WORLD METEOROLOGICAL ORGANIZATION

UNITED NATIONS ENVIRONMENT PROGRAMME

REPORT OF THE SIXTH MEETING OF THE OZONE RESEARCH MANAGERS OF THE PARTIES TO THE VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

(Vienna, Austria, 19–21 September 2005)

WMO Global Ozone Research and Monitoring Project

Report No. 48

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INTRODUCTION

The Sixth Meeting of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer took place at the Vienna International Centre in Vienna from Monday, 19 September, to Wednesday, 21 September 2005. The meeting was organized by the Ozone Secretariat of the United Nations Environment Programme (UNEP) in cooperation with the World Meteorological Organization (WMO), in accordance with decision I/6 of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer. A list of participants is provided in Annex A to the present report.

1. OPENING OF THE MEETING

Mr Marco González, Executive Secretary of the Ozone Secretariat, opened the meeting at 10.40 a.m. on Monday, 19 September 2005, on behalf of Mr Klaus Töpfer, Executive Director of UNEP. After welcoming participants, he thanked the Government of Austria for its arrangements to host and the World Meteorological Organization (WMO) for its cooperation in organizing various activities that were being held in conjunction with the third session of the Preparatory Committee for the Development of a Strategic Approach to International Chemicals Management (SAICM) to mark the twentieth anniversary of the adoption of the Vienna Convention for the protection of the ozone layer.

He recalled that the aim of the meeting of the Ozone Research Managers was to review existing national and international research and monitoring programmes in order to ensure their proper coordination and implementation, and to identify any gaps in such efforts. The meeting would be expected to produce a report with recommendations relating to future ozone research, ways to improve regional and global ozone monitoring and ways to expand cooperation between developed and developing countries. Those recommendations would be presented to the Conference of the Parties to the Vienna Convention at its seventh meeting, which would take place in conjunction with the Seventeenth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer, to be held in Dakar, Senegal, from 12 to 16 December 2005.

He informed the participants that the first event to mark the twentieth anniversary of the Vienna Convention was a seminar on lessons learned from the Vienna Convention that were applicable to the chemicals agenda, to be held on the evening of Monday, 19 September 2005. The second was a Vienna Convention awards ceremony and reception, hosted by the Government of Austria, to be held on the evening of Wednesday, 21 September 2005. All participants at the sixth meeting of Ozone Research Managers were invited to attend.

Mr Paul Krajnik, Chair of the Executive Committee for the Implementation of the Montreal Protocol and representative of the Ministry of Environment, Youth and Family Affairs of Austria, welcomed participants to Vienna on behalf of the Austrian Government and recalled that, three days previously, on 16 September 2005, the United Nations and Governments around the world had celebrated the International Day for the Preservation of the Ozone Layer, which had provided an opportunity not only to reflect on the successful implementation of the Montreal Protocol and the Vienna Convention over the past two decades but also to look to the future. Referring to other multilateral environmental agreements, he emphasized the importance of adopting a holistic approach to environmental protection, as exemplified by holding the meeting of Ozone Research Managers at the same time as the SAICM meeting.

Mrs Elena Manaenkova, Director of the Atmospheric Research and Environment Programme (AREP) of WMO, described a joint initiative by the International Council for Science (ICSU) and WMO to sponsor International Polar Year 2007 - 2008 (IPY). Reviewing the objectives of the initiative, which included the enhancement of ozone observation networks, she pointed out that the initiative afforded a major opportunity to Ozone Research Managers, who might be able to take part in the activities of the observation stations and use the results of the research carried out under the initiative after the campaigns ended. In order to ensure the success of the initiative, WMO and ICSU had established a Joint Committee on IPY responsible for the scientific planning, coordination, guidance and oversight of activities at the international level. More than 40 national committees on IPY were established to coordinate activities at the national level. Drawing attention to the initiative's website (www.ipy.org), she urged participants from all countries – and not only the polar ones – to contact their national committees and become involved in the initiative. Numerous project proposals had already been received by the IPY Joint Committee and efforts were being made to develop a well-resourced, comprehensive project to serve as a flagship project on ozone under the initiative.

2. ORGANIZATIONAL MATTERS

2.1 Election of the Chair

Mr Michael Kurylo (United States of America) was elected Chair of the meeting. Thanking participants for their vote of confidence, he recalled that the meeting had two very important purposes: first, it gave participants an opportunity to share experiences with regard to individual and international collaborative efforts relating to ozone and ultraviolet radiation; and second, and perhaps more important, it provided an opportunity for the Ozone Research Managers to produce a report and a set of practical recommendations, which would be presented to the Conference of the Parties to the Vienna Convention at its seventh meeting.

2.2 Adoption of the agenda

The agenda, which is reproduced in Annex B, was adopted.

3. REVIEW OF THE RECOMMENDATIONS ADOPTED AT THE FIFTH MEETING OF THE OZONE RESEARCH MANAGERS AND THE RESULTING DECISIONS OF THE SIXTH MEETING OF THE CONFERENCE OF THE PARTIES TO THE VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER, IN PARTICULAR DECISION VI/2

Mr Kurylo reviewed the recommendations adopted at the fifth meeting of the Ozone Research Managers, on the themes of systematic observations, data archiving, research needs and capacity-building. He urged participants, when developing the new recommendations, to take into account the progress made and any setbacks in implementing those adopted at the fifth meeting.

Ms Megumi Seki, Scientific Officer of the Ozone Secretariat, reviewed the decisions of the sixth meeting of the Conference of the Parties to the Vienna Convention, in particular decision VI/2 on ozone-related monitoring and research activities, which had resulted from the recommendations of the fifth meeting of the Ozone Research Managers. A copy of the decisions was available to the participants. Recalling the provisions of decision VI/2, she informed the meeting that a trust fund for financing activities on research and systematic observations relevant to the Vienna Convention in developing countries and countries with economies in transition (CEITs) had been established in February 2003 pursuant to that decision, in cooperation with WMO. The terms of reference of that fund and a letter inviting Parties to contribute to the fund had been circulated to the Parties. On the issue of institutional arrangements, she said that a memorandum of understanding had been concluded between the Ozone Secretariat and WMO, covering the modalities of operation to allocate funds for projects issues such as maintenance and calibration projects for Global Environment Watch (GAW) ground-based stations and research and monitoring.

On the status of implementation of decision VI/2, she said that a total of $31,482 had been received to date, from Finland, Kazakhstan, Spain and the United Kingdom, and that one project, a Dobson inter-calibration workshop, had been held in Egypt in March 2004, for which purpose $15,000 had been disbursed. Another project was currently under preparation by WMO. She suggested that, at the seventh meeting of the Conference of the Parties to the Vienna Convention, Parties might be expected to consider extending the life of trust fund, which was originally intended to end December 2007, and that the Ozone Research Managers should perhaps indicate in their recommendations which specific activities required funding and the level of funding needed per activity.

4. CURRENT STATE OF THE OZONE LAYER

Mr Greg Bodeker of the National Institute of Water and Atmospheric Research of New Zealand, and a member of the Scientific Assessment Panel of the Montreal Protocol, gave a detailed presentation on the current state of the ozone layer. Noting that the state of the ozone layer varied according to latitude zone and altitude and underscoring the importance of seasonal dependence in trends, he said that the global average ozone level remained approximately 4 per cent depressed below a 1964 - 1980 baseline, up from a depression of approximately 5 per cent in the mid-1990s. He also drew attention to the value of multiple data sets. He explained that, although ozone remained severely depleted over the Antarctic, many indicators showed signs of the recovery of the Antarctic ozone hole; however, interpretation of recent changes in Antarctic ozone depended very much on the indicators used. Ozone variability over the Arctic was higher than over the Antarctic and showed greater dependence on inter-annual variability in stratospheric temperatures. Recently, as a result of a number of warm Arctic winters, two-year-running means of ozone levels showed that ozone over the Arctic had returned to values similar to those observed in the early 1980s. In the longer term (over the past four decades), however, the Arctic stratosphere had become far more susceptible to severe ozone depletion as a result of stratospheric cooling.

Noting that ozone levels remained depressed over the mid-latitudes of both hemispheres, he said that, over northern mid-latitudes, the magnitude of ozone anomalies had been reduced from around minus 6 per cent shortly after the Mount Pinatubo volcanic eruption to approximately minus 3 per cent over the past five years. Model calculations indicated that those increases in ozone may have been driven largely by changes in atmospheric dynamics. In terms of the mass of ozone removed from the atmosphere, the post-Pinatubo anomaly in northern mid-latitudes exceeded any of the Antarctic ozone holes. The lack of a response in ozone to the Pinatubo eruption over southern mid-latitudes remained unexplained. Ozone over southern mid-latitudes remained about 5 per cent depressed below the 1964–1980 baseline, with little change over the past two decades. Since 1979, there had been little change in ozone over the tropics, but column ozone did show a strong response to the solar cycle in that region. Summer-time ozone trends over southern mid-latitudes had been larger than over northern mid-latitudes.

In conclusion, he said that a number of studies had reported the onset of ozone recovery in different altitude and latitude regions of the globe. Identification of the onset of ozone recovery, however, required detailed attribution of the drivers of the observed changes. Incomplete understanding of the processes and magnitude of a solar cycle effect in ozone might confound correct attribution of recent positive deviations in ozone above the long-term trend to decreases in stratospheric halogen loading. Confirming that the Montreal Protocol had been effective in reducing stratospheric halogen loading, he said that, with continued compliance with the Protocol and its amendments and adjustments, full recovery of the ozone layer could be expected. Chemistry-climate models suggested that recovery to 1980 levels would occur over Antarctica in approximately 2065 and over the Arctic in approximately 2040. That level of recovery would occur in approximately 2050 in extra-polar latitudes.

In the ensuing discussion, participants raised a number of questions on ozone depletion and recovery. Regarding whether it was premature to claim ozone recovery, Mr Bodeker said that even in cases where a large volcano erupted and ozone levels declined, if the expectation, through modelling, was that ozone would have otherwise gone up, it would still be acceptable to claim recovery. On why overall ozone depletion in the Arctic had not been as marked as anticipated in 2005, despite low temperatures, he explained that it was the volume of the Arctic air mass at or

below 195K, which determined the extent of the ozone depletion, and not the absolute minimum temperature. In addition, a sudden warming in early March 2005 caused an early stop in ozone depletion processes.

5. GLOBAL ATMOSPHERE WATCH (GAW) PROGRAMME OF THE WORLD METEOROLOGICAL ORGANIZATION: GLOBAL OZONE AND UV-B RADIATION OBSERVING AND MONITORING SYSTEM

Mr Geir Braathen of WMO explained that the WMO Global Atmosphere Watch (GAW) monitoring programme had been established in 1989 by merging the Global Ozone Observing System and Background Air Pollution Monitoring Network of WMO. It was coordinated by the Environment Division of the Atmospheric Research and Environment Programme (AREP) of WMO. A central function of GAW was to serve as a global network for monitoring the chemical composition of the atmosphere. It was also involved in conducting scientific assessments that were needed for formulating and implementing environment protection policies and in the development of predictive capability modelling. It was motivated by a number of factors, including improved weather forecasting, ozone and reactive gas observations, climate change and climate prediction.

The monitoring component of GAW included professional activities to measure parameters indicative of climate change, which were conducted in GAW facilities across the globe. Such facilities included measurement stations, calibration facilities, training centres and data centres, equipped with reliable instrumentation and qualified personnel to keep the monitoring system operational and ensure its development. Surveying the work of those facilities, he drew attention to the Global Atmosphere Watch Station Information System (GAWSIS), which was being developed and maintained by the Quality Assurance/Scientific Activity Centre of Switzerland in collaboration with the GAW secretariat, the GAW World Data Centres and other GAW representatives to improve the management of information about the GAW network of ground-based stations. He also drew attention to the GAWSIS website (http://www.empa.ch/gaw/gawsis), which contained comprehensive information on all GAW stations.

In conclusion, he urged the meeting to make it clear in its recommendations that, although it supported large-scale activities, funds should be provided to support ozone research activities at the national level.

In the ensuing discussion, attention was drawn to the need for technical and financial support to be provided to developing countries. Mr Braathen urged participants to encourage the relevant authorities in their countries to contribute to the trust fund, which might be used to provide such support. In that connection, Mr Kurylo recalled that one of the recommendations of the fifth meeting of Ozone Research Managers was to provide funds to allow representatives of developing countries and countries with economies in transition to participate in activities relating to ozone research. Research institutions at all levels, in addition to Governments and international organizations, should be encouraged to sponsor the participation of such representatives.

6. NETWORK FOR THE DETECTION OF STRATOSPHERIC CHANGE (NDSC)

Mr Kurylo, speaking as Co-Chair of the Network for the Detection of Stratospheric Change (NDSC) Steering Committee, summarized the history and the goals of the Network and noted that NDSC consisted of a set of more than 70 high-quality, remote-sensing research stations for observing and understanding the physical and chemical state of the stratosphere and upper troposphere and for assessing the impact of stratosphere changes on the underlying troposphere and on global climate. As a major component of the international upper atmosphere research effort, NDSC enjoyed broad international participation and endorsement, but there was still a need for more NDSC research stations in the southern hemisphere and in the tropics.

Stressing that a commitment to data quality lay at the heart of NDSC, he outlined the measurement contributions made by NDSC to GAW and to the Integrated Global Atmospheric Chemistry Observation (IGACO) system and described future NDSC developments. He pointed out that, while NDSC remained committed to monitoring changes in the stratosphere with an

emphasis on the long-term evolution of the ozone layer, its priorities had broadened considerably to encompass issues such as the detection of trends in overall atmospheric composition and understanding their impacts on the stratosphere and troposphere, and establishing links between climate change and atmospheric composition. In conclusion, he said that further information on NDSC was available on the Network's web site (http://www.ndsc.ws), and also in various information publications.

In the ensuing discussion, Mr Kurylo explained, in response to a suggestion, that the best way for representatives of developing countries to become familiar with NDSC activities was to attend working group meetings, and encouraged them to contact the relevant working group representatives for additional information.

7. WORLD CLIMATE RESEARCH PROGRAMME PROJECT ON "STRATOSPHERIC PROCESSES AND THEIR ROLE IN CLIMATE" (SPARC)

Mr Kurylo, speaking as a member of the SPARC Scientific Steering Group, gave an overview of the aims, structure and present and future activities of SPARC. He noted that the World Climate Research Programme (WCRP) had established the Stratospheric Processes and their Role in Climate (SPARC) project in 1992 to consolidate knowledge on the role that the stratosphere played in Earth's climate system. It was the initial goal of SPARC to stimulate research in areas connecting the stratosphere and climate, which had not received sufficient attention during the earlier international research focus on stratospheric ozone. To date, the success of SPARC had been largely attributable to its ability to respond to international scientific assessment needs, to focus on manageable projects where international coordination made a difference, and to produce clear deliverables, such as comprehensive scientific reviews. Of particular note had been the recognition that tropospheric variability could provide a forcing mechanism for the stratosphere and that stratospheric variations could significantly change the radiative forcing on the troposphere.

To improve understanding of the processes linking the stratosphere to climate, the SPARC Scientific Steering Group had identified several scientific themes around which international research could be encouraged. Those included stratospheric indicators of climate change; stratospheric processes and their relationship to climate; and modelling of stratospheric effects on climate. Through a series of initiatives such as the establishment of working groups, the organization of workshops, and the authorship of review or assessment reports, SPARC had fostered a number of significant accomplishments under each of those themes. He described some of the current SPARC projects that were directly linked to WMO/UNEP ozone assessment and said that details of the SPARC organization, its implementation plan, and its initiatives could be found on its website at http://www.atmosp.physics.utoronto.ca/SPARC/index.html

8. SCIENCE, ENVIRONMENTAL EFFECTS AND TECHNOLOGY AND ECONOMIC ASSESSMENTS UNDER THE MONTREAL PROTOCOL

8.1 Status And Plans for the 2006 Assessment

Mr Ayite-Lo Nohende Ajavon, Co-Chair of the Montreal Protocol Scientific Assessment Panel (SAP), introduced the 2006 scientific assessment report that was currently being prepared by the Panel under the auspices of WMO and UNEP, in response to the Montreal Protocol. The report would be used by Governments and representatives of industry as key scientific input to decisions relevant to the protection of the ozone layer. He outlined the key features of the report, which included an executive summary, detailed chapters and a section containing frequently asked questions about ozone. He said that Parties to the Vienna Convention and its Montreal Protocol had identified topics addressed in previous reports and which needed to be reviewed, and had nominated scientists as potential contributors. Furthermore, the scientific community had provided comments on research advances and on the structure of the assessment report. He outlined the stages in the development of the report and explained that the final report would be available in spring 2007.

8.2 Special Report by The Intergovernmental Panel on Climate Change and the Technology and Economic Assessment Panel on Safegaurding the Ozone Layer and the Global Climate System

Mr Stephen O. Andersen, Co-Chair of the Montreal Protocol Technology and Economic Assessment Panel (TEAP), introduced the special report by the Intergovernmental Panel on Climate Change (IPCC) and TEAP on safeguarding the ozone layer and the global climate system, which focused on issues related to hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). A summary of the report was available in the meeting room. In his introduction, he noted that the world owed a debt of gratitude to scientists for sounding the alarm, guiding policy and monitoring recovery with regard to ozone depletion. He said that the special report, which had been prepared by a steering committee co-chaired by TEAP and IPCC, was a good example of cooperation between the assessment panels of different international treaties and the results achieved illustrated the advantages of such interaction and cooperation.

Summarizing the contents of the report, he said that ozone-depleting substances produced before the Montreal Protocol phase out were not controlled by either the Montreal Protocol or the Kyoto Protocol to the United Nations Framework Convention on Climate Change. Uncontrolled emissions from stockpiles, products such as refrigeration and air conditioning equipment and insulating foam accounted for approximately 2.5 gigatons of carbon dioxide equivalent per year, which was about 10 per cent of all carbon-equivalent greenhouse gas emissions between 2000 and 2010. The activities under the “mitigation scenario” of technically feasible options and coordinated investment described in the IPCC/TEAP special report provided an opportunity to protect the ozone layer further and to reduce greenhouse gas emissions significantly. Financial credit for ozone-depleting substance greenhouse gas reductions could finance accelerated phase out and reduced bank emissions of those substances. He suggested that scientists might wish to calculate the reduction in stratospheric chlorine loading and the ozone layer recovery that would result from the actions under the mitigation scenario.

In conclusion, he said that it was clear that the work of ozone research managers was vital to the implementation of the Kyoto and Montreal protocols. He acknowledged the frustration felt by scientists because of the lack of funding for scientific research and said that greater efforts were clearly needed to support such research.

9. NATIONAL REPORTS ON EXISTING AND PLANNED ACTIVITIES RELATING TO OZONE RESEARCH AND THE MONITORING, CALIBRATION AND ARCHIVING OF MEASUREMENTS; AND ON UV-B MONITORING AND INITIATIVES AIMED AT THE PREVENTION OF UV-B AND SUN-RELATED INJURIES

The meeting had before it 48 national reports submitted by Parties to the Vienna Convention on their existing and planned activities relating to ozone research and on the monitoring, calibration and archiving of measurements. The reports also included information about UV-B monitoring and initiatives aimed at the prevention of UV-B and sun-related injuries. The reports are reproduced in Annex C to the present report, in alphabetical order by country. Representatives of 39 Parties presented oral summaries of their national reports to the meeting. An opportunity was provided for participants to pose questions and comment on key issues raised by the national reports, as input to the recommendations developed under agenda item 11. Following the discussion, Mr Kurylo said that issues arising from the national reports would be reflected in the recommendations.

Participants were invited to discuss those recommendations, and raise points on their success or failure to implement the recommendations of the fifth meeting of the Ozone Research Managers.

10. INFORMATION ON THE ORGANIZATION OF EVENTS TO CELEBRATE THE TWENTIETH ANNIVERSARY OF THE VIENNA CONVENTION AND ON THE HOLDING OF THE SIXTH MEETING OF THE CONFERENCE OF THE PARTIES TO THE VIENNA CONVENTION, THE SEVENTEENTH MEETING OF THE PARTIES TO THE MONTREAL PROTOCOL AND ASSOCIATED MEETINGS

A description of events organized to mark the twentieth anniversary of the adoption of the Vienna Convention was provided by Mr González, Executive Secretary of the Ozone Secretariat, in his opening statement (see chapter 1 of the present report).

11. ADOPTION OF THE RECOMMENDATIONS AND THE REPORT

On the morning of Wednesday, 21 September, the meeting adopted the draft report of the meeting, on the basis of the draft text circulated in the meeting room and on the understanding that the Ozone and WMO secretariats would be entrusted with its finalization.

On the afternoon of Wednesday, 21 September, the meeting adopted the recommendations reproduced below, to be forwarded to the Conference of the Parties to the Vienna Convention at its seventh meeting. The recommendations were developed following discussions on the basis of the national reports and presentations made at the meeting. The recommendations are structured as set out in the following sections.

11.1 Introduction

11.1.0 The basis for the recommendations presented in this report is derived from information contained in the national reports presented at the 6th Meeting of Ozone Research Managers, progress and strategy reports from various international programmes and projects, and reports from recent and ongoing assessment activities. It is not the purpose of these recommendations to reproduce this information, but, rather, to draw from it. In particular, shortcomings in existing observation systems are documented in the national reports.

11.1.1 Although considerable progress has been made over the last decade in understanding the role of halogen chemistry in stratospheric ozone loss, there are a number of uncertainties whose resolution define the need for present and future observations and research. The effectiveness of the provisions of the Montreal Protocol and its Amendments has been clearly observed in the declining atmospheric abundances of many ozone-destroying species. In fact, the abundance of effective equivalent stratospheric chlorine (EESC) has been declining slowly for more than five years. Nevertheless, the abundances of many of the replacements for ozone-depleting substances (ODSs) still are increasing, and EESC will remain above pre-1980 levels for several decades. Hence, stratospheric ozone will remain vulnerable to chemical depletion for much of the current century. This vulnerability is highly dependent on climate-induced atmospheric changes. Further, the vulnerability would increase as a result of enhanced atmospheric aerosol loading resulting from major volcanic eruptions. This ozone vulnerability is coupled to continuing risks associated with the effects of increased UV radiation on human health and ecosystems.

11.1.2 Observations and analyses indicate that the rate of stratospheric ozone depletion at midlatitudes has slowed in recent years; however, over the polar regions, while some indicators show reductions in ozone depletion, these have not been unambiguously attributed to changes in stratospheric halogen loading (i.e., declining EESC). At midlatitudes and in the polar regions, other changes in atmospheric composition and dynamics also may be responsible. Continued research and observations are critical to quantifying the chemical and dynamical components of these changes in ozone and, thus, to labeling such changes as ozone recovery associated with anthropogenic halocarbons. Ozone recovery will occur in an atmosphere that is markedly different from pre-1980 conditions. Climate change associated with increased abundances of greenhouse gases is expected to alter the nature and timing of ozone recovery. Specifically, cooler

stratospheric temperatures resulting from climate change will enhance ozone-loss processes, thereby increasing ozone vulnerability in the polar regions, particularly in the Arctic. Observations have shown that cold Arctic winters have been characterized by lower minimum temperatures in the stratosphere. Further, some greenhouse gases pose additional direct threats to ozone through other chemical-depletion cycles. Ozone is a greenhouse gas, and quantifying its role in climate change requires continued high-quality measurements of both total abundance and vertical profile. The strong coupling between climate change, ozone production and loss, and accompanying changes in UV radiation at the ground places more stringent demands on long-term research and measurement needs, many of which are documented in The Integrated Global Atmospheric Chemistry Observations (IGACO) theme report [September 2004] prepared by WMO and ESA under the auspices of the Integrated Global Observing Strategy (IGOS).

11.1.3 As stated in paragraph 11.1.1, ozone vulnerability raises concerns about the adverse effects of increased UV radiation on human health and ecosystems. While a number of regional UV observational networks have been put in place in recent years, there remains a need for a stable, long-term observational capability that is geographically balanced. Without such a capability, the necessary high-quality UV data record cannot be obtained. Various atmospheric effects of climate change (e.g., cloud cover, aerosol abundance, albedo, temperature) on ground-level UV may actually be larger than ozone-induced effects. This recognition places increased demands on improving the observational capabilities for tracking such UV changes, and thereby providing necessary data for effects research. Further, biological effects due to increasing UV may be affected by increased temperature associated with climate change.

11.1.4 The considerable advances achieved in scientific understanding have been used by some to suggest a lessening need for long-term observational systems. On the contrary, the complexities of ozone and UV science highlighted above require the continuation and expansion of systematic measurement and analysis capabilities for tracking the evolution of ozone- and climate-related source gases and parameters, for detecting and tracking the stabilization and expected recovery of stratospheric ozone, for attributing changes in radiation forcing to changes in the ozone profile, and for deriving a global record of ground-level UV radiation.

11.1.5 The Sixth Meeting of the Ozone Research Managers, in recognition of the above issues, adopted the following recommendations. In doing so, they noted that international funding and cooperation are essential for their implementation, and noted once again that past recommendations have not received sufficient attention due to the absence of such funding and cooperation. This has exacerbated problems associated with the maintenance of existing instruments and networks, and with the development and implementation of new capabilities. Further, the implementation of the recommendations requires research and observational capabilities throughout developed and developing countries. Several international global-change initiatives have been formulated recently. Their success requires scientific capabilities at all national levels. Hence, intensified capacity building in developing countries and countries with economies in transition (CEITs) is required. Such capacity building is in the interests of all Parties, since the creation of a scientific community in developing countries will not only contribute to global ozone and UV science, but it will serve as the basis to provide local policymakers with scientific arguments on long-term implementation of the Montreal Protocol and its Amendments. Further, such expertise will enable the participation of experts from developing countries in the international assessment process.

11.2 Systematic Observations

Evaluation of the state of the ozone layer and an understanding of ground-level UV radiation require a stable, integrated global observing system consisting of ground-based, airborne, and satellite measurements. While synoptic-scale measurements are mainly

derived from satellite data, ground-based and airborne measurements add increased temporal and spatial resolution, and provide critical validation of satellite sensors. Continuing validation of all observational components is necessary to insure the high quality of the data products. The continuity and long-term stability of these highly complementary measurements are necessary to assess the onset of ozone layer recovery, to monitor its evolution, and to track changes in ground-level UV radiation associated with ozone and climate.

- Provide financial and institutional support to maintain and to expand well-calibrated ground-based measurement networks for column ozone, including both spectral and filter instruments. This includes the maintenance and preservation of aging instruments, the deployment of unused instruments to developing countries and CEITs, the application of new technologies, and the development and maintenance of adequate regional calibration facilities including, but not limited to, the M-124 instrument network.

- Provide financial support to continue existing long-term profiling of ozone, and to enhance these measurements in data-sparse areas, particularly in the tropics.
- Provide resources to continue and extend the long-term global column ozone trends record provided by validated and quality-controlled space instruments. This requires the continued development of a homogeneous data record from multiple instruments.
- Provide financial support to maintain both ground-based and space-borne measurement capabilities for climate- and ozone-related trace gases and atmospheric parameters. This includes ground-based networks, such as NDSC and WMO GAW, and existing space instruments.
- Continue the implementation of ozonesonde standard operating procedures, and extend these procedures to other ozone and UV instrument types.
- Maintain the radiosonde network, and expand it into areas with inadequate coverage, especially the tropics. Network funding should accommodate the reporting of higher-resolution radiosonde data to the World Data Centres, and the recovery, reprocessing, and archiving of historical radiosonde records.
- Maintain and expand UV networks, including both spectrally resolved and broadband instruments, to achieve geographical balance and to maintain long-term stability. This requires financial support for the establishment and/or expansion of calibration facilities on regional and global scales.
- Provide financial support to conduct regularly scheduled intercomparisons of instruments, algorithms, and standards associated with measurements of ozone, ozone- and climate-related trace gases, and UV radiation in order to maintain long-term data quality and integrity.
- Continue operations of unique high-latitude measurements and facilities, both in the Arctic and the Antarctic. This includes the reactivation of measurement sites recently closed due to funding reductions.

11.3 Research Needs

There are a number of new unanswered questions with respect to expected ozone recovery and the interrelationship between ozone and climate change. The ability to predict future ozone behavior requires quantification of the roles of chemical and dynamical processes responsible for ozone production, loss, and distribution, and their uncertainties. The development of realistic scenarios of the future abundances of anthropogenic and biogenic trace gases also is required. The parameterization of these processes in chemical transport models remains challenging. In addition, these processes are occurring in a continually changing atmosphere. Further research is needed on the response of ground-level UV to changes in ozone, as well as to climate-driven changes in other atmospheric

parameters. Research is required not only to study biological vulnerability to increased levels of UV radiation but also other stress factors (i.e., integrated stress assessments).

- Support studies to quantify the chemical and dynamical components of polar and mid-latitude ozone loss in order to understand ozone evolution in a changing atmosphere. These include:
  - Studies examining the effects of climate change on ozone production, loss, and distribution, as well as possible feedbacks.
  - Studies investigating the dynamical coupling between the upper troposphere and lower stratosphere, particularly as it applies to water vapour, short-lived halogen species, and ozone.
  - Studies of aerosol and polar stratospheric cloud microphysics, and of cirrus in the tropical transition layer.
- Support studies aimed at understanding the budgets of ozone- and climate-related trace gases. This includes studies of the effects of climate change on the sources, sinks, and lifetimes of these gases.
- Support studies on the atmospheric effects of climate change (e.g., cloud cover, aerosol abundance, albedo, temperature) on ground-level UV radiation.
- Support studies on the consequences of interactions between ozone and climate on human health and ecosystems, including longer exposure to increased UV radiation due to a delayed recovery in the stratospheric ozone layer, the effects of increased temperature on the incidence of UV-induced skin cancer, and other biological impacts.

11.4 Data Archiving

The archiving and accessibility of ozone and UV data are as important as the measurements themselves. WMO's World Ozone and Ultraviolet Data Centre (WOUDC), operated by the Meteorological Service of Canada in Toronto, is the primary repository of the world's ozone data. However, additional ozone and UV measurement data are held at individual stations and often are archived at other data centre facilities. It must be recognized that data archiving is a resource-intensive activity; hence, it is important that funding provided for research and observations be adequate to include data archiving activities. Further, it is important that efforts be undertaken to transfer all ozone and UV data to the WOUDC, as well as to conduct re-evaluations of historical data.

- Encourage the submission of near-real-time data for column ozone, ozone profiles, ancillary ozone- and climate-related data, UV radiation, and campaign data to the appropriate local and world data centres. Funding for such data archiving activities should be included in the resources provided for research and observations.
- Urge all data centres to develop procedures for the prompt submission of their ozone, UV, and ancillary ozone- and climate-related data to the World Ozone and Ultraviolet Data Centre (WOUDC). Data archiving must include detailed metadata that describe the quality of the measurement and the instrument history.
- Provide funding for archiving raw data from various observational networks, either at the local institution or at the WOUDC, as appropriate. It is understood that archiving raw data does not replace the archiving of final data products.
- Provide continued support for the re-evaluation of the historical ozone, UV, and trace-gas data, in order to preserve and improve the long-term records.

11.5 Capacity Building

Many of the world's ozone- and UV-measuring stations are located in developing countries and CEITs. The instruments used require sophisticated calibration and maintenance, much of which is unavailable without international capability. At present, there is an insufficient number of regional centres for research, calibration, and validation in developed and, especially, in developing countries. Therefore, it is vitally important that sufficient resources are made available to maintain the current global network of observations, and to expand it to uncovered areas.

- Support and encourage regional and bilateral cooperation and collaboration among developed and developing countries and CEITs to provide a global expertise in ozone and UV measurements and research.
- Provide resources for scientific and technical training, at and beyond the instrument-operation level, thereby allowing instrument operators and other scientific personnel in developing countries and CEITs to use their data, other available data, and models in both regional and international research areas. This should include:
    - Resources for the exchange of visits among personnel from monitoring stations in developed and developing countries and CEITs in order to ensure technology transfer and sustained measurement programmes.
    - Resources to permit the participation of representatives from developing countries and CEITs in regional and international validation and intercomparison campaigns.
- Provide resources to establish systems for public dissemination of information about the effects of ozone and UV changes on human health and the environment. This dissemination, which includes education and outreach programmes, is especially important in developing countries and CEITs. Network facilities, such as those of the UNEP Division of Trade, Industry and Economics (UNEP/DTIE), could be utilized for this purpose.
- Provide resources for the establishment of regional centres for research, calibration, and validation in developed and, especially, in developing countries.
- Urge the Parties to extend the life of and make contributions to the Trust Fund for Observation and Research (established by Decision VI/2). This fund is critical to enabling the capacity-building activities that have been highlighted above. Presently, this fund is far short of satisfying these needs.

12. OTHER MATTERS

No other matters were raised for discussion.

13. CLOSURE OF THE MEETING

Mr Kurylo, after thanking all participants for their attendance and hard work, declared the meeting closed at 4 p.m. on Wednesday, 21 September 2005.

ANNEX A

SIXTH MEETING OF THE OZONE RESEARCH MANAGERS OF THE PARTIES TO THE VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

19–21 SEPTEMBER 2005

VIENNA, AUSTRIA

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ANNEX B

SIXTH MEETING OF THE OZONE RESEARCH MANAGERS OF THE PARTIES TO THE VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER

19–21 SEPTEMBER 2005

VIENNA, AUSTRIA

AGENDA

1. Opening of the meeting.

2. Organizational matters:

(a) Election of the Chair;

(b) Adoption of the agenda.

3. Review of the recommendations adopted at the fifth meeting of the Ozone Research Managers[1], and the resulting decisions of the sixth meeting of the Conference of the Parties to the Vienna Convention for the Protection of the Ozone Layer[2], in particular decision VI/2.

4. Current state of the ozone layer.

5. The Global Atmosphere Watch monitoring programme of the World Meteorological Organization: global ozone and UV-B radiation observing and monitoring system.

6. Network for the Detection of Stratospheric Change (NDSC).

7. World Climate Research Programme project on "Stratospheric Processes and their Role in Climate" (SPARC).

8. Science, environmental effects and technology and economic assessments under the Montreal Protocol:

(a) Status and plans for the 2006 assessment;

(b) Special report by the Intergovernmental Panel on Climate Change and the Technology and Economic Assessment Panel on safeguarding the ozone layer and the global climate system.

9. National reports on existing and planned activities relating to ozone research and the monitoring, calibration and archiving of measurements; and on UV-B monitoring and initiatives aimed at the prevention of UV-B and sun-related injuries.

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[1] *Held in Geneva, Switzerland, from 25 to 27 March 2002. For the report of the meeting, see the World Meteorological Organization's Global Ozone Research and Monitoring Project Report No. 46 of March 2002.*

[2] *Held in Rome, from 25 to 29 November 2002. For the report of the meeting, see document UNEP/OzL.Conv.6/7.*

10. Information on the organization of events to celebrate the twentieth anniversary of the Vienna Convention and on the holding of the sixth meeting of the Conference of the Parties to the Vienna Convention, the seventeenth meeting of the Parties to the Montreal Protocol and associated meetings.

11. Adoption of the recommendations and the report.

12. Other matters.

13. Closure of the meeting.

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