

World Meteorological Organization

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ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME (AREP)

SUMMARY

DECISIONS REQUIRED:

Fifteenth Congress is invited to recognize the key role of weather and atmospheric chemistry research in Member activities by reviewing and approving:

- (a) The present document;
- (b) An up-dated resolution on AREP;
- (c) A new resolution on stratospheric ozone observations replacing two older ones.

REFERENCES:

1. *Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of the Commission for Atmospheric Sciences (WMO-No. 1002)*
2. *Abridged Final Report with Resolutions of the Fourteenth World Meteorological Congress (WMO-No. 960)*
3. *Abridged Final Report with Resolutions of the Fifty-eighth Session of the Executive Council (WMO-No. 1007)*

CONTENT OF DOCUMENT:

Appendices for inclusion in the final report:

- A. Draft text for inclusion in the general summary of Cg-XV
- B. Draft Resolution 3.3/1 (Cg-XV) - Atmospheric Research and Environment Programme
- C. Draft Resolution 3.3/2 (Cg-XV) - Stratospheric Ozone Observations

Appendix for information:

Cg-XV/Rep. 3.3: Progress/Activity Report

DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY OF Cg-XV

3.3 **ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME** (*agenda item 3.3*)

3.3.1 **Atmospheric Research and Environment Programme (AREP): the report of the president of CAS** (*agenda item 3.3.1*)

3.3.1.1 Congress thanked the president of CAS Dr Michel Béland for his report highlighting the significant achievements of the research programmes. It acknowledged that the activities of CAS and AREP are in accordance with the Sixth WMO Long-term Plan, and the relevant resolutions of Congress and the Executive Council.

3.3.1.2 The continuing success of the WMO Research Award for Young Scientists administered by AREP reflects the interest of WMO Members who are encouraged to continue to support the Awards.

3.3.1.3 Congress was pleased with the progress that has been made in AREP programmes. It endorsed the changes in CAS documented in the report of the fourteenth session of the Commission, held in 2006 in South Africa and subsequent amendments by EC-LVIII. It thanked Dr Anton Eliassen, the former president of CAS, for his long-term leadership that ended at CAS-XIV and those experts worldwide that serve as chairs and team members. Congress supported the adoption by CAS-XIV and EC-LVIII of a new operating system for CAS with two Open Programme Area Groups (OPAGs) supporting the Global Atmosphere Watch (GAW) programme, the World Weather Research Programme (WWRP), which includes THORPEX, and other research activities.

3.3.1.4 Congress agreed with the president that the GAW programme under the CAS OPAG for Environmental Pollution and Atmospheric Chemistry (EPAC) is in a mature stage of development with sound management and a growing list of significant services and products. It endorsed the process of implementation through the GAW Strategic Plan approved by the CAS Management Group and monitored by CAS OPAG-EPAC. It noted that the third GAW Strategic Plan: 2008-2015 incorporates the rationale and implementation of the Integrated Global Atmospheric Chemistry Observations (IGACO) strategy (WMO/TD-No. 1235) as recommended by CAS-XIV and endorsed by EC-LVIII. It endorsed the president's recommendation that the GAW programme and CAS play a pivotal role in developing a WMO Integrated Global Observing System.

3.3.1.5 Since weather forecast research is an essential component of a WMO strategy to reduce risk through disaster mitigation and since WWRP and THORPEX initiatives have much in common, Congress strongly endorsed the decision of CAS-XIV and its Management Group to develop and implement under the Open Programme Area Group for WWRP a strategic plan for a new World Weather Research Programme that integrates WMO Member activities in THORPEX, tropical meteorology, mesoscale weather forecasting, nowcasting, verification and societal and economic benefits with those of partners in global forecast research and Earth observations. It agreed that, in such a plan, maintenance and strengthening of the traditional strong links with GAW, the World Climate Research Programme, and other WMO Programmes are needed.

3.3.1.6 Congress expressed its satisfaction that CAS has responded adequately the CAS-XIV (*Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1002) general summary, paragraph 8.1.2) request to review proposed updates to the "*WMO Statement on Weather Modification (including an Executive Summary)*" and the "*WMO Guidelines for the Planning of Weather Modification Activities*". It accepts the CAS proposal to present its decision to EC-LX in 2008.

3.3.1.7 Congress expressed satisfaction with the response of CAS to the request of Cg-XIV (*Abridged Final Report with Resolutions of the Fourteenth World Meteorological Congress* (WMO-No. 960) general summary, paragraph 3.3.5.4) and with the establishment of an ad-hoc group to address the effects of aerosol pollution, including biomass burning, on precipitation. It noted that CAS had designated AREP to lead a joint WMO effort with the International Union of Geodesy and Geophysics (IUGG) that established the WMO/IUGG International Aerosol Precipitation Science Assessment Group and organized a peer-reviewed report entitled "Aerosol Pollution Impact on Precipitation: A Scientific Review". It accepted the president's recommendation that CAS proceed to publish the report as a joint WMO/IUGG publication. Congress expressed its thanks to IUGG, co-editors Professors Z. Levin and W. Cotton and leader of the peer-review Dr G. Isaac as well as to the many contributors and reviewers. It requested that CAS consider possible actions resulting from the recommendations and report to EC LX.

3.3.2 Global Atmosphere Watch Programme (GAW) including support to environment-oriented conventions (*agenda item 3.3.2*)

3.3.2.1 Congress noted the approval by CAS of the Global Atmosphere Watch (GAW) Strategic Plan: 2008–2015. Congress recognized that GAW focuses on integration of all types of observations (surface-based, aircraft, satellite) of ozone, UV radiation, greenhouse gases, aerosols and selected reactive gases using atmospheric models and incorporates many elements of the IGACO strategy. This provides GAW with an appropriate framework for integration of observations and strengthens links to users. Recognizing that the support of countries for the GAW infrastructure is crucial, Members were encouraged to continue their national GAW related activities, to support established trust funds to build capacity in developing regions and to seek possibilities to fill some gaps in those areas still lacking. It noted that gaps in observations exist, particularly in South America, Africa and Asia.

3.3.2.2 Congress was pleased that GAW had initiated the publication of a WMO Greenhouse Gas Bulletin annually. The second Bulletin was very timely for the meeting of the Conference of the Parties to the UNFCCC in 2006. Congress recommended that other services and products connecting GAW activities to user communities be developed, including analysis and forecasting of short-term and long-term hazards related to air pollution episodes, chemical loading of ecosystems from the atmosphere, UV radiation exposure, and restricted visibility and air quality due to smoke and dust.

3.3.2.3 With respect to the Vienna Convention and its Montreal Protocol, Congress emphasized the need for Members to support the monitoring of ozone and ozone-depleting substances over the next several decades to ensure the detection of the state of the ozone layer. It encouraged Members to support the Trust Fund of the Vienna Convention for the Protection of the Ozone Layer on Research and Systematic Observations in support of capacity building in developing regions. Congress noted the significant role that the traditional WMO Antarctic Ozone Bulletin and the Arctic Ozone Bulletin that was initiated in 2006 played in consolidating scientific opinion and as key information.

3.3.2.4 Congress welcomed the strong partnerships developed by GAW with regional atmospheric chemistry monitoring and modelling programmes. It recommended that the strong collaboration with the UNECE Convention on Long Range Transboundary Transport of Air Pollution continue, particularly as the scope of the convention's activities expand to hemispheric. WMO-GAW is co-chairing the Task Force on Measurements and Modelling (TFMM) of the convention's EMEP programme and participating in its Task Force on Hemispheric Transport of Air Pollution (TFHTAP).

3.3.2.5 Congress endorsed the priority placed by GAW on addressing the training and education needs of developing countries and acknowledged the support by Germany of the GAW Training and Education Centre (GAWTEC) and the bi-annual courses it holds. In addition, it extended its appreciation to Argentina, Australia, Canada, Czech Republic, Japan, South Africa, Spain, Switzerland and the United States for special efforts in training. Congress urged Members to continue these activities. The development of the GAW Urban Research Meteorology and Environment (GURME) air quality forecasting training course was recognized as important in strengthening of capability of NMHSs to deal with urban air quality problems. Members were encouraged to assist in providing this course in different WMO Regions.

3.3.2.6 The second quadrennial gathering of leaders and partners of GAW took place in the GAW 2005 Workshop in Geneva. Representatives of all the components of GAW participated including: members of the CAS Open Programme Area Group (formerly working group) on Environmental Pollution and Atmospheric Chemistry; leaders of GAW calibration, quality assurance, data management facilities; station managers; modellers, GAW product users; collaborating partner organizations; and the Secretariat. Congress recommended that this important technical and scientific forum continue.

3.3.2.7 NMHSs throughout the world are broadening their traditional role of meteorological monitoring and forecasting to include prediction of other environmental phenomena that could substantively affect the health and welfare of their citizens (e.g. UV radiation, plumes from biomass burning, dust storms, and air quality). The emergence of air quality forecasting is an illustrative example. Recent developments in atmospheric chemical transport modelling are leading to more effective linkage of air pollution issues on different scales from urban to global. In recognition of the above, Congress welcomed the continuing implementation of workshops and projects by GAW including GURME.

3.3.3 World Weather Research Programme (WWRP) including THORPEX and Tropical Meteorology (agenda item 3.3.3)

3.3.3.1 Congress thanked the many scientists involved in the development of THORPEX and its ongoing activities. It drew particular attention to Canada, China, France, Japan, Korea, Norway, the United Kingdom and the United States for their continuing financial support, and to China for its seconded expert at the IPO. Noting pressing budgetary issues, Congress urged more Members to commit support to the THORPEX Trust Fund.

3.3.3.2 Congress was particularly pleased with the progress made towards the development of the THORPEX Interactive Grand Global Ensemble (TIGGE), which is a prototype for a multi-model ensemble forecast system that would guide the development of a possible Global Interactive Forecasting System (GIFS). In its first phase, TIGGE would provide to all WMO Members near-real-time access to ensemble forecast products for research purposes.

3.3.3.3 Congress was pleased to note: (a) the regional organization of THORPEX in Regional Associations (RAs) II, IV and VI and the rapid development of the THORPEX partnership in the Southern hemisphere involving countries in RA I, RA III and RA V; (b) the importance of the emphasis placed by THORPEX on social and economic benefits; (c) the strong developing cooperation between THORPEX, WCRP, GEO and IPY; (d) the resounding success of the second THORPEX International Scientific Symposium held in Landshut, Germany 2006 signifying a solid and useful programme; and (e) the initiative of WWRP-THORPEX to establish a plan of action to meet the specific needs of RA I countries. In order to ensure that the full benefits of the programme were realized, Congress emphasized that it would be essential for THORPEX to continue to address science and technology transfer issues, and coordinate its activities with WWRP, GAW, other WMO Programmes and international research and application programmes.

3.3.3.4 Congress was pleased to note that during the last four years, the WWRP Sydney 2000 Forecast Demonstration Project (FDP), Mesoscale Alpine Programme (MAP), the 1st Phase of Mediterranean Experiment on Cyclones that Produce High Impact Weather in the Mediterranean (MEDEX) and the Aircraft In-Flight Icing Project (AIFI) were successfully completed. Congress congratulated the relevant WMO Members and all the participants for their valuable contributions and excellent collaboration, which ensured the success of these WWRP Projects.

3.3.3.5 Congress welcomed the establishment of Beijing 2008 FDP/RDP, MAP D-PHASE, the Sand and Dust Storm (SDS) Regional Demonstration Project (RDP) and the RDP on Convective and Orographically-induced Precipitation Study (COPS), and noted with satisfaction the significant progress in the implementation of these WWRP projects.

3.3.3.6 Congress endorsed the WWRP and GAW joint activity to create a WMO Sand and Dust Storm Warning System, aimed at coordinating observations and research forecast modelling of sand and dust storms while forging strong links with users including operational forecasters.

3.3.3.7 Congress noted the creation of a new category of WWRP research activity called Developing Country Forecasting Demonstration Projects (DC-FDP) that would involve scientists of relevant developing countries, a responsible regional meteorological centre, and interested developed countries. Congress strongly encouraged more active participation of developing countries, in particular least developed countries, in WWRP activities. Linked with THORPEX demonstration projects, which emphasize forecast applications, these projects have the potential to substantially improve forecast products in developing countries.

3.3.3.8 Congress noted with satisfaction that a WWRP International Hydro-Meteorological Test-bed (IHMT) for precipitation forecasting, under development by NOAA, USA, would facilitate links between research and forecast demonstration activities and accelerate the transition from research to operations.

3.3.3.9 Congress agreed with CAS that the four priority research areas, i.e., tropical cyclone track forecasting, quantitative precipitation forecasting, structure/intensity changes, and storm surges, were important for improving the early warning systems of tropical cyclones. Congress urged the tropical meteorology research activities of WWRP to continue the development of probabilistic forecasting techniques for tropical cyclones and to quantify the social and economic impacts of tropical cyclones and tropical cyclone forecasts in collaboration with THORPEX, WCRP and the Weather Applications Programme.

3.3.3.10 Congress highlighted the importance of monsoon studies, which contribute to the improvement of heavy rainfall, flooding and drought forecasting, and urged WWRP to cooperate with WCRP and THORPEX to continue monsoon research project and field experiments.

3.3.4 Weather Modification Activities (*agenda item 3.3.4*)

3.3.4.1 Congress noted that weather modification activities conducted by a number of Members were aimed at improving the economy (for example, to increase a water supply for agriculture) or reducing the risks associated with high impact weather (frost, fog, hail, etc.). Congress strongly recommended that such activities be supported by research that provides: (a) a deeper understanding of the effects of cloud modification on cloud/precipitation development; and (b) a scientifically accepted evaluation of the weather modification activities. Congress also encouraged Members to take into account economic, social, ecological and legal aspects when weather modification activities are applied.

DRAFT RESOLUTION

Res. 3.3/1 (Cg-XV) – ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME

THE CONGRESS:

Noting:

- (1) The *Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1002),
- (2) Resolution 10 (Cg-XII) - Atmospheric Research and Environment Programme, and related actions taken by Fourteenth Congress and Executive Council,
- (3) Resolution 12 (Cg-XIV) - THORPEX: A Global Atmospheric Research Programme,
- (4) The WMO Strategic Plan: 2008-2011 - Atmospheric Research and Environment Programme,
- (5) That the skilful prediction of high-impact weather is one of the greatest scientific and societal challenges of the twenty-first century,
- (6) The Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol on Substances that Deplete the Ozone Layer and its subsequent amendments, the United Nations Framework Convention on Climate Change and the United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution and other environment-oriented conventions,

Considering:

- (1) The heightened public awareness and concerns for global, regional and local climate, weather and environmental issues in general,
- (2) The responsibility of WMO within the United Nations system to provide the authoritative scientific voice on the state and behaviour of the atmosphere, weather and climate of our planet,
- (3) The central role played by the atmosphere in environmental issues, which has been foremost among societal concerns during the past years and will continue well into this century, such as, the global increase of greenhouse gases and effect of aerosols on weather and climate, stratospheric ozone depletion and related increase in ultraviolet radiation, long range pollutant transport, air quality and impacts of pollutant deposition,
- (4) The increasing demand by numerical weather prediction (NWP) research and operations for support in adding aerosols, ozone and their gaseous precursors to improve forecasting accuracy as well as enhance products and services,
- (5) The increasing need to move towards environmental predictions, using as a core driver the traditional NWP systems, coupled with other modelling subsystems, with a consideration of the socio-economic impacts, as distinct from strictly traditional weather-only predictions,
- (6) The implementation of the WMO Global Atmosphere Watch (GAW) Programme with the mission of taking into account the Integrated Global Atmospheric Chemistry Observations (IGACO) strategy to: reduce environmental risks to society and meet the requirements of

environmental conventions; strengthen capabilities to predict climate, weather and air quality; contribute to scientific assessments in support of environmental policy; through maintaining and applying global, long-term observations of the chemical composition and selected physical characteristics of the atmosphere; emphasizing quality assurance and quality control; delivering integrated products and services of relevance to user needs,

- (7) The focus of the GAW integrated atmospheric chemistry observations is primarily on greenhouse gases, ozone, UV, aerosols, selected reactive gases and precipitation chemistry with additional support for other IGACO variables,
- (8) The potential of the National Meteorological and Hydrological Services (NMHSs) to contribute substantially to integrated observations via their extensive monitoring system infrastructures and specific scientific expertise in areas such as numerical modeling with four-dimensional data assimilation techniques and real-time data delivery,
- (9) That greenhouse gases, aerosols and ozone are designated “Essential Climate Variables (ECVs)” in the GCOS Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC and that the GAW Global CO₂ and CH₄ Monitoring Network is a comprehensive network of GCOS,
- (10) The international coordination role of WMO in environmental issues that are becoming more extensive and complex not only because of greater activity levels, but also because of the need to encompass a broader range of scientific disciplines (meteorology, atmospheric chemistry, hydrology, oceanography, biosphere sciences and human health) and partner organizations in the resolution of sustainable environmental development issues,
- (11) That the Thirteenth Congress and CAS-XIV concurred with the need for the GAW Urban Research Meteorology and Environment (GURME) activities aimed at improving air quality forecasting, expansion of GAW measurements and strengthening partnerships of NMHSs with key sectors including health,
- (12) That despite the substantial increase in the forecast skill achieved by improvements in atmospheric observing technology, data-assimilation methods, new numerical model formulations, the use of ensemble techniques, the ability to forecast high impact weather events still falls below that required by society,
- (13) The decision of CAS-XIV and its Management Group to develop and implement, under the CAS Open Programme Area Group on World Weather Research Programme (WWRP), a strategic plan for a new WWRP that integrates WMO Member activities in THORPEX, tropical meteorology, mesoscale weather forecasting, nowcasting, verification and societal and economic benefits with those of partners in global forecast research and Earth observations,
- (14) The need of NMHSs for support in practicing sound weather modification research,

Decides:

- (1) That AREP should focus on: GAW including IGACO implementation; WWRP including THORPEX; and the related transfer of appropriate technology and proven methodologies among Members as indicated in the WMO Strategic Plan 2008-2011;
- (2) That education and training aspects be included in all components of the Atmospheric Research and Environment Programme (AREP);

- (3) That, in the implementation of AREP, WMO should continue to cooperate, as appropriate, with the United Nations Environment Programme (UNEP), the World Health Organization (WHO), the United Nations Development Programme (UNDP) and other relevant agencies;

Requests Members:

- (1) To give all possible support to the implementation of AREP, with high priority to GAW and WWRP including THORPEX;
- (2) To support the central role of GAW in the development of a WMO Integrated Global Observing System;

Requests the president of CAS:

- (1) To arrange for the development and implementation of WMO activities in GAW and WWRP including THORPEX using technical strategic plans;
- (2) To encourage CAS Members to participate in and contribute to THORPEX, and its Trust Fund, and to facilitate the activities of the International Core Steering Committee for THORPEX;
- (3) To coordinate activities in the implementation of AREP with other relevant WMO Programmes, in particular WCRP and international organizations;
- (4) To ensure that CAS continues to assist Members through the CAS Expert Team on Weather Modification in practicing sound weather modification research;
- (5) To arrange provision of assistance and advice with respect to the Education and Training Programme;
- (6) To stimulate and coordinate socio-economic research and development activities and studies to increase the value of environmental prediction outputs for the benefit of WMO members;

Requests the Executive Council:

- (1) To take, within available budgetary resources, all necessary actions towards the fullest possible implementation of AREP, in accordance with the WMO Strategic Plan: 2008-2011;
- (2) To support the work of CAS, and other bodies concerned, in the development of component programmes of AREP;
- (3) To continue its coordinating role regarding GAW and WWRP with other relevant WMO activities through the CAS Open Programme Area Groups on Environmental Pollution and Atmospheric Chemistry and on the World Weather Research Programme.

Requests the Secretary-General:

- (1) To take all necessary action, within available budgetary resources, for the implementation of the programme;

- (2) To support the THORPEX international programme office, to assist WMO Members in the international coordination of THORPEX, and to assist Members from developing nations in their utilization of THORPEX-related forecast products;
- (3) To devote particular attention to the education and training aspects of AREP;
- (4) To assist Members participating in the programme, particularly developing Member countries, by facilitating the training and exchange of scientists, and the provision of advice, guidance, and services, as required, within available budgetary resources;
- (5) To take all necessary actions to develop and maintain collaboration of WMO through AREP with agencies, groups and institutions such as GEO, ICSU, UNEP, UNDP and others, which can contribute to the further development and implementation of the research based programmes of AREP and to seek further financial support from such agencies and other national and international institutions and from Members.

Note: This resolution replaces Resolution 10 (Cg-XIII), which is no longer in force.

DRAFT RESOLUTION

Res. 3.3/2 (Cg-XV) – STRATOSPHERIC OZONE OBSERVATIONS

THE CONGRESS:

Noting:

- (1) The Vienna Convention for the Protection of the Ozone Layer and its associated protocols,
- (2) The *Abridged Final Report with Resolutions of the Seventh World Meteorological Congress* (WMO-No. 416), general summary, paragraph 3.2.1.3,
- (3) The *Abridged Final Report with Resolutions of the Twenty-seventh Session of the Executive Committee* (WMO-No. 417), general summary, paragraph 3.3.7.3,

Considering:

- (1) That WMO is the international organization having scientific competence and experience to coordinate atmospheric ozone studies, especially those relevant to the implementation and verification of the Vienna Convention for the Protection of the Ozone Layer,
- (2) The extent to which human activities may affect long-term ozone changes, the need to discriminate such changes from those occurring naturally and the need to assess the consequences of ozone change,
- (3) That quadrennial scientific assessments of ozone depletion assume special importance in the context of the Vienna Convention and its Montreal Protocol,
- (4) The need for a comprehensive atmospheric ozone observational system providing data on total ozone and its vertical distribution, and the value of such data in studies of the general circulation and other meteorological phenomena on various space- and time-scales,
- (5) That the GAW global network of surface-based total ozone and vertical profile observing stations requires careful interregional and intraregional comparisons of ozone instruments and standard operating procedures,
- (6) That reliable detection of trends, ozone turnaround and ozone recovery as well as satellite validation rely critically upon long-term total ozone observations of high quality,
- (7) That the continuation for the next several decades of the current GAW global ozone network and the filling of major gaps in the network are critical to the verification of the effectiveness of halocarbon emission controls enacted under the Montreal Protocol,

Requests Members:

- (1) To establish, upgrade or reactivate, and maintain ozone observations (including observations in the Arctic and the Antarctic) using surface instruments, balloon sondes, aircraft and satellites. The observing programmes should be continued for sufficiently long periods to allow climatological investigations;
- (2) To maintain consistency in global ozone measurements coordinated by GAW through linking observations to WMO World Reference Standards, following measurements guidelines, undertaking regular international calibrations of their total ozone instruments,

and to provide support to developing countries so that they can participate in such calibrations;

- (3) To improve data retrieval by conducting supporting observations (e.g., temperature, aerosol extinction) and related studies (e.g. better algorithms) as required;
- (4) To undertake measurements of atmospheric trace gases relevant to ozone chemistry;
- (5) To contribute to research efforts so that the understanding of the physical, chemical, dynamical, radiative, biospheric and human factors controlling ozone distribution and change can be improved;
- (6) To initiate or continue routine programmes for carefully made "Umkehr" observations at stations operating sensitive and well-kept ozone spectrophotometers in suitable climates;
- (7) To establish additional total-ozone measuring stations in data-sparse areas identified as necessary to complete the global network, and for this purpose to loan or donate any Dobson or Brewer ozone spectrophotometer in their possession, which is not in use, to another Member;
- (8) To cooperate in data storage and a more rapid exchange of total ozone data, particularly by sending data to the WMO-GAW World Ozone and Ultraviolet Data Centre in Toronto, Canada, and by sending data in near real-time to the GTS/WIS;
- (9) To make every effort to continue total ozone monitoring with ozone spectrophotometers, at least at stations with long-term records of high quality data and to ensure adequate overlap when switching from one type of instrument to another in order to avoid breaks and inhomogeneities in the data sets;
- (10) To contribute to observations, analysis and research supporting the WMO Ozone Bulletins and the quadrennial WMO/UNEP Scientific Assessment of Ozone Depletion;
- (11) To participate in the triennial meetings of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer and contribute with recommendations for improvements of the Global Atmosphere Watch ozone observing system;
- (12) To contribute to the Trust Fund of the Vienna Convention for the Protection of the Ozone Layer on Research and Systematic Observations;

Urges Members operating satellites to include atmospheric ozone sensors of proven capability aboard future spacecraft, and to maintain continuous ozone measurements for as long as possible, making a selection of vertical ozone profiles and total ozone values available to all interested users;

Requests regional associations to designate and maintain at least one of their total ozone measuring instruments as regional standard for atmospheric ozone observations, and ensure that the observing station concerned is suitably equipped for that purpose;

Requests the president of CAS to keep under continuous review the programme of atmospheric ozone measurements and research and to propose further recommendations as and when necessary for its improvement;

Requests the Secretary-General:

- (1) To take the actions necessary to support these activities;
- (2) To bring this resolution to the attention of all concerned and to provide assistance within the limits of available resources in implementing it.

Note: This resolution complements the AREP resolution and replaces Resolution 7 (EC-XXXIX), and Resolution 3 (EC-LVI), which are no longer in force.

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**ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME
(AREP)**

PROGRESS/ACTIVITY REPORT

SUMMARY

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CONTENT:

Appendix:

- Progress/Activity Report

PROGRESS/ACTIVITY REPORT

ATMOSPHERIC RESEARCH AND ENVIRONMENT PROGRAMME (AREP)

Report of the President

1. The Atmospheric Research and Environment Programme (AREP) consists of two major initiatives: the Global Atmospheric Watch (GAW) Programme and the World Weather Research Programme (WWRP). They share the common goal of supporting research amongst Members aimed at improved observational and prediction systems of weather, climate, air quality and related environmental issues. They are becoming strongly linked through the increasing recognition of the role of atmospheric chemical composition in weather and the key role that forecast modelling will play in future climate and air quality prediction on all scales from urban to global. AREP programmes also contribute to major cross-cutting issues, particularly disaster prevention and mitigation and WMO integrated global atmospheric observations. The World Weather Research Programme (WWRP) now includes support for THORPEX, undertaken through the extrabudgetary initiatives of Members who have major forecast research initiatives that needed more coordination, global capacity building and outreach.

2. CAS-XIV adopted a new operating system with two Open Programme Area Groups (OPAGs) supporting the Global Atmospheric Watch (GAW) and the World Weather Research Programme (WWRP) that includes THORPEX and other research activities. In order to provide oversight and direction a CAS Management Group was also established. The mission of GAW and WWRP is to support research in atmospheric science to:

- Reduce and mitigate natural disasters;
- Protect the environment;
- Enhance understanding and response to environmental change.

3. The next generation GAW (2008-2015) mission that takes into account the Integrated Global Atmospheric Chemistry Observations (IGACO) strategy is to:

- Reduce environmental risks to society and meet the requirements of environmental conventions;
- Strengthen capabilities to predict climate, weather and air quality;
- Contribute to scientific assessments in support of environmental policy.

Through:

- Maintaining and applying global, long-term observations of the chemical composition and selected physical characteristics of the atmosphere;
- Emphasizing quality assurance and quality control;
- Delivering integrated products and services of relevance to user needs.

In fulfilling the above goals following the GAW Strategic Plan: 2008-2015, it thereby addresses Expected Results 1, 4, 7, 8 and 9 of the WMO Strategic Plan 2008-2011.

4. In addition to addressing climate applications, GAW responds to the increasing demand by NWP research and operational forecasting for atmospheric chemistry modules and observations. The addition of chemical variables to NWP not only adds air quality forecasts and climate-forcing analyses to the products and services of meteorological services but also, influences the accuracy and usefulness of a traditional weather forecast through feedback on direct and indirect radiative forcing and precipitation formation.

5. GAW will respond to the needs and clearly link to the plans of international observing projects/systems/strategies (e.g. GCOS, IGOS, GEO) and of atmospheric process research (i.e. national, regional and international such as the IGAC, SOLAS and ILEAPS projects of IGBP) and the regional projects (GEMS, ACCENT, EUSAAR, SCOUT-O3 and GEOMON of the European Commission).

6. At its first meeting in September 2006, the CAS Management Group decided to develop a strategic plan for implementation of a World Weather Research Programme that included societal and economic benefit research as well as capacity building. The ongoing forecast and research demonstration projects, training and international scientific meetings supported by the former WWRP will be augmented by THORPEX and will involve strengthened activities in the WMO Regions, the joint WWRP/WCRP Working Group on Numerical Experimentation (WGNE), other WMO Programmes, and international organizations particularly GEO and ICSU.

7. The purpose of WWRP is to support research that:

- (i) Develops improved and cost-effective forecasting techniques, with emphasis on high impact weather and promotes their application among Members;
- (ii) Underpins the WMO Multi-Hazard Prevention Strategy aimed at reducing by 50 per cent over the decade 2010-2019 the number of fatalities caused by meteorological-, hydrological- and climate-related natural disasters compared with the ten-year average fatalities of 1995-2004, through improvement of the early warnings of high impact weather globally;
- (iii) Enables governments, societies and economic sectors to realize fully the benefit of weather- and climate-related information in critical decision-making;
- (iv) Demonstrates improvements in the prediction of high impact weather, through the exploitation of advances in scientific understanding, new observing systems, observational network design, data assimilation and modelling techniques, and information systems;
- (v) Demonstrates the benefits of improved global, mesoscale and nowcasting forecast systems to all societies.

In fulfilling these objectives, WWRP addresses Expected Results 1, 6, 7, 8 and 9 of the Strategic Plan. It will assist Members by fostering research leading to better operational weather forecast services and products and to better application of atmospheric chemistry related to weather, climate, air quality and related environmental issues.

8. The WMO Research Award For Young Scientists was established in 1970. From 2003 to 2006, 46 nominations were received for the annual prize that was awarded after independent review to young scientists from South America, Europe, Southeast Asia and Africa (see EC documents for details).

9. Regarding Weather Modification Activities, CAS has responded to the request of CAS-XIV (*Abridged Final Report with Resolutions and Recommendations of the Fourteenth Session of the Commission for Atmospheric Sciences (WMO-No. 1002)*) to *establish "a process for reviewing the Working Group documents"* (see paragraph 3.3.1.6), the CAS Management Group has adopted the following process:

- (i) A group of internationally respected scientific experts provide reviews;
- (ii) The original drafting group revise the original documents using the reviews;
- (iii) The Chair of the Expert Team for Weather Modification reviews the revised documents;
- (iv) The Chair of the original drafting group finalizes the document in consultation with the Chair of the Expert Team;

- (v) The final drafts are submitted to CAS Management Group for approval in September 2007.

10. A joint ad-hoc WMO/IUGG group established in response to the request of Cg-XIV (*Abridged Final Report with Resolutions of the Fourteenth World Meteorological Congress* (WMO-No. 960)) has prepared a scientific technical report entitled "Aerosol Pollution Impact on Precipitation: A Scientific Review." [see the *AREP CD*]. Preparation included a peer-review process. Environment Canada and Météo-France kindly hosted international expert workshops in November 2005 and October 2006. The review has been finalized and presented to the CAS Management Group and IUGG in early 2007. Plans are to publish the review as a book.

Global Atmosphere Watch (GAW), including support to environment-oriented conventions

11. WMO-GAW continued to coordinate global ozone observations in support of the Vienna Convention and its Montreal Protocol and to issue annually Ozone Bulletins on the status of the Antarctic ozone hole on a bi-weekly basis during the period August to November. The first annual WMO Arctic Ozone Bulletin was published in 2006, summarizing the development of stratospheric ozone in the Arctic winter and spring period. The Meeting of the Ozone Research Managers of the Parties to the Vienna Convention and the meeting for the Ozone Science Assessment were organized together with UNEP, and the WMO/UNEP quadrennial Scientific Assessment of Ozone Depletion was published in the spring of 2007. The Balloon Experiment on Standards for Ozone Sondes (BESOS) field campaign was carried out at the University of Wyoming. Intercomparisons of Dobson spectrophotometers took place for Latin America in 2003 and 2006, for RA I in 2004, for RA V in 2006 and for RA II in 2006. The first Brewer comparison, hosted by the GAW Regional Brewer Calibration Centre – Europe, was arranged in Spain in September 2005. Several Brewer spectrophotometers were calibrated by International Ozone Services.

12. The GAW Community and Secretariat actively supported the UNFCCC through contributions to the Strategic Implementation Plan of the Second Report on the Adequacy of the Global Observing Systems for Climate by the Global Climate Observing Strategy (GCOS). GAW is recognized as the lead international programme in coordinating global monitoring efforts of the following Essential Climate Variables (ECVs): greenhouse gases, ozone and aerosols.

13. WMO-GAW continued strong collaboration in Europe specifically by co-chairing the Task Force on Measurements and Modelling (TFMM) of EMEP under the Convention on Long-range Transboundary Air Pollution (LRTAP).

14. The emphasis that GAW places on calibration and quality assurance/quality control as a product and service continues to be important for both developed and developing countries. Many Members operate World and Regional Calibration Centres as well as on-site instrumental calibration programmes, which are part of the GAW quality assurance system. Spain established the first Regional Brewer Calibration Centre at Izaña (Tenerife, Spain) and Canada has provided annual support since 2003 in a WMO trust fund for Brewers. The series of UV reports were continued with "Instruments to Measure Solar Ultraviolet Radiation - Part 2: Broadband Instruments Measuring Erythemally Weighted Solar Irradiance". UV instrument calibration exercises were organized with partial support from WMO for the first time for multfilter UV instruments. The lack of a global UV calibration facility, or regional centres with global coverage when combined, is seen as a serious problem. The World Calibration Centre (WCC) for CH₄, CO, and O₃ has persistently continued to audit, quality assure, train and support instrument operations at remote GAW stations.

15. The WMO GAW World Data Centres continued collecting and making available data and data products. A new WMO data centre for satellite data on atmospheric chemistry will be

established at the German Aerospace Centre (DLR). A MoU and a workplan are being developed and the data centre will be in operation in 2007.

16. The GAW Station Information System (GAWSIS), established to describe the GAW network metadata, was upgraded in 2004 to include mapping facilities and links to data in GAW World Data Centres. This is a very useful and versatile tool supported by Switzerland for obtaining information on GAW stations. However, it is only as accurate as the information in it, and Members are urged to actively monitor the data and keep it up to date. The Mt Waliguan, Cape Point, and Cape Grim GAW stations celebrated anniversaries and new Global stations were established at Danum Valley, Malaysia and Jungfrauoch, Switzerland. The Secretariat conducted with the help of an intern a survey of existing UV measurement stations.

17. Precipitation chemistry remains an important environmental issue due to concerns over acid deposition, eutrophication, ecosystem health, and global climate change. GAW continues to cooperate with contributing partners and regional networks (DEBITS, EANET, CAPMoN, EMEP, NADP) in order to fill a gap in the GAW precipitation chemistry global data. The document Manual for the GAW Precipitation Chemistry Programme: Guidelines, Data Quality Objectives and Standard Operating Procedures was published in 2004.

18. Progress was made in defining a global aerosol optical depth network. The GAW reports "WMO/GAW Experts Workshop on a Global Surface-based Network for Long Term Observations of Column Aerosol Optical Properties" and "WMO/GAW Aerosol Measurement Procedures Guidelines and Recommendations" were published. A major development in the GAW reactive gas activities was made by finalizing a plan for measurements of Volatile Organic Compounds (VOCs), in a global network. The International HALocarbons in Air Comparison Experiment (IHALACE) was carried out to ensure an integrated global halocarbon database and in the long term to establish a global quality assurance system for these compounds. The report "Joint WMO-GAW/ACCENT Workshop on the Global Tropospheric Carbon Monoxide Observations Systems, Quality Assurance and Applications" was published. As for greenhouse gas meetings, the WMO/IAEA Meetings of Experts on Carbon Dioxide Concentration and Related Tracer Measurement Techniques were continued. In particular, data quality objectives for carbon gas measurements were reviewed.

19. GAWTEC continued training, and 132 participants from 46 countries have participated since its establishment in 2001. Training has been given in aerosols, precipitation chemistry, surface ozone, CO, greenhouse gases, Volatile Organic Compounds (VOCs) and UV. The training centre at the Solar and Ozone Observatory (SOO-HK) of the Czech Hydrometeorological Institute (CHMI) in Hradec Kralove has trained 11 Dobson operators in the 2003 to 2006 time period.

20. CAS-XIV noted the wide range of accomplishments in the GURME project that provides an international platform for cross-cutting urban air pollution activities. Passive samplers are a potentially powerful cost-effective observational tool for mega-city pollution studies in developing countries. The results of this GURME pilot project were published in Atmospheric Environment. Air quality forecasting was the focus for GURME in this period; workshops were held within the Latin American Cities project. The development of the GURME training course on air quality forecasting was a major effort and was delivered for the first time in Lima, Peru in 2006. The Moscow and Beijing projects had matured to a second stage.

World Weather Research Programme (WWRP) including THORPEX and Tropical Meteorology Research

21. Since its establishment in 2003 by Cg-XIV, the THORPEX programme has developed rapidly and the following highlights are worthwhile stressing:

- The THORPEX International Science Plan was published in November 2003 and a THORPEX International Research Implementation Plan followed this in December 2004 (both plans are available on www.wmo.int/thorpex/plans.html);
- The establishment of the THORPEX International Programme Office (IPO) and the Boards and Working Groups, reporting to the THORPEX International Core Steering Committee (ICSC);
- The development of enhanced Regional Numerical Weather Prediction activity involving a widened range of scientists from Universities and Research Institutes (through the existing Regional Committees (RCs) in North America (NARC), Europe (ERC), Asia (ARC), the Southern Hemisphere (SHRC) and the National Weather Services); in addition a major effort is underway to develop a regional plan for Africa;
- The scientific and technical success of the first THORPEX Regional Campaign (TReC) carried out under the auspices of THORPEX, the Atlantic regional Campaign (ATReC);
- The International plans for a THORPEX Pacific Asian Regional Campaign (TPARC) for the second half of 2008 which in this case would coincide with the IPY and with the campaign to take additional measurements in support of the Beijing 2008 FDP/RDP;
- The International plans for a European TReC for 2007 relating to summertime high impact weather linked to MAP D-PHASE and the international field experiment of COPS;
- The establishment of the THORPEX Interactive Grand Global Ensemble (TIGGE). A technical proposal for Phase 1 (global analyses and forecasts) has been developed by three archive centres (CMA, ECMWF and NCAR) and agreed by eleven providers (BMRC, CMA, CPTEC, ECMWF, FNMOC, JMA, KMA, Météo-France, Environment Canada, NCEP, UKMO);
- The collaboration with WCRP - with a way forward for joint research and development in forecasting research to improve week 2 forecasting and a TIGGE approach to longer-range forecasting;
- Completion of a successful driftsonde demonstration test in collaboration with AMMA;
- Credible plans for Numerical Weather Prediction elements in GEO and a THORPEX IPY cluster.

However, the current level of commitment of financial resources is well below the level needed for a full programme that was foreseen in the THORPEX Implementation Plan.

22. The following WWRP Projects were initiated and significant progress was made:

- Beijing 2008 FDP/RDP;
- Sand and Dust Storm (SDS) Project;
- MAP-DPHASE;
- RDP on Convective and Orographically-induced Precipitation Study (COPS).

23. The meeting of Science Steering Committee for Sand and Dust Storm (SDS) 2006, Shanghai, China, indicated that large amounts of dust are mobilized and transported by SDS remotely from desert sources. For regions in the desert neighbourhoods, this process represents a serious natural hazard, causing numerous impacts on health, transport, agriculture and environment. A joint initiative of WWRP and GAW was proposed to create a WMO Sand and Dust Storm Warning System, following the interest of more than 40 WMO Members to improve their capabilities to monitor sand and dust storm occurrences. The proposed warning system will promote research on operational sand and dust storm forecasts. Canada, China and Spain were designated as centres to coordinate regional SDS forecasting activities.

24. In addition to many project meetings, the following major conferences and workshops organized by the Programme significantly promoted research activities to improve high-impact weather forecasts and have contributed to the disaster prevention and mitigation:

- First and Second THORPEX Science Symposium (Montreal, Canada, 2004; Landshut, Germany, 2006);
- Third WMO International Workshop on Monsoons (IWM-III) (Hongzhou, China, 2004);
- Fourth WMO International Symposium on assimilation of Observations in Meteorology and Oceanography (Prague, Czech Republic, 2005);
- WWRP International Symposium on Nowcasting and Very Short Range Forecasting (Toulouse, France, 2005);
- WMO International Workshop on Tropical Cyclone Landfall Processes (Macao, China, 2005);
- Second International Symposium on Quantitative Precipitation Forecasting and Hydrology (Boulder, U.S.A., 2006);
- Sixth WMO International Workshop on Tropical Cyclones (IWTC-VI) (San Jose, Costa Rica, 2006).

25. Major training events organized by the Programme served to transfer technology to developing countries:

- Seventh WMO Regional Workshop on Asian/African Monsoon Emphasizing Training Aspects (Nanjing, China, 2004);
- Third WWRP Nowcasting Training Workshop (Pretoria, South Africa, 2005);
- Third International Verification Methods Workshop (Reading, UK, 2007);
- International Training Workshop on Tropical Cyclone Disasters (Guangzhou, China, 2007).

Weather Modification Activities

26. The Expert Team on Weather Modification was established in response to CAS-XIV. The Register of National Weather Modification Projects for the period 2003-2005 has been published and a new, more concise questionnaire has been delivered to the Member States in order to produce the next Register. The quadrennial 9th Scientific Conference on Weather Modification Research will be held in Istanbul, Turkey in October 2007.
