailed report is presented as Annex VIII to this report.

Following detailed discussions of the issues involved in the above presentations relating to the GSN and GUAN, the Panel approved the following decisions:

10. **The AOPC reiterated the need for TEMP observations to 5 hPa from all GUAN stations, while recognizing the benefits to station operators of having clear confirmation of this need from the user communities. It requested that the Chairman continue his liaison with those communities to reconfirm this requirement as an aid to justifying the additional efforts required in meeting it.**

11. **The AOPC, noting the various requests for modifications to the composition of the GSN and GUAN from many of the station operators, requested the Advisory Group on the GSN and GUAN (AGG), through the WMO and GCOS Secretariats and on behalf of the AOPC, to liaise with WMO Members as needed for finalizing and implementing decisions regarding these requests.**

12. **The AOPC endorsed a number of recommendations made by the AGG during the current session as well as during the recent CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (see Annex VII).**

13. **The AOPC requested the AGG to continue its collaboration with the GCOS and WMO Secretariats and the GCOS Monitoring and Analysis Centres to pursue resolution of inconsistencies and other outstanding problems in the GSN and GUAN station lists, including completion of the formal approval process by WMO Members for all stations.**

14. The AOPC noted with appreciation the increase in availability of historical data in the GSN and GUAN Archive and requested that the Archive pursue efforts to remove remaining impediments to this availability, including direct contact with station operators in cooperation with the NCDC in the latter's role as a CBS Lead Centre for GCOS Data.

15. The AOPC requested that the Chairman of the AGG lead action to investigate and resolve the recent serious drop in the reporting of CLIMAT messages from GSN stations in the Antarctic region.

16. The AOPC expressed its appreciation to the US National Weather Service for their current active support in assessing the impediments to regular reporting of observations from a number of GSN and GUAN stations. It requested AGG to review the GSN and GUAN station lists with a view to confirming a priority list of stations which could benefit from this effort, building on the activities recently ongoing in this regard.

17. The AOPC noted with appreciation the CLIMAT TEMP monitoring activity being carried out by the Hadley Centre and welcomed its agreement to be formally designated as a GUAN Monitoring Centre (with ECMWF), in addition to its current role as a GUAN Analysis Centre (with NCDC).

18. The AOPC reviewed the Terms of Reference for the GCOS Monitoring Centres, GCOS Analysis Centres and GCOS Archive and agreed on the final version presented in Annex IX.

19. The AOPC welcomed the progress in submitting historical monthly data from Brazil to the GSN Archive and encouraged the continuation of efforts to provide daily data as well.

20. The AOPC noted with appreciation the major successful effort that had been carried out to digitize historical climate data from a large number of French-speaking West African countries. It noted also, however, that these data had not been made available to the user community, and encouraged the agencies involved to make the data available without restriction as soon as possible.

21. The AOPC recommended that internationally-funded efforts to rescue data stipulate that those data be freely and openly exchanged as a condition of support for their recovery.

22. The AOPC recommended that station operators who had developed corrections for their historical data apply those corrections to the data prior to submitting them to the GCOS Archive, and that both the correction algorithms and the uncorrected data be submitted along with the corrected data. The Panel also recommended that all historical data be adjusted to be consistent with practices currently used for the monthly data which are internationally exchanged.

23. The AOPC expressed its strong appreciation to the GCOS Monitoring and Analysis Centres (DWD, JMA, ECMWF, Hadley Centre, NCDC) and the GCOS Archive (WDC-Asheville) for their dedicated efforts and great progress in monitoring, acquiring and making available GCOS data and products from the GSN and GUAN networks, and encouraged them to continue these efforts.

24. The AOPC encouraged the University of East Anglia Climate Research Unit (CRU) and NCDC to initiate a project to compare the monthly mean temperature values

held at their centres for all GSN stations for which data are available. Comparisons should also be made with the monthly averages of daily data from stations in the GSN Archive, with the objective of determining and documenting the scale of any differences identified.

25. **The AOPC requested that concrete acknowledgement of participation in GSN and GUAN, for example certificates of recognition for display at the site, be prepared and provided to all station operators.**

26. **The AOPC recognized the benefits of developing a broad recognition of 'GCOS/GSN/GUAN Products' in the user community and encouraged all GCOS-related entities to promote such recognition at every opportunity, including suggesting to users that GCOS be acknowledged when acquiring and making use of these data and products.**

8. SST/SEA-ICE ISSUES

8.1 SST/Sea-Ice Working Group

Dr Ed Harrison gave a brief overview of some of the issues that were being addressed by the Sea-Surface Temperature/Sea-Ice Working Group (WG SST-SI), under the leadership of R. Reynolds. The main problem involving SST was that the differences among the products developed by various groups for the same area were of the same order of the signal being sought for climate change detection studies (of order 0.5 to 1 degree K). The tropical regions provided the best results while regions near ice edges and in data-sparse areas provided the most difficulty. A straightforward approach to overcoming most of these difficulties involved simply increasing the number of *in situ* observations being taken, for example through a 50% or more increase in the number of buoys routinely being used on a global basis, and that such an increase would involve a relatively modest overall expenditure on a global basis (of order USD 1 million/year, for example).

8.2 SST and Sea-Ice Data Sets

Mr Chris Folland of the UK Met Office expanded on the issue of SST anomalies and sea-ice extent through a presentation kindly prepared specifically for this AOPC session. Integrated datasets of SST, sea-ice extent and sea-ice concentration are needed for many purposes. This integration ensures that the datasets are mutually consistent, which has not always been true in the past. Such globally-complete datasets are also needed to force models for climate variability and predictability studies and to help create reanalyses of the atmosphere.

Historical SST data coverage is improved considerably using the new International Comprehensive Ocean-Atmosphere Data Set (I-COADS), the product of a blend at the level of individual ship data of the COADS dataset, US Naval data, the Met Office Marine Data Bank, digitization of a substantial portion of the nineteenth century Maury marine collection, digitization of part of the Japanese Kobe collection, data from Norway, Japanese whaling data, and others. SST data from large inland lakes can also be exploited, and additional digitized data are also likely to become available from the Kobe collection. Sea-ice-extent data can be improved using a number of historical sources where the extents around Antarctica in the 1950s and 1960s are of particular interest. However, a major problem is to develop a fully-agreed method of analyzing sea-ice data for their extent and concentration, especially from satellite data. Several recent analyses disagree significantly in both the Arctic and Antarctic.

Improvements in historical SST analyses, together with improvements in other datasets over the oceans that will be possible through I-COADS, should help to better define the behaviour of ENSO and other major climatic phenomena since the 1850s. They should also

allow the IPCC global and hemispheric temperature series to be extended back to near 1850 and improve the quality of much of the SST database, especially before 1950. However, it is highly desirable that global and regional SST analyses be provided with error estimates, and that such analyses take account of temporally- and spatially-varying uncertainties. One way to do this is to use the techniques of optimum interpolation and averaging, adapted for this purpose. A start has been made, including land-surface air temperature in the analyses. It is also desirable to revisit the problem of SST bias corrections and their uncertainties. Existing corrections to SST data prior to 1942 have been substantially validated, but there remain significant uncertainties before 1900, and the new data mix in I-COADS will in any case require reassessment of historical bias corrections. There are also significant uncertainties in modern SST measurements and smaller biases may need correcting here.

It is useful to analyze marine air temperatures at the same time as SST. Night-time marine air temperatures (NMATs) are currently recommended due to the difficulties of identifying large time-varying biases by day that result from the solar heating of ships' decks. NMATs also have biases, however, although improvements have recently been made. Where NMAT and SST anomalies support each other, credibility is added to the SST anomalies. NMATs can also identify problems in SST not easily found by other methods, or can even hint at unexpected physical phenomena. Recent disagreements between NMAT and SST trends in parts of the tropical Southern Hemisphere show either that there are problems with the marine data there or that an unexpected physical phenomenon is occurring.

There are a number of possibilities for more highly resolved (in space and time) analyses of SST in the future, perhaps with higher accuracy. It would be desirable to resolve the diurnal cycle, particularly in the tropics, and increase the spatial resolution of global analyses to better identify features like the Gulf Stream edges, the Antarctic Circumpolar wave, and fronts in the ocean. Toward this end, a combination of infrared and microwave SST data, using geostationary as well as polar orbiting satellites, looks promising. To create the usual bulk SSTs, these data should be integrated with quality *in situ* data from Voluntary Observing Ships (VOSs), surface buoys and possibly Argo float data. Satellite data can also be used, with caution, to provide datasets of "true" sea-surface temperature, useful in some modelling and process studies although not suitable for climate change assessment. An international project has been established to investigate these possibilities (the GODAE High-Resolution SST Pilot Project, GHRSST-PP).

Following discussion of these issues, the Panel approved the following decisions:

27. **The AOPC welcomed the progress of the AOPC/OOPC Working Group on Sea-Surface Temperature and Sea Ice (WG SST-SI) in identifying the sources of some of the differences between SST products, and encouraged further efforts to find ways to reduce the differences between analyses.**

28. **The AOPC encouraged the WG SST-SI to increase its efforts in the evaluation of sea-ice products.**

29. **The AOPC recognized that night-time marine air temperature (NMAT) provides useful validation of SST analyses and encouraged increased effort in the development of NMAT data and analyses.**

30. **The AOPC recognized the crucial importance of the drifting buoy programme for accurate estimation of SST and noted the requirement for a substantial increase in the total number of buoys (~50%) to optimise the system.**

31. **The AOPC noted the success of the recent Workshop on Advances in the Use of Historical Marine Climate Data (Boulder, USA, 29 Jan - 1 Feb 2002) and encouraged the convening of a follow-on workshop, possibly in early 2004.**

32. **The AOPC expressed its appreciation to C. Folland of the UK Met Office for his informative presentation on issues and activities relating to SST, sea-ice and marine air temperatures and noted the conclusions and recommendations presented.**

9. SURFACE PRESSURE WORKING GROUP

Dr Rob Allan, Co-Convenor of the AOPC/OOPC Surface Pressure Working Group (WG-SP), updated the session on the latest activities and plans of the group, including its terms of reference, the membership and some of the actions taken to date. His presentation included a description of the Hadley Centre's historical, gridded, near-global mean-sea-level pressure (MSLP) dataset (HadSLP), which currently extends from 1871 to 1998 on a monthly basis. He described ongoing efforts to improve this dataset and resolve some problems at higher latitudes of the Southern Hemisphere and noted plans to extend the dataset back into the mid-1800s using the new I-COADS data release; to add in new existing observations; and to make it a near-real-time product. He also described efforts to expand and improve the Hadley Centre's MSLP data bank (from which HadSLP versions are created), which aims to contain as many monthly observational MSLP station records for as long as they are available, and he provided examples of the potential improvement and extension of very long MSLP station records used for the creation of critical climatic indices. Dr Allan also noted collaborations and sharing of information in terms of MSLP data comparisons over the Canadian sector by Hadley Centre and Environment Canada researchers, and MSLP dataset advice to colleagues examining sea level data in the UK.

Dr Allan also presented some details of an EC-funded project to develop and analyze daily MSLP data over Europe and the Atlantic sector (EMULATE). He cast this project in the light of efforts to develop a daily MSLP compilation over the US sector and noted the potential to link the results of these two projects.

Following discussion of these issues, the following decisions were agreed by the Panel:

33. **The AOPC noted with appreciation the progress in developing global surface pressure datasets by individual participants in the AOPC/OOPC Working Group on Surface Pressure (WG-SP). It encouraged increased collaboration to accelerate progress in this area and suggested that the group consider holding a workshop toward this end in the near future.**

34. **The AOPC noted the potential benefit of including surface winds in developing surface pressure analyses and looked forward to continuing progress in this area.**

35. **The AOPC expressed its appreciation to R. Allan of the UK Met Office for his leadership of the AOPC/OOPC Working Group on Surface Pressure and his presentation of progress by the group at this session.**

10. CLIMATE INDICATORS

Mr Folland reviewed the issue of indicators or indices for climate monitoring purposes, especially those relevant for large-scale climate phenomena. He considered the types of questions that climate indices should be designed to answer, such as:

- How warm is the world now, both ocean and atmosphere, including selected regions?

- What are the current/recent states of regional atmospheric circulation (or ocean) and how unusual are they?
- What is the state of ENSO?
- Have recent extreme events broken records, and if so, where? What types of extremes?
- What is the expected state of key climate indices in the near future and what is our confidence in the predictions?

Mr Folland then reviewed some of the types of useful data and existing sources of indices, and discussed a number of sample indices. He concluded by suggesting that GCOS might wish to consider establishing a diagnostics/index monitoring system on a dedicated Web site which could be updated seasonally and annually, for example. Specific indices that might be presented on such a site included those related to surface air temperature (global, NH and SH anomalies), sea-ice extent, precipitation, NAO, AO, SOI, PDO, SST, Atlantic hurricane indices, snow cover, tropospheric height, and several others. Such an effort could be undertaken jointly by GCCOS and the CCl/CLIVAR Expert Team on Climate Change Detection, Monitoring and Indices, for example.

Following discussions on Mr Folland's presentation,

36. The AOPC expressed its appreciation to C. Folland for his review of existing and potential indices of large-scale climate variability. It requested the Chairman and E. Harrison to liaise with Mr Folland to pursue the definition and implementation of appropriate large-scale indicators of climate change which could be derived from GCOS data, noting that these indicators could be regularly updated and displayed via the World Wide Web.

11. GAW ISSUES

11.1 Radiation Budget, Ozone

Dr Johannes Schmetz led a discussion on the observations required to determine the radiation budget and radiative forcing of the climate system on a long-term basis, using both satellite and *in situ* measurements. Radiation plays a fundamental role as the principal source and ultimate sink of energy in the earth-atmosphere system, and measurements of the components of the Earth Radiation Budget (ERB) are therefore a fundamental aspect of a climate monitoring system. The radiation balance at the top of the atmosphere (TOA) or net radiation constitutes the basic radiative forcing of the climate system, and measuring its variability in space and time over the globe provides insight into the overall response of the system to this forcing.

Beyond measuring the TOA fluxes, there is a need to develop the ability to measure the entire radiative energy flow within the earth-atmosphere system on a consistent basis. Specifically, short-wave and long-wave surface radiative flux measurements are required, as well as the atmospheric radiative flux divergence. While satellite estimates of solar surface radiative fluxes can be developed into an adequate dataset for climate studies, estimation of downward long-wave flux at the surface is problematic. Satellite observations of the ERB have provided estimates of the cloud radiative forcing (CRF), a quantity that describes the role of clouds in climate. Satellite observations also contribute adequate information on cloud amounts if lower-level cloud layers are not obscured. Other important parameters such as the near-surface temperature and humidity field and cloud-base height are basically not accessible from space and require data from other sources (e.g. model output fields for temperature and humidity).

The relevant measurement systems in space (broadband radiometers) and the pertinent data analysis have been improved continuously. For TOA fluxes, improvements have been made in terms of treating spectral corrections and angular and temporal sampling problems in the data processing. A similar statement can be made with regard to the technology, quality control and data processing of the Baseline Surface Radiation Network (BSRN). Generally speaking, it can be concluded that the measuring and data processing systems have reached a level of maturity that suffices the needs of a baseline observing system.

Following discussion of these and related issues, the Panel adopted the following decisions:

37. **The AOPC noted the difficulties encountered in maintaining a continuous record of satellite-observed tropospheric temperature due to the major advance in instruments from MSU to AMSU. It reiterated the need to ensure that future instrument developments incorporate sufficient backward compatibility to minimize such difficulties and maintain the integrity of the long-term record for climate monitoring. The Panel requested the Chairman of the GCOS SC to communicate this need to the relevant space agencies, and to emphasize the need to support efforts to reconcile the data obtained from different instruments.**

38. **The AOPC reiterated the need for broadband measurements of radiation balance at the top of the atmosphere (TOA) on a long-term basis and recommended that the relevant quantities (incoming solar, reflected solar and outgoing long-wave radiation (OLR)) be measured continuously from at least one polar-orbiting satellite. The Panel also encouraged the continuation of studies to identify which spectral radiance bands and measurement techniques are best suited for monitoring changes in radiative forcing from space.**

39. **The AOPC, recognizing the significant contribution of far infra-red radiation to the total OLR at the TOA and the uncertainty in modelling its effects, both in climate models and in the procedures used to estimate the OLR from multi-spectral satellite radiation measurements, recommended that high priority be given to an experimental satellite mission to study the spectrum of OLR in the far infra-red.**

40. **The AOPC reiterated the need for long-term measurements of the upwelling and downwelling components of surface radiation fluxes to the standards required for climate studies. The Panel noted with appreciation the major progress of the WCRP/GEWEX Baseline Surface Radiation Network (BSRN) and requested that the Chairman initiate dialogue with the Chairman of the GEWEX Radiation Panel and the BSRN International Project Manager regarding long-term perspectives for the BSRN.**

41. **The AOPC recognized the availability of the large, long-term database of radiation measurements at the WDC-St Petersburg and encouraged efforts to fully utilize this valuable resource.**

42. **The AOPC noted the importance of aerosol loading for climate monitoring purposes and the capability for measurement of total aerosol column measurements over the ocean from AVHRR. It encouraged the exploitation of the existing AVHRR dataset for this purpose and the development of techniques for improved monitoring of aerosols.**

12. SATELLITE ISSUES

The Panel discussed the issue of measurement and analysis of upper-air data from both radiosondes and satellites (e.g. MSU observations), including the difficulties that had been encountered in reconciling the upper-air and surface temperature observations that had been the subject of several dedicated investigations. It was agreed that while several groups were pursuing this issue, there still remained significant inconsistency in many of the radiosonde records, and coordination of the efforts in this area should be beneficial.

Dr Schmetz briefed the Panel on the activities of the Coordination Group for Meteorological Satellites (CGMS), noting that the GCOS SC had requested that interactions between GCOS and CGMS be enhanced in recognition of the extensive experience of CGMS in dealing with the ongoing coordination of a robust, reliable observational satellite system of crucial importance to GCOS. Dr Schmetz also reviewed the draft Climate Monitoring Principles for satellites which had been presented to the Second WMO Consultative Meeting on High-Level Policy on Satellite Matters. The Panel made suggestions for modifications to this draft version and requested the Chairman to coordinate the completion of a finalized version (see Annex X).

The following decisions were adopted by the Panel after discussion of the issues involved:

43. The AOPC, noting the continuing lack of consistency in the homogeneity-adjusted upper-air temperature records from radiosondes and the disparity between the upper air and surface temperature trends, recommended the establishment of an ad-hoc Task Group to assist efforts to resolve these difficulties.

44. The AOPC noted with appreciation the work being carried out in various fora to establish procedures for obtaining water vapour measurements in real time using GPS technology.

45. The AOPC reviewed the draft climate monitoring principles with specific application to satellite observations which had been developed for the recent Consultative Meeting on High-Level Policy on Satellite Matters. It requested the Chairman to collaborate with J. Schmetz and P. Mason to develop a final version for submission to WMO EC-LIV (see Annex X).

46. The AOPC noted the review of activities and priorities of the Coordination Group for Meteorological Satellites (CGMS), presented by J. Schmetz, and welcomed the opportunity to increase AOPC links with CGMS through the regular participation of Dr Schmetz in the CGMS forum.

47. The AOPC reiterated the need for baseline satellite observations (i.e. long-term systematic datasets using current and future satellite platforms) to be integrated with *in situ* measurements into a comprehensive climate observing system. It recognized the great potential value of a number of planned missions with particular focus on climate applications and encouraged the agencies involved to continue these efforts.

13. LAND COVER

Dr Shuhei Maeda presented some results of an analysis of the impact of snow-depth data on medium and extended-range NWP forecasts. This analysis showed a clear improvement in forecast scores for temperature in the lower atmosphere when SYNOP snow-depth reports were included in the analyses of land-surface parameters. He noted that although

some improvements in the exchange of snow-depth observations had been observed in recent years, there were still large regions for which these data were unavailable, and efforts to promote the real-time exchange of these data should be continued.

The Panel discussed the issue of differences in land-surface temperature datasets developed by different groups, noting the success of the SST-SI Working Group in reconciling differences among the many available global analyses of SST. It was felt that organization of a workshop to address this issue would be beneficial. Such a workshop could also consider methods of combining land and marine temperatures, attempts to produce OI-analyses of land-surface temperatures and the possible incorporation of satellite estimates of land-surface temperature.

Following discussion, the Panel agreed on the following conclusions and decisions:

48. **The AOPC noted the increasing evidence of sensitivity to snow-depth as a boundary condition in NWP analyses and strongly encouraged the global exchange of snow-depth observations through SYNOP reports, rather than restricting them to regional distribution as is still the case in some regions. It also recommended that necessary action be taken to ensure the smooth distribution of these globally-tagged messages to all users via the WMO Global Telecommunication System (GTS).**

49. **The AOPC noted that recent modelling activities had shown that the impact of land-surface changes over the last 200 years, in terms of radiative forcing, is comparable in magnitude to estimates of the impact of biomass burning over the last 30-50 years. Such work highlights the importance of changes to surface albedo for all aspects of climate modelling and suggests that satellite measurements of albedo could significantly improve seasonal-to-interannual climate prediction. The Panel welcomed these findings and urged that research efforts be continued into the time evolution of surface albedo and its impact on climate.**

50. **The AOPC recognized the continuing existence of significant differences among the land-surface datasets developed by different groups and encouraged the holding of a workshop aimed at resolving these differences as soon as feasible.**

14. PALEOCLIMATE DATA

Dr Phil Jones led a discussion of issues related to paleoclimate data, noting that even the longest of instrumental records are inadequate for addressing issues of representativeness. Data obtained from such sources as tree rings, ice cores, corals, as well as historical documents, for example, allow the instrumental record to be placed in a much longer context and are particularly important for assessing the uniqueness of recent trends. Following discussion, the Panel agreed on the following conclusion:

51. **The AOPC recognized the great value of paleo-archives (ice cores, corals, tree rings) for extending the climate record to before the period of modern instruments, and the urgency to take maximum advantage of these archives before their potential disappearance. The Panel endorsed the high priority being given to this issue by the IGBP/PAGES and related programmes and encouraged their support.**

15. MARINE ISSUES

Dr Harrison presented a brief summary of developments in the Worldwide Recurring ASAP (WRAP) and Voluntary Observing Ship Climate (VOSClim) Projects. In the case of WRAP, preliminary results had demonstrated a clear positive impact of the regular soundings on NWP analyses carried out by the Australian Bureau of Meteorology.

52. The AOPC noted the positive impacts on analyses over the southern oceans of observations from the first year of operation of the Worldwide Recurring ASAP Programme (WRAP) initiative. It welcomed the planned continuation of WRAP using other ships and encouraged expansion of the programme to the extent possible.

53. The AOPC reiterated its recommendation that surface pressure sensors be included on surface drifting buoys deployed in otherwise poorly-sampled regions, noting the importance of sea-level pressure (SLP) observations for monitoring climate variability and change as well as for improving operational analyses of marine surface conditions.

16. DISTRIBUTED DATA ARCHIVE AND ACCESS

Mr Howard Diamond presented a review of eXtensible Markup Language (XML) for more efficient transport of data, for possible use by the atmospheric climate community. This standard for communicating structured data was rapidly expanding but had not yet been widely developed for meteorological applications. Discussions included the overall issue of access to GCOS data, including via the Monitoring and Analysis Centres and the Global Observing Systems Information Centre (GOSIC). The following conclusions were agreed:

54. The AOPC noted the developing technology (e.g. XML) to facilitate access to distributed datasets and metadata and the proposed workshop in 2003 related to this issue. It requested H. Diamond to inform the Panel of developments in this area, including results of the workshop.

55. The AOPC noted with appreciation the ongoing efforts to improve access to data by the GCOS Monitoring and Analysis Centres.

56. The AOPC noted that its Implementation Plan for Atmospheric Observations highlights the importance of data access in the GCOS data management structure, while noting also that the GCOS Monitoring Centres, Analysis Centres and Archive are developing systems which will meet AOPC objectives without recourse to the Global Observing Systems Information Centre (GOSIC).

17. REANALYSIS AND SYNTHESIS PRODUCTS

Dr Phil Arkin reviewed the role of synthesized datasets in GCOS, presented examples of a few types of such products, and described a proposed programme for continuing climate analysis. GCOS requires comprehensive data products that provide time series of complete descriptions of the full climate system as supplements to the time series derived from baseline measurements such as those of GSN and GUAN. Such comprehensive products are generally derived from the objective combination of scattered observations of a single type, or by the synthesis of many observations from varying sources, into complete climate analyses. Dr Arkin presented examples of analyses of precipitation derived entirely from raingauge observations, as well as from the combination of gauge observations and estimates derived from satellite data. He also reviewed the current state of the existing reanalysis efforts and outlined a

proposal for a National Program for Analysis of the Climate System (NPACS) that has been put forward in the US.

Dr Arkin also summarized some of the results from the ERA-40 Workshop which had been held at ECMWF in November 2001 and at which Dr Kevin Trenberth had kindly represented GCOS and AOPC interests. ERA-40 is a cooperative effort centred at ECMWF involving several partners in the European Community as well as the US. Its objective is to create a consistent reanalysis of atmospheric data for the period from 1957-2001 using a model forecast/assimilation system with a resolution of T159 and 60 vertical levels. The workshop focused on the evaluation of preliminary products and comprised 5 Working Groups: Observations, Quality Assessment, Trends, Observing System Experiments and Data Distribution. The general conclusion of the workshop was that, despite difficulties related to the varying composition of the observing networks, ERA-40 appeared to be proceeding extremely well and was on track to conclude with a suite of climate analyses that would be of great value to GCOS and the entire climate community.

57. The AOPC welcomed the review of reanalysis issues presented by P. Arkin. It noted in particular the proposal for a US National Program for Analysis of the Climate System (NPACS) and requested that it be kept informed of further developments.

58. The AOPC expressed its appreciation to K. Trenberth for attending and reporting on the ERA-40 workshop on behalf of AOPC.

59. The AOPC recognized the great value of the ERA-40 reanalysis and the enormous effort and cost that had gone into carrying it out. It nevertheless noted that the costs to researchers of acquiring the data resulting from this effort remained prohibitively high in most cases, and recommended that all possible steps be pursued to ameliorate this situation.

60. The AOPC noted the significant improvement of the ERA-40 reanalysis over the earlier ERA-15 results and the benefits of coordinating the scheduling of reanalyses and pooling of data by the groups involved (Europe, Japan, USA). It strongly encouraged the development of a continuing programme of climate analysis and timely reanalysis to produce both current and historical datasets through international cooperation and collaboration.

Dr Rudolf reviewed the status of ongoing work at the Global Precipitation Climatology Centre (GPCC) to develop high-resolution distributions of global rainfall in addition to the routine 'monitoring products' already being produced. The so-called 'full data' product was being developed using monthly data from all raingauge stations in the GPCC database (up to 40,000 stations) in 0.5 x 0.5 degree boxes for the ten-year period from 1986 to 1995. Results to date had clearly shown that the global average mean precipitation in mm per month from the full-data product was consistently higher (by 1 to 5%) than the same results from the monitoring product (which used data from about 7000 stations). This was likely due to the better depiction of mountainous and heavy-precipitation areas in the higher-resolution product. Work was continuing to complete the full-data product and carry out more detailed analyses of the results. The meeting reiterated the importance of high-resolution global gridded precipitation datasets for climate variability studies and noted with appreciation the continuing collection and archiving of raingauge data by the GPCC.

Dr Rudolf also described a new project (VASClimO: Variability Analysis of Surface Climate Observations) being carried out jointly by DWD and the University of Frankfurt am Main, involving the development and analysis of a global database of temperature, precipitation,

pressure and snow-depth using combined data from four major databases: GPCC, CRU, FAO and the Global Historical Climatology Network (GHCN) of NCDC.

61. The AOPC welcomed the progress in developing high-resolution global rainfall analyses at the Global Precipitation Climatology Centre (GPCC) and looked forward to publication and exploitation of the results of this valuable work.

18. LIAISON WITH OTHER ENTITIES

At its Thirteenth Session (Geneva, 21-30 November 2001), the WMO Commission for Climatology (CCl) restructured its activities into a number of Open Programme Area Groups (OPAGs), Implementation/Coordination Teams and Expert Teams, much along the lines of the structure previously adopted by CBS. One of the originally-proposed OPAGs dealt with global, regional and national climate networks. Recognizing that GCOS, and particularly the GCOS/WCRP AOPC, was already dealing with issues related to global and regional climate networks, the Commission proposed that its President consult with the GCOS Steering Committee and the WCRP Joint Scientific Committee regarding the possible establishment of a joint mechanism to achieve specific tasks related to such networks. A letter was subsequently received by the GCOS SC Chairman and the issue was discussed at the recent SC-X session, which requested that AOPC take the lead in pursuing this issue and consider it at its next session (i.e. this one).

The Panel discussed the above issue in the context of its Terms of Reference and its current activities and plans for the future. It noted that CCl would be creating an Expert Team on national networks, and considered that extension of that group's activities to include regional networks, while at the same time working closely with AOPC regarding the regional aspects of the global networks, would be an appropriate path to follow, at least for the foreseeable future. Such cooperation between the two groups should include extension of the monitoring activities for the GSN and GUAN to include the newly-approved RBCN networks, in the interests of efficiency. The issue could then be revisited as needed following the experience gained from this approach.

62. The AOPC, having reviewed the proposal from the President of the WMO CCl regarding the possible establishment of a joint mechanism to achieve specific tasks related to global and regional climate observing networks, agreed that AOPC should maintain its prime focus on issues involving global climate networks, as is currently mandated by its Terms of Reference, on behalf of GCOS, WCRP, CCl and other relevant groups. It recommended that the proposed CCl Expert Team on National Networks and Observations in Support of Climate Activities be established, and that its mandate include issues involving regional climate networks such as the WMO Regional Basic Climatological Networks (RBCN). The Panel further recommended that the Chairman of the CCl Expert Team be invited to participate *ex officio* in sessions of the AOPC as one mechanism to ensure the appropriate liaison and coordination between GCOS, WCRP and CCl on issues of mutual interest.

63. The AOPC requested that the GSN and GUAN Monitoring Centres extend their monitoring activities to include all CLIMAT and CLIMAT TEMP stations and make the results available to WMO/CCl and other potential users.

Dr Manton noted the recent appointment of Dr Alan Belward as the new Chairman of the Terrestrial Observation Panel for Climate (TOPC). The Panel recognized the importance of close cooperation with the TOPC on issues of common interest such as surface radiation, albedo and land-atmosphere interaction parameters and recommended maximizing such cooperation in the future.

64. The AOPC looked forward to increased cooperation with the TOPC on terrestrial matters of mutual concern, including the observation of land-surface parameters such as soil moisture and surface albedo as boundary conditions for climate models, noting that the development of the Second Adequacy Report would provide an excellent opportunity for such enhanced cooperation.

19. OTHER ISSUES

Dr Harrison presented a summary of recent near-equatorial data from the TAO/Triton Pacific moored array, noting that there had been many episodes of weak-to-moderate westerly surface wind anomalies in the western Pacific (and slightly warmer than normal SST in the western/central Pacific) since May 2001, but that no persistent significant Cold Tongue SST anomalies had been observed. A significant Westerly Wind Event occurred in Nov-Dec 2001 and a pulse of thermocline deepening had crossed the basin in January-March 2002. Warm and wet conditions appeared along the NW South American coast in February-March 2002. NCEP had issued a forecast of an impending ENSO Warm Event in March 2002. Subsequent to that forecast, conditions in the Pacific Cold Tongue returned to very near-normal by the end of April 2002, and colder than normal in the eastern Pacific. These conditions apparently resulted from persistent normal and slightly stronger-than-normal easterly winds over the region. However, in mid-May 2002 westerly anomalies had again appeared in the western Pacific and had moved into the central Pacific by May 21, 2002. Although these wind anomalies were not major so far, the appearance of such anomalies at that time of the year had preceded El Niño conditions in the past, and conditions should be watched closely in the following weeks. The major 1982-83 El Niño did not have persistent wind anomalies or warm SST anomalies in the Cold Tongue until June-July 1982.

Dr Manton recalled the issue of organizing a GCOS 'Atmospheric Observations Conference', along the lines of the successful OceanObs99 conference for the oceans domain. While no action had been taken to date to hold such a conference, it was agreed that it would be beneficial and desirable to do so, ideally in partnership with WCRP/CLIVAR and perhaps other appropriate groups.

65. The AOPC expressed its appreciation to E. Harrison for providing an update on the latest data from the TAO/Triton array in the tropical Pacific and insights into the possible significance of these data.

66. The AOPC confirmed its support for the concept of an international conference on Atmospheric Observations for Climate and encouraged the Chairman to continue discussions with the Chairman of the CLIVAR Scientific Steering Group and the Directors of the GCOS Secretariat and the WCRP Joint Planning Staff concerning the possibility of jointly organizing such a conference, possibly in late 2003 or early 2004.

20. SUMMARY OF DECISIONS AND ACTION ITEMS

A consolidated list of the decisions, recommendations and action items from the meeting is presented as Annex XI to this report.

21. NEXT MEETING

The Panel agreed that the Ninth Session of AOPC should be held on 23-27 June 2003 at a location to be confirmed in due course (subsequently agreed as Asheville, NC, USA).

The Chairman thanked all participants in the meeting and formally closed the Eighth Session of the AOPC at 13:00 on Friday, 24 May 2002.

ANNEXES

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ANNEX I

LIST OF PARTICIPANTS

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ANNEX II

AOPC-VIII: AGENDA

Monday 20 May		**Doc. No.**
1.	Opening of the Meeting	
	1.1 Welcome and introductions *(Manton)*	[INF. 1]
	1.2 Operation of the Meeting *(Secretariat)*	
	1.3 Adoption of Agenda *(Manton)*	[1]
2.	Report of the Chairman *(Manton)*	
	2.2 Review of Issues and objectives for the meeting	
	2.3 Actions from AOPC-VII not covered by agenda	[3]
3.	Report of the Director, GCOS Secretariat *(Thomas)*	[4,5]
4.	UNFCCC and Related Issues *(Mason)*	[6,7]
5.	AOPC Plan *(Manton)*	[8]
6.	CBS Statements of Guidance *(Manton)*	
	• Seasonal-to-Interannual Prediction	[9]
	• Monitoring of Climate Trends	
	• Monitoring Climate Variability	
LUNCH		
7.	GSN and GUAN	
	7.1 Outcomes of Offenbach Meeting *(Manton)*	[24]
	7.2 Activities of the AGG/GCOS Secretariat *(Jones, Teunissen)*	[10,11]
	7.3 GSN Monitoring and Performance Results *(Rudolf)*	[12]
	7.4 Common Standards for GSN Measurements *(Peterson)*	
	7.5 Assembly of and Access to GSN Data Sets *(Jones, Peterson)*	
Tuesday 21 May		
7.	GSN and GUAN (continued)	
	7.6 GUAN Monitoring and Performance Results *(Parker)*	[14]
	7.7 GUAN Products – Development and Availability	
LUNCH		
8.	SST/Sea-Ice Working Group	
	8.1 Status Report *(Harrison)*	[15]
	8.2 SST Analyses *(Folland)*	
9.	Surface Pressure Working Group *(Allan)*	
10.	Large-scale Climate Indicators *(Folland)*	

Wednesday 22 May

11. GAW Issues (Ozone, CO2, aerosols)
    - Radiation budget *(Schmetz)* [16]

12. Satellite Issues
    - 12.1 Baseline observations
    - 12.2 Analysis of upper-air data
    - 12.3 GPS water vapour *(Manton)*
    - 12.4 Liaison with CGMS *(Schmetz)*
    - 12.5 Climate monitoring principles for satellite data *(Manton)* [17]
    - 12.6 EUMETNET/GMES and ECMWF/GLOAMAS Workshops [18]

13. Land Cover
    - Snow cover and depth *(Maeda)* [19]

14. Paleoclimate Data
    - GPOS proposal *(Jones)*

LUNCH

15. Marine Issues *(Harrison)*
    - VOSClim, ASAP, Time-series Reference Sites [15,21,21a]

16. Distributed Data Archive and Access *(Diamond)* [22]

Thursday 23 May

17. Reanalysis and Synthesis Products *(Arkin)*
    - 17.1 Report of ERA-40 workshop (Trenberth report) (*Manton)*
    - 17.2 High-resolution global rainfall analysis *(Rudolf)*

LUNCH

18. Review of Statements of Guidance

19. Review of AOPC Plan

Friday 24 May

20. Liaison with other Entities
    - 20.1 CCl (*Peterson, Manton)* [23]
    - 20.2 CLIVAR *(Harrison)*
    - 20.3 SPARC *(Manton)*

21. Summary of Decisions and Actions

22. Next Session

23. Closure of the Meeting

ANNEX III

LIST OF DOCUMENTS

Agenda Item	Document No.	Description
1.3	**1**	Provisional Agenda
2	**2**	N/A
2	**3**	AOPC-VII Action Items
3	**4**	Report of GCOS Director
3	**5**	GCOS SC-X Action Items
4	**6**	Plan for Second Adequacy Report
4	**7**	GCOS Interim Report to SBSTA-16
5	**8**	AOPC Plan
6	**9**	SOG on Seasonal-to-Interannual Prediction
7.2	**10**	Activities of the AGG/GCOS Secretariat
7.2	**11**	Manual on the GSN and GUAN
7.3	**12**	GSN Monitoring Report No. 5
7.5	**13**	N/A
7.6	**14**	Status Report from GUAN Analysis Centre (Hadley)
8,15	**15**	Report of OOPC Chairman to GCOS SC-X
11	**16**	Draft Statement on Radiation Budget Measurements
12.5	**17**	Climate Monitoring Principles for Satellite Observations
12.6	**18**	EUMETNET/GMES and ECMWF/GLOAMAS Workshops
13	**19**	Impact of in-situ snow depth data on forecasts and status of real-time snow data exchange
14	**20**	N/A
15	**21**	JCOMM Issues (VOSClim, WRAP Status Reports)
15	**21a**	VOSClim Project Document
16	**22**	Distributed Data Access
20.1	**23**	Cooperation among CCl, GCOS (AOPC) and WCRP
7.1	**24**	GCOS Strategy to Support Baseline Observing Systems
1.1	**INF.1**	Provisional List of Participants

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ANNEX IV

REPORT OF THE DIRECTOR, GCOS SECRETARIAT

1. Introduction

This report summarizes the activities of GCOS, and especially the Secretariat, since AOPC-VII in April 2001. Over this period, the activities of the Secretariat have been guided by the GCOS Implementation Plan approved at GCOS SC-IX in September 2000. In accordance with that plan, significant redirection has occurred, within available resources, from scientific planning to an emphasis on implementation, including active GCOS participation in the WMO Technical Commissions and interaction with the IOC, GOOS, and the IGOS partners.

GCOS has extended its activities in response to the decisions of the UNFCCC Conference of Parties, especially with its Subsidiary Body for Scientific and Technological Advice (SBSTA). In this regard, progress has been made on the GCOS Regional Workshop programme, continuing focus of informing SBSTA on issues related to systematic observation, and in the planning for the second report on the Adequacy of Global Climate Observing Systems.

Resource mobilization continues to be a high priority for the Director. Since the last meeting, GCOS has received approval for two grants under the UNDP/GEF National Communications Support Programme in support of the GCOS Regional Workshop Programme. In addition, significant extra-budgetary resources have been received from national and other sources to supplement the contributions from the GCOS Sponsors, thereby allowing for the continuing employment of limited-term contractors and short term consultants and other basic activities of the Secretariat.

2. Implementation of the GCOS Networks

Under the leadership of the GCOS Science Panels (AOPC, OOPC, TOPC), significant progress was made in the implementation of the GCOS networks and systems. For example:

- The GCOS Surface Network (GSN) Monitoring Centres at the Japan Meteorological Agency (for temperature) and the Deutscher Wetterdienst (DWD) (for precipitation) are fully operational and have produced semi-annual reports on the availability of GSN data for the last three years. For the GCOS Upper-Air Network (GUAN), the European Centre for Medium-Range Weather Forecasts (ECMWF) provides monitoring data to the Hadley Centre of the UK Met Office, which publishes monthly statistics on the GUAN Web site. The World Data Centre for Meteorology, Asheville (NCDC) acts as the GSN and GUAN Archive and provides access to the historical data from both networks. Establishment of this data management infrastructure is allowing performance weaknesses to be identified and ultimately improved, as well as providing access to the data.

- Cooperation with CBS has included working with the OPAG on Integrated Observing Systems and its Expert Team on Observational Data Requirements and Redesign of the Global Observing System (ET-ODRRGOS). Based on consultations with OOPC and others, Dr Manton presented a revised statement of guidance (SOG) on seasonal to interannual prediction to the ET-ODRRGOS in January 2001, which was well received by that group.

- Dr Paul Mason, Chairman of the SC, represented GCOS at the Second Session of the Consultative Meetings on High-Level Policy on Satellite Matters on 18-19 February 2002. He presented an initial overview of the satellite observational requirements (specific

evaluations are considered through the CBS Rolling Review of Requirements Process), including the GCOS two-stream strategy of *comprehensive* global networks and *baseline* global networks. The meeting welcomed his proposal on the adoption of GCOS observing principles for climate monitoring for satellite systems as well as *in situ* observations and requested that these principles be presented through CBS for adoption at EC-LIV. The participants felt that a formal WMO endorsement would greatly assist space agencies in obtaining the necessary resources to meet the principles for future satellite systems.

- Solid progress was made in the implementation and operation of the GCOS ocean observation networks (e.g. VOSClim, ASAP, DBCP, the TAO/TRITON array and the Argo initiative), thanks in large part to the strong efforts of the OOPC and the establishment of JCOMM.

- Further progress was made toward the establishment of a global climate network for hydrology (GTN-H, the Global Terrestrial Network – Hydrology) through planning and implementation meetings led by the TOPC and hosted by DWD in June 2001. A major goal of the GTN-H, for which Canada has agreed to provide the initial co-ordinator, will be to produce global products for key hydrological variables.

- Since the last AOPC, the chairs of OOPC (Dr N. Smith) and TOPC (Dr J. Cihlar) have announced their decision to step down and two new Chairs have been appointed, Dr Ed Harrison for OOPC and Dr Alan Belward for TOPC. We in the Secretariat welcome them to GCOS and look forward to working with them and our partners on the range of observing system challenges.

3. Interactions with the UN Framework Convention on Climate Change (UNFCCC)

On behalf of its sponsors, the GCOS Secretariat continued its interaction with the UNFCCC/Conference of Parties (COP) and its Subsidiary Body for Scientific and Technological Advice (SBSTA) through participation in the 14th and 15th sessions of SBSTA, held in conjunction with COP-6bis and COP-7, respectively. GCOS reported on the status of activities pursuant to Decision 5/CP.5 and recent developments in global observing systems for climate:

- The GCOS Secretariat prepared and submitted to SBSTA-15/COP-7 the report Global Climate Observing System: progress report on developments in the global observing systems and activities related to decision 5/CP.5. This report reviewed deficiencies in GSN and GUAN, developments in the climate components of the Global Ocean Observing System (GOOS) and Global Terrestrial Observing System (GTOS), and the needs for improved continuity and calibration of satellite observations. GCOS also submitted a detailed report to SBSTA-13/COP-6 and a short report to SBSTA-14/COP-6bis.

- The Parties to the UNFCCC were requested in Decisions 4/CP.4 and 5/CP.5 to prepare detailed reports on their programs of systematic observations. SBSTA-15/COP-7 invited the GCOS Secretariat to prepare, for SBSTA-16, an interim report on the synthesis and analysis of national reports from Parties, due in November 2001, in accordance with Decision 5/CP.5. This Interim Report has been submitted to SBSTA-16 for consideration at their session in June.

- In response to Decision 5/CP.5, GCOS has developed a Regional Workshop Programme which seeks to build capacity in 10 regions having recognized deficiencies in global observing systems for climate. This Programme is to assist countries on a regional basis to develop Regional Action Plans and obtain financial support for improving their observing systems for climate. The Programme is a recognized part of the GEF/UNDP National Communications Support Programme and, as such, has received significant support from

GEF through UNDP. GCOS is working closely with UNDP to ensure the full involvement of Non-Annex I climate change teams. The two phases of the programme are:

(i) The Pilot Project, completed in 2001, consisted of two Regional Workshops, one for the Pacific Island countries and one for countries in eastern and southern Africa, and was designed to refine workshop methodology. Besides UNDP/GEF support, contributions were received from the UN Environment Program (UNEP), the World Meteorological Organization (WMO), the United States of America, and Australia. The reports from these workshops are available via the GCOS homepage at: http://www.wmo.ch/web/gcos/gcoshome.html.

(ii) The Full Project will be implemented from 2002 to 2005. GEF has approved a GCOS proposal for the Full Project, but matching funds will be needed from donor countries and international organizations. The Full Project was launched in March 2002 through a Regional Workshop for the countries of Central America and the Caribbean, with sponsorship by the Organization of American States, WMO, Canada and the United States. Later in 2002, a Regional Workshop will be held in East Asia.

- At its Ninth Session, the GCOS SC proposed that a second 'Report on the Adequacy of the Global Climate Observing Systems', following on from the first Adequacy Report submitted to COP-4 in 1998, be prepared using the national reports as one input. The goals of the Second Adequacy Report will be to:

  (1) Determine what progress has been made in defining and implementing climate observing networks and systems since the first Adequacy Report prepared for COP4;
  (2) Determine the degree to which these networks meet with scientific requirements and conform with associated observing principles; and
  (3) Assess how well the current systems, together with planned improvements, will meet the needs of the Convention.

  This report will draw upon international scientific experts and take into account the conclusions of the IPCC Third Assessment Report (TAR). SBSTA-15/COP-7 endorsed this proposal and invited GCOS to submit a final report to SBSTA-18 in mid-2003.

- A plan for the Second Adequacy Report has been prepared by the Secretariat and has been made available to the Committee members. The Report is being developed under the overall direction of the Chair of the GCOS SC, and the Chairs of the Science Panels are responsible for organizing and overseeing teams of lead and contributing authors who will prepare the Report. Two meetings have been scheduled and the third is in the planning stage:

  (1) On 1-3 July 2002, the Panel Chairs will meet in Melbourne to finalise the information base concerning the current and planned observing system and define questions for the joint IPCC-GCOS meeting;
  (2) On 12-14 August, a joint meeting with IPCC to review the information base, to consider the observing system needs as reflected in the TAR and determined by the Convention, and to develop appropriate metrics for adequacy analyses will be held at NCAR in Boulder Colorado;
  (3) In October 2002, GCOS will hold a meeting in Geneva for the authors to organize and draft an initial report.

4. Decisions from GCOS SC-X Relating to AOPC

Dr Manton, the AOPC Chairman, presented the status and plans for AOPC activities to the GCOS SC at its Tenth Session in Farnham, UK, from 15-19 April 2002. The SC expressed its satisfaction with the work being carried out by AOPC and adopted a number of decisions and action items relating directly to AOPC, as follows:

- The SC expressed its appreciation to the AOPC for the significant progress made in implementation of the GSN and GUAN baseline systems and encouraged it to continue its efforts to ensure their satisfactory performance.

- The SC noted the publication of the most recent GSN Monitoring Report and reiterated its appreciation to the Deutscher Wetterdienst (DWD) and the Japan Meteorological Agency (JMA) for carrying out this activity in their capacity as the GSN Monitoring Centre. It also reiterated its appreciation to the World Data Centre for Meteorology, Asheville (NCDC, USA) for its efforts in establishing and maintaining the archive for GSN and GUAN data.

- The SC noted the significant progress in the compilation and presentation of monitoring results for the GUAN and expressed its appreciation to the ECMWF and the Hadley Centre of the UKMO in effecting this progress as the GUAN Monitoring and GUAN Analysis Centres, respectively. The SC noted with satisfaction that these results were being made freely available to all interested parties through the web sites of the respective centres and other appropriate means.

- The SC noted with appreciation the completion of Version 1.0 of the “Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN” by the AOPC Advisory Group on GSN and GUAN (AGG), thereby providing a consolidated compendium of the operational guidelines for the GSN and GUAN.

- The SC expressed appreciation for the increasing support of the WMO Commission for Basic Systems (CBS) and the WMO Secretariat in taking action to address the problems in the reporting of real-time data from the GSN and GUAN. It was pleased to note that the concept of establishing CBS Lead Centres for GCOS data to facilitate communication between GCOS Monitoring Centres and operators of GSN and GUAN sites would be pursued at a planned CBS/GCOS Expert Meeting in Offenbach in May 2002. The SC fully supported this concept and requested that appropriate proposals be presented for endorsement to the CBS and the WMO EC and Congress, as appropriate, at the earliest opportunity.

- The SC noted the disappointing response from operators of some GSN sites to the request from WMO to provide unrestricted GSN historical data and metadata to the GSN Archive (WDC-Asheville), as had been accepted as a commitment under the agreement for designating GSN stations, as well as under UNFCCC Article 4 relating to data access. The SC, noting the availability of secondary sources of GSN data and recalling the need for GCOS to provide data products to the world community, recommended:

- that GSN data from all open data sources be prepared and made openly available through the GSN Archive;

- that the proposed CBS Lead Centres for GCOS data be used to make direct approaches to national meteorological services for access to historical GSN data;

- that further direct negotiations with site operators be commenced to ensure access to all GSN data.

- The SC noted with appreciation the development by AOPC and OOPC, in collaboration with WCRP and CCl, of a CBS Statement of Guidance (SOG) on Seasonal-to-Interannual Prediction, and encouraged AOPC to lead the development of complementary SOGs on the detection of climate trends and on monitoring global and regional climate.

- The SC expressed its appreciation to the NOAA Office of Global Programs for its support of a planning meeting in late April 2002 to finalize the science and implementation plan for AOPC, noting that this plan will be very important as background information for preparation of the Second Adequacy Report.

- The SC agreed that the objectives of GCOS would be advanced through capacity-building activities aimed at the recovery and analysis of climate data in developing countries, and encouraged further development of this theme through the GCOS Regional Workshop Programme.

- The SC encouraged the AOPC to document and promote the climate requirements for reanalysis and other composite products.

- The SC reiterated the importance of reconciling satellite and *in situ* measurements of upper-air parameters and encouraged the AOPC to work with relevant groups towards implementing a mechanism to promote further analysis of upper-air data.

- The SC encouraged the AOPC to increase its focus on the development and analysis of systems to monitor climate forcing, and in particular to explore the utility of the global surface radiation network as a component of GCOS.

- The SC endorsed the revised Terms of Reference for the AOPC which had been developed as requested by SC-IX in response to the dissolution of the cross-cutting panels and ongoing developments in GCOS and its implementation strategy.

- The SC recognized the growing pressure for, and importance of, implementing GCOS networks and systems to meet user needs, including the UNFCCC, and the scope and complexity of the work required to oversee and coordinate them. It recommended to GCOS sponsors that a dedicated project office for GCOS Baseline Systems be established as soon as possible, focussing initially on the GSN and GUAN and extending eventually to other networks such as GTN-H.

5. Priority Activities for the GCOS Secretariat

The next year plus will be demanding for the Secretariat with:

- Increased emphasis on implementation through the AGG, in cooperation with the WWW; proposed development of a CBS Lead Centre for GSN, and work with NOAA on improvements to GUAN;

- Support for implementation of GODAE by OOPC and GOOS;

- Support for the TOPC and its new Chair in developing a terrestrial observing strategy for the future. This will include moving forward on GTN-H with the WMO hydrology and water resources department and with GTOS;

- Preparation of the Second Report on the Adequacy of the Global Climate Observing Systems;

- Organization of two more Regional Workshops and the completion of the first two Regional Action Plans (with the third in development) as requested by SBSTA-15;

- Submission of further reports to SBSTA, e.g., the Interim Report to SBSTA-16 on the synthesis and analysis of the detailed reports from Parties.

ANNEX V

SECOND REPORT ON THE ADEQUACY OF THE GLOBAL CLIMATE OBSERVING SYSTEMS

At its Third Session in Kyoto in 1997, the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) requested that a report be prepared to assess the adequacy of the global observing systems for climate to meet the observational needs in support of the Convention. The Global Climate Observing System, on behalf of organizations participating in the Climate Agenda and in collaboration with the climate components of the Global Ocean Observing System and the Global Terrestrial Observing System, coordinated the preparation of such a report and submitted it to COP-4 in Buenos Aires in 1998 ('Report on the Adequacy of the Global Climate Observing Systems', GCOS-48, October 1998). COP-4 noted the report with appreciation and adopted Decision 14/CP.4 in support of research and systematic observation related to the Convention.

The GCOS Steering Committee (SC), at its Ninth Session in September 2000, requested the GCOS Secretariat to develop a Second Report on the Adequacy of the Global Observing Systems for Climate. This report was to build on the information on systematic observations submitted by Parties as part of their National Communications to COP, in accordance with reporting guidelines developed by GCOS and adopted by COP, along with other available information on climate observing systems. At its Fifteenth Session in Marrakesh in November 2001, the UNFCCC Subsidiary Body on Scientific and Technological Advice (SBSTA-15) endorsed the preparation of such a report addressing the needs of the Convention and invited the GCOS Secretariat, in its preparation of the report, to take into account relevant COP decisions on capacity-building, technology transfer and adaptation. It also asked that the report consider an integrated approach to global climate observing systems, including the exploitation of new and emerging methods of observation.

SBSTA-15 also noted the need to complete the Second Adequacy Report in the shortest possible time to provide a framework for further work to improve global monitoring systems. It therefore asked the GCOS Secretariat to prepare an interim report on the synthesis and analysis of the national reports from Parties for consideration by SBSTA-16 in June 2002, and to complete the final report by SBSTA-18 (June 2003) in order for it to be considered by COP-9 in November 2003. That Interim Report included a number of additional recommendations from the Tenth Session of the GCOS SC in April 2002 as well as the plan for completion of the Second Adequacy Report and a proposal to involve experts previously engaged in the work of the Intergovernmental Programme for Climate Change (IPCC). SBSTA-16 welcomed the report and the process proposed for developing the Second Adequacy Report.

OBJECTIVES AND PROCEDURE

The goals of the Second Adequacy Report are to:

- Determine what progress has been made in defining and implementing climate observing networks and systems since the First Adequacy Report prepared for COP-4 in 1998;
- Determine the degree to which these networks meet with scientific requirements and conform with associated observing principles;
- Assess how well current systems, together with planned improvements, will meet the needs of the Convention.

The report will:

- Be based on detailed reports and National Communications by Parties to the UNFCCC Conference of Parties;
- Utilise data and information on operational and research observing systems from all available sources;
- Draw upon a balanced range of scientific experts to develop the specific analyses;
- Take into account relevant COP decisions on capacity building, technology transfer and adaptation;
- Incorporate an integrated approach to global climate observing systems, including the exploitation of new and emerging methods.

Preparation of the report will be under the overall direction of the GCOS Steering Committee, acting through its Chairman. The Chairs of the GCOS Science Panels will organise the analyses to meet the goals of the report. Scientific experts, including those previously engaged in the work of the IPCC, will refine the objectives and define the metrics for analysis in light of the needs of the Convention in preparation for development of the specific analyses. A draft of the report will be made available for open review through the GCOS Web site, presentations at international scientific conferences, and other appropriate distribution methods.

KEY MILESTONES

- 1-3 July 2002 in Melbourne Australia: GCOS Science Panel chairs to finalise the information base and define critical questions for meeting with IPCC experts.

- 12-14 August 2002 in Boulder Colorado USA: Meeting with IPCC experts on needs of the Convention for observing systems as in the IPCC Third Assessment Report (TAR) and to develop appropriate metrics for adequacy analyses.

- 14-18 October 2002 in Farnham U.K.: Meeting of authors to review, organise, and assemble initial adequacy analyses.

- Dec 2002-Mar 2003: Open comment period on the draft report to develop a consensus on the conclusions - e.g., GCOS homepage, presentations at international meetings.

- April 2003: Review of draft report by GCOS SC.

- June 2003: Report available to SBSTA-18.

ANNEX VI

CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (Offenbach, 15-17 May 2002): Draft Recommendations

1. The Expert Meeting, recognizing the target requirement to reach 5 hPa height for GUAN stations, recommended that the GUAN Monitoring Centre include an indication of those stations which were reaching that target in its published performance results .

2. The Expert Meeting, recalling that the GCOS Monitoring Centres may request re-transmission of missing CLIMAT and/or CLIMAT TEMP messages through the WMO/GTS, encouraged them to make use of this procedure to the maximum extent as one means for acquiring the maximum possible data.

3. The Expert Meeting recommended that simple PC software should be made available to NMHSs for encoding and formatting national monthly data into CLIMAT and CLIMAT TEMP reports.

4. The Expert Meeting recommended that the GSN and GUAN Monitoring and Analysis Centres collaborate with the GCOS Archive to ensure that all relevant data and metadata that they have obtained or developed from all sources are provided to the archive, in order to ensure that the archive has, and makes available to users, the most complete and reliable datasets possible.

5. The Expert Meeting recommended that the GCOS Monitoring Centres, Analysis Centres and Archives harmonize the categories used to determine and present performance results to the extent possible. It suggested in particular that the following categories be considered:

Category:	1	2	3	4	5	6
Performance (%):	100	76-99	51-75	26-50	1-25	0

6. The Expert Meeting recommended that appropriate action be taken to ensure that all RBCN CLIMAT and CLIMAT TEMP messages are tagged for global distribution and that deficiencies be brought to the attention of the Regional Telecommunications Hubs (RTHs).

7. The Expert Meeting 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. It recommended that CBS Lead Centres for GCOS Data be established on a trial basis to facilitate the exchange of this information directly with the NMHSs involved, with proposed Terms of Reference as follows:

Proposed Terms of Reference for CBS Lead Centres for GCOS Data

- Evaluate the monitoring results of the GCOS Monitoring and Analysis Centres;
- Co-ordinate activities with other GCOS Centres and/or other centres as appropriate;
- Liaise with nominated Points of Contact for GCOS data to improve data availability and quality;
- Monitor and report to CBS and GCOS on action taken and progress achieved;
- Maintain the list of Points of Contact in co-operation with WMO Secretariat.

The Expert Meeting further recommended the nomination of Points of Contact (POCs) by each of the NMHSs, 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. Proposed Terms of Reference for the POCs are as follows:

Proposed Terms of Reference for Points of Contact for GSN and GUAN

- Liaise within the NMHS on GSN and GUAN issues related to data availability and quality;
- Inform Lead Centres on current and potential problems that might impact data availability and quality;
- Respond to requests from CBS Lead Centres for GCOS Data regarding data availability and quality.

8. The Expert Meeting noted with appreciation the offer, subject to final confirmation, of the GSNMC (DWD and JMA) and the GSN/GUAN Analysis Centre (NCDC) to carry out the function of CBS Lead Centre for GCOS Data on a trial basis.

9. The Expert Meeting recommended that all performance results from the GCOS Monitoring and Analysis Centres be made available without restrictions via their respective Web sites and other appropriate mechanisms.

10. The Expert Meeting noted with appreciation the ambitious plans of the GSNMC for making performance results readily available to all users through interactive access to the GSNMC Web site and strongly encouraged the DWD and JMA to continue their activities in this regard at the highest possible level.

11. The Expert Meeting noted with appreciation the progress being made in identifying the detailed status of a number of underperforming GSN and GUAN stations through efforts being supported through the US National Weather Service and encouraged the continuation of these efforts to improve the availability and quality of GSN and GUAN data.

12. The Expert Meeting recognized the urgent need for overall coordination of GSN and GUAN implementation activities and strongly encouraged the establishment of a project office dedicated to this task.

13. The Expert Meeting recognized the need for a single, centrally maintained list of GSN and GUAN stations and welcomed the activities currently being carried out toward this end.

14. The Expert Meeting noted the substantial progress achieved through the current session of the group and recommended that such meetings be continued.

ANNEX VII

AGG RECOMMENDATIONS APPROVED AT AOPC-VIII

1. The AGG confirmed the requirement for availability of at least 20 years of historical data from prospective GSN stations, but agreed that this requirement could be relaxed in special circumstances – for example, where new stations (including Automatic Weather Stations) are being installed in very important geographical locations where gaps in GSN coverage now exist.

2. The AGG agreed with the GCOS Steering Committee recommendation regarding the urgent need for a dedicated project office for coordination of GCOS Baseline Systems, especially the GSN and GUAN.

3. The AGG recognized the need to identify priority GSN stations which would benefit most from directed support, from amongst the 300-or-so stations which are now consistently underperforming or silent. It decided that these should be selected on a country-by-country rather than station-by-station basis, in view of the fact that contacts with station operators would be on a country-by-country basis. It recommended beginning with the following groups of countries, in priority order:

   (a) Angola, Democratic Republic of Congo, Ethiopia, and Sudan;

   (b) Other WMO RA I countries such as Mozambique, Madagascar and Namibia;

   (c) Peru, Bolivia and Ecuador.

4. The AGG noted the apparent significant underperformance of a number of stations in the south-west Pacific Ocean region based on the GSNMC monitoring results, and requested that the WMO and GCOS Secretariats investigate this situation with some of the countries involved (e.g. France, New Zealand).

5. The AGG recognized that the cut-off date (21st day of the following month) for monitoring receipt of CLIMAT messages by the GSN Monitoring Centre could produce an underestimation of the true performance of some stations, given the possibility of data reaching the GSN Archive at a later time by means other than the WMO/GTS. It therefore recommended that the GSN Archive regularly review the GSN monitoring results on a delayed basis of perhaps six months to identify those stations which are indicated as non-reporting in the regular statistics but for which the missing data have in fact been received at the archive.

6. The AGG reconfirmed the desirability of an additional GUAN station in the central USA and requested that the inclusion of such a station (possibly 72451 DODGE CITY) be pursued.

7. The AGG reconfirmed the high priority of 84008 SAN CRISTOBAL, Galapagos Islands, as an operational GUAN station. It also agreed that 64210 KINSHASHA and 66160 LUANDA be added as high priority stations for GUAN and that 64235 KANANGA and 64400 PONTE NOIRE be removed from the list.

8. The AGG agreed that the following proposed changes (discussed at Offenbach and at AOPC-VIII) be accepted:

- the request of the Japan Meteorological Agency to withdraw 9 current GSN stations from its RA II list of 17 (47421 SUTTO, 47585 MIYAKO, 47678 HACHIJOJIMA, 47740 SAIGO, 47800 IZUHARA, 47821 ASOSAN, 47827 KAGOSHIMA, 47909 NAZE and 47918 ISHIGAKIJIMA) and add instead 5 other stations (47401 WAKKANAI, 47582 AKITA, 47815 OITA, 47817 NAGASAKI and 47927 MIYAKOJIMA), bringing the Japan total to 13 GSN stations (in addition to 89532 SYOWA in Antarctica). The AGG expressed its appreciation to the JMA for already having sent historical data for these new stations to the GSN Archive;

- the offer of the Deutscher Wetterdienst of 89002 NEUMAYER as a GSN station;

- the offer of the Armenian Administration of Hydrometeorology of 37789 YEREVAN as a GUAN station;

- the offer of the Austrian Central Institute for Meteorology and Geodynamics of 11035 WIEN HOHE WARTE as a GUAN and GSN station;

- the offer of Sweden to add 02120 KVIKKJOKK in place of the already deleted 02142 JOKKMOKK;

- delete 15615 MUSSALA as a GSN station;

- retain the number 93947 for CAMPBELL ISLAND, as currently designated in WMO Pub. 9 Vol. A;

- the offer of the Korean Meteorological Administration of 47138 POHANG as a GUAN station.

9. The AGG agreed that, following proposals made by the representative from Argentina at the Offenbach meeting, three GSN stations (87149 PRESIDENCIA ROQUE SAENZ, (87642 AZUL and 87903 LAGO ARGENTINA) be removed, and that three other stations 87155 RESISTENCIA, 87544 PEHUAJO and 87623 SANTA ROSA) be added, thus maintaining the RA III total for Argentina at 22 GSN stations.

10. The AGG accepted the proposal made at Offenbach to replace 87155 RESISTENCIA by 87576 EZEIZA as a GUAN station.

ANNEX VIII

STATUS REPORT FROM GUAN ANALYSIS CENTRE

Mark McCarthy and David Parker
Met Office, Hadley Centre, UK

Background

The principal aims of the GUAN are to ensure a relatively homogenous distribution of upper air stations that meet specific record length and homogeneity requirements outlined by GCOS and to develop, and make available, their current and historical data. It is important to establish a network of stations with reliable prior records and which will continue to provide data in the future. The selection process considered the following guidelines, in order of importance, (1) the position of the station in its contribution to a spatially homogenous network, (2) the performance of the site in producing consistently high quality data, and (3) the existence of a historical record of reasonable length.

Logistical and economical reasons have led to the closures of many global radiosonde sites, particularly in geographically remote or data sparse areas. This has underlined the necessity for a continuous long-term support network. A 150 station network was proposed at the first session of the atmospheric observation panel for climate (AOPC) (GCOS-6, 1994). The European Centre for Medium Range Weather Forecasts (ECMWF) was requested by CBS-XI to act as lead data monitoring centre, and provide 6-monthly reports on availability and quality of upper air data from GUAN stations. The Met Office Hadley Centre in the UK and National Oceanographic and Atmospheric Administration (NOAA), National Climate Data Center (NCDC) in the USA, are to act as GUAN Analysis Centres (GCOS-45, 1998) committed to creating and maintaining datasets and metadata products relating to the GUAN. Monitoring activities are currently occurring at both ECMWF and the Hadley Centre providing reports on quality and receipt of daily TEMP and PILOT observations, and receipt of monthly CLIMAT TEMP data respectively.

Details of the monitoring procedure(s)

CLIMAT TEMP reports are received at the Met Office routinely each month via the GTS, email, post, and fax. These pass though in-house decode and hydrostatic quality control procedures and are maintained on the Hadley centre CLIMAT TEMP archive.

The monthly receipt of CLIMAT TEMP messages is monitored. A reference list of the reliability of all GUAN and other CLIMAT TEMP stations based on percentage of reports received in the 1990s is compared against stations received each month and presented graphically on the Met Office GUAN website . Assessments of station reliability over 6 month to annual timescales are produced on request, with work underway to routinely provide these and other statistics via the web interface. The Annex to this document lists reliability for 1999-2001.

ECMWF provide reports on the quality and availability of daily TEMP and PILOT radiosonde messages received and decoded at ECMWF in time for the appropriate analysis.
Monitoring charts and tables presenting data receipt and gross error counts are being produced on a monthly basis, and work is underway to present these on the ECMWF website.

Results

Figure 1 shows the GUAN performance based on CLIMAT TEMP receipt for February 2002. Also shown are non-GUAN reliable stations that have reported a CLIMAT TEMP message. Typical reception tends to be of the order of 100 stations. Approximately 25-30% of the network fails to report consistently. South America, Africa and parts of Asia are regions where performance is particularly poor.

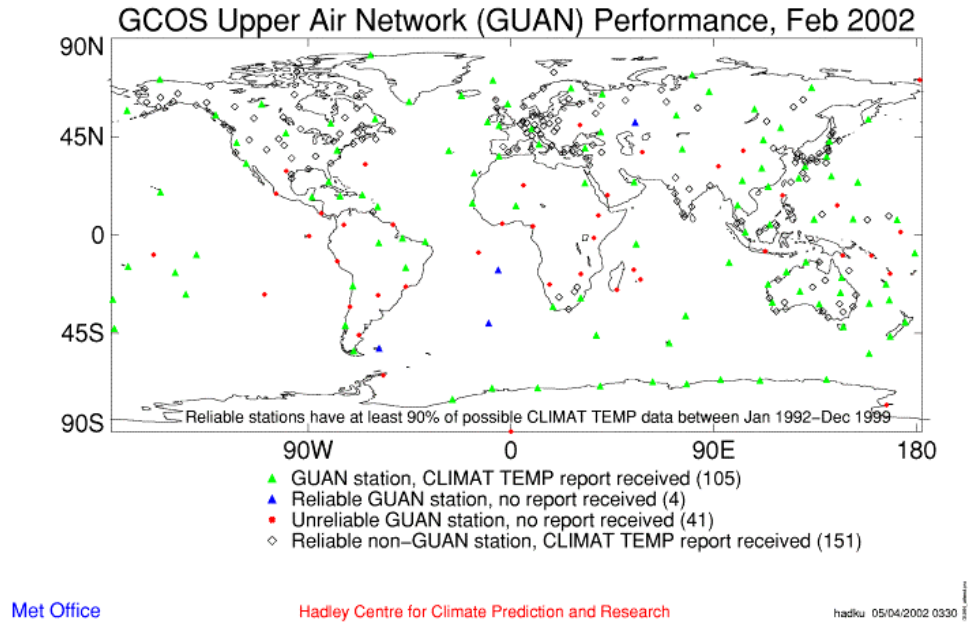

Figure 1: Map of CLIMAT TEMP receipt at Hadley Centre for February 2002

Table 1 shows the percentage receipt of GUAN data since 1999. 18% of the network is effectively silent, with fewer than 10% of reports received. Over this period the GUAN has maintained its overall performance, but it is clear that the network has further degraded over Africa and South America – regions of great importance for climate monitoring and research. Improvement in reporting has been observed in North and Central America, largely due to improved receipt of data from the Caribbean.

WMO REGION	1999 Reporting percentage	2000 Reporting percentage	2001 Reporting percentage
I – Africa	63%	53%	53%
II – Asia	64%	58%	60%
III – S. America	60%	52%	52%
IV– N+Cntrl.America	55%	60%	84%
V – S.W.Pacific	76%	76%	75%

VI – Europe	92%	89%	89%
VII – Antarctica	72%	74%	75%
Globe	69%	66%	69%

Table 1: Reporting percentage of CLIMAT TEMP messages 1999-2001 by WMO RA

Figure 2 shows the availability of historical GUAN data for the period 1958-1998. These data are from a combined temperature series from the Hadley Centre CLIMAT TEMP archive and monthly mean statistics from the CARDS dataset kept at NCDC. It is clear that historically it is possible to obtain 80-100% coverage of the GUAN back to the 1970s. South America, Antarctica, SouthWest Pacific, and Africa still require further augmentation if the GUAN historical series is to achieve acceptable spatial homogeneity. Original data from all GUAN stations are desirable for assessing differences between the currently available datasets, and station history data are vital to assess spurious signals and biases in the time-series.

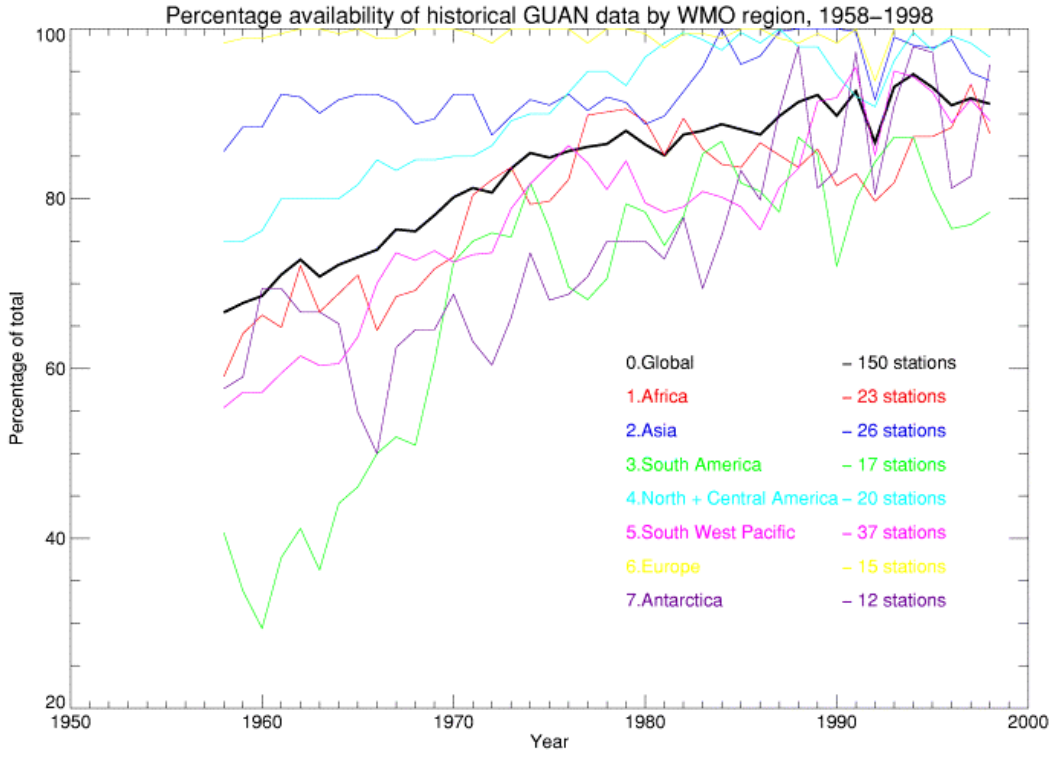

Figure 2: Percentage availability of historical GUAN data by WMO RA. Based on combination of CLIMAT TEMP data from the Hadley Centre, and MONADS from the CARDS project at NCDC.

Figure 3 shows the reception of daily TEMP reports at ECMWF in February 2002 as a percentage of the 28 possible days. Again much of the Northern Hemisphere is well observed, but large regions of the Southern Hemisphere are poorly covered, notably South America and East and South Africa.

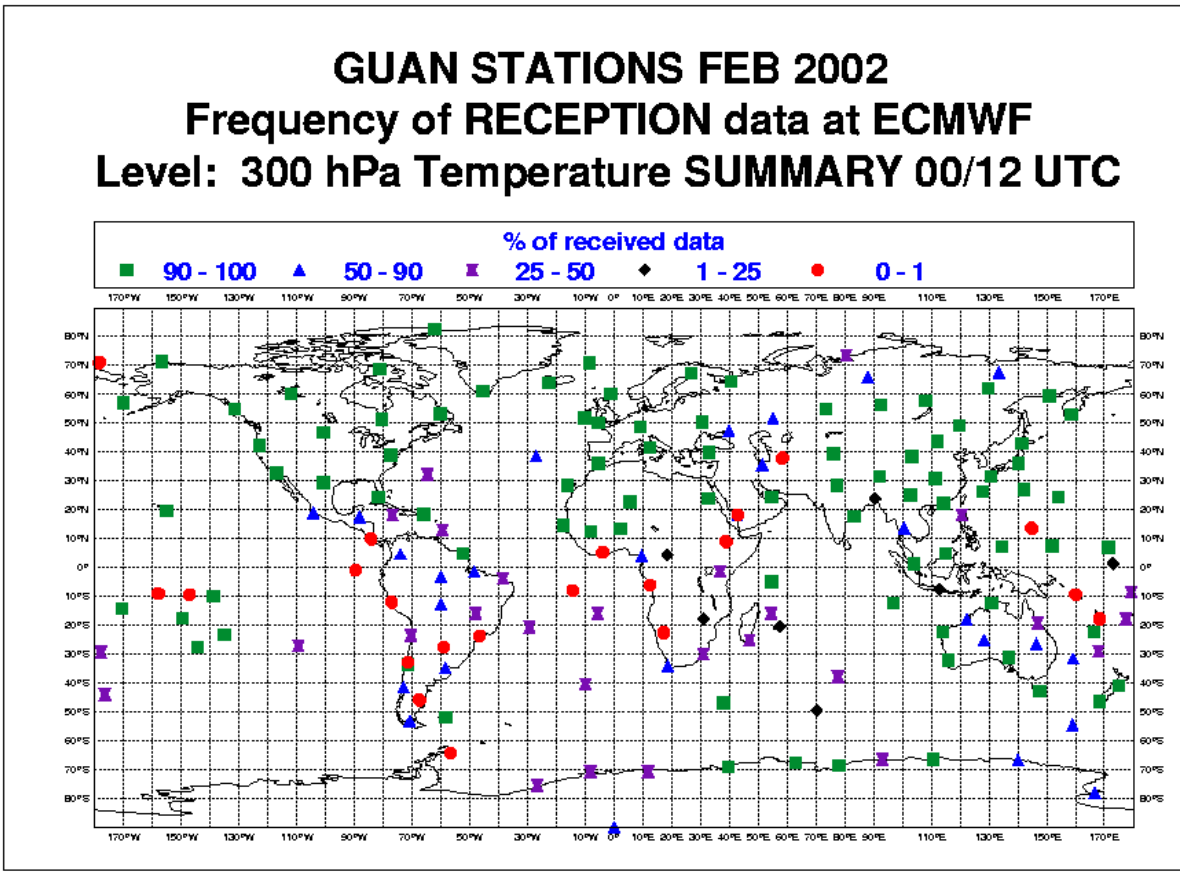

Figure 3:ECMWF monitoring statistics for TEMP reports.

Fuller, regional details, including the numbers of gross errors, are collated monthly in tabular and map form by ECMWF. Figure 4 shows receipt and gross error count for the African region for 300hPa temperatures from TEMP reports in February 2002. For 300hPa temperatures in February 31 gross errors were identified. This is only a very small fraction of the total number of reports received.

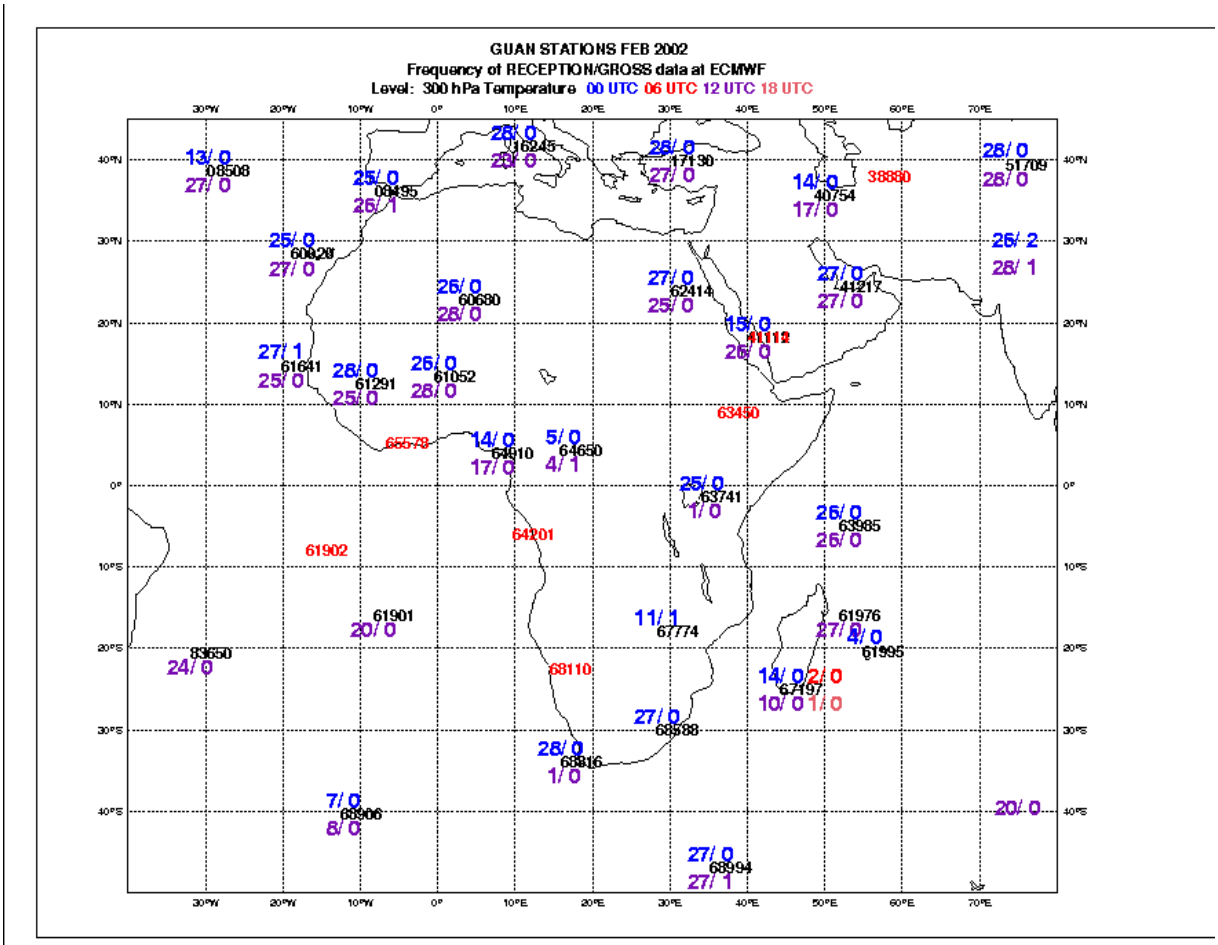

Figure 4: Days with data received/gross errors for African stations for each reporting hour, February 2002. From ECMWF TEMP receipt.

Future activities

Website development is currently underway at the Met Office. Reporting percentages and station reliability lists will become available. It is also intended to place coded and decoded CLIMAT TEMP messages for GUAN stations on the web. Provision of the augmented and improved temperature series (see Figure 2) via the web is problematic due to security issues related to external access to the database on which the data are stored. GUAN Data are currently available from the NCDC CARDS project website, and ECMWF monitoring statistics will be available on the web shortly. 6-monthly summaries corresponding to Figures 3 and 4 would be a useful development.

Station reliability and data receipt, rather than data quality, are the principal issues to be resolved if it is hoped to achieve the network standards of data availability and homogeneity required to make GUAN worthwhile. This includes real-time reporting, and obtaining further historical data and station history information from particular regions.

Conclusions

- Radiosonde observations in South America and Africa need to be supported to reverse the decline in data availability in these important regions.
- Working level contacts should be established for GUAN stations, such that data not received due to GTS or other communication problems can be requested by alternative means.

References

GCOS-6 (WMO/TD-No. 640), 1994: Report of the GCOS Atmospheric Observation Panel, first session (Hamburg, Germany, April 25-28, 1994).

GCOS-45 (WMO/TD-No. 922), 1998: Report of the joint meeting of the GCOS/WCRP Atmospheric Observation Panel for climate and the GCOS/GOOS/GTOS

ANNEX

Reliability of GUAN stations 1999-2001

Number of stations	WMO REGION	Number of reliable stations	Number of less reliable stations	Number of poor stations	Number of silent stations
23	I – Africa	7	6	7	3
26	II – Asia	13	3	3	7
17	III – S. America	2	9	2	4
20	IV – N+Cntrl.America	11	1	7	1
37	V – S.W.Pacific	25	4	0	8
15	VI – Europe	11	3	0	1
12	VII – Antarctica	8	1	0	3
150	Globe	77	27	19	27

A reliable station has reported at least 90% of months, 1999-2001.
A less reliable station has reported between 50% and 89% of months, 1999-2001.
A poor station has reported between 10% and 49% of months, 1999-2001.
A silent station has reported less than 10% of months, 1999-2001.

< 10% reception:

21982 OSTROV VRANGELJA	RUSSIAN FED ASIA	0
33345 KYIV	UKRAINE	0
38880 ASHGABAT	TURKMENISTAN	0
51709 KASHI	CHINA	8
52681 MINQIN	CHINA	0
53068 ERENHOT	CHINA	8
55299 NAGQU	CHINA	0
57461 YICHANG	CHINA	6
61902 WIDE AWAKE FIELD	ASCENSION ISLAND	0
67197 FORT-DAUPHIN	MADAGASCAR	8
68110 WINDHOEK	NAMIBIA	0
78016 BERMUDA NAVAL AIR STATION	BERMUDA	0
81405 CAYENNE/ROCHAMBEAU	FRENCH GUIANA	3
84008 SAN CRISTOBAL (GALAPAGOS)	ECUADOR	0
84628 LIMA-CALLAO/AEROP. INTL CHAVEZ	PERU	8
85469 ISLA DE PASCUA	CHILE	0
89009 AMUNDSEN-SCOTT	ANTARCTICA	8
89055 BASE MARAMBIO (MET. ANTARTICO)	ANTARCTICA	0
89664 MCMURDO	ANTARCTICA	0
91217 WSMO AGANA, GUAM MARIANA IS.	GUAM	0
91517 HONIARA	SOLOMON ISLANDS	0
91557 BAUERFIELD (EFATE)	VANUATU	0
91610 TARAWA	KIRIBATI	0
91801 PENRHYN	COOK ISLANDS	0
92035 PORT MORESBY W.O.	PAPUA NEW GUINEA	0
96935 SURABAYA/JUANDA	INDONESIA	3
98223 LAOAG	PHILIPPINES	6

Between 10% and 49% reception:

41114 KHAMIS MUSHAIT	SAUDI ARABIA	17
50527 HAILAR	CHINA	33
56778 KUNMING	CHINA	47
61995 VACOAS (MAURITIUS)	MAURITIUS	22
61996 MARTIN DE VIVIES (ILE AMSTERDAM)	AMSTERDAM ISLAND	33
63450 ADDIS ABABA-BOLE	ETHIOPIA	22
63741 NAIROBI/DAGORETTI	KENYA	11

64910 DOUALA R.S.	CAMEROON	47
65578 ABIDJAN	COTE D'IVOIRE	25
67774 HARARE (BELVEDERE)	ZIMBABWE	14
70026 BARROW/W. POST W. ROGERS	USA (ALASKA)	31
72201 KEY WEST/INT., FL.	USA	31
72261 DEL RIO/INT., TX.	USA	31
76654 MANZANILLO, COL.	MEXICO	22
78397 KINGSTON/NORMAN MANLEY	JAMAICA	31
78583 BELIZE/PHILLIP GOLDSTON INTL.	BELIZE	39
78954 GRANTLEY ADAMS	BARBADOS	31
85543 QUINTERO	CHILE	17
87860 COMODORO RIVADAVIA AERO	ARGENTINA	47

Between 50% and 89% reception:

02836 SODANKYLA	FINLAND	89
04270 NARSARSUAQ	GREENLAND	86
08508 LAJES/SANTA RITA (ACORES)	PORTUGAL	86
24266 VERHOJANSK	RUSSIAN FED ASIA	83
35121 ORENBURG	RUSSIAN FED ASIA	58
47991 MINAMITORISHIMA	JAPAN	78
60680 TAMANRASSET	ALGERIA	61
61052 NIAMEY-AERO	NIGER	78
61641 DAKAR/YOFF	SENEGAL	89
61901 ST. HELENA IS.	ST. HELENA	69
61976 SERGE-FROLOW (ILE TROMELIN)	TROMELIN ISLAND	64
63985 SEYCHELLES INTER. AIRPORT	SEYCHELLES	81
78762 JUAN SANTAMARIA	COSTA RICA	61
80222 BOGOTA/ELDORADO	COLOMBIA	78
82397 FORTALEZA	BRAZIL	89
83378 BRASILIA (AEROPORTO)	BRAZIL	72
83780 SAO PAULO (AEROPORTO)	BRAZIL	58
85442 ANTOFAGASTA	CHILE	67
85799 PUERTO MONTT	CHILE	75
85934 PUNTA ARENAS	CHILE	81
87155 RESISTENCIA AERO.	ARGENTINA	53
88889 MOUNT PLEASANT AIRPORT	FALKLAND ISLANDS	89
89642 DUMONT D'URVILLE	ANTARCTICA	81
91643 FUNAFUTI	TUVALU	64
91765 PAGO PAGO/INT.AIRP.	SAMOA	81
91925 ATUONA	FRENCH POLYNESIA	86
96315 BRUNEI AIRPORT	BRUNEI	86

GOOD STATIONS > 90% reception:

01001 JAN MAYEN	NORWAY	100
03005 LERWICK	UK	97
03808 CAMBORNE	UK	100
03953 VALENTIA OBSERVATORY	IRELAND	100
04018 KEFLAVIKURFLUGVOLLUR	ICELAND	97
08495 GIBRALTAR	GIBRALTAR	100
10739 STUTTGART/SCHNARRENBERG	GERMANY	100
16245 PRATICA DI MARE	ITALY	100
17130 ANKARA/CENTRAL	TURKEY	97
20674 OSTROV DIKSON	RUSSIAN FED ASIA	100
22550 ARHANGEL'SK	RUSSIAN FED EUROPE	100
23472 TURUHANSK	RUSSIAN FED ASIA	92
28698 OMSK	RUSSIAN FED ASIA	100
30230 KIRENSK	RUSSIAN FED ASIA	94
32540 PETROPAVLOVSK-KAMCHATSKIJ	RUSSIAN FED ASIA	97
34731 ROSTOV-NA-DONU	RUSSIAN FED EUROPE	100
41217 ABU DHABI INTER. AIRPORT	UNITED ARAB EMIRATES	100
45004 KING'S PARK	HONG KONG	100
47412 SAPPORO	JAPAN	100
47646 TATENO	JAPAN	100
47827 KAGOSHIMA	JAPAN	97
47936 NAHA	JAPAN	100
47971 CHICHIJIMA	JAPAN	97
48455 BANGKOK	THAILAND	100
48698 SINGAPORE/CHANGI AIRPORT	SINGAPORE	100
60020 SANTA CRUZ DE TENERIFE, CMZ	SPAIN (CANARY ISLES)	94
61998 PORT-AUX-FRANCAIS	KERGUELEN ISLAND	92
62414 ASSWAN	EGYPT	92
68588 DURBAN INTNL. AIRPORT	SOUTH AFRICA	100
68816 CAPE TOWN INTNL. AIRPORT	SOUTH AFRICA	100
68906 GOUGH ISLAND	SOUTH AFRICA	92

68994	MARION ISLAND	SOUTH AFRICA	94
70308	ST. PAUL	USA (ALASKA)	100
70398	ANNETTE ISLAND	USA (ALASKA)	100
71082	ALERT UA, N.W.T.	CANADA	94
71816	GOOSE UA, NFLD.	CANADA	94
71836	MOOSONEE, ONT	CANADA	92
71934	FORT SMITH UA, N.W.T.	CANADA	94
72293	SAN DIEGO/MIRAMAR, NAS, CA.	USA	100
72403	STERLING, VA.	USA	92
72597	MEDFORD/MEDFORD	USA	100
72764	BISMARCK/MUN., ND.	USA	100
78526	SAN JUAN/INT., PUERTO RICO	PUERTO RICO	97
82193	BELEM (AEROPORTO)	BRAZIL	92
82332	MANAUS (AEROPORTO)	BRAZIL	92
89002	NEUMAYER	ANTARCTICA	97
89022	HALLEY	ANTARCTICA	92
89512	NOVOLAZAREVSKAJA	ANTARCTICA	100
89532	SYOWA	ANTARCTICA	100
89564	MAWSON	ANTARCTICA	100
89571	DAVIS	ANTARCTICA	100
89592	MIRNYJ	ANTARCTICA	100
89611	CASEY	ANTARCTICA	97
91285	HILO/GEN. LYMAN, HAWAII, HAWAII	HAWAII	100
91334	TRUK, CAROLINE IS.	TRUK ISLAND	100
91376	MAJURO/MARSHALL IS. INTNL.	MAJURO	94
91408	KOROR, PALAU IS.	PALAU ISLAND	97
91592	NOUMEA (NLLE-CALEDONIE)	NEW CALEDONIA	97
91938	TAHITI-FAAA	FRENCH POLYNESIA	100
91958	RAPA	FRENCH POLYNESIA	100
93417	PARAPARAUMU AERODROME	NEW ZEALAND	94
93844	INVERCARGILL AERODROME	NEW ZEALAND	94
93986	CHATHAM ISLAND	NEW ZEALAND	94
93997	RAOUL ISLAND, KERMADEC IS.	NEW ZEALAND	94
94120	DARWIN AIRPORT	AUSTRALIA	100
94203	BROOME AIRPORT	AUSTRALIA	100
94294	TOWNSVILLE AMO	AUSTRALIA	100
94302	LEARMONTH AIRPORT	AUSTRALIA	100
94461	GILES	AUSTRALIA	100
94510	CHARLEVILLE AMO	AUSTRALIA	100
94610	PERTH AIRPORT	AUSTRALIA	100
94659	WOOMERA AERODROME MO	AUSTRALIA	100
94975	HOBART AIRPORT	AUSTRALIA	100
94995	LORD HOWE ISLAND AERO	AUSTRALIA (ISLANDS)	100
94996	NORFOLK ISLAND AERO	AUSTRALIA (ISLANDS)	100
94998	MACQUARIE ISLAND	AUSTRALIA (ISLANDS)	100
96996	COCOS ISLAND AERO	COCOS ISLAND	97

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ANNEX IX

GSN-GUAN DATA MANAGEMENT STRUCTURE

The GSN-GUAN Data Management Structure includes monitoring the availability of data, quality control, the analysis of the data, product development, and archiving of the final datasets. Detailed responsibilities of the individual components are given below.

A. GCOS Monitoring Centre (DWD and JMA for GSN; ECMWF and Hadley Centre for GUAN)

The tasks of a GCOS Monitoring Centre are to:

- Monitor the availability, timeliness and completeness of the incoming data and messages received via GTS or other communication medium with the objective of improving the performance of the network being monitored;
- Perform fundamental quality-control and assurance procedures on the incoming data and metadata to ensure the basic quality and completeness of the dataset;
- Make basic quality-controlled data available to National Meteorological and Hydrological Services (NMHSs) and World Data Centres (WDCs) and others for their use in a variety of climate applications and products.

B. GCOS Analysis Centre (NCDC for GSN; Hadley Centre and NCDC for GUAN)

A GCOS Analysis Centre will provide higher-level quality control of both the daily and monthly GCOS network data.

- For the daily data, this will include updating and quality-controlling the data, applying bias corrections, calculating monthly statistics from daily data and providing daily and derived monthly data, metadata and products to users;
- For the monthly data, this will include analyzing the data; improving bias adjustments and the monthly station database; creating global and regional monthly statistics; and developing and providing gridded products with reduced biases;
- The centre will also report on historical data and metadata reception.

C. GCOS Archive (WDC-Asheville for GSN and GUAN)

A GCOS Archive should be co-located with a World Data Centre (WDC) or recognized, established data centre, if possible.

- It will archive both the monthly and the daily data (in delayed-mode), as well as historical data, including metadata, for each station.
- A GCOS archive will make all GCOS data and products available to all potential users on a free and unrestricted basis.
- Data in the WDC may come either from data available at WDCs (e.g., from the Global Historical Climatology Network (GHCN)); from quality-controlled data available at the Monitoring Centres; from data submitted, upon request, by national centres (e.g., NMHSs) and available digitally and updated on a routine basis, or from any other source openly available to the archive for unrestricted further distribution.

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ANNEX X

GCOS CLIMATE MONITORING PRINCIPLES

(as submitted to WMO EC-LIV, June 2002)

Effective monitoring systems for climate should adhere to the following principles:*

1. The impact of new systems or changes to existing systems should be assessed prior to implementation.

2. A suitable period of overlap for new and old observing systems is required.

3. The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves.

4. The quality and homogeneity of data should be regularly assessed as a part of routine operations.

5. Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.

6. Operation of historically-uninterrupted stations and observing systems should be maintained.

7. High priority for additional observations should be focussed on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution.

8. Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of system design and implementation.

9. The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted.

10. Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

Furthermore, satellite systems for monitoring climate should adhere to the following specific principles:

11. Rigorous station-keeping should be maintained to minimize orbital drift.

12. Overlapping observations should be ensured for a period sufficient to determine inter-satellite biases.

13. Satellites should be replaced within their projected operational lifetime (rather than on failure) to ensure continuity (or in-orbit replacements should be maintained).

14. Rigorous pre-launch instrument characterization and calibration should be ensured.

15. Adequate on-board calibration and means to monitor instrument characteristics in space should be ensured.

16. Development and operational production of priority climate products should be ensured.

17. Systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained.

18. Continuing use of still-functioning baseline instruments on otherwise de-commissioned satellites should be considered.

19. The need for complementary in-situ baseline observations for satellite measurements should be appropriately recognized.

20. Network performance monitoring systems to identify both random errors and time-dependent biases in satellite observations should be established.

* *The ten basic principles were adopted (in paraphrased form) by the Conference of the Parties to the UN Framework Convention on Climate Change through Decision 5/CP.5 of COP-5 at Bonn in November, 1999.*

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ANNEX XI

AOPC-VIII: CONSOLIDATED LIST OF DECISIONS, RECOMMENDATIONS AND ACTION ITEMS

Item 3 – GCOS Director's Report

1. The AOPC recognized the need to strengthen the interactions between GCOS/AOPC and the atmospheric constituents community and requested that the Chairman communicate with the GAW infrastructure to augment their collaboration in this regard.

2. The AOPC recognized the need for improving the definition of the science requirements for climate observations in the terrestrial domain and requested that the Chairman initiate increased collaboration with TOPC to assist in fulfilling this need.

3. The AOPC recognized the potential benefits of an improved international framework for terrestrial observations and requested that the Chairman initiate discussions with TOPC to explore the possibilities for establishing such a framework.

4. The AOPC concurred with the need expressed by the GCOS SC for increased involvement of the GCOS Science Panels in the Regional Workshop Programme. The Panel agreed on a number of possible topics and presentations which could be included in the workshops which would focus on AOPC and other Panels' issues and which could involve Panel members directly in many cases.

Item 4 - UNFCCC

5. The AOPC reviewed the draft list of climate parameters proposed as the basis for preparing the Second Adequacy Report to the UNFCCC/SBSTA and provided suggestions to the SC Chairman for a next draft. The Panel also reviewed the parameter summary template, completed the summaries for several sample parameters and agreed on a list of potential authors for completing summaries for the remaining parameters, as initial steps in its participation in the process to develop the report.

Item 5 – AOPC Plan

6. The AOPC expressed its appreciation to the University of Maryland Earth System Science Interdisciplinary Center (ESSIC) and the NOAA Office of Global Programs for supporting the recent meeting (29 April – 2 May 2002) to complete the draft of the AOPC Implementation Plan for Atmospheric Observations (the 'AOPC Plan').

7. The AOPC revised and approved the draft AOPC Plan and requested the Chairman to carry out final editing prior to submitting it to external sources for further review.

Item 6 – Statements of Guidance

8. The AOPC noted the revised Statement of Guidance (SOG) for Seasonal-to-Interannual Forecasts that had been presented to the CBS OPAG/IOS ET-ODRRGOS on behalf of the climate community, and thanked the Chairman for having led its development. It agreed that additional SOGs should be prepared for the two applications of Monitoring Climate Variability and Monitoring Climate

Change, and requested that the Chairman finalize the drafts that had been developed at the meeting for submission to the ET-ODRRGOS. The Panel also agreed that completion of the SOG on Monitoring Climate Change should be delayed until a draft of the Second Adequacy Report had been drafted, in view of the commonality involved in the two exercises. The Panel welcomed the increased cooperation between GCOS/AOPC and CBS in the area of observational requirements for climate applications and looked forward to the continuing strengthening of this important relationship.

Item 7 – GSN and GUAN

9. The AOPC expressed its appreciation to the WMO Commission on Basic Systems and the Deutscher Wetterdienst for their support in organizing and hosting the recent CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (EMCGG, Offenbach, Germany, 15-17 May 2002). The Panel welcomed the excellent progress made in assessing the status of, and identifying procedures to improve, the performance of the networks as demonstrated by the positive results from the meeting (Att. 2). The AOPC expressed its full support for those conclusions and recommendations, welcoming in particular the proposal to establish CBS Lead Centres for GCOS Data on a trial basis and the acceptance of the GSN Monitoring Centre (DWD and JMA) and GSN/GUAN Analysis Centre (NCDC) to fulfill those roles.

10. The AOPC reiterated the need for TEMP observations to 5 hPa from all GUAN stations, while recognizing the benefits to station operators of having clear confirmation of this need from the user communities. It requested that the Chairman continue his liaison with those communities to reconfirm this requirement as an aid to justifying the additional efforts required in meeting it.

11. The AOPC, noting the various requests for modifications to the composition of the GSN and GUAN from many of the station operators, requested the Advisory Group on the GSN and GUAN (AGG), through the WMO and GCOS Secretariats and on behalf of the AOPC, to liaise with WMO Members as needed for finalizing and implementing decisions regarding these requests.

12. The AOPC endorsed a number of recommendations made by the AGG during the current session as well as during the recent CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN (see Annex VII).

13. The AOPC requested the AGG to continue its collaboration with the GCOS and WMO Secretariats and the GCOS Monitoring and Analysis Centres to pursue resolution of inconsistencies and other outstanding problems in the GSN and GUAN station lists, including completion of the formal approval process by WMO Members for all stations.

14. The AOPC noted with appreciation the increase in availability of historical data in the GSN and GUAN Archive and requested that the archive pursue efforts to remove remaining impediments to this availability, including direct contact with station operators in cooperation with the NCDC in the latter's role as a CBS Lead Centre for GCOS Data.

15. The AOPC requested that the Chairman of the AGG lead action to investigate and resolve the recent serious drop in the reporting of CLIMAT messages from GSN stations in the Antarctic region.

16. The AOPC expressed its appreciation to the US National Weather Service for their current active support in assessing the impediments to regular reporting of observations from a number of GSN and GUAN stations. It requested AGG to review the GSN and GUAN station lists with a view to confirming a priority list of stations which could benefit from this effort, building on the activities recently ongoing in this regard.

17. The AOPC noted with appreciation the CLIMAT TEMP monitoring activity being carried out by the Hadley Centre and welcomed its agreement to be formally designated as a GUAN Monitoring Centre (with ECMWF), in addition to its current role as a GUAN Analysis Centre (with NCDC).

18. The AOPC reviewed the Terms of Reference for the GCOS Monitoring Centres, GCOS Analysis Centres and GCOS Archive and agreed on the final version presented in Annex IX.

19. The AOPC welcomed the progress in submitting historical monthly data from Brazil to the GSN archive and encouraged the continuation of efforts to provide daily data as well.

20. The AOPC noted with appreciation the major successful effort that had been carried out to digitize historical climate data from a large number of French-speaking West African countries. It noted also, however, that these data had not been made available to the user community, and encouraged the agencies involved to make the data available without restriction as soon as possible.

21. The AOPC recommended that internationally-funded efforts to rescue data stipulate that those data be freely and openly exchanged as a condition of support for their recovery.

22. The AOPC recommended that station operators who had developed corrections for their historical data apply those corrections to the data prior to submitting them to the GCOS Archive, and that both the correction algorithms and the uncorrected data be submitted along with the corrected data. The Panel also recommended that all historical data be adjusted to be consistent with practices currently used for the monthly data which are internationally exchanged.

23. The AOPC expressed its strong appreciation to the GCOS Monitoring and Analysis Centres (DWD, JMA, ECMWF, Hadley Centre, NCDC) and the GCOS Archive (WDC-Asheville) for their dedicated efforts and great progress in monitoring, acquiring and making available GCOS data and products from the GSN and GUAN networks, and encouraged them to continue these efforts.

24. The AOPC encouraged the University of East Anglia Climate Research Unit (CRU) and NCDC to initiate a project to compare the monthly mean temperature values held at their centres for all GSN stations for which data are available. Comparisons should also be made with the monthly averages of daily data from stations in the GSN archive, with the objective of determining and documenting the scale of any differences identified.

25. The AOPC requested that concrete acknowledgement of participation in GSN and GUAN, for example certificates of recognition for display at the site, be prepared and provided to all station operators.

26. The AOPC recognized the benefits of developing a broad recognition of 'GCOS/GSN/GUAN Products' in the user community and encouraged all GCOS-related entities to promote such recognition at every opportunity, including suggesting to users that GCOS be acknowledged when acquiring and making use of these data and products.

Item 8 – SST-SI Working Group

27. The AOPC welcomed the progress of the AOPC/OOPC Working Group on Sea-Surface Temperature and Sea Ice (WG SST-SI) in identifying the sources of some of the differences between SST products, and encouraged further efforts to find ways to reduce the differences between analyses.

28. The AOPC encouraged the WG SST-SI to increase its efforts in the evaluation of sea ice products.

29. The AOPC recognized that night-time marine air temperature (NMAT) provides useful validation of SST analyses and encouraged increased effort in the development of NMAT data and analyses.

30. The AOPC recognized the crucial importance of the drifting buoy programme for accurate estimation of SST and noted the requirement for a substantial increase in the total number of buoys (~50%) to optimise the system.

31. The AOPC noted the success of the recent Workshop on Advances in the Use of Historical Marine Climate Data (Boulder, USA, 29 Jan - 1 Feb 2002) and encouraged the convening of a follow-on workshop, possibly in early 2004.

32. The AOPC expressed its appreciation to C. Folland of the UK Met Office for his informative presentation on issues and activities relating to SST, sea-ice and marine air temperatures and noted the conclusions and recommendations presented.

Item 9 – Surface Pressure Working Group

33. The AOPC noted with appreciation the progress in developing global surface pressure datasets by individual participants in the AOPC/OOPC Working Group on Surface Pressure (WG-SP). It encouraged increased collaboration to accelerate progress in this area and suggested that the group consider holding a workshop toward this end in the near future.

34. The AOPC noted the potential benefit of including surface winds in developing surface pressure analyses and looked forward to continuing progress in this area.

35. The AOPC expressed its appreciation to R. Allan of the UK Met Office for his leadership of the AOPC/OOPC Working Group on Surface Pressure and his presentation of progress by the group at this session.

Item 10 – Large-Scale Indicators

36. The AOPC expressed its appreciation to C. Folland for his review of existing and potential indices of large-scale climate variability. It requested the Chairman and E. Harrison to liaise with Mr Folland to pursue the definition and implementation of appropriate large-scale indicators of climate change which could be derived from GCOS data, noting that these indicators could be regularly updated and displayed via the World Wide Web.

Item 11 - Radiation

37. The AOPC noted the difficulties encountered in maintaining a continuous record of satellite-observed tropospheric temperature due to the major advance in instruments from MSU to AMSU. It reiterated the need to ensure that future instrument developments incorporate sufficient backward compatibility to minimize such difficulties and maintain the integrity of the long-term record for climate monitoring. The Panel requested the Chairman of the GCOS SC to communicate this need to the relevant space agencies, and to emphasize the need to support efforts to reconcile the data obtained from different instruments.

38. The AOPC reiterated the need for broadband measurements of radiation balance at the top of the atmosphere (TOA) on a long-term basis and recommended that the relevant quantities (incoming solar, reflected solar and outgoing long-wave radiation (OLR)) be measured continuously from at least one polar-orbiting satellite. The Panel also encouraged the continuation of studies to identify which spectral radiance bands and measurement techniques are best suited for monitoring changes in radiative forcing from space.

39. The AOPC, recognizing the significant contribution of far infra-red radiation to the total OLR at the TOA and the uncertainty in modelling its effects, both in climate models and in the procedures used to estimate the OLR from multi-spectral satellite radiation measurements, recommended that high priority be given to an experimental satellite mission to study the spectrum of OLR in the far infra-red.

40. The AOPC reiterated the need for long-term measurements of the upwelling and downwelling components of surface radiation fluxes to the standards required for climate studies. The Panel noted with appreciation the major progress of the WCRP/GEWEX Baseline Surface Radiation Network (BSRN) and requested that the Chairman initiate dialogue with the Chairman of the GEWEX Radiation Panel and the BSRN International Project Manager regarding long-term perspectives for the BSRN.

41. The AOPC recognized the availability of the large, long-term database of radiation measurements at the WDC-St Petersburg and encouraged efforts to fully utilize this valuable resource.

42. The AOPC noted the importance of aerosol loading for climate monitoring purposes and the capability for measurement of total aerosol column measurements over the ocean from AVHRR. It encouraged the exploitation of the existing AVHRR dataset for this purpose and the development of techniques for improved monitoring of aerosols.

Item 12 – Satellite Issues

43. The AOPC, noting the continuing lack of consistency in the homogeneity-adjusted upper-air temperature records from radiosondes and the disparity between the upper air and surface temperature trends, recommended the establishment of an ad-hoc Task Group to assist efforts to resolve these difficulties.

44. The AOPC noted with appreciation the work being carried out in various fora to establish procedures for obtaining water vapour measurements in real time using GPS technology.

45. The AOPC reviewed the draft climate monitoring principles with specific application to satellite observations which had been developed for the recent Consultative Meeting on High-Level Policy on Satellite Matters. It requested the Chairman to collaborate with J. Schmetz and P. Mason to develop a final version for submission to WMO EC-LIV (see Annex X).

46. The AOPC noted the review of activities and priorities of the Coordination Group on Meteorological Satellites (CGMS), presented by J. Schmetz, and welcomed the opportunity to increase AOPC links with CGMS through the regular participation of Dr Schmetz in the CGMS forum.

47. The AOPC reiterated the need for baseline satellite observations (i.e. long-term systematic datasets using current and future satellite platforms) to be integrated with *in situ* measurements into a comprehensive climate observing system. It recognized the great potential value of a number of planned missions with particular focus on climate applications and encouraged the agencies involved to continue these efforts.

Item 13 - Land Cover

48. The AOPC noted the increasing evidence of sensitivity to snow-depth as a boundary condition in NWP analyses and strongly encouraged the global exchange of snow depth observations through SYNOP reports, rather than restricting them to regional distribution as is still the case in some regions. It also recommended that necessary action be taken to ensure the smooth distribution of these globally-tagged messages to all users via the WMO Global Telecommunication System (GTS).

49. The AOPC noted that recent modeling activities had shown that the impact of land-surface changes over the last 200 years, in terms of radiative forcing, is comparable in magnitude to estimates of the impact of biomass burning over the last 30-50 years. Such work highlights the importance of changes to surface albedo for all aspects of climate modeling and suggests that satellite measurements of albedo could significantly improve seasonal-to-interannual climate prediction. The Panel welcomed these findings and urged that research efforts be continued into the time evolution of surface albedo and its impact on climate.

50. The AOPC recognized the continuing existence of significant differences among the land-surface datasets developed by different groups and encouraged the holding of a workshop aimed at resolving these differences as soon as feasible.

Item 14 – Paleoclimate Data

51. The AOPC recognized the great value of paleo-archives (ice cores, corals, tree rings) for extending the climate record to before the period of modern instruments, and the urgency to take maximum advantage of these archives before their potential disappearance. The Panel endorsed the high priority being given to this issue by the IGBP/PAGES and related programmes and encouraged their support.

Item 15 - Marine Issues

52. The AOPC noted the positive impacts on analyses over the southern oceans of observations from the first year of operation of the Worldwide Recurring ASAP Programme (WRAP) initiative. It welcomed the planned continuation of WRAP using other ships and encouraged expansion of the programme to the extent possible.

53. The AOPC reiterated its recommendation that surface pressure sensors be included on surface drifting buoys deployed in otherwise poorly-sampled regions, noting the importance of SLP observations for monitoring climate variability and change as well as for improving operational analyses of marine surface conditions.

Item 16 – Data Distribution and Access

54. The AOPC noted the developing technology (e.g. XML) to facilitate access to distributed datasets and metadata and the proposed workshop in 2003 related to this issue. It requested H. Diamond to inform the Panel of developments in this area, including results of the workshop.

55. The AOPC noted with appreciation the ongoing efforts to improve access to data by the GCOS Monitoring and Analysis Centres.

56. The AOPC noted that its Implementation Plan for Atmospheric Observations highlights the importance of data access in the GCOS data management structure, while noting also that the GCOS Monitoring Centres, Analysis Centres and Archive are developing systems which will meet AOPC objectives without recourse to the Global Observing Systems Information Centre (GOSIC).

Item 17 – Reanalysis and Synthesized Products

57. The AOPC welcomed the review of reanalysis issues presented by P. Arkin. It noted in particular the proposal for a US National Program for Analysis of the Climate System (NPACS) and requested that it be kept informed of further developments.

58. The AOPC expressed its appreciation to K. Trenberth for attending and reporting on the ERA-40 workshop on behalf of AOPC.

59. The AOPC recognized the great value of the ERA-40 reanalysis and the enormous effort and cost that had gone into carrying it out. It nevertheless noted that the costs to researchers of acquiring the data resulting from this effort remained prohibitively high in most cases, and recommended that all possible steps be pursued to ameliorate this situation.

60. The AOPC noted the significant improvement of the ERA-40 reanalysis over the earlier ERA-15 results and the benefits of coordinating the scheduling of reanalyses and pooling of data by the groups involved (Europe, Japan, USA). It strongly encouraged the development of a continuing programme of climate analysis and timely reanalysis to produce both current and historical datasets through international cooperation and collaboration.

61. The AOPC welcomed the progress in developing high-resolution global rainfall analyses at the Global Precipitation Climatology Centre (GPCC) and looked forward to publication and exploitation of the results of this valuable work.

Item 18 – Liaison with Other Entities

62. The AOPC, having reviewed the proposal from the President of the WMO CCl regarding the possible establishment of a joint mechanism to achieve specific tasks related to global and regional climate observing networks, agreed that AOPC should maintain its prime focus on issues involving global climate networks, as is currently mandated by its Terms of Reference, on behalf of GCOS, WCRP, CCl and other relevant groups. It recommended that the proposed CCl Expert Team on National

Networks and Observations in Support of Climate Activities be established, and that its mandate include issues involving regional climate networks such as the WMO Regional Basic Climatological Networks (RBCN). The Panel further recommended that the Chairman of the CCl Expert Team be invited to participate *ex officio* in sessions of the AOPC as one mechanism to ensure the appropriate liaison and coordination between GCOS, WCRP and CCl on issues of mutual interest.

63. The AOPC requested that the GSN and GUAN Monitoring Centres extend their monitoring activities to include all CLIMAT and CLIMAT TEMP stations and make the results available to WMO/CCl and other potential users.

64. The AOPC looked forward to increased cooperation with the TOPC on terrestrial matters of mutual concern, including the observation of land-surface parameters such as soil moisture and surface albedo as boundary conditions for climate models, noting that the development of the Second Adequacy Report would provide an excellent opportunity for such enhanced cooperation.

Item 19 – Other Issues

65. The AOPC expressed its appreciation to E. Harrison for providing an update on the latest data from the TAO/Triton array in the tropical Pacific and insights into the possible significance of these data.

66. The AOPC confirmed its support for the concept of an international conference on Atmospheric Observations for Climate and encouraged the Chairman to continue discussions with the Chairman of the CLIVAR Scientific Steering Group and the Directors of the GCOS Secretariat and the WCRP Joint Planning Staff concerning the possibility of jointly organizing such a conference, possibly in late 2003 or early 2004.

67. The AOPC agreed that the Ninth Session of the panel should be held on 23-27 June 2003 at a location to be confirmed in due course.

68. The SC expressed its appreciation to the UK Met Office and the Chairman of the GCOS Steering Committee and his staff for their strong support and kind hospitality in hosting the session, and particularly for the excellent facilities and congenial venue provided.

ANNEX XII

LIST OF ACRONYMS AND ABBREVIATIONS

AGG	AOPC Advisory Group on GSN and GUAN
AMIP	Atmospheric Model Intercomparison Project
AMSU	Advanced Microwave Sound Unit
AOPC	Atmospheric Observation Panel for Climate
APN	Asia-Pacific Network
ASAP	Automated Shipboard Aerological Programme
AVHRR	Advanced Very High Resolution Radiometer
BOM	Australian Bureau of Meteorology
BSRN	Baseline Surface Radiation Network
CAS	Commission for Atmospheric Sciences
CBS	Commission for Basic Systems (WMO)
CCD/A	Climate Change Detection and Attribution
CCl	Commission for Climatology (WMO)
CDAS	Climate Data Assimilation System
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CLIMAT	Report of monthly means and totals from a WWW land station
CLIVAR	Climate Variability and Predictability (WCRP)
CMA	China Meteorological Administration
CMM	Commission for Marine Meteorology
COP	Conference of the Parties (to UNFCCC)
CRF	Cloud Radiative Forcing
CRU	Climate Research Unit, University of East Anglia
DAO	Data Assimilation Office
DARE	Data Rescue (WCDMP project)
DBCP	Data Buoy Cooperation Panel
DIM	Data and Information Management
DWD	Deutscher Wetterdienst
EC	European Community
EC	Executive Council (WMO)
ECMWF	European Centre for Medium-Range Weather Forecasts
EMCGG	CBS/GCOS Expert Meeting on Coordination of the GSN and GUAN
ENSO	El Niño/Southern Oscillation
ERB	Earth Radiation Budget
ESSIC	Earth System Science Interdisciplinary Center, University of Maryland
ET-ODRRGOS	Expert Team on Observational Data Requirements and Redesign of the Global Observing System
FAO	Food and Agriculture Organization of the United Nations
G3OS	GCOS, GOOS and GTOS
GAW	Global Atmosphere Watch
GCO	Global Carbon Observation
GCOS	Global Climate Observing System
GCMs	Global Climate Models
GDSIDB	Global Digital Sea-Ice Data Bank
GEF	Global Environment Facility

GEMS	Global Environmental Monitoring System
GEWEX	Global Energy and Water Cycle Experiment
GHCN	Global Historical Climatology Network
GLIMS	Global Land Ice Measurements System
GLOSS	Global Sea Level Observing System
GMDSS	Global Maritime Distress and Safety System
GODAE	Global Ocean Data Assimilation Experiment
GOFC	Global Observation of Forest Cover
GOOS	Global Ocean Observing System
GOS	Global Observing System
GOSIC	Global Observing Systems Information Center
GOSSP	Global Observing Systems Space Panel
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRDC	Global Runoff Data Centre
GSN	GCOS Surface Network
GSNMC	GSN Monitoring Centre
GTN	Global Terrestrial Network
GTN-E	Ecosystem Monitoring Network
GTN-G	Glacier Monitoring Network
GTN-H	Hydrology Monitoring Network
GTN-P	Permafrost Monitoring Network
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System
GUAN	GCOS Upper-Air Network
HALOE	Halogen Occultation Experiment
HOPC	Hydrological Observation Panel for Climate
HWR	Hydrology and Water Resources (Department, WMO)
I-COADS	International Comprehensive Ocean-Atmosphere Data Set
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
IGACO	Integrated Global Atmospheric Chemistry Observations (IGOS Theme)
IGOS	Integrated Global Observing Strategy
IGOS-P	Integrated Global Observing Strategy Partnership
IGOSS	Integrated Global Ocean Services System
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IOS	Initial Operational System (GCOS); Integrated Observing System (GOOS)
IPCC	Intergovernmental Panel on Climate Change
ISCCP	International Satellite Cloud Climatology Project
JCOMM	Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM Observing Platform Support Centre
JDIMP	Joint Data and Information Management Panel
JMA	Japan Meteorological Agency
MCDW	Monthly Climatic Data of the World
MECE	Monitoring of Extreme Climate Events
MOU	Memorandum of Understanding
MPERSS	Marine Pollution Emergency Response Support System

MSC	Meteorological Service of Canada
MSLP	Mean-Sea-Level Pressure
MSU	Microwave Sounding Unit
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NGDC	National Geophysical Data Center
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
NPP	Net Primary Productivity
NWP	Numerical Weather Prediction
OGP	Office of Global Programs (US - NOAA)
OLR	Outgoing Long-wave Radiation
OOPC	Ocean Observations Panel for Climate
OPAG	Open Programme Area Group
OSEs	Observing System Experiments
OSSEs	Observing System Simulation Experiments
PAGES	Past Global Changes (within IGBP)
PMEL	Pacific Marine Environmental Laboratory
POGO	Partnership for Observation of the Global Oceans
QC	Quality Control
RBCN	Regional Basic Climatological Network
RRR	Rolling Review of Requirements
SBI	Subsidiary Body for Implementation (UNFCCC/COP)
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC/COP)
SC	Steering Committee
SIA	Seasonal-to-Interannual Forecasting
SIP	Seasonal-to-Interannual Climate Prediction
SIT	Strategic Implementation Team (CEOS)
SLP	Sea-Level Pressure
SOG	Statement of Guidance
SOOP	Ships of Opportunity Programme
SPARC	Stratospheric Processes and their Role in Climate
SPREP	South Pacific Regional Environment Programme
SST	Sea-Surface Temperature
START	System for Analysis, Research and Training
SURFA	Surface Flux Analysis Project
SYNOP	Report of Surface Observation from a Land Station
TAO	Tropical Atmosphere-Ocean Array
TCO	Terrestrial Carbon Observations
TEMS	Terrestrial Ecosystems Monitoring Sites
TOA	Top of the Atmosphere
TOMS	Total Ozone Mapping Spectrometer
TOPC	Terrestrial Observation Panel for Climate
ToR	Terms of Reference
TOVS	TIROS Operational Vertical Sounder
TRITON	Triangle Trans-Ocean Buoy Network
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UOP	Upper Ocean Panel (WCRP/CLIVAR)

UTLS	Upper Troposphere Lower Stratosphere
VOS	Voluntary Observing Ship(s)
VOSClim	Voluntary Observing Ships Climatology Programme
WCDMP	World Climate Data and Monitoring Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDC	World Data Centre
WGCCD	Working Group on Climate Change Detection
WGNE	Working Group on Numerical Experimentation
WG-SP	Working Group on Surface Pressure
WG SST-SI	Working Group on Sea-Surface Temperature and Sea Ice
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organization
WRAP	Worldwide Recurring ASAP Project
WWW	World Weather Watch (WMO)

LIST OF GCOS PUBLICATIONS*

GCOS-1 (WMO/TD-No. 493)	Report of the first session of the Joint Scientific and Technical Committee for GCOS (Geneva, Switzerland, April 13-15, 1992)
GCOS-2 (WMO/TD-No. 551)	Report of the second session of the Joint Scientific and Technical Committee for GCOS (Washington DC, USA, January 11-14, 1993)
GCOS-3 (WMO/TD-No. 590)	Report of the third session of the Joint Scientific and Technical Committee for GCOS (Abingdon, UK, November 1-3,1993)
GCOS-4 (WMO/TD-No. 637)	Report of the fourth session of the Joint Scientific and Technical Committee for GCOS (Hamburg, Germany, September 19-22, 1994)
GCOS-5 (WMO/TD-No. 639)	Report of the GCOS Data System Task Group (Offenbach, Germany, March 22-25, 1994)
GCOS-6 (WMO/TD-No. 640)	Report of the GCOS Atmospheric Observation Panel, first session (Hamburg, Germany, April 25-28, 1994)
GCOS-7 (WMO/TD No. 641)	Report of the GCOS Space-based Observation Task Group (Darmstadt, Germany, May 3-6, 1994)
GCOS-8 (WMO/TD No. 642) (UNEP/EAP.MR/94-9)	Report of the GCOS/GTOS Terrestrial Observation Panel, first session (Arlington, VA, USA, June 28-30, 1994)
GCOS-9 (WMO/TD-No. 643)	Report of the GCOS Working Group on Socio-economic Benefits, first session (Washington DC, USA, August 1-3, 1994)
GCOS-10 (WMO/TD-No. 666)	Summary of the GCOS Plan, Version 1.0, April 1995
GCOS-11 (WMO/TD-No. 673)	Report of the GCOS Data and Information Management Panel, first session (Washington DC, USA, February 7-10, 1995)
GCOS-12 (WMO/TD-No. 674)	The Socio-economic Benefits of Climate Forecasts: Literature Review and Recommendations (Report prepared by the GCOS Working Group on Socio-economic Benefits), April 1995
GCOS-13 (WMO/TD-No. 677)	GCOS Data and Information Management Plan, Version 1.0, April 1995
GCOS-14 (WMO/TD-No. 681)	Plan for the Global Climate Observing System (GCOS), Version 1.0, May 1995
GCOS-15 (WMO/TD-No. 684)	GCOS Plan for Space-based Observations, Version 1.0, June 1995
GCOS-16 (WMO/TD-No. 685)	GCOS Guide to Satellite Instruments for Climate, June 1995
GCOS-17 (WMO/TD-No. 696)	Report of the GCOS Atmospheric Observation Panel, second session (Tokyo, Japan, March 20-23, 1995)

*GCOS publications may be accessed through the GCOS World Wide Web site at:
http://www.wmo.ch/web/gcos/gcoshome.html

GCOS-18 (WMO/TD-No. 697) (UNEP/EAP.MR/95-10)	Report of the GCOS/GTOS Terrestrial Observation Panel, second session (London, UK, April 19-21, 1995)
GCOS-19 (WMO/TD-No. 709)	Report of the GCOS Data Centre Implementation/Co-ordination Meeting (Offenbach, Germany, June 27-29, 1995)
GCOS-20 (WMO/TD-No. 720)	GCOS Observation Programme for Atmospheric Constituents: Background, Status and Action Plan, September 1995
GCOS-21 (WMO/TD-No. 721) (UNEP/EAP.TR/95-07)	GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 1.0, November 1995
GCOS-22 (WMO/TD-No. 722)	Report of the fifth session of the Joint Scientific and Technical Committee for GCOS (Hakone, Japan, October 16-19, 1995)
GCOS-23 (WMO/TD-No. 754) (UNEP/DEIA/MR.96-6) (FAO GTOS-1)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, third session (Cape Town, South Africa, March 19-22, 1996)
GCOS-24 (WMO/TD-No. 768) (UNESCO/IOC)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate, first session (Miami, Florida, USA, March 25-27, 1996)
GCOS-25 (WMO/TD-No. 765) (UNEP/DEIA/MR.96-5)	Report of the GCOS Data and Information Management Panel, second session (Ottawa, Ontario, Canada, May 14-17, 1996)
GCOS-26 (WMO/TD-No. 766)	Report of the Joint CCl/CBS Expert Meeting on the GCOS Surface Network (Norwich, UK, March 25-27, 1996)
GCOS-27 (WMO/TD-No. 772) (UNEP/DEIA/MR.96-7)	Report of the Expert Meeting on Hydrological Data for Global Observing Systems (Geneva, Switzerland, April 29-May 1, 1996)
GCOS-28 (WMO/TD-No. 793) (UNEP/DEIA/MR.97-3)	*In Situ* Observations for the Global Observing Systems (Geneva, Switzerland, September 10-13, 1996)
GCOS-29 (WMO/TD-No. 794) (UNEP/DEIA/MR.97-4)	Report of the Global Observing Systems Space Panel, second session (Geneva, Switzerland, October 16-18, 1996)
GCOS-30 (WMO/TD-No. 795)	Report of the sixth session of the Joint Scientific and Technical Committee for GCOS (Victoria, British Columbia, Canada, October 28-November 1, 1996)
GCOS-31 (WMO/TD-No. 803)	Proceedings of the fifth meeting of the TAO Implementation Panel (TIP-5) (Goa, India, November 18-21, 1996)

GCOS-32 (WMO/TD-No. 796)	GCOS/GTOS Plan for Terrestrial Climate-related Observations, version 2.0, June 1997
GCOS-33 (WMO/TD-No. 798)	GHOST - Global Hierarchical Observing Strategy, March 1997
GCOS-34 (WMO/TD-No. 799)	Initial Selection of a GCOS Surface Network, February 1997
GCOS-35 (WMO/TD-No. 839)	Report of the second Joint CCl/CBS Meeting on the GCOS Surface Network (De Bilt, The Netherlands, June 25-27, 1997)
GCOS-36 (WMO/TD-No. 844) (UNESCO/IOC)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate, second session (Cape Town, South Africa, February 11-13, 1997)
GCOS-37 (WMO/TD-No. 845) (GOOS-10) & (GTOS-9)	Report of the Global Observing Systems Space Panel, third session (Paris, France, May 27-30, 1997)
GCOS-38 (WMO/TD-846) (GTOS-10)	Report of the Meeting of Experts on Ecological Networks (Guernica, Spain, June 17-20, 1997)
GCOS-39 (WMO/TD-No. 847) (GOOS-11) & (GTOS-11) (UNEP/DEIA/MR.97-8)	Report of the GCOS/GOOS/GTOS Joint Data and Information Management Panel, third session (Tokyo, Japan, July 15-18, 1997)
GCOS-40 (WMO/TD-No. 848)	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate, third session (Reading, UK, August 19-22, 1997)
GCOS-41 (WMO/TD-No. 849) (GOOS-33)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC) Ocean Climate Time-Series Workshop, (Baltimore, MD, USA, March 18-20, 1997)
GCOS-42 (WMO/TD-No. 857)	Report of the seventh session of the Joint Scientific and Technical Committee for GCOS (Eindhoven, The Netherlands, September 22-26, 1997)
GCOS-43a (GOOS-36)	TAO Implementation Panel, sixth session (Reading, U.K., November 4-6, 1997)
GCOS-43b (GOOS-55)	International Sea Level Workshop (Honolulu, Hawaii, USA, June 10-11, 1997)
GCOS-44 (GOOS-61)	Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), third session (Grasse, France, April 6-8, 1998)
GCOS-45 (WMO/TD-No. 922) (GOOS-58) & (GTOS-16) (UNEP/DEIA/MR.98-6)	Report of the Joint Meeting of the GCOS/WCRP Atmospheric Observation Panel for Climate and the GCOS/GOOS/GTOS Joint Data and Information Management Panel, fourth session (Honolulu, Hawaii, USA, April 28-May 1, 1998)

GCOS-46 (GTOS-15)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fourth session (Corvallis, USA, May 26-29, 1998)
GCOS-47 (WMO/TD-No. 941) (GOOS-67) (GTOS-20)	Report of the Global Observing Systems Space Panel, fourth session, (College Park, Maryland, USA, October 22-23, 1998)
GCOS-48	Report on the Adequacy of the Global Climate Observing Systems (United Nations Framework Convention on Climate Change, November 2-13 1998, Buenos Aires, Argentina)
GCOS-49 (GOOS-64)	Implementation of Global Ocean Observations for GOOS/GCOS, first session (Sydney, Australia, March 4-7, 1998)
GCOS-50 (GOOS-65)	Implementation of Global Ocean Observations for GOOS/GCOS, second session (Paris, France, November 30, 1998)
GCOS-51 (GOOS-66)	Global Ocean Observations for GOOS/GCOS: An Action Plan for Existing Bodies and Mechanisms
GCOS-52 (GOOS-68)	TAO Implementation Panel, 7th Session (Abidjan, Ivory Coast, November 11-13, 1998)
GCOS-53 (WMO/TD-No. 958)	GCOS Surface Network (GSN) Monitoring Centre Implementation Meeting (Offenbach, Germany, January 19-20, 1999)
GCOS-54 (WMO/TD-No. 953)	Report of the eighth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Geneva, Switzerland, February 9-12, 1999)
GCOS-55	Report of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), fifth session (Silver Spring, MD, USA, April 20-23, 1999)
GCOS-56 (GOOS-75)	Special Report of the Joint GCOS/GOOS/WCRP Ocean Observations Panel for Climate (OOPC), fourth session (May 17, 1999); The CLIVAR Upper Ocean Panel (UOP), fourth session (May 21, 1999); A Joint Planning Meeting of the OOPC and the UOP for the OCEANOBS99 Conference (Woods Hole, MA, USA, May 18-20, 1999)
GCOS-57 (WMO/TD-No. 978) (GOOS-79)	Report of the OOPC/AOPC Workshop on Global Sea Surface Temperature Data Sets (Palisades, N.Y., USA, November 2-4, 1998)
GCOS-58 (GOOS-71**)**	Report of the 6th Session of the IOC Group of Experts on the Global Sea Level Climate Observing System (GLOSS)
GCOS-59 (GTOS-22)	Report of the GCOS/GTOS Terrestrial Observation Panel for Climate, fifth session (Birmingham, UK, July 27-30, 1999)
GCOS-60 (WMO/TD-No. 1004) (GOOS-70)	GCOS/GOOS/GTOS Joint Data and Information Management Plan, Version 1.0, May 2000

GCOS-61 (WMO/TD-No. 1031)	Report of the ninth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS (Beijing, China, September 12-14, 2000)
GCOS-62 (WMO/TD-No. 1038)	Report of the Pacific Islands Regional Implementation Workshop on Improving Global Climate Observing Systems (Apia, Samoa, August 14-15, 2000)
GCOS-63 (WMO/TD-No. 1047) (GTOS-26)	Establishment of a Global Hydrological Observation Network for Climate. Report of the GCOS/GTOS/HWRP Expert Meeting (Geisenheim, Germany, June 26-30, 2000)
GCOS-64 (GOOS-107)	Report of the eighth session of the TAO Implementation Panel (TIP-8) (St. Raphael, France, October 15, 1999)
GCOS-65 (WMO/TD-No. 1055)	Report of the sixth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 10-13, 2000)
GCOS-66 (GOOS-108)	Report of the ninth session of the TAO Implementation Panel (TIP-9) (Perth, Australia, November 16-17, 2000)
GCOS-67 (WMO/TD-No. 1072)	GCOS Implementation Strategy: Implementing GCOS in the New Millennium
GCOS-68 (WMO/TD-No. 1093)	Report of the seventh session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) (Geneva, Switzerland, April 30-3 May, 2001)
GCOS-69 (GOOS-98)	Report of the fifth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Bergen, Norway, June 20-23, 2000.
GCOS-70 (GOOS-113)	Report of the sixth session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), Melbourne, Australia, April 2-5, 2001
GCOS-71 (WMO/TD-No. 1099) (GTOS-29)	Report of the GCOS/GTOS/HWRP Expert Meeting on the Implementation of a Global Terrestrial Network - Hydrology (GTN-H), Koblenz, Germany, June 21-22, 2001
GCOS-72 (GOOS-95)	Report of the 7th Session of the IOC Group of Experts on the Global Sea Level Observing System (GLOSS), Honolulu, April 26-27, 2001
GCOS-73 (WMO/TD-No. 1106)	Manual on the GCOS Surface and Upper-Air Networks: GSN and GUAN, April 2002
GCOS-74 (WMO/TD-No. 1109)	Report of the GCOS Regional Workshop for Eastern and Southern Africa on Improving Observing Systems for Climate, Kisumu, Kenya, October 3-5, 2001
GCOS-75 (WMO/TD-No. 1124)	Report of the tenth session of the WMO-IOC-UNEP-ICSU Steering Committee for GCOS, Farnham, UK, April 15-19, 2002
GCOS-76 (WMO/TD-No. 1125)	Report of the eighth session of the GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC), Wokingham, UK, May 20-24, 2002

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