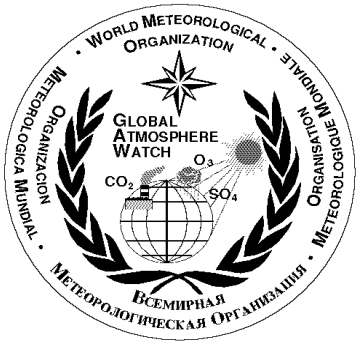
WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH



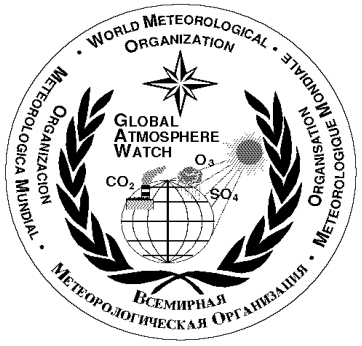
No. 156

Addendum for the Period 2005 – 2007

To the
Strategy for the Implementation of the Global Atmosphere Watch Programme (2001 – 2007), GAW Report No. 142

APRIL 2004

WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH



No. 156

Addendum for the Period 2005 – 2007

To the
Strategy for the Implementation of the Global Atmosphere Watch Programme (2001 – 2007), GAW Report No. 142

WMO TD No. 1209

Table of Contents

1. INTRODUCTION

This document updates the 'Strategy for the Implementation of the Global Atmosphere Watch Programme (2001 – 2007)' that was published in June 2001 as GAW Report No. 142. This strategy reviewed the status of the GAW programme at the time and outlined the strategic goals that were considered to be relevant to guide the development of the programme. It also enumerated implementation tasks, responsibilities and timelines for 2001 to 2004 to achieve these strategic goals. The purpose of this addendum is to guide the work of all the GAW participants for the years 2005 to 2007 by updating the implementation tasks. The general strategy for the implementation of the GAW programme and the goals remain unchanged and the reader is referred to Report No. 142. The structure of this addendum follows that of this base document.

The status of the GAW programme as of 2003/2004 and the base document were reviewed and evaluated by the GAW Scientific Advisory Groups and the WMO/GAW Secretariat. The tasks outlined in this addendum reflect this review and were compiled by the Sub-Group on Strategic Planning of the CAS Working Group on Environmental Pollution and Atmospheric Chemistry under the leadership of Gerhard Müller, MeteoSwiss. This document has been presented to the CAS Working Group for consultation and has been approved by the Executive Council at its 56th session.

During the period 2001 to 2004, the GAW programme has made significant progress in many areas, while in some others, progress has been slower. The attentive reader will note that several tasks given in the base document could not be completed and hence are again present in this addendum. Among the big achievements are the establishment of a number of new Experts Groups and GAW Central Facilities that now offer support to the programme (cf. Table 1). These include

- The Central Calibration Laboratory (Reference Standard) for CH_4 at CMDL,
- The World Data Centre for Surface Ozone at JMA,
- The World Calibration Centre for Aerosol Physical Properties at IfT.
- The World Calibration Centre for Nitrous Oxide at IMK-IFU.
- The World Calibration Centre for Volatile Organic Compounds at IMK-IFU.

The Scientific Advisory Group on Greenhouse Gases has been reactivated. This group will thus continue to provide GAW with scientific leadership. Finally, the Scientific Advisory Group on Reactive Gases has been established with an initial focus on CO.

A GAW website (www.wmo.int/web/arep/gaw/gaw_home.html) was established with the help of partners. The GAW Station Information System (GAWSIS; www.empa.ch/gaw/gawsis) was established to document the GAW network and provide an information system with search engine and mapping capabilities. It is a major step forward that has already proved useful in managing and improving the GAW network of atmospheric composition monitoring stations. The present network as reflected in GAWSIS consists of 27 Global, 637 Regional and 19 Contributing stations (cf. Figure 1).

At the WMO/GAW Secretariat, important changes have taken place that continue to have a significant impact on the future of the programme. Dr John M. Miller retired from WMO in 2001 after having shaped the programme as Chief of the Environment Division in AREP for ten years. He was succeeded by Dr Leonard A. Barrie in 2002. The WMO/GAW Secretariat continues to co-ordinate this complex programme under challenging conditions of very limited resources including being under-staffed, an observation made by the CAS Working Group in a recent review of the programme (GAW Report No. 151). This underlines the importance of adequate resourcing and the continuing role of the SAGs and the Central Facilities to facilitate smooth operations.

It is important to acknowledge the work of all the scientists, administrators and station staff that collectively make up the GAW programme and who are responsible for progress. With rare exceptions, all the tasks that were not carried over into this addendum from GAW Report No. 142 were addressed through the initiative and commitment of these institutions and individuals. The future success of the GAW programme depends on a continuous effort of the large GAW community. In that regard, periodic official renewal of the commitments made by these organizations is critical.

The current 'Strategy for the Implementation of the Global Atmosphere Watch Programme' (GAW Report No. 142) ends with the year 2007. Work on a new strategy for the next period will commence in 2005. Completion of a draft document for consultation by CAS is foreseen for the fall of 2006. The final draft will be presented to Congress Cg-XV in May 2007.

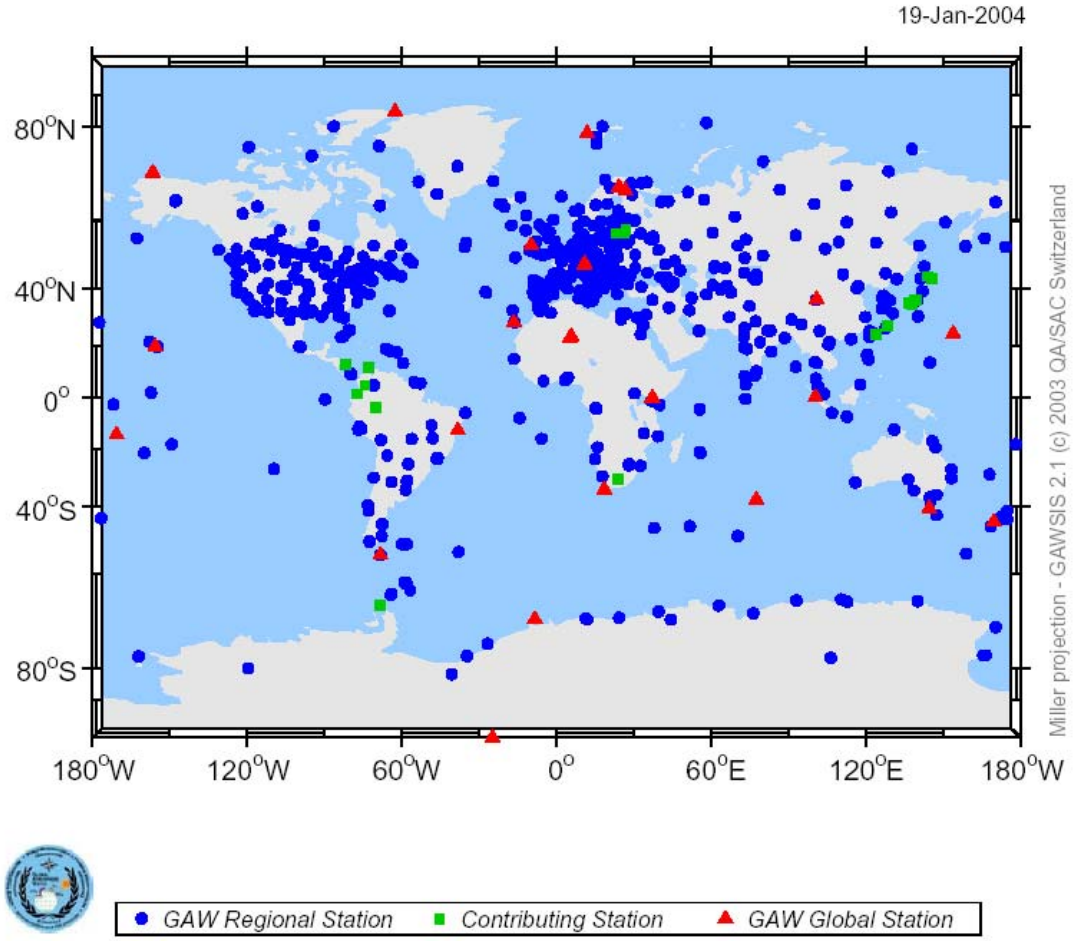


FIGURE 1: Network of Fixed Stations of the Global Atmosphere Watch as reflected in the GAW Station Information System (GAWSIS).

TABLE 1: Overview of the GAW World Central Facilities (as at December 2003). The World Central Facilities have assumed global responsibilities, unless indicated (Am: Americas; E/A: Europe and Africa; A/O: Asia and the South-West Pacific).

Species	QA/SAC	World Calibration Centre	Central Calibration Laboratory (GAW-CCL, Reference Standard)	World Data Centre
CO_2	JMA (A/O)	CMDL	CMDL	JMA
CH_4	EMPA (Am, E/A) JMA (A/O)	EMPA (Am, E/A) JMA (A/O)	CMDL	JMA
N_2O	UBA	IMK-IFU	CMDL	JMA
CFCs				JMA
Total Ozone	JMA (A/O)	CMDL[1], MSC[2], MGO[3]	CMDL[1], MSC[2]	MSC
Ozone Sondes	FZ-Jülich	FZ-Jülich	FZ-Jülich	MSC
Surface Ozone	EMPA	EMPA	NIST	JMA
Precipitation Chemistry	ASRC-SUNY	ASRC-SUNY	ISWS	ASRC-SUNY
CO	EMPA	EMPA	CMDL	JMA
VOC	UBA[5]	IMK-IFU[5]		JMA
SO_2				JMA
NO_x				JMA
Aerosol		IfT (Phys. Properties)		JRC
Optical Depth		PMOD/WRC	PMOD/WRC[4]	JRC
UV Radiation	ASRC-SUNY (Am)	SRRB (Am)[5]		MSC
Solar Radiation		PMOD/WRC	PMOD/WRC	MGO
^{85}Kr, ^{222}Rn		EML		JMA
^{7}Be, ^{210}Pb		EML		EML

ASRC-SUNY Atmospheric Sciences Research Centre, State University of New York (SUNY), Albany NY, USA, hosting the World Data Centre for Precipitation Chemistry (WDCPC)

BSRN Baseline Surface Radiation Network, Federal Institute of Technology (ETH), Zürich, Switzerland

CMDL Climate Monitoring and Diagnostic Laboratory, National Oceanographic and Atmospheric Agency (NOAA), Boulder CO, USA

EML Environmental Measurements Laboratory, Department of Energy (DoE), New York City NY, USA

EMPA Swiss Federal Laboratories for Materials Testing Research and ResearchTesting, Dübendorf, Switzerland

FZ-Jülich Forschungszentrum Jülich, Jülich, Germany

IMK-IFU Institut für Meteorologie und Klimatologie Atmosphärische Umweltforschung, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, Garmisch-Partenkirchen, Germany

ISWS Illinois State Water Survey, Champaign IL, USA

IfT Institute for Tropospheric Research, Leipzig, Germany

JMA Japan Meteorological Agency, Tokyo, Japan, hosting the World Data Centre for Greenhouse Gases (WDCGG) and the Quality Assurance/Science Activity Centre for Asia and the South-West Pacific

JRC Environment Institute, Ispra, Italy, hosting the World Data Centre for Aerosols (WDCA)

MGO A.I. Voeikov Main Geophysical Observatory, Russian Federal Service for Hydrometeorology and Environmental, St. Petersburg, Russia, hosting the World Radiation Data Centre (WRDC)

MSC Meteorological Service of Canada – formerly Atmospheric Services (AES), Environment Canada, Toronto, Canada, hosting the World Ozone and UV Data Centre (WOUDC)

NIST National Institute for Standards and Testing, Gaithersburg MD, USA

PMOD/WRC Physikalisch-Meteorologisches Observatorium Davos/World Radiation Centre, Davos, Switzerland

SRRB Surface Radiation Research Branch of NOAA's Air Resources Laboratory, Boulder CO, USA

UBA German Environmental Protection Agency, Berlin, Germany

[1] Dobson only

[2] Brewer only

[3] Filter instruments

[4] Precision Filter Radiometers (PFR)

2. HOW TO USE THIS DOCUMENT

Please refer to this section in the GAW Strategic Implementation Plan (GAW Report No. 142).

3. THE GAW ORGANIZATIONAL COMPONENTS

3.1 Role of National Meteorological and Hydrological Services (NMHSs)

Task 1. To negotiate and enhance commitments of targeted Member countries that are needed for the success of the GAW programme.

(AREP/WMO – ongoing)

Task 2. To identify and approach Member countries for their support of GAW tasks of high priority. Commitments are needed at least from additional countries of the European Union.

(AREP/WMO - semi-annually)

Task 3. To encourage Members to strengthen co-operation between various agencies within the country.

(AREP/WMO - ongoing)

3.2 Co-operation with other International Programmes

Task 1. To liaise with other international research and measurement programmes – with priorities to IGAC, WCRP (SPARC,BSRN), NDSC and EMEP – by regular participation in appropriate meetings.

(CAS WG, Secretariat - ongoing)

Task 2. To distribute relevant GAW information and publications originating from the Secretariat, the GAW central facilities, and GAW bodies to the officials of other international programmes interested in GAW.

(Secretariat - ongoing)

3.3 Internal Lead Responsibilities

3.3.1 Expert Groups and Central Facilities

Task 1. To maintain and confirm, or establish where necessary, SAGs for at least the following different components of GAW:

UV Radiation	(SAG UV)
Aerosols	(SAG Aerosols)
Ozone	(SAG Ozone)
Precipitation chemistry	(SAG Precipitation Chemistry)
Greenhouse Gases	(SAG Greenhouse Gases)
Reactive Gases	(SAG Reactive Gases)
GURME	(SAG GURME)

The SAGs are assigned the following specific tasks:

To establish scientific priorities on the basis of user requirements and scientific needs.

To establish Data Quality Objectives (DQOs) and, when applicable, Standard Operating Procedures (SOPs).

To track operations at sites and make recommendations regarding the development of networks, observation methodologies, and techniques.

To advise the central facilities with regard to scientific matters.

To organise scientific meetings and assessments and give advice about user applications.

For parameters for which there may be no need to establish a SAG or no possibility of doing so (e.g., radioactivity), alternative scientific leadership responsibilities must be defined.

(CAS WG - review 2005, 2007)

Task 2. To request individual scientists to act as "GAW Advisors" for specific tasks over a given time period. Tasks assigned to these individuals should include:

To assist in the establishment of additional World Calibration Centres as necessary.

To establish regular planning, reporting, and controlling functions with respect to all central facilities in co-operation with the Secretariat.

To clarify the operational functions and interfaces between QA/SACs, Calibration Centres, and Data Centres.

To assist in upgrading measurements at GAW stations and establishing partnerships with appropriate measurement groups.

(Secretariat, CAS WG - ongoing)

Task 3. To organise regular meetings of individuals involved in GAW operational and scientific activities to plan for the future.

(Secretariat - every four years)

3.3.2 Secretariat

Task 1. To recommend specific tasks to GAW participants and to manage their activities.

(Secretariat - ongoing)

Task 2. To maintain the GAW web site as an interactive tool for the GAW system so that all GAW components have appropriate web pages.

(Secretariat, SAGs, WDCs, WCCs, QA/SACs - ongoing)

Task 3. To initiate meetings and sessions based on critical issues of the GAW system.

(Secretariat - ongoing)

Task 4. To formally survey the GAW activities of Members and report this information.

(Secretariat – ongoing)

Task 5. To keep abreast of the activities and reports from the central facilities and the expert groups on a routine basis.

(Secretariat - ongoing)

Task 6. To establish priorities for funding arrangements and to prepare plans for the use of available funds (budgets).

(Secretariat - every three months)

Task 7. To employ GAW Advisors to assist with operational matters.

(Secretariat - as appropriate)

Task 8. To improve the information flow to the GAW community by regular and official distribution of the GAW Information Sheets three times per year, by publication of SAG recommendations, and a "Summary of GAW Current Activities" annually.

(Secretariat - ongoing)

Task 9. To review annually, the station information pages of GAWSIS for all countries represented and to give feedback to GAW country contacts by email and fax.

(Secretariat - ongoing)

3.4 Communications

Task 1. To ensure the regular updating, interlinks and ease of use of the GAW home page and other related web sites.

(Secretariat and GAW central facilities - ongoing)

Task 2. To identify and review on an annual basis a prioritised meeting plan for all GAW meetings as well as proposals for themes and objectives.

(Secretariat – annually in October)

Task 3. To continue the publication of the GAW Report Series, Information Sheets, data reports and other material, and to ensure that these publications are available over the Internet.

(Secretariat and Data Centres - ongoing)

Task 4. To improve communications with universities and other institutions outside the meteorological services that are contributing to GAW.

(Secretariat and GAW central facilities - ongoing)

3.5 Capacity Building

Task 1. To organise and support training and education workshops related to the GAW core measurement parameters.

(Secretariat, QA/SAC, SAGs - ongoing)

Task 2. To identify and provide training through international scientific meetings, and workshops to appropriate station personnel.

(All GAW bodies - ongoing)

Task 3. To promote performance of GAW measurement networks by encouraging GAW global station managers to participate in appropriate GAW training courses, meetings and workshops.

(Secretariat, QA/SACs - begin 2002)

Task 4. To encourage twinning partnerships of developing GAW measurement programmes with established GAW facilities, laboratories and stations, in order to develop the capacity for sustained quality-assured measurements and effective use and publication of data.

(Secretariat, SAGs - ongoing)

Task 5. To build capacity for urban air quality forecasting and management by organizing expert and training workshops as well as through pilot projects in selected urban regions.

(GURME SAG, Secretariat – ongoing)

Task 6. To consider production of a basic introductory textbook appropriate for technical experts involved in making GAW measurements.

(CAS/WG, Secretariat, SAGs)

4. OBSERVING SYSTEMS

4.1 Surface-Based Observations

Task 1. To pursue funding opportunities that maintain and improve the GAW network of stations.

(Secretariat, CAS WG, NMHS's - ongoing)

Task 2. To study the geographical distribution of GAW Global, Regional and Contributing stations for each variable measured and make recommendations regarding placement of stations.

(SAGs - ongoing)

Task 3. To take action aimed at increasing the availability of key instrument spare parts for developing countries to minimise data gaps.

(Secretariat - ongoing)

Task 4. To maintain and further develop the GAW Station Information System (GAWSIS), including automatic updates from the World Data Centres.

(Secretariat, WDCs, QA/SACs – ongoing)

Task 5. To promote the establishment of remote sensing and aircraft monitoring programmes.

(Secretariat, QA/SACs - ongoing)

Task 6. To encourage and organise meetings of the Global station managers to increase communication and co-ordination between Global stations.

(Secretariat, QA/SACs - ongoing)

4.2 Satellite-Based Observations

Task 1. To seek support from space agencies for ground truth observations at certain selected GAW station sites.

(CAS WG, Secretariat, SAGs – ongoing)

Task 2. To specify the needs for ground-based measurements associated with calibration and validation of existing and new generation satellites and to encourage the expansion of the GAW measurement programme accordingly.

(Secretariat, SAGs - ongoing)

Task 3. To identify GAW network stations and GAW measurement parameters that are of value to CEOS as part of the IGOS.

(Secretariat, SAGs, CEOS - ongoing)

Task 4. To promote the establishment of remote sensing and aircraft monitoring programmes.

(Secretariat, QA/SACs - on going)

Task 5. To complete the IGOS Theme Report for a peer reviewed strategy for an 'Integrated Global Atmospheric Chemistry Observation (IGACO)' system and promote its implementation through IGOS and regional programmes

(**Secretariat**, CAS WG, SAG, IGOS – 2005)

5. MEASUREMENT PARAMETERS

5.1 Ozone

5.1.1 Surface Ozone

Task 1. To issue a SAG Guidance Document on surface ozone measurements containing DQOs and SOPs for continuous measurements including calibration and quality assurance.
(SAG RG – 2006)

Task 2. To continue biennial calibrations for South American stations.
(RCC-SMN – ongoing)

Task 3. To compile existing audit information on surface ozone measurements at GAW Global and Regional stations and WDCGG provides summaries of what is available.
(WCC, QA/SAC, WDCGG – 2005)

Task 4. To encourage data exchange agreements between regional networks and the WDCs.
(Secretariat, WDC, SAG RG – ongoing)

5.1.2 Column (Total) Ozone

Task 1a. To continue major intercomparisons alternating between WMO RA I, II, III and V and minor annual intercomparisons in RA VI in the established Dobson calibration centres to ensure regular calibration of each field Dobson every three to four years.
(Secretariat - ongoing)

Task 1b. To perform absolute calibrations and/or intercomparisons of the regional standard Dobsons with the world reference standard Dobson No. 83 from NOAA/Boulder on a two or three years interval.
(Secretariat - ongoing)

Task 2. To update Ozone Report No. 6 on Dobson standard operating procedures.
(SAG Ozone - 2005)

Task 3. To increase participation of Brewer and M124 instruments during Dobson intercomparisons.
(Secretariat, SAG Ozone - ongoing)

Task 4. To increase the number of Umkehr measurement sites through workshops and providing hands on training during intercomparisons and calibration visits.
(Secretariat – ongoing)

Task 5. To increase communication between stations and the WOUDC to maximise data submission.
(WOUDC - ongoing)

Task 6. To establish the Brewer SOPs and to make them available to the Brewer community.
(SAG Ozone – 2005)

Task 7. To encourage Brewer calibrations every 2 to 3 years by travelling standards or by regional reference instruments.
(SAG Ozone - ongoing)

Task 8. To refine the Umkehr data reduction algorithms in collaboration with the satellite community.
(Secretariat, SAG Ozone - ongoing)

5.1.3 Ozone Sondes

Task 1. To continue JOSIE chamber intercomparisons regularly in order to check the quality of ozone sondes.

(WCCOS, SAG Ozone - ongoing)

Task 2. To hold a balloon intercomparison of ozone sondes to verify or further refine the results of JOSIE.

(WCCOS, SAG Ozone - 2005)

Task 3. To finalise standard operating procedures for ozone sondes based upon the JOSIE experiments and balloon intercomparisons.

(SAG Ozone and JOSIE Science Committee - 2005)

Task 4. To seek funding to establish new ozone sonde stations in developing countries within the tropics and Southern Hemisphere.

(Secretariat - ongoing)

5.2 Greenhouse Gases

5.2.1 Carbon Dioxide (CO_2)

Task 1. To review DQOs for data on CO_2 and its isotopes.

(SAG GG - January 2005)

Task 2. To work with the GAW Central Calibration Laboratory (GAW-CCL, Reference Standard), WCC, and QA/SAC to agree upon tasks and procedures for carrying out calibration and intercomparison of all Global GAW stations.

(GAW-CCL, WCC, QA/SAC - December 2006)

Task 3. To promote measurements of greenhouse gas abundance from ships, aircraft, towers (including vertical profiles), and sites in the flux measurement network.

(SAG GG - ongoing)

Task 4. To review the internal consistency of CO_2 global data sets archived at the WDCGG with respect to calibration scales.

(SAG GG, in co-operation with QA/SACs, WDCGG - December 2005)

Task 5. To support and promote development of a plan for integrated satellite and surface-based measurements for monitoring greenhouse gases.

(SAG GG - 2007)

Task 6. To review the status of sampling networks and make recommendations for optimal expansion based on well-characterized model simulations.

(SAG GG – December 2007)

5.2.2 Methane (CH_4)

Task 1. To establish CH_4 data quality objectives (DQOs).

(SAG GG - January 2005)

Task 2. To work with the GAW Central Calibration Laboratory (GAW-CCL, Reference Standard), WCC and QA/SAC to agree upon tasks and procedures for carrying out calibration and intercomparison in the GAW network.

(GAW-CCL, WCC, QA/SACs - December 2006)

Task 3. To enhance co-operation among active laboratories on CH_4 measurement methods and sites, calibration standards, quality assurance, and standard operating procedures.

(SAG GG, QA/SACs - December 2006)

5.2.3 Nitrous Oxide (N_2O), and Chlorofluorocarbons (CFCs)

Task 1. To establish DQOs for N_2O.

(SAG GG – January 2005)

Task 2. To work with the GAW Central Calibration Laboratory (GAW-CCL, Reference Standard), WCC, and QA/SAC to agree upon tasks and procedures for carrying out calibration and intercomparison in the GAW network.

(GAW-CCL, WCC, QA/SACs - December 2005)

Task 3. To establish co-operation among laboratories for N_2O and CFC measurement methods and sites, calibration standards, quality assurance, measurement guidelines and where appropriate, SOPs.

(SAG GG - December 2005)

Task. 4. To co-sponsor the International Halocarbon Intercomparison Experiment (IHALACE) and develop a long term strategy for global N_2O and halocarbons measurements.

(SAG GG, Working Group, Secretariat – 2007)

5.3 Reactive Gases

5.3.1 Carbon Monoxide (CO)

Task 1. To improve the internal consistency of the current CMDL CO scale, to adopt a harmonized CO scale for all GAW activities and to promote its use.

(SAG RG, QA/SAC, WCC – 2006)

Task 2. To issue a SAG Guidance Document on CO measurements containing DQOs and SOPs for continuous measurements including calibration and quality assurance and covering various measurement techniques.

(SAG RG, WCC, QA/SAC – 2006)

Task 3. To recommend a procedure detailing how to apply (a corrected) scale to existing data and how to document such corrections.

(SAG RG, QA/SAC, WDCGG – 2006)

Task 4. To evaluate the existing GAW CO network with a focus on spatial distribution, completeness, and need for further locations.

(SAG RG, QA/SAC – 2007)

Task 5. To establish continuous measurements of CO at global GAW stations in developing countries and additionally, to collect weekly flask samples at these stations for intercomparison with the continuous measurements.

(SAG RG, WCC – ongoing)

Task 6. To promote and support submission of data to the World Data Centre for Greenhouse Gases.

(WDCGG, QA/SAC, WCC, SAG RG – ongoing)

5.3.2 Volatile Organic Compounds (VOCs) and Nitrogen Oxides (NO_x)

Task 1. To establish DQOs and begin developing SOPs in co-operation with EMEP for VOCs and NOx.

(SAG RG, QA/SAC, WCC – 2005)

Task 2. To enlarge the VOC measurement programme in stages, proceeding from the easiest measurements to those that are more difficult, by implementing the following measurement activities at least at three stations:

measurements of C_2-C_9 hydrocarbons, including alkanes, alkenes, alkynes, dienes, and monocyclics,

(WCC, SAG RG – ongoing)

measurements of C_{10}-C_{14} hydrocarbons, including higher homologues as well as biogenic hydrocarbon compounds,

(biogenic hydrocarbons; WCC, SAG RG December 2005)
(C10-C14 hydrocarbons; WCC, SAG RG December 2006)

measurements of oxygenated VOCs, including alcohols, carbonyls, and carboxylic acids.

(alcohols, carbonyls, WCC-VOC, SAG-RG December 2006)
(carboxylic acids, WCC-VOC, SAG-RG December 2007)

Task 3. To evaluate already existing longterm VOC-data sets at GAW-sites.

(QA/SAC, GAW-sites – December 2005)

Task 4. To encourage measurement campaigns at GAW sites that have not yet started their own VOC programme.

(WCC, SAG-RG - ongoing)

Task 5. To issue recommendations for appropriate shipping mechanisms to avoid undue delay before analysis of offline VOC samples.

(QA/SAC, SAG RG – July 2005)

5.3.3 Sulphur Dioxide (SO_2)

No specific tasks.

5.4 Atmospheric Deposition

Task 1. To promote the implementation of the new guidelines for GAW precipitation chemistry measurements through the distribution of a new Guidance Document harmonizing measurement procedures used in various regional and national programmes, and the development of a new data submission/distribution system on the World Wide Web.

(SAG PC - June 2007).

Task 2. To upgrade the Precipitation Chemistry Quality Assurance Programme by:

implementing a comprehensive set of quality assurance and quality control activities (as specified in the Guidance Document),

further developing and improving the QA procedures for precipitation chemistry measurements including the development of stringent data acceptance criteria,

conducting the semi-annual Laboratory Intercomparison Studies and providing training and feedback to countries and laboratories with sub-standard performances.

(SAG PC – ongoing)

Task 3. To continue studies on sample preservation and to make recommendations on the most appropriate preservation methods for minimizing sample degradation during collection and shipping.

(SAG PC - June2006)

Task 4. To assist in developing regional programmes, to identify and attempt to increase the number of precipitation chemistry monitoring sites in data sparse areas of the world, most notably in South America, Asia, and Africa as well as in large and relatively homogeneous ecosystems such as rain forests, savannahs, and Arctic regions. More measurements may also be needed in rapidly industrializing areas to provide information required for political decisions to reduce emissions of pollutants.

(SAG PC - ongoing)

Task 5. To continue to assess the quality of GAW precipitation chemistry data and the success of the new SOPs.

(QA/SAC - June 2005)

Task 6. To promote the use of GAW data in the preparation of scientific assessments of global precipitation chemistry.

(SAG PC - ongoing)

Task 7. To assess the need for trace metal and POPs measurements in the GAW programme. If such needs are identified, to propose a suitable measurement programme.

(SAG PC - December 2007)

5.5 Solar Radiation

Task 1. To maintain UV data archiving and distribution through WOUDC, to promote data submission and in particular to import the data from the European UV database.

(WOUDC, SAG UV - continuous effort, European data: January 2005)

Task 2. To define simplified guidelines for common procedures and format for submission of broadband data to WOUDC.

(SAG UV, WDC - July 2005)

Task 3. To reformat the information in the Instrument and QA/QC GAW reports to produce DQOs and SOPs for UV measurements.

(SAG UV - July 2005)

Task 4. To update the UV station information on the UV SAG website and in GAWSIS.

(SAG UV, EMPA, Secretariat - continuous effort)

Task 5. To define instrument specifications for multi-filter instruments.

(SAG UV - July 2006)

Task 6. To establish further regional calibration centres to enable regular instrument calibration, characterisation and intercomparison.

(SAG UV – Europe: 2005, elsewhere: ongoing)

Task 7. To promote widespread comparison of ground-based UV measurements and satellite derived UV data.

(SAG UV – July 2007)

Task 8. To facilitate data interpretation through the WOUDC web pages.

(SAG UV - July 2005)

Task 9. To promote the data to the user community, e.g. broadband data for UV effects studies, and spectral irradiance (with appropriate conversion to actinic flux) for atmospheric chemistry research.

(SAG UV - continuous)

Task 10. To produce a standard methodology for calculating and distributing the UV Index from different types of UV measurements in the WOUDC database.

(SAG UV - January 2006)

Task 11. To work with WCRP and BSRN to clarify the role of GAW in global radiation measurements.
(CAS WG, Secretariat - 2007)

5.6 Aerosols

Task 1. To establish and maintain a complete register of GAW aerosol activities, responsible officers, associated science programmes, contact details.

(Secretariat, SAG Aerosol - ongoing)

Task 2. To further pursue the establishment of a WCC for aerosol chemical properties.

(Secretariat, CAS WG - April 2006)

Task 3. To deploy the remaining 4 (of 12) PFR instruments at selected stations.
(SAG Aerosol, WORCC, Secretariat - 2005)

Task 4. To establish data submission from participating sites on a regular and timely basis to WDCA.

(SAG Aerosol, WDCA - ongoing)

Task 5. To promote the use of data in WDCA.
(SAG Aerosol, WDCA - ongoing)

Task 6. To organise special sessions on GAW aerosol studies at major aerosol conferences.

(SAG Aerosol - October 2006 and continuing)

Task 7. To collaborate with other major programmes and organisations, such as IGAC, BSRN, NDSC, WHO, and EMEP, establishing where possible common protocols.

(SAG Aerosol - ongoing)

Task 8. To involve members of the modelling and satellite communities in SAG activities.

(SAG Aerosol - ongoing)

Task 9. To contribute actively to capacity building in developing countries.

(SAG Aerosol - ongoing).

Task 10. To assess GAW aerosol activities and provide a synthesis for selected global aerosol parameters.

(SAG Aerosol - December 2007)

Task 11. To produce Standard Operating Procedures for two of the five core aerosol parameters recommended by the SAG in WMO Report No 153.

(SAG Aerosol - January 2006)

Task 12. To produce Standard Operating Procedures for most inorganic aerosol chemical parameters.

(SAG Aerosol - December 2006)

Task 13. To produce Standard Operating Procedures for the remaining aerosol physical parameters.
(SAG Aerosol - December 2007)

5.7 Radioactivity

Task 1. To maintain and develop measurements of natural radionuclides in the GAW network using recommendations made at the 1st International Expert Workshop on Sources and Measurements of Natural Radionuclides Applied to Climate and Air Quality Studies, 3 – 5 June 2003, Gif sur Yvette, France.

(Secretariat, WCC - ongoing)

Task 2. To co-sponsor with IAEA the 2nd International Expert Workshop on Sources and Measurements of Natural Radionuclides Applied to Climate and Air Quality Studies to: (i) review progress on recommendations made in the first workshop, (ii) recommend a plan for developing measurement guidelines, data quality objectives and standard operating stations for Rn^{222} measurements.

(Secretariat, WCC - June 2006)

Task 3. To encourage installation of surface air sampling systems for natural radionuclides recommended at the two Expert meetings (Task 1 and Task 2) at selected GAW sites.

(Secretariat, WCC - ongoing)

Task 4. To review the status of radioactivity data collected at WDCGG, JMA, Japan (for gaseous Kr-85 and Rn-222) and at Environment Measurement Laboratory, USA (for aerosol-bound Be-7 and Pb-210) and to recommend further action.

(Secretariat, WDCGG, WCC - Dec 2006).

6. DATA MANAGEMENT

6.1 Data Submission, Validation, and Archiving

Task 1. To secure proper resources, develop comprehensive back-up strategies, maintain up-to-date storage devices, and implement appropriate network and data access policies.

(WDCs - ongoing)

Task 2. To further develop metadata archives suited to updating site information, measurement-related information and quality assurance information. These archives should be co-ordinated with the GAW Station Information System (GAWSIS).

(WDCs, in co-operation with Secretariat and QA/SACs – ongoing)

Task 3. To work with NDSC and Southern Cone project data managers to submit GAW core programme data monthly to the WDCs.

(WDCs, Secretariat – ongoing)

Task 4. To implement data quality assurance and management procedures developed in co-operation with the SAGs and QA/SACs, with a view to providing timely feedback to data submitters when problems are found.

(WDCs, SAGs, QA/SACs – ongoing)

6.1 Data Analysis and Distribution

Task 1. To implement WMO policy on data usage regarding the international exchange of meteorological and related data and products as it applies to the measurements made in GAW (Resolution 40, Cg-XII).

(WDCs, Secretariat - continuous)

Task 2. To work with the satellite community through IGOS and IGACO to ensure that common needs are met.

(CAS, WDCs, Secretariat - ongoing)

Task 3. To further develop and maintain central Internet sites for the GAW Station Information System (GAWSIS) and World Data Centres that provide user friendly access to measurement data, metadata, quality assurance information, relevant meteorological information, and value-added products such as reports on measurement guidelines, quality assurance and technical issues.

(WDCs, Secretariat, QA/SAC - ongoing)

Task 4. To produce a set of value-added data analysis products such as maps of GAW stations by variable, statistical summaries, quality assurance information and data visualisation.

(WDCs, QA/SACs - ongoing)

Task 5. To assist the SAGs and QA/SACs in improving data quality control and data analysis activities.

(WDCs, Secretariat - ongoing)

7. QUALITY ASSURANCE (QA)

Task 1. To report in a technical document the international terminology related to QA/QC of GAW measurements.

(SAGs, QA/SACs, Secretariat – January 2005)

Task 2. To establish the DQOs for a prioritised list of GAW chemical and UV radiation variables.

(SAGs, QA/SACs, Secretariat - 2007)

Task 3. To identify and, where feasible, establish WCCs and GAW-CCLs/Reference Standards for the variables not currently covered.

(SAGs, QA/SACs, Secretariat - ongoing)

Task 4. To develop measurement guidelines and, when appropriate, SOPs for a prioritized list of variables.

(SAGs, QA/SACs, WCCs - ongoing)

Task 5. To develop guidelines for GAW station system audits.

(QA/SACs, WCCs - 2007)

Task 6. To identify the need for, seek funding support for and establish regional calibration and training centres for selected GAW variables.

(Secretariat, QA/SACs, SAGs - ongoing)

Task 7. To provide training and workshops for GAW measurement personnel with emphasis on building capacity and partnerships for developing countries while simultaneously improving the quality of data provided by all GAW stations.

(Secretariat, QA/SACs, WCCs - ongoing)

8. ASSESSMENTS AND DATA APPLICATION

Task 1. To establish closer contacts with potential data users, to inform them about availability of and access to GAW data through GAWSIS and the WDCs, to identify their needs for data that may be provided by GAW, to outline proposals for joint research work and scientific assessments and to promote the use of GAW data for dealing with specific national and regional environmental problems.

(SAGs, WDCs, Secretariat - ongoing)

Task 2. To organize and contribute to the scientific assessments of stratospheric ozone and fulfil our obligations under the Vienna Convention for the protection of the ozone layer.

(Secretariat in co-operation with UNEP, EU, NOAA and NASA - 2007)

Task 3. To contribute when possible to other conventions and assessments such as UNFCC, IPCC and UN-ECE Convention on LRTAP.

(Secretariat, SAGs, WDCs, QA/SACs, - ongoing)

Task 4. To co-operate with data centres of other programmes in promoting data exchange through the Internet and other media and the use of data for regional and national environmental problems.

(WDCs and SAGs - ongoing)

Task 5. To support relevant modelling activities in close co-operation with other collaborating programmes through organization of joint expert meetings, research projects and model intercomparisons.

(Secretariat - ongoing)

Task 6. To conduct and/or co-sponsor workshops on use of GAW data relevant to scientific assessments.

(Secretariat, SAGs, QA/SACs - ongoing)

9. GAW URBAN RESEARCH METEOROLOGY AND ENVIRONMENT (GURME) PROJECT

Task 1. To extend the use of the existing GURME web site to support GURME objectives with information from the pilot projects, results from recent workshops, and training materials.

(SAG GURME - 2005)

Task 2: To extend the GURME web site to act as a resource centre for countries involved in GURME.

(SAG GURME - 2005)

Task 3. To develop materials for use in air quality forecasting training.

(SAG GURME, Secretariat - 2005)

Task 4. To conduct regional workshops focused on:

Advanced air quality modelling

(SAG GURME, Secretariat - 2005)

Capacity building on basic aspects of air quality forecasting.

(SAG GURME, Secretariat - 2005)

Task 5. To develop new and promote established GURME pilot projects to illustrate the spectrum of NMHSs urban-related activities and opportunities for co-operation with environmental agencies.

(SAG GURME, Secretariat - 2006)

Task 6. To document and articulate ways in which satellite data can be applied to meet GURME objectives.

(SAG GURME, Secretariat - 2005)

Task 7. To link wherever appropriate into related/complementary activities within WMO (e.g., issues related to aerosols, heat islands, and urban climate monitoring within IPCC, CIMO, WWRP programmes) by collaborating on a common topic and/or by collocating a project.

(SAG GURME, Secretariat - 2005)

Task 8. To link, wherever appropriate, GURME activities to related/complementary activities within the international scientific community (e.g., megacity initiatives within IGAC, urbanization of meteorological models in the European FUMAPEX and COST715 Studies).

(SAG GURME, Secretariat - 2005)

Task 9. To foster and continue close co-operation with the urban health impacts community including those involved in climate change.

(SAG GURME, Secretariat - 2006)

Task 10. To provide advice and guidance to NMHSs on measurements in support of GURME activities by developing a web-based resource that provides basic requirements and points to accessible relevant materials from various national Environmental Agencies' guidelines.

(SAG GURME, Secretariat - 2006, first drafts by 2005)

Task 11. To continue to document and provide guidance on the use of passive samplers by expanding the passive sampler content of GURME, giving examples of the use of passive samplers, and conducting a workshop on passive samplers.

(SAG GURME, Secretariat - 2005)

Task 12. To continue to promote GURME activities and accomplishments by organising GURME sessions and presentations in international conferences.

(SAG GURME, Secretariat - 2005 through 2007)

Task 13. To help improve air quality forecasts by documenting various performance metrics in use in evaluating air quality forecasts, and conducting a workshop to share best practices and to explore new methods and metrics.

(SAG GURME, Secretariat - 2007)

Task 14. To assist providers of air quality forecasting services in outreach and public information aspects of air quality by compiling best-practices and experiences and disseminating through the GURME web.

(SAG GURME, Secretariat - 2007)

10. RESOURCES

Task 1. To review annually GAW's costs for:

the establishment and operation of the central facilities of GAW including QA/SACs, Calibration Centres and World Data Centres,

expert advisory, training and education purposes,

purchase of equipment,

operational services and maintenance of GAW.

(Secretariat - beginning of each calendar year)

Task 2. To continually review the funding needs of the programme and identify:

how much is needed to achieve specific GAW goals,

how WMO Member countries can help meet these needs.

(Secretariat - ongoing)

Task 3. To publicize a list of programme needs for which resources are required and to use all avenues to recruit sponsors, as NMHSs, or commercial institutions, etc.

(Secretariat, CAS WG - annually)

Task 4. To promote an integrated approach to global monitoring and encourage commitments from members of the Committee on Earth Observation Satellites (CEOS) to jointly support with WMO long-term ground-based global measurements for calibration and validation of satellite observations.

(CAS WG, Secretariat - ongoing)

LIST OF ACRONYMS

AREP	Atmospheric Research and Environment Programme
ASRC-SUNY	Atmospheric Sciences Research Centre, State University of New York (SUNY), Albany NY, USA
BSRN	Baseline Surface Radiation Network
CAS	Commission for Atmospheric Sciences
CAS WG	CAS Working Group on Environmental Pollution and Atmospheric Chemistry
CEOS	Committee on Earth Observation Satellites
CFC	Chlorofluorocarbon
CIMO	Commission for Instruments and Methods of Observation
CMDL	Climate Monitoring and Diagnostic Laboratory, NOAA
COST715	European Cooperation in the field of Scientific and Technical Research (COST) action on “Meteorology applied to urban air pollution problems”
DQO	Data Quality Objective
EMEP	Cooperation Programme for Monitoring and Evaluation at the Long-range Transmission of Air Pollutants in Europe
EML	Environmental Measurements Laboratory, New York, USA
EMPA	Swiss Federal Laboratories for Materials Testing and Research, Dübendorf, Switzerland
EU	European Union
FUMAPEX	Integrated Systems for Forecasting Urban Meteorology, Air Pollution and Population Exposure
FZ-Jülich	Forschungszentrum Jülich, Germany
GAW	Global Atmosphere Watch
GAW-CCL	GAW Central Calibration Laboratory
GAWSIS	GAW Station Information System
GG	Greenhouse Gas
GURME	GAW Urban Research Meteorology and Environment project
IAEA	International Atomic Energy Agency
IFT	Institute for Tropospheric Research, Leipzig, Germany
IGAC	International Global Atmospheric Chemistry
IGACO	Integrated Global Atmospheric Chemistry Observation
IGOS	Integrated Global Observing Strategy
IHALACE	International Halocarbon Intercomparison Experiment
IMK-IFU	Institut für Meteorologie und Klimaforschung-Fraunhofer Institut für Atmosphärische Umweltforschung, Garmisch-Partenkirchen, Germany
IPCC	Intergovernmental Panel on Climate Change
ISWS	Illinois State Water Survey

JMA	Japan Meteorological Agency
JOSIE	Julich Ozone Sonde Intercomparison Experiment
JRC	Joint Research Centre of the European Commission, Ispra, Italy
LRTAP	Long-range Transboundary Air Pollution
MGO	Main Geophysical Observatory, St Petersburg, Russian Federation
MSC	Meteorological Service of Canada - formerly Atmospheric Environment Services (AES)
NASA	National Aeronautics and Space Administration
NDSC	Network for the Detection of Stratospheric Change
NIST	National Institute of Standards and Technology, Gaithersburg MD, USA
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration
PC	Precipitation Chemistry
PFR	Precision filter radiometer
PMOD/WRC	Physikalisch-Meteorologisches Observatorium Davos/World Radiation Centre
POPs	Persistent organic pollutants
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QA/SAC	Quality Assurance/Science Activity Centre
RA	Regional Association
RCC	Regional Calibration Centre
RG	Reactive Gas
SAG	Scientific Advisory Group
SMN	Servicio Meteorologico Nacional, Argentina
SOPs	Standard Operating Procedures
SPARC	Stratospheric Processes and Their Role in Climate
SRRB	Surface Radiation Research Branch of NOAA's Air Resources Laboratory
UBA	Umweltbundesamt/The Federal Environmental Agency, Germany
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet Radiation
VOCs	Volatile Organic Compounds
WCC	World Calibration Centre
WCCOS	World Calibration Centre for Ozone Sondes
WCRP	World Climate Research Programme
WDC	World Data Centre
WDCA	World Data Centre for Aerosols
WDCGG	World Data Centre for Greenhouse Gases

WDCPC	World Data Centre for Precipitation Chemistry
WDCSO	World Data Centre for Surface Ozone
WHO	World Health Organization
WMO	World Meteorological Organization
WORCC	World Optical Depth Research and Calibration Centre
WOUDC	World Ozone and UV Data Centre
WRC	World Radiation Centre
WWRP	World Weather Research Programme

GLOBAL ATMOSPHERE WATCH REPORT SERIES

1. Final Report of the Expert Meeting on the Operation of Integrated Monitoring Programmes, Geneva, 2-5 September 1980.

2. Report of the Third Session of the GESAMP Working Group on the Interchange of Pollutants Between the Atmosphere and the Oceans (INTERPOLL-III), Miami, USA, 27-31 October 1980.

3. Report of the Expert Meeting on the Assessment of the Meteorological Aspects of the First Phase of EMEP, Shinfield Park, U.K., 30 March - 2 April 1981.

4. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at April 1981.

5. Report of the WMO/UNEP/ICSU Meeting on Instruments, Standardization and Measurements Techniques for Atmospheric CO_2, Geneva, 8-11; September 1981.

6. Report of the Meeting of Experts on BAPMoN Station Operation, Geneva, 23-26 November, 1981.

7. Fourth Analysis on Reference Precipitation Samples by the Participating World Meteorological Organization Laboratories by Robert L. Lampe and John C. Puzak, December 1981.

8. Review of the Chemical Composition of Precipitation as Measured by the WMO BAPMoN by Prof. Dr. Hans-Walter Georgii, February 1982.

9. An Assessment of BAPMoN Data Currently Available on the Concentration of CO_2 in the Atmosphere by M.R. Manning, February 1982.

10. Report of the Meeting of Experts on Meteorological Aspects of Long-range Transport of Pollutants, Toronto, Canada, 30 November - 4 December 1981.

11. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at May 1982.

12. Report on the Mount Kenya Baseline Station Feasibility Study edited by Dr. Russell C. Schnell.

13. Report of the Executive Committee Panel of Experts on Environmental Pollution, Fourth Session, Geneva, 27 September - 1 October 1982.

14. Effects of Sulphur Compounds and Other Pollutants on Visibility by Dr. R.F. Pueschel, April 1983.

15. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1981, May 1983.

16. Report of the Expert Meeting on Quality Assurance in BAPMoN, Research Triangle Park, North Carolina, USA, 17-21 January 1983.

17. General Consideration and Examples of Data Evaluation and Quality Assurance Procedures Applicable to BAPMoN Precipitation Chemistry Observations by Dr. Charles Hakkarinen, July 1983.

18. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at May 1983.

19. Forecasting of Air Pollution with Emphasis on Research in the USSR by M.E. Berlyand, August 1983.

20. Extended Abstracts of Papers to be Presented at the WMO Technical Conference on Observation and Measurement of Atmospheric Contaminants (TECOMAC), Vienna, 17-21 October 1983.

21. Fifth Analysis on Reference Precipitation Samples by the Participating World Meteorological Organization Laboratories by Robert L. Lampe and William J. Mitchell, November 1983.

22. Report of the Fifth Session of the WMO Executive Council Panel of Experts on Environmental Pollution, Garmisch-Partenkirchen, Federal Republic of Germany, 30 April - 4 May 1984 (WMO TD No. 10).

23. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1982. November 1984 (WMO TD No. 12).

24. Final Report of the Expert Meeting on the Assessment of the Meteorological Aspects of the Second Phase of EMEP, Friedrichshafen, Federal Republic of Germany, 7-10 December 1983. October 1984 (WMO TD No. 11).

25. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at May 1984. November 1984 (WMO TD No. 13).

26. Sulphur and Nitrogen in Precipitation: An Attempt to Use BAPMoN and Other Data to Show Regional and Global Distribution by Dr. C.C. Wallén. April 1986 (WMO TD No. 103).

27. Report on a Study of the Transport of Sahelian Particulate Matter Using Sunphotometer Observations by Dr. Guillaume A. d'Almeida. July 1985 (WMO TD No. 45).

28. Report of the Meeting of Experts on the Eastern Atlantic and Mediterranean Transport Experiment ("EAMTEX"), Madrid and Salamanca, Spain, 6-8 November 1984.

29. Recommendations on Sunphotometer Measurements in BAPMoN Based on the Experience of a Dust Transport Study in Africa by Dr. Guillaume A. d'Almeida. September 1985 (WMO TD No. 67).

30. Report of the Ad-hoc Consultation on Quality Assurance Procedures for Inclusion in the BAPMoN Manual, Geneva, 29-31 May 1985.

31. Implications of Visibility Reduction by Man-Made Aerosols (Annex to No. 14) by R.M. Hoff and L.A. Barrie. October 1985 (WMO TD No. 59).

32. Manual for BAPMoN Station Operators by E. Meszaros and D.M. Whelpdale. October 1985 (WMO TD No. 66).

33. Man and the Composition of the Atmosphere: BAPMoN - An international programme of national needs, responsibility and benefits by R.F. Pueschel, 1986.

34. Practical Guide for Estimating Atmospheric Pollution Potential by Dr. L.E. Niemeyer. August 1986 (WMO TD No. 134).

35. Provisional Daily Atmospheric CO_2 Concentrations as Measured at BAPMoN Sites for the Year 1983. December 1985 (WMO TD No. 77).

36. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1984. Volume I: Atmospheric Aerosol Optical Depth. October 1985 (WMO TD No. 96).

37. Air-Sea Interchange of Pollutants by R.A. Duce. September 1986 (WMO TD No. 126).

38. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at 31 December 1985. September 1986 (WMO TD No. 136).

39. Report of the Third WMO Expert Meeting on Atmospheric Carbon Dioxide Measurement Techniques, Lake Arrowhead, California, USA, 4-8 November 1985. October 1986.

40. Report of the Fourth Session of the CAS Working Group on Atmospheric Chemistry and Air Pollution, Helsinki, Finland, 18-22 November 1985. January 1987.

41. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1982, Volume II: Precipitation chemistry, continuous atmospheric carbon dioxide and suspended particulate matter. June 1986 (WMO TD No. 116).

42. Scripps reference gas calibration system for carbon dioxide-in-air standards: revision of 1985 by C.D. Keeling, P.R. Guenther and D.J. Moss. September 1986 (WMO TD No. 125).

43. Recent progress in sunphotometry (determination of the aerosol optical depth). November 1986.

44. Report of the Sixth Session of the WMO Executive Council Panel of Experts on Environmental Pollution, Geneva, 5-9 May 1986. March 1987.

45. Proceedings of the International Symposium on Integrated Global Monitoring of the State of the Biosphere (Volumes I-IV), Tashkent, USSR, 14-19 October 1985. December 1986 (WMO TD No. 151).

46. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1984. December 1986 (WMO TD No. 158).

47. Procedures and Methods for Integrated Global Background Monitoring of Environmental Pollution by F.Ya. Rovinsky, USSR and G.B. Wiersma, USA. August 1987 (WMO TD No. 178).

48. Meeting on the Assessment of the Meteorological Aspects of the Third Phase of EMEP IIASA, Laxenburg, Austria, 30 March - 2 April 1987. February 1988.

49. Proceedings of the WMO Conference on Air Pollution Modelling and its Application (Volumes I-III), Leningrad, USSR, 19-24 May 1986. November 1987 (WMO TD No. 187).

50. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1985. December 1987 (WMO TD No. 198).

51. Report of the NBS/WMO Expert Meeting on Atmospheric CO_2 Measurement Techniques, Gaithersburg, USA, 15-17 June 1987. December 1987.

52. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1985. Volume I: Atmospheric Aerosol Optical Depth. September 1987.

53. WMO Meeting of Experts on Strategy for the Monitoring of Suspended Particulate Matter in BAPMoN - Reports and papers presented at the meeting, Xiamen, China, 13-17 October 1986. October 1988.

54. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1983, Volume II: Precipitation chemistry, continuous atmospheric carbon dioxide and suspended particulate matter (WMO TD No. 283).

55. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at 31 December 1987 (WMO TD No. 284).

56. Report of the First Session of the Executive Council Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, Hilo, Hawaii, 27-31 March 1988. June 1988.

57. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1986, Volume I: Atmospheric Aerosol Optical Depth. July 1988.

58. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the years 1986 and 1987 (WMO TD No. 306).

59. Extended Abstracts of Papers Presented at the Third International Conference on Analysis and Evaluation of Atmospheric CO_2 Data - Present and Past, Hinterzarten, Federal Republic of Germany, 16-20 October 1989 (WMO TD No. 340).

60. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1984 and 1985, Volume II: Precipitation chemistry, continuous atmospheric carbon dioxide and suspended particulate matter.

61. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data for 1987 and 1988, Volume I: Atmospheric Aerosol Optical Depth.

62. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the year 1988 (WMO TD No. 355).

63. Report of the Informal Session of the Executive Council Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, Sofia, Bulgaria, 26 and 28 October 1989.

64. Report of the consultation to consider desirable locations and observational practices for BAPMoN stations of global importance, Bermuda Research Station, 27-30 November 1989.

65. Report of the Meeting on the Assessment of the Meteorological Aspects of the Fourth Phase of EMEP, Sofia, Bulgaria, 27 and 31 October 1989.

66. Summary Report on the Status of the WMO Global Atmosphere Watch Stations as at 31 December 1990 (WMO TD No. 419).

67. Report of the Meeting of Experts on Modelling of Continental, Hemispheric and Global Range Transport, Transformation and Exchange Processes, Geneva, 5-7 November 1990.

68. Global Atmospheric Background Monitoring for Selected Environmental Parameters. BAPMoN Data For 1989, Volume I: Atmospheric Aerosol Optical Depth.

69. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1989 (WMO TD No. 400).

70. Report of the Second Session of EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, Santiago, Chile, 9-15 January 1991 (WMO TD No. 633).

71. Report of the Consultation of Experts to Consider Desirable Observational Practices and Distribution of GAW Regional Stations, Halkidiki, Greece, 9-13 April 1991 (WMO TD No. 433).

72. Integrated Background Monitoring of Environmental Pollution in Mid-Latitude Eurasia by Yu.A. Izrael and F.Ya. Rovinsky, USSR (WMO TD No. 434).

73. Report of the Experts Meeting on Global Aerosol Data System (GADS), Hampton, Virginia, 11 to 12 September 1990 (WMO TD No. 438).

74. Report of the Experts Meeting on Aerosol Physics and Chemistry, Hampton, Virginia, 30 to 31 May 1991 (WMO TD No. 439).

75. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1990 (WMO TD No. 447).

76. The International Global Aerosol Programme (IGAP) Plan: Overview (WMO TD No. 445).

77. Report of the WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques, Lake Arrowhead, California, 14-19 October 1990.

78. Global Atmospheric Background Monitoring for Selected Environmental Parameters BAPMoN Data for 1990, Volume I: Atmospheric Aerosol Optical Depth (WMO TD No. 446).

79. Report of the Meeting of Experts to Consider the Aerosol Component of GAW, Boulder, 16 to 19 December 1991 (WMO TD No. 485).

80. Report of the WMO Meeting of Experts on the Quality Assurance Plan for the GAW, Garmisch-Partenkirchen, Germany, 26-30 March 1992 (WMO TD No. 513).

81. Report of the Second Meeting of Experts to Assess the Response to and Atmospheric Effects of the Kuwait Oil Fires, Geneva, Switzerland, 25-29 May 1992 (WMO TD No. 512).

82. Global Atmospheric Background Monitoring for Selected Environmental Parameters BAPMoN Data for 1991, Volume I: Atmospheric Aerosol Optical Depth (WMO TD No. 518).

83. Report on the Global Precipitation Chemistry Programme of BAPMoN (WMO TD No. 526).

84. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at GAW-BAPMoN sites for the year 1991 (WMO TD No. 543).

85. Chemical Analysis of Precipitation for GAW: Laboratory Analytical Methods and Sample Collection Standards by Dr Jaroslav Santroch (WMO TD No. 550).

86. The Global Atmosphere Watch Guide, 1993 (WMO TD No. 553).

87. Report of the Third Session of EC Panel/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, Geneva, 8-11 March 1993 (WMO TD No. 555).

88. Report of the Seventh WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques, Rome, Italy, 7 - 10 September 1993, (edited by Graeme I. Pearman and James T. Peterson) (WMO TD No. 669).

89. 4th International Conference on CO_2 (Carqueiranne, France, 13-17 September 1993) (WMO TD No. 561).

90. Global Atmospheric Background Monitoring for Selected Environmental Parameters GAW Data for 1992, Volume I: Atmospheric Aerosol Optical Depth (WMO TD No. 562).

91. Extended Abstracts of Papers Presented at the WMO Region VI Conference on the Measurement and Modelling of Atmospheric Composition Changes Including Pollution Transport, Sofia, 4 to 8 October 1993 (WMO TD No. 563).

92. Report of the Second WMO Meeting of Experts on the Quality Assurance/Science Activity Centres of the Global Atmosphere Watch, Garmisch-Partenkirchen, 7-11 December 1992 (WMO TD No. 580).

93. Report of the Third WMO Meeting of Experts on the Quality Assurance/Science Activity Centres of the Global Atmosphere Watch, Garmisch-Partenkirchen, 5-9 July 1993 (WMO TD No. 581).

94. Report on the Measurements of Atmospheric Turbidity in BAPMoN (WMO TD No. 603).

95. Report of the WMO Meeting of Experts on UV-B Measurements, Data Quality and Standardization of UV Indices, Les Diablerets, Switzerland, 25-28 July 1994 (WMO TD No. 625).

96. Global Atmospheric Background Monitoring for Selected Environmental Parameters WMO GAW Data for 1993, Volume I: Atmospheric Aerosol Optical Depth.

97. Quality Assurance Project Plan (QAPjP) for Continuous Ground Based Ozone Measurements (WMO TD No. 634).

98. Report of the WMO Meeting of Experts on Global Carbon Monoxide Measurements, Boulder, USA, 7-11 February 1994 (WMO TD No. 645).

99. Status of the WMO Global Atmosphere Watch Programme as at 31 December 1993 (WMO TD No. 636).

100. Report of the Workshop on UV-B for the Americas, Buenos Aires, Argentina, 22-26 August 1994.

101. Report of the WMO Workshop on the Measurement of Atmospheric Optical Depth and Turbidity, Silver Spring, USA, 6-10 December 1993, (edited by Bruce Hicks) (WMO TD No. 659).

102. Report of the Workshop on Precipitation Chemistry Laboratory Techniques, Hradec Kralove, Czech Republic, 17-21 October 1994 (WMO TD No. 658).

103. Report of the Meeting of Experts on the WMO World Data Centres, Toronto, Canada, 17-18 February 1995, (prepared by Edward Hare) (WMO TD No. 679).

104. Report of the Fourth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the First Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE, Garmisch-Partenkirchen, Germany, 13 to 17 March 1995 (WMO TD No. 689).

105. Report of the Fourth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Garmisch, Germany, 6-11 March 1995) (WMO TD No. 718).

106. Report of the Global Acid Deposition Assessment (edited by D.M. Whelpdale and M-S. Kaiser) (WMO TD No. 777).

107. Extended Abstracts of Papers Presented at the WMO-IGAC Conference on the Measurement and Assessment of Atmospheric Composition Change (Beijing, China, 9-14 October 1995) (WMO TD No. 710).

108. Report of the Tenth WMO International Comparison of Dobson Spectrophotometers (Arosa, Switzerland, 24 July - 4 August 1995).

109. Report of an Expert Consultation on 85Kr and 222Rn: Measurements, Effects and Applications (Freiburg, Germany, 28-31 March 1995) (WMO TD No. 733).

110. Report of the WMO-NOAA Expert Meeting on GAW Data Acquisition and Archiving (Asheville, NC, USA, 4-8 November 1995) (WMO TD No. 755).

111. Report of the WMO-BMBF Workshop on VOC Establishment of a "World Calibration/Instrument Intercomparison Facility for VOC" to Serve the WMO Global Atmosphere Watch (GAW) Programme (Garmisch-Partenkirchen, Germany, 17-21 December 1995) (WMO TD No. 756).

112. Report of the WMO/STUK Intercomparison of Erythemally-Weighted Solar UV Radiometers, Spring/Summer 1995, Helsinki, Finland (WMO TD No. 781).

113. The Strategic Plan of the Global Atmosphere Watch (GAW) (WMO TD No. 802).

114. Report of the Fifth WMO Meeting of Experts on the Quality Assurance/Science Activity Centres (QA/SACs) of the Global Atmosphere Watch, jointly held with the Second Meeting of the Coordinating Committees of IGAC-GLONET and IGAC-ACE^{Ed}, Garmisch-Partenkirchen, Germany, 15-19 July 1996 (WMO TD No. 787).

115. Report of the Meeting of Experts on Atmospheric Urban Pollution and the Role of NMSs (Geneva, 7-11 October 1996) (WMO TD No. 801).

116. Expert Meeting on Chemistry of Aerosols, Clouds and Atmospheric Precipitation in the Former USSR (Saint Petersburg, Russian Federation, 13-15 November 1995).

117. Report and Proceedings of the Workshop on the Assessment of EMEP Activities Concerning Heavy Metals and Persistent Organic Pollutants and their Further Development (Moscow, Russian Federation, 24-26 September 1996) (Volumes I and II) (WMO TD No. 806).

118. Report of the International Workshops on Ozone Observation in Asia and the Pacific Region (IWOAP, IWOAP-II), (IWOAP, 27 February-26 March 1996 and IWOAP-II, 20 August-18 September 1996) (WMO TD No. 827).

119. Report on BoM/NOAA/WMO International Comparison of the Dobson Spectrophotometers (Perth Airport, Perth, Australia, 3-14 February 1997), (prepared by Robert Evans and James Easson) (WMO TD No. 828).

120. WMO-UMAP Workshop on Broad-Band UV Radiometers (Garmisch-Partenkirchen, Germany, 22 to 23 April 1996) (WMO TD No. 894).

121. Report of the Eighth WMO Meeting of Experts on Carbon Dioxide Concentration and Isotopic Measurement Techniques (prepared by Thomas Conway) (Boulder, CO, 6-11 July 1995) (WMO TD No. 821).

122. Report of Passive Samplers for Atmospheric Chemistry Measurements and their Role in GAW (prepared by Greg Carmichael) (WMO TD No. 829).

123. Report of WMO Meeting of Experts on GAW Regional Network in RA VI, Budapest, Hungary, 5 to 9 May 1997.

124. Fifth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry, (Geneva, Switzerland, 7-10 April 1997) (WMO TD No. 898)

125. Instruments to Measure Solar Ultraviolet Radiation, Part 1: Spectral Instruments (lead author G. Seckmeyer) (WMO TD No. 1066)

126. Guidelines for Site Quality Control of UV Monitoring (lead author A.R. Webb) (WMO TD No. 884).

127. Report of the WMO-WHO Meeting of Experts on Standardization of UV Indices and their Dissemination to the Public (Les Diablerets, Switzerland, 21-25 July 1997) (WMO TD No. 921).

128. The Fourth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting, (Rome, Italy, 22-25 September 1996) (WMO TD No. 918).

129. Guidelines for Atmospheric Trace Gas Data Management (Ken Masarie and Pieter Tans), 1998 (WMO TD No. 907).

130. Jülich Ozone Sonde Intercomparison Experiment (JOSIE, 5 February to 8 March 1996), (H.G.J. Smit and D. Kley) (WMO TD No. 926).

131. WMO Workshop on Regional Transboundary Smoke and Haze in Southeast Asia (Singapore, 2 to 5 June 1998) (Gregory R. Carmichael). Two volumes.

132. Report of the Ninth WMO Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques (Edited by Roger Francey), (Aspendale, Vic., Australia).

133. Workshop on Advanced Statistical Methods and their Application to Air Quality Data Sets (Helsinki, 14-18 September 1998) (WMO TD No. 956).

134. Guide on Sampling and Analysis Techniques for Chemical Constituents and Physical Properties in Air and Precipitation as Applied at Stations of the Global Atmosphere Watch. Carbon Dioxide (WMO TD No. 980).

135. Sixth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Zurich, Switzerland, 8-11 March 1999) (WMO TD No.1002).

136. WMO/EMEP/UNEP Workshop on Modelling of Atmospheric Transport and Deposition of Persistent Organic Pollutants and Heavy Metals (Geneva, Switzerland, 16-19 November 1999) (Volumes I and II) (WMO TD No. 1008).

137. Report and Proceedings of the WMO RA II/RA V GAW Workshop on Urban Environment (Beijing, China, 1-4 November 1999) (WMO-TD. 1014) (Prepared by Greg Carmichael).

138. Reports on WMO International Comparisons of Dobson Spectrophotometers, Parts I – Arosa, Switzerland, 19-31 July 1999, Part II – Buenos Aires, Argentina (29 Nov. – 12 Dec. 1999 and Part III – Pretoria, South Africa (18 March – 10 April 2000) (WMO TD No. 1016).

139. The Fifth Biennial WMO Consultation on Brewer Ozone and UV Spectrophotometer Operation, Calibration and Data Reporting (Halkidiki, Greece, September 1998)(WMO TD No. 1019).

140. WMO/CEOS Report on a Strategy for Integrating Satellite and Ground-based Observations of Ozone (WMO TD No. 1046).

141. Report of the LAP/COST/WMO Intercomparison of Erythemal Radiometers (Thessaloniki, Greece, 13-23 September 1999) (WMO TD No. 1051).

142. Strategy for the Implementation of the Global Atmosphere Watch Programme (2001-2007), A Contribution to the Implementation of the Long-Term Plan (WMO TD No.1077).

143. Global Atmosphere Watch Measurements Guide (WMO TD No. 1073).

144. Report of the Seventh Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry and the GAW 2001 Workshop (Geneva, Switzerland, 2 to 5 April 2001) (WMO TD No. 1104).

145. WMO GAW International Comparisons of Dobson Spectrophotometers at the Meteorological Observatory Hohenpeissenberg, Germany (21 May – 10 June 2000, MOHp2000-1), 23 July – 5 August 2000, MOHp2000-2), (10 – 23 June 2001, MOHp2001-1) and (8 to 21 July 2001, MOHp2001-2). Prepared by Ulf Köhler (WMO TD No. 1114).

146. Quality Assurance in monitoring solar ultraviolet radiation: the state of the art. (WMO TD No. 1180).

147. Workshop on GAW in RA VI (Europe), Riga, Latvia, 27-30 May 2002. (WMO TD No. 1206).

148. Report of the Eleventh WMO/IAEA Meeting of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques (Tokyo, Japan, 25-28 September 2001) (WMO TD No 1138).

149. Comparison of Total Ozone Measurements of Dobson and Brewer Spectrophotometers and Recommended Transfer Functions (prepared by J. Staehelin, J. Kerr, R. Evans and K. Vanicek) (WMO TD No. 1147).

150. Updated Guidelines for Atmospheric Trace Gas Data Management (Prepared by Ken Maserie and Pieter Tans (WMO TD No. 1149).

151. Report of the First CAS Working Group on Environmental Pollution and Atmospheric Chemistry (Geneva, Switzerland, 18-19 March 2003) (WMO TD No. 1181).

152. Current Activities of the Global Atmosphere Watch Programme (as presented at the 14th World Meteorological Congress, May 2003). (WMO TD No. 1168).

153. WMO/GAW Aerosol Measurement Procedures: Guidelines and Recommendations. (WMO TD No. 1178).

154. WMO/IMEP-15 Trace Elements in Water Laboratory Intercomparison. (WMO TD No. 1195).

155. 1st International Expert Meeting on Sources and Measurements of Natural Radionuclides Applied to Climate and Air Quality Studies (Gif sur Yvette, France, 3-5 June 2003) (WMO TD No. 1201).