Geosphere-Biosphere Interactions and Climate

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17 Research Objectives of the World Climate Research Programme

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17.1 Introduction

The World Climate Research Programme (WCRP) is the research component of the World Climate Programme (WCP). Soon after the launch of WCP at the First World Climate Conference in Geneva in 1979, the World Meteorological Organization (WMO) and the International Council for Scientific Unions (now called International Council for Science) (ICSU) agreed in 1980 on cosponsorship of WCRP. In 1993, the Intergovernmental Oceanographic Commission (IOC) of UNESCO joined WMO and ICSU as the third cosponsor of WCRP. This unique sponsoring structure has attracted both the scientific community and national meteorological, hydrological, and oceanographic services. Therefore, WCRP has developed into a global research program encompassing all those parts that need international climate research cooperation and coordination for a successful outcome.

17.2 The Overall Goal

WCRP has a clearly set goal: "To understand and predict – to the extent possible – climate variability and change, including human influences."

In reaching this overall goal, WCRP must

- Design and implement observational and diagnostic research activities that will lead to a quantitative understanding of significant climate processes;
- Develop global models capable of simulating the present and past climate and – to the extent possible – of predicting climate variations on a wide range of space and time scales, including the effects of human influences.

In practice, these tasks are executed by obeying a few principles for WCRP activities:

- Add value to climate research in general by international coordination of national research programs.
- Formulate science and implementation plans for projects that need global cooperation for success.

- Implement subprojects only if enough scientists are engaged and additional funding is secured.
- Assess progress regularly (once per year) by an independent scientific advisory body (Joint Scientific Committee) selected jointly by all sponsors.
- Liaise with the users from the beginning. That is, cooperate with numerical weather predictions centers, national meteorological and hydrological services, climate anomaly prediction centers, the Intergovernmental Panel on Climate Change (IPCC), environmental conventions of the United Nations, water resources managers, and so on.
- Integrate operational observation networks, new research observation networks, data management, process (field) studies, modeling and prediction, and applications in each project.

17.3 Present Structure

WCRP concentrates on the understanding of the physical parts of the climate system. However, chemical and biological processes are included if essential to an understanding of the climate processes on the time scales of major interest for a specific project. This is done in close cooperation with the respective projects of the International Geosphere Biosphere Programme (IGBP). As shown in Table 17.1, all climate system components and their interactions are at present part of WCRP projects, and it has been our strategy to limit the number and size of our projects. One earlier project has already been finalized, and two others are nearing completion. It is interesting to note that three projects were first discussed outside, but soon became WCRP projects: Tropical Ocean/Global Atmosphere (TOGA), World Ocean Circulation Experiment (WOCE), and Stratospheric Processes and Their Role in Climate (SPARC).

The WCRP modeling infrastructure is often not seen as being as prominent or important as the projects. However, it is through the Working Group on Numerical Experimentation (WGNE) that we liaise with weather prediction centers, which improve forecasting through new parameterizations of climate processes derived from field experiments. The same holds for climate variability predictions; the Working Group for Coupled Modeling (WGCM) helps improve these predictions, for example, through model intercomparisons.

17.4 Achievements

The successes of WCRP are crowned by the breakthrough to climate anomaly predictions on seasonal-to-interannual time scales, mainly for the areas strongly affected by the El Niño southern oscillation (ENSO) phenomenon. Table 17.2 highlights some of the achievements so far. In all projects, progress rests first on new observing systems and new combinations of existing systems and then on the use of models validated by the new data sets.

Table 17.1. WCRP Projects and Modeling Working Groups

Start of Implementation	Project Name	Central Climate System Component(s)	Main Component Interactions
	Projects		
1989	Global Energy and Water Cycle Experiment (GEWEX)	Atmosphere	Soil/Vegetation/ Atmosphere
1990	World Ocean (Ocean/Atmosphere) Circulation Experiment (WOCE)	Ocean	—
1992	Stratospheric Troposphere/Stratosphere Processes and Their Role in Climate (SPARC)	Stratosphere	(together with IGAC of IGBP)
1994	Arctic Climate System Study and Climate and Cryosphere (ACSYS/CLIC)	Cryosphere	Sea Ice/Ocean/Snow
1998	Climate Variability and Predictability (CLIVAR)	Ocean/ Atmosphere	Ocean/Atmosphere/Land
	Modeling Infrastructure		
Since GARP	Working Group on Surface Numerical Experimentation (WGNE)	Atmosphere	Atmosphere/Earth (together with GEWEX modeling group)
1997	Working Group on Surface/Coupled Modeling (WGCM)	Full Climate System	Atmosphere/Earth Ocean (together with modeling groups in CLIVAR, GEWEX, WOCE, SPARC, CLIC), relating WCRP to GAIM of IGBP and IPCC

17.5 Research Objectives for the Coming Decade

In 1995, one of the sponsors (ICSU) assessed WCRP and proposed to hold a conference on achievements, benefits, and challenges. At this conference the overall research priorities for the next 10 to 15 years were to be set. In August 1997, the World Climate Research Programme: Conference on Achievements, Benefits and Challenges took place in Geneva and asked WCRP to

- Assess the nature and predictability of seasonal-to-interdecadal variations of the climate system at global and regional scales, and to provide the scientific basis for

Table 17.2. Achievements of WCRP Projects

Project or Group	Duration	Main Achievement(s) So Far
TOGA	1985–1994	Breakthrough to seasonal predictions through new observing system and coupled modeling
GEWEX	1989–?	1. First quality-controlled global time series for precipitation, cloud parameters, water vapor column content, and surface radiation fluxes 2. Contribution of water storage in soils to medium-range weather and climate predictions
WOCE	1991–2002	1. First observation of global ocean structure (except polar seas) 2. Sea level change time series every 10 days
SPARC	1992–?	1. Stratospheric temperature trend analysis 2. Realistic stratospheric circulation modules as part of general circulation models (GCMs)
ACSYS	1994–2003	1. Sea-ice modeling for AOGCMs 2. Three-dimensional surveys of the Arctic Ocean
CLIVAR	1995–2010?	1. First initiatives on climate variability in the Americas and Africa 2. Asian monsoon prediction focus
WGNE	1980–ongoing	1. Extended weather forecasting 2. Realistic atmospheric circulation modules for coupled modeling
WGCM	1997	Coupled model intercomparison

operational predictions of the variations for use in climate services in support of sustainable development.

- Detect climate change, attribute causes, and project the magnitude and rate of human-induced climate change, its regional variations, and related sea level rise (as needed for input to the IPCC, UN FCCC, and other conventions).

How difficult it will be to reach these objectives can best be indicated by the formulation of scientific questions that must be answered before we can speak of success:

- Can we predict the onset, strength, and breaks of monsoons weeks and months ahead? Only joint action by the projects GEWEX and CLIVAR will be able to give an answer.
- Are the strength and frequency of ENSOs influenced by humankind?
- Would an increase in strength be a major consequence, and would there be new weather extremes? Only a reconstruction of climate history beyond the instrumental record, as planned in CLIVAR, can give an answer.
- Will the North Atlantic deep water (NADW) formation rate be slowed or stop if the greenhouse gas concentration increase continues unabated? The prerequisite

is better monitoring and improved coupled models. For WCRP CLIVAR, CLIC and WGCM must coordinate their plans.

- Can climate variability predictions and climate change projections be regionalized with confidence? Only better cloud feedback parameterizations and land surface modules in coupled models can give the answer. Again, at least GEWEX, CLIVAR, WGNE, and WGCM must coordinate their plans.