Observations for Climate: NOAA Support of Sustained Ocean and Arctic Research

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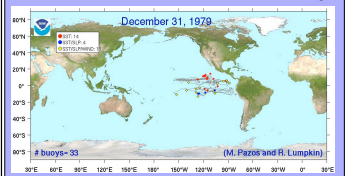
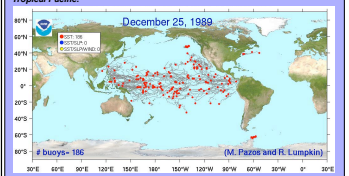
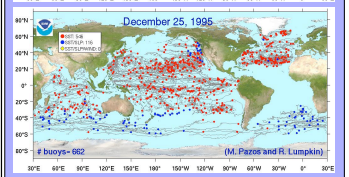
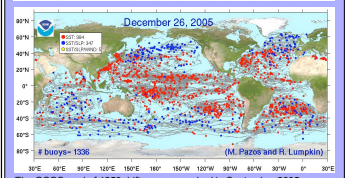
Growth of the Global Drifter Array



First deployments of Surface Velocity Program-type drifters as part of TOGA: ***Tropical Pacific.***







The GCOS goal of 1250 drifters was reached in September 2005.

The Global Drifter Array from 2000-present.

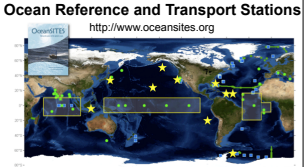
Global drifter data support short-term (seasonal to interannual) climate predictions as well as climate research and monitoring.

Drifters are maintained in a global 5x5 degree array of 1250 surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds and salinity.

(Graphics courtesy of R. Lumpkin, AOML)

☆ NOAA funded Ocean Reference and Transport Stations

http://www.oceansites.org

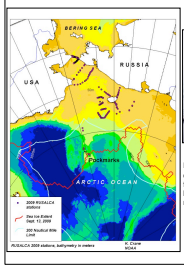


Ocean Reference and Transport Stations are part of a worldwide system of long-term, deepwater reference stations measuring dozens of variables and monitoring the full depth of the ocean from air-sea interactions down to 5,000 meters. These moorings/stations are an integral part of the global ocean observing system and complement satellite imagery and ARGO float data by adding the dimensions of time and depth.

Abstract: Observation is central to describing, understanding, and predicting the Earth's climate system. The NOAA Climate Observation Division supports and maintains one half of the current sustained global ocean observing system with projects focused on ocean and Arctic climate. These projects are designed to contribute to the long-term requirements of operational forecast centers, international research programs, and major scientific assessments. NOAA works with national and international partners to build and sustain this global observational system for climate with projects managed in cooperation with the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology. International partnerships and US interagency cooperation have been critical to development, deployment, and operation of global ocean and Arctic observing arrays. Relatively close ties exist, through international research programs, between the climate observations, modeling/prediction, and process-oriented research communities leading to successes such as the IPCC and resulting assessments, improvements in climate forecasting, and advances in knowledge resulting from research efforts enabled by the observing systems.

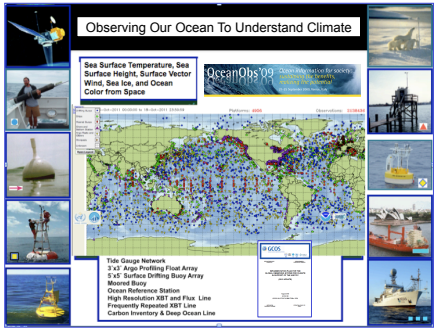
Although a focus of the Climate Observation Division is to support projects that deploy autonomous in situ platforms, the underlying objective is to foster a "system" approach to effective international organization of complementary in situ, satellite, data management and analysis, and modeling components of climate observation, with application to climate services. The updated Implementation Plan for the Global Observing System for Climate and OceanObs'09 Conference Summary highlight the future needs of the climate observing system for research and other applications. Ocean and Arctic observations produce climate data that lead to a better understanding of key climate issues like rising sea level, sea ice decline, increased drought, and impacts on marine biogeochemistry. Only through strong collaborations can the observing system help address these and other needs and issues. This poster, and accompanying cluster posters, provides an historic view of the development of the global ocean and Arctic observing systems with glimpses into the anticipated evolution of the system to develop a more robust understanding of sea level, carbon, heat, salinity, and air-sea exchange parameters via the complementary observing networks, including tide gauges, Argo profilers, drifting buoys, moored buoys, expendable bathythermographs, ocean reference stations, ocean carbon measurements, and the Arctic Observing Network.

RUSALCA 2004-2009-2012



RUSALCA (Russian US Long-term Census of the Arctic Ocean) Program: Every three-five years, ecosystem consequences of the loss of sea ice are examined north to the retreating ice edge.

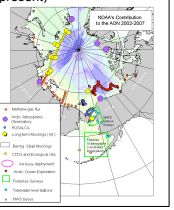
Observing Our Ocean To Understand Climate



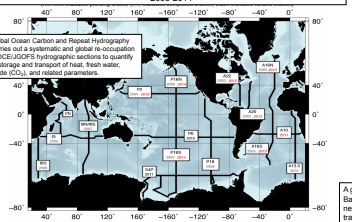
Arctic Observing Network

Supported by the Arctic Research Program (2002-present)

- Sea Ice
- Atmospheric Observatories
- Ocean–Ecosystem Observations and Modeling in Pacific Arctic Sector



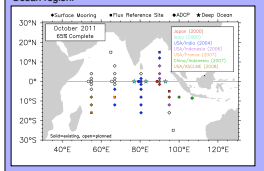
Cruises for the U.S. Global Ocean Carbon / Repeat Hydrography Program 2003-2014

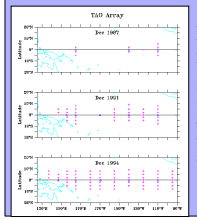


The U.S Global Ocean Carbon and Repeat Hydrography Program carries out a systematic and global re-occupation of select WOCE/JGOFS hydrographic sections to quantify changes in storage and transport of heat, fresh water, carbon dioxide (CO_2), and related parameters.

Tropical Moored Buoy Arrays

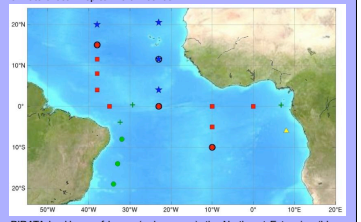
The (RAMA) Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction RAMA is targeted at understanding and predicting the East African, Asian, and Australian monsoons, but it benefits nations outside the Indian Ocean region.





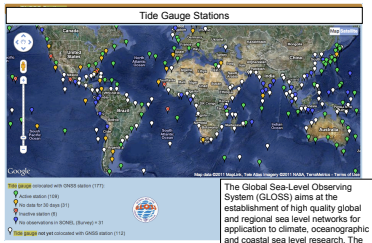
The (TAO/TRITON) Tropical Atmosphere-Ocean / Triangle Trans-Ocean Buoy Network of moored buoys in the tropical Pacific Ocean is a major source of data for understanding and predicting the El Niño–Southern Oscillation (ENSO).

The (PIRATA) Prediction and Research Moored Array in the Tropical Atlantic is used to study climate variability in the equatorial Atlantic. Starting in late 2005, extensions were added to the backbone array in key regions, including the US-led PIRATA Northeast Extension (PNE) in the climate-critical Tropical North Atlantic.



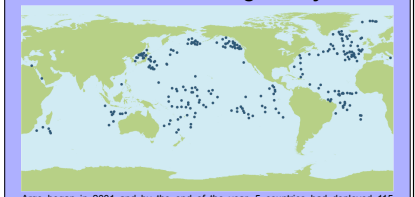
PIRATA backbone of buoys (red squares), the Northeast Extension (blue stars) led by the United States, the Southwest Extension (green circles) led by Brazil, the Southeast Extension pilot site (yellow triangle), and island-based observation sites (green crosses).

Tide Gauge Stations



The Global Sea-Level Observing System (GLOSS) aims at the establishment of high quality global and regional sea level networks for application to climate, oceanographic and coastal sea level research. The main component of GLOSS is the 'Global Core Network' (GCN) of 290 sea level stations around the world for long term climate change and oceanographic sea level monitoring.

Growth of the Argo Array



Argo began in 2001 and by the end of the year, 5 countries had deployed 115 instruments.

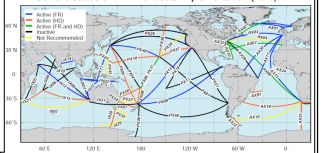
As of 31 January 2004 there were 1043 active floats representing contributions from 17 Nations plus the European Union. The deployments nominally along 30° South in all three ocean basins represent the beginning of the establishment of a global array.

As of 31 October 2007, the Argo Array reached its initial implementation goal of 3,000 active instruments representing contributions from 22 Nations plus the European Union, throughout the world's ice-free oceans, excluding marginal seas.

With the use of Argo, the physical state of the upper ocean is being systematically measured and the data assimilated in near real-time into computer models. Argo builds on other upper-ocean ocean observing networks, extending their coverage in space and time, their depth range and accuracy, and enhancing them through the addition of salinity and velocity measurements.

A global eXpendable Bathy Thermograph (XBT) network of 51 transects exists that utilizes approximately 50 ships of opportunity. A primary objective is to provide oceanographic data to initialize operational climate forecasts. Data from XBT transects have been used extensively in ocean analysis to estimate and monitor the variability of ocean heat storage, western boundary currents, global heat and freshwater transport.

Current Status of XBT Transects Implementation (2010)



NOAA's Formal Ocean-Climate Agreements
Critical Resources for the U.S.: 220 Ship Days - Data Sharing, Expertise, Goodwill Overseas

Mutually Beneficial Resource Sharing Partnerships

- NOAA Provides Most Equipment & Capacity Building, Training, Education
- In Exchange: Regional Partners Provide 220 Gratis Ship Days-At-Sea (DAS), Data, Expertise
- "Make Full and effective use of International Partnerships and Policy Leadership to Achieve NOAA's Mission Objectives" (NOSP – Engagement Enterprise)
- "Leverage the Many Contributions to our Domestic Mission Through International Partnerships " (AGM)

- Japan - signed in 2000 (Western Pacific, TAO)
- France and Brazil – signed in 2006 (75 DAS in Atlantic, PIRATA)
- India - signed in 2008 (75 DAS Central Indian Ocean, RAMA)
- Indonesia - signed in 2009 (40 DAS Eastern Indian Ocean, RAMA)
- UNDP/ASCLME (9 East African Countries) – signed in 2011 (30 DAS Western Indian Ocean, RAMA)
- Korea, Australia, China, Chile – Exploring Partnerships for Indian, Southern and Pacific Oceans

OceanObs'09 *Ocean information for society: sustaining the benefits, realizing the potential*
21-25 September 2009, Venice, Italy

Future challenges include:

- sustaining the global network at an effective level;
- enhancing the global network to include biogeochemical variables to meet societal needs for ocean information;
- developing new technologies to increase cost effectiveness and providing new observing capabilities; and
- improving international agreements on access to marine waters under national jurisdiction & sharing of data in near-real time.