**A perspective on observing system needs for some aspects of climate science and services**

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Recently, we undertook an internal review of observational needs for some aspects of climate science, including improving climate projections, early warning of abrupt changes and operational monitoring and attribution. Here we reflect on what this means for the Global Climate Observing System.

The evolving needs of climate science and services pose significant challenges for our observing system. In particular: the spatial and temporal resolution of the information needed is increasing; and the need to evaluate certainty in our observations requires that independent subsets of the observing system for any particular ECV are maintained, e.g. in order to assess stability of a long-term record, we require independent, stable reference data.

There are some key observing system components upon which many climate research applications critically depend, including: the Argo array; satellite retrievals and *in situ* measurements of sea surface temperature; meteorological station measurements of temperature, precipitation, pressure, wind, etc; satellite retrievals of sea ice extent and thickness.

Consistent observational information is often needed covering many decades, or the past century or two. This is particularly true when assessing our past and current vulnerability to extreme events and putting their projected future occurrence into that context, or in assessing surface temperature change relative to pre-industrial temperatures; the latter requires that we have a good understanding of what pre-industrial temperatures actually were. This means that, as well as maintaining observing systems into the future, we must ensure that we derive maximum benefit from past observations that were made, but remain locked in paper archives; they need to be digitised.

This need for consistency over many decades requires detailed understanding about how the measurements that have been made at one time in the past or in a certain location relate to other measurements from other times or other places; here again, apparent “redundancy” of different parts of the observing system and adequate metadata are essential in order that different types of measurements can be properly reconciled.

As we move into an era of operational climate services, in many cases, observational information for an ECV needs to be delivered in near-real-time (within a day of measurement) or in short-delay mode (within two or three days of measurement) and that information needs to be consistent with the long-term record of that ECV. This is a tough challenge, but one that we need to address for services like climate-related event attribution, or seasonal forecasting.