Monitoring the North Pacific for Improved Ocean, Weather and Climate Forecasts

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LONG-TERM GOALS

This work is funded by the National Oceanographic Partnership Program (NOPP). The goal is to bring together a unique set of observational and modeling opportunities that currently exist within the partnering institutions and agencies to monitor the North Pacific Ocean. The ultimate purpose is to understand the effects of seasonal and decadal variability on short-term North American weather and climate forecasts.

OBJECTIVES

Within the larger scope of the project's long-term goals, the specific objective of this initial partnership effort is to extend in-situ TAO array observations North of 20 degrees N, and in-situ acoustic measurements of integrated heat content to the south and west Pacific, and to combine these measurements and satellite altimeter data in numerical ocean models.

APPROACH

The partnership combines existing expertise and capability in ocean observation and ocean numerical modeling skill. Observational capabilities include the existing in-situ sensors of NOAA/PMEL's TAO array (McPhaden, 1995), ATOC's undersea acoustic network (ATOC Instrumentation Group, 1995), and NOAA/NESDIS' space-borne sensors, including satellite altimeters (Cheney, et.al., 1996). The modeling component of this project combines present efforts at NOAA/PMEL and NRL/SSC (Hurlbut, et.al., 1996).

To make progress toward the long-term goal, the project focuses initially on the eastern and tropical Pacific Ocean, combining data from the TAO array with acoustic and altimetric observations to test and constrain numerical models of the region. Acoustic observations are to be added to the on-going TAO array and satellite altimeter data collection programs by adding low-cost, simple acoustic receivers to a few of the Tropical Pacific TAO moorings to record transmissions from the ATOC Pioneer Seamount source. Also, the TAO array is to be augmented with several moorings in the northern Pacific where data is scarce, also equipped with acoustic receivers. Data from the acoustic receivers will be merged with the TAO array data and telemetered in near real-time via satellite to shore.

Part of this project includes assessing the relative value of the various types of observations through simulations, and also to determine where to add acoustic receivers to the existing TAO array, and where additional data moorings would be most effective. We anticipate that the most cost-effective system will be a combination of all three data types, in which the moored sensors provide detailed vertical

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temperature structure, the acoustic systems provide integrated measures of temperature and heat content between the moorings, and the altimeter provides wide-area information on heat content and surface currents. The numerical models will be used to combine these complementary data types in a dynamically consistent way, to generate analysis fields analogous to those currently generated routinely for the atmosphere. It is conceivable, although by no means certain, that the combination of moored point data with integral acoustic data will allow a reduction in the number of moorings required to monitor the tropical Pacific.

This research is a joint effort involving the following principals: B. Cornuelle, M. Dzieciuch and P. Worcester at the Scripps Institution of Oceanography; H. Hurlburt, G. Jacobs and E. Metzger at the Naval Research Laboratory Stennis Space Center; E. Harrison, M. McPhaden, and H. Milburn at NOAA's Pacific Environmental Research Laboratory; R. Cheney at NOAA/NESDIS; and B. Howe, J. Mercer, and R. Spindel at the Applied Physics Laboratory of the University of Washington.

WORK COMPLETED

An engineering test mooring was designed to withstand the harsh environmental conditions of the North Pacific and was deployed in September, 1998 at Ocean Weather Station Papa (50 N, 145 West) for a one-year trial (Milburn, et.al., 1996). It is equipped with a full suite of TAO-mooring sensors, including a surface buoy with GOES satellite data telemetry links to shore. (Others include wind speed and direction, humidity, air and sea temperatures, subsurface pressure, short-wave solar radiation, downwelling long-wave radiation, rain rate, subsurface currents and conductivity, and barometric pressure.) In addition, a second sub-surface mooring (no surface expression) instrumented with acoustic receiving equipment was deployed about 1.5 km away. Acoustic data is transferred from this mooring to the mooring with the satellite transmitter where it is integrated into the environmental data stream for telemetry to shore. The ultimate goal is to equip the mooring with the surface buoy with an acoustic receiver directly, thereby eliminating the need for two moorings. However, we have not fully evaluated the effects of flow noise induced in the receiver hydrophones as a result of motion caused by wave and wind action on the surface buoy.

The underwater telemetry system is a commercial product, but we have contributed to its design understanding of its operation under various oceanographic conditions though a series of sea tests conducted under the auspices of this project.

Work has proceeded on evaluating various wind fields for forcing NRL's high resolution layered ocean model (1/16 degree, 6 layer) in order to optimize model forecasts. These have included European Center for Medium-range Weather Forecasting (ECMWF), NCEP and Florida State University (FSU) wind fields. Near real-time TOPEX, and now ERS-2 altimeter data (assimilated in the NOAA-NCEP operational model) is available to NRL-SSC for incorporation into NRL's model forecasts. Work is underway to directly assimilate acoustic data into the NRL ocean model.

A specific cost-sharing aspect of this project was to be the installation of a second acoustic thermometry transmitter off the North coast of Kauai to expand the coverage provided by the single transmitter off the California coast. This was accomplished early in the project.

RESULTS

This report is prepared early in the project and no specific results are yet available.

IMPACT/IMPLICATIONS

We expect that this research project will be the beginning of an on-going partnership leading to the development of a long-term observing and forecasting capability for the North Pacific. Information derived from this effort will define the structure of the North Pacific modes of variability, and lead to improved short-term, annual and decadal forecasts over North America, and to improved ocean nowcasts and forecasts of particular value to the Navy. It will provide the basis for observational, numerical and prediction research on upper ocean dynamics and air-sea interaction in the North Pacific and the effects of North Pacific variability on US environment and commerce.

TRANSITIONS

None.

RELATED PROJECTS

1) This project exploits the acoustic network, instrumentation and data of the ONR sponsored North Pacific Acoustic Laboratory (NPAL) program (Code 321OA) and the Acoustic Thermometry of Ocean Climate (ATOC) program (SERDP/DARPA).

2) NOAA/PMEL's ongoing TAO array development supports some of the design and instrumentation of the Ocean Weather Station Papa test moorings.

3) A new NOPP project called the Ocean Acoustic Observatory Federation will provide useful data as well as limited maintenance and improvements to the ATOC network.

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