WORLD CLIMATE RESEARCH PROGRAMME

JOINT SCIENTIFIC COMMITTEE

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Item 4

GLOBAL CLIMATE OBSERVING SYSTEM

and co-sponsored Panels

ATMOSPHERIC OBSERVATION PANEL FOR CLIMATE

OCEAN OBSERVATION PANEL FOR CLIMATE

TERRESTRIAL OBSERVATION PANEL FOR CLIMATE

(submitted by GCOS Secretariat)

1. General Considerations

The Steering Committee of GCOS met in Paris in October 2007 and produced a comprehensive series of actions and recommendations, which can be found at http://www.wmo.int/pages/prog/gcos/index.php. Many have direct relevance to WCRP and are summarized in this paper. The SC Chair and Secretariat wish to express their appreciation to the Chair, JSC, for his participation in this session.

GCOS and WCRP have historically strong ties by the nature of their charges and their recent activities. Research on the climate system is inherently a long-term proposition that must draw support from the climate record in order to produce robust conclusions. Correspondingly, the climate research community must help to define both those variables necessary for sustained observation in support of international climate research and the future observing technologies and systems needed to meet the full range of societal needs for climate observations. GCOS depended heavily upon the leadership of its Domain Panels which are co-sponsored with WCRP (AOPC, OOPC and TOPC) as well as upon other WCRP researchers in the development of its Second Adequacy Report (GCOS-) and the GCOS Implementation Plan (GCOS-92). GCOS also participates fully in the WCRP's Observation and Assimilation Panel, through its co-sponsorship and participation of all three of its domain panels. This report will provide a brief overview of progress with GCOS in support of WCRP and research generally; and what the GCOS Steering Committee and the co-sponsored observation panels seek by way of future observing systems research and development in support of the global sustained observing systems for climate.

This process takes on a more structured format at JSC-29 for two reasons: (1) the preparation of the GCOS 2009 progress report to the UN Framework Convention on Climate Change, and (2) the completion of the jointly sponsored Sydney workshop *Future Climate Chang Research and Observations: Learning form the IPCC Fourth Assessment Report*. These two processes are far from unrelated. Results of the Sydney workshop were to inform the preparation of the GCOS 2009 report, both in the potential modification of Essential Climate Variables and in changes in the ways that they are observed.

Thus for the purposes of this report, there will be a brief discussion of the preparation of the GCOS 2009 report and its major issues, followed by a summary of some of the observing system implications of the Sydney workshop. The issues relating to long-term satellite observations of climate and to observations and the adaptation agenda are dealt with separately, as these are both major issues of joint interest to WCRP and GCOS. Finally, some brief comments on progress from the joint GCOS-WCRP Observing System Panels will be offered, with the proviso that Panel chairs will expand on these issues in their presentations to the JSC.

2. GCOS 2009 Progress Report and Supplement

In November 2005 the Subsidiary Body for Scientific and Technical Advice (SBSTA) of the UNFCCC "requested the GCOS secretariat to provide, for consideration by the SBSTA at its thirtieth session (June 2009), a comprehensive report on progress with the GCOS implementation plan." In preparing for this report, the GCOS Steering Committee at its 15th session (Paris, October 2007) decided that:

"…in response to the request from UNFCCC for a 2009 comprehensive report, the Secretariat should prepare a Progress Report and Supplement that will (1) confirm ongoing requirements and report on progress against GCOS-92 and GCOS-107 and (2) focus on new

actions and drivers such as the impacts, adaptation and vulnerability agenda, as well as regional climate needs. The report could canvass the need for new or revised ECVs. It should identify practical steps that can be taken by parties to advance the overall implementation of GCOS."

In addition to making use of the Sydney workshop, the 2009 report will also make use of information from national communications, GCOS monitoring and analysis centres, GCOS panels and partner observing systems, and WCRP.

3. Some Observing System Implications of the Sydney Workshop

The Sydney Workshop highlighted a number of major scientific issues revealed by IPCC AR4 participants, with some prominent implications for the evolution of the observing system. In Section 5 of this report, some of the ongoing and proposed activities of the Observing System Panels are described, with relation to these issues. The full report can be found at http://www.wmo.int/pages/prog/gcos/Publications/gcos-117.pdf. An overview of some of these issues is provided here:

Abrupt Climate Change, including Changes in Ice Sheets – Four types of abrupt change that stand out in the palaeoclimate record as being so rapid and large in their impact that if they were to occur, they would pose clear risks to society in terms of our ability to adapt. These are: (i) rapid change in ice sheets and hence sea level; (ii) widespread and sustained changes to the hydrological cycle (see below); (iii) abrupt change of the Atlantic meridional overturning circulation; and (iv) rapid release to the atmosphere of methane trapped in permafrost and on continental shelves. In particular, the issue of definition of ice sheet dynamics and its relation to sea level rise received particular attention

Changes in the Hydrological Cycle, including Extremes – The hydrological cycle affects all aspects of climate and its forcing, including floods and droughts, radiative forcing, and forcing of ocean circulation. The immediate future (the next five years) holds a window of opportunity from new satellite observations in particular, to better understand the changing nature of the high frequency supply-side component of the hydrological cycle over land, the storage component of water over land, and the low-frequency supply-side component of the water balance over the oceans. Assembly of the following datasets was recommended:

- Precipitation probability distributions based on high-frequency observations;
- New observations of soil moisture (both remotely-sensed top-soil indicators, and deeper soil moisture profiles from *in situ* measurements);
- Continental-scale runoff from river gauge data;
- Changes in the large-scale hydrological cycle and its relation to ocean salinity.

Land Surface Processes, the Carbon Cycle and Biogeochemical Feedbacks – The terrestrial and ocean environments are the two key players in the Earth's carbon cycle. The oceans currently store 37% of the carbon dioxide emissions. There is concern that the oceans' capacity to store carbon is reducing. From an Earth system modeling point of view, the parameterization of land surface processes is a weakly modeled component of global climate models. Terrestrial environments host the bulk of the biosphere and most of the human population; radiation, energy, momentum, water and carbon cycles are intimately coupled through living processes (notably photosynthesis and respiration) in land-based ecosystems; and this is where much of the economic activities, most of the impacts of climate change, as well as all adaptation and mitigation measures take place. Better process modeling and understanding of feedbacks in the carbon cycle will require a

denser and more evenly distributed network of sustained in situ observations of carbon on land, in the oceans and in the atmosphere.

Aerosol-Cloud Interactions and Radiative Forcing – In the AR4, several of the climate models did not have representation of the anthropogenic aerosol-cloud interactions and thus of the aerosol indirect forcing. Globally averaged, the net radiative effect of aerosols is negative (i.e., contributes to cooling at the surface) and is estimated to have a magnitude of about 75% of the forcing due to the CO2 increase since pre-industrial times. About 60% of this is forcing via aerosol-cloud interactions, which is also the most uncertain of the anthropogenic forcings. There is a critical need to improve the understanding of the processes (e.g., aerosol transport, convective processes, cloud formation and dissipation) leading to this forcing, represent them reliably in climate models and thus simulate the interactions accurately to better quantify the anthropogenic influence on climate.

Building an Information Base for Adaptation – The climate will continue to change substantially from human activities over the next several decades, so that adaptation will be essential. An imperative and essential first step is to provide the scientific basis for a climate information system that informs decision-makers about what is happening and why, and what the immediate prospects are. The development of this climate information system potentially takes on, in a more operational framework, a key part of what is currently done as part of the IPCC assessment process. There are many research questions on how to develop such a system, and what such a system must include in order to be viable. GCOS and WCRP could play a major role in addressing these issues, noting that this would require adequate new funding.

Decadal forecasts/projection observational needs - Ocean initial conditions are essential for decadal forecasts and projections. It appears likely that observations through the full depth of the ocean, and not just to the depth of Argo profiling floats, will be necessary.

4. Information Needs for Adaptation to Climate Change

Concern on the needs for climate information for adaptation has lead to considerable activity within the GCOS community. In considering the needs for information with which to design effective adaptation strategies, it is important to recognize that such strategies will necessarily vary locally, nationally, and regionally depending on how these regions are likely to be affected by climate change. To meet the observational needs for adaptation to climate change it will be essential to focus much more on regional, national and local networks than on the global-scale networks that have received most attention in GCOS planning so far. With adaptation in mind, it is becoming just as important to ensure that regional- and national-scale networks function effectively. Such networks are naturally denser than global networks and therefore, provide much more local detail than do global networks. This greater detail is essential for understanding regional climate change, for example, in enabling the detection of regional climate trends and for use in regional models that provide some capability, currently limited, to project future regional climate changes. However, the accuracy and reliability of regional models depends greatly on the availability and quality of the observations that are used by the models. Looking more broadly, the primary challenge for GCOS in meeting the needs of the adaptation agenda will be to define and observe the major impact variables in the various sectors that will need to adapt.

Climate information for adaptation critically depends on the availability of good quality climate observations with sufficient spatial coverage over a long period of time, on the adequacy of models to depict current and future regional climate, and on a thorough understanding and appreciation of the uncertainties and constraints associated with the use of both data and

regional and global models. To assist the developing and least developed countries of Eastern Africa to undertake and appropriately use climate projections in adaptation planning, GCOS, WCRP, the Climate Prediction and Adaptation Branch of the World Meteorological Organization, and the IGAD Climate Prediction and Applications Center (ICPAC) are collaborating, with the support of the World Bank, to develop and implement a programme of three linked workshops to demonstrate the key elements of an effective climate risk management strategy for the region. This is described in greater detail under Item 8, Document 8.2.

5. Satellite Observation Issues

GCOS and WCRP, with major efforts from the WCRP Observations and Assimilation Panel, have had substantial recent interactions in support of the long-term climate record from satellites. In 2006, the GCOS Steering Committee and Secretariat provided supplemental detail to the space-based requirements of the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (GCOS-92) by issuing the document *Systematic Observation Requirements for Satellite-based Products for Climate*. This Satellite Supplement provided input needed by the Committee on Earth Observation Satellites (CEOS) in leading the preparation of a coordinated response by Parties to the UNFCCC with earth observation space agencies, to the requirements of GCOS-92. This response was submitted to COP in December 2006. At the Climate Conference in Bali in December 2007, the Subsidiary Body for Scientific and Technological Advice (SBSTA)

> … commended the Committee on Earth Observation Satellites (CEOS) and the Parties supporting space agencies on the progress made in 2007 in implementing actions in response to the GCOS implementation plan, and looks forward to continued progress during 2008. The SBSTA invited the CEOS to provide an updated progress report by its twenty-ninth session [December 2008]. The SBSTA noted the continued close working relationship between GCOS and the CEOS for linking space-based capabilities with global climate observing requirements.

The continuing interest of both GCOS and WCRP is reflected in the joint letter of the Chair, GCOS Steering Committee and the Chair, WCRP Joint Scientific Committee, to the Chair of CEOS on 2 January 2008. The letter was primarily initiated through WOAP, and is attached as Appendix A.

6. Actions and Potential Contributions from Observation Panels

The joint observation panels of GCOS and WCRP have a number of activities and potential contributions of relevance to the above discussions. Below are several examples of particular relevance; other aspects will be provided in the presentations of the Panel Chairs.

Atmospheric Observation Panel for Climate (AOPC; Adrian Simmons, Chair)

GCOS Reference Upper Air Network (GRUAN) – A reliable record of water vapor in the upper troposphere/lower stratosphere is a major recommendation of the Sydney report and a major motivation behind GRUAN. The reference network will provide long-term high quality climate records to constrain and calibrate data from more spatially-comprehensive global observing systems, including satellites and current radiosonde networks. GRUAN has been endorsed by SPARC, among other bodies. The Implementation Meeting of the GRUAN, organized by the AOPC Working Group on Atmospheric Reference

Observations, was held on 26-28 February 2008 at the Richard Aßmann Observatory in Lindenberg, Germany hosted by the Deutsche Wetterdienst (DWD). The observatory has recently been designated by WMO as the Lead Centre for the GRUAN network for a pilot phase. The meeting was held under the auspices of GCOS and focused upon necessary actions required to refine the cooperation with all partners, resolve scientific and technical issues from the report of the WG-ARO and define a work plan for the implementation of the network.

Monitoring of Extreme Precipitation Events – AOPC maintains a strong interest in observations to better define climate extremes. AOPC and the GCOS Steering Committee have requested that the Secretariat, in coordination with the World Climate Programme, prepare of a letter from the Secretary-General of WMO to all Permanent Representatives, urging countries to submit as many historical sub-daily atmospheric observations as possible to international data centres, recognizing that this would support the construction of long-term datasets, and thus help improve reanalyses and the analysis of extreme events.

Terrestrial Observation Panel for Climate (TOPC; Han Dolman, Chair)

In preparation of the 2009 GCOS report TOPC will review existing ECV's in the terrestrial domain and evaluate emerging ECV's by analyzing the IGOS theme reports (Land, Water, Carbon, Ice) with respect to terrestrial observation requirements.

Ice Sheets and Observations of the Terrestrial Cryosphere – TOPC will clearly have a strong role in the definition of observing efforts in the terrestrial cryosphere. The GCOS Steering Committee invited TOPC to encourage cryospheric experts to prepare specific recommendations on the observation of the terrestrial cryosphere. TOPC will review the current cryosphere ECVs, recognizing the rapid change in ice sheets and its global impacts. This will be done through cross referencing with the IGOS Cryosphere theme reports. A critical issue is how to sustain and coordinate observing and data and information management activities over the long-term, i.e. after IPY. TOPC aims to work with WCRP-CliC on these issues.

Evolution of Terrestrial Carbon Cycle Observing System - The development of a global carbon-observing system has been slow. There have been a number of advances however: A global standard has emerged for data-basing flux data, post-processing (correction, gap-filling, error removal) of flux data, and flux site ancillary data. In Europe, the ICOS (Integrated Carbon Observing System) has begun its preparatory phase (2008-2012) and will lead to a coordinated continental-scale carbon observing system. ICOS intends to support a large expansion of the in situ atmospheric concentration and flux tower network, creating a centralized gas calibration laboratory. The satellites OCO (orbiting carbon observatory, NASA) and GOSAT (JAXA) are confirmed for launch in December this year. An upward looking FTS network has been established for the purpose of validation of the OCO mission with stations in the United States, Europe and Australia. Planning for several active missions is underway – NASA is planning an active LIDAR mission (ASSENDS), while ESA is proposing an active LIDAR (ASCOPE) as well as a p-band radar mission (BIOMASS) as part of its Earth Explorer programme. These missions will aim at measuring atmospheric concentration profiles (ASSENDS and ASCOPE) and above ground biomass (BIOMASS).

Implementation of the carbon observing system in monitored through the the International Global Carbon Observation (IGCO) Implementation Plan. The Global Carbon Project coordinates research activities.

Ocean Observation Panel for Climate (OOPC; D. E. Harrison, Chair)

Role of Research Institutions in Sustaining the Ocean Observing System – National commitments to build and sustain the initial design of the ocean component of GCOS are critical. Many of the observing networks are still being implemented with research funding. The Board of the Intergovernmental Committee for GOOS had identified the sustainability of the open-ocean component of GOOS (the ocean component of GCOS) and national commitments a major subject of their June 2007 meeting. However, it proved difficult to solicit concrete national commitments, due to the large heterogeneities in funding structures and national agencies involved in ocean observations, as well as ocean observations' status in national priorities. This remains a major issue in the ocean observing system for climate.

Sea Ice Working Group – The joint AOPC/OOPC panel on SST and sea ice is taking on the challenge of trying to improve uncertainty of present estimates of sea ice concentration, both in the historical data set and contemporary analyses.

Ocean Analysis/Reanalysis – The GODAE Final Symposium (Nov 12-15, 2008) will showcase the impact of global ocean observations on near real time analysis/forecast ocean systems. The GSOP/GODAE Ocean Synthesis group will continue its efforts to exploit the historical ocean data set to extract ocean information relevant to social goals. Both groups are performing observing system experiments to evaluate the present observing system plan.

Update of the Ocean Observing System – The OceanObs'09 meeting (21-25 September 2009) is to promote the benefits of the ocean observing system, to demonstrate its impacts, to update plans for the physical and carbon ocean observing systems, and advance observing and forecasting capabilities for marine biogeochemistry and ecosystems.

Appendix A: Letter to Chair, CEOS from Chair, GCOS SC and Chair, WCRP JSC, as drafted by WOAP

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WMO of UNESCO UNEP ICSU

Global Climate Observing System Secretariat
c/o World Meteorological Organization
7 *bis*, Avenue de la Paix
P.O. Box No. 2300, CH-1211 Geneva 2, Switzerland
Tel.: +41 (22) 730 8275/8067; Fax: +41 (22) 730 8052
E-mail: gcosjpo@wmo.int

GENEVA, 2 January 2008

Ms. Pontsho Maruping
Chair, Committee on Earth Observing Satellites
Council for Scientific and Industrial Research
Private Bag X894
Pretoria 0001, Gauteng
South Africa

Dear Ms. Maruping:

The outcome of the recent UN Climate Change Conference in Bali underlines the commitment of all nations to address the greenhouse warming issue. It highlights the need for both adaptation to and mitigation of climate change and thus for comprehensive and reliable climate observations, research and assessments to provide information to decision makers about how climate and its forcings are changing. Satellite records can provide data on a number of essential climate variables that will underpin urgently-needed information for countries about changing conditions at regional scales. However, homogeneity of the records is always a concern, and reprocessing and reanalysis of the records is fundamental in order to transform the data into true climate data and information records.

The importance of climate quality data records should help CEOS activities achieve greater recognition of the value of climate observations from space and hence help establish the required long-term support for satellite-based climate measurements.

We appreciate the progress by CEOS in establishing strategies for ensuring that the needs of the climate community and stakeholders could be met by future satellite missions. In particular, the CEOS Response to the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC" provides many clear actions aimed at coordinating international activities to ensure that high-quality temporally-homogeneous satellite climate measurements will be taken and archived in the future and that past measurements will be reprocessed as required. At the same time we recognize the enormous implementation issues

related to funding shortfalls and setting priorities that may limit the accomplishment of the proposed actions. This has become especially evident with the de-manifesting of several climate instruments from the NPOESS mission in the United States, where climate priorities were not adequately recognised in the planning and budgeting process.

The proposed actions of the CEOS Plan are very encouraging, and the GCOS (Global Climate Observing System) Steering Committee and the Joint Scientific Committee for the WCRP (World Climate Research Programme) look forward to working closely with CEOS in the assessment of progress in bringing all the actions in the Plan to fruition. The fulfilment of the CEOS Plan depends upon the maintenance of climate-quality earth-observation capability in all nations with satellite programs related to climate.

We appreciate the sound plans that the CEOS community has developed for the satellite-based climate data records and climate information records, and we congratulate the CEOS community on this progress. We note that these plans cannot succeed without the full commitment of all nations with climate-related satellite programs. We continue to emphasize the need for continuity and quality of observations to meet climate needs and we would be pleased to work with CEOS to help establish priorities, if necessary, and to ensure that all of the plans are fulfilled in good time.

Yours sincerely,

[signed]

John W. Zillman, Chair
GCOS Steering Committee

John Church, Chair
WCRP Joint Scientific Committee