REPORT OF THE THIRD SESSION OF THE EC PANEL OF EXPERTS/CAS WORKING GROUP

ON

ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
(Geneva, 8-11 March 1993)
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1. OPENING OF THE SESSION

1.1 The meeting of the WMO Executive Council Panel of Experts/CAS Working Group on Environmental Pollution and Atmospheric Chemistry (henceforth referred to as the Panel) was opened by the Chairman, Dr. D. Whelpdale.

1.2 On behalf of the Secretary-General, Prof. G.O.P. Obasi, Dr. D.N. Axford, Deputy Secretary-General, welcomed the participants to the WMO Secretariat (see participants list in Appendix A). In his opening address, Dr. Axford noted the recent developments in the WMO Global Atmosphere Watch (GAW) programme and pointed out the relevant recommendations made at the last Executive Council (EC) meeting concerning the further development of the programme, including the adoption of the WMO Technical Regulations concerning GAW. He invited the Panel to consider these recommendations and to make concrete proposals with regard to the future development and planning of GAW. In particular, the attention was drawn to the regional part of the GAW network, the aerosol component, the proposed GAW Quality Assurance Science Activity Centres (QA/SAC), the relationship of GAW with other WMO programmes, the GAW central facilities including the data centres, the responses to atmospheric environment emergencies, training needs, emerging scientific issues to be addressed in GAW, and the role of GAW in the implementation of the Global Climate Observing System (GCOS), Agenda 21 and the Framework Convention on Climate Change. Finally, Dr. Axford wished the participants every success in their deliberations on the items high-lighted in his address and others which were on the agenda of the session.

2. APPROVAL OF THE AGENDA

2.1 The Chairman introduced the Agenda, which was adopted with some minor clarifications and is reproduced in Appendix B.

3. REVIEW OF RESOLUTIONS AND OTHER GUIDANCE FROM THE EXECUTIVE COUNCIL AND THE COMMISSION FOR ATMOSPHERIC SCIENCES

3.1 Decisions relevant to the WMO Global Atmosphere Watch programme activities taken by CAS-X, Cg-XI and EC-XLIV were briefly reviewed. One important action was the approval by the EC-XLIV of the GAW Technical Regulations now being printed for inclusion as a chapter in the WMO Technical Regulations. It was explained that these regulations formed the overall framework for all aspects of the Global Atmosphere Watch system. The EC-XLIV also emphasized the need for the GAW Guide to be published. Now in final editing, it is expected that the Guide will be printed by mid-summer. Further, the importance of the present Panel deliberations for the upcoming meeting of the Commission for Atmospheric Sciences in April 1994 was pointed out. In all cases, the WMO constituent bodies have emphasized the relevance of atmospheric chemistry especially in relation to climate change. EC-XLIV particularly commended the Panel on its role in organizing the Acid Deposition Assessment.
4. REVIEW OF PROGRAMME DEVELOPMENTS AND RECOMMENDATIONS FROM REPORTS OF WORKING GROUP AND EXPERT MEETINGS

4.1 Dr. Miller presented a review of the main issues relevant to the work of the Panel as follows:

- The EC has approved the development of Quality Assurance Science Activity Centres (QA/SAC) as a major contribution to the Global Atmosphere Watch. The first QA/SAC will be established at the Fraunhofer Institute in Garmisch-Partenkirchen, Germany.

- The WMO World Data Centres are now in a period of change and improvement. This includes not only the addition of UV-B archiving at the World Ozone Data Centre in Toronto, Canada, but also the possibility of the establishment of a new data centre for aerosols by the end of 1993.

- Owing to the development of the Global Climate Observing System (GCOS), GAW will play an important role in the measurements of atmospheric chemistry related to climate.

- The assessments of ozone, precipitation chemistry, carbon dioxide and aerosols programmes in GO3 OS and BAPMoN have been completed.

- Under the Global Environment Facility (GEF), six new GAW global stations are being planned and implemented in Algeria, Argentina, Brazil, China, Indonesia and Kenya.

- The question of the measurement programme at regional GAW sites was discussed in light of the recommendations made during the Halidiki meeting (GAW No. 71).

- Besides the annual training meeting to be held in Budapest, Hungary, in November 1993, two one-week training workshops on the GAW programme will take place in Greece and South America.

- A short summary of the satellite activities which was prepared for the GCOS chapter on atmospheric chemistry was described.

- Activities related to emergency response were reviewed. These include the Kuwait report and the European Tracer Experiment (ETEX).

- A technical conference on GAW-related topics is being planned and will take place in the Peoples Republic of China.

- A major activity of the Atmospheric Research and Environment Department (AREP) will be to conduct the meeting of the Commission for Atmospheric Sciences in April 1994. The input from the Panel meeting will be important in these deliberations.
4.2 Dr. Miller also briefly reviewed recommendations from recent working group and expert meetings which were to be discussed in more detail later in the meeting.

5. SCIENTIFIC DEVELOPMENTS OF INTERNATIONAL INTEREST IN THE FIELDS OF ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY

5.1 Panel members and invited experts made brief presentations on new developments in their fields of scientific interest and made proposals on issues of relevance to Panel activities.

5.2 G. Ayers presented emission data for SO$_2$ and NO$_2$ in Asian countries, and future emission scenarios, that point to very rapidly increasing atmospheric burdens of reactive N and S in the regional atmosphere. The few high-quality data sets on acid deposition available from the region confirm rather high deposition fluxes at some locations. These data illustrate the need for establishment of new GAW stations in the Asia/SE Asia region.

5.3 D. Ehhalt summarized recent measurements and model calculations of atmospheric oxidant distributions and trends. Reliable OH measurement techniques are becoming available, and model results and measurements are showing an encouraging degree of consistency. He stressed the importance of the need, in GAW, for absolute calibrations of the atmospheric concentrations of molecules such as CH$_3$CCl$_3$ to better than 10% if trends in hydroxyl concentrations are to be detected. He recommended that hydrogenated fluorocarbon measurements be added to the list of GAW parameters, and that an effort be made to obtain HFC and HCFC production figures from the Chemical Manufacturers Association. The Secretariat is to take action on these two items.

5.4 A. Eliassen described efforts in Europe to develop suitable sulphur emission reductions based on the critical load concept. This work depends on an important degree on the extensive modelling and long-term monitoring that has taken place within the EMEP programme. The presentation demonstrated the intimate linkage between science and policy developments in Europe, and the short time-scale on which this interaction may occur. This work has also pointed out the importance of using ecological information for siting of monitoring stations.

5.5 B. Hicks reported on developments in the United States in the areas of solar radiation, optical depth and precipitation chemistry measurements. He stressed the importance of matching the measurement to the intended user of the information. He also indicated that Lagrangian and Eulerian modelling approaches are proceeding in parallel, and that modelling and monitoring results are being integrated now to a greater extent. He described developments in modelling capabilities for environmental emergency response.

5.6 M. Hirota described the status of the World Data Centre on Greenhouse Gases. In October 1992, the Centre published the first "data report", which contained the data from 89 observation stations of 33 countries/territories. He also reported on recent developments in the carbon dioxide field. He stressed the importance of regular biannual recalibration of
the CO₂ standards, which was recommended in the WMO CO₂ Experts Meeting in 1990 and is now due, and the need to continue the "round robin" intercomparison of the CO₂ standards.

5.7 I. Nazarov summarized recent work on the large-scale patterns of benz(a)pyrene concentrations in the Russian Federation, along with their potential health effects in comparison with radiation effects. It was suggested that in view of the potential concern for adverse health effects a more extensive review be made of measurements from other areas of the world. It was noted that PAH measurements are now being made in several countries.

5.8 S. Penkett described recent measurements of short-lived chemical species in the troposphere and stressed the importance of having measurements from well-maintained, long-term monitoring stations. He also stressed the value of having an integrated set of measurements (i.e., of all key species) from a single location in order to understand the processes in and behaviour of the atmosphere. The activity should be carried out at a small number of well-located GAW stations representing well-defined components of the troposphere, such as the marine boundary layer, the mid-continental layer and the free troposphere at different latitudes.

5.9 E. Sanhueza summarized available organic acid measurements from around the world, and compared their concentrations to those of the strong acids. Organic acids become relatively more important in tropical areas and in the Southern Hemisphere. He recommended that organic acids be added to the GAW list of parameters, and that guidance for their measurement be prepared. The Secretariat was requested to take action on these two items. He further suggested, in view of the increasing importance of surface flux measurements, that the Panel begin to prepare for their eventual inclusion in GAW, by arranging, for example, evaluations of measurement techniques, development of quality assurance procedures and assessments of existing data. He agreed to work with the Secretariat to develop a proposal for an appropriate activity.

5.10 C. Zerefos presented results from the two European UV-B instrument intercomparison campaigns, and noted the many problems still to be resolved in the measurement of UV-B. He also described the Greek network of six ozone and UV-B measurement stations. He agreed to keep the Panel informed of developments in this field in view of the considerable public and scientific interest.

5.11 R. Prinn described briefly the International Global Atmospheric Chemistry programme, in particular its goals and mode of operation as a research programme. He described the IGAC cooperation developing with the Panel and the GAW, through both Secretariat interaction and overlapping committee membership. The complementary nature of the two programmes and the potential for overlap between the long-term programme of GAW and the process-oriented programme of IGAC were pointed out. He stressed the importance of GAW receiving input from IGAC for tropospheric measurement requirements and from the WCRP SPARC for stratospheric requirements.

5.12 D. Whelpdale described the development of the Global Climate Observing System and the role of the Global Atmosphere Watch in it. The atmospheric component of GCOS will be based primarily upon the World Weather Watch and the Global Atmosphere Watch.
The initial GCOS system will consist of (i) measurements which are essential for climate and which are currently operational; (ii) measurements which are not currently operational, but for which there is a clear requirement within GCOS and for which there is proven technology; and (iii) new measurements which will be required on an operational basis.

5.13 In addition, consideration will be given to measurements which are felt to be a high priority for climate studies, but which require further definition and development. All of the GAW measurements in these various categories, prepared by a sub-group of the Panel and based on the work of a GCOS atmospheric chemistry task group, are given in Appendix C. The Panel approved the role foreseen for GAW within GCOS.

6. REVIEW OF WMO'S ROLE IN FIELDS OF ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY

6.1 Global Atmosphere Watch

6.1.1 The Chairman requested that the Secretariat present a brief overview of the Background Air Pollution Monitoring Network (BAPMoN) and Global Ozone Observing System (GO3OS) programmes that are now incorporated in the Global Atmosphere Watch. The major issues brought before the Panel were the following:

**BAPMoN:**

(i) During the late sixties as a result of the increasing awareness of the importance of pollution on the global environment, the WMO set up the BAPMoN programme to investigate the changing chemistry of the atmosphere. The core measurements determined at that time were precipitation chemistry, total suspended particulate matter and turbidity. Global stations were also to make carbon dioxide measurements. The main points of discussion were as follows:

- The guidance given for both the global and the regional networks based on the two WMO GAW reports 64 and 71 should be implemented.
- The six new stations being established under the GEF project will require strong support from countries already well established to make GAW measurements.
- The QA Science Activity Centres will require guidance from the Panel as they begin to develop their programme in Europe, Africa, the Americas and possibly other parts of the world.
- Training and education are critical areas if the GAW programme is to succeed.
- The WMO Data Centres' performances have varied widely. With new offers to archive UV-B and aerosol data, the system should be reviewed in light of new requirements and technology.
- The production of the GAW Guide, providing a short description of each GAW measurement, is now in the final stages.
GO-$\text{O}_{3}$:

(i) Since as early as 1957, GO-$\text{O}_{3}$ has been the focal point to ensure standardized and coordinated ozone measurements around the world. It is the only network that provides information on total ozone, its vertical distribution and temporal change. An example of the importance of this network is the documentation of very low levels of ozone observed during the northern hemisphere winter 1992-93. The main activities are:

- Prepare for the ozone assessment - 1994
- Put a high priority on changes in the $\text{O}_{3}$ profiles, which includes re-evaluation of 40,000 Umkehr profiles and timely archiving of all $\text{O}_{3}$ sonde data
- Continue near-real-time information on the ozone field during Antarctic spring and Northern Hemisphere winter-spring
- Improve surface ozone and precursor gases monitoring
- Expand GO-$\text{O}_{3}$ in South America and the tropics

6.1.2 The Panel discussed the following major topics:

*Atmospheric Oxidation Rates*

(i) Oxidation is the main chemical process occurring in the earth’s atmosphere. Over a time scale of a thousand years, the "oxidation capacity" of the atmosphere is almost limitless, since it depends ultimately on the oxygen content. Over shorter time periods, however, the rate of oxidation may vary, depending on the average concentrations of the strongly oxidising trace intermediates, particularly hydroxyl radicals, which cause most chemical changes to occur.

(ii) The oxidising intermediates include oxygen atoms, ozone, hydrogen peroxide, hydroxyl and superoxide radicals. They are produced photochemically and, with the exception of oxygen atoms, are mostly removed by chemical reaction with gases other than oxygen, nitrogen, water vapour or carbon dioxide, which make up the bulk of the atmosphere. Their concentrations are sensitive to changes in photon flux, in water vapour, and to changes in the concentration of a few trace substances such as oxides of nitrogen, carbon monoxide and hydrocarbons. These in turn are susceptible to changes in emission fluxes into the atmosphere over relatively short time periods and are certainly capable of being influenced by human activity. It is quite probable, therefore, that changes in the concentrations of atmospheric oxidants will occur over time, affecting the instantaneous oxidation rate for many trace gases.

(iii) The name which has been loosely applied to this oxidation process in the past is "oxidation capacity". This is a misnomer; a far better name is "integrated oxidation rate", which implies a kinetic process occurring at different rates throughout the atmosphere. Panel members agreed to consider the need for a scientific assessment related to integrated oxidation rates.
Measurement of Vertical Ozone Concentrations

(i) In the discussion of the GO_2OS, the panel strongly recommended that the measurement of vertical distribution of ozone using balloon soundings be made in GAW. Emphasis should be placed on measurements in the tropics because little is known of the critical chemical reactions that take place in this region. It was suggested that the efforts of WMO and IGAC could be combined to be more effective in establishing the recommended measurements.

UV-B Radiation

(i) Decreases in stratospheric ozone have given rise to concern over the consequences of increases in the amount of solar ultraviolet radiation reaching the surface of the earth. The intensity of UV-B radiation (280-320 nm) measured at the ground is highly variable, and depends to a large extent on total ozone. While UV-A radiation (320-400 nm) is less affected by ozone, radiation in both bands has adverse effects. UV-B radiation, particularly at high solar elevations, causes skin cancer, skin aging and cataracts in humans. Other adverse effects include damage to plants and animals, deterioration of materials and changes in the rates of atmospheric chemical processes. The UV-B/ozone magnification factor (i.e., the increase in UV-B with decrease in total ozone) depends primarily on total ozone, sun angle, and cloud cover, with factors such as atmospheric pollution being relatively less important.

(ii) The Panel noted the wide range of instruments now available to measure UV-B. Several different kinds of spectrophotometers are in use at research institutes, which with proper operation and calibration offer the potential for accurate absolute measurements of the flux of UV-B radiation in different environmental conditions. These instruments are, however, both expensive and technologically sophisticated. A similar variety of less expensive broad-band sensors is also in use, these being the devices preferred for more routine operation in networks; such sensors impose a reduced demand for expert site operators. Different reasons for obtaining UV-B data result in different instrumentation requirements; at present it does not seem likely that all demands will be satisfied by one specific instrument. Work on improving instrumentation must continue. Already, a number of available instruments are capable of operating continuously (although requiring regular calibration), while others are capable of good performance during shorter periods such as intensive field campaigns.

(iii) At present, a need exists for information on changes in UV-B intensity at different wavelengths for studies of its effects on various media. Considering the difficulties involved in measuring UV-B, particularly at low solar elevations, it was recommended that GAW global stations be encouraged to measure UV-B with a spectral resolution of about 0.5 nm. Measurements of cloud cover, total and surface ozone, direct and diffuse solar radiation, optical depth, temperature, humidity and broad-band UV-B should be made concurrently. Information on surface albedo is required. It was suggested that GAW regional stations make broad-band UV-B measurements along with the same auxiliary measurements. The broad-band instruments should be properly calibrated twice per year in order to maintain reasonable data quality.
(iv) UV-B calibration facilities now exist at a number of institutes (in Australia, Belgium, Canada, England, Greece, New Zealand and the United States). In view of the intensive use of broad-band UV-B instruments anticipated in the coming years, the Secretariat was requested to investigate the possibility of having such institutes serve as regional calibration facilities.

(v) Several countries are actively engaged in public awareness campaigns concerning the dangers of extreme exposures to UV-B. Provision of forecasts and/or warnings is presently being contemplated; predictions of potential UV-B exposure levels are already routinely published in Canada. The Panel noted that forecasting cloud amount and knowledge of surface albedo introduce difficulties into forecasting of actual UV-B exposure; however, it endorsed the principle that development should proceed. Provision of predictions of potential UV-B exposure is a step toward the development of an operational forecasting capability.

Aerosols

(i) The panel discussed the question of the proliferation of international and national aerosol activities that have recently been pointed out by a number of scientists. A discussion ensued on the role of IGAC, IGAP and WMO activities in the aerosol field. Particular concern was expressed that the upcoming meeting of IGAP should have representatives from all parts of the aerosol community, as well as at least some representatives from the relevant atmospheric chemistry and modelling communities. Important issues included:

- Scientists planning major field experiments under IGAC should be aware of the background data available from GAW and that GAW facilities would be available for such studies.

- The recommendations of the aerosol report, GAW No. 79, should be considered in the future planning of the GAW programme.

- Optical depth should be measured. Detailed recommendations by a review committee will be published in the near future.

- The Panel recommended that the programme of Total Suspended Particulate Matter within GAW should be discontinued.

- At some stations (such as Cape Grim) an additional programme of complementary measurements should be considered in order to fully describe all aspects of aerosol formation and deposition.

- The Panel endorsed the measurement of CN concentrations; CCN concentrations should be included when techniques are validated.

Quality Assurance Science Activity Centres

(i) The Panel was informed of the development of the QA/SAC at Garmisch under the directorship of Prof. Volker Mohnen. In particular, a number of issues raised in a letter
from Prof. Mohnen to the Panel were addressed. It was noted that the role of the Panel was largely an advisory one to EC and to the President of CAS. The role of the Secretariat was to carry out the wishes of the WMO Members as conveyed by the Commissions and the Executive Council. For example, a significant activity of the Secretariat in the Atmospheric Research and Environment Department has been the coordination of the Global Atmosphere Watch stations in member countries, the central laboratories, the world data centres, and presumably, in future, the QA/SACs.

(ii) The Panel, in its role as an advisory body, rather than a steering body considered the QA/SACs to be a key element of the GAW system, and expressed their enthusiasm to contribute to the development of the QA/SACs and to provide whatever advice possible. The Panel wished to maintain a close relationship with the QA/SACs, particularly at this formative stage. It was proposed that this could be accomplished by having the Panel chairman or his alternate serve as a member of the QA/SACs' advisory committee.

(iii) It was also suggested that all Panel members be placed on the mailing list of the QA/SAC in order to be kept easily informed of developments. The Secretariat was requested to investigate a joint meeting of the Panel and QA/SAC representatives at a mutually convenient time.

(iv) In view of the fact that QA/SAC structure is still an ad hoc one, the Panel considered that QA/SAC is not able to "act" or "negotiate" on behalf of the Panel or the Secretariat.

(v) In summary, it was considered that an informal but effective relationship could be sought among QA/SACs, the Panel and the Secretariat. The Panel Chairman was requested to write to Prof. Mohnen conveying the results of the Panel deliberations.

Measurement Priorities

(i) Measurement priorities must be reviewed by taking GAW goals into consideration. The purpose of GAW is well outlined elsewhere, but in essence the GAW is intended to provide a critical linkage among national and/or regional measurement programmes, and to furnish relevant data in areas where presently existing programmes are not yet capable of doing so. The major environmental issues of the day are climate and global change, atmospheric ozone, and acid rain and related regional pollution problems. However, the overall role of GAW is to supply basic information indicative of the atmospheric environment that transcends specific issues.

In the discussion of the priority of the GAW measurements, the following points were agreed upon:

(ii) In view of the importance of understanding better the impact of changes in the vertical distribution of ozone on radiative forcing in the upper troposphere and lower stratosphere, particularly in the tropics and in the Southern Hemisphere, additional vertical profile measurements of ozone in those regions were considered a high priority.
(iii) In addition, better comprehension of the influence of aerosols within the climate system is recognized as being of great importance. Thus, implementation of the recommended GAW aerosol programme (GAW Report 79), especially regarding particle size spectrum and chemical composition, optical depth and condensation nuclei concentration, was considered a high priority.

(iv) It was recommended that total suspended particulate measurements be discontinued at GAW stations, in view of the implementation of the aerosol measurements recommended above. In addition, it is likely that a recommendation will be made to stop turbidity measurements because of their serious limitations. However, this must await finalization of an assessment of the turbidity programme.

(v) It was further agreed that higher priority now needs to be given to further atmospheric measurements of organic compounds and trace metals at GAW stations.

(vi) A consequence of these changing priorities is that less emphasis need be placed on maintaining a large number of GAW precipitation chemistry measuring stations in Europe and North America, where effective regional programmes are in place. Whatever savings may be realized should be applied to the establishment of a limited number of reliable stations in data-poor areas of the world, such as Africa, South America, Southeast Asia and other parts of the Southern Hemisphere.

(vii) A key thrust of the GAW should be to ensure comparability of data among all participating countries. Some measurements lend themselves to quality testing by use of travelling sub-standards or references, such as have been used in the cases of the international carbon dioxide and ozone networks.

(viii) As the overall programme develops, an integrated measurement strategy should be developed so that the evolving needs of the science are satisfied but without imposing any undue longevity on all aspects of the monitoring programmes. Changes within GAW will not occur in a short time. However, it is hoped that these proposals for shifting priorities will form the basis for further discussion, and that implementation can occur gradually as resource decisions are made in Member countries.

(ix) The 3-dimensional nature of the atmosphere must be acknowledged explicitly for short-lived species having concentrations highly variable in space and time. For such species, for example $O_3$, water vapour and particles, the vertical representativeness of surface measurements may be quite restricted. Therefore, vertical profile measurements are necessary at least at several of the regionally representative sites as an adjunct to the continuous surface observations.

(x) It must be stressed that not all measurements can or should be made at each GAW station. Global stations are expected to make as many of the key measurements as possible, in order to fulfil their role as research grade stations that can serve as standards for other stations in their region. The choice of measurements at regional stations, however, should be based on capability and scientific priorities, notably those environmental issues which are important in each region.
Data Centres

(i) A brief overview was given of the progress made at the data centres. Particular recognition was made by the Panel of the recent publication by the Japan Meteorological Agency of the first data report from the World Data Centre for Greenhouse Gases. The Panel recommended that the Secretariat pursue the establishment of a new aerosol data centre that has been informally proposed by the ECE Research Centre in Ispra, Italy.

Regional Networks

(i) The Panel recommended that new GAW regional sites be established in Africa and South America in line with the recommendations made at the Halidiki meeting (GAW Report No. 71). Sites in other areas such as South East Asia should be considered. It is hoped that the QA/SACs would play a role in the establishment and maintenance of these stations.

GAW Conference in China

(i) The International Symposium on Global Atmospheric Chemistry under IGAC is planned for 5-9 September 1994 in Japan. This would be in direct competition with the GAW Conference which was to take place in China in July 1994. The Panel suggested that the Chinese meeting be deferred to 1995 and that it be a combined IGAC/WMO conference. At a later date, China agreed to follow this recommendation.

6.2 Transport and dispersion of atmospheric pollutants

6.2.1 The chairman noted that this area has been a traditional focus of WMO cooperation with EMEP. In the past, the WMO has sponsored a number of workshops and is planning another to take place in Germany in November 1993. This cooperation, though modest in size, has been an effective means of reviewing the scientific progress made in transport modelling not only under the EMEP programme but also for coordinating modelling activities from other parts of the world, especially North America.

6.3 Air-sea exchange of pollutants

6.3.1 The Panel was informed about the ongoing GAW activities related to the air-sea exchange of trace substances and pollution of the marine environment through the atmosphere carried out within the UN inter-agency Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) and the UNEP Long-Term Programme for Pollution Monitoring and Research in the Mediterranean Sea (MED POL).

6.3.2 With regard to GESAMP, the Panel noted the preparation by WMO in 1991 of the report on global changes and the air-sea exchange of chemicals, and the plans to initiate in 1993 review studies on the sea-surface microlayer (including physical, chemical and biological processes, air-sea exchange of gases and solar radiation effects) and on the sources and sinks of trace substances in the oceans. The general direction of these studies was discussed and endorsed. However, it was noted that the outline prepared focused heavily on the oceanic subsurface microlayer, paying little attention to the general problems of spray
zone dynamics and highly disturbed seas. Most of the world’s oceans exist in a sufficiently agitated state that the relevance of low-speed surface-film processes may not always be considered important.

6.3.3 Concerning MED POL, the Panel noted the progress achieved in monitoring and modelling of airborne pollution transported to the Mediterranean sea. Assessing the atmospheric load of pollutants is an important factor in evaluating potential environmental effects. Noting that the meteorological services in the region are little involved in these studies, the Panel felt it appropriate for the Executive Council to invite WMO Members in the region to participate in MED POL and to ensure that meteorological information needed for interpretation of measurements and atmospheric transport modelling be made available to the users.

6.4 Integrated monitoring

6.4.1 The WMO/GAW programme has contributed a number of cooperative programmes that fall into the category of integrated monitoring. Integrated monitoring can be described as making measurements over a broad spectrum of interests that include meteorology, atmospheric chemistry, biology, ecology and a multidisciplinary analysis of these parameters. GAW global and regional stations could be appropriate for integrated monitoring. In general, the GAW stations have cooperated by providing locations for measurements that are beyond those related to atmospheric chemistry. Many of the parameters measured at GAW stations can be used by ecologists and others investigating ecological aspects of global change. Such measurements include climatology, UV-B and wet and dry deposition values. A number of activities under UNEP and IGBP have already begun that will be organizing integrated monitoring from the ecological viewpoint and may request the use of GAW sites as locations for such measurements. The Panel supports this use of GAW locations for integrated studies.

6.5 Emergency response analysis

6.5.1 In response to a request from EC Working Group on Environmental Emergency Response, the Panel considered an appropriate GAW role. GAW can contribute in the case of natural and man-made disasters where the atmosphere is important as a transport mechanism. The experience following the Gulf War, when the WMO organized a multinational effort to help forecast occasions of potential health risk to populations in the Gulf states, led to a recognition that the modelling capabilities presently available for rapid-response action are rather limited. Many of these models have insufficient vertical resolution to describe important wind shears, and others do not have the fine horizontal resolution topography. Improvements in these models are being made as permitted by the present expansion in computing power. It was also mentioned that volcanic eruptions such as Mount Pinatubo should be considered as being events that require similar forecasting ability along with industrial accidents.

7. EDUCATION AND TRAINING

7.1 The existence of an interested and involved research community is essential in ensuring high-quality data from both regional and global GAW stations. In the long term,
there is a need to build up a local research infrastructure to support the operation of monitoring stations of all complexities. Bearing in mind that data quality is a dominant consideration of GAW, priority should go to siting stations in countries that have a supporting research infrastructure.

7.2 In determining the level of expertise necessary to operate stations, it is appropriate to reiterate the distinction between regional stations, which make relatively straightforward measurements at many locations, and global observatories, which make far more detailed measurements at research-quality institutions.

7.3 In the case of global stations which presently lack the research component necessary to ensure that data collection will receive appropriate attention, specific steps must be taken to generate the necessary infrastructure. For the operation of global sites, a core of Ph.D. scientists is necessary. In the long term, for global stations, qualified scientists will provide the best possible guarantee of high-quality data. We should move slowly but consistently towards achieving this goal. It is recognized that the desired level of scientific expertise may well need to be provided from outside sources, at least on a temporary basis until in-country capabilities are sufficiently strengthened.

7.4 In the case of regional stations (but also for the global observatories), a cadre of adequately skilled technicians is required, to operate and maintain instruments, to collect data, and to identify and correct problems as they occur. For this purpose, training at the undergraduate level is required. Such training may well need to be offered in the native language of the country in question.

7.5 The need for skilled personnel is recognized by all scientific communities involved in improving the global database and our understanding of it. The training required must be arranged in such a manner as to encourage those who benefit from it to remain in their home countries, working on the collection of data for which the training was designed. To this end, a unified approach is required, involving close cooperation between the activities of GAW and the intensive research focus of IGAC. At the same time, the direct involvement of beneficiary countries is necessary, so as to elevate the importance of operation of a GAW site and provision of quality data to a high level, with benefits (both intellectual and tangible) adequate to ensure long-term continuity of the measurement programme.

7.6 The Panel discussed the role of the QA/SACs in promoting education and training in developing countries. It was noted that informal contacts have been made with the IGBP-START. A number of Panel members raised the issue of the required level of training and education, viz. undergraduate or graduate. It was noted that the IGAC programme is aiming at improving graduate education in developing countries, whereas the QA/SAC draft proposal is directed at the undergraduate level. With training at either level, it appears very difficult to retain the scientists/technicians after they have been trained. The Panel suggested that the most constructive approach to meet the above needs would be the preparation of a single proposal, coordinated among all interested parties. The Panel Chairman was requested to advise the QA/SACs of this desire, and the Secretariat was asked to initiate contacts with the START office as soon as possible.
7.7 The Secretariat also described the plans for GAW training in the coming year, which include the annual course given in Budapest and two special one-week courses in Greece and South America.

7.8 The Panel noted that these activities should be coordinated with the EC Panel on Education and Training and that the syllabus of the training courses requires an update. The Secretariat will investigate what action should be taken.

8. PLANNED PANEL ACTIVITIES

8.1 The main activities of the Panel during the next two years are listed below:

* The Panel will take an active role in the planning of the GAW Technical Conference, in China. The Steering Committee will meet in the near future to work out details of the programme and the necessary arrangements.

* The Panel will be actively involved in an oversight role in the implementation of the QA/SACs and in the development of their work programmes.

* The turbidity assessment is to be completed for Panel consideration.

* Panel members are to explore the feasibility of beginning an assessment of the integrated oxidation rate of the atmosphere. One option is to have a small joint GAW-IGAC workshop in conjunction with the CACGP conference in Japan in 1994. The Secretariat will investigate this possibility.

* Some Panel members have agreed to explore the feasibility of obtaining additional external funding for GAW stations.

* Some Panel members have agreed to explore the possibility of working toward flux measurements at GAW locations.

* A number of the Panel members expressed the opinion that the two-year interval between meetings was too long to deal with the rapidly changing fields of environmental pollution and atmospheric chemistry. It was suggested that at this point, yearly meetings, even on an informal basis, would be useful. The Secretariat was requested to explore this possibility.
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WORLD METEOROLOGICAL ORGANIZATION
EXECUTIVE COUNCIL PANEL OF EXPERTS/CAS WORKING GROUP ON ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
THIRD SESSION, GENEVA, SWITZERLAND 8-11 MARCH 1993

PROVISIONAL AGENDA

1. OPENING OF THE SESSION
2. APPROVAL OF THE AGENDA
3. REVIEW OF RESOLUTIONS AND OTHER GUIDANCE FROM THE EXECUTIVE COUNCIL AND THE COMMISSION FOR ATMOSPHERIC SCIENCES
4. REVIEW OF PROGRAMME DEVELOPMENTS AND RECOMMENDATIONS FROM REPORTS OF WORKING GROUP AND EXPERT MEETINGS
5. SCIENTIFIC DEVELOPMENTS OF INTERNATIONAL INTEREST IN THE FIELDS OF ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
6. REVIEW OF WMO’S ROLE IN FIELDS OF ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY
   6.1 Global Atmosphere Watch
   6.2 Transport and dispersion of atmospheric pollutants
   6.3 Air-sea exchange of pollutants
   6.4 Integrated monitoring
   6.5 Emergency response analysis
7. EDUCATION AND TRAINING
8. PLANNED PANEL ACTIVITIES
9. PREPARATION OF THE REPORT AND CLOSING OF THE MEETING
GAW MEASUREMENTS WITHIN GCOS

Rationale

Routine observations with appropriate accuracy are required of the distribution of greenhouse gases and ozone, and of those gases and aerosol particles which interact with them. Aerosol particles and ozone in the troposphere and lower stratosphere, in particular, are likely to be important in climate variability and climate change, and require improved observations.

Chemical species now measured on a routine basis within the Global Atmosphere Watch which are a high priority for study of variability in climate include:

- vertical profile and column ozone, and
- surface measurements of the various radiatively active gases—ozone, carbon dioxide, nitrous oxide, methane, and the chlorofluorocarbons (and related species such as hydrogenated fluorocarbons and halons).

In addition, operational measurements, by satellite (e.g. SAGE), are made of

- stratospheric aerosols.

Enhancements to Existing Operational Systems

Water vapour is the dominant long-wave absorber. It controls cloud formation and cloud albedo, and affects free radical chemistry, thereby controlling lifetimes of other greenhouse gases. Aerosols have not yet been fully integrated into current measurement programmes. They exert a major influence on (i) the radiation field via both scattering and absorption and (ii) cloud microphysical and chemical properties, including albedo.

Measurements which are not currently operational, but for which there is a clear requirement and a proven technology, include the following:

- vertical distribution of water vapour;
- the aerosol properties such as optical depth, aerosol particle size distributions, cloud condensation nuclei concentrations, and chemical composition of size-fractionated aerosol particles (carbon, sulphur and nitrogen species);

(It is important to note that (i) these measurements are most valuable if made in concert with related species, such as gaseous sulphur compounds, (ii) reliable measurements of these properties are now being made routinely by a limited number of groups, and (iii) the final selection of aerosols properties requires guidance from the radiative forcing community.)

- additional continuous ground- and space-based observations of column ozone, in particular, in tropical areas.
NEW OPERATIONAL COMPONENTS

Measurements of the vertical distribution of ozone throughout the atmosphere are essential in order to understand its influence on the radiative balance and on hydroxyl radical concentrations, and therefore on greenhouse gas lifetimes.

- vertical distributions of ozone from new ozone-satellite missions, sondes, and commercial aircraft.

ENHANCEMENTS

Additional measurements which are considered to be a high priority for climate, but which require further definition, include chemical species and radiation which have a large impact on the control of radiatively active species in the atmosphere. By controlling the extent of photochemical processing occurring in the troposphere, these species largely determine the atmospheric lifetimes of many atmospheric trace gases. The requirement at this time is for these measurements to be made at a limited number of high-quality stations for a period of about a decade. These are not routine measurements. This category includes:

- spectrally resolved solar radiation in the near UV with adequate calibration and resolution of about 0.5 nm;
  (These are necessary to derive the photolytic rate coefficients \( j(\text{NO}_2) \) and \( j(\text{O}_3) \) in atmospheric conditions.)
- carbon monoxide;
- non-methane hydrocarbons;
- hydrogen and organic peroxides;
- nitrogen species - NO, NO\(_2\), NO\(_y\), and HNO\(_3\);
- sulphur species, including H2S, (CH3)2S, CS2, COS and SO2.

(A number of these species are presently being measured with commercial instruments at locations where concentrations are high enough.)

In addition, the measurement of other aerosol properties is required:

- aerosol properties, including aerosol light scattering coefficient, aerosol light absorption coefficient, and angular scattering phase function.
ENVIRONMENTAL POLLUTION MONITORING AND RESEARCH PROGRAMME 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 *


*Out of Print
17. General Consideration and Examples of Data Evaluation and Quality Assurance Procedures Applicable to BAPMoN Precipitation Chemistry Observations by Dr. Charles Hakkari, 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


23. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1982. November 1984


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


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


35. Provisional Daily Atmospheric CO₂ Concentrations as Measured at BAPMoN Sites for the Year 1983. December 1985


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


50. Provisional Daily Atmospheric Carbon Dioxide Concentrations as Measured at BAPMoN Sites for the Year 1985. December 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

55. Summary Report on the Status of the WMO Background Air Pollution Monitoring Network as at 31 December 1987


58. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the years 1986 and 1987


62. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at BAPMoN sites for the year 1988


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


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72. Integrated Background Monitoring of Environmental Pollution in Mid-Latitude Eurasia by Yu.A. Izrael and F.Ya. Rovinsky, USSR

73. Report of the Experts Meeting on Global Aerosol Data System (GADS) (Hampton, Virginia, 11-12 September 1990)


75. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at Global Atmosphere Watch (GAW)-BAPMoN sites for the year 1990

76. The International Global Aerosol Programme (IGAP) Plan: Overview

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


80. Report of the WMO Meeting of Experts on the Quality Assurance Plan for the GAW (Garmisch-Partenkirchen, Germany, 26-30 March 1992)


83. Report on the Global Precipitation Chemistry Programme of BAPMoN

84. Provisional Daily Atmospheric Carbon Dioxide Concentrations as measured at GAW-BAPMoN sites for the year 1991

85. Chemical Analysis of Precipitation for GAW: Laboratory Analytical Methods and Sample Collection Standards by Dr. Jaroslav Santroch
