World Meteorological Organization
Weather · Climate · Water

OCEANS AND THE LAW OF THE SEA: REPORT OF THE SECRETARY-GENERAL – PART II (2017)

CONTRIBUTION OF WMO

EXECUTIVE SUMMARY

The World Climate Research Programme (WCRP) continues to coordinate a wide range of ocean-related science activities such as on the El Niño/Southern Oscillation in a Changing Climate, Decadal Climate Variability and Predictability, Planetary Heat Balance and Ocean Heat Storage, the ocean's role in Monsoons, and on polar sea-ice variability. WCRP's Coupled Model Intercomparison Experiment Project (CMIP), as used by Intergovernmental Panel on Climate Change (IPCC),is now in its 6th phase, aims to better understand past, present and future climate changes arising from either natural, unforced variability or in response to changes in radiative forcing in a multi-model context. Among the Grand Science Challenges addressed by WCRP, "Regional Sea Level Change and Coastal Impacts" addresses the need for integrated interdisciplinary approach for quantitative understanding of global to regional and local sea level variability, to foster the development of sea level predictions and projections for coastal zone management. The Grand Challenge on "Understanding and Predicting Weather and Climate Extremes" invigorates community-wide efforts to improve understanding, assessment and prediction of weather and climate extremes, such as coastal storms. [A/RES/71/257, para 203]

The latest analysis of observations from the WMO Global Atmosphere Watch (GAW) Programme shows that atmospheric CO_2 reached 144% of the pre-industrial level in 2015. The increase of CO_2 from 2014 to 2015 was larger than that observed from 2014 to 2015 and that averaged over the past 10 years, despite evidence that global anthropogenic emissions remained essentially static between 2014 and 2015. The El Niño event in 2015 contributed to the increased growth rate through complex two-way interactions between climate change and the carbon cycle. The main sinks for CO2 emissions from fossil fuel combustion are the oceans and terrestrial biosphere. Uptake of CO2 by the ocean leads to ocean acidification (see *WMO Greenhouse Gas Bulletin* 2014). [A/RES/71/257, paras 18, 185]

The 69th WMO Executive Council adopted an implementation plan for the Integrated Global Greenhouse Gas Information System (IG3IS), which was established by the 17th World Meteorological Congress in recognition of the growing need for data and research related to understanding of greenhouse gas budgets on enhanced temporal and spatial scales to support implementation of the Paris agreement and provision of climate services. The implementation of IG3IS is already underway and relies on the globally harmonized observations of GHGs and will require the development of high resolution and complex observing systems, modelling tools and data assimilation techniques, entailing collaboration with organizations and institutions that address the carbon budget of biosphere and ocean. [A/RES/71/257, paras 18, 185]

WMO continues its collaboration with IMO and IHO for coordinated and standardized metocean information (as a component of the Maritime Safety Information, provision) , forecasts and warning services for safety of life and property at sea, improved marine environment and sustainable management of natural resources, with due focus on Polar Regions. Efforts to improve the WWMIWS continued with the implementation of the Marine Forecaster Competency Framework undertaken by 11 of 16 NMHSs that have responsibilities for the WWMIWS. A user survey was also completed and positive results were maintained from the previous survey. An ad hoc Working Group on Marine Services has been established to examine needs and opportunities to strengthen the delivery of marine services by WMO. [A/RES/71/257, para 156]

The Coastal Inundation Forecasting Demonstration Project (CIFDP) is a multi-hazard warning system that promotes an integrated and enhanced approach to deliver early warnings, no matter what the causes for coastal inundations. This is in line with the concept of impact-based forecasting and the UN Sendai Framework for Disaster Risk Reduction (DRR). The CIFDP is currently underway in four sub-projects (Bangladesh, Dominican Republic, Fiji and Indonesia), two of which are in urban coastal settings and two in SIDS. The project is expected to be completed in 2019. Before then, an independent external evaluation of the CIFDP is foreseen to assess the strengths, room for improvement and ongoing sustainability beyond the demonstration phase, and to encourage opportunities for other countries to engage in a MHEWS for coastal inundation. [A/RES/71/257, para 203]

The 17th WMO Congress (2015) reiterated the importance to address ship security and piracy, and prevention of vandalism to data buoys, requesting the Secretary-General to organize a second WMO-IMO high level meeting in 2016/2017 to safeguard the buoys at sea, and further urged Members to follow recommendations of the Data Buoy Cooperation Panel (DBCP) Technical Document No. 41, *Ocean Data Buoy Vandalism – Incidence, Impact and Responses*. As further response, WMO and IOC have developed a draft Outreach Strategy to Reduce Damage to Ocean Data Buoys from Vandalism or Interference, which is intended to be finalized by October 2017. [A/RES/71/257, para 282]

To support the implementation of SDG 14, WMO has launched three voluntary commitments for the Ocean Conference: (1) Year of Polar Prediction, (2) Responding to El Niño: Improving International Coordination for Improved Early Warning, and (3) Weather and climate services for Africa, Caribbean and Pacific (ACP) countries.

INTRODUCTION

WMO is the authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. The Oceans provide essential natural resources to human beings, and regulate the global climate. WMO contributes to oceans-related issues through the observation and monitoring of the ocean and climate; research on the climate and Earth systems; development and delivery of services for disaster risk reduction, including marine hazards; coordination of studies on the exchange of gases and particles between the atmosphere and the ocean; and provision of science-based information and tools for policymakers and the general public at regional and global levels.

WMO continues strengthening the global observing systems through implementation of the WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS), and observing networks with partners. The WMO-ICSU-IOC-UNEP Global Climate Observing System (GCOS) serves the requirements of Members for comprehensive, continuous, reliable climate data and information, for climate monitoring, research, projections and assessments, to provide climate information and to promote sustainable development. The IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS) improves its capabilities in climate- and ocean-related services, and recognizes the importance of coastal observations and links to products for societal benefits.

WMO, jointly with IOC-UNESCO and ICSU, coordinates the World Climate Research Programme (WCRP), which tackles major challenges in climate research that reflect the complexity and interactions among the major components of the planet – ocean, atmosphere, land and ice. The WCRP Grand Challenges[1] focus on high-priority research questions, in close partnership with IOC and other national and international entities; for example, the WCRP Grand Challenges on Regional Sea Level Change and Coastal Impacts, and Understanding and Predicting Weather and Climate Extremes (e.g. coastal storms).

The Global Atmosphere Watch (GAW) continues to coordinate systematic observations and analyses of atmospheric abundances of the most influential long-lived greenhouse gases, many other atmospheric substances and atmospheric deposition. WMO, through GAW, is also the lead agency behind studies of the impact of atmospheric chemicals (including nutrients) on ocean biogeochemistry under the purview of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

WMO continues its collaboration with IMO and IHO for coordinated and standardized metocean information (as a component of the Maritime Safety Information, provision), forecasts and warning services for safety of life and property at sea, improved marine environment and sustainable management of natural resources, with due focus on Polar Regions. WMO through the work of the Marine Meteorology and Oceanography Programme coordinates and implements the Coastal Inundation Forecasting Demonstration Project (CIFDP) among others, to protect livelihoods and support the sustainable development of coastal communities.

WMO contributes to the global development agenda through its programmes and initiatives. The 17th World Meteorological Congress established new Small Island Developing States programme to consolidate WMO actions and activities for improved weather and climate services in SIDS and Member Island Territories. In the context of the Third World Conference on Disaster Risk Reduction to develop the Sendai Framework for DRR, WMO with multiple stakeholders in the UN system and beyond advocated to substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments, including for marine hazards, by 2030.

[1] https://www.wcrp-climate.org/grand-challenges/grand-challenges-overview

DEVELOPMENTS RELATING TO INTERNATIONAL SHIPPING ACTIVITIES

Maritime safety

1. WMO continued to work with the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO) for the provision of marine safety information services in the context of the World Wide Met-Ocean Information and Warnings Service (WWMIWS) and the Global Maritime Distress and Safety System (GMDSS). Work is being undertaken to fully review the Manuals and Guides which provide the standards, recommended practices and guidance for services in the marine sector, principally WMO-No. 558 and WMO-No. 471, and in particular on the role of the Metarea Coordinators, as outlined in the IMO Resolution A.1051 (27). In this regard, WMO governing bodies have called further on Members to support the introduction of competency standards into marine forecasting and support the compliance to these standards within their National Meteorological and Hydrological Services and to introduce impact-based services into the marine sector, whilst ensuring that services continue to meet requirements outlined in the International Convention for the Safety of Life at Sea (SOLAS).

2. Metocean Forecasting services are also promoted in alignment with the WMO services delivery strategy and roadmap for marine services, including compliance with the future seamless Global Data-processing and Forecasting Systems (GDPFS), and its updated manual. These and other technical regulations are expected to be adopted by the fifth session of JCOMM (Bali, Indonesia, 25-29 October 2017). Efforts to improve the WWMIWS continued with the implementation of the Marine Forecaster Competency Framework undertaken by 11 of 16 NMHSs that have responsibilities for the WWMIWS. A user survey was also completed and positive results were maintained from the previous survey. An ad hoc Working Group on Marine Services has been established by the Secretary-General following the discussions at the 17th World Meteorological Congress (2015) to strengthen marine services. The sixty-eighth session of the Executive Council (2016) provided further direction to the Working Group. The results of their assessment will be considered by JCOMM-5 and reported to the seventieth session (2018). [A/RES/71/257, para 156]

SUSTAINABLE DEVELOPMENT OF OCEANS AND SEAS

Marine observations and services

3. WMO is collaborating with partner organizations such as the IOC of UNESCO to further develop, optimize and maintain in complement to satellite observations and remote sensing technology, *in situ* marine meteorological and oceanographic (metocean) observing networks in support of applications such as weather forecasting and operational meteorology, the monitoring, understanding and prediction of climate variability and climate change at various time scales, ocean forecasting and marine services activities, the protection and sustainable development of the ocean and marine environment, and the efficient management of marine resources, including disaster risk reduction in coastal regions. In face of evolving requirements and advances in observing technology, and in response to GCOS requirements in particular, the WMO and the IOC of UNESCO through JCOMM are revising observing network implementation targets and addressing the means to reach those targets in the most cost-effective way.

4. Today's global ocean observing system relies on composite observing networks comprising meteorological and oceanographic satellites, coastal high frequency radars, and thousands of observing platforms in the global ocean and coastal regions, including drifting and moored data buoys, ice buoys, profiling floats, sub-surface ocean gliders, tide gauges, tsunameters, and voluntary observing ships. Assuring sustainability of metocean observing systems and the required exchange of the collected data on free and unrestricted basis is also critical for addressing the user requirements, and particularly those for disaster risk reduction. The 17th World Meteorological Congress reiterated the importance to address ship security and piracy, and prevention of vandalism to data buoys, requesting the Secretary-General to organize a second WMO-IMO high level meeting in 2016/2017 to safeguard the buoys at sea, and further urged Members to follow

recommendations of the Data Buoy Cooperation Panel (DBCP) Technical Document No. 41, *Ocean Data Buoy Vandalism – Incidence, Impact and Responses*. As further response, WMO and IOC have developed a draft Outreach Strategy to Reduce Damage to Ocean Data Buoys from Vandalism or Interference, which is intended to be finalized by October 2017 [A/RES/71/257, para 282]

5. Collaboration with the maritime industry is critical to maintain the ocean observing arrays as it provides opportunities for making observations from ships, or for deploying or servicing autonomous observing platforms at sea. While good progress was made since the beginning of the century to complete the global ocean observing systems (two third completed), much efforts remain to be made to reach the implementation targets for some of the observing networks. Exciting technological advances in observing platforms, communications and sensors provide opportunities to close gaps, expand into new frontiers (deep ocean, under ice), measure new variables, and lower costs per observation

6. The GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC) is charged with delivering requirements for the Ocean Component of GCOS (Global Climate Observing System), the physics variables for GOOS (Global Ocean Observing System), and observations for the World Climate Research Programme (WCRP) in addition to scientific advice to the Joint WMO-IOC Commission for Oceanography and Marine Meteorology (JCOMM). OOPC-20 was held from 14-17 March 2017 in Woods Hole Oceanographic Institution, Cape Cod, USA. The main focus of the meeting was the forward work plan for the panel, which includes initiatives on evaluating observing system design for wind stress, heat fluxes, boundary currents, and a review of the observing system to capture changes in ocean heat and freshwater content. [A/RES/71/257, para 279]

7. The Tropical Pacific Observing System, TPOS 2020 project was established by agency sponsors, reporting to GOOS following challenges to sustain key components of the observing system, and a recognition that as the observing system was designed in the mid-1980s, a revisit of observing system requirements was timely. The 1st report of TPOS 2020 makes key recommendations and actions for the observing system considering satellite and in situ in an integrated manner, including enhanced Argo coverage, and a reconfigured mooring array. Recognizing the importance of the tropical Pacific observations to the mission of met services, WMO EC has approved key recommendations, and will assist in coordinating regional implementation through JCOMM.

8. The Year Of Polar Prediction was officially launched during WMO's annual Executive Council meeting (May 2017) and it has been registered as a voluntary commitment for the Ocean Conference[2]. Polar and high mountain activities are among WMO's top strategic priorities because of the growing impact of climate change from greenhouse gas emissions, because of the need to improve our understanding of weather phenomena in extreme regions and because the poor monitoring network leaves gaping holes in the global weather observing capability. The Year of Polar Prediction, which takes place from mid-2017 to mid-2019 in order to cover an entire year in both the Arctic and Antarctic, is a concerted international campaign to improve predictions of weather, climate and ice conditions in the Arctic and Antarctic. When it comes to the extreme environment at the poles, forecasts of weather and sea-ice conditions have serious shortcomings. The Arctic and Antarctic are the world's most poorly observed regions. Lack of data and forecasts in the Arctic and Antarctic impacts on the quality of weather forecasts also in other parts of the world. It is therefore expected that advances in polar prediction will lead to improved weather forecasts and climate predictions both for polar regions and densely populated countries.

9. WMO and IOC/UNESCO jointly coordinate through JCOMM global efforts to implement operational ocean forecasting services. A Marine Service Ad Hoc Working Group has been established since the 17th World Meteorological Congress to assess the work and future direction of WMO marine meteorology activities, including examining links to JCOMM, the cooperation between WMO, IOC/UNESCO, IMO and IHO and identifying positive engagement mechanisms

[2] https://oceanconference.un.org/commitments/?id=14082.

with all relevant partners/stakeholders (both within WMO and externally) for improved service delivery in marine meteorology, whilst taking into account the needs of users beyond mariners.

10. WMO is advocating the established of an International Network for Multi-hazard Early Warning Systems (IN-MHEWS), and is now working extensively on engaging interested stakeholders, partners and organizations to develop and facilitate IN-MHEWS. In this regard, WMO, in collaboration with UNISDR, UNESCO and its Intergovernmental Oceanographic Commission (IOC) organized the "Multi-Hazard Early Warning Conference" (Cancun, Mexico, 22-23 May 2017). The Conference addressed progress in the implementation of Goal (g) of the Sendai Framework[3], reviewed good practices in multi-hazard early warning systems and promoted investments in these systems. At the Conference, WMO launched the vision of a Global Multi-Hazard Alert System approved by the 69th WMO Executive Council.

Scientific information and assessments to support decision-making

11. A significant body of oceanographic research of direct benefit for decision-making in climate related risks is spearheaded and coordinated by the WMO-IOC/UNESCO-ICSU co-sponsored World Climate Research Programme (WCRP)[4]particularly through its CLIVAR[5] (Climate and Ocean: Variability, Predictability and Change) core project and in the polar regions through its CliC[6] (Climate and Cryosphere) core project. CLIVAR supports a host of different ocean activities, for example with Research Foci on ENSO in a Changing Climate, Decadal Climate Variability and Predictability, Planetary Heat Balance and Ocean Heat Storage, and Eastern Boundary Upwelling Systems. As well as a variety of regional basin panels CLIVAR also includes global panels with foci on Ocean Model Development, Global Synthesis and Observations, Climate Dynamics, and on the ocean's role in Monsoons. CliC covers a wide range of cryospheric activities, including those related to observing and modelling sea ice, on Southern and Arctic Ocean science (jointly with CLIVAR) and leads the Polar Climate Predictability Initiative. Through its scientific leadership to consolidate global and regional efforts to understand the dynamics, the interaction and the predictability of the coupled ocean-atmosphere system, significant improvement has been made in understanding climate variability and changes, as well as the benefit of society and the environment in which we live – such as predictive experiments for the future state of climate system and project how it will evolve under different emission scenarios.

12. WCRP continues to coordinate the Coupled Model Intercomparison Experiment Project (CMIP), used in the assessments of the Intergovernmental Panel on Climate Change (IPCC). CMIP is one of the foundational elements of climate science, to better understand past, present and future climate changes arising from either natural, unforced variability or in response to changes in radiative forcing in a multi-model context. The 5th phase of CMIP (CMIP5, 2010–2013) provided essential dataset to support research compiled in the Report of IPCC entitled "Climate Change 2013: The Physical Science Basis"[7] (September 2013). The 6th phase, CMIP6[8], is structured to address three broad scientific questions in support of the WCRP Grand Scientific Challenges[9]: (1) how the Earth System responds to forcing; (2) the origins and consequences of systematic model biases; and (3) modality to assess future climate changes given climate variability, predictability and uncertainties in scenarios.

13. In support of decision making WMO, through WCRP, supports climate science that underpins planning for future, and provides reliable source for metocean-climate services. Development of scientific methods for treatment of uncertainty in climate-related decision-making

[3] Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030
[4] See http://www.wcrp-climate.org/.
[5] See http://www.clivar.org.
[6] See http://www.climate-cryosphere.org.
[7] See http://www.ipcc.ch/.
[8] See http://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6.
[9] See http://www.wcrp-climate.org/grand-challenges.

is one of key subjects of research conducted by WCRP. For example a WCRP Grand Science Challenge on "Regional Sea Level Change and Coastal Impacts"[10] addresses the imperative need for integrated interdisciplinary approach to establish quantitative understanding of global to regional and local sea level variability, to foster the development of sea level predictions and projections that are of increasing benefit for coastal zone management. The Grand Challenge on "Understanding and Predicting Weather and Climate Extremes"[11] invigorates community-wide efforts to improve understanding, assessment and prediction of weather and climate extremes, such as coastal storms. [A/RES/71/257, para 203]

14. WCRP and the Prince Albert II of Monaco Foundation (FPA2) are jointly promoting a Polar Challenge with a Prize money award of 500,000 Swiss francs to the first team able to complete a 2000km continuous mission under the sea-ice with an autonomous underwater vehicle in the Arctic or Antarctic. The start of the competition was formally announced at the Arctic Science Summit Week in March 2016. This challenge aims to promote innovation towards a cost-effective, scalable and sustainable monitoring system for the polar oceans.

15. WMO/GAW is a long-time sponsor of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) Working Group on The Atmospheric Input of Chemicals to the Ocean (WG 38). WG 38 has produced numerous peer-reviewed publications related to the impact of the atmospheric deposition of anthropogenic sulphur and nutrients (nitrogen, phosphorous and mineral dust) to the ocean on ocean biogeochemistry. The next round of publications from this group will focus on two new areas: 1) the changing atmospheric acidity and the oceanic solubility of nutrients, and 2) the impact of ocean acidification on fluxes of non-CO_2 climate-active species. The WG held two expert workshops from 27 Feb to 2 March at the University of East Anglia to develop scientific insights and plan a list of publications on these two priorities.

16. WMO/GAW coordinates global observations of reactive gases and aerosols which are considered as harmful air pollutants. Several countries that perform observations on island or coastal zones and cities with large ports report increasing deterioration of air quality due to ship emission based on their observations. For many island countries this increasing pollution represents not only environmental but economic problem as well as their main industry is tourism. WMO works with the ocean community concerning harmonization of CO2 observations at the land based stations and from ships.

OCEANS AND CLIMATE CHANGE AND OCEAN ACIDIFICATION

Mitigating the impacts of climate change

17. Carbon dioxide is the single most important anthropogenic greenhouse gas in the atmosphere.[12] It contributes ~65% to radiative forcing by long-lived greenhouse gases (LLGHGs). It is responsible for ~81% of the increase in radiative forcing over the past decade and ~82% over the past five years. Observations at the marine and terrestrial ground based stations around the world contributing to the Global Atmosphere Watch (GAW) Programme of WMO are used to assess globally averaged levels of CO_2 and other LLGHs and trace species in the lower atmosphere.

18. The pre-industrial level of ~278 ppm for CO_2 represented a balance of fluxes between the atmosphere, the oceans and the biosphere. The latest analysis of observations from the WMO GAW Programme shows that globally averaged surface mole fractions for CO_2 reached new highs in 2015 at 400.0±0.1 ppm constituting 144% of the pre-industrial (before 1750) level. The increase of CO_2 from 2014 to 2015 was larger than that observed from 2014 to 2015 and that averaged over

[10] See http://www.wcrp-climate.org/grand-challenges/gc-sea-level.
[11] See http://www.wcrp-climate.org/grand-challenges/gc-extreme-events.
[12] See *WMO Greenhouse Gas Bulletin* no. 12, 24 October 2016 (http://www.wmo.int/pages/prog/arep/gaw/ghg/GHGbulletin.html).

the past 10 years, despite evidence that global anthropogenic emissions remained essentially static between 2014 and 2015.[8] The El Niño event in 2015 contributed to the increased growth rate through complex two-way interactions between climate change and the carbon cycle. The year 2016 was the first year in which CO_2 at the Mauna Loa Baseline Atmospheric Observatory remained above 400 ppm all year.[13,14]

19. WMO acknowledges that climate engineering covers a wide spectrum of technologies, each with a different level of complexity, uncertainty and associated risk. WMO/GAW is a supporting agency of a new GESAMP Working Group on Marine Geoengineering (WG 41) led by IMO. The WG was tasked with carrying out an assessment of a wide range of marine geoengineering approaches for their potential environmental and socio/economic impacts on the marine environment as well as their potential scientific practicality and efficacy for climate mitigation purposes. The final peer-reviewed report is intended to assist the Parties of the London Convention and London Protocol to determine which marine geoengineering activities might be listed in Annex 4 of the Protocol and consequently regulated. WMO hosted the 2nd meeting of WG41 in Geneva on 26-28 April, 2017. WMO will also host GESAMP's 44th session in Geneva from 4-8 September 2017.

20. There is an ongoing effort to improve coordination of CO_2 observations between atmospheric and ocean communities[15]. The 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases, and Related Measurement Techniques (GGMT), held on 13–17 September 2015 in La Jolla, California, included a special session on measurements of dissolved greenhouse gases and related ocean tracers during which requirements for network compatibility and recommendations for QA/QC procedures and ocean observations were reviewed. These recommendations are published as GAW report 229 (Section 13 reflects the recommendations for air measurements of CO2 on ships). The 19th GGMT, taking place on 27-31 August 2017 in Dübendorf, Switzerland, will also include a session on ocean observations of GHGs.

21. Recognizing the growing need for data and research related to understanding of greenhouse gas budgets on enhanced temporal and spatial scales to support implementation of the COP 21 (Paris) agreement and provision of climate services, the 17th World Meteorological Congress adopted a resolution on the implementation of the Integrated Global Greenhouse Gas Information System (IG^{3}IS). WMO GAW provides the standards for atmospheric measurements, and IG^{3}IS will establish, propagate and, over time, improve the methodological standards for how atmospheric transport inverse model analyses of atmospheric GHG concentration measurements ("top-down") can be combined with spatially and temporally explicit socioeconomic emission inventory data ("bottom-up") to better inform and manage emission reduction policies and measures. The implementation of IG^{3}IS is now underway according to a set of principles and three objective areas defined in the Concept Paper approved by WMO 68th Executive Council[16]: (1) reduce uncertainty of national emission inventory reporting to UNFCCC; (2) locate, quantify and inform emitters of previously unknown emission reduction opportunities; and (3) provide national and subnational entities with timely and quantified information on the amounts, trends and attribution of their emissions to support progress towards emission reduction goals.[A/RES/71/257, para 185]

Adapting to the impacts of climate change and variability

22. The El Niño of 2015-16 exerted severe impacts to more than 60 million people around the globe. The phenomena, with impacts mainly visible through extreme weather and climate events, led to heavy rains, flooding and mud slides, droughts, forest fires, and contributing to severe food

[13] National Atmospheric and Oceanic Administration's Global Greenhouse Gas Reference Network https://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html.
[14] See WMO's Press Release (18 May 2016) "CO2 breaches milestone, drives warming" (http://public.wmo.int/en/media/news/southern-hemisphere-breaches-co2-milestone).
[15] The Secretary-General of WMO, Prof. Petteri Taalas, has been invited to act as moderator of the Ocean Conference Partnership Dialogue 3 on "Minimizing and addressing ocean acidification".
[16] WMO, 2016. Integrated Global Greenhouse Gas Information System (IG3IS), http://www.wmo.int/pages/prog/arep/gaw/ghg/IG3IS-info.html.

insecurity especially in parts of Africa and South America. Marine ecosystems were also affected through extensive coral bleaching episodes. The El Niño led to large economic and social impacts, impeding global development targets. Consensus models for 2017 are predicting a 50-60% probability[17] of return of El Niño conditions in the 2017 Northern Hemisphere summer. To support governments in taking early precautions against the impact of this and future events through early warning of associated hazards and early action to save lives, protect critical infrastructures and mitigate impacts on their socio-economic sectors, WMO, in collaboration with partners, is proposing to strengthen international coordination for the provision of information on El Niño episodes and their impacts to take early precautions and actions including early warnings for extreme weather and climate events. This initiative has been launched as a voluntary commitment for the Ocean Conference.[18]

23. WMO's Global Framework for Climate Services (GFCS) has launched a voluntary commitment at the Ocean Conference[19] to optimize the use of the available hydrometeorological infrastructure and knowledge to support decision making to contribute to climate adaptation and mitigation policies in African, Caribbean and Pacific Group of States (ACP countries), in particular SIDS. The general objective of the initiative is to foster sustainable development in ACP countries by improving the decision-making process through informed adaptation options to climate variability and change. The specific objective is to support the climate information services value chain with technical assistance, financial assistance, infrastructure and capacity building to improve wide access and use of climate information, and to enable and encourage the creation and use of climate services and applications for decision making processes at all levels. It will strengthen the tools to bridge climate services stakeholders and users in various priority sectors to resource and implement the GFCS at all levels. [A/RES/71/257, para 191]

24. The Coastal Inundation Forecasting Demonstration Project (CIFDP) is a multi-hazard warning system that promotes an integrated approach in the enhancement and delivery of early warnings, no matter what the causes for coastal inundations are, in line with the concept of impact-based forecasting and the UN Sendai Framework for Disaster Risk Reduction (DRR). Implementation will demonstrate how integrated coastal inundation forecasting and warnings can be improved and effectively coordinated by the National Meteorological and Hydrological Services (NMHSs). The CIFDP is currently underway in four sub-projects (Bangladesh, Dominican Republic, Fiji and Indonesia), three of which are in urban coastal settings. Substantial progress to date has been made in each of these CIFDP sub-projects since 2013. As the project is expected to be completed in 2019, an independent external evaluation of the CIFDP is foreseen to assess the strengths, room for improvement and ongoing sustainability beyond the demonstration phase, and opening up opportunities for other countries to engage in a MHEWS for coastal inundation. [A/RES/71/257, para 187]

25. Tropical storms are addressed by WMO through its Tropical Cyclone Programme (TCP). The regional component is based on the five tropical cyclone regional bodies and their RSMCs-TC (Regional Specialised Meteorological Centres for Tropical Cyclones) and TCWCs (Tropical Cyclone Warning Centres) to ensure regionally coordinated forecasting and warning systems. The general component deals with global coordination, training, capacity and competency developments and transfer of research to operations. TCP's historical objective is to strengthen the capabilities of WMO Members to provide reliable and timely forecasts of tropical cyclone tracks and intensities, together with related forecasts of strong winds, heavy rainfall, and storm surges, covering all tropical cyclone-prone areas. Based on recent decisions made by WMO governing bodies (Cg-17 and EC-68), TCP supports the WMO Members to establish and upgrade early warning systems which are impact-based and with multi-hazard approach. Examples of the impact-based forecasting and warning products promoted by the TCP with the lead of the RSMCs-TC are the *Potential Storm Surge Flooding Map* and the *Storm Surge Watch and Warning* developed by the RSMC/National Hurricane Centre in Miami. [A/RES/71/257, para 187]

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[17] WMO Statement 28 April 2017

[18] https://oceanconference.un.org/commitments/?id=15659.

[19] https://oceanconference.un.org/commitments/?id=15752.

SMALL ISLAND DEVELOPING STATES

26. The 17th World Meteorological Congress approved Resolution 5.3(2)/1 (Cg-17) to create a Programme for WMO Small Island Developing States (SIDS) and Member Island Territories. The new Programme will consolidate existing WMO activities to support improved weather and climate services in SIDS and Member Island Territories, with a view to increase their resilience to extreme weather events and other adverse climate change impacts. Through the Partnership established at the 3rd International Conference on Small Island Developing States in Samoa (1–4 September 2014), WMO aims at implementing the "Samoa Pathway" for: (1) improved delivery of weather and climate information services; (2) enhanced human and technical capacities at national and regional climate centres; (3) increased range of products and services delivery to stakeholders; (4) South-South/ North-South Cooperation fostered; and (5) expansion of the infrastructure required for weather and climate research and services.

ACRONYMS

CIFDP	Coastal Inundation Forecasting Demonstration Project
CliC	Climate and Cryosphere
CLIVAR	Climate and Ocean: Variability, Predictability and Change
CMIP	Coupled Model Intercomparison Experiment Project
DBCP	Data Buoy Cooperation Panel
DRR	Disaster risk reduction
ENSO	El Niño-Southern Oscillation
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GDPFS	Global Data-processing and Forecasting Systems
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GMDSS	Global Maritime Distress and Safety System
GOOS	Global Ocean Observing System
IAEA	International Atomic Energy Agency
ICSU	International Council for Science
IG3IS	Integrated Global Greenhouse Gas Information System
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOC/UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
LLGHG	Long-lived greenhouse gas
MHEWS	Multi-hazard early warning system
OOPC	Ocean Observations Panel for Climate
SIDS	Small Island Developing States
TPOS	Tropical Pacific Observing System
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Programme
WIGOS	WMO Integrated Global Observing System
WIS	WMO Information System
WMO	World Meteorological Organization
WWMIWS	World-Wide Metocean Information and Warning Service