

EXPECTED RESULT 5

AGENDA ITEM 4.3: RESEARCH

THE GLOBAL ATMOSPHERE WATCH PROGRAMME (GAW)

SUMMARY

DECISIONS/ACTIONS REQUIRED:

- (a) Request Members:
- To continue and expand GAW measurements and to establish stations in data sparse regions;
 - To submit their GAW data in a timely fashion;
 - To contribute to the development of the Integrated Global Greenhouse Gas Information System (IG³IS);
 - To contribute to the development of an Integrated Global Aerosol Observation System;
- (b) Adopt draft Resolutions 4.3(4)/1 and 4.3(4)/2.

CONTENT OF DOCUMENT:

The Table of Contents is available only electronically as a Document Map*.

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APPENDIX A: DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY

4.3 Research (agenda item 4.3)

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The Global Atmosphere Watch Programme

4.3(4).1 Congress noted the development of the GAW Implementation Plan for the period 2016-2023 (www.wmo.int/gaw). It recommended that the WMO priorities approved by Congress are taken into consideration in the development of the GAW Implementation Plan. Congress noted with pleasure that the programme development is aimed at delivery of enhanced products and services to Members through cross-cutting application areas.

4.3(4).2 Congress recognized that the GAW observing network continues to play an important role as a tool underpinning research and service delivery. Congress noted that substantial regional gaps still exist in this network. It urged Members to establish stations or provide resources to cover those spatial gaps with observations. Congress encouraged Members to extend observational programmes at active stations to include more parameters related to atmospheric composition, including those currently only performing meteorological observations. Congress stressed that GAW observations contribute to the WMO Integrated Global Observing System (Cg-17/Doc. 4.2.1(2)) and that the network evolution should follow the Rolling Review of Requirements process. Congress invited Members to provide contributions to trust funds dedicated to supporting GAW in developing countries.

4.3(4).3 Congress recognized that much better integration between ground-based, aircraft and satellite observations using comprehensive modelling tools is required to address atmospheric composition application areas. Congress acknowledged contributions of the In-service Aircraft for a Global Observing System (IAGOS) project to atmospheric composition observations for the past 20 years and appreciated the link established between IAGOS and the global Aircraft Meteorological Data Relay (AMDAR) programme for near real-time chemical data delivery. Congress requested Members to contribute with aircraft observations to the GAW Programme using the quality assurance principles laid down in the Programme. Congress urged Members involved in the operation of satellites to take into consideration the needs for atmospheric composition observations and encouraged them to share data with minimal delays. Congress encouraged Members to get more actively involved in atmospheric composition and deposition modelling coordinated through the GAW Programme to tackle environmental issues.

4.3(4).4 Congress took note of the decline in data submission of several GAW parameters and it urged Members to submit observational data to WMO Data Centres in a timely fashion, as specified in the GAW Implementation Plan. Congress appreciated efforts of Members supporting WMO/GAW World Data Centres. Congress noted that the GAW Station Information System (GAWSIS, <http://www.meteoswiss.ch/gawsis>) supported by MeteoSwiss will in the future distinguish active from silent stations based on their data submission status as outlined in the GAW Implementation Plan. GAWSIS with all its contributing data centres also supports the WIGOS platforms. Congress appreciated the efforts of the GAW Expert Team on World Data Centres to link metadata and data collected within GAW to the WMO Information System (WIS).

4.3(4).5 Congress noted that several applications require near real-time data submission. Congress requested Members to ensure that observations are made available with minimum delay

for such applications (such as atmospheric composition forecast verification and data assimilation in numerical weather prediction (NWP)).

4.3(4).6 Congress noted that GAW established an ad hoc team to review user requirements for atmospheric composition and related needs for satellite measurements following a request made by Cg-XVI (abridged final report, paragraph 3.2.3). Congress appreciated the proposed substitution of the “atmospheric chemistry” application area with more specific application areas related to “atmospheric composition forecasting”, “atmospheric composition analysis and monitoring” and “urban services”. Congress agreed that atmospheric composition observations are required in a number of WMO application areas (<http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html>), including Global NWP, high resolution NWP, Nowcasting and Very Short -Range Forecasting, subseasonal to longer predictions, aeronautical meteorology, agricultural meteorology and climate applications.

4.3(4).7 Congress stressed that increased modelling capacity is required in GAW to address different applications areas. Congress supported the recommendation of the Environmental Pollution and Atmospheric Composition Scientific Steering Committee (EPAC SSC) to extend the scope of the GAW Expert Team on Near-real-time Chemical Data Transfer to cover atmospheric composition forecasting on regional and global scales. Congress agreed that the revised group will be referred to as the Scientific Advisory Group on Near-Real-Time applications.

4.3(4).8 Congress noted that changes in atmospheric composition have numerous two-way links with agriculture. Congress urged Members to establish joint activities between agrometeorological and GAW activities, especially in the context of the agriculture and food security priority area of the Global Framework for Climate Services [*see Cg-17/Doc. 3.1(6)*].

4.3(4).9 Congress encouraged stronger collaboration between GAW, the World Weather Research Programme (WWRP) and the World Climate Research Programme (WCRP) in addressing cross-cutting applications. Congress stressed that model based services can benefit substantially from integrated atmospheric composition modelling especially when addressing high impact weather and climate events and related air pollution episodes. Congress agreed that the Working Group on Numerical Experimentation (WGNE), established by the Commission for Atmospheric Sciences and WCRP, provides an ideal platform to foster such collaboration. Congress appreciated the ongoing collaboration between WWRP and GAW on WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) and GAW Urban Research Meteorology and Environment (GURME) project. Congress requested that similar joint research be undertaken in support of the development of biomass burning services [*Cg-17/Docs. 4.3(1), 4.3(3) and 4.3(5)*].

4.3(4).10 Congress recognized that the rapid urbanization currently taking place requires new types of services making best use of science and technology. Congress appreciated the contribution of GURME projects to urban services. Congress encouraged Members to establish GURME pilot projects in those areas with potential high exposure of the population to air pollution. GURME and urban related cross-cutting activities with WHO, and other programmes are reflected under items 4.3 and 9 [*Cg-17/Docs. 4.3(5) and 9.8*].

4.3(4).11 Congress noted the on-going development of the Implementation Plan for an Integrated Global Greenhouse Gas Information System (IG³IS) (see: www.wmo.int/gaw). Congress agreed that IG³IS can become an important science-based tool for independent quantification of GHG sources and sinks, both natural and anthropogenic, delivering actionable information to help Members understand and manage greenhouse gas budgets on enhanced temporal and spatial scales. Congress further noted that the implementation of IG³IS can provide new and innovative services in support of the Global Framework on Climate Services (GFCS). Congress urged Members to undertake efforts related to the development of observational networks and modelling

tools in support of IG³IS. Congress requested Members to report by the next Congress on the efforts undertaken in this direction in individual countries and regions. To this end Congress adopted Resolution 4.3(4)/1 (Cg-17) – Integrated Global Greenhouse Gas Information System.

4.3(4).12 Congress recognized that aerosol observations and analysis are critical for weather, climate, human health and aviation security. Congress encouraged Members to take note of the recommendations made in GAW Report No. 207 “Recommendations for a Composite Surface-Based Aerosol Network”. It requested Members to establish observations that allow estimates of aerosol parameters following GAW recommendations. Congress appreciated developments of the GAW Lidar Observational Network (GALION) especially in support of volcanic ash observation [Cg-17/Doc. 3.1(2)] and verification of satellite products. Congress welcomed the important steps taken by EARLINET and the EUMETNET E-PROFILE programme towards an integrated monitoring approach and operational use of ceilometer and lidar data in Europe. Congress encouraged stronger collaboration between GAW and other aerosol observation networks seeking synergies and complementarities to enhance specific model and satellite atmospheric applications.

4.3(4).13 Congress acknowledged, in view of the IPCC AR5 report, the importance of aerosols and reactive gases (NO_x, VOCs, tropospheric ozone) as short-lived climate forcers/pollutants (SLCFs/SLCPs). Congress urged Members to undertake observations of SLCF in their countries. Congress noted that WMO has joined the Climate and Clean Air Coalition (CCAC) as a partner. Congress reminded that WMO could participate in a number of relevant initiatives, in particular through provision of observations of SLCFs, and to nominate a person for the roster of the Scientific Advisory Panel.

4.3(4).14 Congress appreciated the publication of the Global Precipitation Chemistry Assessment. Congress agreed that total atmospheric deposition is a more critical parameter for understanding biogeochemical cycles and ecosystem effects than wet deposition alone. Congress encouraged Members to take further steps in developing their capacity to observe and model total atmospheric deposition. Congress supported the recommendation of EPAC SSC to extend the scope of the GAW Scientific Advisory Group on Precipitation Chemistry to cover total deposition. Congress agreed with the proposed change of name of this expert group to the Scientific Advisory Group on Total Atmospheric Deposition (SAG-TAD).

4.3(4).15 Congress noted the activities of Working Group 38 (Atmospheric Input of Chemicals to the Ocean) of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) of the United Nations. Congress highlighted that collaboration within GESAMP is very important in the context of total atmospheric deposition analysis. Congress confirmed that WMO will continue sponsorship of WG 38 and encouraged Members to contribute to the WMO GESAMP Trust Fund.

4.3(4).16 Congress took note of the publication of the WMO/UNEP Scientific Assessment of Ozone Depletion and stressed the importance of long-term continuous time series of total ozone as well as vertical ozone profiles for the detection and attribution of the expected ozone recovery during coming decades. Congress urged Members to maintain their observations of stratospheric ozone and other parameters relevant to ozone depletion. Congress encouraged Members to take note of the recommendations made by the Ninth Meeting of the Ozone Research Managers of the Parties to the Vienna Convention for the Protection of the Ozone Layer. Congress noted with satisfaction that the Vienna Convention Trust Fund for Research and Systematic Observations was prolonged until the end of 2020. Congress encouraged Members to contribute to this Trust Fund.

4.3(4).17 Congress recognized that future changes in surface ultra-violet (UV) radiation, that have potential detrimental and beneficial impacts on human health and the environment, depend on other factors in addition to ozone, such as cloud cover and type, surface albedo and

atmospheric aerosol load. Congress therefore requested Members to include observations of parameters that influence surface UV radiation in their programmes. Congress urged GAW to make such data available in a format appropriate for medical and biological users. Congress recommended that Members should ensure participation in intercomparison campaigns to improve data quality in the global GAW UV network. Congress recommended that Scientific Advisory Group on UV Radiation (SAG UV) should address the growing issue of low levels of UV radiation in many populated areas in the world by working jointly with other organizations such as World Health Organization (WHO) and International Commission on Illumination (CIE).

4.3(4).18 Congress recognized that quality assurance and quality control (QA/QC) of observational data constitutes one of the cornerstones of high-quality product delivery and that GAW has established a WMO benchmark in this regard. Congress requested Members to implement the *WMO Quality Management Framework* (WMO-No. 1100) for atmospheric composition measurements. Congress appreciated Members efforts that support GAW Central Facilities in their countries. Congress noted the increasing cooperation with the International Bureau of Weights and Measures (BIPM) and appreciated the involvement of the GAW community in BIPM activities through joint workshops and projects.

4.3(4).19 Congress appreciated the efforts on capacity development and collaboration activities by Finland, France, Germany, Spain and the United States of America, especially in relation to observational capacity building in South America, Africa and Asia. Congress noted with satisfaction the contribution of Switzerland in the global observational capacity development through the Capacity Building and Twinning for Climate Observing Systems (CATCOS) project. Congress encouraged Members with advanced capacity to enter into partnerships with less developed Members to address the gaps in observational networks.

4.3(4).20 Congress expressed its appreciation to Germany for their efforts since 2001 in support of the GAW Training and Education Centre (GAWTEC). Congress recognized that this training plays an important role in the building of GAW-related technical expertise of Members and in establishing international networks among experts. Congress encouraged Members to take advantage of GAWTEC training and it invited WMO Regional Training Centres to consider the hosting training courses on atmospheric composition.

4.3(4).21 Congress expressed its satisfaction with the number and quality of GAW publications and with the timely preparation of the annual Greenhouse Gas Bulletin that provides important science-based evidence on the fundamental causes of climate change. Congress appreciated the publication of the WMO Antarctic Ozone Bulletins during the Antarctic ozone hole season and urged Members to support this publication through data submission and analyses. Congress noted the publication of the Aerosol Bulletin in 2013 and urged the GAW community to pursue its continuation. Congress appreciated the publication of the special brochure dedicated to the celebration of the [25th anniversary](#) of GAW highlighting the achievements of the Programme. Congress recommended that more publications in support of WMO application areas related to atmospheric composition be delivered by the GAW Programme.

4.3(4).22 Congress took note that GAW research initiatives of a cross-cutting nature with WCRP and WWRP are reflected in more detail in subsequent section below.

4.3(4).23 CONGRESS ADOPTED RESOLUTION 4.3(4)/2 (CG-17) THAT REFLECTS MAJOR ASPECTS OF THE GAW PROGRAMME.

APPENDIX B: DRAFT RESOLUTIONS

Draft Resolution 4.3(4)/1 (Cg-17)

INTEGRATED GLOBAL GREENHOUSE GAS INFORMATION SYSTEM (IG³IS)

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

- (1) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1128),
- (2) The Global Framework for Climate Services (GFCS) is one of the WMO priorities,
- (3) The United Nations Framework Convention on Climate Change,

Noting further:

- (1) That the Intergovernmental Panel on Climate Change in its fifth Assessment Report recognized emissions of greenhouse gases as the major driver of climate change,
- (2) The responsibility of the WMO and other ~~associated~~ relevant bodies within the United Nations system to provide the authoritative scientific voice on the state of weather, climate, hydrology and water resources and related environmental issues,
- (3) That the Global Atmosphere Watch Programme coordinates observations and analysis of greenhouse gases in the atmosphere globally,
- (4) That greenhouse gases, aerosols and ozone are designated “Essential Climate Variables” established by Global Climate Observing System (GCOS) in support of the UNFCCC and that the GAW Global CO₂, CH₄ and N₂O monitoring networks are recognized by GCOS as comprehensive (and a subset as baseline) networks by GCOS,
- (5) That there is a growing need for actionable information to understand and manage greenhouse gas budgets on enhanced temporal and spatial scales and the Integrated Global Greenhouse Gas Information System (IG³IS) would address this need,

Requests Members:

- (1) To give all possible support to the development, improvement and modernization of networks for observations of greenhouse gases and co-emitted species;
- (2) To carry out greenhouse gas observations in accordance with GAW quality assurance principles;
- (3) To ensure submission of observational data as well as metadata to the dedicated WMO/GAW Data Centre as well as GAWSIS within the period of time required to

support IG³IS as will be documented in the specification of requirements through WIGOS and its OSCAR/Requirements catalogue;

- (4) To cooperate on development of modelling tools for inverse modelling and anthropogenic greenhouse gas flux attribution;
- (5) To collaborate with organizations and institutions that address the carbon budget of biosphere and ocean;

Requests the president of the Commission for Atmospheric Sciences:

- (1) To encourage Members of the Commission to support implementation of IG³IS;
- (2) To stimulate and coordinate research and development activities and studies of carbon cycles to increase potential benefits of IG³IS implementations for WMO Members;
- (3) To work together with other WMO technical commissions on implementation of IG³IS;

Requests regional associations to implement IG³IS on a regional scale;

Requests the Executive Council:

- (1) To take, within available budgetary resources, all necessary actions towards the fullest possible implementation of IG³IS as a tool supporting GFCS and GFCS Implementation Plan in accordance with the WMO strategic and operational plans;
- (2) To support the work of CAS in the development of IG³IS.

Requests the Secretary-General:

- (1) To take all necessary actions, within available budgetary resources, for the implementation of IG³IS;
 - (2) To assist Members implementing IG³IS, 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;
 - (3) To take all necessary actions to develop and maintain WMO collaboration in matters related to the carbon cycle with relevant organizations, agencies, groups and institutions, such as the Food and Agriculture Organization (FAO), the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Group on Earth Observations (GEO).
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Draft Resolution 4.3(4)/2 (Cg-17)

GLOBAL ATMOSPHERE WATCH PROGRAMME

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

- (1) The *Abridged Final Report with Resolutions and Recommendations of the Sixteenth Session of the Commission for Atmospheric Sciences* (WMO-No. 1128),
- (2) Resolution 10 (Cg-XVI) – Global Atmosphere Watch Programme,
- (3) Resolution 15 (Cg-XV) – Stratospheric Ozone Observations,
- (4) The WMO Strategic Plan,
- (5) 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 (UN-ECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) and other environment-oriented conventions,

Noting further:

- (1) The heightened public awareness and concerns for global, regional and local climate, weather and environmental issues in general,
- (2) The responsibility of the WMO and other ~~associated~~ [relevant](#) bodies within the United Nations system to provide the authoritative scientific voice on the state of weather, climate, hydrology and water resources and related environmental issues,
- (3) The central role played by the atmosphere in environmental issues, such as, the global increase of greenhouse gases and their impact on climate, effects of aerosols on weather, climate and human health, stratospheric ozone depletion and related increase in ultraviolet radiation, long range pollutant transport, urban and regional air quality, atmospheric deposition and its impact on biogeochemical cycles,
- (4) The increasing demand by numerical weather prediction (NWP) research and operations for integrating aerosols, ozone and other atmospheric compounds to improve forecasting accuracy as well as enhance products and services,
- (5) The development of the WMO Global Atmosphere Watch (GAW) Programme towards a “science for services” concept,
- (6) That the focus of the GAW is primarily on greenhouse gases, ozone, UV, aerosols, selected reactive gases and atmospheric deposition,
- (7) The need for cross-cutting applications, including biomass burning, volcanic ash transport, sand and dust storms, services for agriculture and biological systems, and urban services,

- (8) The potential of the National Meteorological and Hydrological Services (NMHSs) to contribute substantially to integrated observations and modelling activities, as they are well positioned through their capacities to observe, do research including development and application of models, operationalize, verify/validate, disseminate and reach out,
- (9) That changes in air pollution, climate and the biogeochemical cycles of trace components in the atmosphere, such as carbon and nitrogen containing compounds, give rise to environmental problems that are often strongly affected by meteorological processes,
- (10) That the links between air quality, climate, extreme weather events are not well quantified and need further research to underpin those links,

Requests Members:

- (1) To support current observations for sufficiently long periods to allow for trend analysis, support of conventions and climatological studies and upgrade the elements of the observing system which are out of date;
- (2) To give all possible support to the further development of the observational component of GAW as a contribution to WIGOS especially in data sparse regions and to support application areas that require atmospheric composition observations utilizing ground based and satellite platforms, including implementation of multi-component measurements;
- (3) To carry out observations in accordance with the GAW quality assurance principles;
- (4) To ensure submission of observational data and metadata to dedicated WMO/GAW Data Centres and GAWSIS within the agreed period of time as specified in the GAW Implementation Plan to support WMO publications, Bulletins and Assessments;
- (5) To progressively implement near real-time data exchange in support of selected applications, including verification of atmospheric composition forecasts, satellite observations, assimilation in NWP and process studies;
- (6) To contribute research efforts for improved understanding of physical, chemical, dynamical, radiative, biospheric and human factors controlling variability of atmospheric composition;
- (7) To undertake modelling studies of atmospheric composition past and future changes in relation to changing meteorology and emissions and taking into consideration feedbacks in the Earth System;
- (8) To give all possible support to the implementation of GURME pilot projects as research contributions towards integrated urban services;
- (9) To contribute to trust funds related to GAW activities;
- (10) To support training activities related to atmospheric composition;

Requests the president of the Commission for Atmospheric Sciences (CAS):

- (1) To encourage Members of the Commission to participate in and contribute to GAW and to trust funds related to its activities;

- (2) To encourage and coordinate research and development activities and studies to increase the value of environmental prediction for the benefit of WMO Members;
- (3) To support the work of the CAS Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee;
- (4) To work closely with the other WMO technical commissions on issues of joint interest;

Requests regional associations:

- (1) To encourage Members to participate in and contribute to GAW activities in the Regions;
- (2) To encourage Members to support calibration and training facilities related to atmospheric composition in the Regions;
- (3) To support regional GURME activities;

Requests the Executive Council:

- (1) To take, within available budgetary resources, all necessary actions towards the fullest possible implementation of GAW, in accordance with the WMO strategic and operational plans;
- (2) To support the work of CAS and other bodies concerned in the development of GAW and joint GAW-related cross-cutting activities.

Requests the Secretary-General:

- (1) To take all necessary actions, within available budgetary resources, for the implementation of the GAW Programme;
- (2) To support cross-cutting modelling activities within GAW and joint activities with other research programmes and to assist Members from developing nations in building their capabilities to participate in these activities;
- (3) To assist Members participate in GAW, particularly developing Member countries, by facilitating the training and exchange of scientists, and the provision of guidance and services, as required, within available budgetary resources;
- (4) To take all necessary actions to develop and maintain WMO collaboration in matters of atmospheric composition and related physical parameters through GAW with relevant organizations, agencies, groups and institutions, such as the Food and Agriculture Organization (FAO), the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), European Union (EU), the Group on Earth Observations (GEO) and the International Council for Science (ICSU).

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