WORKSHOP/MEETING SUMMARIES

IGWCO/GEWEX/UNESCO WORKSHOP ON TRENDS IN THE GLOBAL WATER CYCLE

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More than 50 experts from the water cycle community attended the Workshop, which was held to identify significant advances in understanding trends and to make recommendations that could be taken under consideration by GEWEX, the Integrated Global Observing Strategy–Partners (IGOS-P) Integrated Global Water Cycle Observations (IGWCO) Theme, and the Intergovernmental Panel on Climate Change. Presentations and discussions indicated that the assessment of climate trends from data is much more complex than it would first appear. For example, detection of climate change on a global scale requires that rigorous data standards be met. In particular, data sets must be global (to preclude misinterpretation of regional changes as global changes), long-term (data records that are too short cannot distinguish between longer term variability and a true trend), and of sufficient accuracy (to distinguish the signal in the large volume of noise). It is also important to know the type of change for which one is looking.

Based on model projections associated with a doubling or a quadrupling of carbon dioxide, experts expect to see increases in surface temperatures, particularly at higher latitudes over land areas. They also expect to see an acceleration of water cycle processes on the order of 1 to 3% in evaporation and precipitation over the last 50 years. Models indicate that the relative humidity remains roughly constant producing an increase of precipitable water at about 7% per degree Celsius of warming.

In most parts of the world, the predicted trends are relatively small in comparison to signals such as the annual cycle. Given that the available data systems were not designed to address long-term trend detection and rarely are accompanied by published uncertainty estimates, few significant trends are indicated, and these are mainly confined to regional rather than global manifestations. Workshop participants unanimously accepted that there is evidence that surface temperatures are increasing on a global basis, but there were differences of opinion on some of the other global trends in shorter-term water cycle variable records.

Regional trends are more frequently observed. For example, seasonal shifts in runoff timing (but not runoff amounts) have been documented in midlatitude areas especially where spring streamflows are dependent on snow melt. Only two to three decade time period regional trends exist in precipitation patterns, although most of these tendencies currently are within the bounds of observational uncertainty. Natural variability is characterized by interannual variations and longer-term (decadal to centennial) variations that must be separated from the effects of anthropogenic forcing. Several presentations demonstrated that data sets based on the current suite of satellites can be used to document and diagnose the causes of this shorter-term variability and to better understand key processes influencing the water cycle.

Another approach used in the past few years to identify trends involves the use of model simulations and reanalyses as tools to obtain trend estimates. Examples given at the Workshop included a study showing how an increase in lower stratospheric water vapor simulated with models is the same order as *in situ* balloon observations at Boulder, Colorado since 1980. Other studies showed that there had been an increase in specific humidity and changes in extreme precipitation events. Although these techniques show trends, they need to be confirmed with the analysis of data because the results from reanalysis systems are affected by the quality of the input data sources and by the model physics.

Ongoing cross-comparisons of available data products that are globally extensive and have records exceeding 1 to 2 decades suggest that the uncertainties in these data products can be significantly reduced. A comprehensive reanalysis of a combination of satellite and *in situ* measurements should be undertaken to obtain more homogeneous water cycle data products for trend and variability analysis.

Preliminary conclusions from the workshop follow.

- While there is considerable confidence in the trends derived from *in situ* data records for temperature, the same confidence does not exist for water cycle variables (i.e, precipitation or clouds).
- Some of the strongest trends seen in hydrologic variabilities (glacier retreat, changes in the seasonality of runoff) are to a large extent, responses to global warming rather than responses to changes in the global water cycle variables (i.e, precipitation).

– Current reanalysis products from models do not provide an adequate basis for identifying trends in climate variables due to uncertainties in data, including inputs, model physics, and resolution.

– While global maps derived from satellite data are reaching the point where they have long enough time series for confirming trends, many of these products have not been optimized for homogeneity of record and for climate analysis. These satellite products need to be reprocessed on an urgent basis to provide a reliable basis for future assessment of recent climate trends.

Specific recommendations (partial list) include:

1. An assessment of the utility of data sets for climate change detection should be undertaken by identifying limitations and artifacts of the analysis procedures.

2. The global climate modeling community should provide "fingerprints" of the changes in water cycle variables expected as the climate changes.

3. A better process for bringing the observational community together with the climate diagnostics community is needed to improve data sets.

4. Data providers should have a more consistent approach to the use of radiance data.

5. A strategy is needed for dealing with the heterogeneity of *in situ* and satellite data and for merging these data to generate long-term data sets.

6. An analysis should be carried out to assess the consistency of trends in the full range of water cycle variables.

7. The Earth Observation Summit ad-hoc Group on Earth Observations (GEO), IGOS-P, and WMO need to encourage the development and acceptance by nations of common data standards and data sharing practices. These standards also should address regional radar precipitation data sets.

8. The global, long-term data sets, including older versions of these data (by data rescue) should be evaluated (by cross-comparison and investigation of differences) and reprocessed.

9. Satellite agencies should make long-term commitments to producing principal climate data products.