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OBSERVATIONS OF ANOMALOUS NEAR-SURFACE LOW-SALINITY PULSES OFF THE CENTRAL OREGON COAST: AN INTEGRATED APPROACH

Risien C.M.*, P.L.F. Mazzini*, J.A. Barth* and OO Colleagues#

*College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331

Contact: crisien@coas.oregonstate.edu

Ocean Observing Colleagues#

Glider Team: Kipp Shearman, Anatoli Erofeev, Zen Kurokawa, Kate Adams, Chris Ordonez and Pat Welch. OOI: Ed Dever, Bob Collier, Mike Vardaro, Jon Fram, Walt Waldorf, Chris Wingard, Chris Holm, David Neiman, Linda Fayler and Kent Fletcher. NANOOS: Murray Levine, Mike Kosro, Anne Dorkins and David Langner.

INTRODUCTION

21st century integrated ocean observing programs will allow for near real-time measurement of the ocean-atmosphere system. These observations drive basic research, which in turn improves our ability to model and forecast climate, weather, and ocean conditions. At present major ocean observatory infrastructure programs exist in Canada, Japan, Australia and Europe and are under construction in China and South Korea.

The United States has a number of ocean observing programs aimed at understanding changes within our coastal and ocean environments, including the Integrated Ocean Observing System (IOOS®) and the Ocean Observatories Initiative (OOI).

The Intergrated Ocean Observing System

IOOS® comprises a coastal component, with a focus on amongst other things climate change, coastal hazards, ecosystem-based management, and maritime operations, and a global component, with a focus on the role of the ocean in climate variability and change. The coastal component is the result of a partnership across 17 federal agencies and 11 Regional Associations. The Northwest Association of Networked Ocean Observing Systems (NANOOS) is the Regional Association for the Pacific Northwest (PNW) (Figure 1).

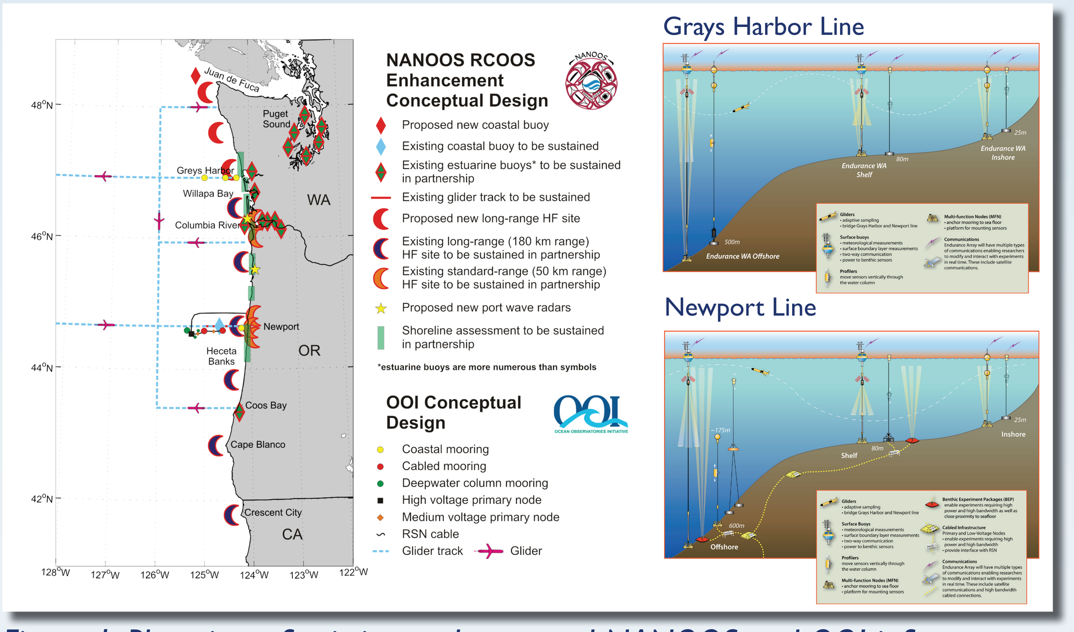


Figure 1: Plan view of existing and proposed NANOOS and OOI infrastructure (left panel) and cross-section views of proposed OOI infrastructure along the Grays Harbor and Newport lines.

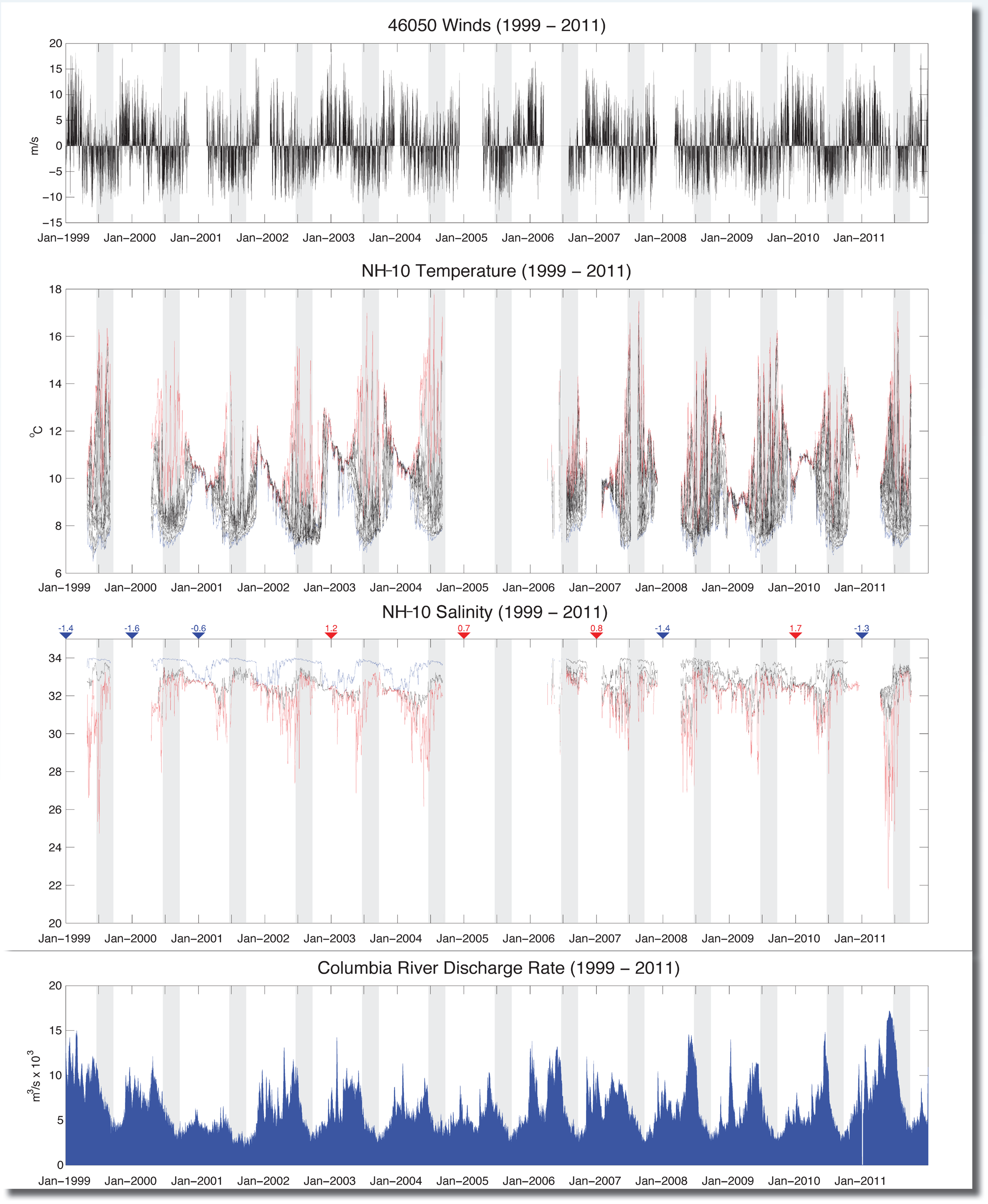


Figure 2: NDBC Buoy 46050 winds for the period 01/1999 to 12/2011 (top panel). Temperature and salinity observations for 01/1999 to 12/2011 derived from NOPP, GLOBEC, OrCOOS and NANOOS/CMOP mooring deployments. The red and blue triangles above the salinity time series show the Oceanic Niño Index for December, January and February for January's that exceed 0.5°C (middle panels). Columbia River discharge at the Beaver Army Terminal, near Quincy, OR for 01/1999 to 12/2011 (lower panel).

The Ocean Observatories Initiative

The OOI, the National Science Foundation's contribution to IOOS®, is an integrated science-driven system that will measure physical-biogeochemical variables in the ocean and seafloor on coastal, regional and global scales. The OOI will deliver data and data products to research communities that will help address large-scale science issues from climate to ecosystem health to sea floor dynamics and water column processes. The PNW component of the coastal observatory, called the Endurance Array (EA) and operated by Oregon State University (OSU), will place a series of long-term moorings off the PNW coast (Figure 1). It will include a network of undersea gliders that can be programmed to patrol the near-shore waters, collect a variety of data and transmit these data to shore in near real-time.

This poster describes how NANOOS and OOI EA infrastructure can be used to track and study, in near real-time, the space/time evolution of the Columbia River plume and associated low-salinity events along the Oregon coast. The location of plume water is important to Oregon-Washington shelf ecosystems as it affects sediment deposition, nutrient concentrations as well as circulation and stratification (Hickey et al., 2005).

OBSERVATIONS & DISCUSSION

Annually, during spring, relatively fresh water is frequently observed off the central Oregon coast advected south from the Columbia River by upwelling favorable winds (Figure 2). From mid-May through July 2011, extreme Columbia River discharge, associated with an anomalously high snowpack (Figure 3), ranged from 14,000-16,000 m^3/s (Figure 2). This freshwater discharge was detected 180 km south of the river mouth off Newport, OR, where salinity values of 22 were recorded, the lowest recorded values since sustained mooring observations began in 1999 (Figure 2).

On 9 July 2011 MODIS/Aqua 555 nm remote sensing reflectance (R_{rs}) measurements show plume water that was advected south (Figure 4, left) by upwelling favorable winds (Figure 5) and surface currents (Figure 4, left) 45 km west of Newport, OR at approximately 124.6°W. A wind reversal to mostly southerly winds for the period 10-18 July 2011 (Figure 5, shaded region) resulted in the onshore movement of this plume water.

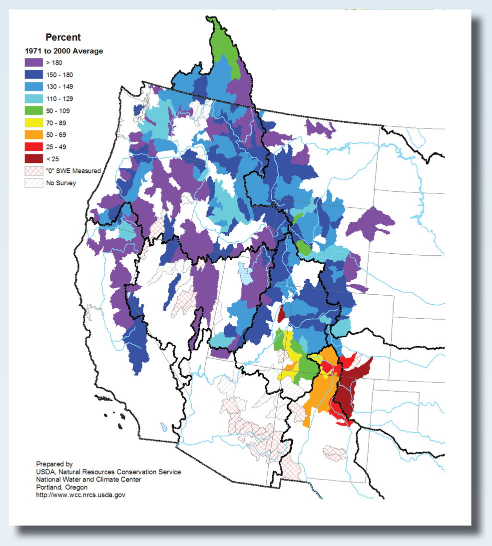


Figure 3: Mountain snowpack across the western United States on 1 May 2011. All states show snowpacks that are 110 to over 180 percent above normal with the exception of southern Colorado.

This onshore movement was observed by an OSU glider on 12 July 2011 at approximately 124.45°W (Figure 6) and the NH-10 mooring located at 124.3°W (Figure 5). On 13 July 2011 a nearshore OOI test mooring (ISMT2), located approximately 2 km west of Newport, OR, measured the eastward propagating plume water (Figure 5). These observations are corroborated by 13 July 2011 MODIS observations that show the plume water located just west of Newport (Figure 4, right). One day later on 14 July 2011 plume water was observed by the WET Labs LOBO (Land/Ocean Biogeochemical Observatory) System located in the Yaquina Bay estuary (Figure 5). The propagation of this low salinity surface front from NH-10 to inside the Yaquina Bay estuary over the course of approximately 3 days occurred at an average speed of approximately 8 cm/s.

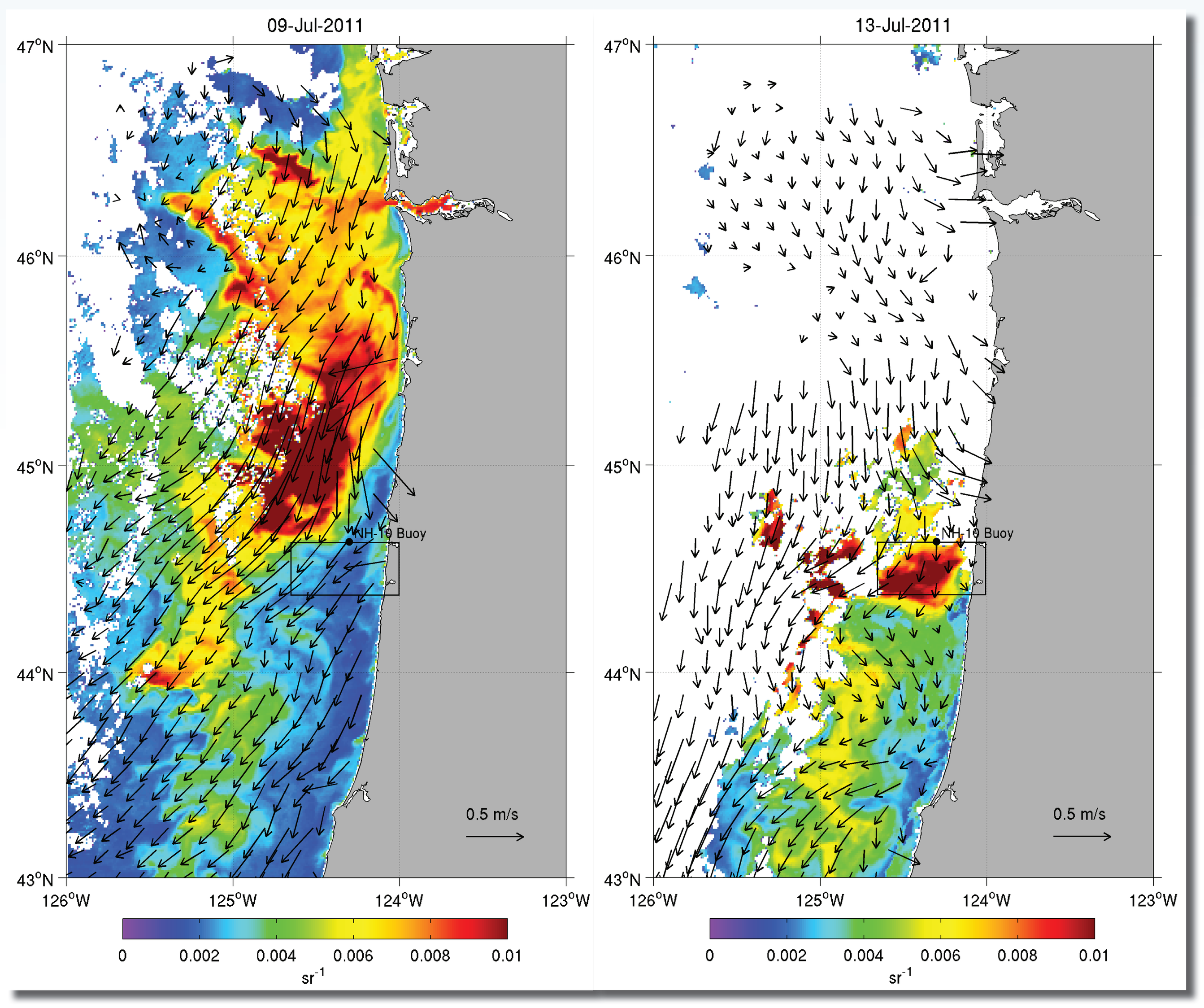
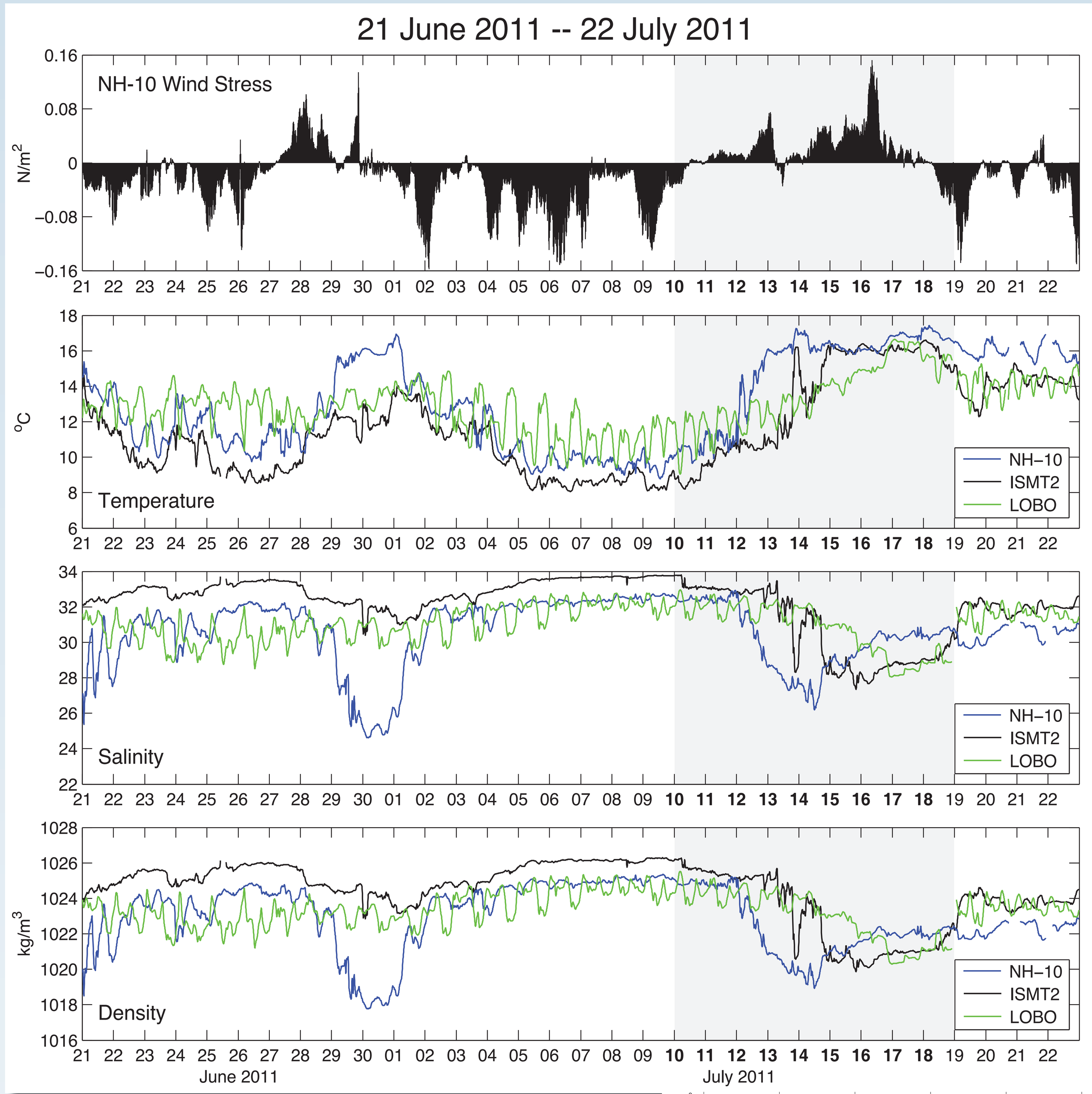


Figure 4: Daily averaged MODIS/Aqua 555 nm R_{rs} measurements, an effective tracer of particulate matter in the water column (Thomas and Weatherbee 2006), for 9 July 2011 (left panel) and 13 July 2011 (right panel) in color. Vectors show daily averaged surface current velocities derived from HF Radar observations. The black box denotes the bounding box of the map associated with Figures 5 and 6.



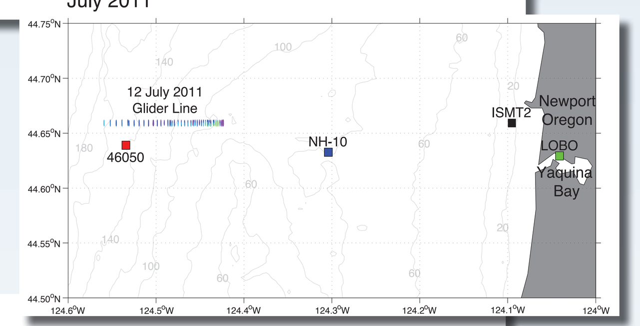


Figure 5: Wind stress at NH-10 (top panel) and surface temperature, salinity and density observations at the NH-10, ISMT2 and LOBO moorings (lower three panels) for the period 21 June - 22 July 2011. The map to the left shows the three mooring locations.

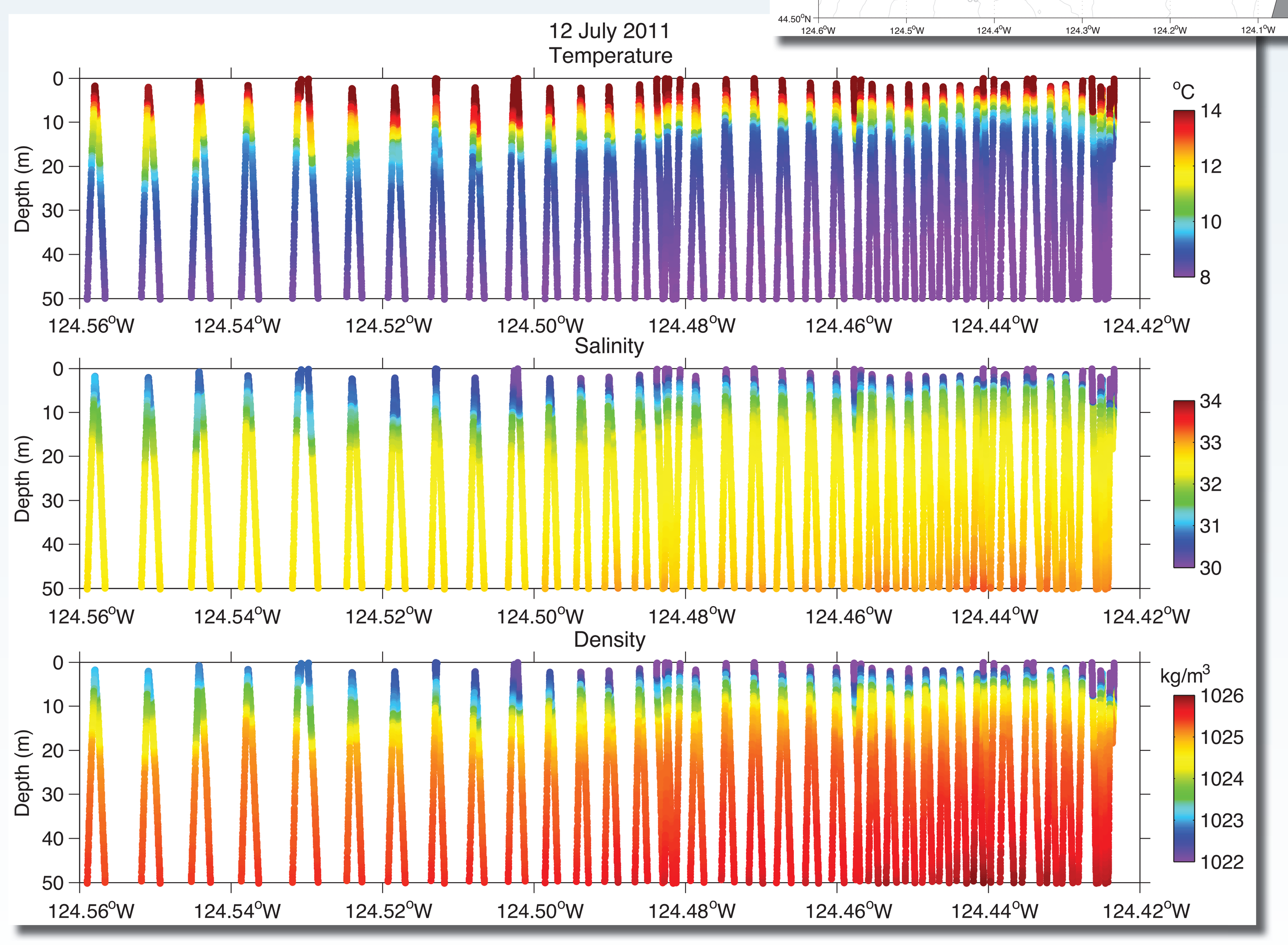


Figure 6: 12 July 2011 profiles of temperature (top panel), salinity (middle panel) and density (lower panel) observations along 44.66°N between 124.56 and 124.42°W (see above map) derived from an OSU Slocum glider.

SUMMARY & CONCLUSIONS

Here we describe current capacity to measure and study, in near real-time, transient phenomena such as the advection of Columbia river plume water off the central Oregon coast, a phenomenon that affects sediment deposition, nutrient concentrations as well as circulation and stratification.

Looking forward, our ability to monitor and forecast transient phenomena such as is described here, seasonal phenomena such as coastal hypoxia as well as annual and inter-annual changes associated with, for example, the Pacific Decadal Oscillation and the El Niño Southern Oscillation will be greatly enhanced with the forthcoming OOI EA glider deployments, scheduled for June 2012, as well as the deployment of the OOI Newport and Grays Harbor mooring lines (Figure 1). The planned build out of NANOOS infrastructure over the next 10 years, which includes expanding the HF RADAR array to include the Washington coast, will further enhance our ability to monitor and forecast ocean conditions.

oceanobservatories.org

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