REPORT OF THE SIXTH SESSION OF THE EC PANEL OF EXPERTS/CAS WORKING GROUP ON ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY

(Zürich, Switzerland, 8-11 March 1999)
REPORT OF THE SIXTH SESSION OF THE
EC PANEL OF EXPERTS/CAS WORKING GROUP
ON
ENVIRONMENTAL POLLUTION AND
ATMOSPHERIC CHEMISTRY

(Zürich, Switzerland, 8-11 March 1999)
Sixth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry
(Zürich, Switzerland, 8-11 March 1999)

Table of Contents

1. Opening of the Session................................................................. 1
2. Approval of the Agenda ................................................................. 1
3. Panel Member Presentations of their Scientific Programmes .................. 1
4. Global Atmosphere Watch Programme ............................................. 3
5. Special Topics and Issues ............................................................... 4
6. Cooperation with Other Organizations ............................................. 5
7. Reports of the Scientific Advisory Groups (SAGs) ............................. 7
8. Recommendations and Observations of the Panel ............................... 9
9. Closing of the Meeting ................................................................. 12

Annex A  List of Participants
Annex B  Agenda
SIXTH SESSION OF THE EC PANEL OF EXPERTS/CAS WORKING GROUP ON ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
(ZURICH, SWITZERLAND, 8-11 MARCH 1999)

1. OPENING OF THE SESSION

1.1 The Sixth Session of the WMO Executive Council Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (henceforth referred to as the Panel) was welcomed to the Swiss Meteorological Institute (SMA) by Dr T. Gutermann, the Permanent Representative with WMO from Switzerland on 8 March 1999. Dr Gutermann indicated the importance of the Panel in providing scientific guidance for the Global Atmosphere Watch (GAW) programme. He mentioned the importance of the GAW programme in the SMA where it is part of the core funding of the Institute, supporting facilities and personnel at Arosa, Payerne and Jungfraujoch. It was also pointed out that the other GAW activities such as the calibrations of instruments and training of personnel at many stations are also sponsored by SMA through the Swiss Federal Laboratories for Materials Testing and Research (EMPA). He wished the Panel have a successful meeting.

1.2 Dr F. Delsol then expressed appreciation on behalf of the WMO Secretariat to SMA for hosting this meeting and welcomed all participants (see Annex A) on behalf of Prof. G.O.P. Obasi, the Secretary-General. He commented that this Panel is the primary body for making recommendations to the Executive Council (EC) regarding promoting and implementing the GAW Strategic Plan. It was pointed out that WMO through the EC and the Commission for Atmospheric Sciences (CAS) considers the GAW programme to be successful, as it provides guidance on many subjects such as acid deposition, ozone depletion, and trans-boundary pollution. The GAW programme has long term monitoring responsibilities but does not have adequate long term funding, therefore there is an ongoing need to find international financial support. He then mentioned that the WMO will be moving to its new building soon which will have good facilities for meetings.

2. APPROVAL OF THE AGENDA

2.1 The participants introduced themselves and the chairman, Prof. O. Hov, reviewed the proposed agenda and invited participants to propose additions or other revisions. Changes were made in the order of the presentations to accommodate the recommendations of the participants. The agenda as adopted is given in Annex B.

2.2 Dr Hov reminded the Panel that the main purpose of the meeting was to review the GAW programme, provide guidance, and recommend action items to the EC and the WMO Congress. He also referred to the ten terms of reference adopted by the Twelfth Session of CAS for this Panel to consider. These include promoting the use of the data, and encouraging the training and education activities necessary at the GAW stations.

3. PANEL MEMBER PRESENTATIONS OF THEIR SCIENTIFIC PROGRAMMES

3.1 As is the customary procedure at sessions of the Panel, members were invited to make brief presentations on recent scientific advances in their areas of responsibility.

3.2 Prof. G. Ding presented four components of the atmospheric chemistry programmes within the Chinese Academy of Meteorological Sciences: acid rain, ozone, urban meteorological environment and aerosols. Their studies include studies of acid rain at 86 stations including transport, the interaction between agriculture and the atmosphere, changes in UVB, and the physical and chemical properties of aerosols and their effects on climate.

3.3 Prof. D. Ehhalt showed detailed research on the chemistry involving OH and H₂. He mentioned that the measurement of OH has progressed sufficiently to allow transport of an
instrument for the measurement of OH to various GAW sites where other complimentary measurements are being made for the study of local ozone photochemistry. He also suggested that H₂ be measured at some selected GAW sites and that stations deep within continents be encouraged.

3.4 A new satellite instrument for Measurements of Pollution in the Troposphere (MOPITT) was described by Dr J. Gille. Spacecraft TERRA is expected to be launched in July 1999 and carry a variety of instruments including MOPITT, which measures CO in six IR radiance channels and CH₄ in two channels. The data will provide tropospheric CO profiles nearly to the ground and CH₄ column. GAW stations with surface CO measurements plan to provide data for satellite validation which offers an opportunity for long term collaborations. Dr Gille mentioned that CO measurements in the free troposphere, e.g. at high altitude GAW sites, would be particularly valuable for intercomparison.

3.5 Dr R. Hoff presented his research interests in atmospheric transport and deposition of toxic substances and remote sensing by LIDAR. A process called "global distillation" was described along with the resulting "grasshopper effect" where pollutants are transported by repeated deposition and distillation. The LITE aerosol LIDAR shuttle experiment was described and comparisons were made with aircraft and ground based data. Pollution plumes from Taiwan were evident in the LIDAR data and space based estimates of sulphate fluxes were presented.

3.6 On the subject of climate forcing by aerosol, Dr J. Gras presented arguments for an immediate need to characterise the global aerosol field. It was pointed out that modelling in conjunction with remote sensing and in-situ measurements offers the only realistic path to this complete global aerosol description. The desired outcome is the ability to accurately predict aerosol related forcing and the climate response. Positive advances have been made through international aerosol experiments such as ACE-1, ACE-2, AOE-1996, and INDOEX. He also pointed out that the GAW aerosol programme could make a unique contribution to these efforts through process studies, in-situ data, and ground-truth for remote sensed aerosol properties.

3.7 Wet and dry deposition in the USA was discussed by Mr. B. Hicks. Dry nitrogen deposition (nitric acid) was indicated as the source of the measured increases in the total nitrogen deposition rate and is believed to be due to changes in agricultural practices. It was also mentioned that we are witnessing a fundamental change in the chemistry of the boundary layer in the USA and that the total nutrient loading of the lakes and streams is also being affected, and as world-wide efforts to clean up polluted waters continues, the relative contribution of atmospheric loadings will likely increase. He also pointed out that the WMO/GAW wet deposition and precipitation chemistry record is likely to be a key resource for future assessments and continuing these measurements should be a GAW priority.

3.8 Mr. W. Kimani reported on the WMO/GAW station on Mount Kenya as nearly completed, with power being the last logistical problem before opening the station. Power installation is expected to be completed before the end of May, and the station can officially begin operation in the next few months. Since May 1996, weekly ozone sondes have been launched from Nairobi and Mr. Kimani presented the monthly average ozone profiles. These revealed increased tropospheric ozone values in September when compared with April and May and a pronounced temperature inversion at about 6 km whenever ozone is enriched. He discussed possible sources of the increased ozone such as mid-tropospheric transport from regions of biomass burning. Mr. Kimani finally pointed out that more training of station personnel is needed if they are to properly manage the data from the new station.

3.9 Dr A. Ryaboshapko provided insights into more than three decades of data from the former USSR. These data include measurements of precipitation chemistry, chemistry of aerosols, and gaseous oxides of sulphur and nitrogen and these data have been generalised, checked and harmonised. An effort is now underway to identify a site for a new GAW global station in Siberia with the astronomical station Mondy being a good candidate. They have already begun measurements of surface ozone, precipitation chemistry, and chemistry of aerosols at that site. He
also mentioned the importance of mercury measurements at a few GAW global stations and that they should be seriously considered as part of the GAW programme.

3.10 The Japanese Meteorological Research Institute’s programme, 3-D observations of greenhouse gases for understanding their global cycles, was discussed by Dr K. Fushimi. Their approach has four distinct components: measurements aboard commercial aircraft, surface measurements at GAW stations, ocean sampling and chemical transport modelling. Growth rates and seasonality of carbon dioxide from aircraft, ground based and ocean data were shown using their measurements, some going back as far as 1984. Using their chemical transport model and their extensive data set, it was concluded that biomass burning has a significant influence on the upper air chemistry in the sampled regions and that 3-D observations are useful for understanding the global cycles of the greenhouse gases, as well as for improving modelling techniques.

3.11 Data during the past decade showing relationships between column ozone and UV irradiance at 305 and 325 nm and erythemal irradiance were presented by Prof. C. Zerefos. These data demonstrate the expected anti-correlation of ozone with 305 nm and the erythemal irradiance, but only a weak anti-correlation with the 325 nm irradiance. Regressions were made over shorter time intervals and at two solar zenith angles with similar results. The annual cycles were compared and found consistent with the long term correlations. Positive correlations of UV with the QBO were also presented.

3.12 Dr O. Hov started his presentation showing flask sample data from the GAW Global station at Ny Alesund (Mt. Zeppelin, Spitsbergen) showing trends in CFC’s, CCl₄, and CH₂Cl₂ with data beginning 1983 and the recent success at numerical forecasting of ozone in the boundary layer including intercomparisons with aircraft data. He then presented a programme for the interactive retrieval of atmospheric data through the Norwegian Institute for Air Research (NILU) Atmospheric Database for Interactive Retrieval (NADIR). This database has more than 400 users through internet (ftp and telnet) and include extensive meteorological data sets dating from 1988 to the present. A user interactive air quality information system (AirQUIS) was also presented which provides forecasting and surveillance of European pollution using an elaborate emission model.

4. GLOBAL ATMOSPHERE WATCH PROGRAMME

4.1 Dr J. Miller presented a brief history of the WMO as an introduction to the GAW programme. It was mentioned that the Panel first met in 1988 and has played an important role in providing guidance to the EC regarding the GAW programme. The supporting components of GAW were discussed including GAW centres for calibration, data archiving and quality assurance and GAW groups such as the Operations Support Group, the Observations Group, and the Scientific Advisory Groups for the various measurement categories. A list of GAW contributions that further our understanding of ozone and greenhouse issues was presented. GAW issues for the next century were also proposed.

4.2 Dr. Miller then described the GAW station network, which includes 22 Global stations and more than 300 Regional stations. He pointed out that there is still need for refinement of the network and expansion to regions of the globe where measurements are sparse. A summary of recent GAW meetings and publications was also given.

4.3 The status of the GAW infrastructure and data management was presented by Prof. V. Mohnen. The growing list of GAW World Calibration Centres (WCC’s) was discussed along with proposed new centres for aerosol chemistry, ultraviolet radiation and radionuclides. The World Data Centre Managers meeting of 21-25 September 1998 in Norway for the six WMO/GAW centres was summarised. The data management and QA/QC aspects of the GAW programme were outlined, noting that the flow of data from the stations to the World Data Centres (WDC) should be better defined, particularly to assure that the quality of data that is found in the data centres meets the requirements of the GAW data protocols and ultimately of the scientific community. Suggestions were made for the Panel to consider. The ongoing problem of regular and complete submission of data into the centres was also discussed. Changes to the original or
“classic” approach for QA/SAC operations where they assume only regional responsibilities must also be reconsidered. The suggestion here is that each centre be responsible for a limited number of measurements globally rather than all measurements regionally. That would minimise duplication of facilities between the data centres. Presently the QA/SAC funding is secure for most of the centres long term. Prof. Mohnen finally suggested that this Panel approve a letter of appreciation to the World Data Centres recognising their contributions to the GAW programme.

4.4 Dr. J. Hales presented the OSG responsibilities and activities as defined in the GAW Strategic Plan, GAW Report No. 113. These include reviewing GAW funding needs, clarifying functions of, and interfaces between, the QA/SACs, WDCs, and the WCCs through recommendations to the Panel and Secretariat, and proposing additional WCCs as necessary. The OSG also is to advise on regular planning, reporting, and controlling functions for the central facilities and on near term definition and activation of all GAW calibration protocols. In this regard, suggested revisions of the GAW organisational relationships were discussed by the Panel. The Panel recommended that when feasible, individual QA/SACs should assume global QA responsibility for individual measurement parameters and, where feasible, the WCC should assume similar global responsibilities, although regional sub-WCCs could be a part of this system. The Panel also recommended that the GAW data flow directly to the data centres who would implement some QA checking and, where possible, flagging of data as to its quality. The QA/SACs should serve an advisory role in this process where data compilations could be sent for further QA review. It was noted that although it is preferable to have data flow through the QA/SACs, this arrangement was not practical given available personnel and financial resources. The Panel noted that the OSG is to implement an OSG website to co-ordinate access to data residing in the GAW data centres, provide an interactive communication forum for the various arms of the GAW programme, distribute GAW information, and implement an interactive electronic reporting system for GAW. This website would be transferred to the WMO in Geneva and become a part of the GAW website in the near future.

5. SPECIAL TOPICS AND ISSUES

5.1 Prof. A. Eliassen outlined the history of the European Monitoring and Evaluation Programme (EMEP) and its relationship to the GAW programme. He particularly emphasised chemical transport and climate modelling aspects of current research and how it is contributing toward our understanding of long range trans-boundary air pollution. It was pointed out that the GAW network might play an important role in monitoring certain pollutants.

5.2 The status of real time exchange of ozone data was presented by Dr. F. Delsol. He mentioned that ozone data simulation techniques had improved over the past few years and can now be used to better represent the stratospheric winds and UV radiation. WMO has agreed to provide ECMWF with virtually real time profile information. NILU has taken a lead role in receiving and distributing the data and has overcome early formatting problems. Dr. Delsol mentioned that use of ozone for forecasting is a natural link between GAW and other WMO groups.

5.3 The WMO Ozone Mapping Centre uses total column ozone data in real time both from ground based measurements (Dobson, Brewer, SAOZ and M124 filter instruments) and from satellite measurements. Prof. Zerefos pointed out that the Centre pre-screens the data real time for quality and does the analysis and assessments of regional ozone patterns. Reports are also published for use by scientists, politicians and journalists. The Laboratory of Atmospheric Physics of the Aristotle University of Thessaloniki operates this Centre with a long-term commitment.

5.4 Dr. D. Moller referred to the report of the EC Panel/CAS Working Group on Physics and Chemistry of Clouds, and Weather Modification Research. The Working Group had found that between 1992 and 1997 significant changes in the characteristics of ozone concentration, cloud physics and chemistry had taken place. It was concluded that ozone is consumed in clouds whereas the ozone reduction potential is decreasing. Tropospheric ozone data were presented from German stations that showed wintertime ozone increased from 15 ppb to 31 ppb over this period whereas the summertime ozone remains constant at 47 ppb. Why this change has taken
place is not clear but may arise from changes in cloud physical parameters that are induced from chemical changes in the atmosphere. Decreases in emissions in Eastern Germany during this period could also play a role by changing the active cloud condensation nuclei in the atmosphere. The Panel noted the latest statements by EC and Congress on this matter, namely that although rainmaking has a long tradition, there is no operational model available and it is frequently difficult to justify the expense. Hall suppression is operational in Russia and China while fog suppression has possible applications, but again only an empirical approach has been used. The Panel noted that chemistry is ignored in the models.

5.5 Presentations were made by Ms L. Jalkanen on two important issues for developing countries. The first concerns the regional trans-boundary smoke and haze in South East Asia. It was noted that the new global GAW station established in Indonesia is well located for these studies and that aerosol measurements made there have been of excellent quality. Expert visits and training of station personnel at stations in developing countries are functions of the GAW programme that are essential for obtaining the reliable data that the science community needs. For example, a WMO Workshop on Trans-boundary Smoke and Haze in South-East Asia took place during June 1998 in Singapore. Recommendations from this workshop included strengthening regional monitoring efforts to assess the effects of smoke and haze and enhancing the regional capabilities to provide meteorological support. An executive summary of the workshop is available. The Panel was informed that Prof. G. Carmichael spent his sabbatical at WMO to develop the Programme to Address ASEAN Regional Trans-boundary Smoke (PARTS).

5.6 The second topic discussed by Ms Jalkanen concerned the WMO Urban Environment Research programme, an emerging focus for the GAW programme. One of the major environmental problems in both developing and developed countries is urban air pollution. It has detrimental effects on human health in the cities, and can be transported far from its source regions and can therefore have adverse effects on the biosphere. In view of this, the Secretariat was requested to form a small ad hoc expert group to prepare a programme on urban matters for submission to Congress XIII in May 1999.

6. COOPERATION WITH OTHER ORGANIZATIONS

6.1 Prof. V. Mohnen and Dr J. Gille discussed what role GAW might play in satellite validation programmes, particularly through the Integrated Global Observing System (IGOS) for ozone and atmospheric chemistry measurements. It is clear that there will be an increased reliance on ground based measurements particularly in regions of the world where such measurements are sparse. It was stated that validation sites should maintain their capabilities over the lifetime of the satellites, thus requiring continuous and substantial funding for the GAW network.

6.2 An overview of IGAC, the International Global Atmospheric Chemistry Project was presented by Dr A. Pszenny including a refocusing of the IGAC structure that was started more than a year ago. Significant for the GAW / IGAC co-operative relationship is their mutual interest in the Global Tropospheric Ozone Project (GTOP). The purpose of GTOP is to establish a truly global climatology of tropospheric ozone and to quantify the components of its global budget. GTOP is also a programme that will provide a framework for international co-ordination in tropospheric ozone research. In addition to the enhancement of observational capabilities as a means of gaining a more comprehensive understanding of the science, GTOP will advocate for an awareness of the tropospheric ozone issue, and encourage education and capacity building for the next generation of scientists.

6.3 Prof. A. Ohmura presented a historical summary for the WCRP Baseline Surface Radiation Network (BSRN). The objectives of the Network are to provide accurate radiation fluxes for validating climate models, provide the ground truth for satellite radiometry, and to monitor long-term changes in radiation. Data from a recent evaluation of the measurement accuracies were presented that demonstrate the Network has fulfilled the BSRN accuracy requirements set in 1990 for global irradiance, direct solar irradiance diffuse sky irradiance and longwave down irradiance. It
was noted that changes in radiation fields due to the greenhouse effects are expected, but there is
disagreement about what those changes will be.

6.4 The Acting Director of the GCOS Secretariat, Dr M. Coughlan, was not able to attend the
meeting of the Panel and Dr J. Miller made a brief presentation. He pointed out that at this time
GCOS is waiting for a new Director to be appointed and that activity is at a minimum. Historically,
GAW is a strong supporter of GCOS interests in atmospheric chemistry, and this role is one that
could be enhanced.

6.5 Participation of the WMO/GAW in the work of the inter-agency Group of Experts on the
Scientific Aspects of Marine Environmental Protection (GESAMP) was briefly presented by Mr A.
Soudine. The GESAMP is presently preparing two comprehensive reports: "The state of the
marine environment – current major issues and emerging problems" and "Land-based sources and
activities affecting the quality and use of the marine, coastal and associated freshwater
environment". The WMO contribution to these reports included evaluation of such problems as
changes of nitrogen fluxes and deposition of persistent organic pollutants to the marine
environment, effects of climate and global changes, UV radiation and others. Both reports were
expected to be completed in 2000. Mr A. Soudine also informed the Panel about the WMO/GAW
co-operation with the Meditterranean Pollution (MED POL) programme where the role of WMO is to
initiate and co-ordinate national activities related to monitoring, modelling and assessment of
pollution of the Mediterranean Sea through the atmosphere. In particular, he noted two recently
prepared reports on modelling of atmospheric input of mercury and persistent organic pollutants to
the Mediterranean Sea which confirmed that the atmospheric inputs of these pollutants are equal
to or exceed their riverine inputs.

6.6 The Stratospheric Processes and their Role in Climate (SPARC) research project was
established in 1992 under the auspices of the WCRP. In her presentation, Dr M. Chanin outlined
the issues of SPARC as stratospheric indicators of climate change and stratospheric processes
and their relation to climate and modelling of stratospheric effects on climate. Science results that
have been fostered or encouraged through SPARC activities were outlined including trends in
ozone, temperature, and water vapour stratospheric profiles. It was pointed out that GAW, along
with the Network for the Detection of Stratospheric Change (a GAW contributing network), should
continue to ensure the quality of their monitoring programmes remains high. Long-term monitoring
requirements for various atmospheric parameters were presented, including a high priority for
increasing the ozone profile measurements in the tropics.

6.7 A summary of the World Health Organization's (WHO) air quality programme was given by
Dr D. Schwela, noting that WHO has issued guidelines for air quality standards that are applicable
globally. These guidelines offer governments the background information necessary for setting
their local standards, and WHO also offers assistance in local, regional, and national action plans.
Examples of these guidelines were shown, including guidelines for carbon monoxide, nitrogen
dioxide, ozone, and sulphur dioxide. WHO also issues guidelines for episodic vegetation fire
events and a report of these guidelines will be available on the Internet on 30 April 1999. The Air
Management Information System (AMIS) was also described. AMIS objectives are to conduct
global assessments of environmental quality, act as a data/information broker, run global
databases with validated data from cities, produce technical documentation, establish regional
collaborating centres, and to establish codes of best practice.

6.8 The Global Environment Facility (GEF) with component organisations UNEP, UNDP, and
the World Bank has funded two WMO/GAW projects that were discussed by Dr J. Miller. The first,
"Global Monitoring of Greenhouse Gases Including Ozone" establishes new globally important
GAW stations in carefully selected locations in Algeria, Argentina, Brazil, China, Indonesia and
Kenya. The second project "Monitoring of Ozone and UV-B in the Southern Cone Countries"
establishes a network of carefully selected stations for the measurement of ozone and UV-B in
Argentina, Brazil, Chile, Paraguay, and Uruguay. The two projects together totalled about 6 million
US dollars in GEF support together with about US$5million from the host countries. The first
project has resulted in the creation of 6 new global stations and the second in 9 stations for
monitoring total ozone, 7 for surface ozone, and 13 for UV-B. Initial training of national personnel has been completed but further training will need to continue in the long-term. The host countries have agreed to maintain the stations. The status of the six global stations was described as generally operational, with Kenya and Brazil still in the start-up stage.

7. REPORTS OF THE SCIENTIFIC ADVISORY GROUPS (SAGs)

7.1 Ms L. Jalkanen reported that the GAW Scientific Advisory Group on UV Radiation, the first GAW SAG, was established in 1995 to guide the harmonization of UV measurements on the global scale. The SAG has met five times, with the next planned for April 1999. There are working groups on the following issues: quality assurance and control (QA/QC), data archiving, instrumentation, data analysis, network, modelling and user community. Satellite observations will also be addressed.

7.2 There is a great need for guidelines on UV radiation measurements. The QC document "Guidelines for Site Quality Control of UV Monitoring" has been printed and the QA document is under preparation. The two instrument documents, "Instruments to measure solar ultraviolet radiation." "Part 1 Spectral instruments" and "Part 2 Broadband instruments measuring erythemally weighted solar radiation" will be published in the near future. A workshop report on broadband UV radiometers has been published. The Panel reiterated that instrument intercomparisons were an important activity and there was a need for calibration centres for UV radiation. It therefore proposed that possible regional calibration centres be investigated at this time. The development of the Central UV Calibration Facility (CUCF) at NOAA was warmly welcomed.

7.3 The number, distribution and quality of UV instruments have significantly increased in the last 3-4 years. The Panel proposed that the network working group would need to address this development. A joint WMO/IGAC intercomparison of visible and UV radiative models with campaign data was arranged in June 1998 in Boulder and the data analysis working group was working on a guidelines report. The World Ozone and Ultraviolet Data Centre (Woudc) at the Atmospheric Environment Service of Environment Canada collects and distributes UV data. The Panel noted that the guide for data submission "Guide to WMO/GAW World Ultraviolet Radiation Data Centre" was accessible on the web.

7.4 Another objective of the GAW UV programme, the Panel noted, was to link the UV data with the user community and to increase public awareness of UV changes and their potential effects. In this regard, the WMO had arranged a second meeting on UV Indices in cooperation with WHO and UMAP in 1997. A joint recommendation for a simple, uniform and universally applicable solar UV index and its usage has been published and adopted by many countries for the daily UV index issued to the public. The Panel noted that a revision of this index is planned within the next few years. Furthermore, it recommended that the relationship with UV data users needs to be enhanced and their requirements for data need to be incorporated into the UV measurement programme.

7.5 The SAG chairman for greenhouse gases, Dr K. Holmen, reported that the first meeting was held 16-17 Feb 1999 in San Diego California. The meeting discussed the assigned activities of SAGs and examined the objectives of the greenhouse gases programme. Objectives were identified as 1) providing multi-decadal high quality records of the greenhouse gases for the purpose of emission estimation and verification studies, 2) understanding the cycles of greenhouse gases on global and regional scales and 3) contributing to the international climate change assessments. He reported that since the Kyoto Conference of the Parties to the UNFCCC, the pressure to provide more measurement stations has increased, particularly in continental and tropical areas. It was emphasised that the need for such stations making vertical profiles of CO2, CH4, N2O and SF6 is exceptionally great. Improving the quality of data provided from stations should also be a high priority for the GAW network, including establishing WCCs for each of the greenhouse gases. It was also the opinion of the SAG that it is essential that there is a strong scientific/interpretive component in direct association with all measurement programmes. It was felt that the incentive to maintain a high quality data record over decades requires a continuously
maintained scientific interest in utilising the data. This implied a strong financial commitment that required partnerships to be formed by all new and many established stations in developing countries in order to stimulate these continuous data appraisal efforts.

7.6 Prof. I. Isaksen presented the views of the Ozone SAG as expressed during their first meeting in Geneva, 6-7 June 1998. A list of areas of particular interest to the GAW ozone programme was given which included ozone-climate interaction, ozone-UV interaction, the observational networks, observational verification of modelling of regional and global ozone distribution, and large scale regional tropospheric ozone increases. The SAG identified the issue of how to use models to predict ozone changes as of much interest. To achieve this, an expanded ozone measurement programme is needed, particularly for all levels of the troposphere. For example, the climate impact of ozone change has been shown to have a strong regional variation in the climate change induced through radiative forcing. That is, regional variations in ozone may be very important and can easily go undetected without a substantially enhanced ground based and sonde measurement programme for ozone. He concluded by emphasizing that a tropospheric ozone report is needed which would focus on a few key questions. These might be 1) What do observations and models tell us about ozone distribution and trends? 2) What do we know about the ozone-climate interaction? 3) What are the important uncertainties in the chemistry and transport of ozone? and 4) What are the uncertainties in budgets and precursors emissions. Dr Isaksen reported that the next meeting of the ozone SAG will be 24-25 May 1999 in Crete.

7.7 A list of members of the Precipitation Chemistry SAG was provided by Prof. R. Artz who informed the Panel that this group has worked closely with the QA/SAC Americas and the Precipitation Chemistry Data Centre in Albany, New York. A website has been launched during the summer 1998 with many features of interest to the data user community. Site data downloads and user documentation are not available at this time but will be provided in the future. There are 491 contributing stations of which 288 are GAW sites. The twentieth laboratory intercomparison on precipitation chemistry was initiated in 1997 and is now nearly complete. The results of many of the intercomparisons are available on the web site. Significant upgrading of the data centre hardware has taken place and a full time system support person has been employed. With this added support, the SAG is considering changing the reporting of intercomparison results in a variety of ways including developing a new recommended sample history form, studying sample preservation criteria, establishing acceptable detection limits, and studying emerging instrument technology. Proposals are being considered to fund the production of operating manuals for the GAW Precipitation Chemistry programme, increased expert visitation to GAW stations, providing standard reference materials for GAW stations, and to study precipitation chemistry sample handling and preservation techniques. Following the revision of policies regarding data collection, data analysis, and database development, the goal of the SAG is to establish new stations in data sparse regions. A policy will be developed to establish "twinning" of successful, operational stations and laboratories with the interested participants in under-reported regions. It is envisioned that most of the effort will be toward the establishment of high quality stations in developing countries.

7.8 Dr U. Baltensperger presented the views of the SAG on Aerosols and Optical Depth as expressed during their two meetings. There are 11 members of this SAG, most of whom are experienced in aerosol measurements. The SAG has suggested that its objectives be restated "To determine the spatio-temporal distribution of aerosol properties related to climate forcing and air quality up to multi-decadal time scales. It was pointed out that GAW is the only programme that can provide long-term measurements on global scales". The questions to be addressed by the GAW aerosol programme might be 1) To what extent do aerosols affect the climate? and 2) To what extent do aerosols adversely affect regional air quality, including for example morbidity, mortality, visibility, and damage to ecosystems?. The SAG proposed that the number of global GAW stations needs to be increased to accommodate the need for better global coverage over a wide array of aerosol measurements. A total of 28 sites were suggested, including 14 of the present 22 global GAW stations. Other regional stations can provide the less extensive measuring programmes. The future needs were also identified to include 1) finalising the operation procedures for measurement of the aerosol parameters 2) synthesising the integrated global
aerosol data sets by the WDC for aerosols 3) solving the funding problems of the WCC for aerosols 4) increasing capacity building in developing countries and 5) intensifying the collaboration with other international programmes, e.g. for ground truth of satellite measurements and IGAC. The SAG also suggested that 1) considerable effort is needed for instrument development, 2) QA procedures need be established through an urgently needed and well organized WCC for aerosols, and 3) collaboration with modellers should be encouraged. The next Aerosol SAG meeting is to be 7-9 June 1999 in Boulder, Colorado USA where it is expected the aerosol procedure report will be finalized.

8. RECOMMENDATIONS AND OBSERVATONS OF THE PANEL

8.1 The Strategic Plan of GAW serves as a primary implementation document to address the GAW vision and broad objectives as approved by the Twelfth Congress. Currently GAW is completing the third year of implementation of the Plan. After intensive discussions the Panel made a number of observations and recommendations which are reported below.

8.2 Continuity of GAW activities under the broad guidelines of the Strategic Plan to attain the vision and objectives of CG-XII is essential. It is to be recognised that the Plan is an evolving document, and that specific elements will be modified with changing conditions and with operating experience. It is also recognised that attainment of specific goals is, and will continue to be, constrained by available financial, personnel, and material resources. Within this context it is especially important that data of documented quality, adequate for their intended purpose, be made available for use by the scientific community, thus providing the GAW sponsors with tangible evidence of the programme's success.

8.3 Recognition of specific individuals and institutions supporting GAW activities is an important factor in maintaining their continued intellectual and financial support. GAW should ensure that such contributions are properly acknowledged, and the Panel suggested the Secretariat formally recognise the contributing institutions on a regular basis.

8.4 The Panel reviewed the structural change within GAW through the formation of the Operations Support Group (OSG), the World Calibration Centres (WCC), and the Scientific Advisory Groups (SAG), in addition to the existing Quality Assurance/Science Activity Centres (QA/SAC) and Data Centres, which had been implemented in accordance with the Strategic Plan. The Panel noted that the GAW organisation is sufficiently complex, especially with regard to information-flow pathways, to render management and comprehension difficult. The Panel therefore, strongly recommended streamlining data and information flow to the maximum extent possible.

8.5 Cognisant that GAW will be judged on the scientific results derived from its data, the Panel recommended that the SAGs expand their responsibilities and become more data-user oriented, with the intent of facilitating the rapid flow of data to the scientific community and of scientific results to the public. It also recommended that countries hosting global GAW stations should actively use GAW data for scientific purposes, recognizing that data quality is best maintained and enhanced when those who take the data also have a scientific interest in the data. The Panel encouraged further co-operation and communication between the GAW stations.

8.6 In further compliance with the desire for data-flow streamlining (including metadata files) and in recognition of limited available resources, the Panel recommended the following:

A. The QA/SACs, with advice from the SAGs, should set requirements for each measured parameter; e.g., the data quality objectives and acceptable data formats. Furthermore, each station should work with the WDC to formally establish the data submission pathways that provide final data to the WDC archives in a timely manner and meet the data quality objectives. These pathways should be consistent with QA/SAC, WCC, and SAG functions, and serve to routinely inform these centres and groups of the data.
ultimately submitted to the WDCs. Efforts by the WDCs to harmonise the data pathways and establish efficient data submission procedures were strongly supported by the Panel.

B. Where feasible, a shift from QA/SACs having regional responsibility for all GAW measurement parameters toward global responsibility for specific measurement parameters at WCCs, which may or may not reside within a QA/SAC, was strongly supported. The Panel was of the view that this shift could maximise the effective use of limited QA/SAC resources, while at the same time enhancing global harmonisation of GAW data at highly specialised WCCs. In this context, the Panel recognized the successful implementation of such a globalisation by EMPA’s calibration facility (WCC) for CO and surface ozone which could serve as a model for the future.

8.7 During their review of GAW, the Panel recommended the following additional actions be undertaken:

A. The uncertain status of the WCC for Aerosol Chemistry should be resolved as soon as practical and that a search for alternative candidate laboratories to serve in this capacity should be resumed. Furthermore, a WCC for Aerosol Physics should be established, and aerosol optical depth data should be included in the WDC for Aerosols.

B. Formal identification of the QA/SAC(s) having responsibility for the following GAW measurement parameters: aerosols, radionuclides, O₃, CO, NOₓ, NOy, VOCs, and the greenhouse gases N₂O, CH₄ and CFCs. It also recommended that WCCs be established for these parameters, and that data-flow to appropriate WDCs be defined. As an alternative, the Panel recommended developing partnerships, where appropriate, with existing measurement programmes (e.g., IGAC and EMEP) to promote harmonisation of QA/QC.

C. The QA efforts for POPs and heavy metals in GAW be linked to the ongoing EMEP, AMAP, and North American activities.

D. The interpretation and publication of data should reflect that the measurement data are the intellectual property of others.

E. The efforts of the German Umwelt Bundesamt should be supported to re-establish the QA/SAC in Germany.

8.8 The Panel emphasised that the Strategic Plan is a dynamic document and requested the Secretariat to update the Plan for the years 2001-04, taking into account any additional new guidance from Cg-XIII (May, 1999).

8.9 The Panel noted the importance and future potential of the World Wide Web as a medium for communicating GAW data and information. It endorsed current GAW activities in this area and encouraged rapid expansion and development. It also suggested merging the current Operations Support Group website with the new GAW website in Geneva. It requested the Secretariat to provide and maintain active links to all external GAW-related websites.

8.10 The Panel reviewed the list of focal issues for the next two years presented as near-term action items by the Secretariat. This list was amended and endorsed as follows:
OBJECTIVES:
- Provide up-to-date information on the chemical composition of the atmosphere and related physical parameters.
- Address specific issues related to changes in the global atmosphere (climate, ozone, pollution transport, and others) and participate/contribute in/to preparation of relevant scientific assessments.

HOW TO MEET THESE OBJECTIVES:
- Maintain, augment, and enhance the GAW Global and Regional networks and related infrastructure, with particular emphasis on the vertical distributions of measured parameters.
- Provide international QA/QC through active SAGs, QA/SACs, WCCs and WDCs for such activities as QA/QC guidance, inter-calibrations, and data management.
- Promote wider use of GAW data and products by employing modern information exchange and communication systems.
- Encourage strong interaction with the scientific community. Request SAGs to take leadership roles in disseminating scientific information.
- Pursue new areas of interest for GAW such as the urban environment, biosphere burning, and POPs/heavy metals.
- Improve GAW interactions with the satellite and modelling communities; specifically:
  - Participate in the efforts of the Committee on Earth Observing Satellites in establishing an Integrated Global Observing Strategy (IGOS) and assure that the GAW measurement parameters are utilised to the maximum possible extent.
  - Develop partnerships with the World Health Organization (WHO) and European Monitoring and Evaluation Programme (EMEP) for jointly implementing QA/QC procedures, in particular for aerosols and reactive gases.
- Provide training, especially for developing countries, through twinning, workshops, and teleconferencing technologies as they emerge.
- Continue active co-operation with other international groups such as IGAC, SPARC, UNEP, and others.
- Obtain sufficient resources to continue and expand WMO's role through GAW as the central international organisation.

8.11 The Panel was concerned about the potential loss of satellite-derived ozone data relevant to the long-term stratospheric and total-column ozone trends. If indeed such a gap in satellite ozone coverage developed in the near future (extending up to three years), WMO-GAW and affiliated programmes (e.g., Network for the Detection of Stratospheric Change) should co-operate closely with space agencies to assure proper ground-based global coverage, using data from the Dobson, ozone-sonde, Brewer, and LIDAR stations during the interim time-period. This would require enhanced sampling and QA/SAC activities that must be carefully co-ordinated and monitored.

8.12 The Panel proposed the Secretariat establish contact and develop procedures with space agencies that would ameliorate the situation should this emergency indeed occur.

8.13 In the meantime, the Panel issued the following text and requested the Secretariat to bring it to the attention of NDSC, SPARC and Thirteenth WMO Congress.

"The WMO is aware of the need for an Integrated Global Observing Strategy (IGOS) advocated by the Committee on Earth Observing Satellites (EOS). WMO-GAW is a major contributor of ground-based observations providing both, long-term, quality assured measurements
on the composition of the atmosphere and campaign style measurement support for ground truthing satellite sensors. Satellite- and ground-based observations are essential and mutually dependent components of IGOS. IGOS recommends that satellite sensors be continuously validated over their entire lifetime, a policy strongly endorsed by WMO-GAW and SPARC. To ensure the availability of high quality, ground-based measurements over a long period of time, the Panel strongly recommends that the satellite community shares responsibility and resources with WMO-GAW and related programmes in maintaining high quality network operations in support of satellite groundtruthing over the lifetime of sensors.

8.14 With respect to global radiation measurements, the World Radiation Centre in Davos (WRC) together with the World Radiation Data Centre in St. Petersburg (WRDC) and the World Radiation Monitoring Centre for the Baseline Surface Radiation Network in Zurich (WRMC) were requested:

- to clarify GAW’s need for solar radiation data relating to the infrared and visible spectrum;
- to identify existing and propose new interfaces of GAW with the Baseline Solar Radiation Network and World Weather Watch programmes; and
- to clarify the role of WRC, WRDC and the WRMC with respect to GAW.

8.15 Air quality is a major factor for public health and life expectancy in many urban regions throughout the world. The Panel recognised the responsibility of WMO, in collaboration with other UN bodies, to contribute to the diagnosis and forecast of urban air quality and supported an urban initiative within the GAW umbrella.

9. CLOSING OF THE MEETING

9.1 The meeting was closed in the afternoon of 11 March 1999.

*****
Sixth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry

(Zürich, Switzerland, 8-11 March 1999)

List of participants

Panel members

Prof. Oystein Hov (Chair)
Norwegian Institute for Air Research (NILU)
Postboks 100
N-2007 KJELLER
Norway
Tel: 47 63 89 80 00
Fax: 47 63 89 80 50
e-mail: oystein.hov@nilu.no

Dr John C. Gille
NCAR
P.O. Box 3000
BOULDER, CO. 80307-3000
USA
Tel: 303 497 1412/8062
Fax: 303 497 1492
e-mail: gille@ucar.edu

Prof. Guoan Ding
Institute of Atmospheric Chemistry
Chinese Academy of Meteorological Sciences
46 Baishiqiao Road
BEIJING 100081
China
Tel: 86 1 062 1 76414
Fax: 86 1 062 1 75931
e-mail: tangi@publicintercom.co.cn

Dr John Gras
CSIRO Division of Atmospheric Research
Private Bag 1
Aspendale, Vic., 3195
Australia
Tel: 61-3-9239 4400
Fax: 61-3-9239 4444
e-mail: jlg@dar.csiro.au

Prof. Dr Dieter H. Ehhalt
Institut für Atmosphärische Chemie
Forschungszentrum Juelich
Postfach 1913
52428 JUELICH
Germany
Tel: 49 2461 61 4692
Fax: 49 2461 61 5346
e-mail: k.welthofer@kfa-juelich.de

Mr Bruce Hicks
NOAA
Air Resources Laboratory
Room 3152, SSMC3
1315 East West Highway
SILVER SPRING, MD 20910
USA
Tel: 301 713 0684
Fax: 301 713 0119
e-mail: bruce.hicks@noaa.gov

Dr Katsuhiko Fushimi
Geochemical Research Department
Meteorological Research Institute
1-1 Nagamine, Tsukuba
IBARAKI 305-0052
Japan
Tel: 81 298 53 8718
Fax: 81 298 53 8728
e-mail: kfushimi@mri-jma.go.jp

Dr Raymond M. Hoff
Air Quality Research Branch
Atmospheric Environment Service
R.R. #1
EGBERT, Ontario LOL 1NO
Canada
Tel: 705 458 3310
Fax: 705 458 3301
e-mail: ray.hoff@ec.gc.ca
Mr Wilson Kimani  
Kenya Meteorological Department  
P.O. Box 30259  
NAIROBI  
Kenya  
Tel: 2542 567 880/9  
Fax: 2542 567 888/9  
e-mail: wilson.kimani@meteo.go.ke

Dr Urs Baltensperger  
Paul Scherrer Institute  
CH-5232 Villigen PSI  
Switzerland  
Tel: 41-56-310 2408/2111  
Fax: 41-56-310 4435  
e-mail: urs.baltensperger@psi.ch

Dr Alexey G. Ryaboshapko  
Institute of Global Climate and Ecology  
Glebovskaja Str. 20-B  
MOSCOW 107258  
Russian Federation  
Tel: 7095 160 5867  
Fax: 7095 160 0831  
e-mail: ryaboshapko@ra.igce.msk.ru

Dr Kim Holmen  
Department of Meteorology  
Arrhenius Laboratory  
Stockholm University  
S-10691 STOCKHOLM  
Sweden  
Tel: 46 8 164 352  
Fax: 46 8 159 295  
e-mail: kim@misu.su.se

Prof. Christos Zerefos  
Aristotle University of Thessaloniki  
Campus Box 149  
THESSALONIKI 54006  
Greece  
Tel.: 00 3031 998 041  
Fax: 00 3031 283 752  
e-mail: zerefos@ccf.auth.gr

Prof. Ivar S.A. Isaksen  
Department of Geophysics  
University of Oslo  
P.O. Box 1022  
Blindern  
N-0315 OSLO  
Norway  
Tel.: 47 22 855 822  
Fax: 47 22 855 269  
e-mail: ivar.isaksen@geofysikk.uio.no

Prof. Anton Eliassen (President of CAS)  
Norwegian Meteorological Institute  
P.O. Box 43  
Blindern  
0313 OSLO  
Norway  
Tel: 47 22 963 000/152  
Fax: 47 22 963 050  
e-mail: anton.eliassen@dnmi.no

Dr Paul C. Simon  
Institut d'Aeronomie Spatiale de Belgique  
3 Avenue Circulaire  
B-1180 Brussels  
BELGIUM  
Tel: 32 2 373 0400  
Fax: 32 2 375 9336  
e-mail: paul.simon@oma.be

### SAG Chairs

Mr Richard Artz  
NOAA Air Resources Laboratory  
Room 3151  
1315 East West Highway  
SILVER SPRING, MD 20910  
USA  
Tel: 301 713 0972  
Fax: 301 713 0119  
e-mail: richard.artz@noaa.gov

### Invited Experts

Dr Marie-Lise Chanin  
CNRS/SA  
Service d'Aéronomie  
B.P. 3  
91371 VERRIERES LE BUISSON Cedex  
France  
Tel: 33 1 6920 0794  
Fax: 33 1 6920 2999  
e-mail: chanin@aerov.jussieu.fr
Dr Wolfgang Fricke
Deutsche Wetterdienst
Meteorologisches Observatorium
Albin Schwaiger Weg 10
D-82383 HÖHENPEISSENBERG
Germany
Tel: 49 8805 0037
Fax: 49 8805 920 046
e-mail: wofri@mohp.dwd.d400.de

Mr Gerhard Müller
Swiss Meteorological Institute
P.O. Box 514
Krähbühlstrasse 58
8044 ZURICH
Switzerland
Tel: 411 256 9403
Fax: 411 256 9278
e-mail: gmu@sma.ch

Dr Jeremy M. Hales
ENVAIR
60 Seabreeze Court
PASCO, WA 99301
USA
Tel: 509 546 9541
Fax: 509 546 9522
e-mail: jake@odysseus.owt.com

Prof. Dr Atsumu Ohmura
Geographisches Institut
ETHZ
Winterthurerstrasse 190
8057 ZURICH
Switzerland
Tel: 1 635 52 20
Fax: 1 362 51 97
e-mail: ohmura@geo.umnw.ethz.ch

Dr Peter Hofer
EMPA
Überlandstrasse 129
8600 DUBENDORF
Switzerland
Tel: 01 823 5511
Fax: 01 821 6244
e-mail: peter.hofer@empa.ch

Dr Alex Pszenny
IGAC
Building 24-409
Massachusetts Institute of Technology
CAMBRIDGE, MA 02139
USA
Tel: 617 253 9887
Fax: 617 253 9886
e-mail: pszenny@mit.edu

Prof. Dr Volker Mohnen
Atmospheric Environmental Institute – IFU
Kreuzebahnstrasse 19
D-82467 GARMISCH-PARTENKIRCHEN
Germany
Tel: 0049 8821 183 263
Fax: 0049 8821 735 73
e-mail: mohnen@ifu.fhg.de

Dr Dieter Schwela
World Health Organization
20 Avenue Appia
1202 GENEVA
Switzerland
Tel: 791 4261
Fax: 791 4127
e-mail: schwelad@who.ch

Prof. Dr Detlev Möller
Brandenburg Technical University of Cottbus
P.O. Box 10 13 44
D-03013 COTTBUS
Germany
Tel: 0355 7 81 31 31
Fax: 0355 7 81 31 32
e-mail: moe@btu.ic.fra.berlin.de

WMO Secretariat
Frédéric Delsol
Liisa Jalkanen
John Miller
Michael Proffitt
Alexandre Soudine
Sixth Session of the EC Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry

(Zürich, Switzerland, 8-11 March 1999)

Agenda

1. OPENING OF SESSION

2. APPROVAL OF THE AGENDA

3. PANEL MEMBER PRESENTATIONS OF THEIR SCIENTIFIC PROGRAMMES

4. GLOBAL ATMOSPHERE WATCH PROGRAMME
   - Overview
   - Global and Regional Networks
   - Status of GAW Infrastructure
   - Data Management

5. SPECIAL TOPICS AND ISSUES
   - EMEP
   - Real Time Ozone Information
   - Weather Modification and Atmospheric Chemistry
   - S.E. Asia Fires
   - Urban Programme

6. COOPERATION WITH OTHER ORGANIZATIONS
   - IGOS
   - IGAC
   - BSRN
   - GCOS
   - GESAMP
   - SPARC
   - WHO
   - GEF

7. REPORTS OF THE SCIENTIFIC ADVISORY GROUPS (SAGs)
   - UV Radiation
   - Greenhouse Gases
   - Ozone
   - Precipitation Chemistry
   - Aerosols and Optical Depth

8. RECOMMENDATIONS AND OBSERVATIONS OF THE PANEL

9. CLOSING OF THE MEETING
GLOBAL ATMOSPHERE WATCH
REPORT SERIES


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


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


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


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


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 (TD No. 10)

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


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 (TD No. 103)


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 (TD No. 67)


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

35. Provisional Daily Atmospheric CO₂ Concentrations as Measured at BAPMoN Sites for the Year 1983. December 1985 (TD No. 77)


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


46. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1984. December 1986 (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 (TD No. 178)


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


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 (TD No. 283)

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


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


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


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


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 (TD No. 400)


72. Integrated Background Monitoring of Environmental Pollution in Mid-Latitude Eurasia by Yu.A. Izrael and F.Ya. Rovinsky, USSR (TD No. 434)
73. Report of the Experts Meeting on Global Aerosol Data System (GADS), Hampton, Virginia, 11-12 September 1990 (TD No. 438)
75. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1990 (TD No. 447)
76. The International Global Aerosol Programme (IGAP) Plan: Overview (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 (TD No. 446)
83. Report on the Global Precipitation Chemistry Programme of BAPMoN (TD No. 526)
84. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at GAW-BAPMoN sites for the year 1991 (TD No. 543)
85. Chemical Analysis of Precipitation for GAW: Laboratory Analytical Methods and Sample Collection Standards by Dr Jaroslav Santroch (TD No. 550)
89. 4th International Conference on CO₂ (Carqueiranne, France, 13-17 September 1993) (TD No. 561)
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, 4-8 October 1993 (TD No. 563)


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


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 (QAPp) for Continuous Ground Based Ozone Measurements (TD No. 634)


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


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, 13-17 March 1995 (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) (TD No. 718)


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) (TD No. 710)


109. Report of an Expert Consultation on 85Kr and 222Rn: Measurements, Effects and Applications (Freiburg, Germany, 26-31 March 1995) (TD No. 733)
110. Report of the WMO-NOAA Expert Meeting on GAW Data Acquisition and Archiving (Asheville, NC, USA, 4-8 November 1995) (TD No. 755)


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


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


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

125. Instruments to Measure Solar Ultraviolet Radiation

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

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

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

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

131. WMO Workshop on Regional Transboundary Smoke and Haze in Southeast Asia (Singapore, 2-5 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) (TD No.956)


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)