Climate Monitoring Statement of Guidance for the EUCOS region

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In 2016, WMO published the "Global Observing System for Climate: Implementation Needs" (or GCOS implementation document thereafter) providing a list of essential climate variables (or ECVs) grouped by measurement domain (Energy and temperature, Other physical properties, Carbon cycle and other GHGs, Hydrosphere, Snow and ice, Biosphere, Human use of natural resources) and area covered (Atmosphere, Terrestrial, and the Oceans) measured by surface observing systems and/or by meteorological satellites. This document also includes recommendations for "a functional and robust Global Climate Observing System (GCOS)". Many of the proposed recommendations should be implemented by NMHSs with support from WMO through various WMO activities; some are directly related to the EUCOS area of responsibility. Building on this document, the EUMETNET Observations Programme has led the development of a Statement of Guidance for the EUCOS region for Climate Monitoring in collaboration with the EUMETNET Observation Programme Science Expert Team (Obs-SET), which includes the WMO GCOS Network Manager) and the EUMETNET Climate programme (full list of participants included at the end of the document).

The SoG captures the most important observation gaps that users wish to be addressed in order to help tackle some high priority challenges in NMHS's service delivery. The SoG does not provide a record of all user requirements; these are documented in the WMO OSCAR database which has been used to inform the SoG. The consensus view from the EUMETNET Climate Monitoring community is that the EUCOS region is the best observed region on a global scale; nevertheless, the EUCOS and NMHS observing networks are not currently fulfilling Climate Monitoring requirements, with significant weakness particularly but not limited to oceans regions. The starting assumption for this SoG is that existing networks should be maintained, forming the basis on which enhanced capabilities are introduced in an optimal manner to enhance the overall performance of composite network over the EUCOS region.

The EUMETNET Climate Monitoring community identified the dominant Climate Monitoring challenges within the EUCOS region which are impacted by gaps in EUCOS networks; these currently include (in order or priorities):

- Observations' providers tend to primarily focus on the quality of the variables. For Climate monitoring, the quality of the metadata recorded alongside the meteorological variable is as valuable as the variable itself. Without good quality, homogenous and continuous records of the metadata even the highest quality observations can have little value for Climate Monitoring. In addition, it is essential to have access to reliable, interoperable, very long-term observations databases, with the capability to hold records at high temporal and spatial resolutions for all observations (past, present, and with capacity for the future) together with their associated metadata.
- One of the main foundations to Climate Monitoring is consistency of the recorded data that feeds it. As a minimum, consistency of a static baseline for long-term records should be preserved. The current lack of guarantees around the safeguarding of funding to support long-term stations is an important issue for Climate Monitoring for networks around the Globe but also over the EUCOS region (e.g. radiosonde network). Equally,

when changes to GCOS observing networks become unavoidable, it is essential to follow GCOS network management practices, which require for example, a period of parallel running of old and the new stations to characterise any difference that might otherwise be introduced to the climate record.

- Observations used to monitor the energy cycle of the global atmosphere are one of the highest priority requirements as the derived estimates of the Lorenz energy cycle can be used as an indicator of the impact of Climate change. Obtaining the required datasets is currently a high priority challenge due to the lack of 3D profile observations over the oceans.
- Another impact of climate change relates to the increase of the frequency and intensity of (what we currently refer to) extreme weather events. There is currently a lack of observing systems capable of recording these short-term, often highly localised, extreme weather events. In addition, there is a potential risk that current observing capabilities may not be able to reliably observe the extremes of the future climate.
- Climate monitoring observations require rigorous quality control. There is currently a lack of parallel measurement to adequately perform quality control particularly in case of isolated extreme maxima or minima.
- A significant amount of historical global observations data continues to exist only in paper form or on microfiche, the value of which will only be realised when it has been digitised and made accessible.

Based on these Climate Monitoring challenges, the Climate Monitoring community selected and prioritised the following statements to guide the evolution of the EUCOS and national networks; Climate Monitoring community would benefit from increased:

- detailed and robust recording of metadata, to ensure the continuity and homogeneity of climate records, and efforts to ensure that these standards are consistently applied particularly when new technologies become available.
- investment in the development of very long-term storage of high temporal and spatial resolution of all observations (past, present, and with capacity for the future) along with their associated metadata is indispensable.
- protection of long-term stations to maintain static baseline for long-term records.
- temperature and wind profiles over the ocean, as well as sea surface pressure. These observations are crucial to determine and monitor the long-term variation in the Lorenz energy cycle, hence tracking the impact of climate change on the amount of energy available to be converted into kinetic energy.
- observations of snow/ice cover and depth, as well as records of extreme weather events (e.g. hail, heavy rainfall, lightning density). These observations are required at high spatial and temporal resolutions in order to observe the extremes of these events. Effort should also be invested into developing current observing systems to ensure they will be capable of observing future extremes caused by climate change.
- efforts to investigate the value and limiting factors in the mass access and exploitation of crowdsourced observations i.e. high volume, yet lower quality observations. These type of data sources have huge potential to support quality control of climate records to identify erroneous from genuine extremes.
- effort to develop data digitisation capability to unlock paper and microfiche observation records

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