JCOMM Status & Ocean-Observing Satellite Elements

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CEOS Executive Secretary

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The WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology

The JCOMM Vision

- Integrated ocean observing system
- Integrated data management
- State-of-the-art technologies and capabilities
- New products and services
- User responsiveness and interaction
- Involvement of all maritime countries
Integrated Ocean Observing System

Satellites

Ship observations

ASAP

Sea level

Drifting buoy

Argo

Moorings
Data stored here, there, and everywhere
Variables that are both currently feasible for global implementation and have a high impact on UNFCCC requirements.

Three Domains

- **Atmospheric (over land, sea and ice)**
  - **Surface**
    - Air temperature, Precipitation, Air pressure, Surface radiation budget, Wind speed and direction, Water vapor.
  - **Upper-air**
    - Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapor, Cloud properties.
  - **Composition**
    - Carbon dioxide, Methane, Ozone, Other long-lived greenhouse gases, Aerosol properties.

- **Oceanic**
  - **Surface**
    - Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Current, Ocean color (for biological activity), Carbon dioxide partial pressure.
  - **Sub-surface**
    - Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton.

- **Terrestrial**
  - River discharge, Water use, Ground water, Lake levels, Snow cover, Glaciers and ice caps, Permafrost and seasonally-frozen ground, Albedo, Land cover (including vegetation type), Fraction of absorbed photo-synthetically active radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance
### Multi-Year Phased Implementation Plan (NOAA), 100% Requirement

<table>
<thead>
<tr>
<th>Year</th>
<th>Tide Gauges</th>
<th>Surface Drifting Buoys</th>
<th>Tropical Moored Buoys</th>
<th>Ships of Opportunity</th>
<th>Argo Floats</th>
<th>Reference Stations</th>
<th>Arctic System</th>
<th>Ocean Carbon Network</th>
<th>Dedicated Ship Time</th>
<th>Total System</th>
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<td>67</td>
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<td>54</td>
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</tbody>
</table>

**Legend:**
- **Green**: Base Budget
- **Yellow**: FY 07 President’s Budget
- **Red**: Planning, Unfunded

**System % Complete**
- Real-time Stations
- Initial GCOS Subset
- Number of buoys
- Number of moorings
- High resolution and frequently repeated lines occupied
- Number of floats
- Number of observatories, flux and ocean transport stations
- Ice buoys, drifting and Moored stations
- Repeat Sections Completed, One inventory per 10 years
- Days at sea (NOAA contribution)

**Representative milestones including international contributions**
- One inventory per 10 years

**Note:**
- The diagram shows the phased implementation plan with milestones for each year, indicating the progress of the system. The total system progress is marked with a bar graph.
Observing System Status: 2006 - Q1
Sea Surface Temperature

Requirement: All boxes blue

Goal:
100% Global Coverage
JCOMM Reporting

Visit http://www.jcommops.org/network_status

Systems Approach to Standard Mapping and Reporting

2003 → 2005

Argo Network, as of April 2003 (770 floats)

Argo Network, as of July 2005

STATUS OF GLOBAL DRIFTER ARRAY

GLOBAL DRIFTER PROGRAM

DRIF status by country, August 2005 (data buoys reporting on GTS)

SCORP numerical survey: January 2004 to December 2004

GLOSS Status, October 2004
COP-10 Decision on Research and Systematic Observation

- “Invites Parties that support space agencies involved in global observations to request these agencies to provide a coordinated response to the needs expressed in the GCOS Implementation Plan”

- CEOS was asked to present its response to SBSTA at COP 12 in November 2006
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-92)”

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GCOS Secretariat

GCOS-107
WMO/TD No. 1338
### Requirements for space-based observations of ocean ECV’s (1)

<table>
<thead>
<tr>
<th>Essential Climate Variable</th>
<th>(a) Requirements re: past/current data sets</th>
<th>(b) Requirements re: future systems</th>
<th>(c) Requirements re: calibration and validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>O.1 Sea Ice</td>
<td>Consolidate existing sea ice products</td>
<td>Continue existing series of MW/Vis/IR CryoSat-2, Sent-3, IceSat</td>
<td>Focus on ice thickness and drift data sets with rigorous cal/val</td>
</tr>
<tr>
<td></td>
<td>Combine with <em>in situ</em> records</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O.2 Sea Level</td>
<td>Reprocess altimetry data as orbit, geoid &amp; tides improve</td>
<td>Continue series of overlapping Jason-class &amp; plan two ERS-class missions</td>
<td>Ancillary validation system as part of the missions</td>
</tr>
<tr>
<td>O.3 Sea Surface Temperature</td>
<td>Continue support to GHRSSST pilot projects</td>
<td>Sustain IR &amp; MW sensors (extend ATSR, TMI, AMSR…)</td>
<td>Need to sustain <em>in situ</em> observations</td>
</tr>
</tbody>
</table>

*ECV* stands for *Essential Climate Variable*.
Requirements for space-based observations of ocean ECV’s (2)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>O.4 Ocean Colour</td>
<td>Ocean colour products freely available through ftp/Web Reprocess</td>
<td>Sustain ocean colour record Risk of gap beyond 2007</td>
<td>Improve <em>in situ</em> measurement network for vicarious cal</td>
</tr>
<tr>
<td>O.5 Sea State</td>
<td>Build a comprehensive unified record</td>
<td>Continue at least altimeter and SAR Explore new techniques</td>
<td>Use existing buoys for calibration</td>
</tr>
<tr>
<td>O.6 Ocean reanalysis</td>
<td>Data availability to reanalysis centres</td>
<td>Partnership with reanalysis centres</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- *O.4 Ocean Colour*
  - Ocean colour products freely available through ftp/Web Reprocess
  - Sustain ocean colour record
  - Risk of gap beyond 2007
  - Improve *in situ* measurement network for vicarious cal

- *O.5 Sea State*
  - Build a comprehensive unified record
  - Continue at least altimeter and SAR
  - Explore new techniques

- *O.6 Ocean reanalysis*
  - Data availability to reanalysis centres
  - Partnership with reanalysis centres
### Requirements for space-based observations of ocean ECV’s (3)

<table>
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<tr>
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<th>(b) Requirements re: future systems</th>
<th>(c) Requirements re: calibration and validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerging product (O.7): Sea Surface Salinity</td>
<td>N/A</td>
<td>Support research missions (SMOS, Aquarius)</td>
<td>Special <em>in situ</em> observing efforts needed to evaluate sensor performance</td>
</tr>
</tbody>
</table>

OCEAN OBSERVATIONS FROM SPACE HAVE SO FAR BEEN GATHERED MOSTLY THROUGH EXPERIMENTAL SATELLITES TRANSITIONING FROM RESEARCH TO OPERATIONAL (i.e., « CROSSING THE VALLEY OF DEATH ») REMAINS OUR FIRST CHALLENGE

Note: Surface Vector Wind is considered as an Atmospheric ECV
“KNOWN” FUTURE ALTIMETRY MISSIONS

ERS-2/RA

ERS-1

TOPEX/Poseidon

ERS-1

ENVISAT/RA-2

GFO

GFO

ERS-2/RA

TOPEX/Poseidon

ERS-1

ERS-2/RA

CNES/EUMETSAT/NASA/NOAA signed Letter of Agreement for Jason-2

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While CMIS has been cancelled, a less capable CMIS is planned beginning with C-2 in 2016.
Oceanic Domain ECV Status as of Mid-2006

Note: this color graph (and similar ones for Atmospheric and Terrestrial Domains) was withdrawn from CEOS Response to GCOS-IP
CEOS Response to the GCOS Implementation Plan – September 2006

Satellite Observation of the Climate System

The Committee on Earth Observation Satellites (CEOS) Response to the Global Climate Observing System (GCOS) Implementation Plan (IP)

Developed by CEOS and submitted to the United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body on Scientific and Technical Advice (SBSTA) on behalf of CEOS by the United States of America (USA) delegation

Visit http://www.ceos.org for the full report
Ocean Domain – Overall status

“Space-based ocean observations for climate are currently at a crossroads: unless additional urgent actions in response to relevant GCOS requirements are taken, only observations for the sea surface temperature ECV will be adequate in the next six years. The level of observation for all other ocean ECVs will be marginal (sea ice, sea state) or even inadequate (sea level, ocean colour) within and beyond that timeframe. It should be noted, however, that new research missions are planned that will provide the first-ever measurements of sea surface salinity, an emerging ECV.”
Sea Level: ensure continuity of high-accuracy altimetry measurements
A series of dedicated high-accuracy altimetry missions has been operated continuously since 1992 (Ocean Topography Experiment (TOPEX)/Poseidon, then Jason-1), and complemented for geographical coverage by the polar-orbiting European Remote Sensing satellite (ERS)-1, ERS-2, Envisat, and Geosat F/O; this continuity will be secured (though with little chance of overlap with Jason-1) with the planned launch of Jason-2 in mid-2008. Beyond this, however, there is currently no firm plan. The time series of dedicated high-accuracy altimetry missions must be continued beyond 2012 and complemented by other altimeter data from polar-orbiting platforms.

Action O-4: The National Oceanic and Atmospheric Administration (NOAA) and EUMETSAT will lead a CEOS study team to establish, by 2007, the basis for a future Ocean Surface Topography Constellation that satisfies the threshold requirements for the sea level ECV (and those of the sea state ECV). This will include consideration of a future Jason-3 mission and requirements for new altimeter technologies to improve spatial resolution and extend observations in coastal regions (and over lakes and rivers for the lakes ECV).

Action O-5: The Centre National d’Etudes Spatiales (CNES) and the Indian Space Research Organization (ISRO) will cooperate on a new polar-orbiting altimeter aimed at filling a potential data gap beyond 2008. ESA and the European Union (EU) will lead planning for Sentinel-3 carrying an altimeter to complement spatial/temporal coverage of the sea level (and sea state) ECVs (and possibly sea ice extent and thickness, river, and lake level with the altimeter operating in Synthetic Aperture Radar (SAR) mode beyond 2012).
Ocean Reanalysis: ensure the optimal utilisation of data already collected for all ocean ECVs.

For all ocean ECVs, reprocessing of past data sets must be undertaken at regular intervals and their utilisation for ocean reanalysis must be facilitated through framework agreements between CEOS agencies and reanalysis centres.

Action O-17: CEOS agencies will undertake planning for reprocessing past data to improve FCDRs and legacy databases (e.g., AVHRR Pathfinder, ATSR, Sea Level Pathfinder, and the sea ice ECV) in close coordination and partnership with existing advisory groups and reanalysis centres. All Level 2 data products for use in reanalysis should be properly accompanied by estimates of their uncertainty.

Action O-18: CEOS, through its Working Group on Calibration and Validation (WGCV) and in the context of developing standards for on-going missions and for the Constellations, will recommend best practices for pre-launch and onboard calibration of ocean sensors and for validation of space-based ocean observations with *in situ* sensors, including the establishment and maintenance of calibration and validation sites and networks. This will facilitate the combination of data from different sources and enable the establishment of global data sets and long-term series.

Action O-19: CEOS agencies, in cooperation with other partners, will support planning for a follow-on to GODAE by 2007.
“The SBSTA welcomed the report submitted by the United States of America on behalf of the Committee on Earth Observation Satellites (CEOS) (FCCC/SBSTA/2006/MISC.14), which describes the coordinated response by space agencies involved in global observations to the needs expressed in the GCOS implementation plan. The SBSTA invited the Parties that support space agencies to enable these agencies to implement, to the extent possible, the actions identified in the CEOS report and to continue responding in a coordinated manner through CEOS to the efforts to meet these needs. The SBSTA encouraged the GCOS and CEOS to continue their partnership for linking space-based capabilities with global climate observing requirements and encouraged Parties to improve access to space-based climate observations to all interested Parties.”
In conclusion, CEOS recognizes that both satellite and \textit{in situ} data are required to better monitor, characterize, and predict changes in the Earth system. While \textit{in situ} measurements will remain essential and largely measure what cannot be measured from satellites, Earth-observation satellites are the only realistic means to obtain the necessary global coverage, and with well-calibrated measurements, will become the single most important contribution to global observations for climate.