WORLD METEOROLOGICAL ORGANIZATION

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Call for Submissions 2024

Research and systematic observation in support of science and services

Submission from WMO and GCOS

August 2024

Research and systematic observation in support of science and services

Possible themes for and ways to organize Earth Information Day 2024.

Thematic structure

Earth Information Day (EID) presents an opportunity to highlight the role of Earth information for climate action. WMO proposes that the thematic structure of EID focus on elevating the role, status and impact of systematic observations and research for improved services for decision-making in climate change mitigation, adaptation and resilience, building on common themes critical to the work of all organizations. Noting that many stakeholders of climate action are interested in climate change mitigation, adaptation and resilience and that earth information has a central role in each, there is room for maintaining a larger holistic view with key strategic themes that can benefit their work now and in the future on the three aspects of climate change (i.e., mitigation-adaptation-resilience). In this context, a thematic structure could be organized around three overarching themes: a) *Science-Policy-Practice (SPP) interface for global goal on adaptation*, b) *systematic observation for mitigation,* and c) *diversity, equity, inclusion, and justice (DEI&J) for climate action.*

Centred around earth information, specific thematic areas can be explored with each bringing together three key strategic themes and discussed in a World Café format. Table 1 lists aims and potential topics of discussion for each theme.

Table 1. Proposed themes for the Earth Information Day 2024

Theme	Aim	Sub-themes
1) Science-Policy-Practice (SPP) interface for global goal on adaptation	To highlight the role of systematic observations and research data as a connector, i.e. bridging the interfaces	• Science and innovation: high-impact events and tipping points (with IPCC) • GCOS • State of Global Climate 2024 • Multi-hazard Early Warning Systems Indicator for GGA • State of Global Water Resources and HydroSOS
2) Systematic observation for mitigation	To explore how AI can support climate targets by integrating observations and modelling To discuss the unique role of AI for the provision of just and fair (climate) data services for everyone	• Global Greenhouse Gas Watch (G3W) • Research - climatic stressors and sustainability of the carbon sinks, including drought, vegetation fires and El Niño/La Nina oscillations • Digital transformation, emphasis on required infrastructure for data exchange • AI serving the research and mitigation action

3) Diversity, equity, inclusion, and justice (DEI&J) for climate action	To explore perspectives on how data services can benefit from principles of DEI&J to improve SPP interface for CC mitigation and adaptation	• Early Warning for All (EW4All): Inclusiveness, climate justice and equity in the access to EW information • Research: how atmospheric pollution affects food security and human health in a changing climate.

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Themes and sub-themes

1. **Science-Policy-Practice (SPP) interface for global goal on adaptation**

Science and Innovation: high-impact events and tipping points (with IPCC)

High-impact meteorological and climatological events and tipping points can induce substantial, impactful and potentially irreversible changes in the climate system, ecosystems or human systems. The IPCC AR6 WGI has assessed tipping points in the Earth system, such as a potential collapse of the Atlantic Meridional overturning circulation and its possible consequences, abrupt changes in weather patterns and the water cycle, as well as increased Antarctic ice sheet melt, and forest dieback. While the associated uncertainty is generally very high, there is also high confidence that such events cannot be ruled out and that they would cause severe consequences. This topic remains essential to characterize climate risk relevant for adaptation and mitigation strategies, and with abundant literature being produced, it is anticipated that it will be considered in the AR7 WG reports.

Global Climate Observing System (GCOS)

Maintaining and upgrading the observational networks is a fundamental prerequisite for successful climate change adaptation. Climate information begins with the collection of observations. Support is particularly important for the Global South which faces a disproportionate share of the climate change impacts while having a limited capacity to develop and deliver services. As noted in the 2021 GCOS Status Report (GCOS-240), in-situ observations for almost all the Essential Climate Variables (ECVs) are consistently deficient over certain regions, and this significant spatial heterogeneity of monitoring capacity across the globe calls to foster observational capacity equity to harmonize risk management and adaptation tools and metrics worldwide. To ensure the delivery of climate data records, long-term, sustained funding to observational networks is key. GCOS could present recent findings providing a health snapshot of the financial support for the in-situ networks providing climate data as well as the declining performance of some of the GCOS networks.

To enable the provision of climate information, climate observations need to be properly preserved, curated, shared and made available. Essential Climate Variables need to have a recognized global data repository, adequately supported and funded (GCOS-244). Data should be stored in check hyphenation curated, open and freely available, sustainable archives with clear guidance for data centres and users. GCOS could present how data rescue from hard copy or archaic digital formats and sharing of historical data holdings allows data series to be extended in the past, improving reanalysis and forecasts and, hence supporting adaptation.

Climate observations must be coordinated at a national level. Many climate observations are made by national bodies. National programmes provide the information needed to support adaptation and mitigation and can be focussed on specific issues of national importance. These programmes are also important to focus efforts within a country, identify national priorities and, where appropriate, report issues and needs

internationally to potential donors. However, these efforts need support and coordination. GCOS is encouraging the development of national coordination of climate observations through national GCOS programmes, to help link these national efforts into the global system, promoting support needs, and enhancing contributions of national observations to global datasets. GCOS would like to encourage nominations of GCOS National Coordinators to aid these efforts.

The State of the Global Climate 2024

WMO and its Members monitor the state of the climate, at global, regional and national levels and issue annual statements on the status of the global climate to provide credible scientific information on climate and its variability. In 2024, WMO will release the Provisional State of the Global Climate 2024 to provide Parties with updated information on key state of the climate indicators. The Provisional State of the Global Climate Report 2024 is always presented at Earth Information Day to inform policymakers of climate action's utmost urgency. Key findings related to various cryospheric components can be included in the State of the Global Climate 2024 presentation.

Multi-hazard Early Warning Systems – Indicator to monitor progress under the global goal on adaptation

This sub-theme explores potential indicators to monitor progress of climate action under the global goal on adaptation. This is measured by Member States under the SDG Goal 1 on Poverty and the Sendai Framework on Disaster Risk Reduction Targets 1 and 2.

The proposed indicator on access to early warning systems for extreme climate and weather events is one level of aggregation down and measures the effectiveness of an early warning system against the number of people potentially impacted by the extreme events affecting the country and region to whom warnings are disseminated so they can take action to protect their lives and livelihoods.

Measuring this requires the aggregation of several indicators on early warning service delivery and accessibility, referred to as end-to-end (risk information availability and tools, monitoring and forecasting, warning communications and preparedness to respond). The UN (UNDRR, WMO and ITU) and the IFRC develop these indicators, assist countries to monitor them and aggregate them in the context of the EW4All and its maturity index.

State of Global Water Resources and HydroSOS

WMO monitors and reports on the state of water resources at global and regional levels through its annual State of the Global Water Resources Report. This summarizes the latest observations and model results of streamflow, groundwater, soil moisture, evaporation, levels of lakes and reservoirs and snow and ice. In 2024, WMO will release the latest report in October with the latest information on key state variables. The State of the Global Water Resources report could be presented at Earth Information Day 2024 to inform policy and decision-makers about the state of water resources in a changing climate. WMO HydroSOS (Hydrological Status and Outlook System) provides a framework enabling Members to better assess the current status and produce seasonal to sub-seasonal forecasts of the water resources in a standardized and consistent manner at a global scale.

2. Systematic Observation for Mitigation

Global Greenhouse Gas Watch (G3W)

The G3W aims to establish and support a coordinated global operational greenhouse gases (GHGs) observation network of space-based (e.g., satellites) and surface-based sensors (e.g. in-situ stations) that can accurately estimate GHG fluxes, focusing on carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), the top three gases that are responsible for global warming and the associated impacts that manifest in extreme weather. By integrating several sources of quality-controlled observations in earth system models that consider physical, chemical, and biological processes reaching far beyond physical atmospheric and oceanic processes, the natural and anthropogenic sources and sinks of GHGs can be better monitored and provide support to existing efforts. The integration of observations and modelling (leveraging AI) is coordinated within G3W and counts on established operating centres to produce consolidated and continuous global information on the total fluxes and concentrations of GHGs, with guidance on the accuracy of the data and their interoperability all along the value chain. The G3W implementation plan has outlined a staged approach, beginning with the G3W-IPP, the Implementation and Pre-Operational Phase from 2024 to 2027, followed by the G3W-IOP Initial Operational Phase from 2028 to 2031, and finally, transitioning to the G3W-EOP Enhanced Operational Phases from 2032 to 2050. The Implementation and Pre-Operational Phase focus on the Research to Operation transition including the necessary standardization and benefit from the WMO long-term efforts in coordinating greenhouse gas GHG observations and research under the Global Atmospheric Watch (GAW) Programme, IPCC, and GCOS, as well as on the experience of the intergovernmental commissions for infrastructure and services that benefit from expertise and collaboration of the 193 Members of WMO. The goal of G3W is to ensure that key observation-based information is available with agreed standards, following the principle of joint contribution and shared benefits, supporting all Nations in the implementation of the Paris Agreement climate targets, and serving the Enhanced Transparency Framework processes of the UNFCCC.

Research - climatic stressors and sustainability of the carbon sinks, including drought, vegetation fires and El Niño/La Nina oscillations.

Long-term measurements of Earth’s atmosphere still show rapid rising concentrations of greenhouse gases linked to human activities. The rise is modulated by mechanisms acting on the efficiency of the carbon sinks due to the response of the terrestrial carbon cycle to stressors like droughts, vegetation fires or strong El Niño events. The global monitoring of greenhouse gases needs to be interpreted in the light of a science-based knowledge of the connected climate system where warmer and drier conditions are influencing the intensity of the carbon sinks. This theme can feed into the Global G3W presentation.

AI serving the research and mitigation action

Over the last years, significant strides have been made towards making Earth system science more accessible through AI. Capability for processing different data modalities, such as time series forecasting, image processing or text processing, has been enhanced and AI and natural language processing models for verifying scientific claims have been developed. These point to AI’s potential to refine the Earth system science approach by offering more accurate and unbiased information. A better understanding of the limitations of AI in Disaster Risk Reduction (DRR) is required to realize its benefits, which will demand interdisciplinarity, multistakeholder involvement and international

collaboration. AI is also likely to deliver better forecasting and risk monitoring for "hyper local" or kilometer-scale events – such as thunderstorms, which can give rise to extreme rainfall, tornados or damaging hail – as well as for improved hurricane track forecasting.

The WMO engagement with AI in Earth system science includes technology but also embraces and fosters a more well-informed global community confronted by climate challenges.

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The partners in the Early Warnings for All initiative are also seeking to integrate AI to improve disaster management and climate adaptation. This paradigm shift in the WMO approach is apparent in many areas.

3. Diversity, equity, inclusion, and justice (DEI&J) for climate action

Early Warning for All (EW4All): Inclusiveness, climate justice and equity in the access to EW information

Leveraging Earth observations and Artificial Intelligence for climate justice and enhanced Early Warning Systems (EWS) is critical to ensuring that vulnerable and marginalized communities have equitable access to life-saving information in the face of hazardous events. The Early Warnings for All (EW4All) initiative actively pursues this goal by integrating advanced technologies to improve the precision, timeliness, and accessibility of early warnings. As a key actor in Earth observations, the WMO plays a central role in this effort, working with partners across the value cycle—from understanding risks, data collection to dissemination—to ensure that the most accurate and relevant information reaches those who need it most. By focusing on inclusiveness and equity, WMO and its partners under EW4All promote climate justice and reduce disparities in disaster preparedness and response.

A specific illustration could be developed about countries and communities exposed to tropical cyclones. It is essential to emphasize the crucial role that advanced observation technologies play in forecasting tropical cyclones, particularly their rapid intensification and impacts on in particular coastal communities. As climate change drives more intense storms, accurate and timely forecasts and warnings are more important than ever. Enhanced satellite imagery, airborne sensors, and ocean observation platforms, such as buoys, gliders, sail drones, and drifters, provide detailed data on the atmospheric and oceanic conditions that fuel these powerful storms. Precise bathymetry and coastal topography are key to developing accurate, impact-based warnings, giving coastal communities the time they need to prepare and evacuate if necessary. Investing in better observation technologies is not just about understanding our planet—it's about protecting the people fairly and inclusively, ensuring everyone on Earth is protected by adequate early warning services.

Research: how atmospheric composition affects food security and human health in a changing climate

In addition to the direct effect of intense heat, climate change affects food security and human health by enhancing the formation of specific secondary pollutants like ozone, or by reducing their removal during droughts as for particulate matter. There is a potential to substantially worsen these adverse impacts in many climate scenarios considered, despite efforts to reduce emissions of particulate and ozone precursors. Mitigation strategies to safeguard food production or health must be considered based on science-based climate projections accounting for ozone–temperature and particulate-temperature co-variations. This theme can feed into the Early Warning for All (EW4All) thematic presentation.