



- AGENDA ITEM 7: EARTH SYSTEM RESEARCH**
AGENDA ITEM 7.1: Scientific knowledge of the Earth system

EARTH SYSTEM RESEARCH

DRAFT RESOLUTIONS

Draft Resolution 7.1-2/1 (Cg-18)

FUTURE WMO RESEARCH AND SUPPORTING ACTIVITIES

THE WORLD METEOROLOGICAL CONGRESS,

Recalling:

- (1) Resolution 15 (Cg-17) World Climate Research Programme (WCRP),
- (2) Resolution 45 (Cg-17) World Weather Research Programme (WWRP),
- (3) Resolution 47 (Cg-17) Global Atmosphere Watch Programme (GAW),
- (4) Resolution 11 (Cg-17) – Towards a future enhanced integrated and seamless WMO Data-processing and Forecasting System,
- (5) Decision 61 (EC-68) – World Weather Research Programme Implementation Plan for the period 2016-2023,
- (6) Decision 62 (EC-68) – Global Atmosphere Watch Implementation Plan for the period 2016-2023,
- (7) Resolution 30 (EC-70) – The 2018 review of the World Climate Research Programme,
- (8) Resolution 46 (Cg-17) – Integrated Global Greenhouse Gas Information System,
- (9) IG³IS Science Implementation Plan,
- (10) Recommendation 18 (EC-70) – Future WMO research and supporting activities,

Recalling also the outcome of the 17th session of the Commission for Atmospheric Sciences (CAS-17), the preceding Science Summit, and the recommendations on the future WCRP strategy made by the WCRP review panel,

Recalling further:

- (1) the United Nations General Assembly Resolution 70/1 – Transforming our World: the 2030 Agenda for Sustainable Development, [Iran]
- (2) the United Nations General Assembly Resolutions 73/237, 72/225 and 71/219 – Combating Sand and Dust Storms, [Iran]

Noting:

- (1) That WCRP has played a pivotal role in advancing fundamental understanding of the climate variability and change in support of the Earth system science and societal demands by initiating and coordinating major collaborative activities around its Core Projects (GEWEX, CLIVAR, SPARC and CliC), Grand Challenges (e.g. on Extremes, Regional Sea Level etc.), the Coupled Model Intercomparison Project (CMIP) in support of IPCC, the Coordinated Regional Climate Downscaling Experiment (CORDEX), and through the work of its respective Working Groups and other initiatives,
- (2) That WWRP is fostering fundamental Earth system science and application of science for services through the effective execution of its Implementation Plan, its three core projects (Polar Prediction Project, High-Impact Weather Project and the WWRP-WCRP co-sponsored Sub-Seasonal to Seasonal Prediction Project), the co-design of the future seamless Global Data Processing and Forecasting Implementation Plan, and key regional research initiatives with main thrust on extreme weather events,
- (3) That GAW is growing the international network of high-quality atmospheric composition observations across the global to local scale to drive high quality and impact science while co-producing a new generation of research-enabled products and services. GAW provides contributions to the cross-cutting integrated urban and health services and develops a new generation of science-enabled user-driven services through three core projects: Integrated Global Greenhouse Gas Information System (IG³IS) that supports climate services, Measurement-model fusion for total atmospheric deposition (MMF-TAD) that supports the ecosystem assessment and food security communities and Monitoring, Analysis and Prediction of Air Quality (MAP-AQ) that supports the health sector,

Noting further that the advancement in research coordinated by WMO is essential to advance the capabilities of National Meteorological and Hydrological Services (NMHSs), and furthermore, to fully implement the WMO Strategy for Service Delivery for the benefit of society,

Recognizing the critical need and its timeliness to improve integration and cross-coordination of research activities of weather, climate, water and related environmental domains in all WMO programmes, in order to provide a suitable environment for mutually beneficial collaboration among NMHS, research in public and private sectors [Spain] academic institutions and the private sector and users, with the common goals of necessary scientific and technical advances for targeted and societally relevant services,

Recognizing further that the scientific leadership of GAW, WCRP and WWRP have already initiated consultations within and outside of the traditional WMO community to strengthen their strategic partnerships and to promote the co-design of relevant research activities with the relevant organizations,

Decides to address the three strategic objectives of the long-term goal 3 defined in the WMO Strategic Plan (draft Resolution 3(1)/1 (Cg-18)), namely "Advance scientific knowledge of the Earth system", "Enhance the science-for-service value chain ensuring scientific and technological advances improve predictive capabilities" and "Advance policy-relevant science" [Spain] through the collaborative and integrated work of existing and new (sponsored and co-sponsored) research programmes together with IPCC, GCOS and the scientific component of GFCS;

Requests the Executive Council to ensure effective coordination, integration and resourcing of those activities among technical and scientific bodies supporting the continuous research-to-operations-to-services value chain;

Requests the Research Board [Germany]:

- (1) To ensure coherent planning and implementation of WMO research activities, as framed in the WMO Strategic Plan and Reform documents, across weather, water, climate and environmental related topics, considering research elements in all WMO programmes, developing future research areas with special attention to emerging unusual high impact events [Tanzania] and taking into account the advice of the Scientific Advisory Panel, as appropriate [Germany and Argentina];
- (2) To foster a research for services approach through the implementation of the Global Data Processing and Forecasting System and development of collaborative frameworks such as outlined in the Ocean Dialogue, and the Integrated Urban and Health Services;

Requests the Secretary-General [Germany]:

- (1) To promote WMO research at high levels of the United Nations as well as to the major international science initiatives, and to foster their engagement in its implementation, considering also the alignment with IPCC and GFCS;
- (2) To facilitate consultation with other relevant agencies of the United Nations (such as UNESCO), [Germany] international scientific agencies (including Future Earth) [Uruguay], engagement of social science and humanitarian communities [Hong Kong, China] and initiatives within the context of Earth System science;
- (3) To actively engage in resource mobilization initiatives to support the Research Programmes and their collaborative work towards a seamless Earth system approach;

Urges Members and Regional Associations:

- (1) To actively reach out and collaborate with research institutions, academia and stakeholders to enhance national and regional partnerships for weather, climate, water and environmental related [Hong Kong, China]research;
 - (2) To establish collaboration in developing coherent research initiatives at regional and national level;
 - (3) To increase support for global, regional and national research-related activities, including through Global Producing Centres, Regional Climate Centres and National Meteorological and Hydrological Services, to facilitate the development of advanced predictive capabilities within the context of Earth System science;
 - (4) To increase their support to CMIP, CORDEX [Spain] and to its international coordination so as to ensure sustained and timely contributions to IPCC and GFCS [Hong Kong, China];
 - (5) To continue their support to WWRP core projects (Polar Prediction Project, co-sponsored Sub-Seasonal to Seasonal Prediction, High-Impact Weather) in order to guarantee a continuous research-to-operation development;
 - (6) To continue their support to initiatives that will advance cross-cutting integrated urban and health services, Sand and Dust Storms early warning advisory systems, and the new generation of science-enabled user-driven services, and ensure financial support of such activities [Canada and Iran]
 - (7) To cooperate on data exchange and management of data, including impact information from societal and economic perspectives, [Hong Kong, China]in support of research activities and applications development.
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Draft Resolution 7.1-2/2 (Cg-18)

INTEGRATED AND COORDINATED WMO RESEARCH TO SERVE SOCIETY

THE WORLD METEOROLOGICAL CONGRESS,

Recalling:

- (1) Decision 50 (EC-69) – An integrated research and development approach, which includes the main principles to fill the gap between research and operations,
- (2) Decision 41 (EC-69) – Guidelines for the development of an integrated operational platform to meet urban service delivery needs, which requested to “expedite work on a Guide for Urban Integrated Hydrometeorological/Climate/Environment Services, using the expertise of the WMO GAW (Global Atmosphere Watch) Urban Research Meteorology and Environment (GURME)” project, which would improve the connection between research and operations,

Recognizing:

- (1) The advances in Earth system prediction that integrate different time scales and compartments, and the growing need of the user community for more sophisticated services,
- (2) That better integration of science and services requires a move from the current linear model of sporadically transferring research results to operations, to an interactive model in which stakeholders assess and articulate their future needs, researchers work in dialogue with stakeholders to define and implement appropriate research programmes, the research results are transferred to operations at appropriate intervals, and stakeholder needs and research programmes are refined taking into account the knowledge and experience gained,
- (3) That the World Climate Research Programme and programmes of the Commission for Atmospheric Sciences (the World Weather Research Programme and Global Atmosphere Watch) draw on the capabilities of a much larger science community than those in National Meteorological and Hydrological Services (NMHSs), and that those capabilities are fundamental for advancing the WMO strategy for service delivery,
- (4) That WMO research activities have a central role in promoting innovation across different service applications and that their coherence and consistency are an added value for WMO in promoting its international profile,

Noting that the development of specific services in diverse application areas requires involvement of the scientific community at all stages of the production chain,

Decides that WMO research needs to be better integrated and more closely coordinated across weather, climate, water and related environmental domains in order to provide the necessary scientific and technical advances needed to address the growing need for targeted and societally relevant services and to create an attractive environment in which NMHSs, academic institutions, the private sector and end users can engage in research to their mutual benefit;

Requests the WMO technical commissions and the Research Board, regional associations and other relevant WMO bodies [Argentina]:

- (1) To co-design in advance, when designing operational projects that rely on research, with WMO research Programmes the full range of activities that are required to bring a new or improved service or supporting system from conception through the different phases of production;
- (2) To promote the development of integrated research pilots to foster the value chain approach by jointly identifying research needs based on regional priorities for meteorological and environmental services;

Requests also the WMO technical commissions, the Research Board and other relevant bodies to develop a technical guide on the measuring, monitoring and modelling of the Urban Heat Island (UHI) effect, which is a growing concern due to accelerating urbanisation and warming trends, to support Members' service delivery needs and planning efforts to mitigate the impacts of UHI, using the expertise of the WMO GAW (Global Atmosphere Watch) Urban Research Meteorology and Environment (GURME) project [Singapore];

Urges Members to improve connections among NMHSs, research institutions, academia, stakeholders and end-users of services [Hong Kong, China] on a national level to ensure that research responds to requirements for the development of new and improved [USA]services, and that advances in research are appropriately included in operations;

Requests the Secretary-General:

- (1) To take all necessary actions, within available budgetary resources, to ensure a strongly coordinated and integrated WMO research function to support science-based services that will promote innovation across the Organization;
 - (2) To ensure a coordination mechanism within the Secretariat, led by the Research Department, to identify and coordinate, according to the agreed principles of the integrated research and development approach, WMO activities aimed at developing new or improving existing services and supporting systems in the weather, climate, water and related environmental domains;
 - (3) To assist Members in promoting research as part of the development of new and enhancement of existing services, particularly in developing countries, by promoting capacity-building, facilitating training and exchange of scientists, and providing guidance and advice, as required, within available budgetary resources;
 - (4) To take all necessary actions to initiate, develop and maintain WMO collaboration in matters related to weather, climate, water and related environmental research with relevant organizations, agencies, groups and institutions, from both the public and private sectors.
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Draft Resolution 7.1-2/3 (Cg-18)

A SEAMLESS RESEARCH STRUCTURE FOR WMO

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

- (1) That leveraging the predictive skill at a broad range of temporal and spatial scales that are inherent in the various components of the Earth system and their interactions would allow Members to improve their services,
- (2) That the Data-processing and Forecasting System (DPFS), through Resolution 17 (EC-69) – Seamless Data-processing and Forecasting System, will become a pillar in the future WMO Service Delivery Strategy,
- (3) Decision 50 (EC-69) – An integrated research and development approach, which endorsed the principles towards better integrated research and development support to Members,
- (4) Decision 49 (EC-69) – WMO priority actions in hydrology and water resources management, in support of the ambitious work plan of the Commission for Hydrology,
- (5) Resolutions 5.3.1 and 5.3.2 (Cg-18) on existing and future WMO hydrology activities [Germany]

Recalling that the implementation plans of the World Weather Research Programme (WWRP) and of the Global Atmosphere Watch (GAW) Programme, endorsed by Decision 61 (EC-68) – World Weather Research Programme Implementation Plan for the period 2016–2023, and Decision 62 (EC-68) – Global Atmosphere Watch Implementation Plan for the period 2016–2023, respectively, call for development of integrated modelling products and services,

Considering that:

- (1) Advancing the scientific understanding of the Earth system has been endorsed by Decision 65 (EC-69) – Preparation of WMO Strategic Plan 2020–2023, as a strategic objective (strategic objective 3.1) of the Plan,
- (2) Collaborations among GAW, WWRP and other partners are essential to make research advances in the emerging strategic areas of WMO, in particular on aspects of model development, the water cycle and urban development,
- (3) The ongoing Sub-seasonal to Seasonal Prediction Project (S2S Project) (Resolution 16 (EC-LXIV) – Sub-seasonal to Seasonal Prediction Project), Polar Prediction Project (Resolution 17 (EC-LXIV) – Polar Prediction Project), High-impact Weather Project (Resolution 12 (EC-66) – High-impact Weather Project), GAW Urban Research Meteorology and Environment Project, and Integrated Global Greenhouse Gas Information System (Decision 51 (EC-69) – The Integrated Global Greenhouse Gas Information System Implementation Plan) complement each other towards a seamless-oriented research structure,

Agrees that:

- (1) Research plays a critical role in developing future predictive seamless systems and in underpinning decisions on the development of related observing systems for weather, climate, water and environment;

- (2) The Working Group on Numerical Experimentation shall [Italy] play a central role in coordinating the development of seamless research components across GAW, WWRP and the World Climate Research Programme (WCRP), including interacting and building connections with the technical commissions' relevant subsidiary bodies that work on aspects of numerical experimentation;

Decides:

- (1) That GAW, WWRP and WCRP, supported by the Research Board and [Argentina and USA] in collaboration with technical commissions' relevant subsidiary bodies, shall play a major role in promoting research across temporal and spatial scales and across environmental domains towards a unified, integrated Earth system modelling approach in an interactive set-up that ensures the transfer of research concepts, tools and techniques to operations as informed by users;
- (2) To convene an overarching Open Science Conference on the Earth System, possibly in 2022, to facilitate this integrated and interactive approach;

Requests the Research Board to further strengthen collaborative efforts between the Research Programmes' steering committees to support innovation for DPFS;

Encourages the Research Board, subsidiary bodies of technical commissions in charge of hydrology and agrometeorology, Hydrology Coordination Panel and Climate Coordination Panel, to further strengthen interactive feedbacks between multi-disciplinary research activities within WMO, as well as to promote the use of research products such as S2S Project database across the research and application domains;

Requests also the Secretary-General to align the appropriate research activities and resources in WMO to optimally support the development and enhancement of DPFS and of the Global Framework for Climate Services;

Requests further Members to actively participate in research activities for predictive seamless systems, to contribute to the trust funds of the above-mentioned Programmes and to provide strong support for the implementation of project activities in their respective countries.

Draft Resolution 7.1-2/4 (Cg-18)

SEAMLESS REGIONAL RESEARCH FOR WATER

THE WORLD METEOROLOGICAL CONGRESS,

Noting:

- (1) Resolution 12 (EC-66) – High-impact Weather Project, which established the Project,
- (2) Decision 5 (EC-69) – Flood forecasting, which requested the relevant technical commissions to ensure that the future Global Data-processing and Forecasting System is an operational system that has a direct interface to applications such as the Flash Flood Guidance System,
- (3) Decision 49 (EC-69) – WMO priority actions in hydrology and water resources management, which expressed support for the ambitious work plan of the Commission for Hydrology (CHy),

Noting further:

- (1) That sustainable development requires a systematic assessment of water resources from global to regional and local scales,
- (2) The common interests of the World Weather Research Programme (WWRP), the World Climate Research Programme, the WMO Hydrological Water Resources Programme (HWRP), UNESCO International Hydrological Programme (IHP), the UNEP GEMS/WATER Programme [Germany] and the [International Groundwater Resources Assessment Centre](#) in the monitoring of groundwater and the dissemination of data,
- (3) The need to develop links between the Global Atmosphere Watch Programme, WWRP and the Global Energy and Water Cycle Experiment on aspects of extreme events and precipitation processes, such as quantitative precipitation forecasts and urban flooding,
- (4) The role of water vapour as a climate driver and an atmospheric chemical constituent,

Stressing:

- (1) The need to strengthen WMO regional activities related to the understanding and assessment of the coupled water cycle, avoiding redundancy and duplications across weather, climate, water and environment programmes,
- (2) The need to establish integrated pilot projects, which should be developed in collaboration with key partners, as well as with stakeholders and users, following the example the Hydrological Cycle in the Mediterranean Experiment,

Requests the technical commissions, the Research Board and regional associations [New Zealand] in collaboration with the Hydrological Coordination Panel, to enhance WMO's involvement in research activities that address regional needs focusing on the exchange processes between Earth system components related to water [UK], in cooperation with the WMO Research Programmes and UN-Water [Germany], taking into account the advice from the Scientific Advisory Panel and other relevant WMO bodies [Argentina];

Requests further the Secretary-General to strengthen or establish cooperation on water-related issues with relevant United Nations and other international organizations.

Draft Resolution 7.1-2/5 (Cg-18)

CREATING AN ENVIRONMENT FOR INNOVATION AND ITS OPTIMAL RESOURCING

THE WORLD METEOROLOGICAL CONGRESS,

Recalling:

- (1) Decision 73 (EC-68) – Cooperation between the public and private sectors for the benefit of society, which promotes a framework for fruitful collaboration between National Meteorological and Hydrological Services (NMHSs) and the private sector for the benefit of society,
- (2) Decision 50 (EC-69) – An integrated research and development approach, which endorsed the principles towards better integrated research and development, and among which it stressed the role of co-design and continuous consultation between users and stakeholders,
- (3) Decision 69 (EC-68) – Resource mobilization, which approved the WMO Resource Mobilization Strategy that highlighted, among potential mechanisms, appropriate partnerships with the private sector and increased focus on research funding mechanisms,
- (4) Resolution 17 (EC-69) – Seamless Data-processing and Forecasting System, which requested the Steering Group on the Seamless Data-processing and Forecasting System (DPFS) to develop a detailed implementation plan, and the Commission for Atmospheric Sciences (CAS) to utilize its forthcoming Science Summit and its seventeenth session as a platform for interaction between the Commission for Basic Systems, CAS and representatives of other technical commissions and regional associations, to define the scientific progress needed to realize the future seamless DPFS,

Mindful of the draft Resolution 3(1)/1 (Cg-18) - WMO Strategic Plan, which defines the long-term goal of advancing targeted research with the purpose of improved understanding of the Earth system and the implications to weather, climate, water and related environmental matters, and enhancing predictive capabilities in a seamless context through the application of scientific and technological advances,

Noting that:

- (1) The development of integrated services for urban environments was requested by Members and supported by the technical commissions and the Global Framework for Climate Services, and that development of such services requires advances in science and innovation to resolve processes on different spatial and temporal scales,
- (2) Research and operations need to work hand in hand with user needs as a target in advancing the seamless DPFS,
- (3) Research activities are at the base of any innovation, and that these require adequate investment, the involvement of a critical mass of experts through shared facilities and virtual partnership, and a culture that recognizes and values excellence,

Mindful also that non-optimal use of resources in research and the duplication of effort between different stakeholders lead to the depletion of innovation potential,

Satisfied with the fact that the private sector and foundations create opportunities for innovation through open calls and competition,

Recognizing that research needs a balanced approach, combining long-term activities that will support continuous improvement and short-term innovation for targeted challenges,

Agrees that:

- (1) There is a need to join efforts between NMHSs, the private sector, civil society and the academic world in promoting partnerships at the national, regional and global levels;
- (2) There is a need to involve key international partners in co-designing WMO research activities with a special focus on the seamless DPFS and on cross-cutting areas of interest;
- (3) There is a need for a formal engagement of key international stakeholders in setting up the WMO research agenda in order to deliver the WMO Strategic Plan and long-term goals and in providing concrete inputs to research implementation and governance;

Urges Members:

- (1) To contribute to the WMO research coordination efforts through global partnerships towards a dramatic increase in predictive skills, to be materialized in improved services of the seamless DPFS;
- (2) To sustain funding for long-term research activities and fund research supporting the development of new products and services, including research activities that incorporate social sciences;
- (3) To work closely with funding agencies and other resourcing mechanisms to ensure inclusion of the unified scientific priorities defined by the WMO Strategic Plan and long-term goals in their agendas;

Encourages NMHSs to take a more active part in innovation calls supported by the private sector;

Requests the technical commissions, the Research Board and regional associations, taking into account the advice of the Scientific Advisory Panel and other relevant WMO bodies [Argentina], to work towards the establishment of centres of excellence and virtual networks to be driven by ambitious scientific targets in order to catalyse innovation, for example using the Severe Weather Forecasting Demonstration Project as an opportunity to foster innovation through co-design between research and operations;

Requests also Members to ensure support of communication systems to allow distributed access to the centres of excellence and virtual networks and for effective cooperation on research challenges;

Requests further the Secretary-General:

- (1) To take all necessary action, within the available budgetary resources, to encourage the culture of innovation and research across the Organization;
- (2) To assist Members in establishing global partnerships towards the development and utilization of distributed centres of excellence;
- (3) To assist Members in mobilizing resources through research funding mechanisms;

- (4) To promote the value of research and innovation in partnership with the private sector and other stakeholders in civil society within WMO, and acknowledge the excellence of groups for their contribution;
 - (5) To ensure that excellence in science is recognized through appropriate incentive schemes;
 - (6) To take all necessary actions to initiate, develop and maintain WMO collaboration on matters related to weather, climate, water and related environmental research with relevant organizations, agencies, groups and institutions, from both public and private sectors.
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