Observations and their analysis for WCRP/COPES

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The World Climate Research Program has, through the Joint Scientific Committee, established a new framework to guide its development and progress. As a part of the implementation of this framework, called "Coordinated Observation and Prediction of the Earth System" or COPES, new overarching panels have been established on modeling (WCRP Modeling Panel) and observations (the WCRP Observations and Assimilation Panel, WOAP). On WOAP membership includes representatives from all the other WCRP projects, panels and working groups, chairs of GCOS (Global Climate Observing System): AOPC (Atmospheric Observations Panel for Climate), OOPC (Ocean Observations Panel for Climate), and the TOPC (Terrestrial Observations Panel for Climate); a representative of the GEOSS (Global Earth Observing System of Systems), the Chair of the WCRP Modelling Panel, representatives from major reanalysis centres, and possibly other experts as necessary and appropriate. I am the chair of this panel. I also have the perspective of being Coordinating Lead Author of the Intergovernmental Panel on Climate Change (IPCC) chapter on observations of the atmosphere and the surface.

In 1985 the Earth System Science Committee of NASA wrote:

"To advance our understanding of the causes and effects of global change, we need new observations of the Earth. These measurements must be global and synoptic, they must be long-term, and different processes must be measured simultaneously

** **Long-term continuity is crucial**. A 20-year time series of the crucial variables would provide a significant improvement in our understanding.*

** Now we are on the verge of establishing a global system of remote sensing instruments and Earth-based calibration and validation programs. Together, these space- and Earth-based measurements can provide the necessary data."*

Here the bold emphasis is mine. Now 20 years later we arguably still do not have reliable time series of observations from space. It is an opportunity lost. And it is a challenge for us now to place our observing and processing systems on a track so that we will not say this 20 years from now.

The paraphrased terms of reference for WOAP include (i) identify climate observational requirements; (ii) help optimize observations; (iii) act as a focal point for WCRP interactions with other groups on observations and (iv) promote and coordinate analysis, reprocessing, reanalysis and assimilation; and (v) promote and coordinate information and data management activities, including web sites. Observations include those from space platforms. Hence the WOAP is attempting to help coordinate and promote

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reanalyses and reprocessing of past observations, as well as participate in GCOS in developing an improved system of observations for the future.

For reanalysis, the chief outstanding issue is that the underlying data base is not constant, and changes disrupt the analyzed climate record.

- There is no baseline reference network to anchor the data.
- Radiosondes improve and change type over time.
- Satellites mainly exist after 1979, last order 5 years, decay and drift in orbit, change instruments, and change calibration.
- Bias corrections are applied but remain imperfect.
- Continuity is a key issue, especially for climate change.
- Further technological developments, change and improvement in observations are expected.

Hence a major challenge is to deal with changing observations. Many examples exist of problems with radiosondes and other basic data that feed into reanalysis. Particular problems have been identified with clouds, water vapor, radiation, precipitation, temperature (satellite MSU temperatures), ocean heat content, sea level, and sea ice, to name just a few variables that are in need of reprocessing especially with regard to the satellite component. Accordingly, WOAP has written a letter to the space agencies through CEOS on the **need to exploit satellite data we already have and continue observational streams.** The letter points out and endorses the GCOS Implementation Plan but adds a sense of priority from the standpoint of WCRP and IPCC needs. The main points made in the letter are the need to: 1) ensure the continuity of established capabilities; 2) the need for continuity and homogeneity of observations for climate purposes; 3) the need for more attention to data synthesis, reprocessing, analysis and reanalysis of existing data sets; and 4) the recognition of the need for a complementary in situ observation strategy. The letter was sent on 30 June 2005 and a reply was received on 15 August 2005 but it was not satisfactory, as it failed to recognize the key points.

There are also many examples of problems with reanalyses associated with changes in observations. To address these problems for the future WOAP is firstly advocating the establishment of some baseline observations, in particular a reference radiosonde network and use of Global Position System (GPS) Radio Occultation (RO) sounding of the atmosphere (see also Trenberth et al. 2006). The latter depend on accurate timing of a signal between two satellites and hence overcome many calibration problems associated with microwave or infrared soundings. The newly launched COSMIC set of six low Earth orbiting satellites is a promising step in this direction. A key role of the radiosonde network is to provide redundant temperature observations with different sensors that allow radiation effects to be removed, and also much improved water vapor soundings. The use of ground-based GPS also allows total column water vapor to be sampled at high frequency. These platforms may also be used for ozone soundings and other variables. The vision for the future includes a network of 30 to 40 such high quality sondes but fewer regular sondes as satellite-based observations take over, including the RO soundings. The second part of the strategy is reprocessing past observations, and then the third part is the comprehensive reanalysis of all observations. Special attention is needed to address the problem of the continually changing observing system in reanalysis. A major goal must be to be able to relate the fields today to those 20 or 30 years ago in a reliable fashion.

Reference

Trenberth, K. E., B. Moore, T. R. Karl, and C. Nobre, 2006: Monitoring and prediction of the Earth's climate: A future perspective. *J. Climate*, **19**, (CLIVAR special issue), in press.