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**WCRP Observations**

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## WCRP Observations

**WCRP Aim: To facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.**

### Overview

It is helpful to divide the observations into three categories:

1. *sustained observations* – acquired on a semi-permanent basis
2. *process study observations* – required to augment the network of sustained observations for understanding key processes
3. *enhanced monitoring* – observations that are needed to fill the gap between the “sustained” and “process” categories. These could be enhanced monitoring in time or space to resolve features of importance for climate modelling and prediction, or enhancements to study processes of a longer-term nature.

The coordinated collection, analysis and reanalysis of climate observations are required to describe the structure and variability of the climate system. This will allow the generation of descriptions of states of the coupled climate system that are consistent with both the observations of all variables and the physical framework provided by models, both for the numerical prediction of climate and for documenting the climate record. Special efforts will be required to obtain, analyze and assimilate data from the new generation of environmental satellites.

In addition to the longer-term data for climate monitoring and analysis of time-dependent variations, there will be a need to collect, analyze and archive high spatial and temporal resolution data of physical variables and chemical constituents using *in situ* as well as remote-sensing methods. Many such data will likely be obtained for short periods from observational campaigns designed for process studies. Often these studies occur with field programs or special regional foci, such as those promoted by the projects under WCRP. Data from these observational components will help formulate, evaluate, and parameterize processes that go into the global models and also help validate satellite data. There may be increasing use of special observational sites and joint experiments that bring the community together in an efficient way, giving maximum opportunity for the cross-WCRP collaboration and synergy that are essential.

The very strong interaction of observations and models is central to WCRP, with observations giving the basis for evaluating and improving models and models providing the framework and impetus for deciding what observations to take. Observations also enable the bias removal and downscaling that is required for the application of model predictions. More complete exploitation of observations and improvement of models necessitate a major activity in climate/Earth system data assimilation. This is already occurring in some operational centres as an extension of numerical weather prediction procedures. It requires the best climate/Earth system models and is an excellent test of them. Maximum possible value of observations is obtained by combining them with other observations in the context of the model. The resulting products are essential for providing our best estimates of the current state of the climate and for many uses in the context of the development, use and evaluation of climate models. Independent observational data sets and analyses are also required to make an independent check of both models and analyses.

Observations should adhere to the Global Climate Observing System (GCOS) observing principles, thereby ensuring that they are useful for multiple purposes, including climate change. A commitment is required for the progressive, coordinated, ongoing analyses and periodic reanalyses of observations, which are necessary to incorporate lessons from new measurements and research. Commitment is also required for the stewardship, archival and access of data, as well as the support to enable institutions to do these tasks. A balance is needed between new observations and the need to achieve more effective exploitation of current and planned observations (especially from satellites), the latter being achieved through increased international cooperation on developing integrated analyses and products. The transition from research to operational systems is also an important practical issue.

A major concern is the development and improvement of climate data records (CDRs) which can be used for studies and assessments of climate variability and change, such as for IPCC. Particular concerns for which there are activities underway include:

- Continuity and homogeneity of observations, especially from space.
- The need for reprocessing of records in a coordinated way and with agreement on algorithms, and comprehensive validation, evaluation and assessment of results.
- The need for reanalysis to produce global gridded fields. Promotion of reanalysis has been successful, leading to a problem of proliferation of reanalyses without the ability to adequately vet them. Reanalyses have been or are directed at producing the best series of analyses given the observations. None, so far, have been directed at fully addressing spurious effects of the changing observing system on the record. Dataset development and stewardship, archival and data management of records are needed in ways to facilitate reanalysis and access.

## **WCRP and observations**

New observational data, particularly those from the new generation of satellites, will be exploited to the maximum possible extent in pursuit of the aims and objectives of WCRP. A particular aim will be to determine what can be predicted and how it can be done. Hence, WCRP will position itself to help argue for the climate observational system that will be required in future for both assessments of the climate system and for prediction. There is a need to continue to provide a coordinated WCRP input into the international process of defining the *in-situ* and space observing systems for the next decade required for climate studies and in particular to address the aims and objectives of WCRP. Consideration needs to be given to identifying gaps and deficiencies in existing observing systems, encouraging reprocessing and reanalysis of past data, and addressing other shortcomings which may have resulted in reduced skill of existing prediction schemes. The *WCRP Observations and Assimilation Panel* interacts with the GCOS climate panels (AOPC, OOPC and TOPC) to achieve these objectives.

*WCRP should play a major role in supporting the development of new climate information systems. Because global warming is “unequivocal” to quote IPCC, and some warming is guaranteed, adaptation to climate change is essential. This requires information to assess vulnerability, devise coping strategies, determine possible impacts, and plan for future changes. Research is required and the role of WCRP is as follows:*

1. *Advocate improved observations and analysis suitable for climate (satisfying the GCOS Climate Monitoring Principles that are designed to ensure continuity of record). This especially includes those from space.*
2. *Data set development: evaluating observations and promoting their reprocessing and reanalysis into global fields. Develop new products and datasets. Develop analytical and diagnostic techniques to process observations and model data. Develop new products and datasets, often high level derived products, for use in understanding and analyzing climate variability and change, and for evaluating models.*
3. *Continue to carry out studies on mechanisms and modes of variability that have contributed to observed climate anomalies. Further develop capabilities that contribute to an operational attribution activity by pioneering studies and numerical experimentation that might be used in near real time to allow reliable statements to be made not only about what the state of the climate is, but also why it is the way it is and the mechanisms involved. Studies involve the atmosphere and the fully coupled system.*
4. *Promote improved data assimilation and analysis. Improve initializing of coupled models for prediction. Promote use of assimilation and analysis products and corresponding evaluation of their utility for different applications.*
5. *Provide advice on best datasets for various purposes (climatologies and time series) and their merits and limitations. (Error bars are greatly needed.) High priority needs are to have assessments of datasets for use in evaluating climate models, and specifically those used in the AR5 IPCC report that will participate in the CMIP5 activity.*
6. *Help improve and promote sound data stewardship, including data archiving, management, and access. This includes making sure that climate-related data variables are reaching data archives, and that standards are set for archiving new types of data. Help make data accessible and available e.g., through the internet. Promote shared efforts for data quality control.*

## Current activities: WOAP

The [WCRP Observation and Assimilation Panel \(WOAP\)](#) is co-sponsored by the [GCOS \(Global Climate Observation System\)](#). WOAP consists of a panel of representatives from all of the other activities in WCRP (projects and working groups) and GCOS to deal with cross cutting issues related to global observations, their analysis and assimilation, and the resulting products, from a research perspective on behalf of WCRP and GCOS.

WOAP is complementary to the GCOS Panels and it includes representatives from the WCRP/GCOS co-sponsored panels [AOPC \(Atmospheric Observation Panel for Climate\)](#), [OOPC \(Ocean Observation Panel for Climate\)](#) and [Terrestrial Observation Panel for Climate \(TOPC\)](#) to establish requirements of climate researchers for *in situ* as well as satellite observation networks and systems. WOAP, AOPC, OOPC and TOPC also serve the research community in the collection and reanalysis of climate observations in order to better describe the structure and variability of the climate system, as well as climate change. WCRP exploits observations and re-analyses in its input to the [Intergovernmental Panel on Climate Change \(IPCC\)](#) assessment reports and other wide-ranging policy advice.

WOAP also has representatives from the WCRP modeling working groups, as models are essential to analyze observations, and assimilation of observations provides fields for initializing climate predictions with models. It therefore also provides a forum for exploring modeling and prediction observational needs. WOAP further includes representatives from the WCRP projects, who typically lead in process studies but whose activities are necessarily set in a global context. WOAP also explores mechanisms for the management, stewardship and access of data (WCRP's [Data Management](#)), climate system data assimilation, synthesis, reprocessing and reanalysis of observations. In addition WOAP interacts and represents WCRP on observational issues with the [Global Earth Observing System of Systems \(GEOSS\)](#).

### Terms of reference for the WCRP Observations and Assimilation Panel are:

- a. to define observational requirements for climate system analysis and prediction and assist in optimization of observational strategies for sustained observation and to act as a focal point for WCRP interactions with other groups and programmes,
- b. to promote and coordinate synthesis of global observations from the atmosphere, oceans, land and cryosphere, and for the fully-coupled system, through analysis, reanalysis and assimilation activities across WCRP,
- c. to promote and coordinate WCRP information and data management activities, including development of web sites, in liaison with WCRP projects.

Hence WOAP:

- Helps identify climate observational requirements
- Helps optimize observations
- Provides a forum and focal point for WCRP observational issues
- Promotes and coordinates analysis, reprocessing, reanalysis and assimilation
- Promotes and coordinates information and data management activities, including web sites.

WCRP has led re-analysis efforts since they started for the atmosphere in 1988, and WOAP now provides ongoing leadership in promoting reanalysis and expanding it to embrace ocean re-analysis and even whole Earth system re-analysis. A series of three WCRP reanalysis conferences have been held, with the first in 1997 at NOAA, USA; the second in 1999 in Reading, UK; and the [Third WCRP International Conference on Reanalysis](#) was held in January/February 2008 in Tokyo, Japan (see the [Conference Statement](#).) A fourth is being planned for the USA in 2011.

WOAP has also interacted with CEOS through a series of letters to reinforce aspects of the GCOS implementation plans and especially emphasize the need for reprocessing of satellite datasets.

WOAP has set up two tasks or working groups: (i) the Task Group on Data Management in the WCRP; and (ii) the Working Group on Observational Data Sets for Reanalysis, joint with AOPC. The latter has done a few things, but neither has been especially active.

**Future activities:**

1. *Scope*: Unchanged, see below

2. *Interaction with core projects*: Essential; requires active involvement of one or more persons in each project and recognition of WOAP in the core activity agenda.

3. *Operating ground rules*: Activities that are of limited scope and which can be performed within a project should be done so, but with WOAP informed and with an alertness for synergies or expanded efforts across multiple projects that might be led by WOAP. Limited term task groups should be one vehicle for getting a report and fostering some activities, but have so far been of limited value. Two working groups were set up under WOAP. Neither has met and not much has been accomplished. These activities are voluntary, and involve work that is not especially rewarding. Why should anyone participate? Perhaps the promise of support for a science-focused meeting among colleagues doing similar research would be one potential incentive. How can funds be raised to support such activities? WOAP would benefit if there were a clear pathway for writing proposals to support working groups and science-focused workshops on topics pertinent to the WOAP objectives. Use of telecons may help but these also require funding and staff support for set up.

4. *Meeting frequency at JSC or extra-sessionally*. Meetings about every 18 months have been adequate for WOAP deliberations but do not synch with GCOS-SC or JSC meetings. Meetings of task or working groups may be essential for them to really work?

5. *Representation*: WOAP has had no members, other than the chair, who are affiliated with WOAP. All members have represented other projects, working groups and GCOS panels, or external bodies such as CEOS and IGBP. It has not been a Working Group therefore but has only been able to act as a forum. Members come and go frequently, and some who remain leave behind their original affiliation. Continuity has been an issue. Also there is also no mechanism for evolving the chair. It must be recognized that it is very difficult to only have members who have affiliations elsewhere, and no-one to delegate anything to. It is also difficult when WOAP has no staff member at JPS to do things and help move things forward.

## **WCRP/WOAP role**

### *Observations*

- *WCRP advocates improved observations and analysis suitable for climate (satisfying the climate principles that are designed to ensure continuity of record). This especially includes those from space.*
- *WCRP scientists evaluate observations and promote their reprocessing and reanalysis into global fields as a key activity in dataset development.*
- *WCRP also promotes advances in observations to improve models.*
- *WCRP scientists participate in GCOS assessments and reports on adequacy of the observing system, including updates to the requirements for Essential Climate Variables.*

### *Analysis*

- *WCRP promotes development of analytical and diagnostic techniques to process observations and model data, and facilitates their comparison and evaluation.*
- *WCRP helps enable development of new products, often high level value-added derived products, for use in understanding and analyzing climate variability and change, and for evaluating models.*

### *Assimilation*

- *WCRP/WOAP advocates analysis of observations into forms suitable for use in models and to initialize models. This includes all components of the coupled climate models, including those involving chemistry and biology.*
- *Assimilation enables reanalysis and model diagnostics that can be compared with observations to evaluate and improve the models.*
- *Initialized models enable attribution studies and prediction.*

### *Attribution*

- *WCRP scientists have carried out many studies on mechanisms and modes of variability that have contributed to observed climate anomalies.*
- *WCRP helps develop capabilities that contribute to an operational attribution activity by pioneering studies and numerical experimentation that might be used in near real time to allow reliable statements to be made not only about what the state of the climate is, but also why it is the way it is and the mechanisms involved.*
- *Studies involve the atmosphere and the fully coupled system, and should include not just physical variables, but also, for example, those involving air and water quality.*

### *Assessment*

- *WCRP scientists use information from analyses and other products to assess the state of the climate.*
- *WCRP scientists assess the merit and shortcomings of datasets for various purposes.*
- *Scientists participate in international (IPCC) assessments.*

### *Prediction and predictability*

- *Evaluations of model strengths and weaknesses, possible improvements, comparisons among models and with observations and evaluations to score their results in multi-model ensembles are underway.*
- *Calibration of model predictions based on past performance against observations is essential*

### *Data management and access*

- *WOAP promotes a consistent data archive and access across WCRP programmes.*
- *WCRP promotes making data and derived information available through the internet and at minimal cost.*
- *WCRP advocates complete documentation and version control for climate datasets, including metadata.*
- *Prioritization of and advocacy for improved historical data, including digitization, preservation and archaeology activities focused on improving data sparse periods and regions is required.*

### *Decision making*

- *WCRP contributes to how to reduce vulnerability and what the impacts will likely be associated with climate variability and change that in turn contribute to adaptation and risk assessment, such as to ecosystems, water resources, and communities.*