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**Bonn, 19–27 May 2005**

**Item 9 of the provisional agenda**

**Cooperation with relevant international organizations**

## **Report on progress with the initial ocean climate observing system**

### **Submission from the Global Climate Observing System secretariat**

1. The Conference of the Parties (COP), by its decision 11/CP.9, invited the Global Climate Observing System (GCOS) secretariat, in conjunction with the Global Ocean Observing System secretariat, to provide information to the Subsidiary Body for Scientific and Technological Advice (SBSTA), at its twenty-second session, on progress made towards implementing the initial ocean climate observing system.
2. In accordance with the procedure for miscellaneous documents, this document is reproduced\* in the language in which it was received from the GCOS secretariat and without formal editing.

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## **Progress with the initial ocean climate observing system**

Prepared by the Secretariat of the Global Ocean Observing System (GOOS)  
of the Intergovernmental Oceanographic Commission of UNESCO,  
in cooperation with the Global Climate Observing System (GCOS)

### **Executive Summary**

A report on progress made towards implementing the initial ocean observing system for climate was requested by UNFCCC COP-9 (December 2003) in Decision 11/CP.9. The initial ocean observing system seeks to measure the ocean essential climate variables (ECVs) identified in the Second Adequacy Report<sup>1</sup>. It is composed of continuous high-quality satellite measurements, a composite *in situ* ocean surface observing system, and a composite *in situ* ocean sub-surface observing system. It builds on existing observing activities, and in addition calls for efforts to create and make use of ocean climate products.

Progress has been made in a number of the system components. Highlights include the planned completion by the end of 2005 of the surface drifting buoy network, and significant progress in the implementation of the Argo sub-surface profiling buoy network, which is now more than 50% complete. Incremental progress of each of the main elements of the *in situ* ocean climate observing network is reported. Overall it is now 51% complete, compared to about 40% complete at the beginning of 2003.

Sixty-six nations participate in the ocean climate observing system, with the greatest participation in the global sea level network. Progressive investment by the Parties will be necessary to complete the initial ocean climate observing system by 2010. Challenges include improving national responsibilities, assuring a transition from research to operational funding for much of the system, assuring continuity of key satellite measurements of the ocean surface, and continuing to build the capacity of developing nations to participate in the ocean climate observing system.

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<sup>1</sup> *The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC*, Report GCOS-82, April 2003, available at <http://www.wmo.int/web/gcos/gcoshome.html>.

## Background

*The Second Report on the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC*<sup>2</sup> (hereafter referred to as the Adequacy Report) noted that “despite... significant progress, ocean networks are not yet adequate to meet the specific needs of the UNFCCC for most variables and in most regions of the planet.” The Adequacy Report was submitted to SBSTA at its eighteenth session (June 2003), and considered by COP at its ninth session (December 2003). COP-9 adopted decision 11/CP.9 regarding the Global Observing Systems for Climate, which invited “the Global Climate Observing System secretariat, in conjunction with the Global Ocean Observing System (GOOS) secretariat, to provide information to the Subsidiary Body on Scientific and Technical Advice, at its twenty-second session, on progress made towards implementing the initial ocean climate observing system.”

Decision 11/CP.9 also requested the GCOS secretariat to coordinate the development of a phased 5- to 10-year implementation plan for the integrated global observing systems for climate. The *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC*<sup>3</sup> (hereafter referred to as the Implementation Plan) was prepared with broad input and support from both the wider climate and the ocean science communities and included an implementation strategy and targets for the ocean climate observing system. The plan takes into consideration existing global, regional and national plans, programmes and initiatives, including those of GOOS as well as the plan for the Group on Earth Observations System of Systems (GEOSS). The plan depends on composite surface and sub-surface networks, making the best use of existing observing activities, and depends on the continuation of critical satellite observations. In the oceanic domain, 41 specific actions were identified, spanning *in situ* and satellite observations, the development of ocean products and analyses, and investments in data infrastructure and systems. These actions have an estimated annually recurring cost of about US\$ 200 million. They involve:

- improving key satellite and *in situ* networks for ocean observations,
- generating integrated global climate analysis products,
- enhancing the participation of least-developed countries and small island developing states,
- improving access to high-quality global data for Essential Climate Variables, and
- strengthening national and international infrastructure.

COP-10 endorsed the Implementation Plan through Decision 5/CP.10, which also encourages Parties to strengthen their efforts to address the priorities identified. The decision also welcomes the emphasis given to enhancing the participation of developing countries in the global observing system for climate, and invites GCOS to provide information to future sessions on how the actions identified in the Implementation Plan are being implemented.

This report notes progress made since the Adequacy Report, and in the context of the Implementation Plan. It has drawn information from a number of sources. Many of the *in situ* ocean observing networks are coordinated through the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM). JCOMM, through its Observations Programme Area coordinator and the JCOMM *in situ* Observing Platform Support Centre (JCOMMOPS), is now tracking the status of the ocean observing system networks that it coordinates, as well as partner ocean networks<sup>4</sup>. Plans for ocean satellite missions are coordinated by CEOS<sup>5</sup>. Finally, specific input from the Member States of the IOC was requested via a national questionnaire.

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<sup>2</sup> Report GCOS-82, available at <http://www.wmo.int/web/gcos/gcoshome.html>.

<sup>3</sup> Report GCOS-92, available at <http://www.wmo.int/web/gcos/gcoshome.html>.

<sup>4</sup> These reports are available from [http://www.jcommops.org/network\\_status/](http://www.jcommops.org/network_status/).

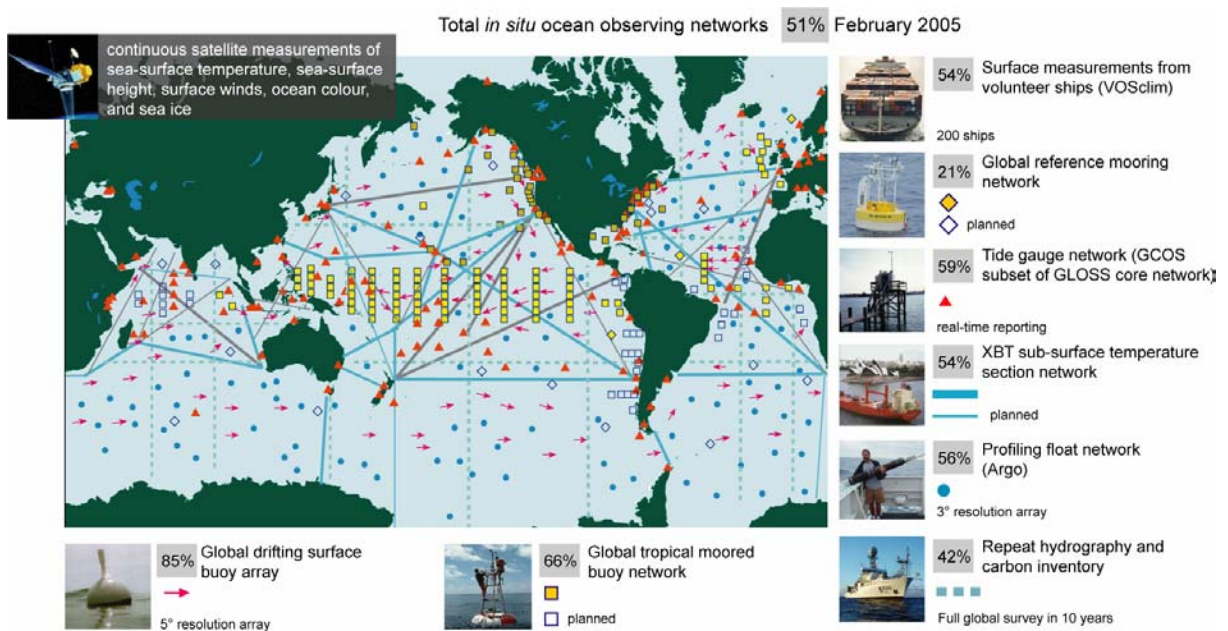
<sup>5</sup> The latest CEOS handbook is available at <http://www.eohandbook.com/>.

## The ocean observing networks

The Adequacy Report established a list of Essential Climate Variables (ECVs) that are both currently feasible for global implementation, and have a high impact on the requirements of the UNFCCC. For the oceanic domain, these are:

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

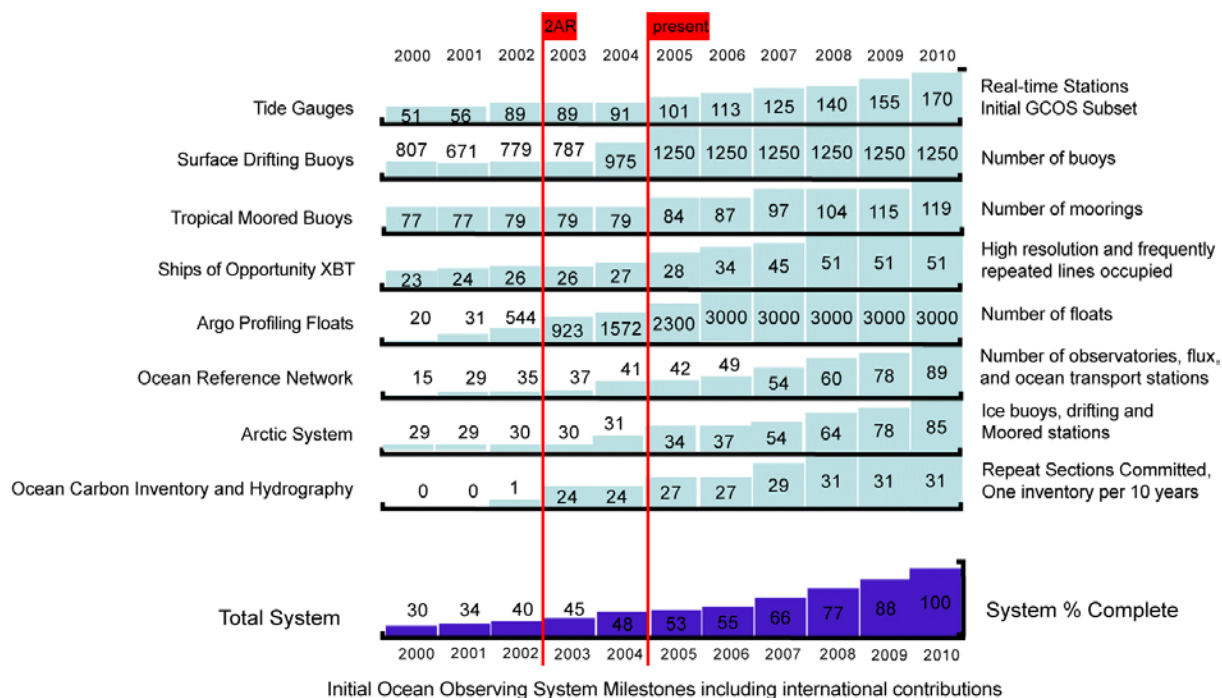
The total ocean observing system is a composite system, made up of sustained high-quality satellite measurements of the ocean surface, and *in situ* surface and *in situ* sub-surface observing systems, each made up of a mix of sensors and platforms (see schematic in Figure 1).



**Figure 1:** A schematic of the composite ocean observing systems, including the current status against the goals of the Implementation Plan.

Substantial progress has been made in the implementation a number of the observing networks contributing to the total system since the preparation of the Adequacy Report, and incremental progress is being made in the implementation of the overall initial ocean climate observing system. The last 5 years of progress and the plan for the next five years are found in Figure 2. Completion of the initial ocean climate observing system by 2010, as the plan envisions, will require substantial additional yearly investment by the Parties. At the time of the preparation of the Adequacy Report, the system was estimated to be about 40% complete, which can be compared to the estimate of 51% today.

Whilst a strong involvement of the research community is desirable, the Adequacy Report found that research programmes are the primary source of funding for many elements of the present ocean climate observing system, and this remains true. In some cases agreement exists on an orderly staged approach from research to pilot projects on to sustained operations. The US contribution to the tropical moored array in the Pacific was transferred from a research to an operational entity in 2004. Successful operational implementation of the initial ocean observing system will depend on sustained funding, and securing this remains a major challenge.



**Figure 2:** The history and future plan for the implementation of the *in situ* elements of the ocean observing system for climate, showing the publication of the Adequacy Report (2AR) and the present. The plan envisions completion of the initial ocean climate observing system by 2010, which will require substantial additional investment by the Parties.

### Composite surface observing system and satellite observations

Satellite observations of the ocean surface provide near-global coverage of sea-surface height, wind, sea level, significant wave height, sea-ice extent and concentration, and ocean colour. The surface *in situ* observations provide essential satellite calibration information, accurate time series, and an effective link with the historical record. For a number of the ocean surface ECVs they are the only source of information.

A major milestone in the ocean surface observing system will be the planned completion, in September 2005, of the global surface drifting buoy array, which measures bulk sea-surface temperature and sea level pressure. It will be the first *in situ* ocean network to reach its goal. In February 2005 there were 1061 of the planned 1250 buoys deployed.

Incremental progress in the other *in situ* surface observing networks has occurred, with modest growth in the number of tide gauge stations measuring sea level and reporting in real time, and the start of the extension of the global tropical moored network into the Indian Ocean. The network to measure surface fluxes of carbon into the ocean has also grown.

Planning lead times for satellite missions are measured in years, and continuity between different missions with different sensors, critical for climate monitoring, remains difficult to assure. Gaps in coverage after 2008 for high-resolution sea level altimetry and for satellite surface winds remain a concern.

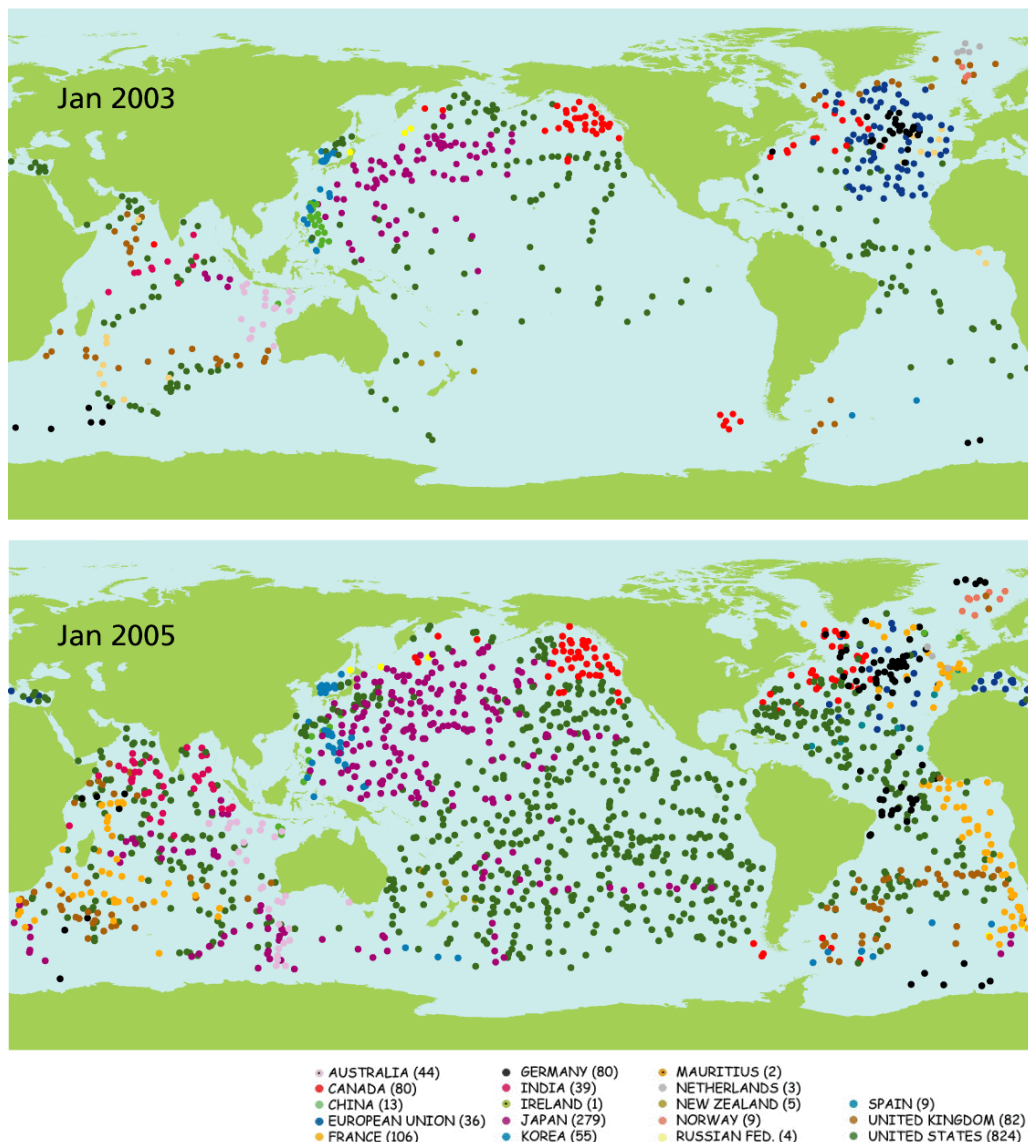


### Composite sub-surface observing system

*In situ* networks are the primary source of observations to fully characterize the three-dimensional structure of the ocean climate. Satellite altimetry and ocean colour data provide additional data on spatial variability and upper ocean biology.

The number of subsurface ocean profiles of temperature and salinity has increased dramatically since the Adequacy Report. This is in large part due to the growth of the Argo profiling float network (Figure 3), with 1671 floats reporting in February 2005 out of the required 3000 needed for global 3° resolution coverage. In some parts of the world ocean, Argo floats have now contributed more vertical profiles of temperature and salinity to the historical record than all other previous measurements combined.

Incremental progress in the other sub-surface ocean observing networks has also occurred. As noted above, the tropical moored array network has started an expansion to the Indian Ocean. The number of subsurface temperature profiles collected from ships of opportunity and reported in real time has increased by 30% since 2003, although global coverage of the sections called for in the Implementation Plan remains a concern.



**Figure 3:** An illustration of the progress made in the Argo profiling float network in two years. Argo floats measure temperature, salinity, and in some cases other variables, from the surface to 2000 m depth every 10 days. The Argo network is now 56% complete, and the goal is to seed the ocean with 3000 floats by 2007, yielding a 3° global resolution of sub-surface temperature and salinity. The colours denote the country responsible for the float.

### **Improving access to high-quality global data for Essential Climate Variables**

The systems and policies needed to manage and take stewardship of the data collected by the ocean observing networks are as important as the data themselves. The data system communicates data from often remote platforms, exchanges data between components of the network, and assembles and controls the quality of data for users. While real-time data access is not required for most climate products, experience has shown that a policy of immediate acquisition and exchange is the most effective for assuring the quality and continuity of the data.

Incremental progress has been made on many fronts, with increases in the availability of data, its standardization, and quality control for new elements in the observing system. Full global coverage of *in situ* sea level in particular remains blocked by national concerns ranging from security to cost recovery.

All Parties are requested to participate fully under the agreed data exchange practices and in accordance with agreed data standards. Only if these are fully subscribed will it be possible to ensure that the needed global ocean information can be made available to all Parties.

### **Analysis**

The purpose of the observing system is to provide the information necessary to meet the needs of the UNFCCC. The products needed to support the testing of climate change models and the evaluation of ocean climate variability have been identified.

The Global Ocean Data Assimilation Experiment, which is focused on operational ocean forecasting but is also beginning to create products of use for climate, entered a demonstration phase in 2004, with publicly available products<sup>6</sup>. Close interaction with and feedback from the user community is being sought.

### **Research**

In order to meet the full needs for information of the Parties (i.e., the full range of ocean physical and biogeochemical variables), vigorous ocean climate research programmes must be maintained by the Parties in order to make observations more effectively using new techniques and technologies, to develop new analysis procedures, and to improve ocean information products. These research efforts will contribute best if they are coordinated via international ocean research projects supporting GOOS, GCOS, WCRP, and IGBP priorities.

### **Global participation and targeted capacity building**

The number of countries participating in the ocean observing system is large (66), although a majority of the system is implemented by a smaller number of countries. The network with the largest number of countries participating is the GLOSS network of tide gauge stations measuring sea level (see Figure 4).

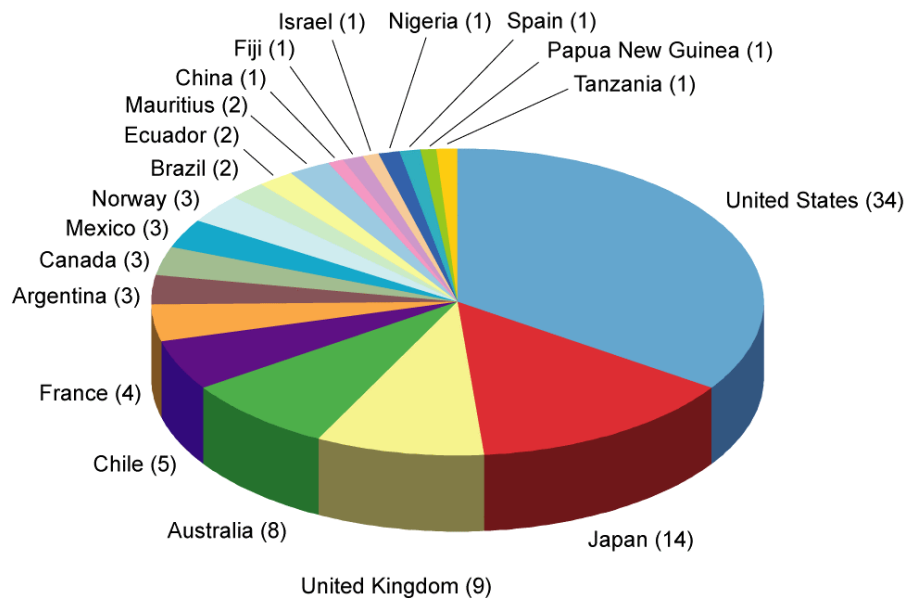
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<sup>6</sup> Details of which can be found on the GODAE site: <http://www.bom.gov.au/bmrc/ocean/GODAE/>.

The Implementation Plan identified the designation and strengthening of national and regional agents for implementation as a high priority. The majority of nations participating in the ocean observing system continue to report a lack of formal mechanisms for national coordination between agencies and scientists contributing to the observing system.

Stronger national infrastructures for ocean observations need to be established in most countries. This will include the designation of national (or regional, where appropriate) agents for implementation to facilitate and coordinate the actions identified in the Implementation Plan, to collect the observations and provide the needed information and services, and to ensure that reporting mechanisms are in place to monitor national (or regional) progress.

The need for all Parties to improve the global observing systems for climate in developing countries has also been identified. The GLOSS tide gauge programme has continued with training programme activities to build the capacity of developing nations to maintain and benefit from tide gauge measurements of sea level. The IOC of UNESCO in 2004 reaffirmed a commitment to capacity building focused on marine science and ocean observations with the creation of a specific capacity-building section, and will publish an implementation plan in 2005.



**Figure 4:** An example of current national contributions to one element of the ocean observing system, the GCOS subset of real-time reporting GLOSS tide gauge stations. The number of stations reported by each country is noted.

## Cooperation

While design of the initial ocean climate observing system is focused on the needs of the Convention, it also serves other more operational needs such as prediction of weather and marine hazards. The JCOMM Observations Coordination Area has adopted the oceanic domain section of the Implementation Plan a guiding document for its work plan.

Finally we note the tragic events surrounding the 26 December 2004 earthquake and tsunami in the Indian Ocean. While the observations necessary for an effective tsunami and natural hazard warning system are outside the scope of the observations addressed in this report, there are natural synergies between these observational networks. Tide gauges are one observation that can provide concrete evidence of the generation of a tsunami, critically reducing the rate of false



alerts in a tsunami warning system. The tide gauge networks for climate purposes and for tsunami warning purposes are compatible, and now overlap in many locations in the Pacific and Indian Oceans. The climate and tsunami warning ocean networks are cooperating by sharing ship time in their deployment and servicing strategies, and further ways of cooperating are under exploration.

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