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SATELLITE REQUIREMENTS OF IOC PROGRAMMES

In response to CGMS agenda item E.3

The major observing programme of the IOC is the Global Ocean Observing System (GOOS), the ocean observing component of GEOSS. Broad community consensus has been sought in the design and planning process for GOOS, which calls for continuous high-quality observations of the oceans from satellites and *in situ* instruments. This document serves to point out some of the challenges in maintaining satellite observations of sea ice, sea level, sea surface temperature, ocean colour, sea state, and salinity, and encourages the members of the CGMS to work with GOOS and other IOC programmes in meeting these challenges.

SATELLITE REQUIREMENTS OF IOC PROGRAMMES

1 Introduction

The Intergovernmental Oceanographic Commission of UNESCO (IOC/UNESCO) is a forum for intergovernmental coordination of marine science and marine observations. The Global Ocean Observing System (GOOS) is a major programme of the IOC, co-sponsored by the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU).

GOOS was designed for international coordination of sustained observations of the oceans, as a platform for the generation of oceanographic products and services, and as a forum for interaction between the research, operational, and user communities. Its goals are wide-ranging, and include: monitoring and understanding climate, climate and weather prediction, ocean forecasting, better management of marine and coastal ecosystems, mitigation of damage from natural hazards and marine pollution, and protection of life and property on coasts and at sea. GOOS is implemented by many national agencies and institutions, and thematically is divided into global and coastal modules. The design and implementation strategy have been developed and refined with these multi-purpose goals in mind, since a broad user base will strengthen the resource base and increase the likelihood of the observing system being sustained. GOOS is the ocean observing component of the GEOSS system of systems.

2 Satellite observations in GOOS

Satellite observations of sea surface temperature (microwave and infrared), sea ice, sea surface height (both high-precision and high-resolution), surface vector winds, ocean colour, and eventually of surface salinity, are a critical component of the composite ocean observing system necessary to generate the benefits of GOOS.

3 Requirements for global GOOS

The ocean community has designed and made some significant progress in the implementation of an initial ocean observing system in the last five years. The global component of GOOS, which is also the ocean component of the Global Climate Observing System (GCOS, also sponsored by the IOC, WMO, UNEP and ICSU), is a composite system of satellite and *in situ* observations collected by operational and research groups, to be synthesized into information products. The recommended observations are feasible for global implementation with current technologies, and are of high impact, contributing to the multiple objectives of the ocean observing system. The composite strategy makes the best use of existing observing efforts and organizational structures.

The scientific requirements for global GOOS, after wide consultation with the ocean observing and research communities, have been defined in a recent series of reports

invited by the UN Framework Convention on Climate Change (UNFCCC). Climate monitoring, prediction, and research are one of the major goals of global GOOS, though the system is also the base for global operational oceanography and contributes to weather forecasting. These reports are the *Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC*[1] (April 2003) and the *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*[2] (GCOS IP, November 2004), recommended for implementation by the tenth Conference of the Parties of the UNFCCC. These reports defined a number of Essential Climate Variables (ECVs). Many of the *in situ* ocean observing networks are coordinated by the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), which at its second session in September 2005 agreed that the ocean and relevant atmospheric actions of GCOS IP would form the basis of the its observations work plan.

The strictest quality and continuity requirements for ocean observations come from the climate objectives of GOOS, and are embodied by the GCOS Climate Monitoring Principles[3]. These principles call for high and documented levels of quality control, including overlap in observing methods during periods of change, and long-term continuity of measurements. Specific principles for satellite observations are also enumerated.

Additional detail on satellite requirements for global GOOS were specified when the Parties of the UNFCCC invited the satellite observing community, through the Committee on Earth Observation Satellites (CEOS), to provide a response to the needs expressed in *GCOS-92*. CEOS requested some additional details on requirements in addition to those spelled out in GCOS-92, which were recently published as *Systematic Observation Requirements for Satellite-based Products for Climate*[4] (September 2006).

4 Conclusions

In some ways, the present day is a golden age for ocean remote sensing. Multiple missions for measuring sea level, sea surface temperature, sea ice and sea state have revolutionized scientific understanding of and our predictive ability for the oceans. Most of these observations are made with experimental research satellites. Transitioning successful measurements to operational satellites has proved challenging, although progress is being made.

Nevertheless, the future adequacy of continued coverage for the six remotely-sensed ocean ECVs (sea ice, sea level, sea surface temperature, ocean colour, sea state, and salinity) remains a concern. A summary of the adequacy of these measurements is shown in the timeline below.

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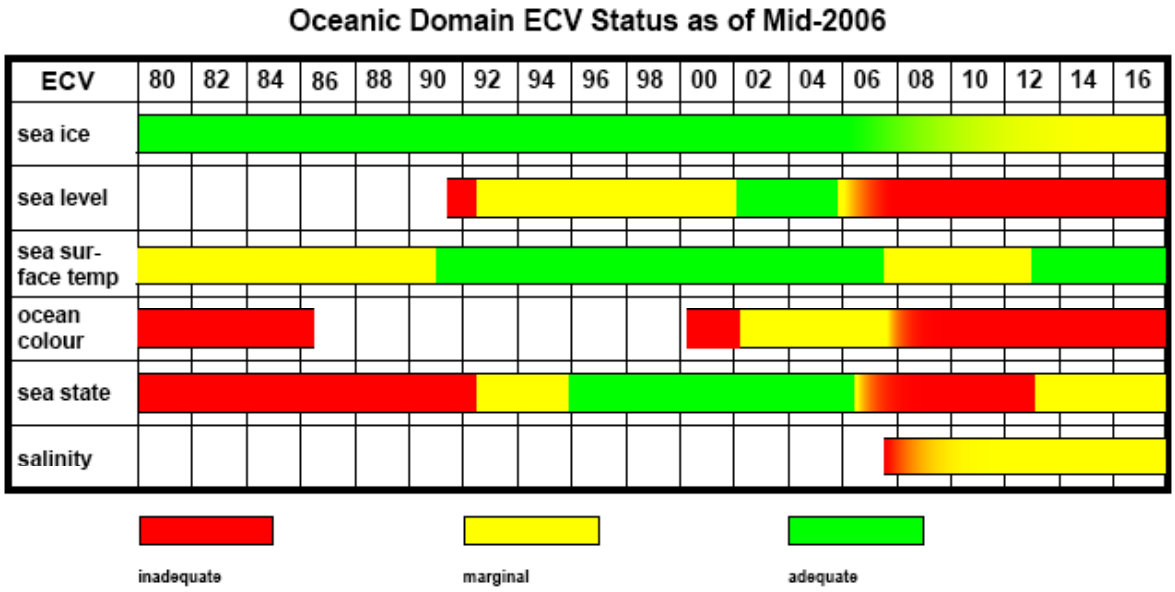
[1] GCOS Document No. 82 (WMO/TD No. 1143), available from http://ioc.unesco.org/oopc/

[2] GCOS Document No. 92 (WMO/TD No. 1219), available from http://ioc.unesco.org/oopc/

[3] http://www.wmo.ch/web/gcos/Publications/GCOS_Climate_Monitoring_Principles.pdf

[4] *Systematic Observation Requirements For Satellite-Based Products For Climate: Supplemental details to the satellite-based component of the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC",* GCOS Document No. 107, WMO/TD No. 1338, available from http://www.wmo.ch/web/gcos/gcoshome.html



Timeline of the adequacy of remotely sensed measurements of ocean Essential Climate Variables (ECVs) based on the requirements defined by GCOS IP. Red indicates some measurements, but below the GCOS IP threshold for the ECV, yellow indicates measurements at the threshold, and green indicates a fully adequate above-threshold number and quality of measurements. Courtesy E. Lindstrom/NASA.

CEOS provided a response to the UNFCCC, which was recently published[5] and will be brought to the Conference of the Parties in December 2006. It recognized the requirements as well-judged and technically feasible, but pointed to a need for increased coordination of Earth observations from space, as well as the challenging nature of a sustained and coordinated response on the part of the space agencies to the expressed requirements. It noted the structural difficulties inherent in the separation of research and operational missions, and noted the importance of countries being willing to make their data more widely available, in order to combine the value of groups (constellations) of satellites. The response also stressed the importance of the integration of *in situ* and satellite measurements, encouraging space agencies to work more closely with the *in situ* observing communities including those organized under GCOS, GOOS, and JCOMM.

5 Requirements for coastal GOOS

The scientific requirements for a global network of coastal ocean observations are laid out in the *Implementation Strategy for the Coastal Module of GOOS*[6]. The goals of the coastal module of GOOS as the same as the for GOOS overall, though the number of different types of measurements and the number of organizations involved is much greater than for the global module of GOOS.

[5] *Satellite Observation of the Climate System: The Committee on Earth Observation Satellites (CEOS) Response to the Global Climate Observing System (GCOS) Implementation Plan (IP),* September 2006, available at: http://www.ceos.org/

[6] GOOS Document No. 148, available from http://www.ioc-goos.org/

The Integrated Global Observing Strategy (IGOS) Coastal Theme document[7] outlined a strategy for integrated land and ocean observations in the coastal zone, with the goal of improving policy and management for the coastal zone. The Theme focuses on coastal populations at risk, including coastal hazards and coastal development and urbanization; and on coastal ecosystems, including the hydrological and biogeochemical cycles, and ecosystem health and productivity. Implementation of the theme is important for effective and robust policies and management plans. It outlines the requirements for both *in situ* and remotely-sensed observations in the coastal zone, in three realms: geophysical, biological/biogeochemical, and for mapping. The report identifies priority areas for the space agencies to address.

6 Conclusions

The member agencies and organizations of the CGMS are critical to the creation and sustenance of a successful global ocean observing system. Their coordination with each other and with research satellite agencies to ensure the high quality and continuity of ocean remote sensed data streams, as well as the creation of value-added products, is greatly appreciated and needed. The feedback and input of the CGMS to GOOS and the IOC are welcome.

[7] available at http://www.igospartners.org/