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IOOS BACKBONE EXPANSION EFFORTS BY NOAA'S NATIONAL DATA BUOY CENTER

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1. INTRODUCTION

The National Weather Service's (NWS) National Data Buoy Center (NDBC) operates the NDBC Ocean Observation System, consisting primarily of moored buoys and shore and platform-based coastal marine stations around the continental U.S., Alaska, Hawaii, and the Great Lakes. This system constitutes a substantial portion of the "National Backbone", the federal contribution to the U.S. Integrated Ocean Observing System (IOOS). A description of NDBC observing systems and processing can be found in Conlee and Moersdorf, 2005.

Expansion plans for the National Backbone have long included the enhancement of NDBC stations for additional ocean parameters, as well as the expansion of the overall network to as many as 500 stations (Ocean.US, 2002). The recently approved U.S. IOOS Development Plan (Ocean.US, 2005) calls for expansion to 350 stations and directional wave measurements on all buoys. Although congressional appropriations in FY05 did not provide for additional stations, resources were provided to enhance the existing network ocean-sensing capability.

2. SURVEY OF REGIONAL ASSOCIATION REQUIREMENTS

Before proceeding with IOOS expansion, NDBC asked the nascent IOOS Regional Associations (RA) specifically for their priorities in augmenting stations for currents, salinity and directional waves, a combination of the highest priority and most rapidly achievable additions. NDBC also asked for any additional recommendations that they would like to air. Most availed themselves of the opportunity to address a wide range of issues such as additional stations, additional parameters and cooperative projects.

The responses from the RAs varied in length, detail and coordination effort. Significant contributing factors to these differences were the maturity of both the RA (some were not yet funded) and the existing efforts in observing and coordination within the region. Among the most useful for NDBC and the emerging IOOS effort were those which had substantial vetting and represented a unified and prioritized list of desired NDBC improvements from the regional perspective.

3. NEAR-TERM ENHANCEMENTS

Using the results of the RA survey as primary input, NDBC is currently undertaking enhancement of existing stations in the key variables of directional wave, currents and salinity. The in-house development of a lower-cost directional wave sensor (Teng and Bouchard, 2005) will enable the upgrade of virtually all NDBC buoys for this capability. In addition, a small 1.8m foam buoy (Figure 1) is now in production which will bring wave measurements to selected Coastal-Marine Automated Network (C-MAN) stations and 6m NOMAD buoys. Use of acoustic

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FIG 1. NDBC 1.8m foam buoy (on stand). Contains angular rate sensor, onboard processor, and Iridium communications for directional wave measurement. Can also be outfitted with acoustic current profiler and CT sensor "string."

Doppler wave technologies is also being investigated for C-MAN application. Even with a goal of 100% directional waves, RA inputs are helping to determine the phasing priority for directional wave modifications.

Current measurements will also be a near-universal addition to NDBC buoys. At a minimum, a surface current meter will be installed. Again using the RA survey as input, selected stations are receiving acoustic current profiling instruments. NDBC is currently working with IOOS academic partners to evaluate different mounting methods and sampling schemes, with an eye toward bottom mounting when feasible. The requirement for real-time data communication makes current profiling an especially challenging endeavor.

A more measured approach to adding salinity to our network is being undertaken. The expected service interval for a typical NDBC station is 2-3 years, which is incompatible with current salinity measuring technology due to the bio-fouling problem. Salinity enhancement is concentrating on stations where more frequent maintenance is possible. This could be an excellent opportunity for additional IOOS cooperation with local and regional partners. NDBC is also developing temperature and salinity profiling capability in conjunction with the transition of the Tropical Atmosphere Ocean (TAO) network from the Pacific Marine Environmental Laboratory (PMEL). This will eventually allow the addition of these capabilities to select NDBC coastal buoys and stations to better meet IOOS regional requirements.

4. IOOS DATA ASSEMBLY CENTER AND CALIBRATION LABORATORY IMPROVMENTS

The addition of more data, including more complex ocean parameters, has necessitated the expansion of data management and communication infrastructure. Some of this data increase is the result of an increasing number of IOOS Regional Coastal Ocean Observing Systems (RCOOS) observations, which now constitute some 38% of the buoy observations processed (Figure 2). The NDBC IOOS Real Time Data Assembly Center (DAC) is responsible for quality control and data forwarding of both organic and IOOS-partner data. The DAC has expanded to 24/7 operations and added personnel with increased oceanographic expertise. A partnership with the National Ocean Service Center for Operational Oceanographic Products and Services (NOS/CO-OPS) has developed to coordinate and share QA/QC efforts and ultimately

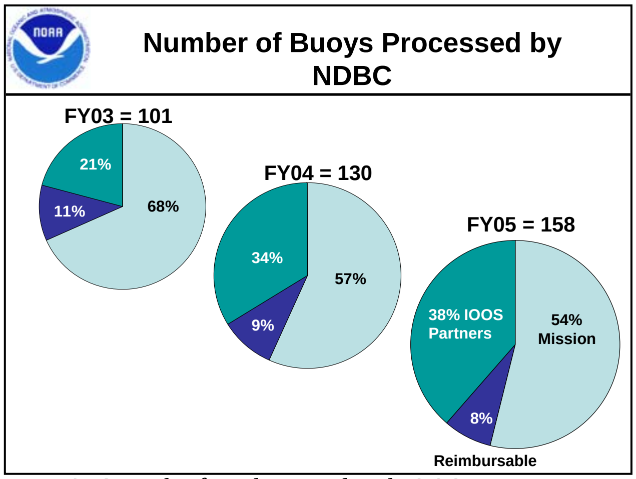

FIG 2. Growth of total moored and IOOS partner platforms processed by NDBC. Mission is base-funded, Reimbursable is deployed by NDBC for a funding sponsor.

create a virtual joint DAC. NDBC remains heavily engaged in community QA/QC efforts such as Quality Assurance of Real-Time Ocean Data (QARTOD) and IOOS QC demonstrations.

In January 2005, the Department of Interior's Minerals Management Service (MMS) asked NDBC to process and distribute acoustic current profile data from oil and gas industry platforms. The DAC is now processing these data which add approximately 45 web-available deep current profiles to the western and central Gulf of Mexico.

In partnership with CO-OPS, NDBC will also host the IOOS National HF Radar Server, distributing surface current data from existing and future sites utilizing this technology. Initial demonstrations of this capability are expected in early 2007.

NDBC has traditionally approached commercial meteorological instruments with a "trust but verify" strategy, maintaining an extensive calibration laboratory for state variables such as temperature, pressure, humidity and wind. The calibration facilities are also expanding to accommodate more oceanographic variables.

5. LONG TERM NDBC BACKBONE ENHANCEMENTS

The regional associations, in general, certainly expressed an interest in other backbone enhancements, including the obvious call for additional buoys and C-MAN stations. Figure 3 depicts new stations suggested by their inputs. Although not specifically sought in the survey, such information is very useful to NDBC and the IOOS community as a whole as planning progresses towards a fully-realized U.S. IOOS.

In NOAA's long range master plan, IOOS is included as a component of the Global Earth Observation System of Systems (GEOSS). In this plan, expansion of NDBC stations begins in Fiscal Year 2009 with the addition of 28 stations and continues for ten years. In advance of master plan execution, congress has funded three expansions (New England, Southern California and Hurricane), and could consider other accelerations.

There will clearly be a need for other parameters to be observed by NDBC backbone stations. RA-recommended parameter expansions included atmospheric visibility, bi-static HF radar, CO_2, nitrates, radiometers, fluorescence, backscatter from acoustic profilers, dissolved oxygen, and chlorophyll. While NDBC has limited experience in some of these parameters, an ongoing effort will be to identify operational candidates for sensors/parameters which will serve a broad IOOS interest including chemical and biological sensors.

6. SUMMARY

The development of the IOOS national backbone and integration with regional observing efforts is proceeding, in part through the expansion of NDBC observing capability and the ongoing NDBC efforts to

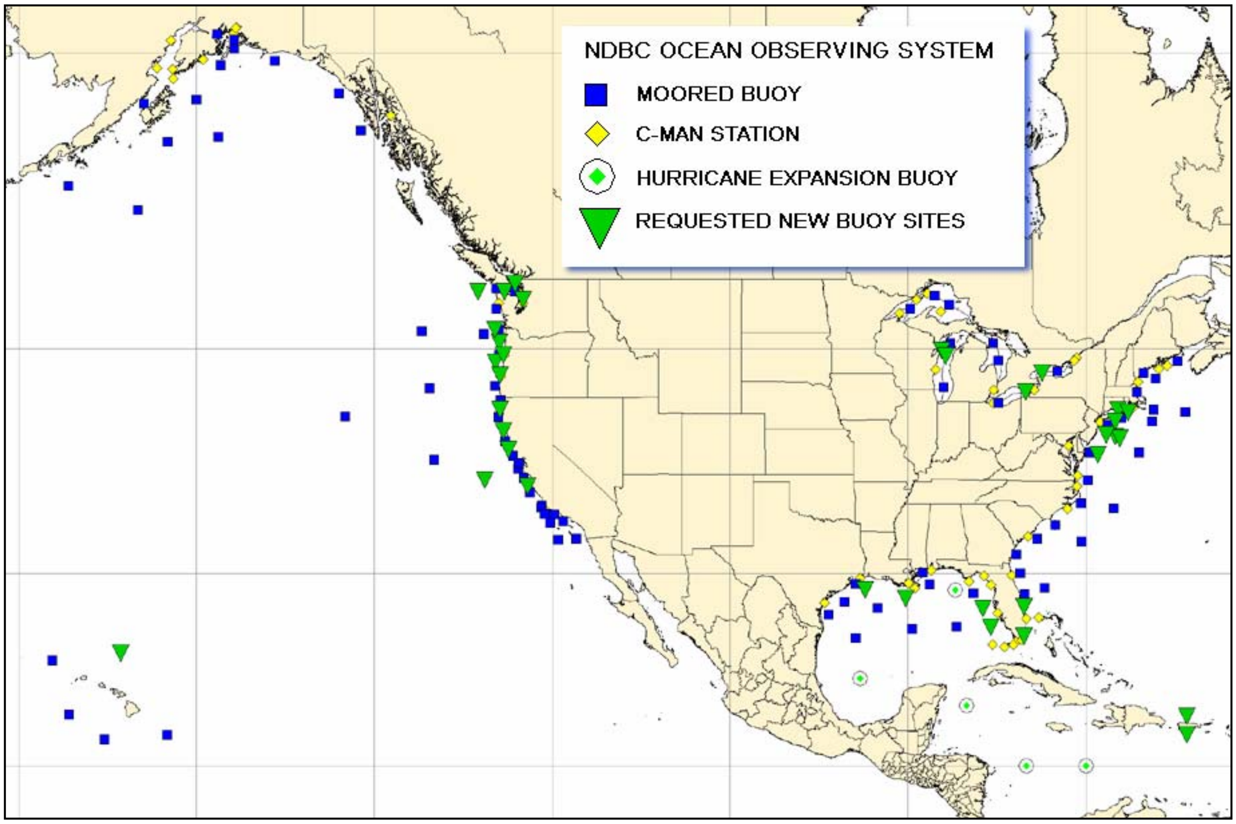

FIG 3. Map showing locations of additional buoys requested by IOOS Regional Associations in 2005. Not depicted are requested buoys to support American Samoa and the Northwest Pacific.

assemble, quality-control and distribute regional data. To date the increased observing capability has been primarily accomplished through augmentation of existing platforms. The required expansion of the national backbone in terms of new stations and sustained support for them remains a significant challenge.

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