Commission for Atmospheric Sciences

Sixteenth session

Antalya, Turkey
20–26 November 2013

Abridged final report with resolutions and recommendations

World Meteorological Organization
Weather • Climate • Water

WMO-No. 1128

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GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING OF THE SESSION (agenda item 1)

1.1 The sixteenth session of the Commission for Atmospheric Sciences (CAS) was held in Antalya, Turkey, from 20 to 26 November 2013. The session venue was the Rixon Downtown Hotel, Antalya. The opening ceremony took place at 10.00 a.m. on Wednesday, 20 November 2013.

1.2 Dr Michel Béland, president of CAS, welcomed the participants to the sixteenth session of the Commission and opened the meeting by introducing the distinguished members of the platform committee, Mr Ismail Günes, Director General of the Turkish State Meteorological Service (TSMS) and Permanent Representative of Turkey with WMO; Mr Jerry Lengoasa, Deputy Secretary-General of WMO; and Dr Lütfi Akca, Undersecretary of Ministry of Forestry and Water Affairs. A complete list of participants is given in the appendix to the present report.

1.3 Dr Béland expressed his thanks to the Government of Turkey and TSMS for hosting the meeting and for the excellent arrangements that would ensure the success of the session.

1.4 Mr Günes underlined the importance of accurate and reliable weather and related services in support of the safety of life and property and for enhancing the quality of the life of citizens. Mr Günes provided an overview of investments that the TSMS has made in observational systems, the integration of data from various sources and in using new communication techniques to ensure end users can optimally benefit from services and products. He also highlighted the regional and global contributions of TSMS within the WMO context and the benefits of such involvement to NMHSs. He expressed his belief that NMHSs can make substantial contributions to societal needs and that Members should take on related challenges.

1.5 Mr Jerry Lengoasa, Deputy Secretary-General of WMO, expressed his appreciation on behalf of WMO to the Turkish Government and in particular to the TSMS for the excellent facilities and support to the meeting, including for the technical conference “Responding to the Environmental Stressors of the 21st Century”, held from 18–19 November 2013 in the same venue. He commended the role of the TSMS as a WMO Regional Training Centre. Several scientific experts from around the world have benefitted from this training in a wide range of fields relevant to the mandate of WMO. WMO and its Members were grateful to TSMS and its staff for the continuous support to WMO Programmes and activities.

1.6 Mr Lengoasa extended his gratitude to Dr Béland, for his leadership of the Commission and for the work accomplished during the intersessional period since the fifteenth CAS session, held in the Republic of Korea in November 2009. He also thanked the Management Group, the two Joint Scientific Committees (JSCs) of CAS and all contributing experts in the various working groups, scientific advisory committees and expert teams. He acknowledged with thanks the participation of the representatives of WMO Members, partner organizations and the delegates to the meeting.

1.7 Mr Lengoasa emphasized the fact that the Commission benefited from the insights and wisdom of a large pool of scientific experts from Members. Collectively, these experts have made a substantial contribution towards advancing atmospheric sciences and, in particular, through the work of the World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW) Programme.

1.8 Mr Lengoasa highlighted that the sixteenth session of CAS was taking place at a very challenging and interesting time in our history. The global population has surpassed the seven billion mark and we now have half of the population living in urban environments, a growing tendency, which will result in new and an increasing number of megacities around the world. The need to optimize the use of resources and energy, and to protect our environment, has become central to a sustainable future. Humanity is becoming more vulnerable to the extremes of weather and climate and the evidence that humans are responsible for our changing climate is stronger

than ever before. New and improved weather, climate and related services based on sound scientific data and principles are crucial for the future.

1.9 In conclusion, the Deputy Secretary-General encouraged the delegates, through their deliberations, to ensure strong links between the work of the Commission and the priorities of WMO for the 2016–2019 financial period as they emerge. He stated that this is particularly relevant now that research is recognized as an important enabler to ensure tangible benefits under the priorities of WMO.

1.10 Dr Akca welcomed all the participants on behalf of the Government of Turkey. He highlighted the relevance of the discussions at the session in light of the very recent tremendous damage and loss of life in the Philippines caused by typhoon Haiyan and expressed his deep sorrow to the delegation of the Philippines on behalf of the people of Turkey. Dr Akca added that it was a pleasure to be host to delegates of CAS from different countries and cultures coming together for a common goal: serving humanity by minimizing the risk caused by extreme atmospheric and environmental conditions and to ensure a sustainable world for future generations. He emphasized the importance of a global conscience and cooperation to achieve this. In conclusion Dr Akca wished the commission a fruitful session.

2. ORGANIZATION OF THE SESSION (agenda item 2)

2.1 Consideration of the report on credentials (agenda item 2.1)

In accordance with General Regulations 20 to 23, the Commission noted and approved the report of the representative of the Secretary-General as the first report on credentials.

2.2 Adoption of the agenda (agenda item 2.2)

The proposed annotated agenda, as contained in CAS-16/Doc 2.2(2), was adopted without amendments on the understanding that, at any time during the session, additions or alterations could be made.

2.3 Establishment of committees (agenda item 2.3)

In accordance with Regulations 23 to 32, the session decided to establish a Nomination Committee and a Coordination Committee. The Nomination Committee comprised Dr Jörg Klausen (chairperson, Switzerland) and the principal delegates from the following Members of the Commission: Canada, Japan and South Africa. The Coordination Committee comprised the president of the Commission, the representative of the Secretary-General and a representative of the host country and the chairpersons of the Joint Scientific Committees on Environmental Pollution and Atmospheric Chemistry and the World Weather Research Programme complemented by invited members as required. The commission agreed that the work of the session would be carried out in plenary. General Plenary would be chaired by the president of the Commission and consider agenda items 1, 2, 3, 4.1, 6.1, and 9 to 14 while the chairperson of the JSC World Weather Research Programme, Dr Brunet would chair items 5 and 8.1 and Prof Hov, chairperson of the Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry, would chair items 7 and 8.2. In addition, Dr Andy Brown was requested to chair item 4.2 and Prof Carmichael item 6.2.

2.4 Other organizational matters (agenda item 2.4)

The session agreed on the working hours of the session. It was agreed that minutes of plenary meetings were not required in view of the technical nature of discussions. In accordance with Regulation 3, the Commission agreed to suspend for the duration of the whole session Regulation 110.

3. ACTIVITIES AND PROGRESS SINCE THE FIFTEENTH SESSION OF THE COMMISSION (agenda item 3)

3.1 Report by the president of the Commission (agenda item 3.1)

3.1.1 The Commission accepted the report of the president of CAS, Dr Michel Béland noting the considerable progress in the intersessional period on the priorities identified at CAS-XV. In particular, it acknowledged the initiatives of the Commission in fostering new activities aligned to the five vision papers that formed the basis of identifying priorities in the intersessional period:

(a) Strengthening and promoting the links between climate, weather, water and environmental prediction and services and promoting these concepts under the Global Framework for Climate Services (GFCS);

(b) Enhanced regional prediction systems through very high resolution modelling systems supported by new observing systems and data assimilation, parameterization, numerical and verification techniques;

(c) Enhanced environmental (chemistry) observations, predictions and service delivery through near real-time delivery of chemical observations, and links with the WMO Information System (WIS) and the WMO Integrated Global Observing System (WIGOS), and new emphasis on improved greenhouse gas information systems and the needs of urban environments;

(d) The launch of the Polar Prediction Project in support of the Global Integrated Polar Prediction System (GIPPS) under the EC Panel of Experts on Polar Observations, Research and Services (EC-PORS) as a legacy to the International Polar Year (IPY) and THe Observing system Research and Predictability EXperiment (THORPEX) after its conclusion in 2014;

(e) Enhanced ocean related cooperation related to weather and climate which is also central to the newly launch sub-seasonal to seasonal (S2S) project, jointly between the World Climate Research Programme (WCRP) and the World Weather Research Programme (WWRP) including THORPEX, the ongoing participation in the Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP) and growing emphasis on coupling between the components of the earth system in modelling and prediction systems.

3.1.2 The Commission appreciated the active involvement of the president in THORPEX, especially so as to ensure a smooth transition that will build on the achievements of the experiment after its conclusion at the end of 2014. The Commission noted the constructive guidance provided by the president and the CAS Management Group on the three legacy projects, namely the Sub-seasonal and Seasonal prediction project (S2S), the Polar Prediction project (PPP), both in partnership with the WCRP, and more recently, the High Impact Weather prediction project (HIW).

3.1.3 The Commission noted the active involvement of CAS, facilitated through its president, in the establishment of the GFCS and in particular by ensuring recognition of the contributions of CAS through WWRP and the Global Atmosphere Watch (GAW) Programme, towards observation and monitoring, and research, modelling and prediction pillars of the framework. It further acknowledged the S2S, PPP and proposed the Integrated Greenhouse gas Information Systems (IGIS) as substantial contribution to enhanced climate services under the framework.

3.1.4 The Commission valued the contributions of its president towards better coordination of the activities of the CAS with other technical commissions and regional associations. The Commission acknowledged that the growing number of Research and Development Projects (RDPs) and Forecast Demonstration Projects (FDPs) provide a bottom-up mechanism through which regional research needs can benefit from the engagement of CAS and in particular the WWRP. The Global Atmosphere Watch Training and Education Centre (GAWTEC) training

opportunities kindly supported by Germany and the regional initiatives of the GAW Urban Research Meteorology and Environment (GURME) Programme provide similar bottom-up opportunities from which Members can benefit in terms of GAW.

3.1.5 The Commission noted the ongoing focus its president placed on gender balance in the working structures of CAS and in the provision of gender statistics to track progress. The Commission acknowledged that some progress has been made but reminded itself that ongoing efforts are required to ensure that the Commission and its activities will draw benefits from the growing number of world-renowned female scientists active in atmospheric sciences.

3.1.6 The Commission also noted the progress reported by the president on the key areas entrusted to him at CAS-XV, namely: (1) implementation and successful completion of the Year of the Tropical Convection project; (2) extension of capacity-building programmes to the developing countries showing real evidence of progress and achievement; (3) elevation of the JSC-WWRP to a status of international respect and recognition, noting that the changes in the terms of reference and the proposed review will assist in this regard; (4) evidence of real progress from the implementation of a joint strategy in hydrometeorology that cuts across relevant programmes of this and other Commissions; (5) implementation of a comprehensive initiative in air quality involving all programme areas of the Commission including regional aspects; and (6) evidence of progress in strengthening the governance arrangements of the Commission, particularly in relation to broader participation and gender equity and the preparation of plans that include expected results and performance indicators for consideration at the next session.

3.1.7 The Commission extended its appreciation to the president for his dedication and wise leadership to CAS over the past eight years.

3.2 Report by the Director of the Atmospheric Research and Environment Branch of the Research Department (agenda item 3.2)

3.2.1 The Commission noted the report of the Director of Atmospheric Research and Environment (ARE) Branch of the WMO Research Department (RES) which highlighted the close collaboration and the complementary roles between the Commission and the Secretariat. The Commission appreciated that the collaboration had contributed towards significant progress in the World Weather Research Programme (WWRP) including THe Observing system Research and Predictability EXperiment (THORPEX) and the Global Atmosphere Watch (GAW) Programme including the GAW Urban Research Meteorology and Environment (GURME) project since CAS-XV.

3.2.2 Considering the overall strategic direction of WMO, the Commission noted with appreciation the promotion and implementation of CAS-related activities linked to the five WMO strategic priorities for the current financial period. Three of these priorities, the Global Framework for Climate Services (GFCS), WMO Integrated Global Observation System (WIGOS) and Disaster Risk Reduction (DRR) have a special relevance to CAS, and specifically in terms of:

(a) The joint WWRP - World Climate Research Programme (WCRP) Sub-seasonal to Seasonal Prediction Research Project (S2S);

(b) The WWRP Polar Prediction Research Project (PPP) which has strong links with the WCRP Polar Climate Predictability Initiative;

(c) The development of the Integrated Greenhouse Gas Information System (IGIS);

(d) The new initiative on megacities and large urban complexes;

(e) The new project on high impact weather focusing on improving short timescales and high-resolution forecasts.

3.2.3 The Commission acknowledged with satisfaction the support provided by the Secretariat to the activities and meetings of the CAS Management Group, the Joint Scientific Committee of the Open Programme Area on Environmental Pollution and Atmospheric Chemistry (JSC OPAG EPAC), the Joint Scientific Committee of the World Weather Research Programme (JSC WWRP) and the Working Groups, Expert Teams and Science Advisory Groups (SAGs).

3.2.4 The Commission was informed that the Secretariat was committed to ensuring that relevant components of the THORPEX working groups are included in the future WWRP structure to continue the research momentum achieved through THORPEX after its conclusion in 2014.

4. PROGRESS AND FUTURE DIRECTION OF THE WORLD WEATHER RESEARCH PROGRAMME (agenda item 4)

4.1 Report by the chairperson of the Joint Scientific Committee for the Open Programme Area Group on the World Weather Research Programme (agenda item 4.1)

4.1.1 The Commission acknowledged the report of the chairperson of JSC OPAG-WWRP, Dr Gilbert Brunet, on the activities of the WWRP aligned to the *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (WMO/TD-No. 1505). The report highlighted the long-term objectives of the WWRP:

(a) To improve public safety and economic productivity by accelerating research on the prediction of high-impact weather;

(b) To demonstrate improvements in the prediction of weather, with emphasis on high-impact events through the exploitation of advances in scientific understanding, observational network design, data assimilation and modelling techniques and information systems;

(c) To improve understanding of atmospheric processes of importance to weather forecasting through the organization of focused research programmes (e.g., WWRP Strategic Plan, RDPs);

(d) To encourage the utilization of relevant advances in weather prediction systems to the benefit of WMO Programmes and Members (e.g., FDPs);

(e) To maintain a strong focus on training opportunities for young scientists, in particular from developing countries, to encourage more countries to contribute to and benefit from the research advances.

4.1.2 The Commission acknowledged the contributions and dedication of the chairperson of the JSC OPAG-WWRP, JSC members, as well as the chairpersons and members of the WWRP Working Groups and Expert Teams, for their significant accomplishments in WWRP since CAS-XV in 2009 (Incheon, Republic of Korea). These working groups and expert teams cover a wide field of expertise relevant to assessing the status of weather modification techniques, enhancing systematically the scientific understanding and improving the predictive skill of weather phenomena, especially on high impact events, and establishing scientific procedures to evaluate forecasts, and ensure socio-economic use.

4.1.3 The Commission noted the development, implementation or conclusion of a number of Research and Development Projects (RDPs) and Forecast Demonstration Projects (FDPs) such as the Lake Victoria and La Plata Basin RDPs focusing on convection, lake and topographic effects; Typhoon Landfall FDP and North Western Pacific Tropical Cyclone Ensemble Forecast Project focusing on the testing and use of new experimental multi-model ensemble forecast products; the Southern China Monsoon Rainfall Experiment targeting heavy rainfall events including that from embedded mesoscale systems. Further achievements include testing and refining winter weather

nowcasting techniques during Science and Nowcasting of Olympic Weather for Vancouver 2010 (SNOW V-10) FDP/RDP for the Vancouver Winter Olympic Games and for Forecast and Research: the Olympic Sochi Testbed (FROST-2014) FDP/RDP for Sochi Winter Olympic Games in 2014 for which high resolution modelling is also planned, and the Integrated Nowcasting through Comprehensive Analysis - Central Europe (INCA-CE) Nowcasting FDP for public safety and risk management in Central Europe.

4.1.4 The Commission noted the "Statement on Tropical Cyclones and Climate Change" by the Working Group on Tropical Meteorology Research (WGTMR) Expert Team on Climate Change Impacts on Tropical Cyclones, the Bulletin of the American Meteorological Society (BAMS) publications on Earth-system prediction, the text books Global Perspectives on Tropical Cyclones and Global Monsoon System, as well as guidance documents on evaluating cloud and related parameters and verification of tropical cyclone forecasts. The WWRP Working Group on Societal and Economic Research and Applications (WG SERA) participated in the WMO Forum: Social and Economic Applications and Benefits of Weather, Climate and Water Services and is contributing to the publication of a book to quantify the socio-economic value of NMHSs.

4.1.5 The Commission further noted the various international workshops, symposiums and conferences, organized by WWRP, as contributions to capacity development and to promote global scientific debate. The topics in these events covered tropical cyclones, the monsoon systems, weather modification, forecast verification, data assimilation, nowcasting, and sand and dust storm processes.

4.1.6 The Commission acknowledged the progress in the WWRP current and planned activities and recognized its maturity into a well-established global research initiative. The Commission supported the growing cooperation between WWRP and other WMO co-sponsored Programmes, including the World Climate Research Programme (WCRP), the Global Atmosphere Watch (GAW) Programme, as well as with other international organizations. The activities include the implementation of the THORPEX legacy projects (Sub-seasonal to Seasonal Prediction Project and the Polar Prediction Project) and the development of new RDPs/FDPs, e.g. for the 2018 Winter Olympic Games to be held in the Republic of Korea. The Commission also noted preparations for the World Weather Open Science Conference to be held in Montreal, Canada, 16–21 August 2014.

4.1.7 The Commission acknowledged the development of the implementation plan now in progress by the Task Force of the High-impact Weather Project, as the third THORPEX legacy project, whose scope and limits are being defined by a set of weather-related hazards and corresponding applications and which is covering predictions from minutes to the weekly timescale complemented by a strong socio-economic application component.

4.2 World Weather Research Programme focus areas and activities (agenda item 4.2)

4.2.0.1 The Commission noted the progress in the implementation of the WWRP activities in accordance with the *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (WMO/TD-No. 1505). The Commission acknowledged the role of the WWRP in advancing societies' ability to cope with high impact weather through research focused on improving the accuracy, lead time and utilization of weather predictions. The Commission also noted the proactive steps being taken within the WWRP to ensure a smooth post-THORPEX transition at the end of 2014, which will strengthen the WWRP through capitalizing on the research momentum achieved within THORPEX. The Commission supported the actions taken to strengthen cooperation with the WCRP, GAW and other WMO Programmes and initiatives such as the Severe Weather Forecast Demonstration Project (SWFDP) to ensure better integration of research and to optimize the operational benefits that can be derived from mature research results.

4.2.0.2 The Commission was pleased to note that preparation for the World Weather Open Science Conference (OSC), scheduled to be held from 16 to 21 August 2014 in Montreal, Canada is proceeding well and that an International Organizing Committee (IOC) and sub-structures have

been established with broad international representation. The Commission noted that the overarching theme of the OSC is the Seamless Prediction of the Earth System: from minutes to months; that a strong focus will be placed on applications in key sectors and on the active involvement of early career scientists, especially those from developing countries.

4.2.1 Nowcasting research and mesoscale forecasting research

4.2.1.1 The Commission noted the progress, following a recommendation of EC-LXII, to consider a WWRP Research and Development Project (RDP) for the Lake Victoria Watershed that would include a test-bed for field campaigns to collect data for research to understand the dynamics over the lake in order to reduce disaster from water spouts, waves and wind gusts that affect both lake transport and fishermen who rely on the lake for their livelihoods. The project plan proposes an extensive field programme, participation of local weather services and the broad international research community, to develop a nowcasting and predicting system for the East African region, and to validate a tailored nowcasting system appropriate for East Africa. It aimed to demonstrate, in collaboration with the SWFDP for East Africa, how the provision of enhanced warning services over Lake Victoria will lead to greater safety for people dependent on Lake Victoria for their livelihood. The mesoscale weather forecasting research community could also contribute to the project by implementing an extensive high-resolution modelling programme.

4.2.1.2 The Commission noted with appreciation the useful outcomes of the 3rd WMO International Symposium on Nowcasting and Very Short-Range Forecasting (WSN12) held in 2012 in Rio de Janeiro (Brazil), attended by 166 participants from 21 countries. The Symposium reviewed the capabilities and requirements for improved forecasts in the 0–6 hour timeframe with emphasis on forecasts of high impact weather (heavy rain, hail, lightning, high winds, snowstorms, blizzards, etc.).

4.2.1.3 The Commission noted the information from the UK Met Office regarding capability and research projects developed for the London 2012 Olympics. Applications showcased during the events included an hourly 1.5 km resolution NWP nowcast up to 12 hours ahead; a 6-hourly, 2.2 km resolution convection-permitting ensemble of 12 members processed to provide probabilistic products of temperature, wind and precipitation for the next 36 hours; daily forecasts of wind and waves for Weymouth Bay using a ⅓ km resolution atmospheric forecasting model and a ¼ km ocean wave forecasting model; and 2-hourly forecasts of UK air quality for the next 5 days. These cutting edge science capabilities were extremely well received by users.

4.2.1.4 The Commission noted that there are growing common scientific interests and activities between the Working Group on Nowcasting Research (WGNR) and the Working Group on Mesoscale Weather Forecasting Research (WGMWFR). The two working groups have jointly held several workshops and meetings in recent years. The 6th meeting of the WWRP JSC recommended merging the WGNR and WGMWFR to further strengthen the collaboration between these two working groups. The Commission agreed with this recommendation and requested the WWRP JSC to establish the joint working group on Nowcasting and Mesoscale Weather Forecasting Research (WGNMWFR) in 2014.

4.2.1.5 The Commission noted that there are several ongoing and proposed RDPs and FDPs aimed at addressing specific weather related research needs identified by Members:

(a) FDP INCA-CE (INtegrating nowCAsting with Crisis management and risk prEvention in a transnational framework) is a mesoscale research project coordinated by the Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Austria, with the participation of eight central European countries. It is aimed at reducing risks and impacts of weather-related natural disasters (e.g. windstorms, flooding, mudflows, icing, and drought) by integrating nowcasting with crisis management and risk prevention decision-making. The main purpose is to improve risk management standards and methodologies to enable management institutions and public authorities to issue more detailed risk assessments and warnings. The project includes studying of significant

societal impacts, such as developing a transnational (central Europe) strategy in road safety, civil protection and operational hydrology;

(b) RDP La Plata Basin Project is a project demonstrating the feasibility of dynamical prediction of local extreme weather using dense observation data and numerical models over shared catchments in South America. This RDP is motivated mainly by the incomplete understanding of the processes that determine severe weather events in the La Plata Basin – particularly those related with heavy precipitation – and aims at providing skilful forecasts which would contribute to minimize their impacts. La Plata Basin is a catchment covering five countries (Argentina, Brazil, Uruguay, Plurinational State of Bolivia, and Paraguay) with a total population exceeding 200 million;

(c) RDP/FDP FROST 2014, for the Winter Olympic Games in Sochi, currently in the phase of testing the real-time forecasting and nowcasting facilities to be used during the Games, is aimed to demonstrate usefulness of high-resolution deterministic mesoscale forecasts, regional ensemble prediction systems and nowcast systems for winter weather phenomena (temperature, snow levels, wind, visibility, precipitation type and intensity) in a complex terrain. The list of the project participants includes the international mesoscale modelling consortia COSMO (presented in the project by Italy, Switzerland, Germany, and the Russian Federation), ALADIN (presented by Austria), and HIRLAM (presented by Norway and Finland), the Central Institute for Meteorology and Geodynamics (Austria), Environment Canada, the National Oceanic and Atmospheric Administration of the United States of America, the Finnish Meteorological Institute, the Korea Meteorological Administration, and Roshydromet. Additional observations that are not normally available via GTS are provided for the project by several neighbourhood countries – Armenia, Turkey and Ukraine;

(d) TOkyo Metropolitan Area Convection Study for extreme weather resilient cities (TOMACS) is an international initiative focused on urban meteorology studies, including air quality. The project is targeting local high impact weather events in the Tokyo metropolitan area and will act as a test-bed for deep convection. The project is mainly led by the National Research Institute for Earth Science and Disaster Prevention (NIED) and the Japan Meteorological Agency (JMA) with international partners which include the Bureau of Meteorology (Australia), Sao Paulo University (Brazil), Environment Canada (Canada), University of Hohenheim (Germany), Pukyong National University (Republic of Korea), University Paris-Est (France), the National Center for Atmospheric Research (United States) and Colorado State University (United States).

4.2.2 Tropical meteorology research

4.2.2.1 The Commission recognized the importance of knowledge transfer, specifically on converting recent research findings to operational use. The Commission noted that the WGTMR published books and scientific articles in support of knowledge transfer and to better understand the tropical cyclones and monsoons. It also noted the WGTMR training events held on a regular basis. The Commission acknowledged that these activities benefited the early career scientists from least developed and developing countries in the tropics. It therefore recommended that these efforts be supported in the future as they contribute towards sustainable weather services in the tropics.

4.2.2.2 In view of the growing significance of the ensembles in improving forecast performance, the Commission fully supported the activities to further enhance the understanding and use of these products by forecasters.

4.2.2.3 The Commission noted with appreciation the valuable contribution of China, Japan and the United States by hosting the monsoon data activity centres.

4.2.2.4 The Commission noted the successful organization of the 7th International Workshop on Tropical Cyclones (La Réunion, France, November 2010) and 5th International Workshop on

Monsoons (Macao, China, October 2013). It also noted that these workshops contributed to the improved communication of valuable information between researchers and forecasters. The Commission recommended the continuation of these quadrennial workshop series.

4.2.2.5 The Commission noted with appreciation the actions taken on the implementation of WWRP FDPs/RDPs such as the Typhoon Landfall Forecast Demonstration Project (TLFDP), the South China Monsoon Rainfall Experiment (SCMREX), and the North Western Pacific Tropical Cyclones Ensemble Forecast Project (NWP-TCEFP) and stressed the significance of these projects in light of recent extreme weather events and their impacts on humanity. In addition, the Commission noted the ongoing planning for the not yet CAS-approved Research and Development Project "High-resolution Numerical Prediction of Landfalling Typhoon Rainfall". The project, led by the Nanjing University and the Chinese Academy of Meteorological Sciences, is ultimately geared toward improving forecasts of typhoon rainfall.

4.2.2.6 The Commission noted with appreciation that the NWP-TCEFP, a 5-year collaborative effort of the WMO Tropical Cyclone Programme (TCP) and the WWRP has provided guidance on tropical cyclone ensemble forecasts in near real-time, through the website operated by the Japan Meteorological Agency (JMA) since October 2010, to the Members of the Economic and Social Commission for Asia and the Pacific (ESCAP)/WMO Typhoon Committee Members and the SWFDP in Southeast Asia, using the THORPEX Interactive Grand Global Ensemble (TIGGE) Cyclone XML (CXML) data. The Commission was informed that the surveys by the WMO WWRP/TCP in 2011 and by GIFS-TIGGE WG in 2012 identified the Members' needs for operational use of the ensemble guidance on the website as well as their needs for more timely and sustainable provision of such ensemble guidance, including probabilistic information of surface wind speeds and precipitation. The Commission acknowledged with expectation that the project has been extended to 2015 for the investigation of tropical cyclogenesis prediction over the North Western Pacific on medium-range timescales, and encouraged JMA to enhance its research on further development of guidance on tropical cyclone ensemble forecasts.

4.2.2.7 The Commission noted that RSMC Tokyo – Typhoon Centre was planning to provide guidance on tropical cyclone ensemble forecast over the North Western Pacific in real time to the ESCAP/WMO Members, based on the success of the NWP-TCEFP project, in order to further promote the operational use of such ensemble guidance. The Commission welcomed with appreciation this initiative of RSMC Tokyo – Typhoon Centre and encouraged timely and sustainable dissemination of forecasts of ensemble prediction systems by NMCs operating global ensemble prediction systems to support such initiative.

4.2.2.8 The Commission noted that the Research and Development Project (RDP) SCMREX aimed at improving the observation of precipitation processes using new generation in-situ and remote sensing systems operated from the ground, on aircraft, and aboard satellites to shed light on the internal structure of convective clouds and their environment, and also the use of advanced high resolution modelling facilities able to resolve and represent the monsoon thermodynamics. The Commission noted with satisfaction that the field campaign phase of the project was successfully held in May 2013. The Commission looks forward to the implementation phase of the project which will be conducted during May and June 2014.

4.2.2.9 The TLFDP is a collaborative effort with the NWP-TCEFP and a complement of the Shanghai Multi-hazard Early Warning System (MHEWS) project to develop and integrate techniques to evaluate and assess the accuracy of forecast of time and location of typhoon landfall, gale distribution, and torrential rain, calculate forecast errors of various systems and make a comprehensive analysis of forecast performance, evaluate the reliability of the forecasts and finally assess the social and economic impacts of an improved tropical cyclone forecast service. The Commission was pleased to note that the project had been extended to 2015 to include tropical cyclogenesis forecasting and to eventually develop techniques for the verification of the genesis forecasts.

4.2.3 Societal and economic research and applications

4.2.3.1 The Commission noted the successful transition of the Working Group on Societal and Economic Research and Applications (WGSERA) from its original focus only on THORPEX issues to a broader responsibility covering the entire range of time-scales and research issues associated with the WWRP.

4.2.3.2 The Commission noted the collaboration established between WGSERA and the Integrated Research on Disaster Risk (IRDR) in support of building hazard-resilient communities, which is an international disaster mitigation and risk reduction priority.

4.2.3.3 The Commission was pleased to note the success of the Communicating Risk and Uncertainty Workshop organized by WGSERA held in Melbourne, Australia in July 2012. The workshop brought together SERA experts and Australasian multi-disciplinary researchers and practitioners to update and report on current and cutting-edge research across two of the SERA research priorities: understanding and improving the use of weather information in decision-making; and understanding and improving the communication of weather forecast uncertainty.

4.2.3.4 The Commission acknowledged that the WGSERA continuously provides guidance to assess user needs/requirements and to study/facilitate the use of new tools and information to evaluate the benefits and performance of WWRP FDPs and RDPs as well as the Sub-seasonal to Seasonal (S2S) Prediction Project, Polar Prediction Project (PPP) and the planned High Impact Weather (HIW) Prediction Project.

4.2.3.5 The Commission noted the importance of the WGSERAs' on-going activities on developing a SERA RDP: Understanding the societal and economic dimensions of weather-related warning systems. This involves the development of a SERA research and application framework (i.e. hypotheses and evaluation methods/designs) which can be applied to the identified projects/case studies. The projects/case studies could include the new long-term WWRP endeavours such as the three THORPEX Legacy projects (S2S, PPP and HIW) as well as other technical commissions' activities, for example, the JCOMM/CHy Coastal Inundation Forecast Demonstration Project (CIFDP) which is developing case studies in Bangladesh, Fiji and the Dominican Republic.

4.2.3.6 The Commission expressed its strong support for the work of SERA in assessing the socio-economic benefits of meteorological and hydrological services is now a part of a larger project, financially supported by the World Bank and Climate Services Partnership and administered through the WMO Forum: Social and Economic Applications and Benefits of Weather, Climate and Water Services and Public Weather Services Programme. The aim is to provide a cutting-edge guidance document on Assessing the Socio-Economic Benefits of Meteorological and Hydrological Services. Three SERA-WG members and several scientific topics on the WMO Forum are leading and/or contributing to chapters in this guidance document which should be available by mid-2014. The scope of the value chain to be considered includes research, development, and technology transfer steps that are of primary interest to WWRP, and the activity also has a direct link to support the Global Framework for Climate Services (GFCS).

4.2.4 Weather modification research

4.2.4.1 Due to increasing evidence of the modification of our environment by anthropogenic activities and increasing interest in geoengineering, continued attention should be paid to improving the scientific bases for weather modification techniques.

4.2.4.2 The Commission recognized that more than 42 countries have active weather modification projects to enhance rainfall, to suppress hail, and to disperse fog and haze. For example, China has the largest investment in both operational programmes and weather modification research programmes, and the United States has two major research programmes in weather modification to enhance snowpack that are currently ongoing in Wyoming and Idaho.

4.2.4.3 The Commission noted the updated document of the "WMO Statement on Weather Modification" prepared by the Expert Team on Weather Modification (ETWM) in 2010.

4.2.4.4 The Commission thanked Indonesia and, in particular, the Indonesian Agency for the Assessment and Application Technology for hosting the 10th Scientific Conference on Weather Modification, held in Bali, Indonesia in October 2011.

4.2.4.5 The Commission noted that weather modification activities are pursued in many countries and several major research programmes in this field have been initiated in the past few years. The Commission noted the lack of contributions to the Weather Modification Research Trust Fund from Members. This holds a considerable risk to future activities, including the quadrennial organization of the International Conference on Weather Modification Research and the review of the scientific status and guidance material on weather modification.

4.2.4.6 The Commission noted the recommendation of the sixth meeting of the WWRP JSC that the activity on weather modification be considered to continue for another two years with limited financial support from the trust fund, followed by a final review on its future. The Commission strongly encouraged Members with an interest in this activity to contribute to the Trust Fund for Weather Modification to sustain and continue the activities in advancing the practice of sound science in weather modification.

4.2.4.7 The Commission noted the offer from the Russian Federation to make available unique instrumentation of a large size cloud chamber at "Typhoon", which is a Research and Production Association in Roshydromet. This could offer an alternative to running expensive full-scale experiments.

4.2.5 Forecast demonstration projects/research and development projects

The Commission acknowledged the importance of the Forecast Demonstration Projects/Research and Development Projects (FDPs/RDPs) in responding to regional needs. The Commission encouraged Members, in collaboration with the WWRP, to strengthen the links between these projects and NMHSs to ensure that FDPs and RDPs are aligned to regional user needs and would benefit operational weather and related environmental services and demonstrate quantifiable benefits to society. The Commission further encouraged Members to actively engage in and support FDPs and RDPs as these projects provide opportunities for regional research cooperation and capacity development.

5. PROGRESS AND FUTURE DIRECTION OF THORPEX (agenda item 5)

5.1 Report by the chairperson of the International Core Steering Committee for THORPEX (agenda item 5.1)

5.1.1 The Commission accepted the report of the chairperson of the International Core Steering Committee (ICSC) for THe Observing system Research and Predictability EXperiment (THORPEX), Dr Alan Dickinson, presented by Dr Andy Brown, on progress made to advance the goals of Members with respect to global weather prediction. The Commission recalled that THORPEX is a ten-year research experiment focusing on high impact weather and the prediction of such events from one to fourteen days ahead.

5.1.2 The Commission agreed that THORPEX had contributed substantially in addressing the Members needs, fostered cooperation between NMHSs and the academic research community and had provided new insights into the following areas:

(a) The potential of targeted observations through field experiments;

(b) Improved understanding of dynamical processes;

(c) New data assimilation techniques;

(d) The value of large multi-model ensemble prediction systems through the THORPEX Interactive Global Grand Ensemble (TIGGE) database.

5.1.3 The Commission noted that the 2012 THORPEX Progress Review, summarizing the significant progress in relation to the original eight core objectives of the experiment, had been published online: http://www.wmo.int/pages/prog/arep/wwrp/new/documents/MTR_PARTI_v0_5.pdf.

5.1.4 The Commission noted that the THORPEX scientific contributions have become operational practices at the numerical modelling centres around the world. The Commission also noted that THORPEX had provided opportunities to discuss and identify new and emerging issues of importance to the development and improvement of predictive skill of weather phenomena on local, national, regional, and global scales.

5.1.5 The Commission noted with appreciation the contribution of Canada, China, France, Germany, Japan, Norway, the Republic of Korea, the United Kingdom of Great Britain and Northern Ireland and the United States in THORPEX, including financial contributions in its Trust Fund. The Commission also noted with appreciation the provision of the forecast data from ten operational centres to the TIGGE archives hosted by the European Centre for Medium-Range Weather Forecasts (ECMWF), the National Centre for Atmospheric Research (NCAR) and China Meteorological Administration (CMA).

5.1.6 The Commission acknowledged the activities and continuing efforts in the five THORPEX Regional Committees in Africa, Asia, Europe, North America, and the southern hemisphere. The Commission was pleased to note that each Regional Committee had developed broad research and implementation plans.

5.1.7 The Commission further noted that the THORPEX summary paper is in preparation towards the end of the experiment to describe its overall achievements as well as the lessons learnt and to also provide a publication list on the research. Scientific and technical achievements include THORPEX-Pacific Asian Regional Campaign (T-PARC), International Polar Year (IPY), African Monsoon Multidisciplinary Analyses (AMMA), Year of Tropical Convection (YOTC), and the excellent progress made by the working groups of GIFS-TIGGE, Data Assimilation and Observing Systems (DAOS) and Predictability and Dynamical Processes (PDP), and the THORPEX Interactive Grand Global Ensemble for Limited Area Models (TIGGE-LAM), the Global Earth Observation System of Systems interoperability for Weather, Ocean and Water (GEOWOW), targeting, advances in DA, socio-economic research and applications, weather and climate in Polar Regions.

5.2 THORPEX focus areas and activities (agenda item 5.2)

THORPEX progress, governance and structure

5.2.0.1 The Commission acknowledged the contributions of THe Observing system Research and Predictability EXperiment (THORPEX), established in 2004, Resolution 12 (Cg-XIV) – THORPEX: A Global Atmospheric Research Programme. The aim is to accelerate improvements in the accuracy of one-day to two-week high impact weather forecasts for the benefit of society, the economy and the environment. The Commission acknowledged with appreciation the Members contribution to the success of THORPEX, both financially and through the services of their experts. The Commission noted the comprehensive review of THORPEX progress which was completed during 2012 and the plans to prepare a detailed summary report of the successes and achievements of the programme at the end of 2014.

5.2.0.2 The Commission noted that THORPEX continues until the end of 2014 and encouraged Members to maintain their support and to continue contributing to the THORPEX Trust Fund to enable completion of the experiment.

5.2.1 THORPEX Predictability and Dynamical Processes

5.2.1.1 The Commission noted that the main task of the PDP Working Group (WG) was to identify basic research challenges of central importance to numerical weather prediction and to accelerate the transfer of relevant new techniques from academia to the operational practice. The PDP WG achieved these goals by bringing together experts from the academic dynamical meteorology community and from the operational numerical weather prediction centres. It encouraged the dynamical meteorology community to carry out dynamical process studies with the specific aim of improving the understanding of the relationship between particular processes and weather forecast accuracy.

5.2.1.2 The Commission acknowledged the links between dynamics, predictability and ensemble forecasting techniques and that dedicated expertise on these subjects would be important to the future work, projects and activities of the WWRP.

5.2.2 THORPEX Data Assimilation and Observing Systems

5.2.2.1 The Commission noted that the main task of the DAOS WG was to ensure that THORPEX contributed to the international efforts to optimize the use of the current WMO Global Observing System (GOS) and to the development of well-founded strategies for the evolution of the GOS to support Numerical Weather Prediction primarily for 1 to 14 day weather forecasting.

5.2.2.2 To achieve its mission, the DAOS WG should act, in collaboration with the CBS OPAG on Integrated Observing Systems (IOS), to:

(a) Address data assimilation issues including the development of improved understanding of the sources and growth of errors in analyses and forecasts;

(b) Promote research activities that lead to a better use of observations, the introduction of new types of observations, e.g. of atmospheric composition, and the understanding of their value;

(c) Provide input and guidance for THORPEX regional campaigns for the deployment of observations to achieve scientific objectives.

5.2.2.3 The Commission noted that the research activity on data assimilation and observing systems is a fundamental activity for the activities of WWRP. It recommended that the future collaboration of the activity through the DAOS WG with meteorological centres be conducted in a more coordinated manner and that it could include standardization and sharing of forward operators, standards for measuring fit to observations and sharing such data and, sharing responsibility for developing global Observation System Simulation Experiment (OSSE) capability.

5.2.2.4 The Commission also noted that a future objective of the DAOS WG would be to "Facilitate the coordination of data assimilation and observing system research and activities between operational weather prediction centres that may result in mutual benefit."

5.2.3 Ensemble prediction: the THORPEX Interactive Grand Global Ensemble and its Limited Area Modelling counterpart

5.2.3.1 The Commission noted that the THORPEX Interactive Grand Global Ensemble (TIGGE) project, managed by the Global Interactive Forecast System (GIFS)-TIGGE Working Group (WG), was established at the start of THORPEX to foster international collaboration on research and development of ensemble prediction internationally, and between operational centres and universities.

5.2.3.2 The Commission noted that following the establishment of the TIGGE dataset, the TIGGE data providers have continued with ongoing developments of their Ensemble Prediction Systems, and the archive centres have implemented a number of improvements to the TIGGE data

portals. The focus of the GIFS-TIGGE WG has shifted towards ensemble prediction research, particularly the use of ensemble forecasts from multiple centres and the on-going promotion of scientific investigations using the TIGGE dataset.

5.2.3.3 The Commission also noted that a second major focus of the GIFS-TIGGE WG has been the longer-term development of a GIFS. GIFS is foreseen as a forecast system supported by TIGGE data providers and other partners, offering advanced probabilistic warnings for high impact weather events especially for less developed areas of the globe.

5.2.3.4 The Commission was pleased to note that the forecast guidance products from the TIGGE archive will provide a new insight for the development and execution of the Severe Weather Forecast Demonstration Projects (SWFDPs). The probabilistic forecasts based on the TIGGE database may add additional information for forecasters and decision-makers.

5.2.3.5 The Commission supported the continuation of the TIGGE archive beyond the end of the THORPEX programme, with the continuing ingestion of new data, recognizing the value of the TIGGE data to support ongoing WWRP research projects. In view of its planned continuation after the completion of THORPEX, it is recommended that the name of the TIGGE be changed from “THORPEX Interactive Grand Global Ensemble” to “The International Grand Global Ensemble”.

5.2.3.6 The Commission noted the value of expertise in the two THORPEX Working Groups of the GIFS-TIGGE and PDP for the activities of the WWRP, to provide expertise in dynamical processes, predictability and ensemble forecasting, and to carry out basic research and to support WWRP projects.

5.2.4 Regional activities and field programmes

5.2.4.1 The Commission noted that consortia of nations have also established THORPEX Regional Committees (RCs) that define regional priorities for participation in THORPEX activities within the framework of the THORPEX International Science and Implementation Plans. These THORPEX RCs facilitate provision of funding, logistical and other support, planning, coordination and implementation of THORPEX activities conducted by the region and as part of global initiatives with respect to the THORPEX International Research Implementation Plan. THORPEX RCs have been established for Asia, Africa, Europe, North America and the southern hemisphere.

5.2.4.2 The Commission noted the development of the case studies in high-impact weather events in four subregions in Africa (North, West, East, and South), led by the THORPEX Africa Regional Committee and urged Members to support the implementation of this activity. The Commission also noted the regular series of THORPEX symposia organized by the Asian Regional Committee and the many contributions made by the Asian, European and North American Committees to THORPEX field campaigns and projects.

5.2.4.3 The Commission noted that an international scientific field campaign over the Pacific in 2008, called the THORPEX Pacific Asian Regional Campaign (T-PARC), was carried out by the international scientific community and a wide range of institutions, including several Regional Committees (RCs) in Asia, North America and Europe. The main aim was to improve typhoon track forecasts and to study extra-tropical transition (ET) and downstream impacts. During T-PARC, there were several targeting guidance products available for adaptive observations taken by airplanes to improve typhoon track prediction. These products identify the “sensitive area”, where the in-situ observations by airplane are expected to give a high impact for improving the forecast. The Commission noted that the adaptive observations on average improve the typhoon track forecast over the western North Pacific, although the amount of improvement differs between the models.

5.2.4.4 The Commission approved Recommendation 1 (CAS-16) – Post-THORPEX Activities, for consideration by the Executive Council at its sixty-sixth session.

6. PROGRESS AND FUTURE DIRECTION OF THE GLOBAL ATMOSPHERE WATCH PROGRAMME (agenda item 6)

6.1 Report by the chairperson of the Joint Scientific Committee of the Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry (agenda item 6.1)

6.1.1 The Commission noted with appreciation the report of the chairperson of JSC OPAG-EPAC, Prof Øystein Hov, on the activities of the GAW Programme.

6.1.2 The Commission acknowledged that the rationale for GAW is to understand the increasing influence of human activity on the global atmosphere, based on good-quality observations. The mandate of GAW covers issues of broad socio-economic consequences. The main challenges are stratospheric ozone depletion and UV increase; weather and climate change from greenhouse gases, ozone and aerosols; air pollution impacts on human health and ecosystems, and man-made changes in water quality, and food production. The Commission noted the GAW role to account for the human impact on the atmosphere including its feedbacks to the natural system, in such a way that scientific integrity is established before knowledge is transferred to services or operations.

6.1.3 The Commission further recalled that the mission of GAW is to reduce environmental risks and support environmental conventions; strengthen prediction of climate, weather and air quality; and contribute to scientific assessments in support of environmental policy through global, long-term observations of atmospheric composition, while ensuring adequate quality assurance and quality control, and the delivery of user driven products and services.

6.1.4 The Commission acknowledged the preparation in 2011 of the *Addendum for the Period 2012–2015 to the WMO Global Atmosphere Watch (GAW) Strategic Plan 2008–2015* (http://www.wmo.int/pages/prog/arep/gaw/documents/FINAL_GAW_197.pdf). This is the guiding document for all GAW activities. The Commission agreed that the 29 global and several hundred regional stations for atmospheric chemical composition and related physical parameters observations form the backbone of GAW, but this is insufficient.

6.1.5 The Commission further agreed with the chairperson that the way forward for GAW as seen against current and new priorities within WMO and its Research Department “Science for Service” is to strengthen (1) its focus on Disaster Risk Reduction; (2) its contribution to the Global Integrated Polar Prediction System (GIPPS) including Global Cryosphere Watch; (3) its contribution to Megacities and other large urban complexes and their influences on environmental health; (4) its support for the build up of the Global Framework for Climate Services (GFCS), where GAW, in conjunction with GCOS, can provide the information required to carry out cost effective mitigation measures of greenhouse gases and aerosols; and (5) its contribution to the WMO Integrated Global Observing System (WIGOS) through the GAW observational network, in part by encouraging the GAW World Data Centres to adapt to WIS standards and structures as well as to WIGOS.

6.1.6 The Commission noted that key points in the future GAW strategy for 2016–2019 are to further develop user driven products (1) for air quality, deposition, UV, and dust, including volcanic ash; (2) for understanding mitigating and adapting to climate change; and (3) for NWP, including seasonal weather forecasts and marine input. In doing so, GAW is to strive towards “one chain” delivery with research driven and operational observations, model development and application, and services; to foster the core GAW activity which is to *do good observations*, not only collecting observations by others; to facilitate policy actions that improve air quality and reduce long range transboundary transport of air pollution; to provide the technical underpinning for climate mitigation through existing and new global and regional alliances; and to ensure that there are no unintended parallel processes in the technical underpinning of policies. The Commission agreed that storage, search and retrieval mechanisms for observations, governed by metadata following international standards, are becoming essential elements in getting adequate payback from investments in observational systems. It further agreed that Member contributions to research, infrastructure,

education, and institutional building are essential, and that the governance structure needs to be transparent and competent, with a fair distribution of tasks and responsibilities geographically while taking gender balance into consideration.

6.2 Global Atmosphere Watch focus areas and activities (agenda item 6.2)

6.2.1 General

6.2.1.1 The Commission acknowledged the continuous development of the Global Atmosphere Watch (GAW) Programme (http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html). It noted the importance for Members to follow the guidance and contribute to the tasks formulated in the Addendum to the GAW Strategic Plan (GSP) 2008–2015 (GAW Rep 197). The good progress made in GAW was especially shown through the GAW 2013 Symposium held in March 2013 (http://www.wmo.int/pages/prog/arep/gaw/gaw2013symp.html).

6.2.1.2 The Commission noted that the GAW Programme contributes to the WMO Expected Result Five (ER 5) on Research and additionally to several WMO priority areas, including the Global Framework for Climate Services (GFCS), capacity building for the developing and least developed countries, and implementation of the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS). The Commission noted that GAW-related strategic issues are planned to be included within the WMO Strategic Plan. The Commission recommended that the GAW Implementation Plan that will be published separately for the 8-year period starting 2016 should reflect the above and future WMO strategic priorities.

6.2.1.3 The Commission recognized that continuous long-term high-quality observations constitute the backbone of the GAW Programme. It noted that GAW coordinates global observations and analysis of data from 29 Global Stations, 424 fully operational Regional Stations, and about 18 stations operated by contributing networks. Three new sites were designated as Global Stations since CAS-XV: Pyramid (Nepal), Monte Cimone (Italy) and Halley, Antarctica (United Kingdom). The Commission welcomed the expansion of climate-relevant observations at several stations by Switzerland within the CATCOS project and requested other Members to consider providing such support. The Commission noted that the criteria that must be met by a GAW Global, Regional or contributing station will be specified in the GAW technical regulations as part of WIGOS. The Commission expressed gratitude to the GAW data contributors from all over the world for their quiet dedication and perseverance, and among others, particularly to those at background stations located at high mountains, isolated islands, and in pristine tropical forests or frozen zones, where living itself poses sometimes many difficulties.

6.2.1.4 The Commission recognized the importance of developing GAW into a three-dimensional global atmospheric chemistry measurement network, as discussed in the strategic plan.

6.2.1.5 The Commission recognizes the value of the Essential Climate Variables ozone, greenhouse gases, and aerosol properties observed from civil commercial aircraft in advancing understanding and services for climate, weather, and environmental risk reduction. It urges Members to consider supporting proven and accepted efforts to implement observations of atmospheric composition and chemistry from commercial aircraft, using best practices such as those developed by the international research infrastructure programme of the European Union (IAGOS) and by the Japanese CONTRAIL programme of the National Institute for Environmental Studies and the JMA Meteorological Research Institute. The Commission further encouraged such efforts to seek to transmit data in real time.

6.2.1.6 The Commission stressed the importance of collaboration with the satellite community, of the inclusion of satellite measurements in GAW activities, and the harmonization of these observations as required, e.g., as concerns UV data from TOMS, OMI, as well as GOME series and SCIAMACHY. It noted the initiative with the World Health Organization (WHO) to look at satellite observations in connection with air quality and health.

6.2.1.7 Considering the importance of activities in urban areas, the Commission recommended to add a new category “local” to the GAW stations. These stations would provide important locally representative information to be used for many purposes, e.g., air quality studies and forecasting, health studies, and urban climate services. It is ***not*** the intention to capture existing urban network observations within GAW under this new “local” site designation, but rather to be able to include sites influenced by urban or industrial complexes.

6.2.1.8 The Commission agreed that GAW requires collaboration between different agencies, institutions and academia. The Commission appreciated the already established collaboration between WMO/GAW and other UN agencies and programmes, the International Global Atmospheric Chemistry (IGAC) project of the International Geosphere-Biosphere Programme (IGBP), with European Union programmes and projects. The Commission encouraged WMO/GAW to foster collaboration with environmental agencies worldwide on urban issues. The Commission requested also for collaboration to be taken up with the relevant communities addressing ocean acidification.

6.2.1.9 The Commission acknowledges and supports the Mutual Recognition Arrangement between WMO and the Bureau International des Poids et Mesures (BIPM) to cooperate in ensuring both traceabiity and compatibility of measurements in global networks. The Commission especially appreciated the signed supporting statements from the United States (NOAA) and Switzerland (EMPA) regarding the WMO World Reference Scales for greenhouse gases.

6.2.1.10 The Commission stressed that the quality of observations is directly related to their value for users and in this regard was pleased to note that the GAW quality assurance system has matured. It appreciated the contributions by Members who have set up several important Central Facilities in this system since the previous CAS session. It further noted that keeping up all these central facilities is crucial for the functioning of GAW.

6.2.1.11 The Commission appreciated the usefulness of the GAW Station Information System (GAWSIS, http://gaw.empa.ch/gawsis/) supported by Switzerland, and the six World Data Centres (WDCs) kindly hosted by Canada, Germany, Japan, Norway, the Russian Federation and the United States. The Commission noted that GAWSIS can serve as an example for the WIGOS metadata system. The Commission recognized the importance of the provision of near-real-time (NRT) data and appreciated the actions by the WDCs on the NRT collection and distribution of data.

6.2.1.12 The Commission acknowledged the valuable publications, freely accessible on-line, prepared by volunteers such as GAW Scientific Advisory Groups (SAGs) and Expert Teams (ETs) and specially dedicated task groups. These are available through the GAW website (http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html).

6.2.2 Ozone depletion, ultraviolet radiation and the Vienna Convention

6.2.2.1 The Commission expressed its satisfaction with the important Biennial Brewer User Group Workshops that have been arranged regularly since 1990, the thirteenth and latest one was arranged by Canada in Beijing in September 2011. The Commission urged Members to consider securing funds for the arrangement of such workshops in the future.

6.2.2.2 The Commission noted with satisfaction that a gap in the data at WOUDC of ozone observations using Russian filter ozonometers was now being filled. After the planned modernization of the Russian ozonometric network, the new data could be transferred in near-real-time.

6.2.2.3 The Commission requested that data from the newly and soon to be established stations with Mini-SAOZ instruments be submitted to WOUDC.

6.2.2.4 The Commission welcomed the new Standard Operating Procedures (SOPs) for ozonesonde observations and data reporting, published in GAW Report No. 201, and the

"Guidelines for Reporting Total Ozone Data in Near Real-Time", GAW Report No. 193. The Commission urged all Members that launch ozonesondes to comply with the new SOPs and to report the data in agreement with the outlined requirements and further urged Members to submit total ozone data in NRT to the GTS/WIS according to the report No. 193.

6.2.2.5 The Commission recalled that WMO/GAW and the International Ozone Commission under IAMAS established in 2009 an ad-hoc expert team to standardize the use of absorption cross sections in global ozone observations. The Commission recognized the key role of the European Calibration Centres (RBCC-E, RDCC-E) under ESA funded CEOS CAL/VAL project in clarifying the historical differences between the total ozone reference instruments. The application of the new developed Bremen cross sections to the CEOS Calibration campaign data of reference instruments eliminates the bias and reduces the seasonal differences if the temperature dependences of the algorithm are taken into account. The ad-hoc expert team has held four workshops between 2009 and 2013, and, to ensure compatibility, it has been agreed to adopt the new ozone absorption cross sections published by the University of Bremen for the Dobson and Brewer measurements. The Commission requested for this information to be made easily available.

6.2.2.6 The Commission recognized that a feedback mechanism exists between ozone depletion and climate change and recommended closer collaboration with WCRP to investigate the role of this mechanism. The Commission further noted that chlorofluorocarbons (CFCs), which are observed in the atmosphere in particular in relation to ozone depletion, are potent greenhouse gases. Thus the implementation of the Montreal Protocol also allowed reduction in radiative forcing. The Commission recommended to continue and extend the observations of the CFCs and their substitutes, some of which, while not threatening the stratospheric ozone layer, are increasing and very potent greenhouse gases.

6.2.2.7 The Commission noted with pleasure that the UV SAG and its subgroup on instruments have finalized publishing the series Instruments to Measure Solar Ultraviolet Radiation (four Parts). In this regard, it agreed that these publications need to be kept up to date.

6.2.2.8 The Commission recognized that many Members are producing UV Index forecasts as an important product for public services and requested for a survey to be made on who are making these and for more details on the forecasting itself. The Commission noted that vitamin D production is a positive effect of UV radiation and requested that WMO, together with WHO, discuss how best to communicate the positive and negative effects of UV. The Commission welcomed the planned collaboration with WHO on developing international standards for non-ionizing radiation under an inter-agency committee.

6.2.3 Atmospheric chemistry and climate change

6.2.3.1 The Commission noted that the GAW Programme addresses atmospheric chemistry and climate change through systematic and comprehensive observations and analysis of greenhouse gases, ozone, reactive gases and aerosols. While greenhouse gases (GHGs) are considered as long-lived climate forcers (LLCFs), aerosols, that have both direct and indirect impact on climate, and ozone, a greenhouse gas itself, are considered as short lived climate forcers or pollutants (SLCFs or SLCPs). The Commission recommended that, while continuing to ensure a strong programme for LLCFs, further efforts be made to better quantify the role of SLCFs in climate change and to investigate the possible measures that can be recommended to policy makers on emission controls to get simultaneous benefits by minimizing health, climate and other impacts (e.g., crop loss) due to these compounds.

6.2.3.2 The Commission noted the important collaboration between GAW and the Global Climate Observing System (GCOS). Since CAS-X the subset of "WMO/GAW Global Atmospheric CO_2 and CH_4 Monitoring Network" was recognized as a comprehensive (in addition to baseline) network of GCOS and the "WMO/GAW Global Atmospheric N_2O Monitoring Network" was recognized as a comprehensive and a baseline network of GCOS.

6.2.3.3 The Commission recommended to enhance both greenhouse gas and aerosol observation networks in GAW to improve the understanding of climate and air pollution connections and also for provision of data in NRT of these species. The Commission recognized that the NRT data provision of CO_2 mole fractions at several GAW stations had made it possible to receive good public coverage when the 400 ppm threshold was broken at these stations.

Greenhouse gases

6.2.3.4 The Commission recognized the major importance of greenhouse gas observations and analysis within the GAW Programme. The Commission recommended increasing the density of these observations in data sparse regions (particularly the tropical regions of Africa, Southeast Asia and Latin America, and in Eurasia and the Arctic) and especially over oceans. The Commission noted that Arctic observations are relevant for diagnosing the tipping point in the climate system (e.g., release of methane). The Commission encouraged collaboration with communities measuring carbon dioxide dissolved in water (oceans) and with those measuring biogenic fluxes of GHGs, in order to improve understanding of the carbon cycle and its human induced modifications, and to take measures to ensure compatibility of observations performed by different communities.

6.2.3.5 The Commission noted that JMA has been measuring atmospheric and oceanographic CO_2 concentrations by research vessels in the western North Pacific on an operational basis since 1980s. It recognized that such long-term ship-based observations over the oceans have played an important role in the global network of CO_2 observations.

6.2.3.6 The Commission stressed the importance of GHG information provided by GAW for the Global Framework for Climate Services (GFCS) as this forms the basis for the understanding of, and projections for, climate change.

6.2.3.7 The Commission appreciated the publication of the annual WMO/GAW Greenhouse Gas Bulletins which report on the latest trends and atmospheric burden of the most influential, long-lived greenhouse gases, and recommended that Members making GHG observations report their data in a timely manner for their inclusion in this important publication. The Commission noted that the Bulletins are used as background documents at the sessions of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). The Commission acknowledged the inclusion of the state of the GHGs and their global trends in the WMO annual climate statement and the WMO Decadal Climate Survey.

6.2.3.8 The Commission recognized the importance of the contribution by the World Data Centre for Greenhouse Gases (WDCGG), operated by Japan, to the GAW activities and for the global analysis of major greenhouse gases, a major contribution to the WMO Greenhouse Gas Bulletin.

6.2.3.9 The Commission agreed that traceable, accurate measurements will be critical for post-Kyoto carbon mitigation actions. It noted an important role of NOAA (United States) in supporting the WMO World Reference Scale for Greenhouse Gases in its function of the Central Calibration Laboratory (CCL) for the key GHGs and the role played by the Republic of Korea for supporting the World Calibration Centre (WCC) for SF_6. The Commission recommended that all Members ensure that their measurements are traceable to the WMO scale. It further encouraged the Members to participate in the quality assurance activities, including use of measurement guidelines, participation in round-robin exercises and site audits. The biennial WMO/IAEA Meetings on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT) work to this end. The Commission noted that Members are invited to participate in the annual Greenhouse gas meetings organized by KMA. The Commission appreciated the efforts by well established laboratories to support less developed countries through station twinning.

6.2.3.10 The Commission noted that it is desirable to supplement the programme of measurements at GAW stations by measurements of total amount of greenhouse gases in the atmospheric column using solar absorption spectroscopy. The measurements of total GHGs

combined with surface gas concentrations would contribute to a better understanding of radiative transfer in the Earth's atmosphere and the GHG impact on climate.

6.2.3.11 The Commission noted that the Integrated Global Greenhouse Gas Information System (IGIS) is being dealt with under agenda item 9.3.

Aerosols

6.2.3.12 The Commission noted that the impact of aerosols is one of the most significant and uncertain aspects of climate change projections, regarding both their direct and indirect effects. Furthermore, they play a significant role in human health issues and in environmental effects caused by biomass burning, dust storms and volcanic eruptions, and at shorter timescales in NWP.

6.2.3.13 The Commission appreciated the expansion of aerosol observations but noted that many areas of the globe are still lacking measurements. In this regard, the Commission welcomed the publication of the “Recommendations for a Composite Surface-Based Aerosol Network”, GAW Report No. 207. The Commission agreed on the importance for provision of long-term sustained and consistent observations of aerosol properties on a global scale through a system of existing aerosol networks, complementing satellite and environmental agencies. The Commission recommended that this consortium should address in particular observational gaps and filling these, standardization of measurement methods and data archiving protocols, improved data quality and an improved data delivery/data management system to multiple users, including researchers. The consortium should foster aerosol-related process studies, satellite validation, model development and validation, assimilation of observational data into operational models, and the creation of a comprehensive aerosol climatology on a global scale. The Commission recognized that GAW is in the position to coordinate this activity, and invited existing networks of global reach presently outside GAW, such as AERONET, SKYNET and MPLNET, to join.

6.2.3.14 The Commission appreciated the support by Switzerland for the aerosol optical depth (AOD) GAW-PFR network, coordinated by the World Optical Depth Research and Calibration Centre (WORCC) in Davos. The Commission noted that WMO/GAW aerosol observations are not yet recognized as GCOS networks and that this PFR network would be suitable as a GCOS Reference Network.

6.2.3.15 The Commission in particular noted the important role the European research lidar network EARLINET played in the crisis of the Eyjafjallajökull eruption in 2010. It recommended providing further services related to the information on volcanic ash based on this and other regional networks contributing to the GAW Aerosol Lidar Observation Network (GALION). The Commission welcomed the opportunity to formulate a project in WIGOS to address the volcanic ash issue (see agenda item 8.2).

6.2.3.16 The Commission noted the importance of Black Carbon (BC) for both climate and health impacts. It appreciated the joint publication with UNEP of the “Integrated Assessment of Black Carbon and Tropospheric Ozone” and welcomed the publication by the Aerosol SAG on recommendations for reporting “black carbon” measurements in Atmos. Chem. Phys in 2013. It further requested for work on BC to continue, in collaboration with WHO and also by participation in the Climate and Clean Air Coalition (CCAC). In this regard, the Commission further agreed that GAW should look into the measurements and reporting of PM2.5 and PM10 that are made by many different institutes and authorities, that are very relevant in urban areas, and that are used extensively in health studies. The Commission further noted a need to scrutinize and complement the information available on BC as reported in GAWSIS.

6.2.4 Globalization of air pollution

6.2.4.1 The Commission addressed precipitation chemistry and reactive gases in this section. The Commission acknowledged their importance in the collaboration with the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP), the Acid Deposition Monitoring Network in East Asia (EANET) and the WMO-IGAC sponsored Deposition of Biogeochemically Important

Trace Species (DEBITS). The Commission agreed that WMO/GAW should continue to co-chair the Task Force on Measurements and Modelling (TFMM) and to participate in the Task Force on Hemispheric Transport of Air Pollution (TFHTAP) of CLRTAP.

Precipitation chemistry

6.2.4.2 The Commission recalled that acid deposition is being addressed through effective reductions in sulfur emissions in some parts of the world, though this remains a problem in other locations. Deposition of acidic and acidifying forms of nitrogen remains a problem, and there is an increased concern about the excessive deposition of nutrients that affect sensitive aquatic and terrestrial ecosystems and concerns linkages between atmospheric deposition and climate change.

6.2.4.3 The Commission noted the role of desert-iron deposition into the ocean. It is important to realize that the insoluble soil iron becomes more soluble during atmospheric transport, affecting atmospheric acidity. The Commission recognized that the research initiatives on desert-iron deposition have strong relevance to this work.

6.2.4.4 The Commission was pleased that the Global Precipitation Chemistry and Deposition Science Assessment was accepted for publication in a special issue of the journal Atmospheric Environment, and was especially pleased that both measurement and model results were included. The Commission requested that Members act upon the identified need for measurements in Latin America, Africa and parts of Asia, where data are sparse or lacking, and that Members report data to the World Data Centre for Precipitation Chemistry (WDCPC). Other needs identified in the Assessment include measurements of organic nitrogen and total phosphorus. Organic nitrogen is thought to comprise a substantial yet unmeasured fraction of deposited nitrogen. Total phosphorus deposition data is required in limited regions where aquatic resources are adversely affected by nutrients deposited from the atmosphere.

6.2.4.5 The Commission noted that it would be important to update the Manual for the GAW Precipitation Chemistry Programme as the current one dates from 2004.

6.2.4.6 As regards the UN Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP), specifically the work of the Working Group on the Atmospheric Input of Chemicals to the Ocean (WG38) that WMO leads, the Commission was pleased to learn that eight publications are planned to be submitted by autumn 2014 addressing issues related to the impact of the atmospheric deposition of anthropogenic nitrogen to the ocean.

6.2.4.7 The Commission noted that recommendations from the recent Global Precipitation Chemistry and Deposition Science Assessment confirm that a strategic approach to monitoring is required for future improvements in global concentration and deposition estimates. This will require increased spatial coverage of long term wet and dry deposition measurements of acidifying species, mineral base cations, sea salt, organic acids and nutrients such as phosphorus in regions of the world that are data sparse, highly sensitive, or affected by changing regional emissions. A singular focus on strong mineral acids in wet deposition is no longer sufficient to meet emerging science and policy requirements. A comprehensive international framework based upon established methodologies is essential.

Reactive gases

6.2.4.8 The Commission expressed satisfaction with the developments of the volatile organic compound (VOC) activity within GAW. It welcomed the establishment of CCLs hosting primary standards for two groups of VOCs and the development of standards in close collaboration with BIPM. The Commission was pleased that VOC data submission has resulted in the inclusion of these in the Annual Data Summary published by the WDCGG in 2013. This publication will be further enhanced by adding the new parameter propane from the next issue forward. The Commission stressed that continuous observations of VOCs have high value but are still rare, and encouraged Members to include these measurements at their stations. The Commission further

noted that an extension of the VOC network could be reached through better collaboration with the biosphere community and encouraged steps to be undertaken to establish such a collaboration.

6.2.4.9 The Commission welcomed the publication of the Guidelines for the Measurement of Atmospheric Carbon Monoxide (GAW Report No. 192) that provides details of the measurement network and the best operating practices together with an overview showing trends over the last 15 years. The Commission recommended that CO observations be more widely utilized for the assessment of biomass burning or other pollution episodes at GAW stations.

6.2.4.10 The Commission welcomed the progress made in the tropospheric ozone network, in particular the collaborative analysis of the global trends of tropospheric ozone (GAW Report No. 199, IGAC Newsletter Issue No. 45, Oct 2011 and Oltmans et al, Atmos. Environ., 2013). The Commission also noted that differences in observational techniques and approach to quality assurance can impact trend estimates. In this respect the Commission welcomed the publication of the Guidelines for Continuous Measurements of Ozone in the Troposphere, GAW Report No. 209, in 2013. It encouraged further research on ozone trends especially in connection with the analysis of the variability of its precursors utilizing both observations and model simulations. The Commission welcomed more efforts to reduce the cost of upper-air soundings and encouraged the Members to conduct long-term ozone soundings in more regions, especially the developing countries in Asia and Africa.

6.2.4.11 As regards the NO_x network development, the Commission requested Members to establish these observations as NO_x is considered not only a pollutant itself, but impacts the global nitrogen cycle and is involved in surface ozone formation, a strong SLCF. The Commission appreciated the development of comprehensive measurement guidelines for VOCs and NO_x observations within the European project ACTRIS which are useful for the GAW community. The Commission encouraged the development of the quality assurance system for NO_x measurements.

6.2.5 Review of Technical Regulations

The Commission noted the current Draft Revision of Technical Regulations concerning GAW, developed and finalized in consultation with the SAGs and ETs, and in line with WIGOS. The Commission deferred the approval of the finalized draft to the CAS Management Group.

7. PROGRESS AND FUTURE DIRECTION OF GAW URBAN RESEARCH METEOROLOGY AND ENVIRONMENT (agenda item 7)

7.1 Report by the chairperson of the Scientific Advisory Group on GAW Urban Research Meteorology and Environment (agenda item 7.1)

7.1.1 The Commission noted with appreciation the report of the chairperson of the Global Atmosphere Watch (GAW) Urban Research Meteorology and Environment (GURME), Prof Greg Carmichael, on progress made in enhancing the capabilities of Members to handle meteorological, air quality (AQ) and related aspects of urban pollution. The Commission further noted that GURME provides an international platform for cross-cutting urban air pollution activities, with involvement of NMHSs, environmental agencies, municipal authorities, academia and other international initiatives.

7.1.2 The Commission recognized that GURME's contributions include setting up pilot projects in megacities that have addressed observational and modelling needs with clear links to users, working from research through operations to services and products, and capacity development. Regarding cross-cutting collaboration, the Commission acknowledged the successful example of the Shanghai Multi-Hazard Early Warning System (MHEWS) that was demonstrated at the 2010 EXPO. The Shanghai GURME project provided the seed for this undertaking.

7.1.3 The Commission noted that GURME forms the basis on which the new megacity initiative, Integrated Urban Weather, and Climate Service (see agenda item 9.5) can build upon,

and agreed that GURME will be a relevant part of this initiative. In addition to weather and climate related activities, AQ will play an important role in the provision of these new services.

7.2 Transitioning from research to applications in urban services (agenda item 7.2)

7.2.1 The Commission recalled that climate change, population growth and urbanization are major stressors driving demand for more accurate and user-friendly environmental products and services. These need to be developed through appropriate research activities. The Commission noted that urban areas differ from their surroundings by morphology, population density, high concentration of industrial activities, energy consumption and transport. They also pose unique challenges to atmospheric modelling and monitoring and create a multi-disciplinary spectrum of potential threats, including air pollution, which need to be addressed in an integrated way. Thus they require a different approach from traditional meteorology.

7.2.2 The Commission noted the negative impacts of urban areas on local air quality. In addition in recent years, the understanding of the interaction between megacities and urban complexes and surrounding areas, such as the impact of urban areas on high sensitive weather (e.g. severe rain, fog, haze), the impact of anthropogenic emissions from megacities on regional and global climate, and the impact of severe weather on a city's safety and on human health have received increasing attention.

7.2.3 The scientific and engineering knowledge that has been accumulated when developing megacities dealt with their air quality problems in earlier years is a significant resource for current and future megacities. The Commission agreed that GURME, through its international role, is in a position to bring experts from cities in different development stages together to assist in addressing these problems.

7.2.4 The Commission recommended continuing the good collaboration with other international organizations and relevant projects. The collaboration with WHO is especially important. The Commission recognized that the publication of the "Atlas of Health and Climate" by WMO together with WHO, includes a section on air pollution, is very useful in portraying these hazards in a short and effective manner. The Commission also welcomed the collaboration with WHO to organize a meeting on the use of satellites for air quality purposes. WHO has a database on ambient air quality in cities, but it would be important to expand data coverage, although it is not straightforward to relate satellite measurements to close to ground level concentrations. The meeting will address this and other relevant issues. In view of making available observational data at all spatial and temporal scales in support of science and services, the Commission recommended that efforts be made to connect more closely the WHO ambient air quality data base to the GAW data management and discovery infrastructure. The Commission was informed that WMO maybe represented in WHO regional meetings enabling good communications between the organizations. The Commission noted that data should be combined with chemical transport models in order to be able to produce maps of outdoor air pollution and that these would need surface-based observation data for validation and for input. The Commission recommended that GURME collaborate with other initiatives, such as those of WHO, in providing good quality urban air quality data obtained from, e.g., GURME project observations, for relevant studies. The Commission noted that GAW SAGs, especially as regards reactive gases and aerosols, should collaborate with GURME experts on this issue.

7.2.5 The Commission welcomed the new collaboration with UN Habitat in the Task Team "Urban Risk Management & Climate Smart Cities" of the High Level Committee on Programmes (HLCP) Working Group on Climate Change, and in the organization of the Habitat III Conference, the Third United Nations Conference on Housing and Sustainable Urban Development, to be held in 2016. The Commission agreed that it is time for GURME to move beyond the experts involved in NMHSs and academia on air quality issues to present the WMO activities in urban areas to the broader community. This could possibly bring advantages to those active in the GURME activities by highlighting them in a wider context.

7.2.6 The Commission was pleased that a new website had been established for GURME (http://mce2.org/wmogurme) with a clear and attractive structure, but noted that more efforts are

needed for this site to provide up-to-date information and to become a portal for relevant links in this field. The Commission noted that it is important for WMO/GAW and GURME projects as well as other users to provide materials to keep the site updated. The Commission further noted that the new, more comprehensive initiative on research and services for megacities and large urban complexes (see agenda item 9.5) would also need a considerable website and recommended that GURME look into the possibility of combining efforts in this area.

7.2.7 The Commission recognized the importance of the provision of near-real-time (NRT) data within GURME and was pleased with the NRT aspects of the GURME pilot projects and the work of the expert team ET NRT CDT. The Commission noted that CMA and WMO jointly developed a Pilot GURME-NRT Project. This project assimilates the FY-2C/D satellite data and the NRT AOD data derived from the China Aerosol Remote Sensing NETwork (CARSNET) into the CUACE/Haze-fog numerical prediction system. It also uses the NRT black carbon monitoring data of the China Atmosphere Watch Network (CAWNET) to derive or correct the source of black carbon emissions, which improves the modelling performance of CUACE model on black carbon. The Commission asked that NRT activities be continued and extended.

7.2.8 The Commission noted that ozone and aerosols, short-lived climate forcers, are very relevant in a health context and agreed that these types of measurements are important and need to be enhanced in GURME and to include activities to address the impacts of short-lived climate forcers in the cryosphere region, especially the Andean/Patagonian regions, which have not received as much attention as the Arctic or the Himalayas. The Commission was pleased with the biomass burning initiative collaboration with IGAC and noted that this is important also in regards to urban environments as many of the negative impacts are felt there.

7.2.9 The Commission noted that GURME should continue its collaboration with the TF HTAP of EMEP as urban areas are affecting regional and global air quality through atmospheric transport. The Commission recalled that sulfur remains an environmental problem in parts of the world, and that continued efforts are needed to measure its concentration in ambient air and precipitation and model its distribution.

7.2.10 The Commission was pleased with the continued collaboration with EU projects, now with the recently funded project PANDA (Partnership with China on Space Data) and MarcoPolo (Monitoring and Assessment of Regional air quality in China using space Observations), which are targeted at EU and Chinese collaboration on air quality. GURME can contribute to this well, as there are already many good connections in GURME with China. The Commission noted the establishment by the Republic of Korea of the new weather information service engine designed to help resolve urban environmental issues and agricultural disasters through scientific advances in high-resolution weather forecasting, urban flash flood prediction, road meteorology, urban carbon dynamics and agricultural meteorology, and new service systems to minimize and mitigate the impacts of natural disasters and climate change. The Commission appreciated the extended offer to Members for collaborations in this service.

7.2.11 The Commission recognized the strong links between the GURME directions and the Disaster Risk Reduction (DRR) and the WWRP projects and the more comprehensive initiative on research and services for megacities and large urban complexes (see agenda item 9.5) and recommended the establishment of explicit collaborations between the appropriate initiatives.

8. RECOMMENDATIONS ON JOINT ACTIVITIES (agenda item 8)

8.1 Collaborative activities between the World Climate Research Programme, World Weather Research Programme and Global Atmosphere Watch (agenda item 8.1)

8.1.1 Model development and numerical experimentation: Working Group on Numerical Experimentation

8.1.1.1 The Commission noted that the Working Group on Numerical Experimentation (WGNE), jointly established by the WCRP Joint Scientific Committee (JSC) and CAS, has the responsibility of fostering the development of atmospheric circulation models for use in weather, climate, water

and environmental predictions on all time scales and diagnosing and resolving shortcomings (http://www.wmo.int/pages/about/sec/rescrosscut/resdept_wgne.html).

8.1.1.2 The Commission acknowledged the importance of WGNE in its role of bridging the weather and climate modelling and research communities, by addressing a growing number of common challenges, and by promoting model development to improve weather, climate, hydrological and environmental predictions.

8.1.1.3 The Commission noted the work being conducted in the Transpose-Atmospheric Model Intercomparison Project (Transpose-AMIP). In this project climate models are run in weather forecast mode starting from a common analysis. This project allows the longer timescale biases in climate models to be explored, understood, and compared to those at shorter timescales in Numerical Weather Prediction (NWP) models. Recent results have highlighted some shortcomings in many models, for example in cloud and boundary layer structure representation in cold air outbreaks.

8.1.1.4 The Commission recognized the unique contribution of WGNE to Members interests by providing a forum for major modelling centres to review progress (e.g. through centre reports), to allow intercomparisons of performance, to compare data assimilation and ensemble techniques and to discuss future plans and projects aimed at improving models and predictive skill.

8.1.1.5 The Commission supported the decision of the 28th session of WGNE in 2012 that the THORPEX Data Assimilation and Observing Strategies (DAOS) Working Group will be responsible for the core activities in these fields and to include a DAOS ex officio member to ensure an effective link between the working groups.

8.1.1.6 The Commission noted the importance of the Grey Zone project, a joint project between the Global Atmospheric System Studies (GASS) and WGNE, focusing on the behavior of atmospheric models at horizontal resolutions in the range of 1 to 10 kilometers, i.e. typical scales for key processes such as convection. The Commission noted that this work is of great relevance for future atmospheric models at all time ranges and encouraged WGNE to continue its active participation in this project.

8.1.1.7 The Commission noted that the Madden Julian Oscillation Task Force (MJO-TF), responsible for research on the MJO, is now reporting to WGNE. The Commission noted this development and encouraged the weather and climate modelling and research communities to utilize this linkage through WGNE. The MJO-TF should ensure full collaboration, including common planning, with the WWRP/S2S project.

8.1.1.8 The Commission further encouraged the emerging cooperation between WGNE and GAW, including the focus on aerosols and the Global Atmosphere Watch (GAW) Programme Urban Research Meteorology and Environment (GURME) project.

8.1.2 Forecast verification research

8.1.2.1 The Commission recognized the importance of forecast verification and noted with satisfaction the activities undertaken by the Joint Working Group on Forecast Verification Research (JWGFVR) in collaboration between WWRP and WGNE such as the organization of the 5th International Verification Methods Workshop (Melbourne, Australia, 2011). The Commission noted that the organization for the 6th workshop during 13–19 March 2014 in New Delhi, India, has been initiated. The Commission noted with satisfaction that JWGFVR is working on two guidance documents, i.e. verification of precipitation forecasts and verification of mesoscale model forecasts.

8.1.2.2 The Commission was pleased to note that members of the working group had organized training activities during the intersessional period namely, a 3 day Tutorial on Verification (Melbourne, Australia, 2011), Hands-on forecast verification training (Lima, 2010), Summer Colloquium on Forecast Verification (Boulder, United States, 2010), and a 1 day Training Workshop on Verification of Ensembles (Reading, United Kingdom, 2013).

8.1.2.3 The Commission noted the publication of the proceedings of the 4th International Verification Workshop (Helsinki, 2009) and the special issue of Meteorological Applications (Journal of the Royal Meteorological Society) in June 2013 on verification and two new guidance documents: Recommended Methods for Evaluation of Clouds and Related Parameters (2012) and Recommended Methods for the Verification of Tropical Cyclone Forecasts (2013).

8.1.2.4 The Commission noted the active involvement of the JWGFVR in various WMO projects which includes: Commission for Instruments and Methods of Observations (CIMO)/Solid Precipitation Instrument Calibration Experiment (SPICE), FROST2014 (WWRP FDP/RDP for the Sochi Olympics), South China Monsoon Rainfall Experiment RDP (SCMREX), Typhoon Landfall FDP, Polar Prediction Project, Sub-seasonal to Seasonal Prediction project (S2S), and WMO Severe Weather Forecast Demonstration Projects (SWFDPs). Its involvement in these projects is mainly to ensure the use of appropriate verification methods. The Commission recognized the substantial work carried out by JWGFVR for WWRP RDPs and FDPs and encouraged the working group to provide the same level of support to the High Impact Weather (HIW) project which is being established.

8.1.3 Sub-seasonal to seasonal prediction

8.1.3.1 The Commission recalled its request during CAS-XV to WWRP including THORPEX, to set up an appropriate collaborative structure with the World Climate Research Programme (WCRP) to carry out an international research initiative on sub-seasonal to seasonal forecasting, closely coordinated with the existing CBS infrastructure for long-range forecasting. The Commission appreciated the significant progress that has been made in establishing the Sub-seasonal to Seasonal Prediction project (S2S) as a joint WWRP-WCRP project, and the detailed science and implementation plan for the S2S which was developed and is available at: http://www.wmo.int/pages/prog/arep/wwrp/new/documents/S2S_Implementation_plan_final.pdf.

8.1.3.2 The Commission also noted that EC-64 approved the S2S project and the establishment of its Trust Fund and International Coordination Office (ICO) as support mechanisms. The Commission extended its appreciation to the Republic of Korea whose offer to host the ICO for the project has met all the requirements. WMO and the Korea Meteorological Administration (KMA) signed a Memorandum of Understanding (MoU) during EC-65 to formalize the S2S ICO.

8.1.3.3 The Commission viewed S2S as an important project for the weather and climate research communities to jointly address a forecasting time scale that has traditionally been regarded as scientifically challenging, at the interface between weather and climate. The Commission was pleased to note the constructive cooperation S2S had established between these research communities. The Commission acknowledged that improvements in the predictive skill and use of sub-seasonal to seasonal predictions could also benefit shorter-range weather predictions and longer timescale climate predictions as well as contributing towards improved climate services within the Global Framework for Climate Services (GFCS).

8.1.3.4 The Commission noted that the WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (LC-LRFMME) is coordinated by the KMA. The Commission encouraged the WWRP to ensure that the co-location of this Lead Centre with the S2S ICO be used optimally in ensuring strong links between operational requirements and research activities, and in facilitating transitioning of research outcomes into operations.

8.1.3.5 The Commission noted with appreciation the contributions of Australia, the United Kingdom and the United States to the S2S Trust Fund. The Commission also encouraged Members to contribute to the Trust Fund that will support the implementation of the research activities related to this project.

8.1.3.6 The Commission noted with appreciation the contribution of ECMWF and CMA to undertake the S2S database archiving and to provide data services.

8.1.4 Links between the Polar Prediction Project and the WCRP Polar Climate Predictability Initiative

8.1.4.1 The Commission noted that significant progress had been made in the implementation of a Polar Prediction Project (PPP) following the discussion at CAS-XV on the decision by the Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS), that the design and development of polar prediction systems is an important task that will require effective collaboration across WWRP, including THORPEX, GAW and WCRP along with other partners as appropriate.

8.1.4.2 The Commission appreciated that detailed science and implementation plans for the PPP have been developed and are available on the website: http://polarprediction.net/en/documents/.

8.1.4.3 The Commission noted that EC-64 approved the project and the establishment of a Trust Fund and an International Coordination Office (ICO) as support mechanisms. The Commission extended its appreciation to the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany, for offering to host the ICO for the project.

8.1.4.4 The Commission noted the rapid changes in Polar Regions, both in terms of the physical environment as evidenced from record variability in sea-ice melts in the Arctic in recent NH Summers and with regards to the growing socio-economic need for improved environmental predictions. The Commission recognized that changes in the Polar Regions could also have consequences for weather and climate events that extend far beyond these regions. It also noted that there are significant gaps in observational networks in the Polar Regions, for weather and climate timescales in the understanding of key processes, and in modelling and predictions. The Commission expressed its satisfaction regarding the cooperation between PPP and the WCRP Polar Climate Predictability Initiative and encouraged the two initiatives to continue to engage closely and seek areas for active collaboration.

8.1.4.5 The Commission accepted that the PPP will promote cooperative international research which will develop improved weather and environmental prediction services for the Polar Regions, on time scales from hourly to seasonal and that PPP constitutes the hourly to seasonal research component of the WMO Global Integrated Polar Prediction System (GIPPS) under EC-PORS, while WCRP Polar Climate Predictability Initiative is a longer-term component of GIFFS covering the time ranges from seasons to decades.

8.1.4.6 The Commission noted the progress in the planning of a Year of Polar Prediction (YOPP) and that YOPP includes strong links with other related activities. The Commission encouraged Members to engage in the planning process and, where appropriate, to use this as an opportunity to strengthen observational networks and polar science initiatives.

8.1.4.7 The Commission noted with appreciation the contributions of Canada, the United Kingdom and the United States to the PPP Trust Fund. The Commission also encouraged Members to contribute to the Trust Fund that will support the implementation of the research activities related to this project.

8.1.5 Year of Tropical Convection

The Commission recognized that the WWRP-THORPEX/WCRP YOTC project has contributed to significant advances in understanding and modelling of tropical convection and its organization into complex multiscale precipitation system that are often associated with extreme weather, e.g., monsoon floods and breaks, intraseasonal oscillations and tropical cyclones (yotc.ucar.edu). The YOTC project will formally conclude at the end of 2014 but the research component will continue in collaboration with the WWRP/WCRP S2S project, and the WGNE MJO Task Force. The Commission urged a continued focus on improving understanding and modelling of organized convection at the intersection of weather and climate (sub-seasonal to seasonal time scales) to improve operational weather and climate predictions.

8.1.6 Japanese 55-year Reanalysis by the Japan Meteorological Agency

The Commission acknowledged that the Japan Meteorological Agency has completed the Japanese second global atmospheric reanalysis: JRA-55 covering from the year 1958 onward. The Commission took note that advanced reanalysis products are indispensable for better weather and climate monitoring and applications which also contribute promoting GFCS.

8.2 Cross-cutting initiatives within WMO and with partners (agenda item 8.2)

8.2.1 Supporting implementation of the Global Framework for Climate Services

8.2.1.1 The Commission noted the significant progress made in the development of the Global Framework for Climate Services (GFCS).

8.2.1.2 The Commission recognized its relevant role in the effective implementation of the pillars of the GFCS (User Interface Platform; Observations and Monitoring; Climate Services Information System; Research, Modelling and Prediction; and Capacity Development) as well as the activities in the initial four priority areas of the GFCS (Agriculture and Food Security; Water; Health, and Disaster Risk Reduction).

8.2.1.3 The Commission noted the roles of the World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW) Programme, in close cooperation with the World Climate Research Programme (WCRP), in the development of the GFCS Implementation Plan, specifically the Observations and Monitoring, and Research, Modelling and Prediction Annexes.

8.2.1.4 In particular, the Commission noted the initial activities as identified under the Annex on Research, Modelling and Prediction component of the GFCS as follows:

(a) Strengthening planning and coordination of present and future research strategies and virtual forums supporting them, engaging sponsors;

(b) Bridging communities producing experimental and regular climate information;

(c) Research in support of core climate products, including sub-seasonal to seasonal predictions, decadal and centennial predictions;

(d) Research on climate observations, climate change detection, and development of climate data records.

8.2.1.5 Early efforts for implementation of the GFCS are taking place through specific activities supported by various donors. Early implementation will also be effected through the implementation of the activities contained in the Annexes to the Implementation Plan that describe the components of the GFCS, and the compendium of initial GFCS projects approved by the first session of the Intergovernmental Board on Climate Services (IBCS-1). The Commission recognized that these activities will require the support of the Commission, particularly as they relate to research and other issues of relevance to the Commission.

8.2.1.6 The Commission viewed the initiatives related to the Sub-seasonal to Seasonal Prediction Project (S2S) and the Polar Prediction Project (PPP), and the integrated greenhouse gas information system as important contributions to the GFCS. The Commission recommended that the climate service needs for megacities and large urban complexes and enhanced information systems for greenhouse gases should be considered as priorities in GFCS in the future.

8.2.2 Interaction with the WMO Integrated Global Observing System and the WMO Information System

8.2.2.1 The Commission noted that WIGOS is a future framework for coordination and evolution of WMO observing systems and WMO contributions to co-sponsored observing systems;

a framework for enabling the integration, interoperability, optimized evolution and best practice operation of WMO observing systems.

8.2.2.2 The Commission thanked its CAS experts that have been actively involved in WIGOS by representing the Commission in its activities and Expert Teams, including the Inter-Commission Coordination Group (ICG-WIGOS), the Task Teams on WIGOS Metadata (TT-WMD), WIGOS Regulatory Material (TT-WRM), WIGOS Implementation Plan (TT-WIP) and WIGOS Quality Management (TT-WQM).

8.2.2.3 The Commission recognized that GAW, with its well developed quality assurance/ quality control (QA/QC) system, infrastructure for central facilities, and the GAW Station Information System (GAWSIS), is in a position to serve as an example in WIGOS. The Commission noted the importance of involving facilities outside of the Secretariat for the upkeep of operational activities. This concerns in particular the WIGOS Observing Systems Capabilities Analysis and Review Tool (OSCAR) in support of the Rolling Review of Requirements (RRR) process. The Commission stressed that the relevant benefit of WIGOS for Members will be easier interoperability between its different components and through this the easier access to, and documentation of, data and products.

8.2.2.4 Recognizing that in order to function properly GAW requires collaboration between NMHSs, different agencies, institutes and academia, the Commission noted that it will be very important that for mutual benefit, access to the WIS system be provided in an easy way to these institutes. Meteorological observations play a very relevant role in the interpretation of atmospheric chemistry data and thus both depositing and accessing data is very important.

8.2.2.5 Considering that detection of volcanic ash requires collaboration between different WMO Programmes, the Commission agreed to work with CBS, CIMO, CAeM, RA VI and other relevant bodies on the development of a RA VI WIGOS volcanic ash project.

8.2.2.6 The Commission noted that WIS, the WMO Information System, became operational in January 2012. Fifteen centres have been designated as Global Information System Centres (GISCs) to coordinate the global exchange of information. The Commission was pleased to note that two WMO/GAW World Data Centres (WDCs) had been fully designated as Data Collection or Production Centres (DCPCs): WDC-RSAT (World Data Centre for Remote Sensing of the Atmosphere, Germany) and WDCGG (World Data Centre for Greenhouse Gases, Japan). Three further GAW centres were being assessed: Regional Ozone Centres in Argentina and Egypt and the GAW World Data Centre for Aerosols in Norway. The Commission for Basic Systems (CBS) is responsible for assuring the WIS functionality of these centres, and CAS is responsible for assuring the quality of the data provided through them. The Commission was informed that although actively preparing WIS Discovery Metadata records, the GAW Station Information System (GAWSIS, Switzerland) was actively preparing WIS Discovery Metadata records and will undergo the procedure for designation as a DCPCin 2014 after complete re-factoring of the application.

8.2.2.7 WIS Discovery Metadata records allow users to find out what information is available through the WIS, the formats in which the information is available (these are not limited to electronic formats), and how users can request the information. Authorized users can download recent copies of information that is exchanged globally in real time from a GISC or request that the information is sent to them each time new sets of information are received by the GISC (by e-mail, ftp or other method supported by the GISC). The Commission encouraged centres supporting its programmes to provide relevant WIS Discovery Metadata records to describe the information they are able to share.

8.2.2.8 The Commission welcomed the increased availability offered by WIS for centres to receive information exchanged on the GTS. The Commission recognized that WIS allows centres not connected to NMHSs to submit information for routine global exchange, but noted that the procedures for doing so were not uniform across WIS centres and relied on the centres providing information to liaise with a WIS National Centre, DCPC or GISC to agree on the protocols for

delivering the information. The Commission also noted that GAW information was being used routinely by operational NWP centres.

8.2.2.9 Noting that WIS allows information to be exchanged in a wider range of formats than had been traditionally allowed by the GTS, the Commission recognized that proliferation of data formats potentially acts against the WIS objective of sharing information between different communities. To avoid unnecessary complexity in data exchange, the Commission recommended that CAS experts were to represent the interests of the Commission in the relevant CBS Inter-Programme Expert Teams so that the standards being developed by CBS would meet the needs of the Commission.

8.2.3 Supporting disaster risk reduction

8.2.3.1 The Commission recalled that Sixteenth Congress (Geneva, 2011) approved the WMO Disaster Risk Reduction (DRR) Programme's two-tier Work Plan (hereafter referred to as the DRR Work Plan) which was further endorsed by the sixty-fourth session of the Executive Council (Geneva, 2012) (http://www.wmo.int/pages/prog/drr/documents/2013.09.26-DRRWorkPlan2012-2015.pdf). The components of the this Plan include: (i) development of thematic guidelines, standards and training modules, based on documentation and synthesis of good practices; and (ii) coordinated DRR and climate adaptation national/regional capacity development projects. It further recalled that EC-64 (2012) and EC-65 (2013) approved the establishment of four thematic DRR user-interface expert advisory groups to guide and support implementation of the DRR Work Plan and related deliverables, involving leading experts from the diverse DRR user community (public and private sectors), UN and international partner agencies, academia as well as NMHSs.

8.2.3.2 The Commission noted that following discussions at the 2012 Meeting of the Presidents of Technical Commissions (TC), the WMO TCs and Programmes designated DRR Focal Points who had been actively reviewing the DRR Programme Work Plan with a view to contributing to the development of guidelines, recommended practices and standards on weather-, water- and climate-related hazard definitions, monitoring, detection, archiving data and metadata, and hazard mapping and analysis using statistical and forward looking techniques (now-casting, forecasting and analysis) to support risk analysis. The Commission's Focal Point is a member of the WWRP Working Group SERA.

8.2.3.3 The Commission recognized that the research initiatives on high-impact weather, megacities and large urban complexes and the joint WWRP and WCRP research project on sub-seasonal to seasonal prediction has strong relevance to this work.

8.2.4 Group on Earth Observations: activities and cooperation

8.2.4.1 The Commission noted the strong and constructive links with the Group on Earth Observations (GEO).

8.2.4.2 The Commission specifically noted that cooperation between GAW and GEO focuses on the GEO Carbon activities and the development of an integrated global carbon observation and analysis system. The Commission appreciated the contributions that have been significant through the legacy of the IGOS Carbon Theme and through direct participation of GAW in the GEO Carbon Community of Practice. The Commission further noted that GAW observations and analysis constitute the basis for GEO Carbon strategy implementation in the atmospheric domain with high quality observations.

8.2.4.3 With regard to GEO Health activities and the development of tools and information for health decision-making, the Commission was informed that the WMO Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS) has been a key contribution, in particular for monitoring/forecasting aerosol atmospheric cycles and reducing related risks for health (e.g., meningitis). The Commission encouraged Members involved in SDS-WAS activities to re-establish links with GEO as additional environmental data available to GEO would also benefit sand and dust storm process studies and research.

8.2.4.4 The Commission noted that as of 2013, WWRP-THORPEX (THe Observing system Research and Predictability EXperiment) and GAW have been providing key contributions to the Weather and Climate Tasks of the GEO Work Plan, and thus, considering the cross-cutting nature of GEOSS, to GEOSS implementation as a whole (e.g., to Agriculture, Disasters, Energy, Health, Water). The cooperation on THORPEX has been on-going since 2006.

8.2.4.5 The Commission took special note of the fact that key outputs of the ARE-GEO collaboration include the funding by the European Union of the GEOWOW project 2011–2014 (THORPEX Interactive Grand Global Ensemble (TIGGE) related; see http://www.geowow.eu/) and the GEO Carbon project 2011–2014 (GAW related; see http://www.geocarbon.net/).

8.2.4.6 The Commission was informed of the future prospects related to the next GEO Plenary and Ministerial Summit (Geneva, 15–17 January 2014) which include a number of opportunities for interaction. The development of the next phase of GEO (post-2015) and the new GEOSS Implementation Plan will provide the possibility for updating the GEOSS Strategic Targets and further improving the framework for collaboration between the Commission and GEO.

8.2.5 Capacity development

8.2.5.1 The Commission recognized the increased coordination between the WWRP, GAW, and the Education and Training Programme. This coordination allows NMHS personnel, particularly young scientists, to contribute to and benefit from wider research activities and outcomes.

8.2.5.2 The Commission noted that during the intersessional period WMO, through its Fellowship Programme, had signed a Memorandum of Understanding with the World Academy of Sciences (TWAS – www.twas.org). This allows for the promotion and support to Masters and PhD studies in order to build the research capacity in NMHSs, especially in developing and least developed countries. The Commission also encouraged Members to consider hosting on-the-job training fellowships, thereby creating opportunities for efficient knowledge transfer from experts in a real-world environment.

8.2.5.3 The Commission recalled that a number of its experts had provided input or feedback for courses organized and supported by the WMO Regional Training Centres (RTCs). The Commission encouraged these, in collaboration with GAW, to develop capacity for conducting atmospheric composition observations training. It supported the plan of the WWRP to organize future training events in WMO RTCs and to utilize e-learning (i.e., web-based technologies).

8.2.5.4 The Commission appreciated the vital support by Germany for the regularly organized training sessions at the GAW Training and Education Centre (GAWTEC) on atmospheric composition observations and their quality assurance, and acknowledged regular contributions by Switzerland, the United States, Norway and Finland. The Commission further appreciated the support of other training activities, especially those combined with instrument intercomparisons, and the support of young scientists to attend important conferences. All these activities are also important for expert network building. The Commission stressed that high quality observations and the provision of reliable services can only be performed by trained staff.

8.2.6 Sand and Dust Storm Warning Advisory and Assessment System

8.2.6.1 The Commission noted that dust emissions represent an important natural source of atmospheric particulate matter on a global scale. The Commission realizes the importance of various impacts of the atmospheric dust on health, natural ecosystems (including acidification), and economical sectors, such as air and ground transportation, generation of solar energy and semiconductor industry, and insurance sector, but also that it plays an important role for weather and climate through direct and indirect aerosol effects.

8.2.6.2 Understanding that there are still large uncertainties in diagnosing and predicting dust genesis and fate, the Commission encourages research especially in implementing high resolution

dust modelling, performing dust reanalysis, developing dust data assimilation and identification of dust sources at high resolution scales. Observations are essential for nowcasting, data assimilation, and forecast evaluation. However, most of the current observations are integrated over all aerosol components and often over the full atmospheric column. For these reasons the Commission encourages the deployment of advance dust observation systems near dust sources, as well as facilitation of active observation data sharing on research basis.

8.2.6.3 The Commission recognizes the efforts of Spain and China to support the SDS-WAS Regional Centres and to lead the development of the SDS-WAS Regional nodes.

8.2.6.4 The Commission recognizes the efforts of Spain and France to increase the observational capacity in Northern Africa, i.e. North of the equator, and to support regular training events aimed to encourage and facilitate the use of the products supplied by the SDS-WAS.

8.2.6.5 The Commission was pleased to note that the WMO EC-65 (2013) approved the Commission for Basic Systems (CBS) recommendations made at its fifteenth session in 2012 that mandatory functions and criteria for the designation of an RSMC with activity specialization in Atmospheric Sand and Dust storm Forecasts (RSMC-ASDF) are to be incorporated in the *Manual on the Global Data-processing and Forecasting System (GDPFS)* (WMO-No. 485). EC-65 also approved the recommendation to formally designate the SDS-WAS regional node in Barcelona, Spain, as the RSMC-ADSF for the region consisting of Northern Africa (north of Equator), the Middle East and Europe. The Commission also welcomed the initiative to designate another SDS-WAS regional node in Beijing, China, as the RSMC-ADSF for the region consisting of Asia and the Central Pacific.

8.2.6.6 The Commission agreed that the Joint CBS-CAS Task Team on Atmospheric Sand and Dust Storm Forecasts should prepare a study on the evaluation of dust prediction models to address concerns expressed at CBS-15 and report on it to the CAS Management Group (MG).

8.2.6.7 The Commission noted that at CBS-15 many Members had informed of their own capabilities to produce and deliver atmospheric sand and dust storm forecasts, and expressed keen interests in cooperating in such activities. The Commission therefore recalled and stressed the need for an assessment of these capabilities, especially as related to serving as an RSMC-ADSF.

8.2.6.8 The Commission noted that the project “Assessment of Sand and Dust Storms in West Asia Region” was realized by WMO in collaboration with UNEP in response to emerging interest of West Asian countries to improve monitoring and forecasting the atmospheric dust genesis and fate. The Commission also noted that the outcome of the project is a report that includes providing guidance for the possible future establisment of a new SDS-WAS regional node in West Asia.

8.2.6.9 The Commission noted that ‘Dust and Sand Storms in East Asia’ had been published by the Asia-Pacific Journal of Atmospheric Sciences as a special issue on January 2013. This special issue was stimulated by the international collective efforts by Northeast Asian countries according to the Tripartite Environment Ministers Meeting among China, Republic of Korea and Japan (TEMM). The Commission was especially pleased to note that this special issue was produced as a result of continuous data sharing since 2007 (for scientific cooperation against Sand and Dust Storms).

8.2.6.10 The Commission noted the establishment of the Pan American Centre in the United States as a third regional node in SDS-WAS. This Centre, sponsored by Chapman University, will cover North, Central, and South America as well as the Caribbean. The Commission urged all Members in this region to reach out to this new Centre in order to ensure a global perspective of wind-blown dust.

8.2.6.11 The Commission noted the need to carry out capacity building activities of dust forecasting systems and on development of dust products from remote sensing observations specially focused to developing countries in Africa and Asia severely affected by dust storms.

8.2.6.12 The Commission supported the updating of the SDS-WAS Implementation Plan during 2013 and requested that this be brought to the CAS MG. The Commission urged the Secretariat to establish an SDS-WAS Steering Committee for global research coordination of regional activities, supported by a trust fund, as proposed by the Plan. The Commission recommended EC-66 to invite contributions to the trust fund that is to be established. The Science and Implementation Plan would serve as a guide to the research community for further improvements of dust monitoring and forecasting.

8.2.7 Transitioning from research to operations in numerical weather prediction, including links to the Severe Weather Forecasting Demonstration Project

8.2.7.1 The Commission highlighted the importance of the cooperation and coordination between the WWRP, THORPEX and the CBS OPAG on Data-processing and Forecasting Systems (CBS/OPAG-DPFS) for the transfer of relevant research outcomes to operations, including for example the implementation of a series of proven, modernizing enhancements to the forecasting process, i.e., products and methods that have already been introduced in many Global Data-processing and Forecasting System (GDPFS) centres, which could be relevant to a number of NMHSs that have not yet used or applied them. In particular, the Commission recommended the early engagement of the CBS/OPAG-DPFS in the following projects and bodies: (a) Sub-seasonal to Seasonal Prediction Project; (b) Polar Prediction Project; (c) High-Impact Weather Prediction Project; the to be established (d) WWRP Working Group on Predictability, Dynamics and Ensemble Forecasting; and (e) WWRP Working Group on Data Assimilation and Observing Systems after THORPEX. In this context, the Commission requested that its president consider inviting CBS to appoint (a) representative(s) from the CBS/OPAG-DPFS to the THORPEX ICSC, the WWRP JSC, as well as to the above-mentioned projects' steering groups and teams.

8.2.7.2 The Commission recognized that the Severe Weather Forecasting Demonstration Project (SWFDP), developed and led by CBS, has proven to be an excellent framework for building capacity and for transferring knowledge and skills to NMHSs, especially those of developing countries, and agreed that its approach should be used to implement a series of ready-for-production enhancements to the forecasting process and to provide benefits to other scientific and technological developments that are intended for operational implementation. In addition, the Commission noted that several of the WWRP Working Groups have already been engaged in assisting in activities of regional SWFDP projects, including as examples, on Global Integrated Forecast System (GIFS)-TIGGE, Nowcasting Research, and Forecast Verification Research.

8.2.7.3 The Commission recalled that the CAS Forecast Demonstration Projects (FDPs) and Research and Development Projects (RDPs) focus on demonstrating the potential of research models, tools and techniques in an operational setting and the initial stages of the transfer of research to operations, while SWFDP has demonstrated a concept-of-operations (the "Cascading Forecasting Process"), which has now become mature (as a demonstration and as a project) and rolled out in several regions as a development programme. The Commission requested that synergies be established between its FDPs/RDPs and the SWFDP to maximize the long-lasting benefits of innovative techniques to real-time operational communities and users.

8.2.8 Identified regional needs

8.2.8.1 The Commission noted that its president, in early 2013, in support of the efforts to improve cooperation between technical commissions and regional associations, requested the presidents of regional associations to identify the primary research priorities of Members in their Regions. The feedback received includes the following:

(a) High impact weather research through observational research, data assimilation and model development focusing on high resolution spatial scales, ensemble techniques aligned to satisfying user needs;

(b) Sub-seasonal to seasonal prediction research to improve forecasts related to the onset and end of seasonal rainfall and intra seasonal variations, primarily aimed at agriculture and water resource management;

(c) Polar prediction research and the impact of polar processes on mid-latitude weather;

(d) Improving the accuracy of quantitative precipitation estimates (QPEs) and the accuracy and lead times of quantitative precipitation forecasts (QPFs) for flash flood and river basin flood warning systems and water resource management;

(e) Continuous improvements related to all aspects of tropical cyclone forecasts;

(f) The importance of RDP and FDP in responding to the regional and national research needs related to weather, climate, water and related environmental issues;

(g) Strengthening the global observation network related to aerosols, including sand and dust, volcanic ash, and the data assimilation, modelling and prediction systems for these phenomena;

(h) General strengthening of the GAW networks and its data quality and availability to support assessments and policy development.

8.2.8.2 The Commission observed that the current and planned activities of the Commission are well positioned to meet the needs identified. The Commission endorsed these priorities and agreed to take them into account in future planning. It further encouraged the president to continue with the engagement with other technical commissions and regional associations to strengthen cooperation and alignment.

9. EMERGING CHALLENGES AND OPPORTUNITIES FOR THE DECADE TO COME (agenda item 9)

9.1 High-impact weather and its socio-economic effects in the context of global change (agenda item 9.1)

9.1.1 The Commission acknowledged that despite noteworthy progress in the development of weather prediction and early warning systems during the past decades, high impact weather remains a serious risk to sustainable development in the 21st Century. High impact weather events have a growing social and financial impact in a changing climate, on a growing population and the infrastructure they depend on. The Commission agreed that accelerated and focused research is required to further improve the prediction of these events at wide range of scales, especially at local scales where decisions need to be made.

9.1.2 The Commission noted with appreciation that the World Weather Research Programme (WWRP) is placing special emphasis on advancing better predictions of high impact weather events on wider time ranges, from nowcasting to seasonal time scale, as the socio-economic effects of these events remain of central importance to Members. The Commission requested WWRP to coordinate its activities related to high impact weather with the World Climate Research Programme (WCRP), GFCS, and relevant Commissions, the regional associations, NMHSs, and the appropriate WMO Programmes.

9.1.3 The Commission urged WWRP to work closely with WCRP towards preparing scientific studies on the impact of climate change on high impact weather events (frequency and intensity), along similar lines to the statement on the impact of climate change on tropical cyclone activity by the Expert Team on Climate Change Impacts on Tropical Cyclones.

9.1.4 The Commission stressed the importance of high-resolution, coupled modelling systems in predicting and addressing the consequences of high impact weather experienced on a

local level and often characterized by a chain domino effect triggered by an atmospheric event. Seamless prediction systems that cover a range of forecast and spatial scales and which follow an Earth system modelling approach have the potential to provide the accurate, quantitative information needed by Members to support societal decision-making. A high priority should be given to research into realizing the potential of coupled systems, including improving process understanding, the usage of observation, the technical realization, and assessing the utility and value of a coupled approach for different applications. These prediction systems must be supported by an appropriate observational capability to support accurate initialization.

9.1.5 The Commission noted that in addition to the several common indices used for forecast verification, WWRP should also contribute towards developing user-orientated verification indices for high-impact weather events in order to quantify how well the modelling systems predict these events and to track changes in the predictive skill over time.

9.1.6 The Commission noted the outline and executive summary of the draft High Impact Weather (HIWeather) Research Project that has been developed during 2013 under the auspices of WWRP and THORPEX as a post-THORPEX legacy project. The Commission appreciated the scope and limits of the project being defined by a set of weather-related hazards and corresponding applications. The Commission noted that the project covers timescales of minutes to two-weeks but it supported the special emphasis given to shorter timescales (minutes to a few days), higher resolutions and coupling between the atmosphere and surface processes, including hydrological processes.

9.1.7 The Commission acknowledged that the use of predictions has value only when they support decisions and supported the emphasis placed on communication and interaction with stakeholders. In particular, the Commission emphasized the importance of involving operational forecasters in the HIWeather project. The Commission welcomed the consideration that will be given to high impact weather in urban environments, as well as including flooding as a central element in many high impact weather phenomena. The Commission recommended that special attention be given to better predict the hydrological consequences of high impact weather and to build resilience of the urban environment against them.

9.1.8 The Commission noted that in addition to promoting research to advance the prediction of high-impact weather events, WWRP should consider also promoting research in the prediction of the societal impacts of these high-impact weather events.

9.1.9 The Commission requested the WWRP to further refine the HIWeather project plan and to consult widely in the process to ensure that the needs of Members are considered, so that the most pertinent scientific issues receive priority. The link to the WMO priority on disaster risk reduction (DRR) should be particularly strong. WWRP should actively engage the academic community in the project and continue to develop cooperation between the academic and operational communities. The Commission further requested WWRP to ensure that this project is formally established in a similar manner to the Polar Prediction Research Project (PPP) and the Sub-seasonal to Seasonal Prediction Research Project (S2S) through the consideration of Members at the sixty-sixth session of the Executive Council, with a resolution that calls for establishing a trust fund and solicits Members to host an international coordination office for the project.

9.1.10 The Commission noted with appreciation that the new research initiative on High Impact Weather (HIWeather) is well aligned to address DRR and urged the WWRP to ensure that the recommendation made is incorporated in the development of the implementation plan of this project. The Commission requested Members to prepare their support to the HIWeather project through making expertise and resources available to effectively develop and implement the project.

9.2 Water: modelling and predicting the water cycle for improved disaster risk reduction and resource management (agenda item 9.2)

9.2.1 The Commission acknowledged that the water cycle provides a crucial link between the various Earth system components that govern weather and climate processes. It further agreed that besides water supporting life, its relative abundance or scarcity is often at the core of weather- and climate-related disasters, such as floods, droughts and storm surges. The Commission also noted that humanity is dependent on fresh water from precipitation for many of its activities, including energy generation, and that developing parts of the world are exposed to water stress.

9.2.2 The Commission realized that the water cycle processes and associated energy exchanges are complex. The phase changes of water involve substantial exchanges of energy that feed into weather systems and impact on climate. The Commission further realized that the numerical frameworks that represent water cycle process in numerical atmospheric models are complex and not fully resolved. The Commission acknowledged that atmospheric models still have deficiencies related to the treatment of water and encouraged efforts to further improve the representation of moist processes and the coupling between atmospheric, oceanographic, hydrological and cryosphere models.

9.2.3 The Commission recognized that water is also closely linked to atmospheric chemistry and the work of the Global Atmosphere Watch (GAW) Programme. These links are not limited only to precipitation chemistry, but also include in more general terms the ways chemical transformation is affected by humidity and the presence of water in liquid or solid form. Furthermore, aerosols and droplet nucleation in clouds are intimately linked.

9.2.4 The Commission, in considering the importance of water and the gaps in scientific understanding and prediction system on both weather and climate scales, requested the WWRP and WGNE to include a water-specific emphasis in activities and projects. The Commission was encouraged by the closer cooperation with the Commission for Hydrology (CHy) and requested the S2S and HIWeather projects to ensure representation of CHy in their activities. The Commission further recommended that research be conducted on how to improve communication between providers and users of weather and water information, particularly in the context of disaster risk reduction.

9.3 Integrated Greenhouse Gas Information System: serving society and supporting policy (agenda item 9.3)

9.3.1 The Commission noted the conclusions of the recent IPCC report, which confirmed that the climate is changing, and that those changes are driven by greenhouse gases with the dominant role played by carbon dioxide.

9.3.2 The Commission acknowledged the efforts by society to reduce CO_2 emissions. Mitigation efforts will vary by region, nation and local communities and emission sectors (energy, industry, etc.) and will be diverse in their approach. On the other hand, the complexity of the carbon cycle, the scale of the problem, and the number of greenhouse gases involved in negotiations are challenging. The Commission recognized that emission reduction approaches require independent, scientific information to support verification and policy decisions.

9.3.3 The Commission noted that currently emission reductions are monitored through self-reported inventories, but that it has become increasingly clear that these alone are not enough, as inventories require independent verification. To be useful for verification on policy-relevant scales, independent analyses are best derived with atmospheric inversions (where atmospheric observations are used to constrain numerical models). Because there are large reservoirs of carbon in the terrestrial and oceanic environment that exchange with the atmosphere, the verification process must be able to separate human from natural influences if it is to inform policy or engineering decisions. Doing this requires an Integrated Greenhouse Gas Information System (IGIS) that is global in scale, but also addresses sub-continental, policy-relevant regions.

9.3.4 The Commission appreciated on-going developments to establish IGIS, including such programmes as the North American Carbon Program (NACP) in the United States, Canada, and Mexico, the Integrated Carbon Observation System (ICOS) in Europe, expansions of observation suites in developing countries such as China and Brazil, cross-cutting initiatives involving commercial aircraft, and even private organizations that can enhance observing system infrastructure and information delivery. The Commission appreciated on-going efforts from TCCON (Total Carbon Column Observing Network) to consolidate a global network that can play a key role in GHG satellite and model validation as well as in model data assimilation. By integrating these and other observations, in particular emerging observations from satellites, through validation, quality control, and analysis, one can deliver robust, sub-continental scale information that is globally coherent.

9.3.5 The Commission noted that implementations of IGIS requires higher density of the greenhouse gas observational network and increased variety of observations (including isotopic measurements and measurements of co-emitted species), improved complexity and performance of transport models on global, regional and local scales, and better coordination of efforts with developments in other Earth system components (e.g. biosphere and oceans). The Commission requested Members to undertake the necessary steps in the development of these high-quality observations for them to be compatible with the established GAW network and to improve the modelling tools to implement IGIS.

9.3.6 The Commission agreed that WMO Programmes have a confirmed capacity to develop the atmospheric part of IGIS but it also stressed that full implementation of IGIS would require the established collaboration with other international organizations and coordination bodies, e.g., working together with GEO-Carbon, GCOS and CEOS.

9.4 Aerosols: impacts on air quality, weather and climate (agenda item 9.4)

9.4.1 The Commission noted that atmospheric aerosols affect our health, influence weather and climate and carry acidifying, eutrophying and toxic chemicals over long distances before they are deposited. The link between mortality and particulate matter is well established but not well understood. Aerosols are relatively short-lived and complex in composition, resulting in a high spatial and temporal variability. Therefore monitoring and modelling aerosol is a significant challenge, with many stations needed to measure a wide variety of variables including chemical characterization and modelling developments across the spatio-temporal scales, from global to local.

9.4.2 The Commission further noted that concerning climate, the uncertainty in total anthropogenic climate forcing is to a great extent due to uncertainties in aerosols' radiative forcing. However, only few stations have data sets long enough to perform trend analyses of aerosol properties. In this context, the Commission noted with appreciation the establishment of four advanced aerosol sites (in Indonesia, Chile, Viet Nam and Kenya) within GAW supported by Switzerland (CATCOS). Other groups are also involved in capacity building which is essential in setting up a network covering all relevant regions of the Earth.

9.4.3 The Commission recommends to make use of advances in aerosol research, with new measurement methods like the aerosol mass spectrometer that recently has become available and allow performing a detailed source apportionment in an unprecedented way. Simplified versions, such as the aerosol chemical speciation monitor, allow for long-term operation and year-long data sets have been acquired at certain sites. Their long-term performance is currently tested within the European project ACTRIS; if successful these instruments should also be applied at GAW stations outside of Europe.

9.4.4 The Commission recommended to carry out vertical profiling for aerosols, also as a bridge between in-situ observations and satellite observations, using lidar technology, and strive for a 3-dimensional observed distribution of aerosols and their properties by integrating available measurement platforms - in situ, ground based and satellite borne remote sensing as well as aerosol properties observed from civil aircraft (IAGOS).

9.4.5 The Commission recommended to plan for an integrated global aerosol observation system. It should foster aerosol-related process studies, validation of satellite sensors, model development and evaluation, assimilation of aerosol data into operational models, and comprehensive aerosol climatology on a global scale.

9.4.6 The Commission recommended to learn from the MACC-II European project how it provides global environmental predictions, in general, and particularly concerning aerosols. It also provides a framework that allows testing for proposed parameterizations on, e.g., aerosol formation or aerosol radiative effects, trying out the magnitude of the aerosol direct effects on numerical weather prediction in the ECMWF/IFS system.

9.4.7 The Commission underlined that the global air composition forecasting system needs to be complemented with higher resolution aerosol models covering regional and urban scales (megacities), which allow addressing air quality and health impacts in particular. Again, the MACC-II European project can provide a way forward. Dust forecasts provided through SDS WAS Regional Nodes meet specific needs in large areas of the world. Aerosol modelling exercises and model intercomparisons, such as conducted in WGNE (aerosol-NWP), AEROCOM (global aerosol), SDS-WAS RC NA-ME-E (Dust) or AQMEII (air quality), are necessary for progress.

9.5 Urbanization: research and services for megacities and large urban complexes (agenda item 9.5)

9.5.1 The Commission noted that more than half the world's population is living in urban areas, and that this proportion and the absolute numbers will increase throughout this century. The Commission also noted that high density populations have particular sensitivities to climate variability and change, and degration of air quality; these sensitivities arise through the enhancement of extreme events (e.g., flooding, drought, heat waves, storm surges, and air pollution episodes), health impacts (e.g., epidemic breakouts, and respiratory chronic diseases), and economic disruption (e.g. transportation, tourism, construction, and school access).

9.5.2 The Commission realized that it is essential to establish capabilities in urban areas for the provision of necessary environmental information for urban planning and safe functioning of cities. This in turn can profit surrounding areas and also other urban areas or cities within, or outside of the country, directly or indirectly, by setting an example. The Commission noted that cross-cutting coordination and collaboration is required, as in many cases several wide ranging agencies have responsibilities for providing services that are impacted by weather and climate.

9.5.3 The Commission appreciated the initiative to develop comprehensive guidelines for establishing weather, climate, water and related environmental services for megacities and large urban complexes (referred to as Integrated Urban Weather, and Climate Services). The Commission was pleased with the findings of the 2013 meeting of experts representing CAS and CBS in cooperation with the China Meteorological Administration (CMA), that the draft guidelines not only include science and technology, and operational and user interface components, but also provide input on resource requirements for establishing this activity. The Commission also noted that including case studies in the guidelines provide a useful reference to established practices around the world.

9.5.4 In realizing the importance of urban areas to sustainable development, the Commission recommended that the service needs of cities be included in evolving priorities of the Global Framework for Climate Services. In this regard the Commission recommended that the coupled high resolution modelling requirements of the urban environment be considered by the Working Group on Numerical Experimentation in cooperation with the working groups on Mesoscale Meteorological Forecasting Research and Data Assimilation and Observation Systems, and GURME. The Commission further requested that urban requirements be considered in future integrated observing systems and also by WWRP in the THORPEX legacy projects on High Impact Weather (HIWeather) and Sub-seasonal to Seasonal prediction (S2S).

9.5.5 The Commission viewed the collaboration between CAS and CBS as well as that between the RES and WDS Departments of WMO as critical elements towards establishing a collaborative activity on megacities and large urban areas. The Commission recommended for this activity to be brought up to the next Executive Council and then to the next WMO Congress. The Commission noted that this initiative also offers opportunities to expand cooperation with WHO and other agencies. The Commission requested for Members to consider establishing an international coordination office for the megacity and large urban complexes activity and seconding experts, and encouraged Members to make resources available for support to the project.

9.6 Evolving technologies: their impact on science and their use (agenda item 9.6)

9.6.1 The Commission acknowledged that new technologies in weather and related environmental monitoring observations, computing and social media will play an increasing role in developing and providing services. It requested WWRP and GAW to pay special attention to non-conventional observations and how these could be used through sophisticated data assimilation techniques as input to ultra high resolution models and the verification of predictions. The Commission stressed the need for the GAW Programme to expend its quality management system to ensure that sufficient quality assurance and calibration techniques are available in the regions and for new automated measurement platforms for atmospheric composition in near real-time.

9.6.2 The Commission noted that new computing technologies progressed steadily, which will give us confidence in our capability to run global high-resolution models for operational purposes. The Commission recognized that the projected exascale computing will be a major challenge for the current dynamical cores and encouraged WWRP and WGNE to further the collaborative development of systems capable of harnessing the future computing capacity. The Commission reaffirmed its endorsement of the seamless modelling approach and encouraged its expansion to the concept of seamless forecasts which transition smoothly from one time scale to the next.

9.6.3 The Commission noted that satellite observations have now become one of the essential components to provide the initial conditions, including emissions, for running the forecast models through advanced data assimilation techniques. The Commission noted the importance of further developing the use of ground-based remote sensing (e.g. RADAR, LIDAR), in particular for regional NWP. In the coming ten years, it is planned that new datasets will be available from several sensors, such as liquid or solid precipitation estimates by global precipitation measurement (GPM), aerosol and cloud (EarthCARE), global wind profiles (ADM-Aeolus), soil moisture (SMAP), and carbon dioxide (GOSAT, OCO-2). The Commission recognized that the amount of data generated by upcoming satellite observations as well as ensemble prediction systems is increasing exponentially and encouraged WWRP to facilitate innovations to ensure efficient and comprehensive use of these big datasets. The timely availability of improved forecasts will depend on the early availability of test satellite data sets, and provision of community software to allow early exploitation of the data.

9.6.4 The Commission acknowledged that the rapid increase in interest in geoengineering warrants for the Commission to advise WMO on a suitable position on this subject. The Commission noted that further research is needed to adequately understand the feasibility, the effectiveness and comprehensive effects of geoengineering. The Commission agreed to contribute to a comprehensive assessment of the state of knowledge, science capacity and understanding of information gaps and to appropriate research to address these gaps. Recognizing the broad range of relevant climate system sciences, CAS will contribute to the relevant international activities in this regard. The Commission advised that WMO should facilitate a process towards establishment of an international assessment mechanism for geoengineering research and applications, through the UN system.

9.6.5 The Commission noted the six grand challenges identified by WCRP for the next decade, namely regional climate information; regional sea-level rise; cryosphere in a changing climate; clouds, circulation, and climate sensitivity; changes in water availability; and, science underpinning the prediction and attribution of extreme events. It acknowledged the established and

growing collaborations between WCRP's transformative initiatives and WWRP and the THORPEX legacy projects.

10. THE STRUCTURE OF THE COMMISSION AND LINKAGES WITH THE WMO STRATEGIC PLAN (agenda item 10)

10.1 The post-THORPEX legacy and realignment of the World Weather Research Programme (agenda item 10.1)

10.1.1 The Commission noted that THe Observing system Research and Predictability EXperiment (THORPEX) has made substantial research contributions since the inception of the experiment in 2005 towards improved predictive skill of high-impact weather in the first two weeks of the forecasting time range. The Commission acknowledged the role that THORPEX played in fostering cooperative research between the academic research community and the operational research within the NWP centres of WMO Members. The Commission extended its appreciation to the THORPEX International Core Steering Committee and Regional Committees and the three working groups, i.e. Data Assimilation and Observing Systems, Predictability and Dynamical Processes, and Global Interactive Forecasting System – THORPEX Interactive Grand Global Ensemble (GIFS-TIGGE) on their achievements.

10.1.2 The Commission recalled that THORPEX was launched in 2005 to focus attention and mobilize international resources and cooperation on medium-range weather forecast challenges and opportunities. At the time of the launch of THORPEX, the World Weather Research Programme (WWRP) was predominantly a structure that guided a grouping of Research and Development Projects (RDPs) and Forecast Demonstration Projects (FDPs) and it was not well equipped as a platform from which to launch an ambitious international experiment. The Commission recognized that WWRP has since matured, benefitted from THORPEX, the guidance of the Joint Scientific Committee of WWRP, as well as its interaction with the World Climate Research Programme (WCRP) and the Working Group on Numerical Experimentation (WGNE) and has now established itself as a major player in coordinating international weather research.

10.1.3 The Commission took note of the fact that THORPEX will conclude at the end of 2014 and acknowledged the importance of arranging a smooth post-THORPEX transition in which the research momentum achieved by THORPEX will be subsumed and advanced by the WWRP. In this regard the Commission was pleased by the WWRP JSC and THORPEX ICSC joint effort to establish three THORPEX legacy projects under the WWRP that address pertinent research challenges of relevance to WMO Members, namely the Sub-seasonal to Seasonal prediction research project (S2S), the Polar Prediction research Project (PPP) and High Impact Weather prediction research project (HIWeather). These three projects will form the cornerstones of the post-THORPEX project activities.

10.1.4 The Commission agreed that the expertise and activities within the THORPEX working groups are valuable to the Commission and agreed that two new working groups be created within the WWRP during 2014 to ensure continuity and ongoing benefits in specific fields. The Commission recommended that these working groups, namely the Working Group on Data Assimilation and Observing Systems and the Working Group on Predictability, Dynamics and Ensemble Forecasting, be reflected in the updated working structure of the Commission and the WWRP.

10.1.5 The Commission acknowledged that the expertise and activities within the THORPEX Regional Committees (RCs) are valuable to the Commission and recommended that the activities of the current THORPEX Regional Committees are continued under the WWRP after the end of THORPEX, if the participating regional members decide on the continuation, on a self-organizing and self-funding basis. The purpose of such RCs is to identify the regional needs, and to develop and implement the regional plans in collaboration with the Regional Associations and the WWRP Working Groups through projects, including three THORPEX legacy projects (S2S, PPP, and HIWeather), RDPs and FDPs.

10.1.6 The Commission acknowledged that the science and practice of nowcasting is rapidly evolving to include very high resolution mesoscale modelling. The observational technologies that support nowcasting have become important to new data assimilation in support of mesoscale models. The Commission recognized that there are significant advantages to be gained by merging the Working Group on Nowcasting Research with the Working Group on Mesoscale Forecasting Research to create a new Working Group on Nowcasting and Mesoscale Forecasting Research. The Commission agreed that this merger should take place during 2014 and be reflected in the updated working structure of the Commission.

10.1.7 In considering the above, the Commission felt confident that the restructured WWRP will be well positioned to carry forward the momentum achieved over the past ten years into the future. The Commission supported the working arrangement in which projects (e.g. S2S, PPP, HIW and FDPs/RDPs): (i) utilize the expertise contained within the WWRP Working Groups; and (ii) provide focus to the WWRP programme.

10.2 The Commission and gender (agenda item 10.2)

10.2.1 The Commission noted that EC-65 (May 2013) urged technical commissions and regional associations to compile appropriate statistics on the participation of men and women involved in their work. It also took note of the ongoing gender mainstreaming activities at WMO, including the development of monitoring indicators designed to measure progress in the implementation of the WMO Policy on Gender Mainstreaming, the collection of relevant statistics, and a planned global survey.

10.2.2 The Commission recalled its ongoing interest in ensuring gender balance in its bodies and activities since CAS-XV and that it requested Dr Mariane Diop-Kane to act as gender focal point of the Commission in the CAS Management Group. The Commission noted that Dr Diop-Kane analyzed and made a presentation on the evolution of gender balance within the structures of the Commission during the 8th CAS Management Group Meeting in May 2013. The Commission has managed a slow increase in female experts to the current 12.7%. The regional figures range from about 7.5% to just over 20% with RA III having the largest female presence.

10.2.3 The Commission agreed that the slow progress required ongoing focus on effective participation of female scientists in its activities. With the lag in female representation, which is currently not the case in most atmospheric science research institutions, the Commission is not benefitting from the expertise of a growing number of leading female scientists active in atmospheric and related sciences. The Commission requested the president and vice-president to ensure that gender balance remains high on their agenda and that it should be considered seriously when populating the working structures of the Commission. The Commission reminded its members of their role to ensure balanced representation at sessions of the Commission and when requested to provide experts to assist in the implementation of the Commission's activities.

10.2.4 The Commission acknowledged its responsibility to contribute towards promoting atmospheric and related sciences among the youth. It acknowledged that the weather, climate and related environmental challenges of the 21st Century will require well trained, motivated and exceptional scientists that can effectively work in a transdisciplinary environment. The Commission was especially pleased that the World Weather Open Science Conference planned for August 2014 will make special provision for the active participation of young scientists. The Commission requested the president and vice-president to promote, where relevant, activities that will expose talented young persons to the opportunities in atmospheric and related sciences. The Commission noted that it is important to consider gender also in this context.

10.2.5 The Commission further noted that EC-65 urged Members to nominate female candidates to working structures of the WMO constituent bodies. It also welcomed the planned organization of a Third Gender Conference in 2014 on *"Gender Dimension of Weather and Climate Services: The Benefits of Working Together."*

10.2.6 The Commission recommended that the vice-president of the Commission be tasked as gender and youth focal point and to reflect this responsibility explicitly in the terms of reference of the CAS Management Group. The Commission requested that information and statistics on gender and youth involvement in the activities of the Commission be kept up-to-date.

10.3 Commission mandate, structure and relevant terms of reference (agenda item 10.3)

10.3.1 The Commission noted the need to update the Terms of References (ToRs) of its working structure as stated in CAS-XIV and CAS-XV reports and the *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (http://www.wmo.int/pages/prog/arep/wwrp/new/documents/final_WWRP_SP_6_Oct.pdf) and the *WMO Global Atmosphere Watch (GAW) Strategic Plan: 2008–2015* (ftp://ftp.wmo.int/Documents/PublicWeb/arep/gaw/gaw172-26sept07.pdf) and its Addendum (http://www.wmo.int/pages/prog/arep/gaw/documents/FINAL_GAW_197.pdf). The Commission agreed that ToRs should only be defined in the Commission report and that any changes to the ToRs should be made by the Commission, or during the intersessional period by the CAS MG, to ensure consistency of its work.

10.3.2 The Commission recognized that it is important to offer independent and wide-ranging regular reviews, keeping in mind current societal needs, of the GAW and WWRP Programmes through their SSCs. The Commission recognized that it had started to introduce these elements in the WWRP Joint Scientific Committee at its 15th session by ensuring that its membership consists of independent experts that have a deep interest in the progress of the Programme.

10.3.3 The Commission acknowledged that CAS and its working structures provide valuable advice to WMO and the Secretariat for coordinating the implementation of activities agreed to by Congress and the Executive Council. The Commission expressed its appreciation for the constructive and mutually supportive roles between itself and the Secretariat which had facilitated progress within the Commission and relevant Programmes. The Commission also realized the need for oversight of its activities during the intersessional period through a CAS Management Group (MG).

10.3.4 The Commission adopted Resolution 1 (CAS-16) – Review of previous resolutions and recommendations of the Commission for Atmospheric Sciences, Resolution 2 (CAS-16) – Working structure of the Commission for Atmospheric Sciences and Resolution 3 (CAS-16) – Commission for Atmospheric Sciences Management Group, including the relevant terms of reference.

10.4 WMO Strategic Plan 2016–2019 (agenda item 10.4)

10.4.1 The Commission noted that EC-65 considered the draft WMO Strategic Plan (SP) 2016–2019 prepared by the EC Working Group on WMO Strategic and Operational Planning (WG/SOP) and requested the WG/SOP to review the draft taking into account the Council's recommendations. The revised Plan was to be sent to Members for their input not later than September 2013, which would then be integrated into the draft SP for consideration by the WG/SOP in early 2014 before being presented to EC-66 in June 2014.

10.4.2 The Commission also noted that the Council further considered the potential future strategic priorities to consist of WIGOS (supported by WIS), Capacity Development, GFCS and DRR, while recognizing the importance of Service Delivery (notably aviation and marine services) and Research (namely, improving user-oriented sub-seasonal to seasonal forecasts, polar prediction and advancing megacity services).

10.4.3 The Commission noted that EC-65 considered and endorsed the following recommendations of its WG/SOP regarding the preparation of the next WMO Operating Plan 2016–2019:

(a) The move to a single Integrated Operating Plan should take into account priority areas and be flexible. The Organization should avoid frequent changes in the strategic

planning process noting that a single Strategic Plan for the Organization was adopted for the period 2012–2015;

(b) More clarity should be provided as part of the process to achieve a single Operating Plan given that there are variations in the planning cycles of RAs and TCs;

(c) RAs, TCs and Secretariat activities should be integrated into a single Integrated Operating Plan;

(d) The draft Operating Plan 2016–2019 should be presented to EC-66 for consideration.

10.5 Monitoring and evaluation of CAS activities (agenda item 10.5)

10.5.1 The Commission noted that the Secretariat had developed two documents on the WMO Monitoring and Evaluation (M&E) system that define the system and provide guidance for its implementation. The two documents are available for use by Members and constituent bodies at the WMO website: http://www.wmo.int/pages/about/monitoring_evaluation_en.html. The Commission also noted recent improvements made in the implementation of the M&E system, which included revisions to the Key Outcomes and Key Performance Indicators (KPIs) and the establishment of baselines and targets for all KPIs. The Commission recognized the benefits in using WMO standard practice and requested that the CAS Management Group use these documents in its M&E. The Commission requested the CAS Management Group to engage with the Secretariat to ensure the KPIs are appropriate and clear to the Commission.

10.5.2 The Commission noted that the Secretariat conducted a survey in 2012 to assess the impacts of achieved results on Members, the report of which is available at the WMO website: http://www.wmo.int/pages/about/documents/Fullreport_ImpactsofAchievedResultsonMembers_Oct12_FINALx.pdf. It further noted that the WMO Secretariat is currently conducting a similar survey, the results of which will be used to measure progress in the achievement of the Expected Results in the first biennium of the sixteenth financial period.

11. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS FOR THE FUTURE (agenda item 11)

The Commission reviewed the resolutions and recommendations adopted at its previous sessions that were still in effect at the time of the sixteenth session. It also reviewed the Executive Council resolutions based on previous recommendations of the Commission that were still in effect. The decisions of the session were incorporated in Resolution 1 (CAS-16) and Recommendation 2 (CAS-16) – Review of resolutions of the Executive Council relevant to the fields of responsibility of the Commission for Atmospheric Sciences.

12. ELECTION OF OFFICERS (agenda item 12)

The Commission elected Mr Øystein Hov (Norway) as president and Mr Jae-Cheol Nam (Republic of Korea) as vice-president of the Commission for Atmospheric Sciences.

13. DATE AND PLACE OF THE SEVENTEENTH SESSION (agenda item 13)

13.1 In accordance with Regulations 188 and 189 of the WMO General Regulations, the president of the Commission should determine the date and place of the seventeenth session in agreement with the President of the World Meteorological Organization and after consultation with the Secretary-General, during the intersessional period.

13.2 The Commission agreed that its seventeenth session should be held in 2017 at a place to be determined.

13.3 The Commission recognized the need to keep CAS sessions efficient, potentially allowing more resources to be invested in the activities of the Commission and delivering to the WMO Expected Result 8: An effective and efficient Organization. It further noted the Members appreciation of the TECO and the value this had to them. It recognised that it would be possible to improve the efficiency of, and hence shorten, the intergovernmental session, by focusing on key discussion documents and other measures which are specifically relevant to the intergovernmental session. The Commission requested the Secretariat and the CAS Management Group to take this into account in the planning for future sessions of CAS, with a target to arrange the combined TECO and CAS session within a timescale of 6 days or less.

14. CLOSURE OF THE SESSION (agenda item 14)

The sixteenth session of the Commission for Atmospheric Sciences closed at 9.45 a.m. on 26 November 2013.

RESOLUTIONS ADOPTED BY THE SESSION

Resolution 1 (CAS-16)

REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION

THE COMMISSION FOR ATMOSPHERIC SCIENCES**,**

Noting:

(1) Resolution 3 (CAS-XV) – Review of previous resolutions and recommendations of the Commission,

(2) Regulation 191 of the General Regulations calling for an agenda item to review previous resolutions and recommendations of the Commission,

(3) The action taken by the competent bodies on the resolutions of the previous sessions,

Decides:

(1) To keep in force Resolution 4 (CAS-XV) – Participation of women in the work of the Commission;

(2) Not to keep in force Resolutions 1 (CAS-XV), 2 (CAS-XV) and 3 (CAS-XV).

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Note: This resolution replaces Resolution 3 (CAS-XV), which is no longer in force.

Resolution 2 (CAS-16)

WORKING STRUCTURE OF THE COMMISSION FOR ATMOSPHERIC SCIENCES

THE COMMISSION FOR ATMOSPHERIC SCIENCES,

Considering the continuing need:

(1) To identify emerging challenges and opportunities in atmospheric and related sciences relevant to the understanding of weather, climate, water and related environmental matters and to the services involved,

(2) To acknowledge the evolving requirements of WMO Members in terms of atmospheric and related sciences and their application to weather, climate, water and the environment,

(3) To initiate, coordinate and promote research in atmospheric and related sciences to advance understanding and predictive skill of the Earth system,

(4) To meet the requirements of environmental security and environmental conventions regarding the composition of the atmosphere and related physical parameters,

(5) To coordinate international aspects of the activities of the Commission with relevant scientific bodies,

(6) To update standards and best practices related to atmospheric sciences in WMO regulatory and guidance materials,

(7) To support research on the policy and socio-economic impacts of advances in the understanding of atmospheric sciences,

(8) To ensure broad involvement of Members in the activities of the Commission,

Decides:

(1) To establish:

(a) The World Weather Research Programme Scientific Steering Committee (WWRP SSC) consisting of leading experts tasked with assisting, guiding and advising the Commission on its activities related to the World Weather Research Programme, with terms of reference described in Annex 1 to the present resolution;

(b) The Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) consisting of leading experts tasked with assisting, guiding and advising the Commission on its activities related to environmental pollution, atmospheric chemistry and the Global Atmosphere Watch (GAW) Programme, with terms of reference described in Annex 2 to the present resolution;

(c) The Open Programme Area Group on the World Weather Research Programme (OPAG WWRP), as a resource pool for CAS consisting of experts in weather research and application development who will contribute to and benefit regionally and nationally from the implementation of CAS activities related to the WWRP and act as contacts to provide feedback on relevant research developments, needs, opportunities and challenges, primarily through correspondence;

(d) The Open Programme Area Group on Environmental Pollution and Atmospheric Chemistry (OPAG EPAC), as a resource pool for CAS consisting of research and application development experts in atmospheric chemistry, composition and related physical parameter observations who will contribute to and benefit regionally and nationally from the implementation of CAS activities related to environmental pollution, atmospheric chemistry and GAW;

(2) To request each Scientific Steering Committee (SSC) to:

(a) Ensure that contributions to the WMO strategic priorities, including the Global Framework for Climate Services (GFCS), Disaster Risk Reduction (DRR), the WMO Integrated Global Observing System (WIGOS), the WMO Information System (WIS) and other priorities to be identified in the Strategic Plan 2016–2019, are integrated in its activities;

(b) Promote cooperation that will benefit the SSC and the Global Climate Observing System (GCOS), the Global Earth Observation System of Systems (GEOSS), the World Climate Research Programme (WCRP) and other research and science bodies of relevance to CAS and its activities;

(c) Enhance multidisciplinary links to provide synergy in research and applications through collaboration with WMO technical commissions (the Commission for Basic Systems, the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology, the Commission for Instruments and Methods of Observation, the Commission for Climatology and others);

(d) Contribute to the development and implementation of societal and economic applications and services, informed by the needs expressed by users and stakeholders;

(e) Take into consideration Resolution 4 (CAS-XV) – Participation of women in the work of the Commission;

(3) To select, in accordance with Regulation 33 of the General Regulations:

(a) Gilbert Brunet (until 31 December 2014) and Sarah Jones (starting 1 January 2015), as chairperson of the World Weather Research Programme Scientific Steering Committee (WWRP SSC);

(b) Greg Carmichael as chairperson of the Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) for the GAW Programme;

Requests the chairpersons of the SSCs:

(1) To act upon matters referred to the SSC by the president of the Commission;

(2) To prepare and submit a report to the CAS Management Group and the Commission no later than two months prior to their sessions, which will include advice on the emerging issues relevant to Members and related to atmospheric sciences and plans of the Commission in the context of the overall WMO strategic direction;

(3) To advise the president and the CAS Management Group in selecting, as appropriate, chairpersons of the working structure, taking into account technical expertise, gender and geographical balance;

Authorizes the CAS Management Group to appoint, in accordance with Regulation 33 of the General Regulations, chairpersons of the working structure of the Commission, as appropriate.

Annex 1 to Resolution 2 (CAS-16)

TERMS OF REFERENCE OF THE WORLD WEATHER RESEARCH PROGRAMME SCIENTIFIC STEERING COMMITTEE, WORKING GROUPS AND EXPERT TEAM

1. The World Weather Research Programme Scientific Steering Committee (WWRP SSC) has the following terms of reference:

(a) To provide the overall scientific guidance for the World Weather Research Programme (WWRP);

(b) To develop and review the science and implementation plan for the WWRP and a work programme aligned with the WMO strategic planning process;

(c) To review and assess the development of all elements of the WWRP, including major research projects, Forecast Demonstration Projects, Research and Development Projects and forecast evaluation methods, to formulate recommendations to guide further actions and to report on the progress of the programme to the president of the Commission for Atmospheric Sciences (CAS);

(d) To facilitate and prioritize weather research and development activities, which are planned and implemented through the project committees and working groups, to meet the objectives of CAS;

(e) To facilitate the exchange of information among scientists participating in the Programme and relevant scientific institutions and agencies, at the national, regional and international levels;

(f) To collaborate, as appropriate, with EPAC SSC, the Commission for Basic Systems (CBS) and other technical commissions, the regional associations, relevant groups and project committees of the Joint Scientific Committee of the World Climate Research Programme (WCRP) and, academia, users of forecast products and other partners;

(g) To delegate to each working group and expert team, as required, the responsibility to promote the timely exchange of information, data and new knowledge through publications, workshops, training activities and meetings.

2. Membership of the World Weather Research Programme Scientific Steering Committee (WWRP SSC) and WWRP Working Groups and Expert Team:

(a) The chairperson of the WWRP SSC is appointed by CAS during its session. In the event that a chairperson of the WWRP SSC has to be appointed in the intersessional period, the appointment is made by the president of CAS in consultation with the CAS Management Group. The WWRP SSC chairperson is appointed for four years with the possibility of renewal of maximum another four years;

(b) The WWRP SSC shall consist of up to ten scientists selected for their scientific expertise, capacity and breadth of vision. The WWRP SSC members should be drawn to promote geographical and thematic representation and gender balance. The members are appointed by the CAS president in consultation with the CAS Management Group, upon the WWRP SSC chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the WWRP SSC members is four years and can be renewed for a maximum of another four years. For the sake of continuity, members are reviewed and appointed in a staggered fashion every two years. The WWRP SSC includes as ex-officio members the chairpersons of the WWRP Working Groups and Expert Team and major Projects. Observers may be invited to attend as required;

(c) The WWRP Working Groups (WG) and Expert Team (ET) chairpersons are selected for their scientific expertise, capacity, leadership and teamwork abilities. The chairpersons should be drawn to promote thematic representation and geographical and gender balance. The WG and ET chairpersons are appointed by the CAS president in consultation with the CAS Management Group, upon the WWRP SSC chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the WWRP WG and ET chairpersons is four years and can be renewed for a maximum of another four years;

(d) The WWRP WG and ET members are selected for their scientific expertise, capacity, and teamwork abilities. The members should be drawn considering WWRP priorities and promoting wide thematic representation and geographical and gender balance, from both operational and academic fields. The WWRP WG and ET members are appointed by the chairperson of the WWRP SSC, upon the relevant WWRP WG or ET chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the WWRP WG and ET members is four years and can be renewed for a maximum of another four years. The WWRP WGs and ET includes as ex-officio members representatives of the major Projects when a clear need is identified and approved by the SSC chairperson. The provisions related to length of terms do not apply to ex-officio members.

3. World Weather Research Programme Working Groups and Expert Team:

The Working Groups of the WWRP cover:

(a) Nowcasting and Mesoscale Weather Forecasting Research (WG-NMWFR);

(b) Data Assimilation and Observing Systems (WG-DAOS), which will be transferred from THORPEX at the beginning of 2015, if so decided by WMO EC-66 in 2014;

(c) Predictability, Dynamics and Ensemble Forecasting (WG-PDEF), which will be transferred from THORPEX at the beginning of 2015, if so decided by WMO EC-66 in 2014;

(d) Tropical Meteorology Research (WG-TMR);

(e) Societal and Economic Research Applications.

The Joint Working Groups of the WWRP cover:

(a) Forecast Verification Research with the CAS/WCRP Working Group on Numerical Experimentation (WGNE) (JWG-FVR).

The Expert Team of the WWRP covers:

(a) Weather Modification.

The WWRP Working Group terms of reference are to:

(a) Develop a work programme aligned with the WWRP Science and Implementation Plan;

(b) Facilitate and prioritize research and development activities in their area of expertise, which are planned and implemented through the teams and groups to meet the objectives of WWRP and CAS;

(c) Plan and implement the (WG's area of expertise) component of the WWRP;

(d) Review and assess the development of all elements of research in their field of expertise, formulate recommendations to guide further actions and report on the progress of the working group to the SSC of WWRP;

(e) Advance the science of the WG's field of expertise;

(f) Identify and support the research initiatives of NMHSs in the WG's field of expertise;

(g) Provide advice and support on the planning, implementation, monitoring and reporting of WWRP RDPs and FDPs aimed at advancing the science of the WG's field of expertise, and similarly advise and support, on matters related to the WGs' fields of expertise, the three projects: S2S, PPP and HIWeather;

(h) Facilitate, encourage and promote capacity development in their area of expertise;

(i) Identify emerging challenges and opportunities in their field of expertise;

(j) Promote collaboration among scientists conducting research on the WG's area of expertise;

(k) Maximize opportunities for collaboration with the other WWRP working groups, relevant groups of WMO, academia, users of forecast products and other partners;

(l) Delegate to the WG's panels, expert teams, and task groups as required, the responsibility to promote the timely exchange of information, data and recent research advances in their areas of expertise through publications, workshops and meetings.

The Expert Team on Weather Modification terms of reference is to:

(a) Promote scientific practices in weather modification research;

(b) Provide and regularly update status on weather modification and its effectiveness, with guidance material of best practices;

(c) Facilitate, encourage and promote capacity development in their area of expertise;

(d) Identify emerging challenges and opportunities in their field of expertise.

Annex 2 to Resolution 2 (CAS-16)

TERMS OF REFERENCE OF THE ENVIRONMENTAL POLLUTION AND ATMOSPHERIC CHEMISTRY SCIENTIFIC STEERING COMMITTEE AND OTHER GAW ADVISORY BODIES

1. The Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) has the following terms of reference:

(a) To keep informed of scientific developments in the fields of environmental pollution and atmospheric chemistry, including the interrelationships between changes in atmospheric composition, global and regional climate and other aspects of the Earth system, and disturbances to the natural cycles of chemical species in the atmosphere/ocean/biosphere system;

(b) To advise CAS and recommend actions that WMO should take to promote, initiate, facilitate or set priorities for:

(i) Long-term globally integrated observations of atmospheric composition and related physical parameters, including greenhouse gases, ozone, ultraviolet (UV) radiation, reactive gases, aerosols and precipitation chemistry;

(ii) The high quality, timeliness and continuity of data from the monitoring network, including aircraft and satellites;

(iii) A system for real-time or near real-time data delivery and exchange;

(iv) User-friendly access to data and the application of data for analysis, satellite and model validation, assimilation and environmental assessments;

(v) Research on transport, transformation, deposition and sources and sinks of atmospheric constituents on all space- and timescales using observational and modelling tools;

(vi) The development of modelling tools, including predictive capability, for support of atmospheric environment research;

(vii) Research on urban air quality;

(viii) Development of products and services in the area of atmospheric chemistry taking into consideration socio-economical needs;

(c) To contribute to the development of and to review the science and implementation plan for the GAW Programme;

(d) To facilitate cooperation with other relevant programmes and organizations inside and outside WMO, including GFCS, WIGOS/WIS, GCOS, GEO, satellite initiatives, WWRP, and WCRP and other WMO technical commissions, bodies and Programmes;

(e) To promote CAS activities in support of international conventions.

2. Membership of the Environmental Pollution and Atmospheric Chemistry Scientific Steering Committee (EPAC SSC) and other GAW advisory bodies:

(a) The chairperson of the EPAC SSC is appointed by CAS during its session. In the event that a chairperson of the EPAC SSC has to be appointed in the intersessional period, the appointment is made by the president of CAS in consultation with the CAS Management Group. The EPAC SSC chairperson is appointed for four years with the possibility of renewal of maximum another four years;

(b) The EPAC SSC shall consist of up to ten scientists selected for their scientific expertise, capacity and breadth of vision. The EPAC SSC members should be drawn to promote geographical and thematic representation and gender balance. The members are appointed by the CAS president in consultation with the CAS Management Group, upon the EPAC SSC chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the EPAC SSC members is four years and can be renewed for a maximum of another four years. For the sake of continuity, members are reviewed and appointed in a staggered fashion every two years. The EPAC SSC includes as ex-officio members the chairpersons of GAW Scientific Advisory Groups and Expert Teams and major Projects. Observers may be invited to attend as required;

(c) The GAW Scientific Advisory Group (SAG) and Expert Team (ET) chairpersons are selected for their scientific expertise, capacity, leadership and teamwork abilities. The chairpersons should be drawn to promote thematic representation and geographical and gender balance. The SAG and ET chairpersons are appointed by the CAS president in consultation with the CAS Management Group, upon the EPAC SSC chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the GAW SAG and ET chairpersons is four years and can be renewed for a maximum of another four years;

(d) The GAW SAG and ET members are selected for their scientific expertise, capacity, and teamwork abilities. The members should be drawn considering GAW priorities and promoting wide thematic representation and geographical and gender balance. The GAW SAG and ET members are appointed by the chairperson of the EPAC SSC, upon the relevant GAW SAG or ET chairperson's proposal, prepared in consultation with the Secretariat. The initial term of the GAW SAG and ET members is four years and can be renewed for a maximum of another four years. The SAGs and ETs include as ex-officio members representatives of GAW central facilities when a clear need is identified and approved by the SSC chairperson. The provisions related to length of terms do not apply to ex-officio members.

3. GAW Scientific Advisory Groups and Expert Teams

The Scientific Advisory Groups (SAGs) and Expert Teams (ETs) of the GAW Programme cover:

(a) Ozone (SAG-Ozone);

(b) UV Radiation (SAG-UV);

(c) Greenhouse Gases (SAG-GHG);

(d) Aerosols (SAG-Aerosols);

(e) Precipitation Chemistry (SAG-PC);

(f) Reactive Gases (SAG-RG);

(g) Urban Research Meteorology and Environment Project (SAG-GURME);

(h) World Data Centres (ET-WDC);

(i) Near-real-time Chemical Data Transfer (ET-NRT CDT).

The GAW SAGs and ETs have the following terms of reference:

(a) Keep informed of scientific and technical developments in their field;

(b) Advice the SSC and Members on the developments, priority areas and progress in their field, taking into consideration user requirements;

(c) Contribute to the review of the GAW Implementation Plan;

(d) Implement recommendations, tasks and projects as defined in the GAW Implementation Plan;

(e) Review the status of the relevant part of the GAW network, ensure active collaboration with contributing networks, and advise on further enhancement of the observational capacity of the GAW Programme, fostering the development of QMF;

(f) Promote timely data delivery;

(g) Develop a broad spectrum of products and services, taking socio-economical needs into consideration;

(h) Interact effectively with the WMO Secretariat on matters related to the GAW Programme;

(i) Take into consideration activities by other UN organizations and institutes in their field and collaborate as appropriate.

Resolution 3 (CAS-16)

COMMISSION FOR ATMOSPHERIC SCIENCES MANAGEMENT GROUP

THE COMMISSION FOR ATMOSPHERIC SCIENCES,

Noting:

(1) The views of the Sixth World Meteorological Congress on retaining the system of advisory bodies to provide advice to presidents of technical commissions,

(2) The future policies, strategy, objectives and outline plans of the Commission for Atmospheric Sciences adopted by the Sixteenth World Meteorological Congress,

(3) Resolution 1 (CAS-XV) – Working structure of the Commission for Atmospheric Sciences,

Recognizing:

(1) That the effectiveness of the Commission depends to a large extent on the effective management of its activities and the coordination of cross-cutting aspects of the programme areas between sessions,

(2) That a management group will be required to promote collaboration between the programme areas, evaluate the progress achieved, coordinate strategic planning and decide on any necessary adjustments to the working structure during the intersessional period,

Decides to establish the CAS Management Group, with terms of reference described in the annex to the present resolution, to provide the president with appropriate and timely advice and ensure that the Commission can respond effectively to the issues at hand.

Annex to Resolution 3 (CAS-16)

TERMS OF REFERENCE OF THE CAS MANAGEMENT GROUP

(1) The CAS Management Group has the following terms of reference:

(a) To make decisions and provide guidance on CAS activities during the intersessional period, as required;

(b) To review the short- and long-term strategic planning and work programmes of the Commission and assist in their adoption and implementation;

(c) To maintain overall responsibility for the excellence, relevance and impact of the work of the Commission and for the transfer of research results, techniques and information between Members in the fields of atmospheric and related sciences, including environmental aspects;

(d) To review the internal structure and working methods of the Commission, including its relationship with other bodies, both inside and outside WMO, and to propose changes, if required;

(e) To be the focal point for formulating CAS contributions to the relevant elements of the WMO strategic planning process and for communication on scientific matters of relevance to the Commission;

(f) To consult with the president on the membership of SSCs and chairpersons of the working bodies, as appropriate, upon the recommendation of the SSC chairpersons;

(g) To ensure gender and youth mainstreaming in its structures and activities.

(2) The composition of the CAS Management Group should be as follows:

(a) President of CAS (chairperson), Øystein Hov;

(b) Vice-president of CAS, especially tasked with gender and youth matters, Jae-Cheol Nam;

(c) Immediate former president of CAS or if not available, an invited expert, Michel Béland;

(d) Chairperson of EPAC SSC, Greg Carmichael;

(e) Chairperson of WWRP SSC, Gilbert Brunet (until 31 December 2014) and Sarah Jones (from 1 January 2015);

(f) An invited expert representing the academic research community, Duan Yi-Hong;

(g) A co-chairperson of the Working Group on Numerical Experimentation, Andy Brown;

(h) Up to six members broadly representing thematic and regional diversity of the membership of the Commission, taking note of gender balance:

Mariane Diop-Kane (Regional Association I (Africa))

Shiv Dev Attri (Regional Association II (Asia))

Alice Grimm (Regional Association III (South America))

James Butler (Regional Association IV (North America, Central America and the Caribbean))

Elizabeth Ebert (Regional Association V (South-West Pacific))

Philippe Bougeault (Regional Association VI (Europe))

The members in (2)(h) and the invited expert referred to in (2)(f), are appointed by the Commission or, by the president of the Commission in the absence of a decision by the Commission, after consideration of nominations made by the members of the Commission;

(3) To authorize the president to call on regional rapporteurs and other experts, keeping in mind Regulation 34 of the General Regulations, to participate in any particular task when the president considers such additional assistance necessary.

RECOMMENDATIONS ADOPTED BY THE SESSION

Recommendation 1 (CAS-16)

POST-THORPEX ACTIVITIES

THE COMMISSION FOR ATMOSPHERIC SCIENCES,

Noting:

(1) Resolution 12 (Cg-XIV) – THORPEX: A Global Atmospheric Research Programme,

(2) The *Strategic Plan for the Implementation of WMO's World Weather Research Programme (WWRP): 2009–2017* (WMO/TD-No.1505),

(3) The conclusion of THe Observing system Research and Predictability EXperiment (THORPEX) at the end of 2014, including the closure of its trust fund,

(4) The advice by the 11th THORPEX International Core Steering Committee meeting (ICSC-11) and the 6th Joint Scientific Committee meeting of the WWRP (WWRP JSC-6) on the benefits of merging THORPEX working groups (the Predictability and Dynamical Processes Working Group and the Global Interactive Forecast System THORPEX Interactive Grand Global Ensemble Working Group) into a new working group under WWRP, called Working Group on Predictability, Dynamics and Ensemble Forecasting, with new terms of reference,

(5) The advice by the THORPEX ICSC-11 and the WWRP JSC-6 on moving the THORPEX Working Group on Data Assimilation and Observing Systems to WWRP, with updated terms of reference,

Recognizing the establishment of the THORPEX legacy projects (the Polar Prediction Project (PPP), Sub-seasonal to Seasonal Prediction Project (S2S), and High Impact Weather Prediction Project (HIWeather)),

Considering the need for activities and research on data assimilation and observing systems, and on predictability, dynamics and ensemble forecasting under WWRP,

Recommends:

(1) That the Working Group on Data Assimilation and Observing Systems and the Working Group on Predictability, Dynamics and Ensemble Forecasting be established at the beginning of 2015 under WWRP, funded from the regular budget;

(2) That the activities of the current THORPEX regional committees be continued under the WWRP after the end of THORPEX, if the participating regional members decide to continue on a self-organizing and self-funding basis, in collaboration with the regional associations, the WWRP working groups and projects, including three THORPEX legacy projects (S2S, PPP and HIWeather), research and development projects and forecast demonstration projects;

(3) That the THORPEX legacy projects work together to (i) coordinate the respective roles of the projects in areas of common interest and (ii) share the results, techniques and accomplishments of the projects;

(4) That executive management oversight of the THORPEX legacy project trust funds be provided by the CAS Management Group;

Requests the Secretary-General to bring this recommendation to the attention of the Executive Council at its sixty-sixth session for its consideration.

Recommendation 2 (CAS-16)

REVIEW OF RESOLUTIONS OF THE EXECUTIVE COUNCIL RELEVANT TO THE FIELDS OF RESPONSIBILITY OF THE COMMISSION FOR ATMOSPHERIC SCIENCES

THE COMMISSION FOR ATMOSPHERIC SCIENCES,

Noting the action taken on its previous recommendations by the Executive Council,

Considering:

(1) That some of these recommendations have become redundant,

(2) That the substance of some of its previous recommendations has been included in the recommendations of the sixteenth session,

Recommends:

(1) That the following Executive Council resolution not be kept in force:

Resolution 5 (EC-LXII) – Report of the fifteenth session of the Commission for Atmospheric Sciences;

(2) That the following Executive Council resolutions be kept in force:

Resolution 16 (EC-64) – Sub-seasonal to Seasonal Prediction Project;

Resolution 17 (EC-64) – Polar Prediction Project;

Resolution 6 (EC-XXXVI) – International collection and publication of radiation data.

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Note: This recommendation replaces Recommendation 2 (CAS-XV), which is no longer in force.

APPENDIX

LIST OF PARTICIPANTS

1. Officers of the session

Michel BÉLAND	President

2. Members of CAS

Australia

Elizabeth EBERT (MS)	Principal Delegate

Austria

Michael MORGAN (PROXY)	Principal Delegate

Brazil

Alice Marlene GRIMM (MS)	Principal Delegate

Brunei Darussalam

Haji Sidup BIN HAJI SIRABAHA	Principal Delegate
Hassanul Kamal BIN HAJI ADAM	Delegate

Bulgaria

Ekaterina BATCHVAROVA (MS)	Principal Delegate

Canada

Charles LIN	Principal Delegate
Marjorie SHEPHERD (MS)	Alternate
Véronique BOUCHET (MS)	Delegate

China

RUCONG Yu	Principal Delegate
YUNFENG Luo	Alternate
YIHONG Duan	Delegate
JIANDONG Gong	Delegate
JIANGUO Tan	Delegate

Costa Rica

Jorge A. AMADOR ASTUA	Principal Delegate

Croatia

Branka IVANCAN PICEK	Principal Delegate
Cleo KOSANOVIC	Alternate

Denmark

Julia KELLER (PROXY) (MS)	Principal Delegate

Egypt

Ahmed Abd El-aal Mohamed ABD ALLAH	Principal Delegate
Ashraf Saber ZAKEY	Delegate

Ethiopia

Dula SHANKO	Principal Delegate

Finland	
Heikki LIHAVAINEN	Principal Delegate
France	
Philippe BOUGEAULT	Principal Delegate
Gambia	
Lamin Mai TOURAY	Principal Delegate
Germany	
Sarah JONES (MS)	Principal Delegate
Julia KELLER (MS)	Delegate
Greece	
Panagiotis SKRIMIZEAS	Principal Delegate
Hungary	
László BOZÓ	Principal Delegate
India	
Shiv Dev ATTRI	Principal Delegate
Iraq	
Tahir Hassan HANTOSH	Principal Delegate
Ali Tarek ABDUL JABBAR	Delegate
Raid Abdulmoumen ABDULHADI	Delegate
Abbas Yaseen HUSSEIN	Delegate
Italy	
Véronique BOUCHET (MS) (PROXY)	Principal Delegate
Japan	
Hiroshi KOIDE	Principal Delegate
Masayuki KYODA	Alternate
Yoshiro TANAKA	Alternate
Jordan	
Mohammad M. SAMAWI	Principal Delegate
Hatem AL HALABI	Delegate
Kenya	
Bernard Agesa CHANZU	Principal Delegate
Libya	
AbduRrahman M. SHETA	Principal Delegate
Husein O. ABUSHAWASHI	Delegate
Ali S. EDDENJAL	Delegate
Malaysia	
Maznorizan MOHAMAD (MS)	Principal Delegate
Mali	
Djibrilla Ariaboncana MAIGA	Principal Delegate
Netherlands	
Peter VAN VELTHOVEN	Principal Delegate

New Zealand

Cory DAVIS	Principal Delegate

Nigeria

Ifeanyi D. NNODU	Alternate
Ernest A. AFIESIMAMA	Delegate

Norway

Øystein HOV	Principal Delegate

Philippines

Flaviana D. HILARIO (MS)	Principal Delegate

Republic of Korea

Youngsin CHUN (MS)	Principal Delegate
Gwangdeuk AHN	Delegate
Youngjean CHOI (MS)	Delegate
Yunsun JUNG (MS)	Delegate
Jaehoon KIM	Delegate
Seungwoo LEE	Delegate
Hancheol LIM	Delegate
Seoleun SHIN (MS)	Delegate

Romania

Bogdan LUCASCHI	Principal Delegate

Russian Federation

A. FROLOV	Principal Delegate
Aminat MALKAROVA (MS)	Alternate
Elena ASTAKHOVA (MS)	Delegate
Viacheslav SHERSHAKOV	Delegate

Senegal

Mariane DIOP-KANE (MS)	Principal Delegate

Slovakia

Viliam PÄTOPRSTÝ	Principal Delegate

South Africa

Lucky NTSANGWANE	Principal Delegate

Spain

Emilio CUEVAS AGULLÓ	Principal Delegate

Sweden

Heiner KÖRNICH	Principal Delegate

Switzerland

Jörg KLAUSEN	Principal Delegate

Thailand

Worapat TIEWTHANOM	Principal Delegate
Sumridh SUDHIBRABHA (MS)	Alternate
Hathaichanok NGERNDEE (MS)	Delegate

Turkey

Mehmet Bahaettin KAPTAN	
Lutfi AKCA	
Ismail GÜNES	
Mehmet Fatih BÜYÜKKASABASI	Principal Delegate
Bülent AKSOY	Delegate
Ayhan ERDOGAN	Delegate
Haci Murat PULLA	Delegate
Yüksel YAGAN	Delegate
Mustafa YURTSEVEN	Delegate

Ukraine

Vitalii SHPYG	Principal Delegate

United Kingdom of Great Britain and Northern Ireland

Andy BROWN	Principal Delegate
Gilbert BRUNET	Alternate
Richard SWINBANK	Delegate
Jane WARDLE (MS)	Delegate

United Republic of Tanzania

Pascal WANIHA	Delegate

United States of America

James BUTLER	Principal Delegate
Renée TATUSKO (MS)	Alternate
Greg CARMICHAEL	Delegate
Randall DOLE	Delegate
Mitch MONCRIEFF	Delegate
Michael MORGAN	Delegate
James SMOOT	Delegate

Uzbekistan

Barkhriddin NISHONOV	Principal Delegate

3. Representatives of international organizations (observers)

European Centre for Medium-Range Weather Forecasts
Peter BAUER

4. Invited experts
Sarantuya GANJUUR (MS)
Sami AHMED
Jae-Cheol NAM
Maidel ROMERO (MS)

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