

Using Autonomous Underwater Gliders to Observe Continental Margins and Oceanic Boundary Currents

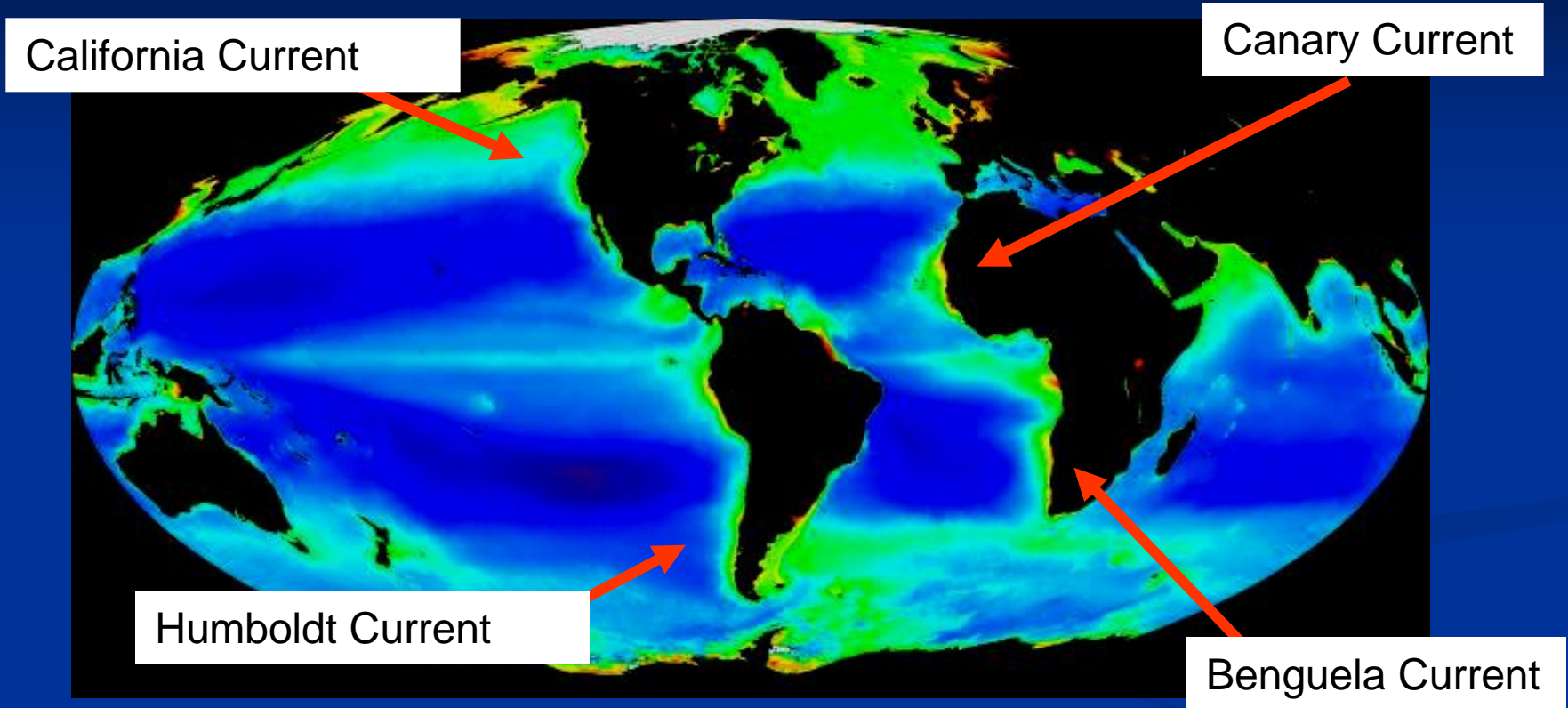
Jack Barth

College of Earth, Ocean, and
Atmospheric Sciences



PICES W4 Workshop
Yeosu, Republic of Korea
October 17, 2014

Coastal Upwelling Ecosystems

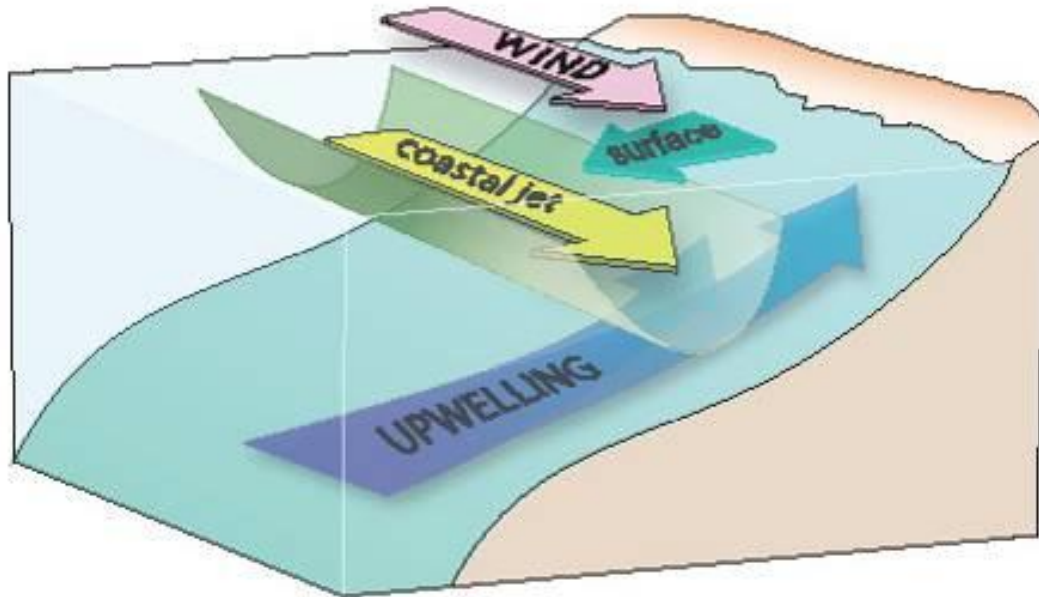
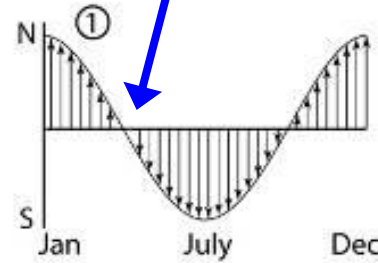


1% of surface area, but > 20% of wild caught seafood

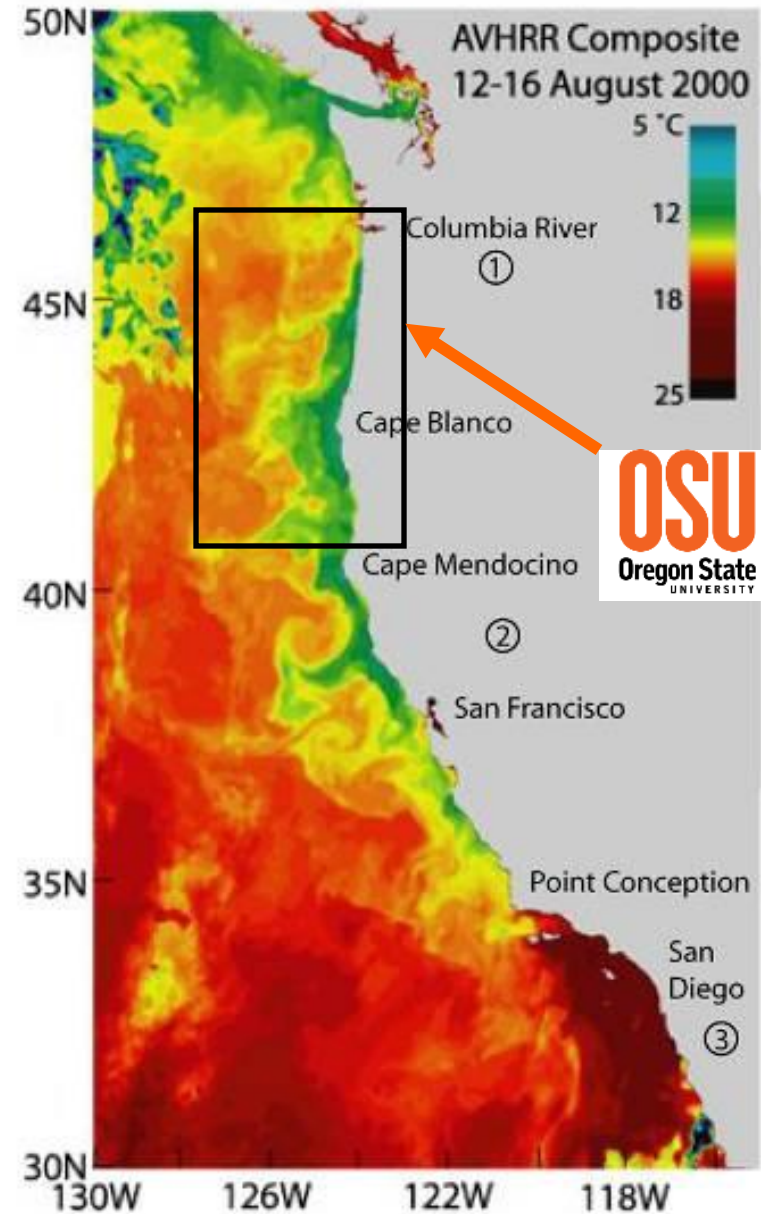
upwelling

Seasonal cycle of winds

spring transition



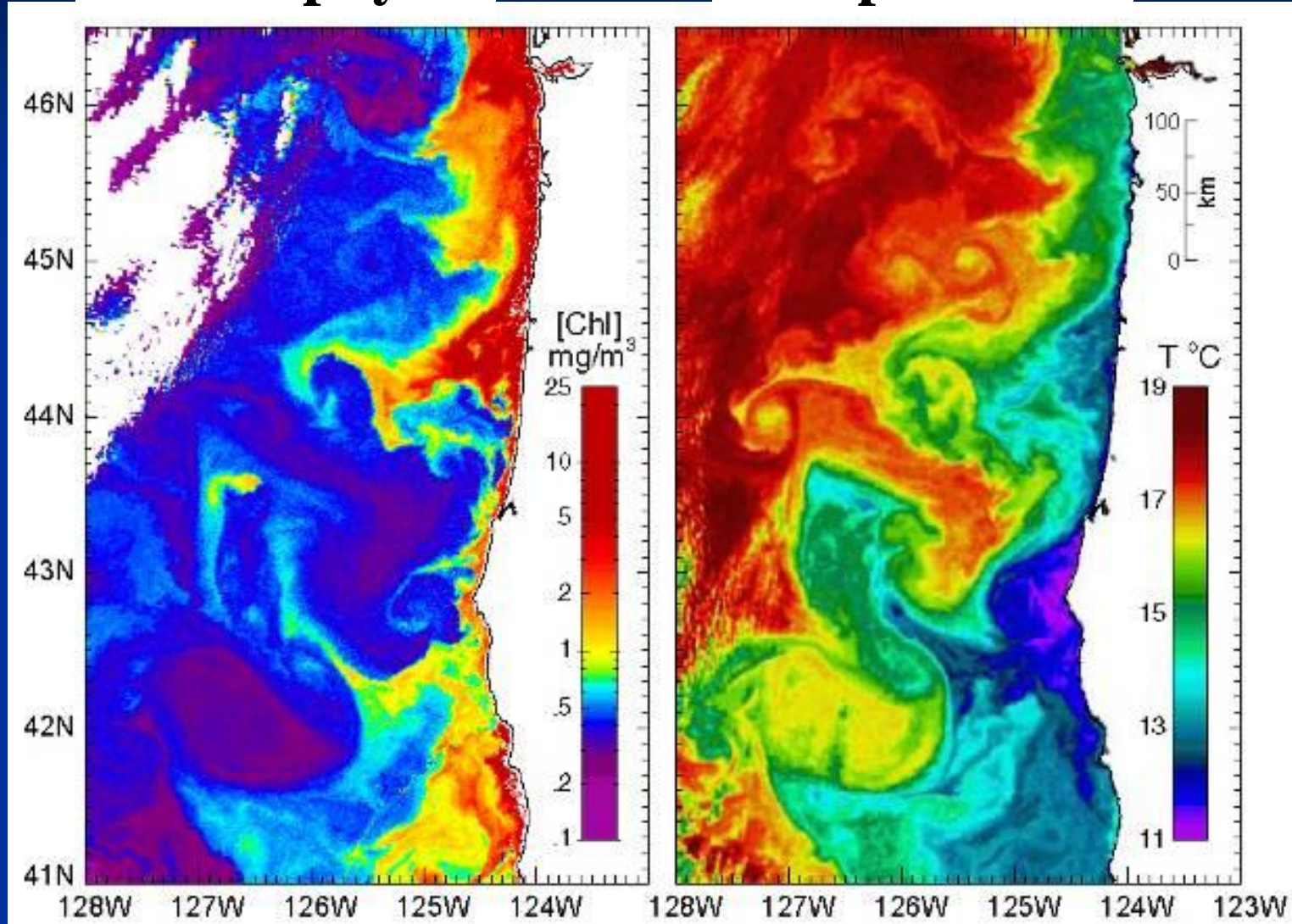
Sea-surface temperature



wind-driven upwelling drives ocean productivity

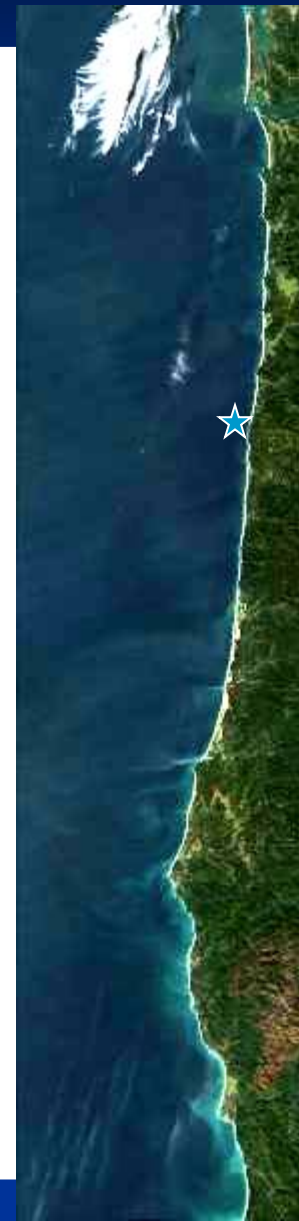
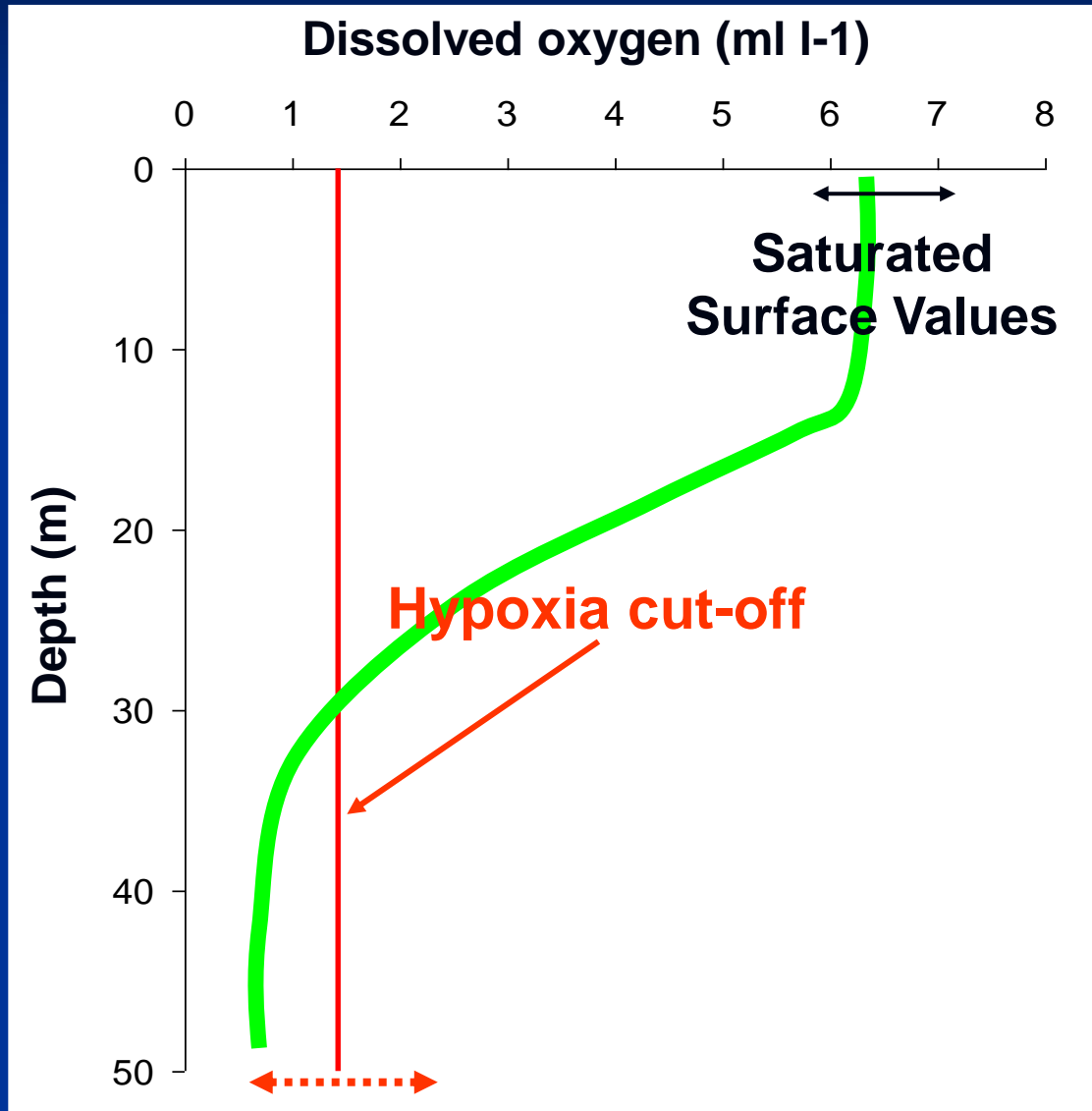
chlorophyll

temperature



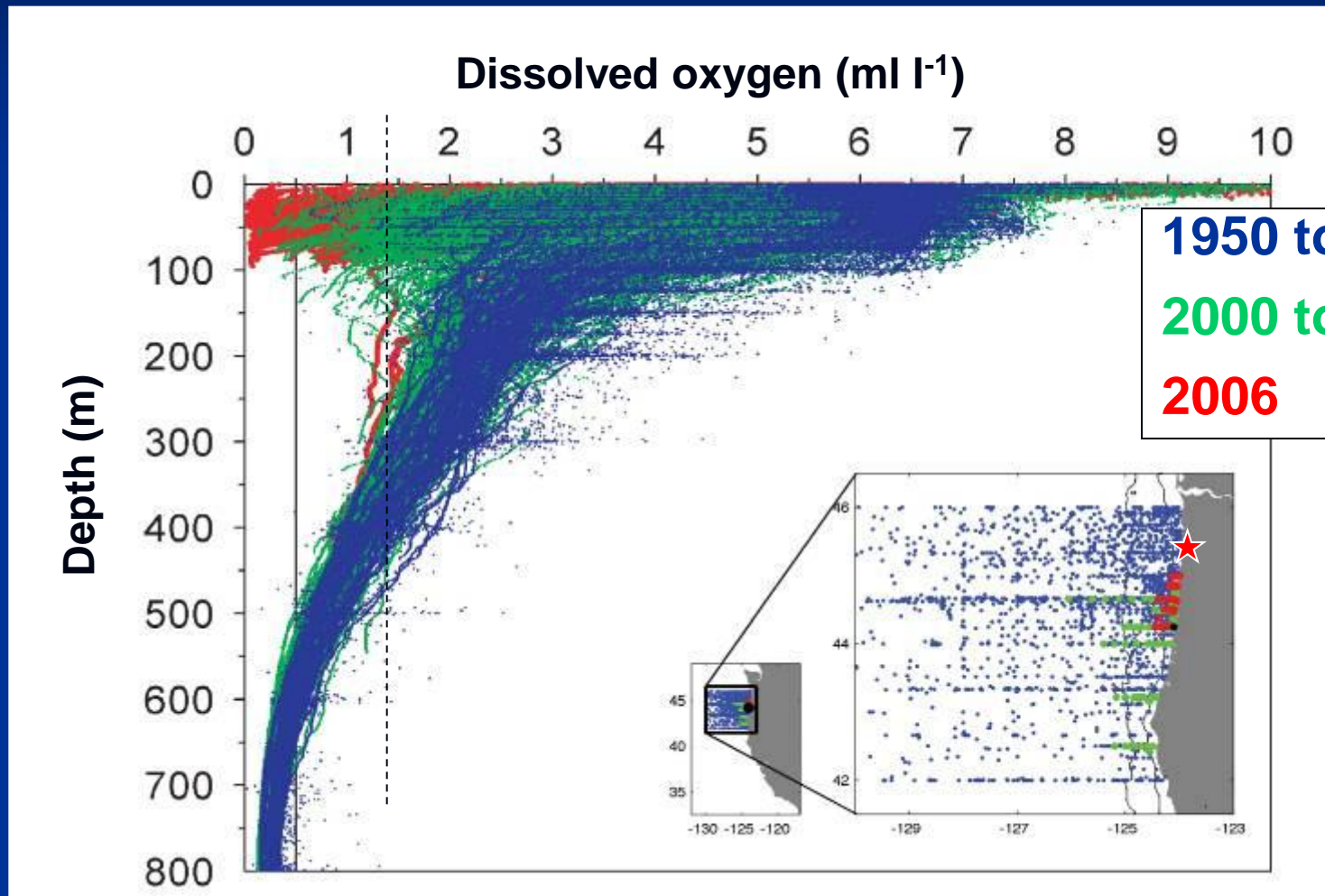
Courtesy of Ted Strub (OSU)

Off Oregon, hypoxia develops on the open continental shelf



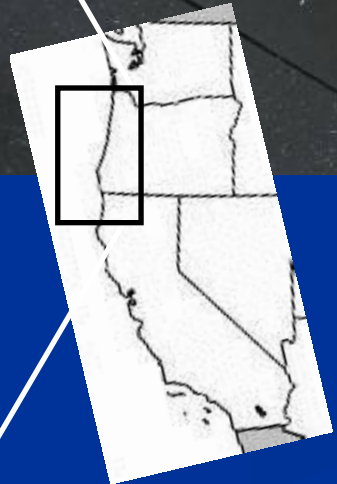
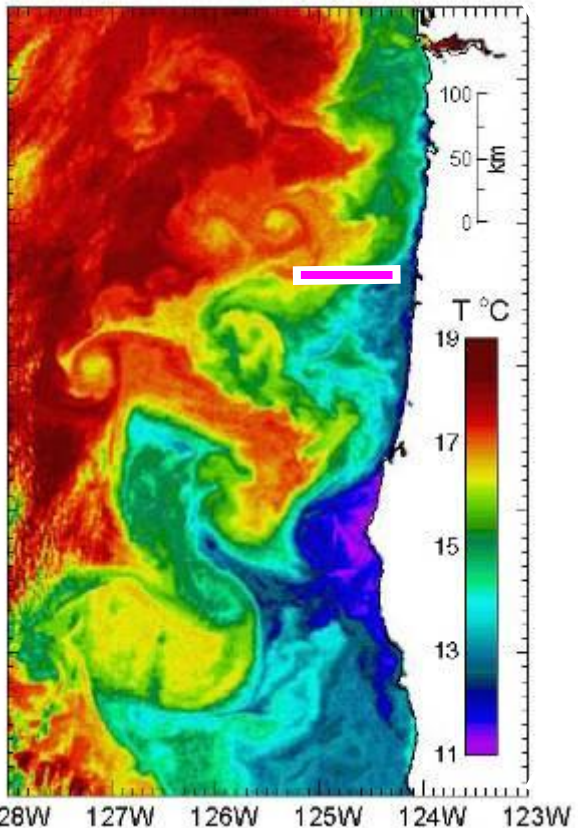
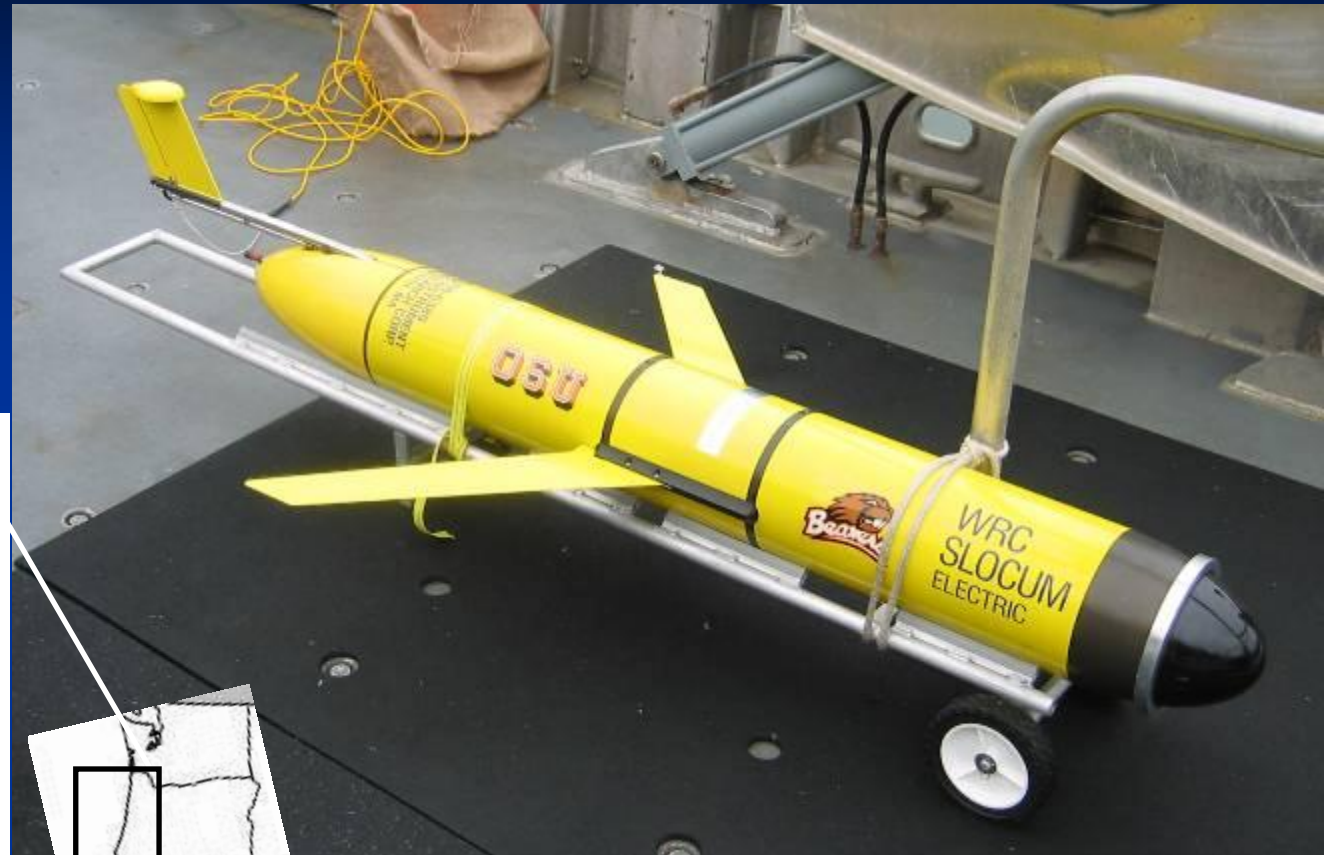
Subsurface ocean observations off Newport for the last ~60 years

N ~ 4000 hydrocasts



Autonomous Underwater Vehicle Gliders

cross-margin
transect twice
per week
since April
2006



CTD
dissolved oxygen
chlorophyll fluorescence
CDOM fluorescence
light backscatter
depth-averaged velocity

Autonomous Underwater Glider

GPS, Iridium and Freewave Antennae in tail fin

Aanderaa Optical Dissolved Oxygen sensor

Glider Control and more batteries

Science Bay

Air bladder

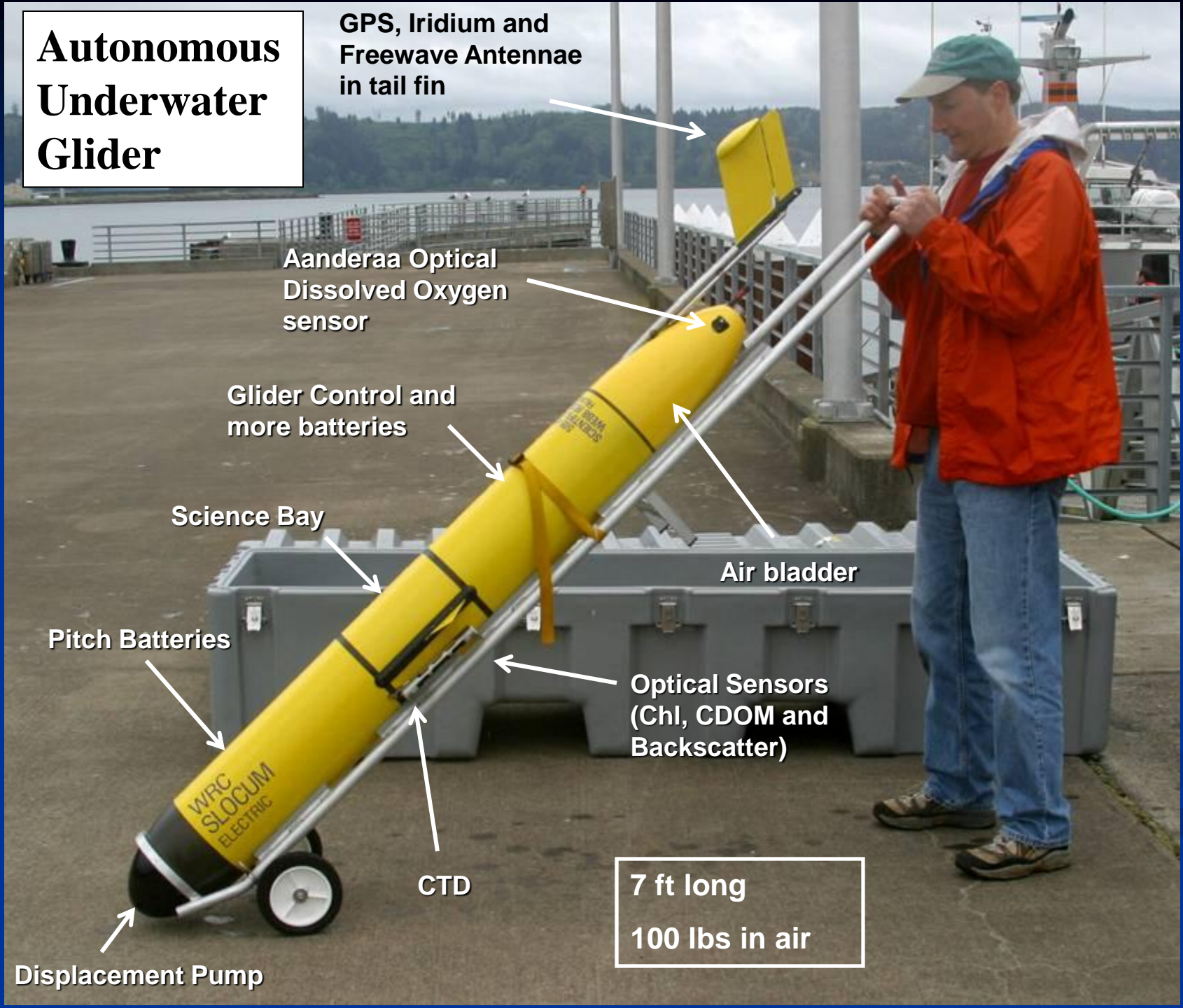
Pitch Batteries

Optical Sensors (Chl, CDOM and Backscatter)

CTD

7 ft long
100 lbs in air

Displacement Pump



University of Washington “Seaglider”

424

IEEE JOURNAL OF OCEANIC ENGINEERING, VOL. 26, NO. 4, OCTOBER 2001

Seaglider: A Long-Range Autonomous Underwater Vehicle for Oceanographic Research

Charles C. Eriksen, T. James Osse, Russell D. Light, Timothy Wen, Thomas W. Lehman, Peter L. Sabin,
John W. Ballard, and Andrew M. Chiodi



Glider operations from just about any size boat

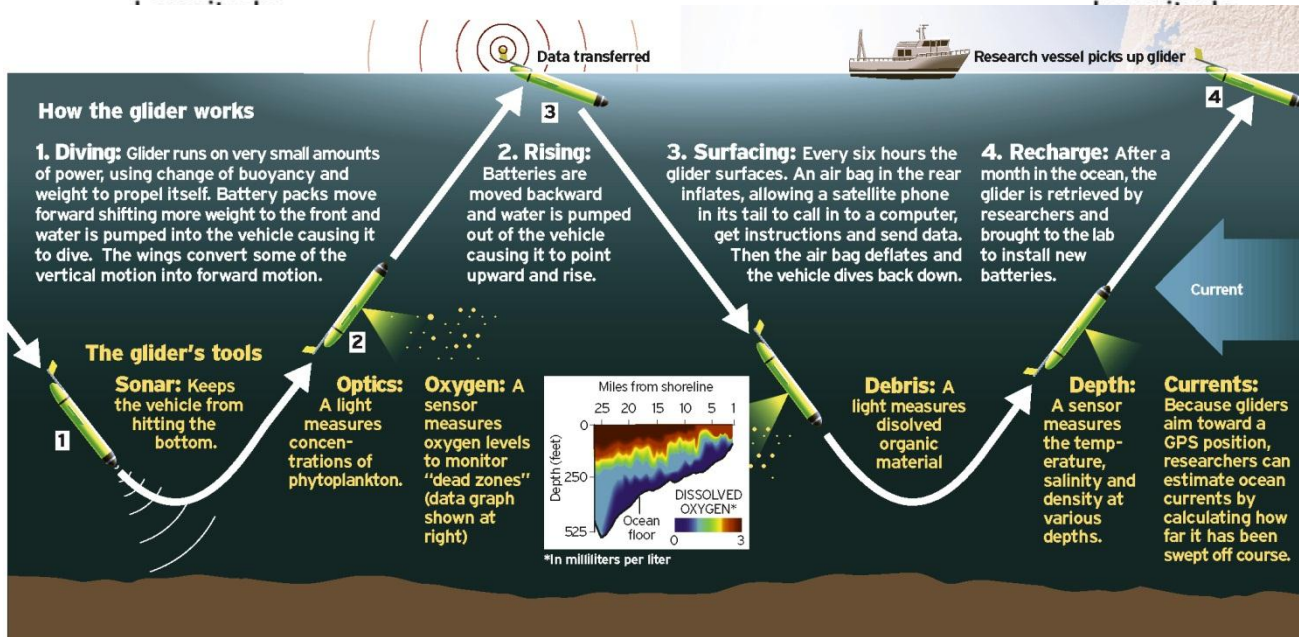
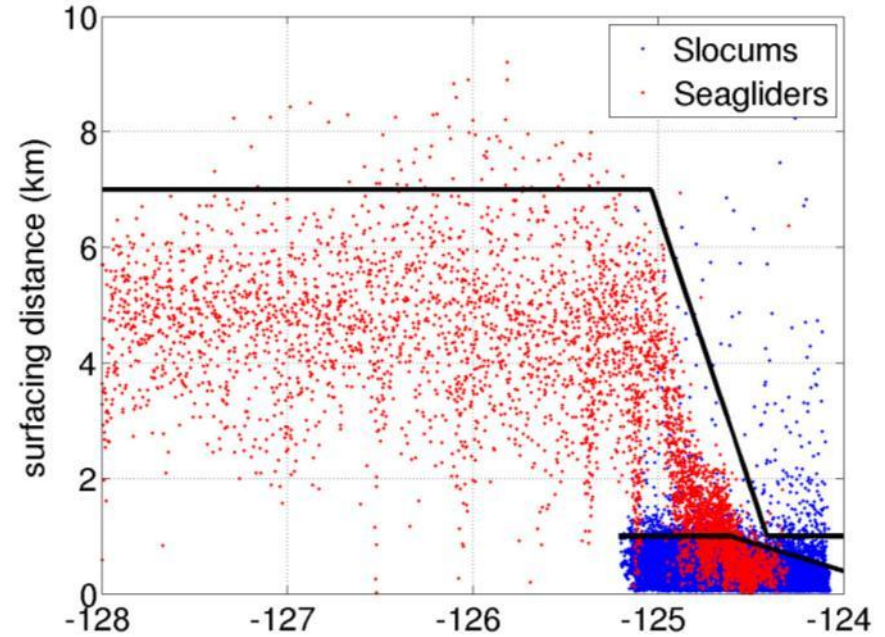
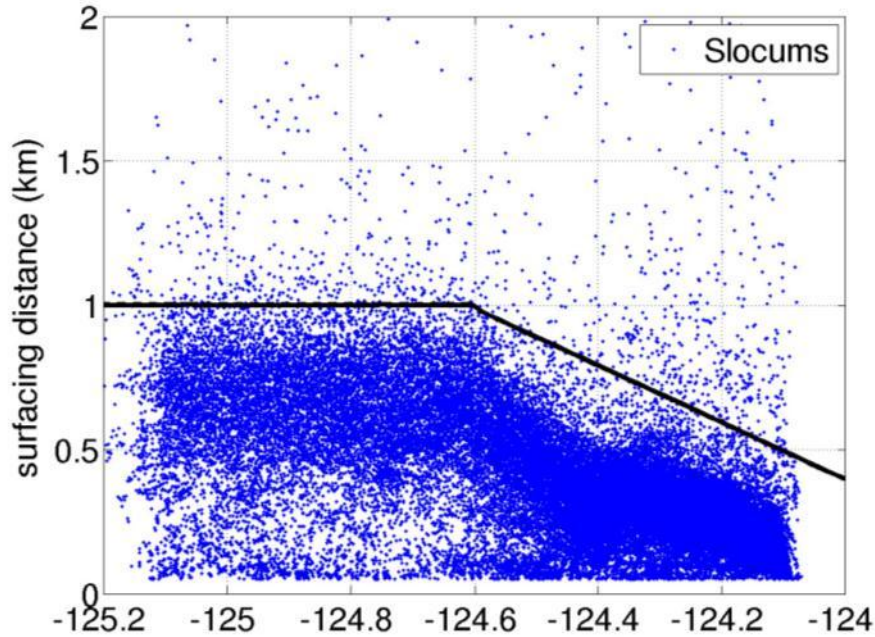
OSU's 16-m R/V Elakha



from a rowboat off Chile

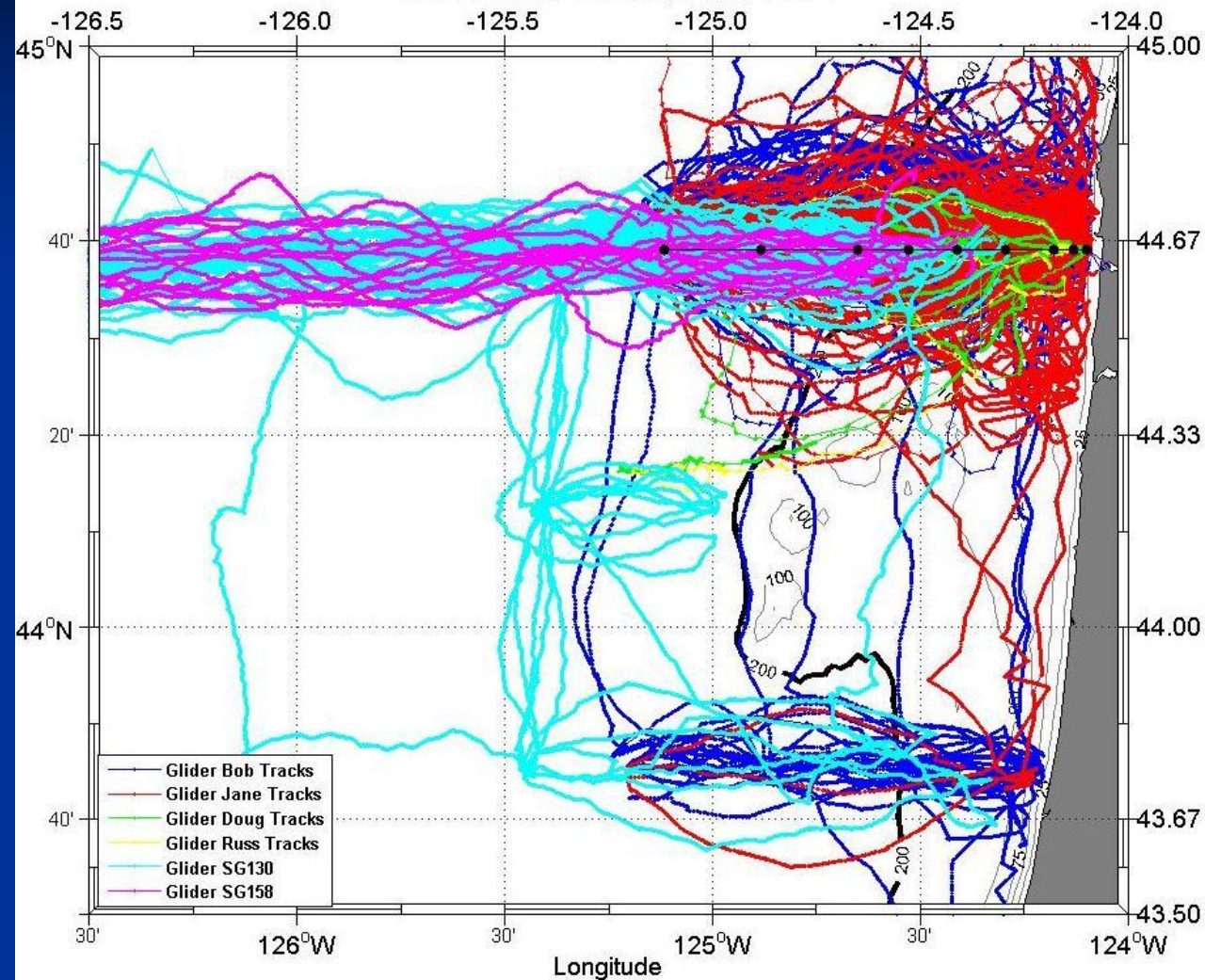


Horizontal resolution



OSU Glider Operations

OSU Glider Tracks, 2006-2014



April 2006–Sep 2014

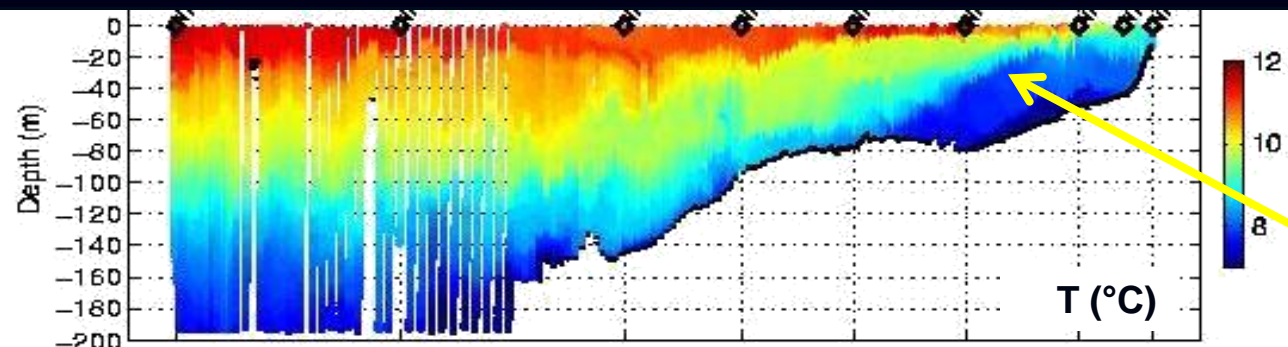
3485 glider-days

260,190 vertical profiles

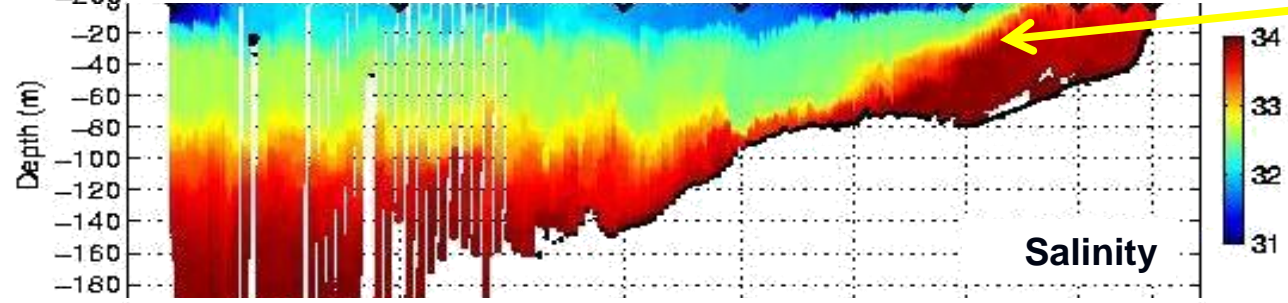
82,000+ km

Over twice around
the Earth!

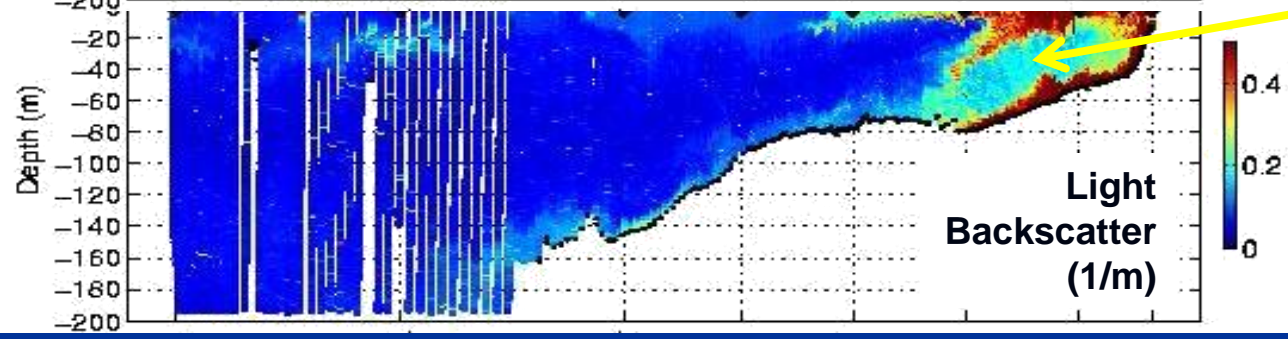
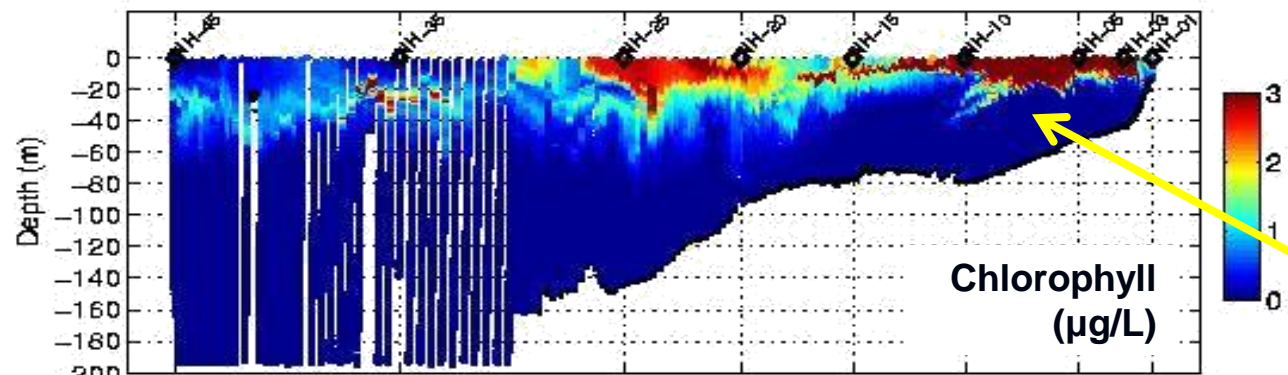
May 05 – 10, 2006



A temperature & salinity "front"

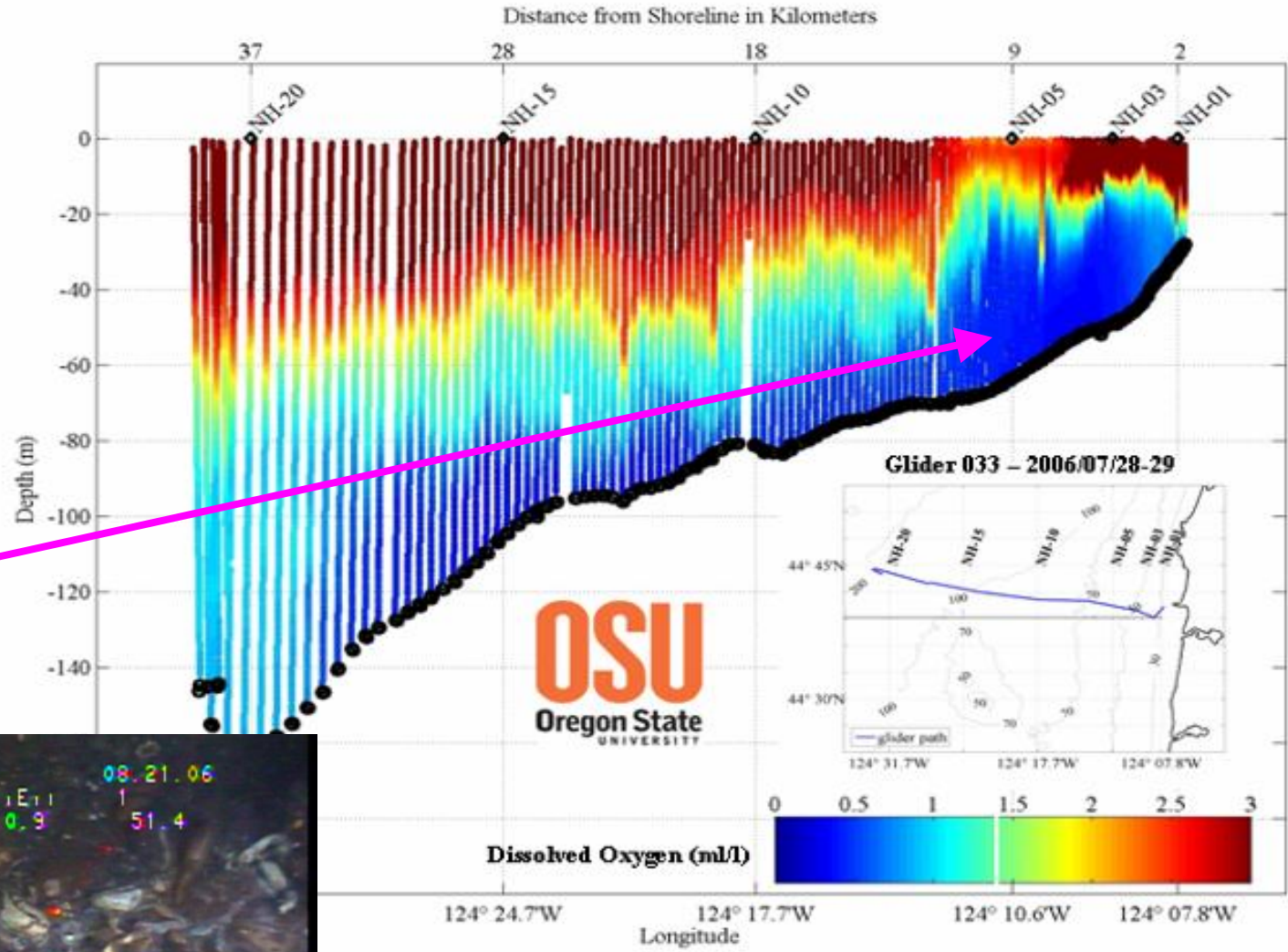


A "hotspot" for phytoplankton



Dissolved Oxygen from glider

Hypoxia



July 2006

Barth et al. (in prep)

glider “bob” in the January 18-19, 2012 storm

Yaquina Bay Bridge (AP photo)



November 28, 2001

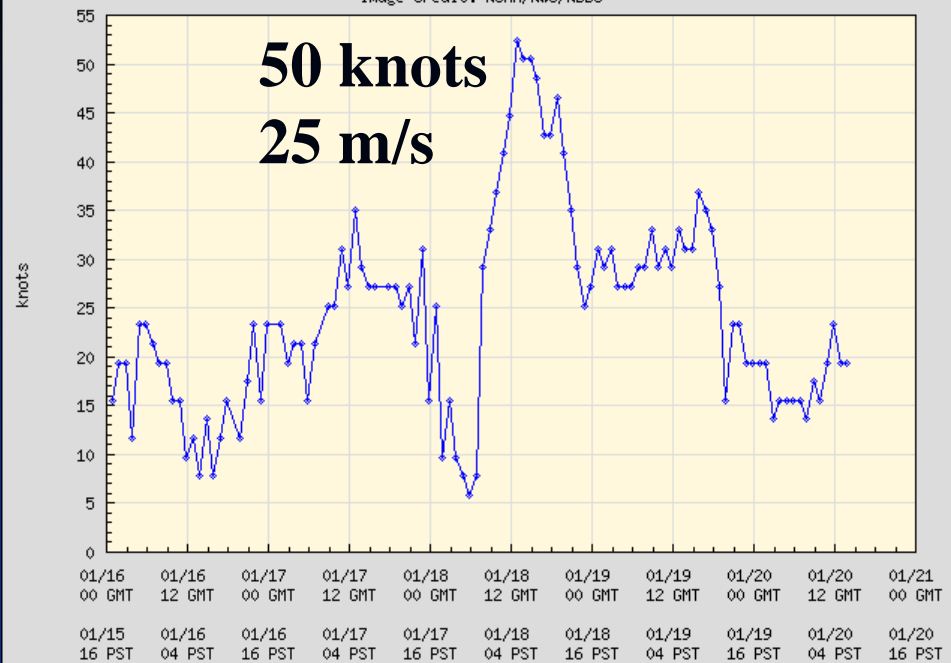


NOAA Buoy 46050

wind speed (knots)

wave height (feet)

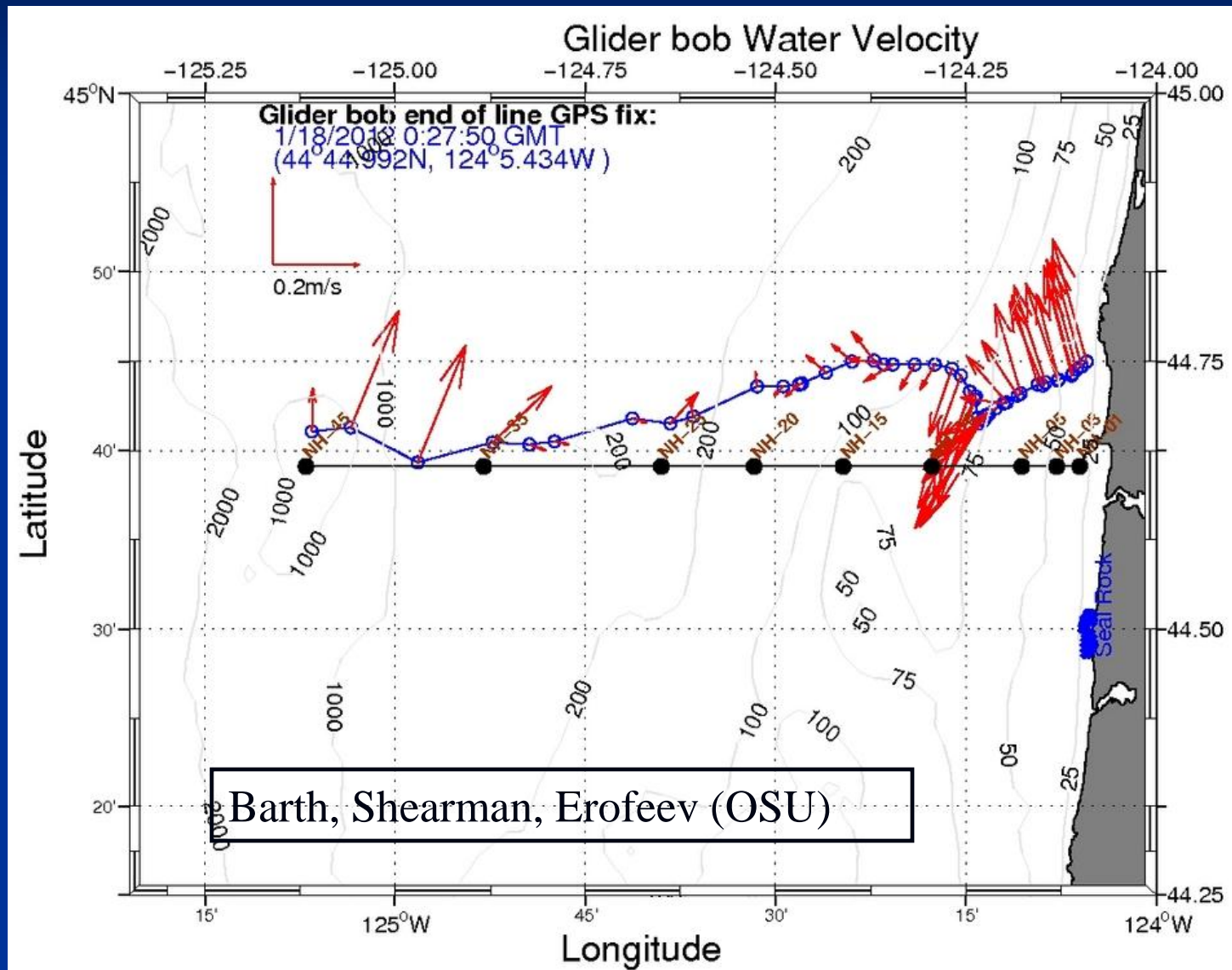
Wind Gust at 46050
Image Credit: NOAA/NWS/NDBC



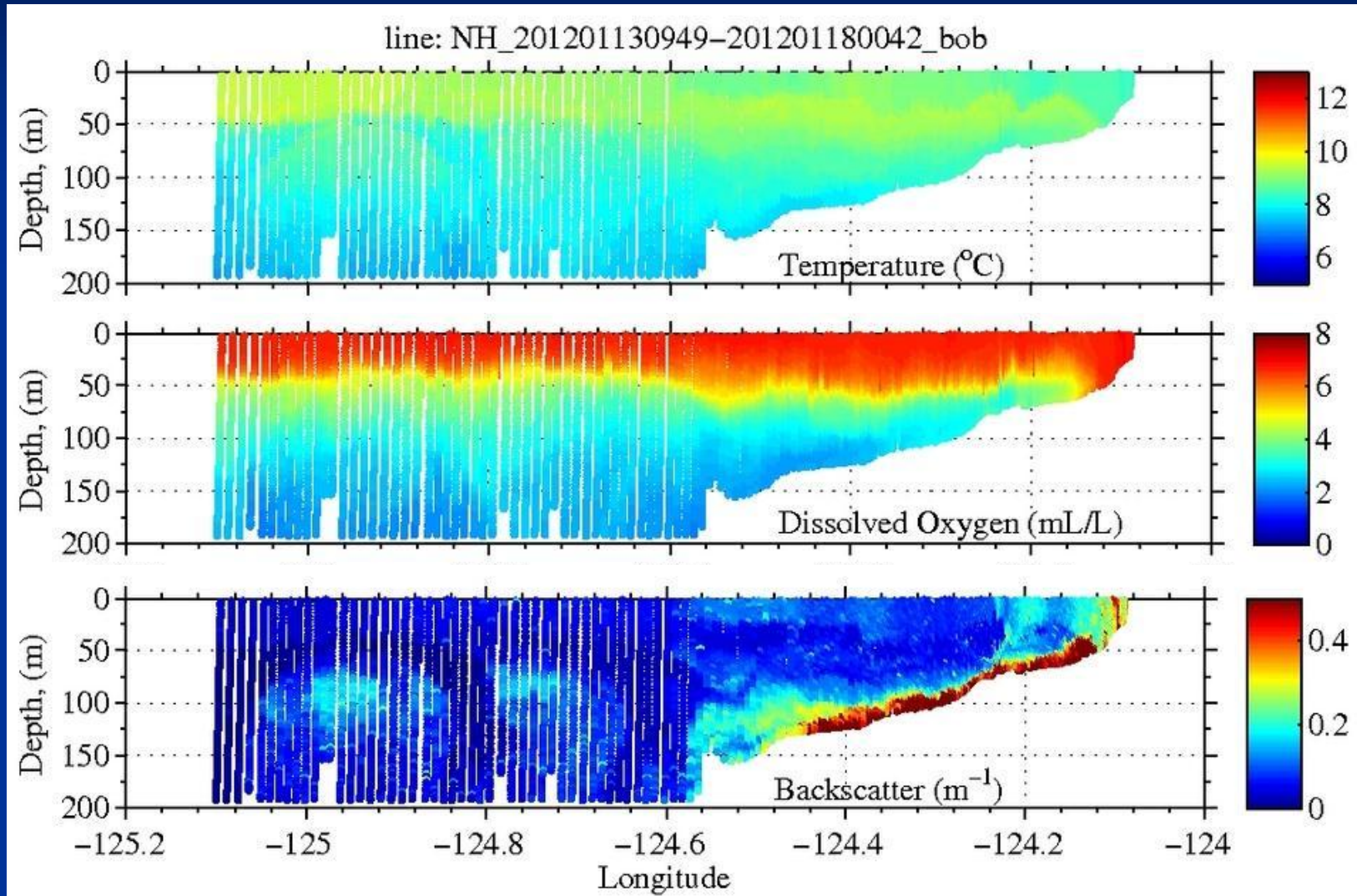
Significant Wave Height at 46050
Image Credit: NOAA/NWS/NDBC



glider “bob” approaches shore and gets carried north in the January 18-19, 2012, storm

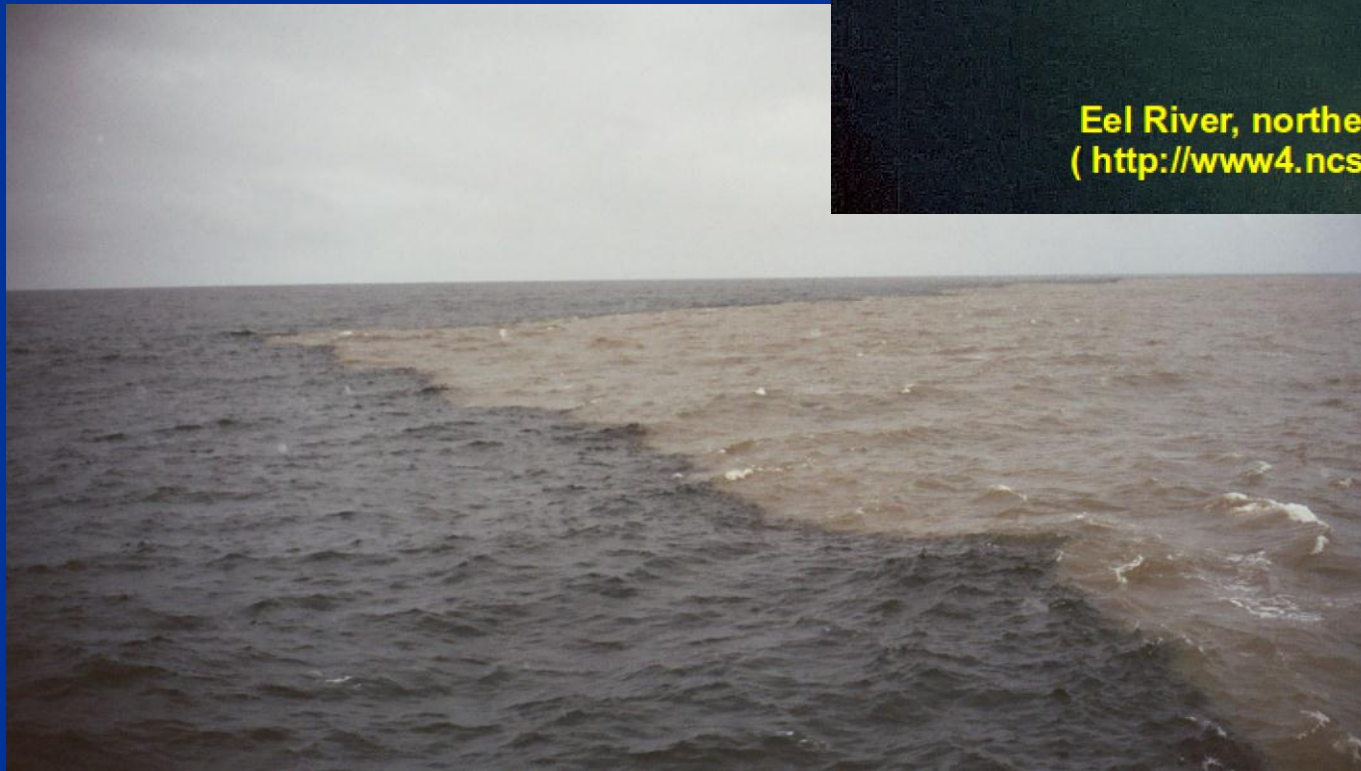


oceanographic data from across the shelf in 30-foot (~10 m) seas!



Let's take a closer look at freshwater forcing

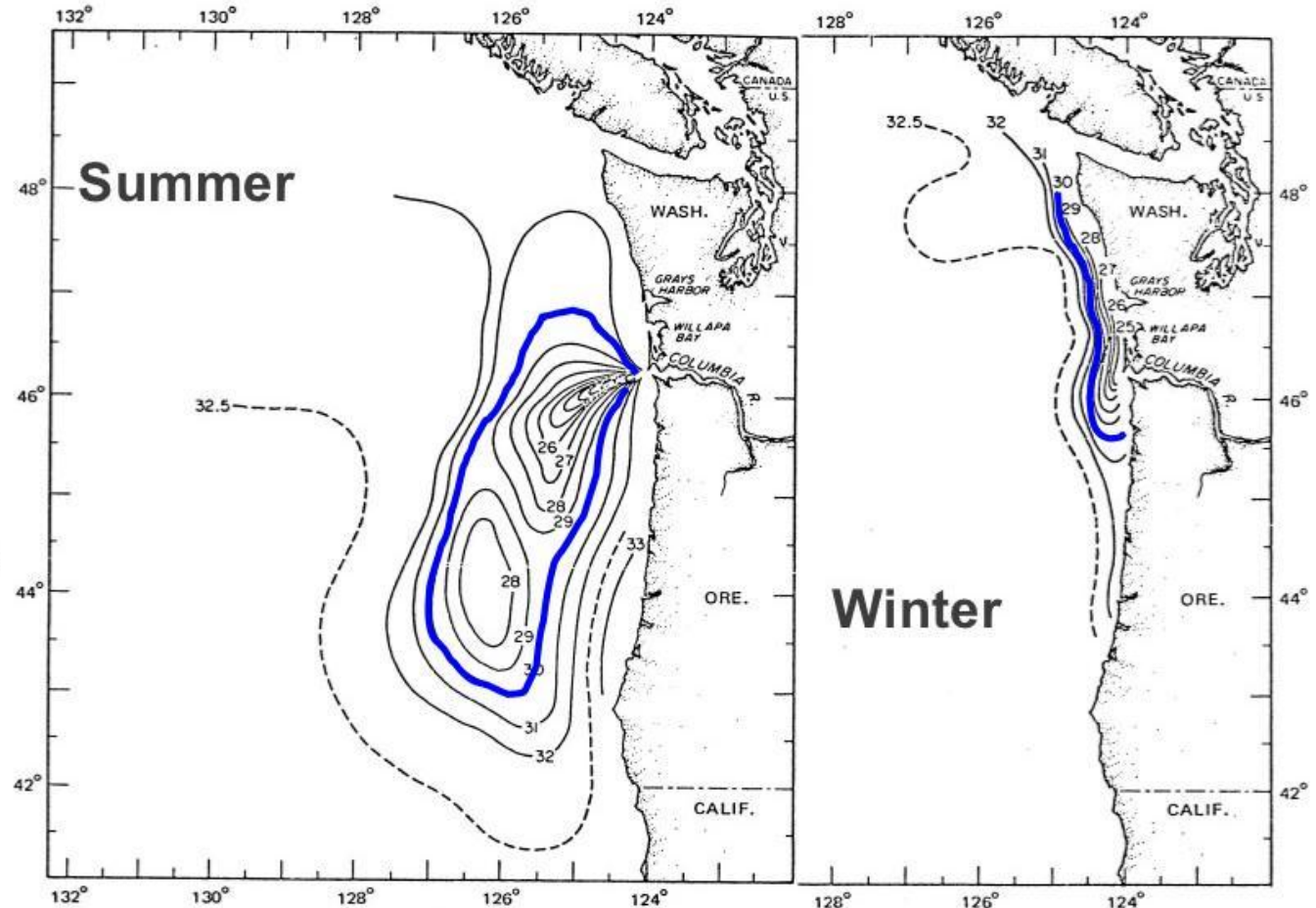
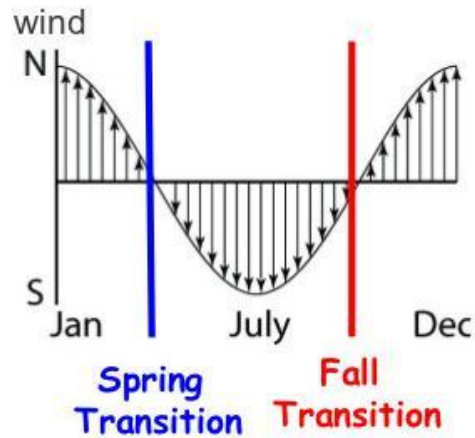
**Siletz River,
central Oregon coast**



**Eel River, northern CA - USA (1974).
(<http://www4.ncsu.edu/~elleitho/>)**

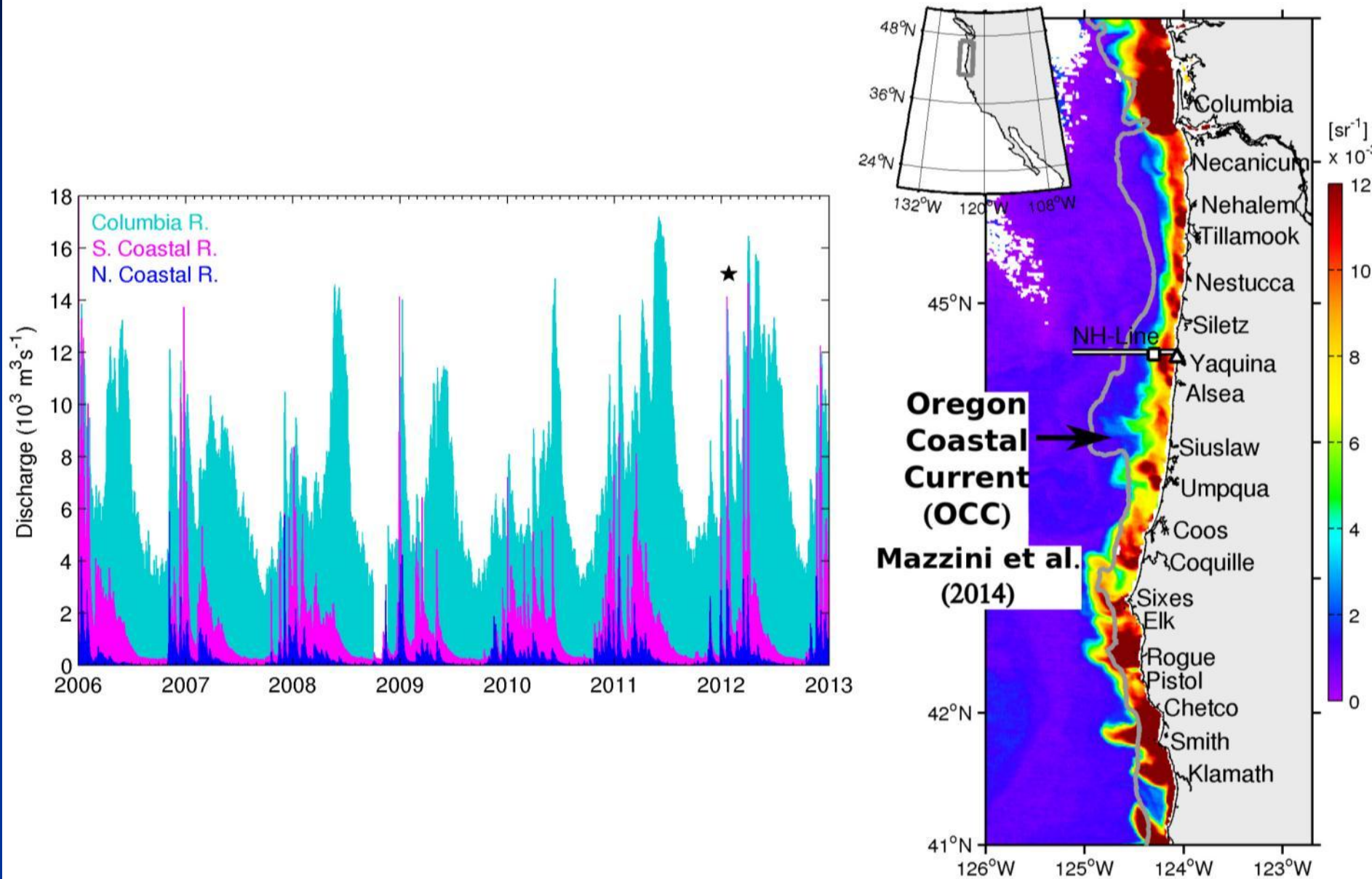
**Photo by
J. Barth**

Columbia River – largest river on US west coast

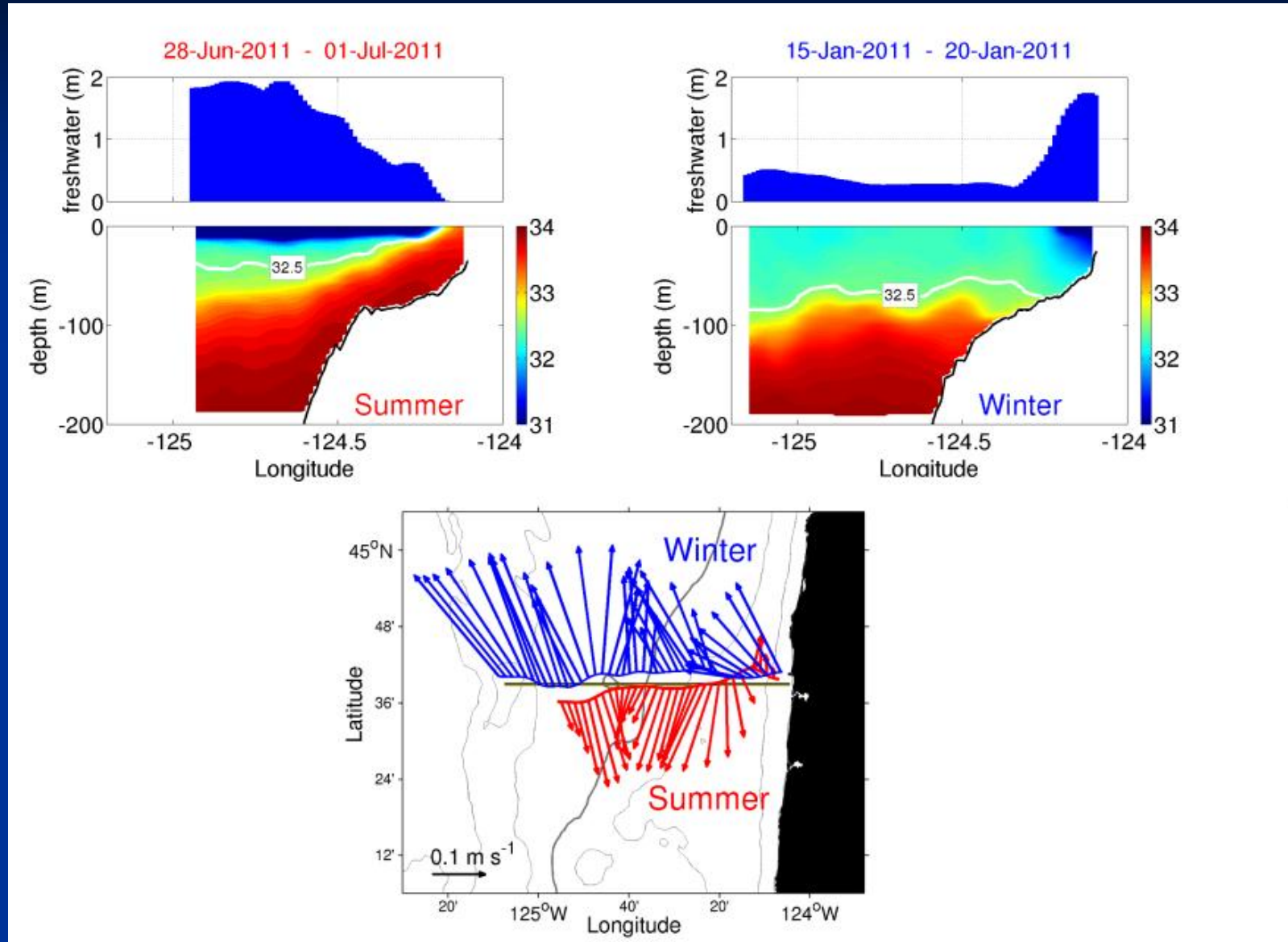


Barnes *et al.* (1972)

The Oregon Coastal Current (OCC)



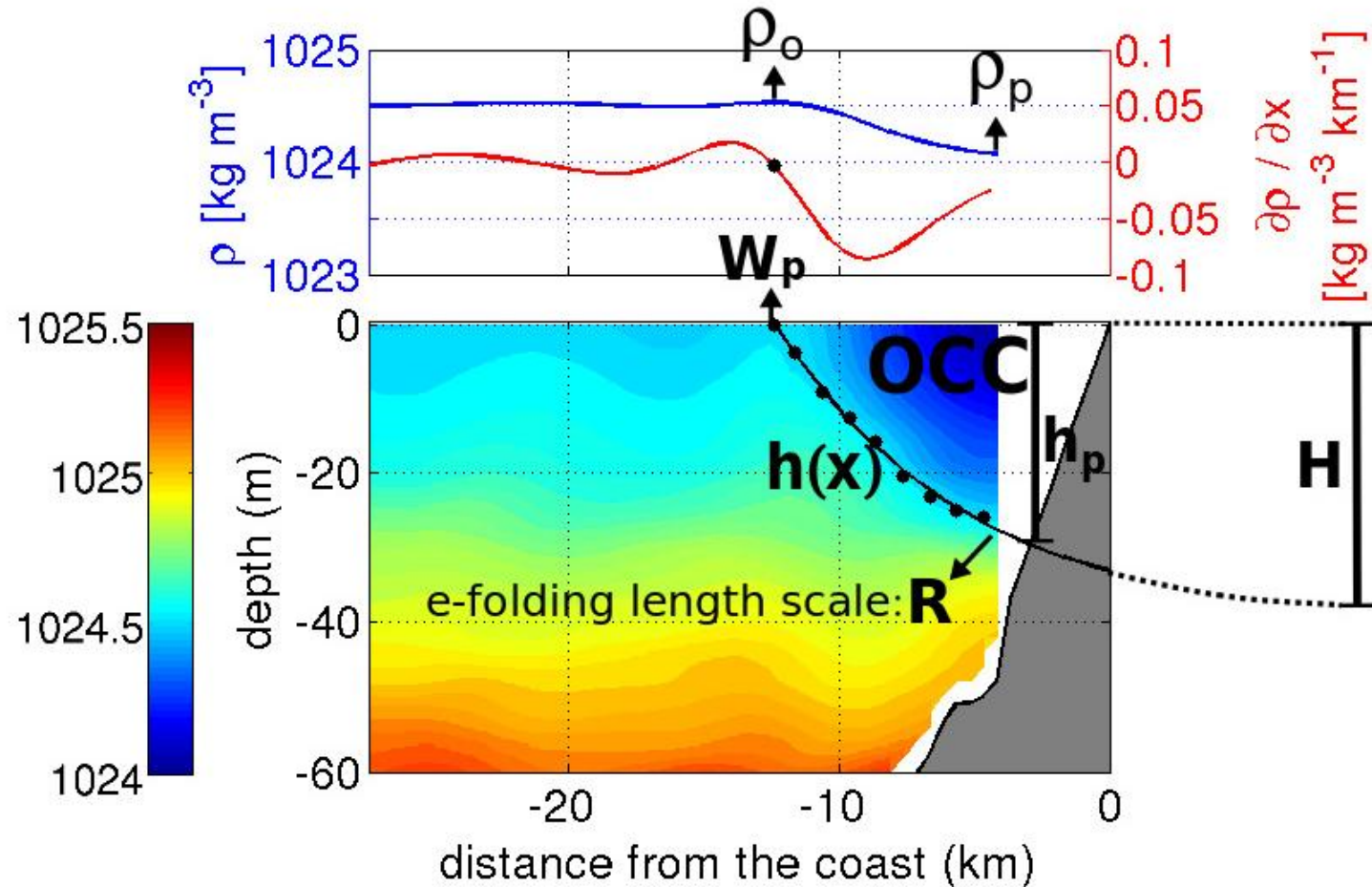
Example glider lines: summer vs. winter



Mazzini, Barth, Shearman and Erofeev (JPO, 2014)

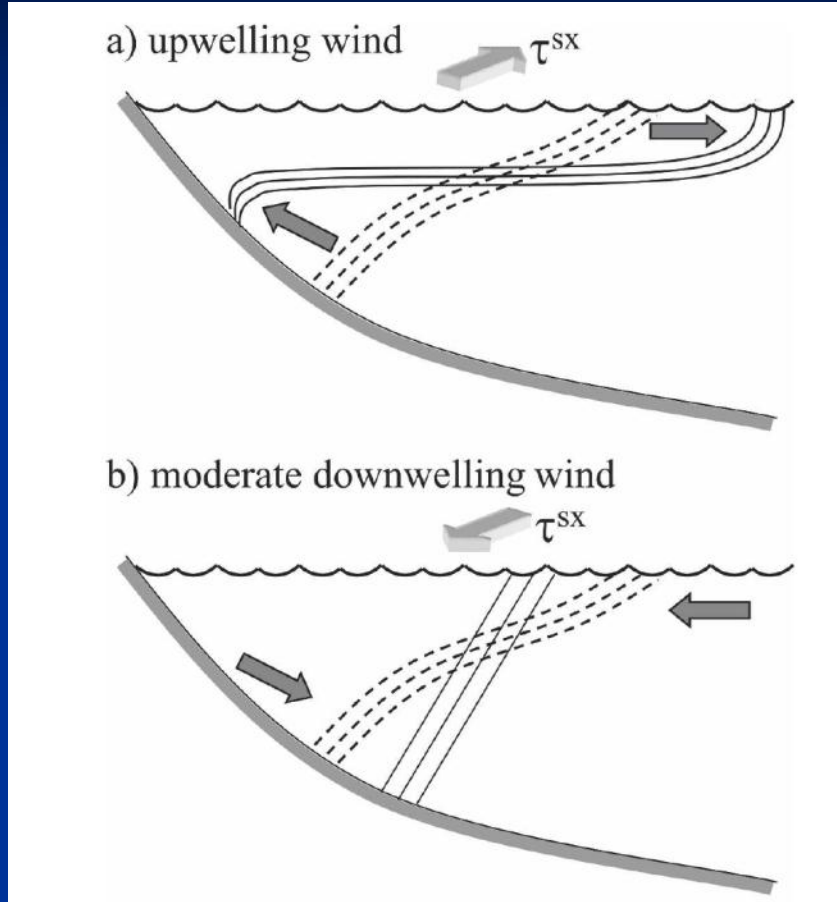
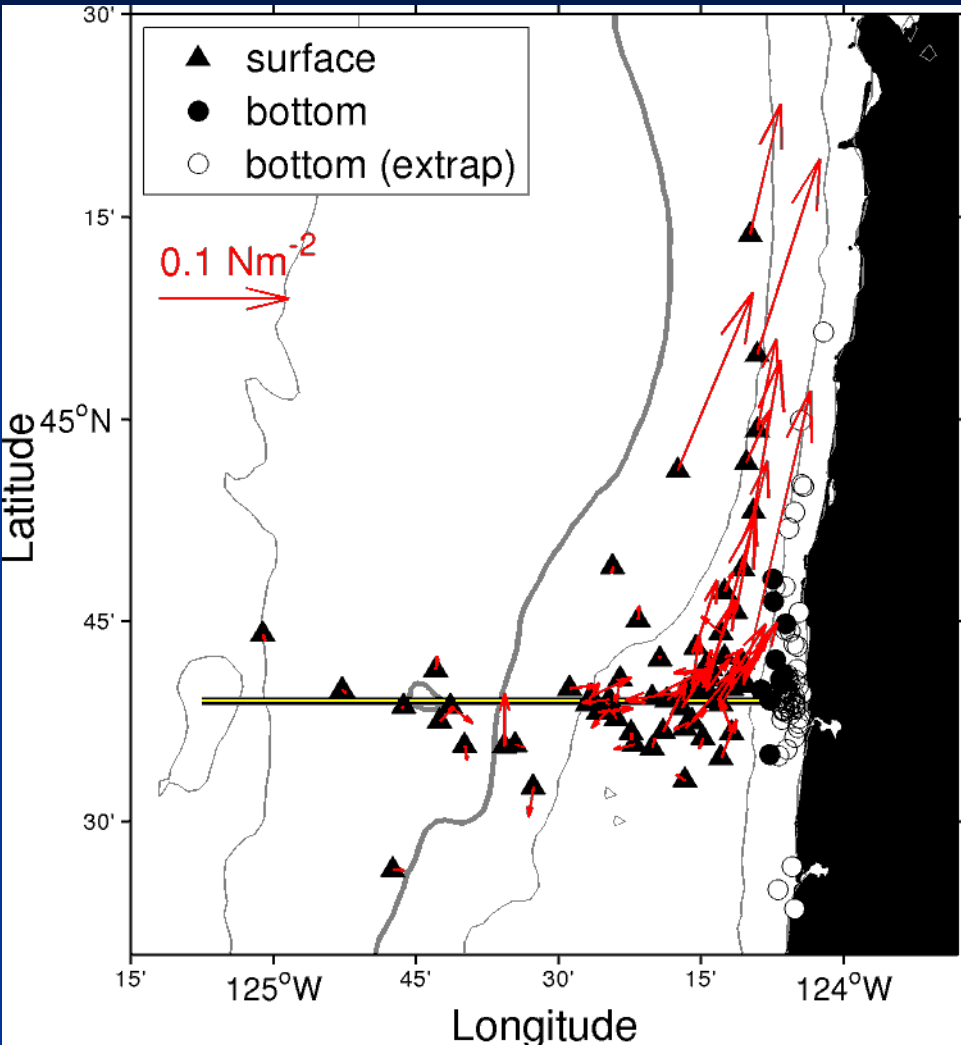
Use glider data to describe buoyancy front/current

Fit: $h(x) = H[1 - e^{-\left(\frac{x+W_p}{R}\right)}]$, finding W_p , R and H .



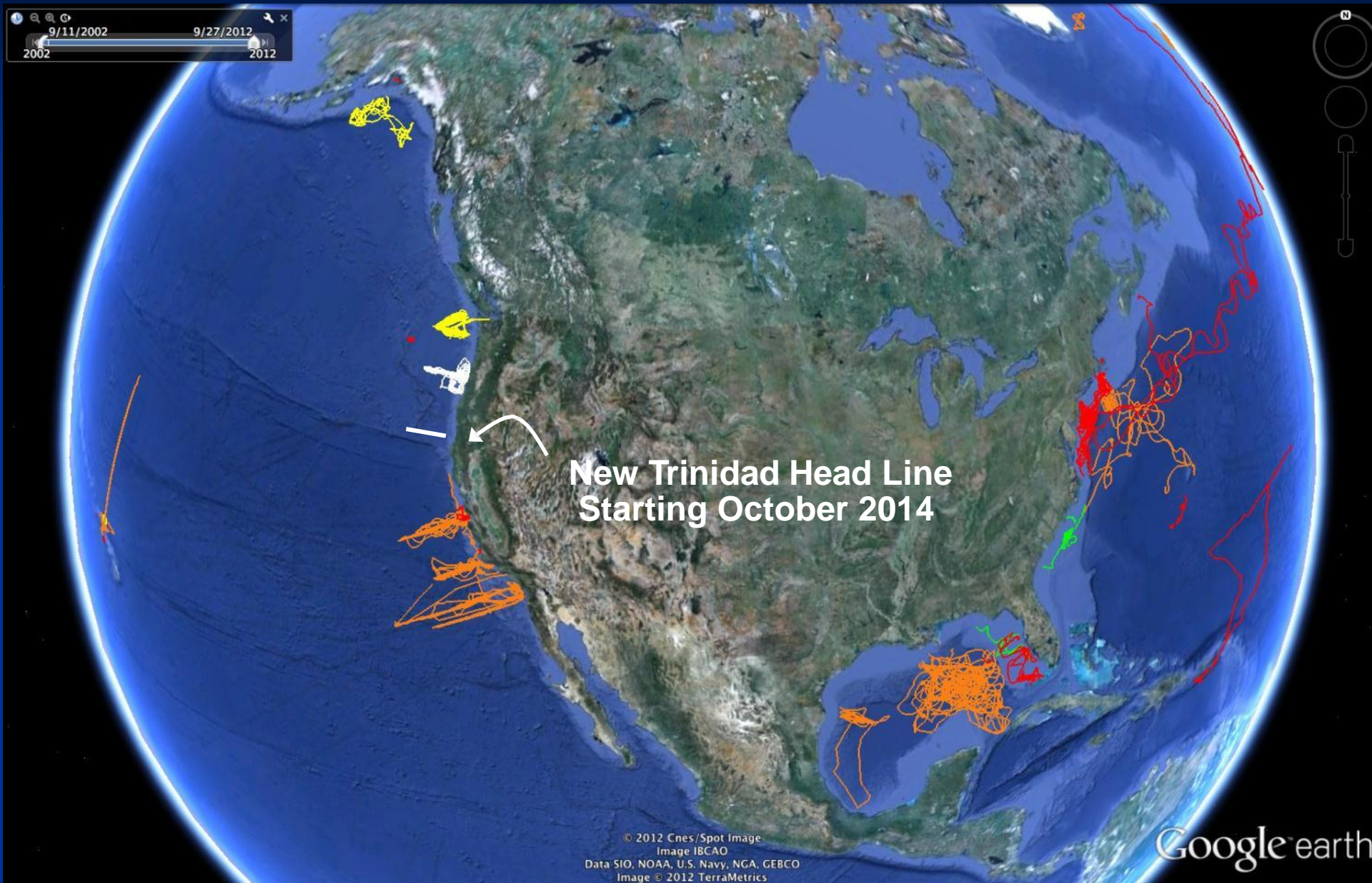
Mazzini, Barth, Shearman and Erofeev (JPO, 2014)

Wind effects width and shape of front/current



Lentz and Largier (2006)

Glider measurements from around the US

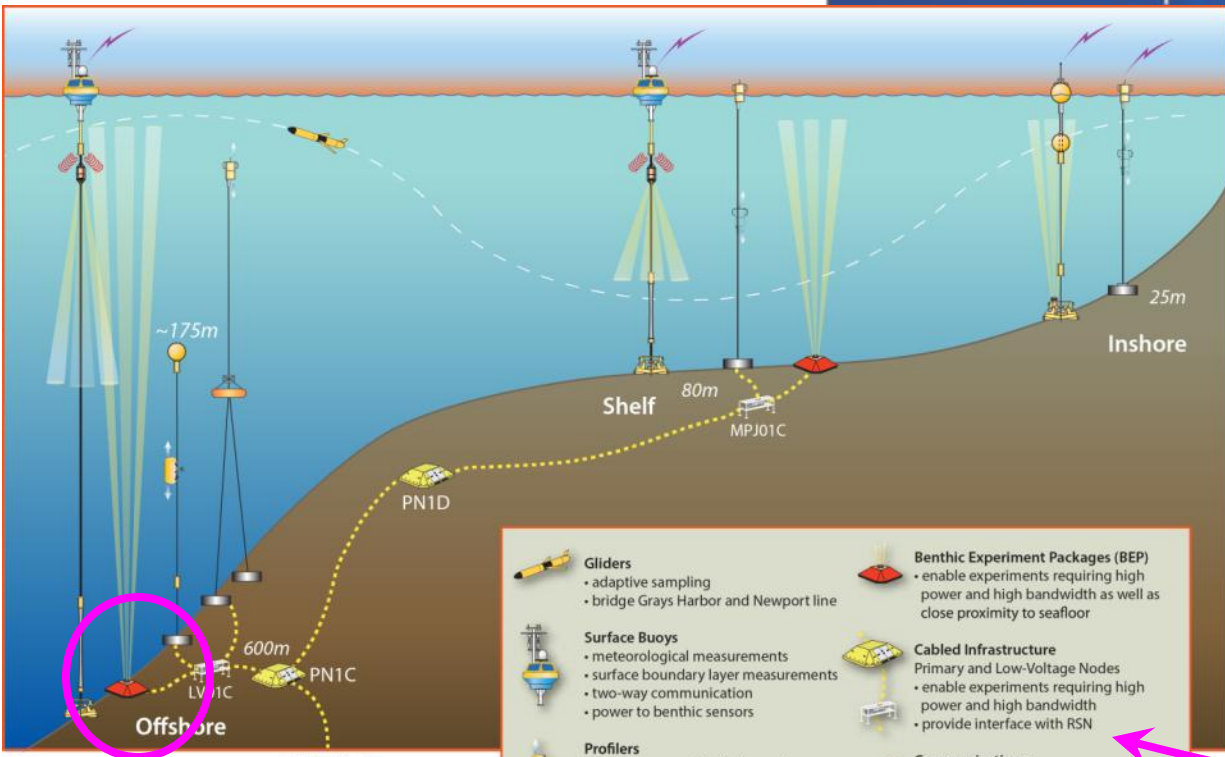
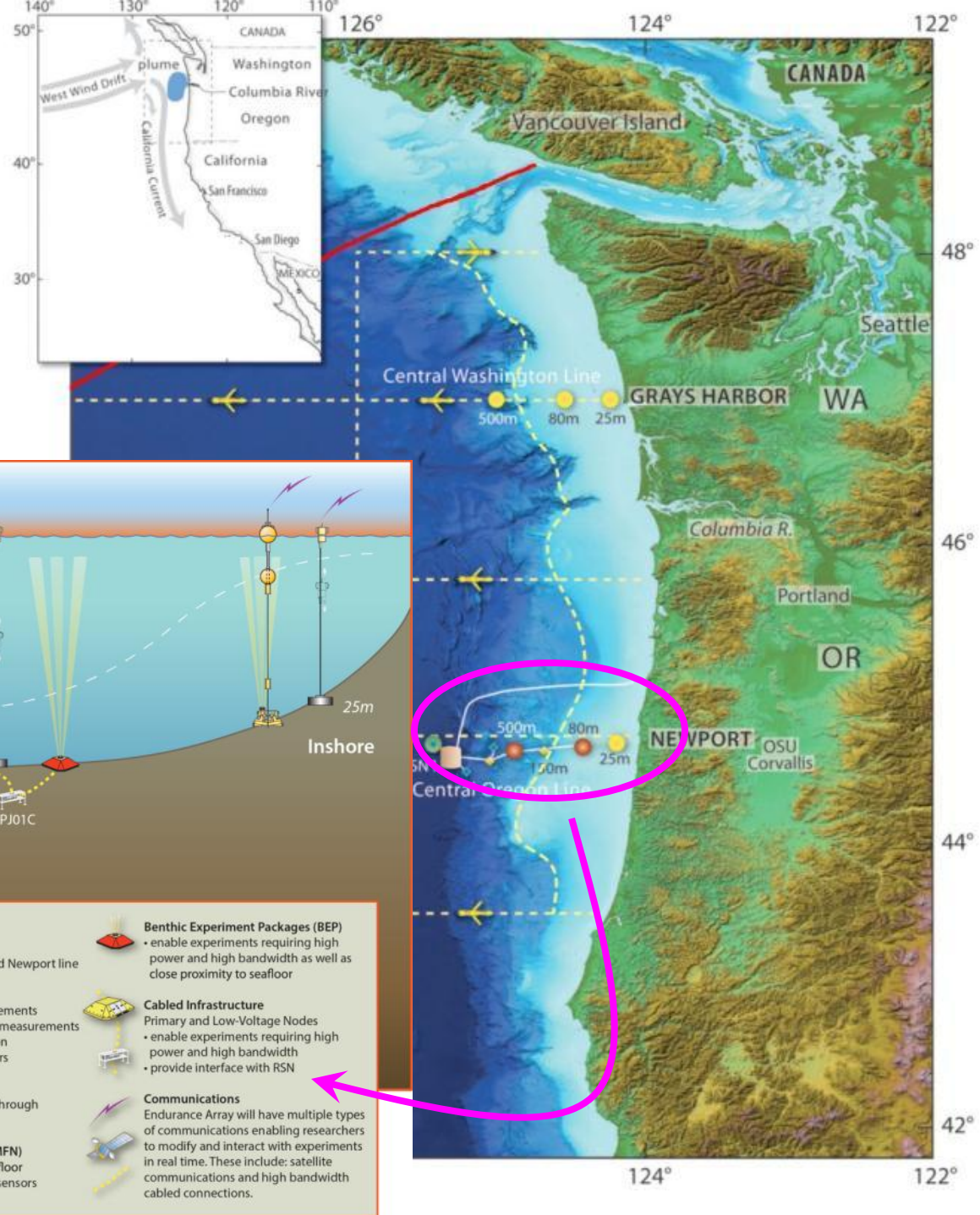


Ocean Observatories Initiative (OOI)

Installing observing arrays off the Pacific Northwest
2010-2015



(operate for 25-30 years)



To PN1B of the RSN cable

- | | |
|---|--|
| <p>Glanders</p> <ul style="list-style-type: none"> • adaptive sampling • bridge Grays Harbor and Newport line | <p>Benthic Experiment Packages (BEP)</p> <ul style="list-style-type: none"> • enable experiments requiring high power and high bandwidth as well as close proximity to seafloor |
| <p>Surface Buoys</p> <ul style="list-style-type: none"> • meteorological measurements • surface boundary layer measurements • two-way communication • power to benthic sensors | <p>Cabled Infrastructure</p> <p>Primary and Low-Voltage Nodes</p> <ul style="list-style-type: none"> • enable experiments requiring high power and high bandwidth • provide interface with RSN |
| <p>Profilers</p> <ul style="list-style-type: none"> • move sensors vertically through the water column | <p>Communications</p> <p>Endurance Array will have multiple types of communications enabling researchers to modify and interact with experiments in real time. These include: satellite communications and high bandwidth cabled connections.</p> |
| <p>Multi-function Nodes (MFN)</p> <ul style="list-style-type: none"> • anchor mooring to sea floor • platform for mounting sensors | |

Using Gliders to Explore Boundary Currents

- high spatial and temporal resolution
- cost effective
- physical, bio-optical, chemical measurements
- use in combination with moorings and ship-based work
- future work: additional sensors (e.g., bioacoustics)



Thanks to my OSU glider teammates: Kipp, Anatoli, Zen, Justin, Laura, Amanda, Kate, Piero, Chris, Pat, Meghan