

HAB Forecaster

BACKGROUND

In this activity, students can take on the role as a resource manager or scientist, tasked with deciding if razor clam harvesters should go out onto the beach to harvest razor clams.

This activity has been adapted from an activity conducted with a summer science program with the Quileute Tribal School. The slideshow used for that summer science program is attached at the end of this document.

This activity assumes participants understand upwelling off the coast of WA and OR and how the process of upwelling can lead to blooms of phytoplankton. The NANOOS activity “Well, Well, Well” walks students through looking for signs of upwelling off the WA and OR coast.

For background information on harmful algal blooms, see “What are HABs?”:

http://www.nanoos.org/products/habs/harmful_algal_blooms.php?section=what_are_habs

For info on HABs in the Pacific Northwest see:

http://www.nanoos.org/products/habs/harmful_algal_blooms.php?section=habs_in_pnw

For info on the Environmental Sample Processor, see:

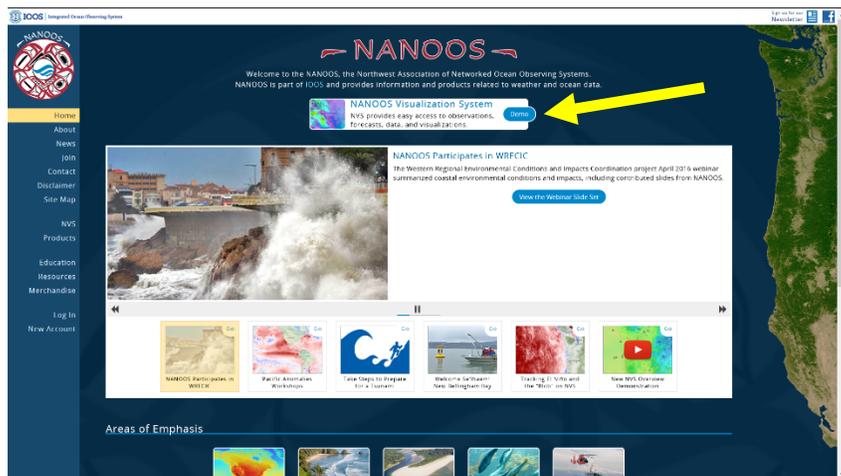
http://www.nanoos.org/products/habs/harmful_algal_blooms.php?section=nanoos_and_habs

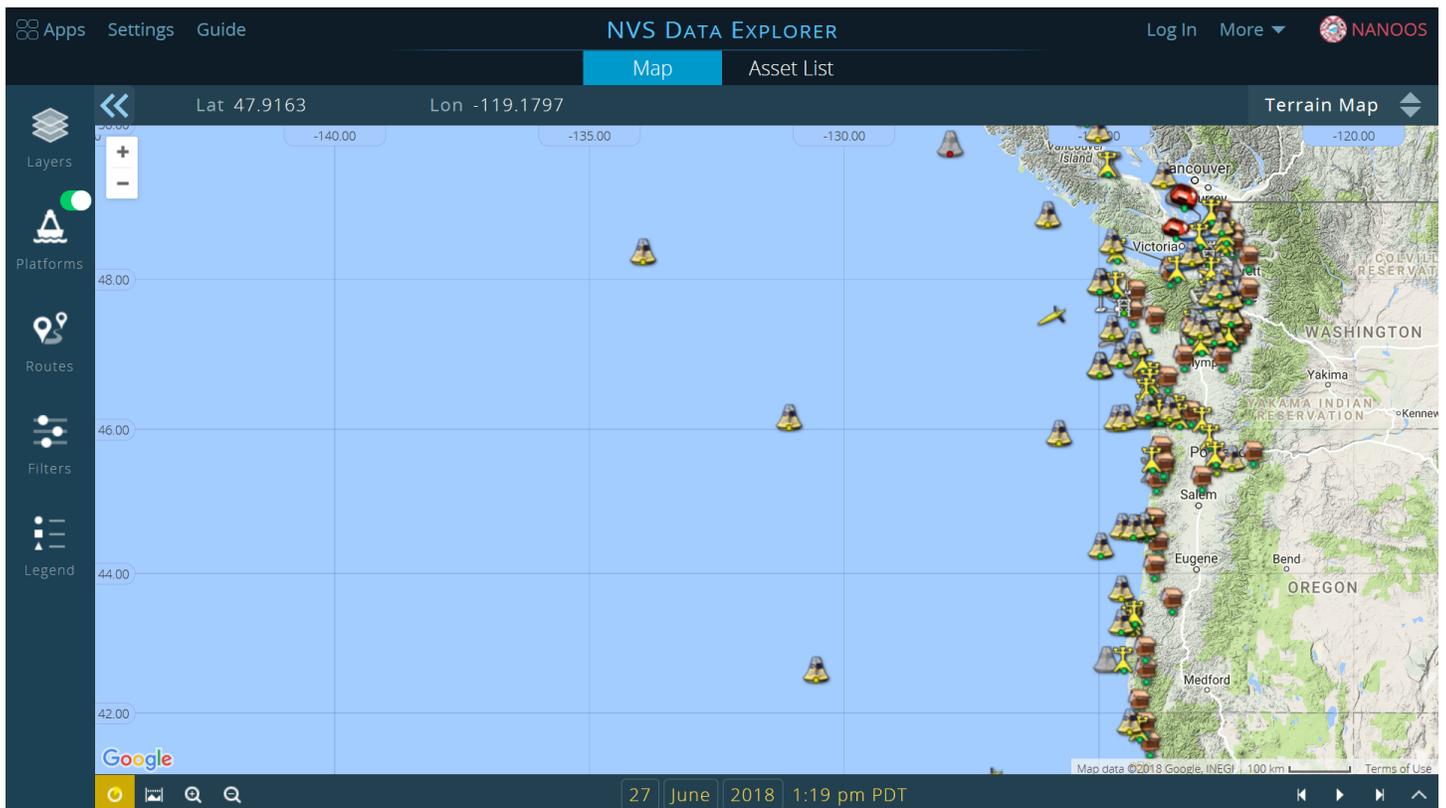
and see:

http://www.nanoos.org/products/real-time_habs/about/esp.php

GET STARTED

- 1) Go to www.nanoos.org
- 2) Navigate to the **NANOOS Visualization System (NVS)**
- 3) Once on the home page of NVS, select the “**Data Explorer**” button. NVS Data Explorer is the “kitchen sink” of NVS – it has a LOT of different data. Have fun looking around on all the different data types and different ways ocean scientists are collecting data.





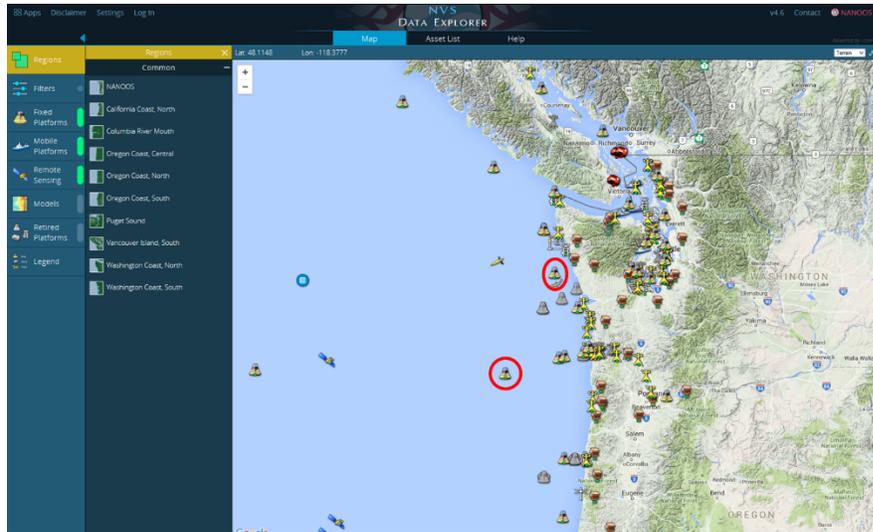
- 4) You will see symbols that are colored and you may find symbols that are gray. The grayed symbols are off-line for some reason. Some symbols are active only seasonally and others may not be transmitting data. Monitoring in the marine waters is difficult for many reasons. It is not an easy place for sensors to be! Scientists are constantly looking to see IF their sensor is collecting data even before they look at the data. Occasionally data may seem wrong, especially if the data changes dramatically.

FIND THE DATA – Will HABs make it to the beach?

IMAGINE: You are a scientist responsible for alerting your community to a possible HAB event. You are using real time data and forecasts to see if there is a bloom forming at the Juan de Fuca Eddy, and if the bloom may make it to shore.

STEP 1: WATER TEMPERATURE

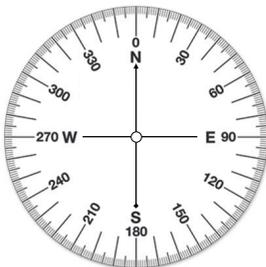
Comparing water temperature at different buoys – closer to shore and further from shore, can indicate upwelling conditions. Find 2 Buoys near the WA Coast: NDBC Elizabeth and NDBC Tillamook. If there is upwelling, which buoy may show warmer temperatures?



Station location	Water Temperature TODAY	Average water temperature for past 7 days (approximate)	Upwelling prediction

STEP #2: WIND DIRECTION

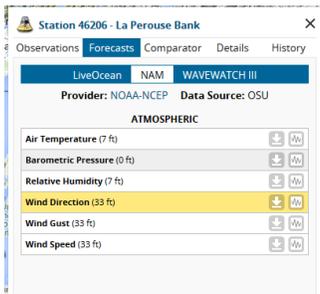
Wind direction is given in degrees from which the wind is coming **FROM**. On the compass rose below, the red curve shows the general direction wind blowing **from** the NORTH would look like.



Wind direction in red outlined areas of graph would mean winds blowing FROM the North

Find 2 stations along the WA Coast that are currently measuring wind direction. Do the wind data indicate upwelling conditions? Do you think the winds may blow the waters of the JUAN de FUCA EDDY towards shore?

Station location	Wind Direction TODAY	Average wind direction (estimate) for past 7 days	Prediction

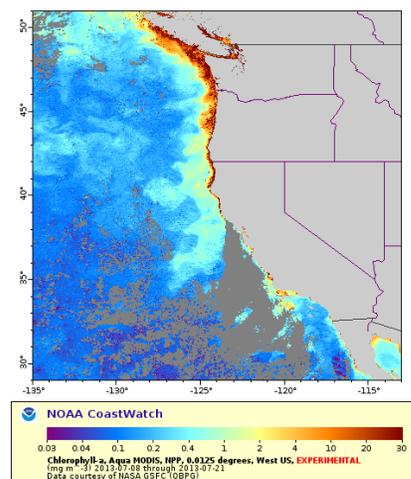
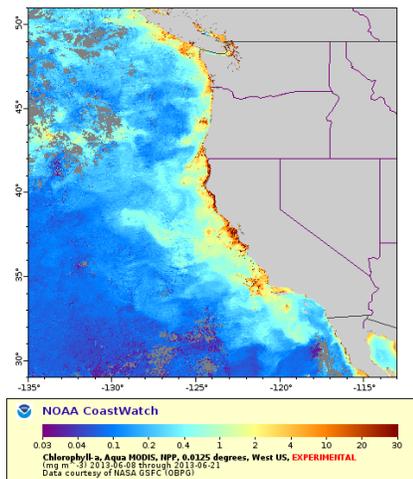


We can also see the FORECASTS for winds for the stations. These are from a computer model called NAM (the NORTH AMERICAN MESOSCALE model). In the pop-up window for your station, find the Forecast” tab and choose the NAM model and scroll down to wind direction

Station location	Average wind direction FORECAST for next 3 days	Prediction

STEP #3: CHLOROPHYLL

The abundance of phytoplankton, the base of the coastal ocean’s food web, is measured by **chlorophyll**, a photosynthesizing pigment in plant cells. Here is an example of how the chlorophyll concentrations can change during upwelling – the first visualization is from Jun 8-21, 2013, when it was not upwelling, and the second pic is from July 8-21, 2013, when it had been upwelling for over a week.



Under Remote Sensing, scroll down to Satellite data and select the MODIS Chlorophyll data. Select a time range (1 Day to 1 Month) and be sure to select a date/time within the cyan color bar (on timeline at bottom of page) to see the data.

What is the concentration of chlorophyll (mg of chlorophyll per cubic meter of water - mg/m^3) near the Juan de Fuca Eddy? Does it seem like there is a bloom there?

You can also see how the amount of chlorophyll compares to past years by looking at the chlorophyll anomaly. Scroll down further in the Remote Sensing menu and select OSU MODIS Climate and select Chlorophyll (Anomaly) and then choose May 2016 as date. Is there more chlorophyll this May than in past years?

	Observations and predictions
MODIS satellite Chlorophyll	
Chlorophyll Anomaly	

Step #4: Columbia River Plume

The Columbia River Plume can act as a barrier or as a pathway to helping HAB blooms reach the coast. Scientists at the Univ. of WA have created a computer model called LiveOcean to forecast the ocean conditions in the Pacific Northwest. Select “Models”, scroll down to LiveOcean and select Salinity. Freshwater from the Columbia River plume will show up as “bluer” or “colder” color. What does it look like the Columbia River Plume is Forecasted to go over the next few days?

Columbia River Plume	
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Step #5: ESP DATA

Does it seem like there are blooms of the different phytoplankton species the ESP monitors for?

What are the concentrations of Domoic Acid? Use NVS to see the ESP data from NEMO

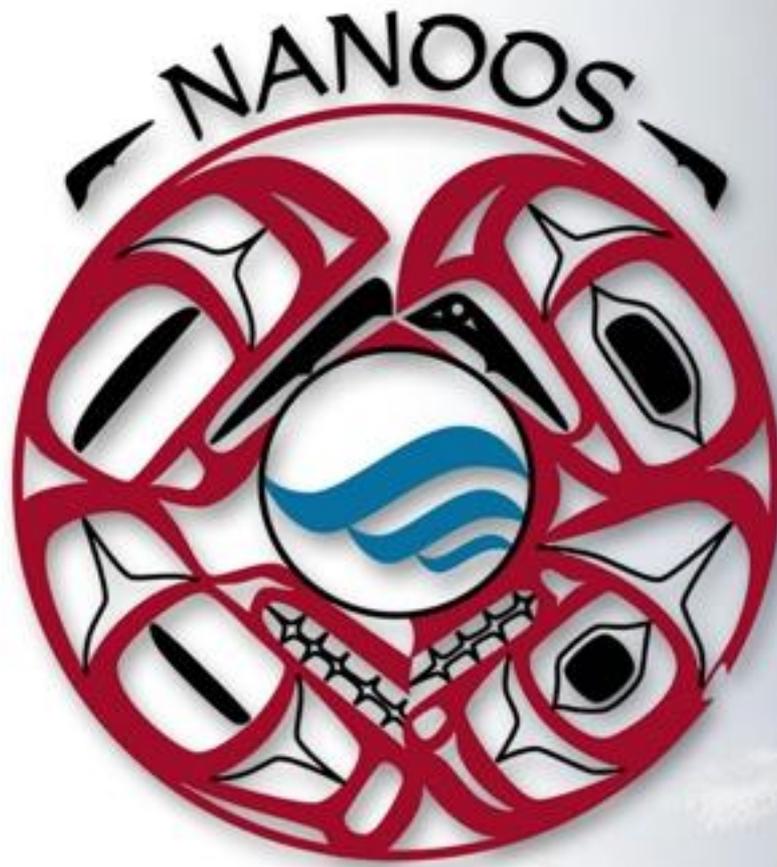
http://nvs.nanoos.org/Explorer?action=oiw:fixed_platform:APL_Nemo:observations:H1_Pressure or visit

http://www.nanoos.org/products/real-time_habs/

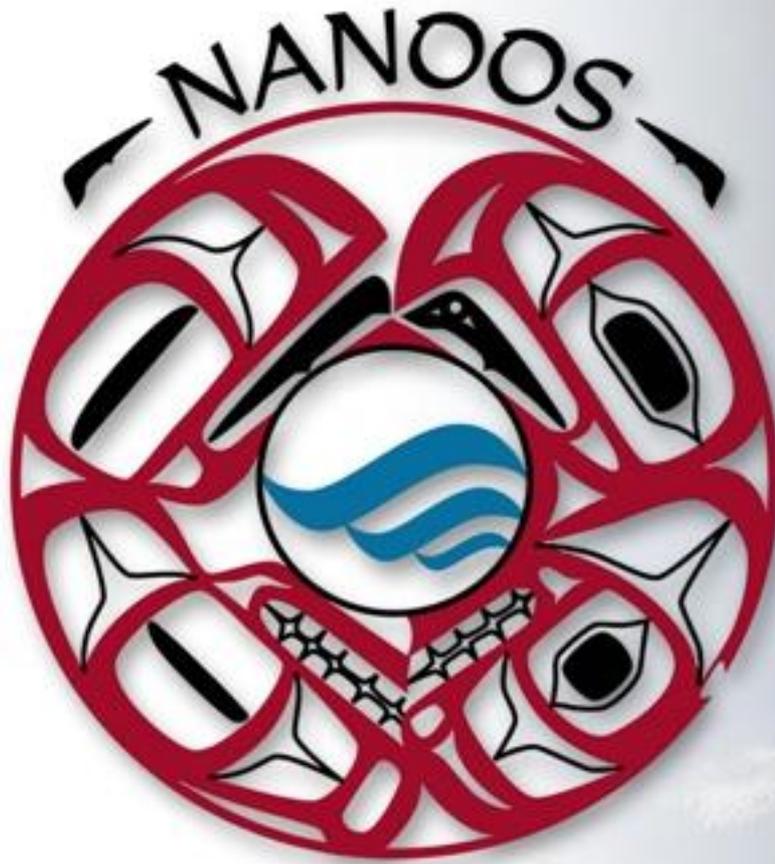
ESP Data	

PUTTING IT ALL TOGETHER

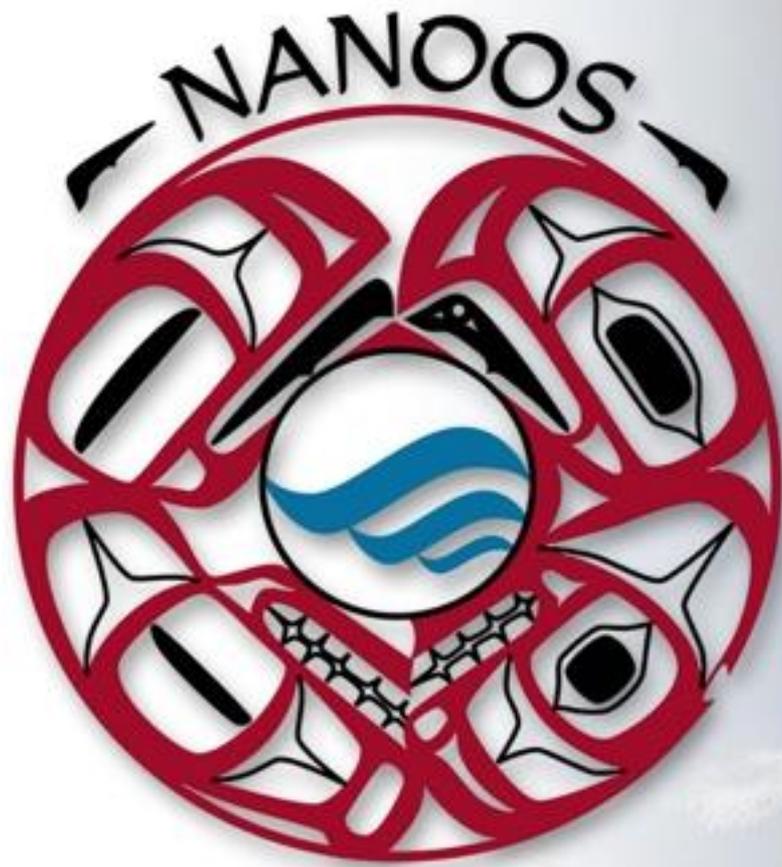
Now that you have sleuthed through the data for clues, your final task is to give a recommendation. Do you think there may be a risk of a HAB event happening now or in the near future? Why? What should be done?

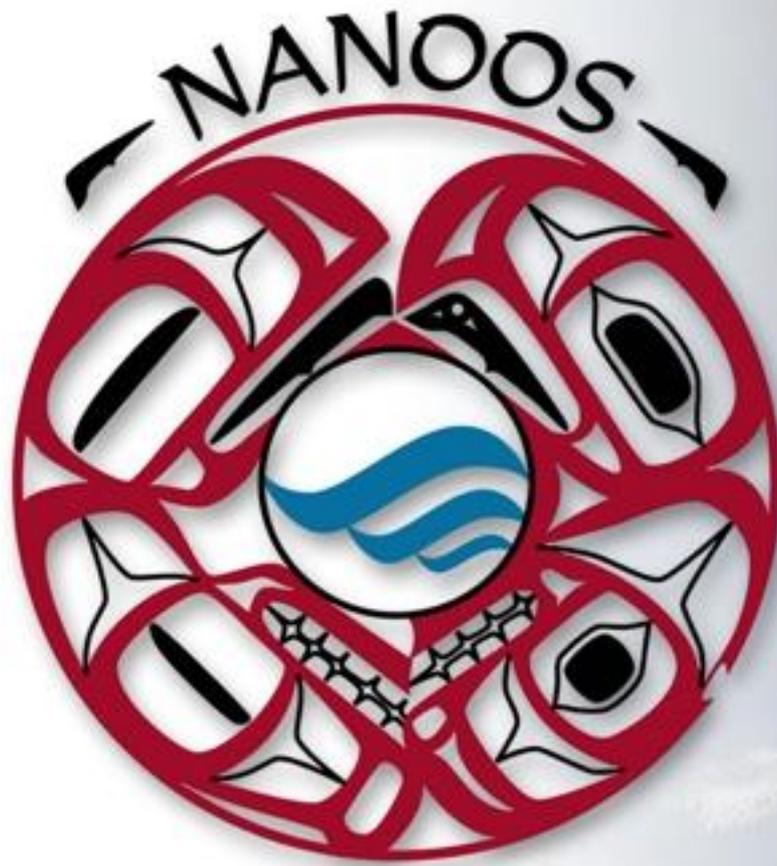


Northwest
Association of
Networked
Ocean
Observing
Systems



- What does that mean?





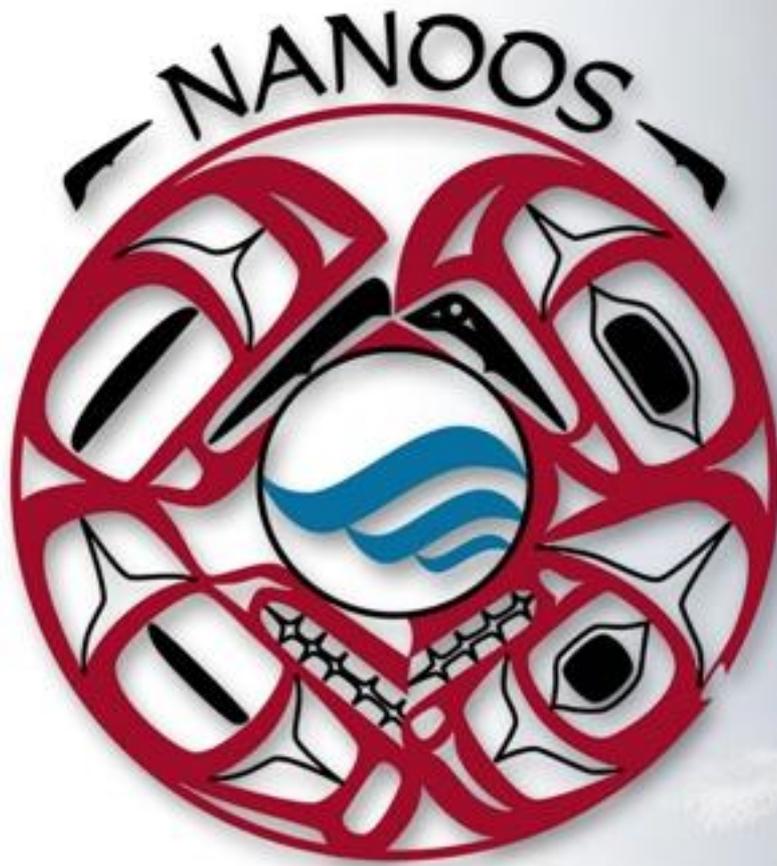
Protectors:

Raven

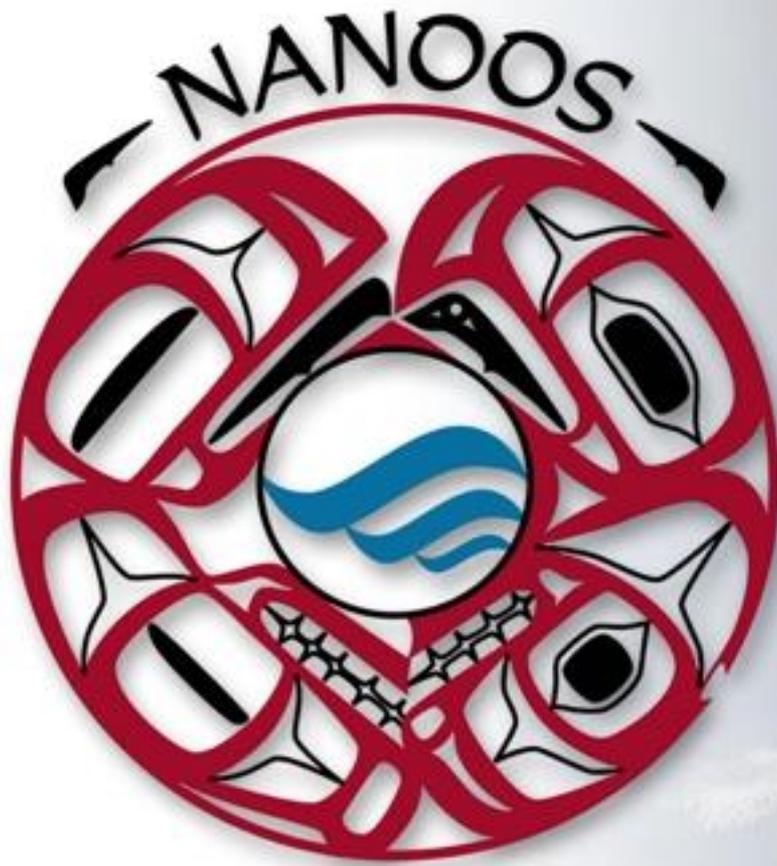
Eagle

Wolf

Orca



The Red Circle:
Life



The Center:
Ocean

WHAT IS AN OCEAN OBSERVING SYSTEM?

- Network of people and technologies
- Collecting data on the atmosphere, ocean, and coast
- Regularly (minutes, hours, days)
- Sustained over time



WHY IS THIS DATA COLLECTED?

- Healthy Ecosystems
- Living Marine Resources
- Coastal Hazards
- Marine Operations
- Public Health Risks
- Climate



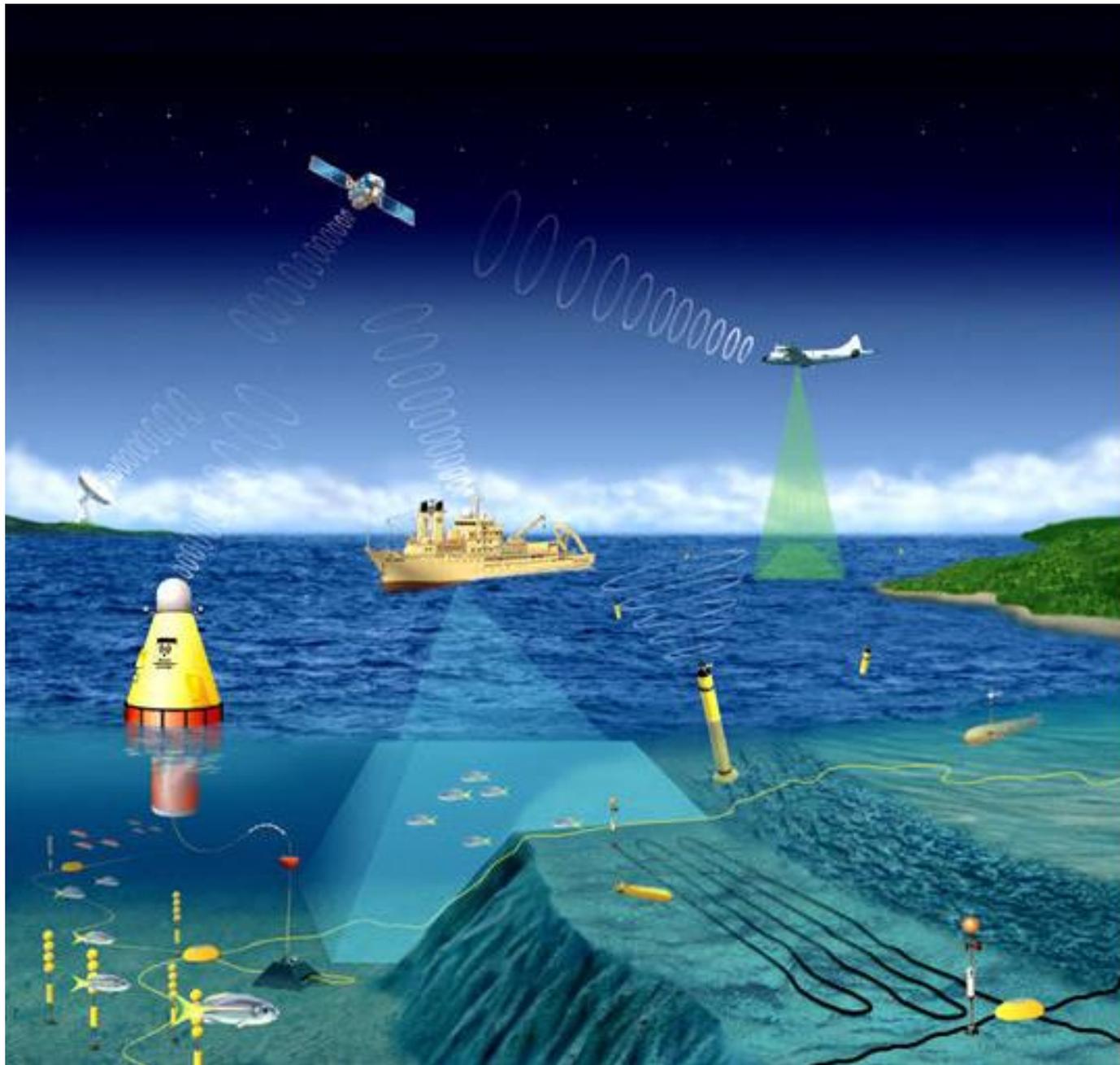


HOW ARE THESE DATA COLLECTED?

- Buoys
- HF Radar
- Meteorological Stations
- Shore stations
- Research vessels
- Vessels of Opportunity
- Satellites
- Robots
- Animals







The Regional Associations of IOOS



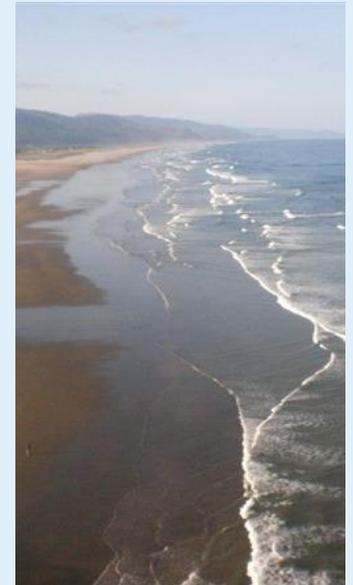
MANY People & Programs together:

- University of Victoria
- Olympic Coast National Marine Sanctuary
- University of Washington
- Washington Department of Ecology
- Washington Department of Natural Resources
- Pacific Shellfish Institute
- USGS
- Quileute
- Quinault
- Oregon Department of Fish and Wildlife (ODFW)
- NOAA Pacific Marine Environmental Lab (PMEL)
- NOAA National Marine Fisheries Service (NMFS)
- NOAA National Ocean Service
- Vancouver Island University
- Northwest Fisheries Science Center (NWFSC)
- Oregon Health and Sciences University
- Oregon State University (OSU)
- South Slough National Estuarine Research Reserve System (NERRS)



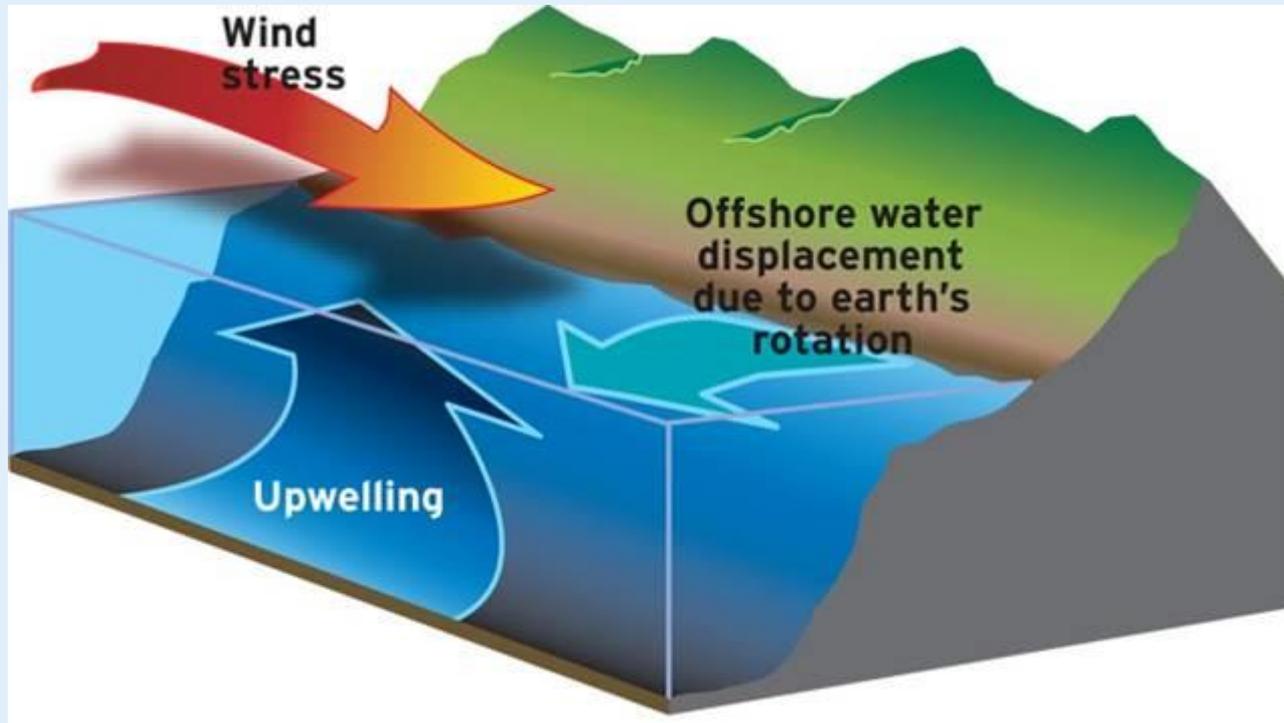
Current focus:

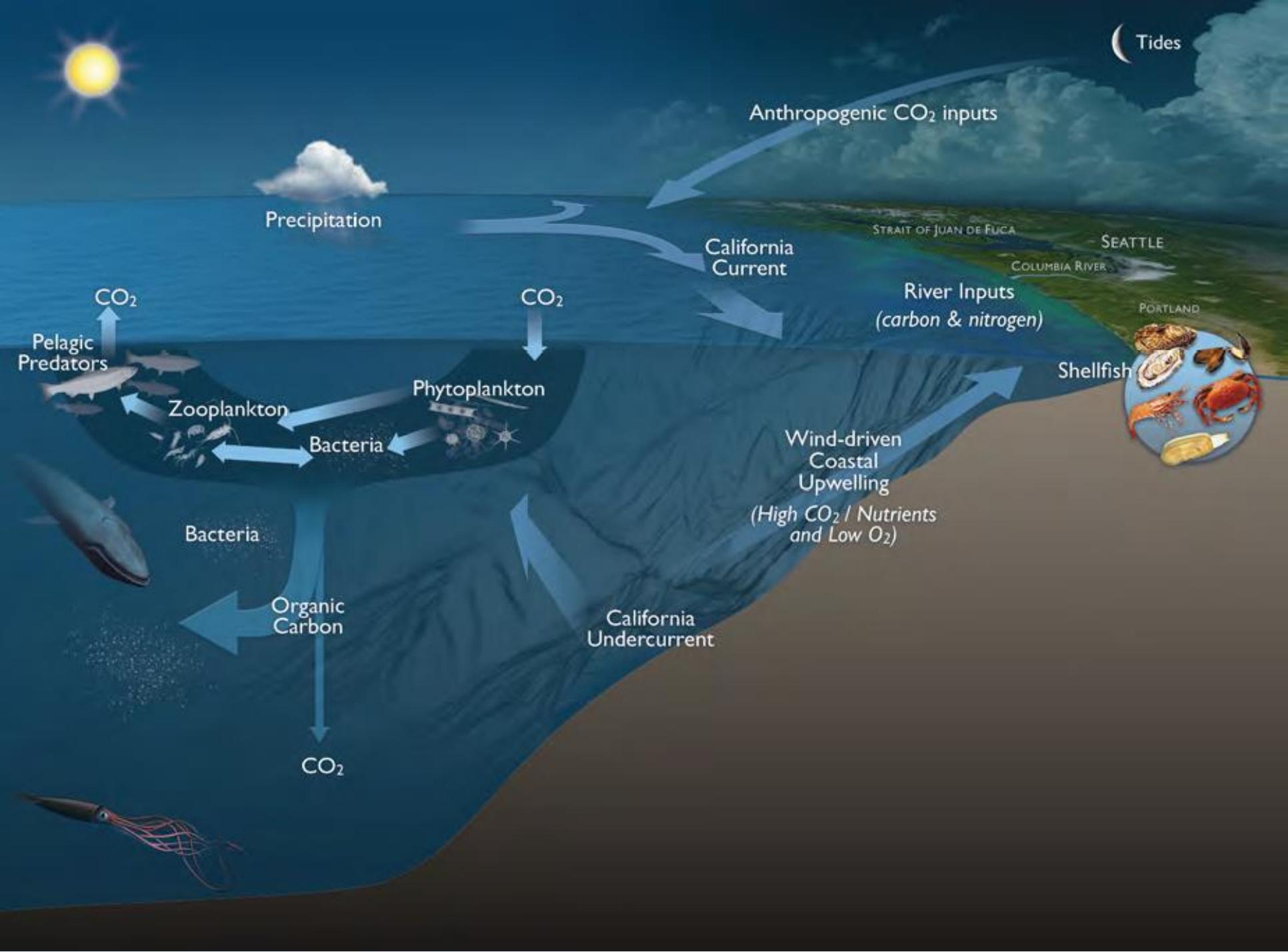
- HABs & Ocean acidification
- Shellfish and salmon
- Coastal hazards (erosion, waves)
- Maritime sector
- Ecosystem health



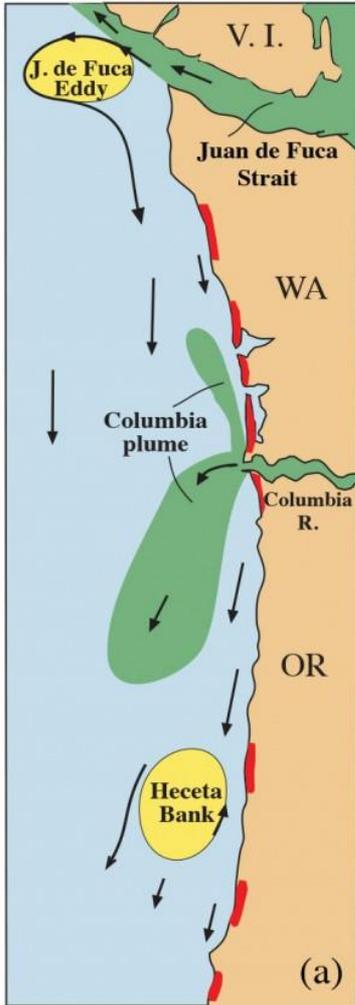


WA COAST

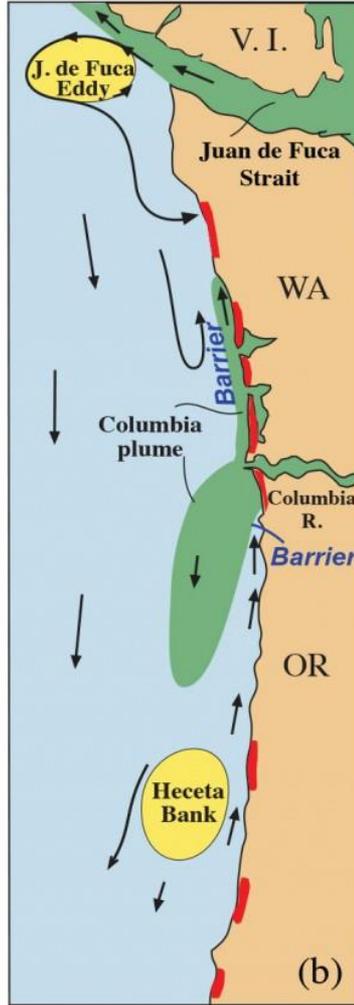




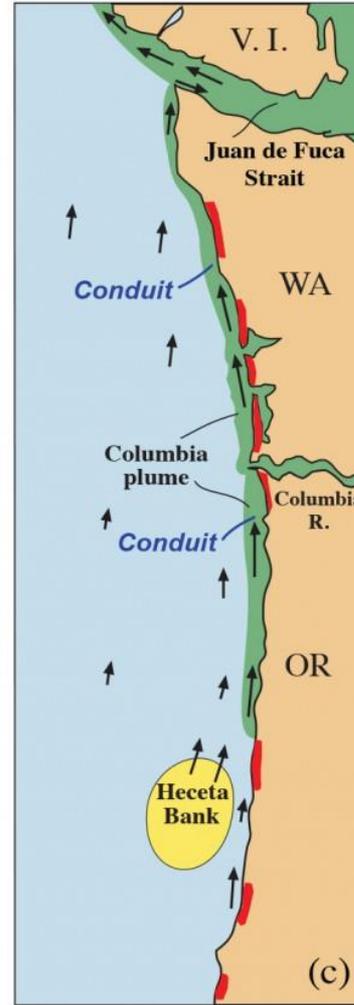
**Summer/Fall
good weather**



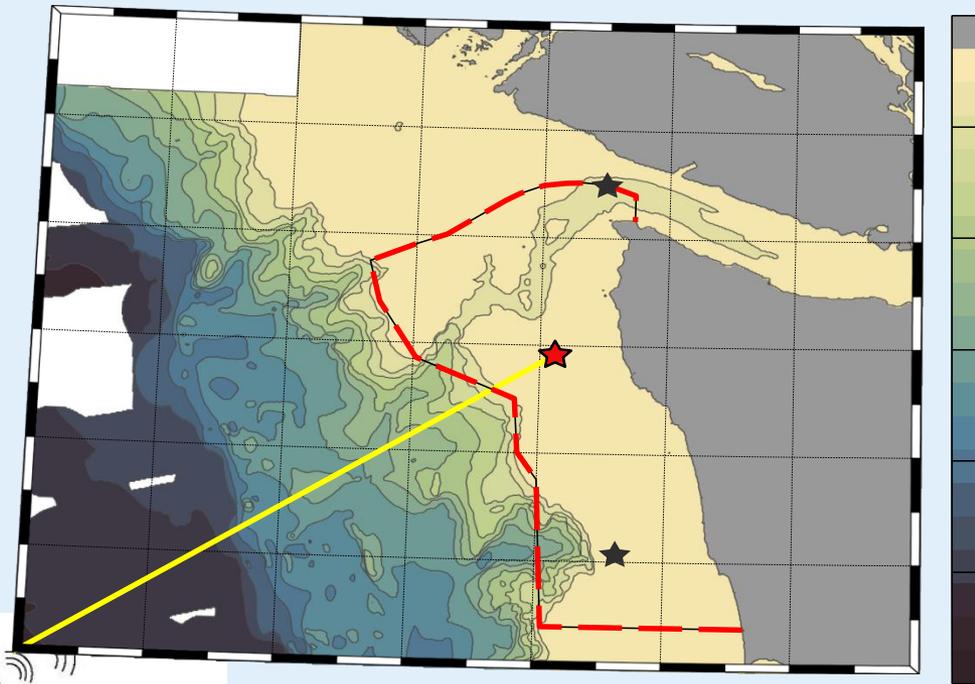
**Summer/Fall
weak storms**



**Winter/ Early Spring
strong storms**

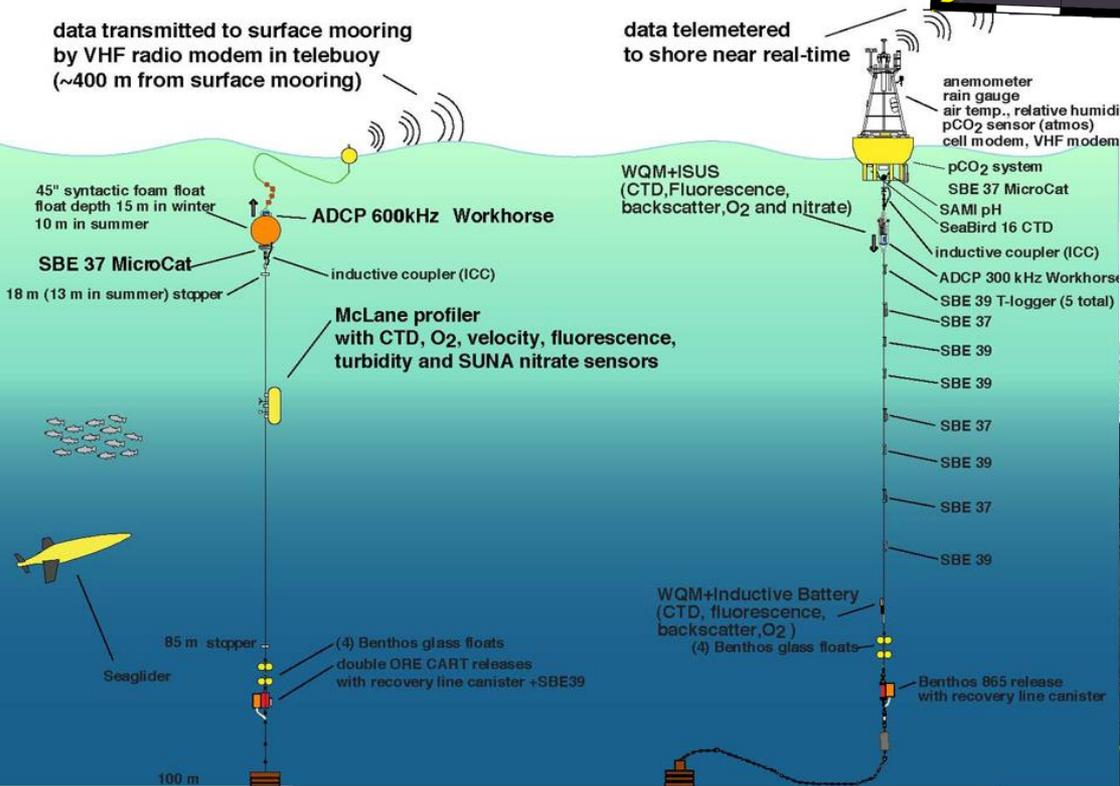


Cha'ba Buoy and NEMO profiler, La Push, WA



data transmitted to surface mooring by VHF radio modem in telebuoy (~400 m from surface mooring)

data telemetered to shore near real-time



- anemometer
- rain gauge
- air temp., relative humidity
- pCO₂ sensor (atmos)
- cell modem, VHF modem

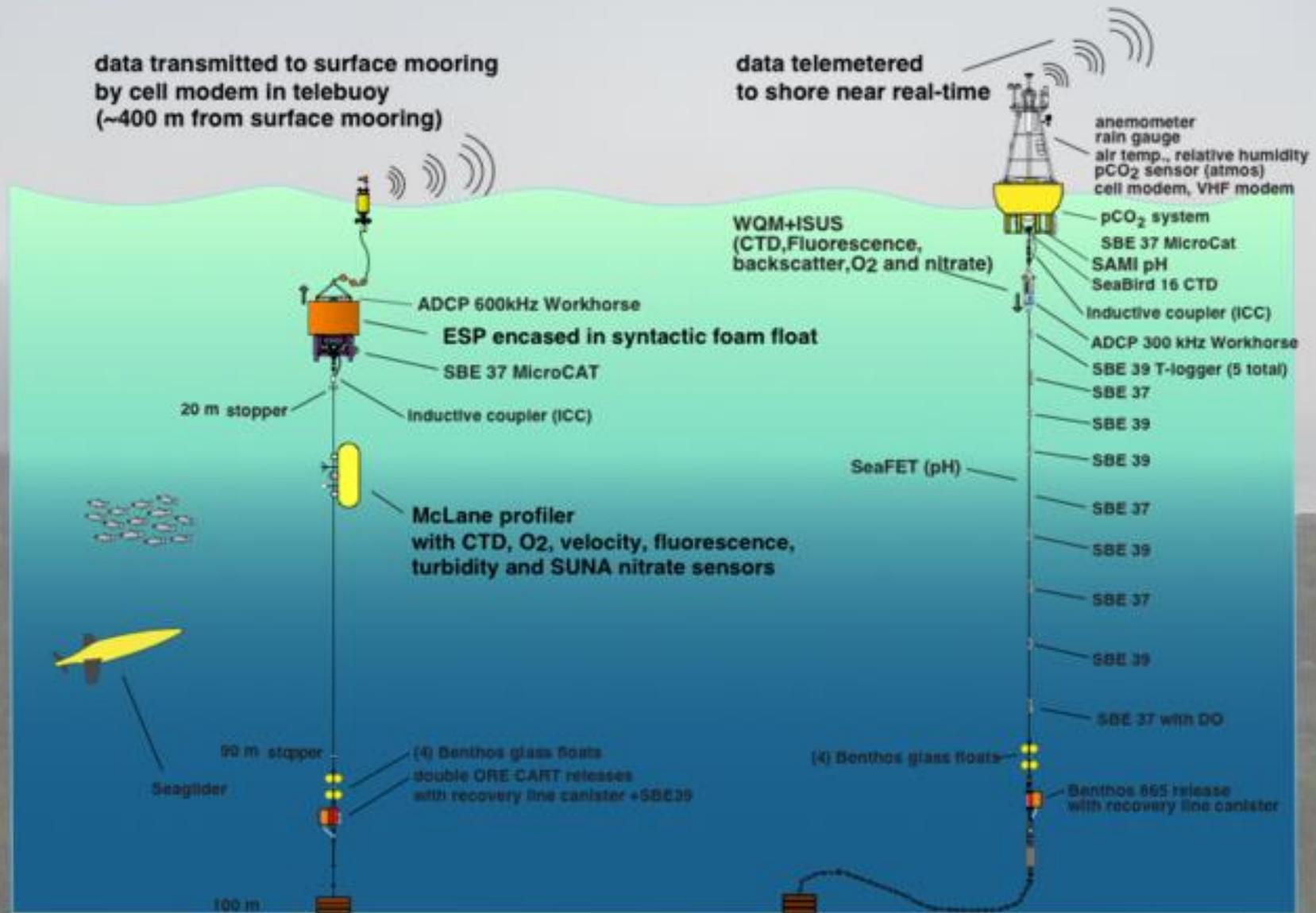
- pCO₂ system
- SBE 37 MicroCat
- SAMI pH
- SeaBird 16 CTD
- inductive coupler (ICC)
- ADCP 300 kHz Workhorse
- SBE 39 T-logger (5 total)
- SBE 37
- SBE 39
- SBE 37
- SBE 39
- SBE 37
- SBE 39

- WQM+Inductive Battery (CTD, fluorescence, backscatter, O₂)
- (4) Benthos glass floats

- Benthos 865 release with recovery line canister



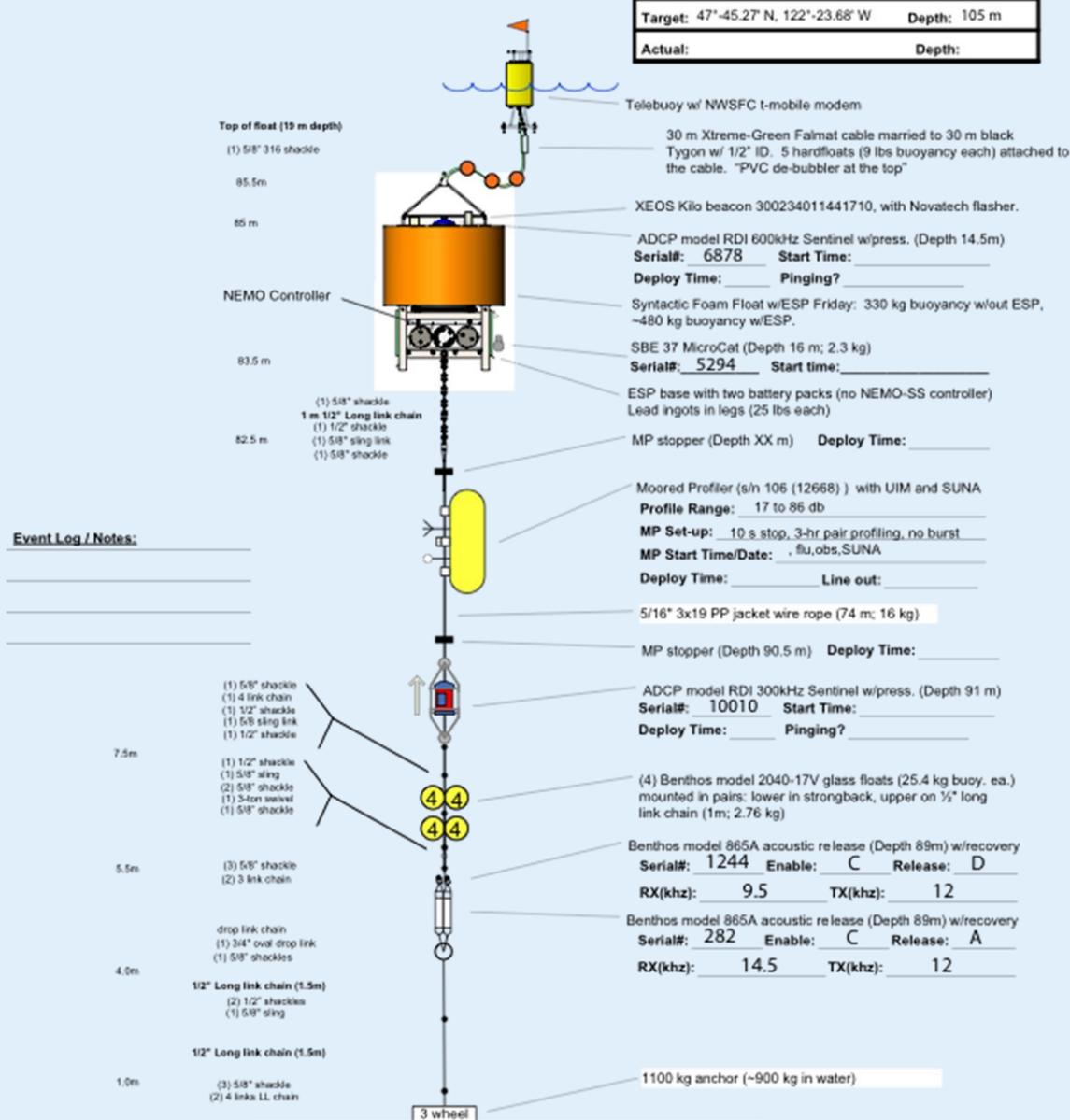
Overview



NEMO ESP SUBSURFACE MOORING

Version: May 3rd, May 2016 deploy

Target: 47°-45.27' N, 122°-23.68' W	Depth: 105 m
Actual:	Depth:

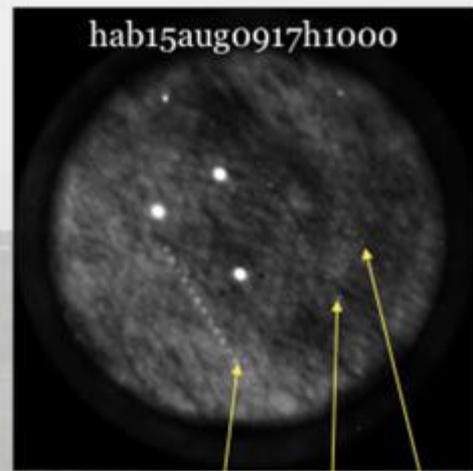
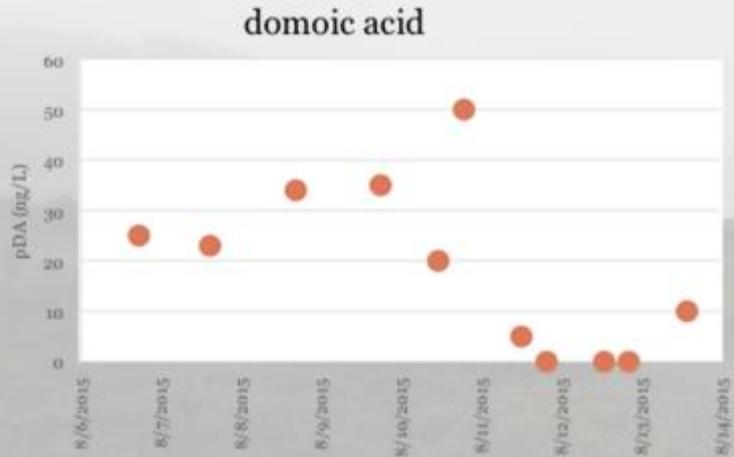


Start Deploy: Date: _____ Time: _____ Wind Dir / Spd: _____ Lat: _____ Long: _____

Drop Anchor: Date: _____ Time: _____ Hdg / Spd: _____ Lat: _____ Long: _____

Puget Sound Test Deployment

Low level detections of DA and Pn



- P. fraudulenta*
- P. multiseris*
- Heterosigma*

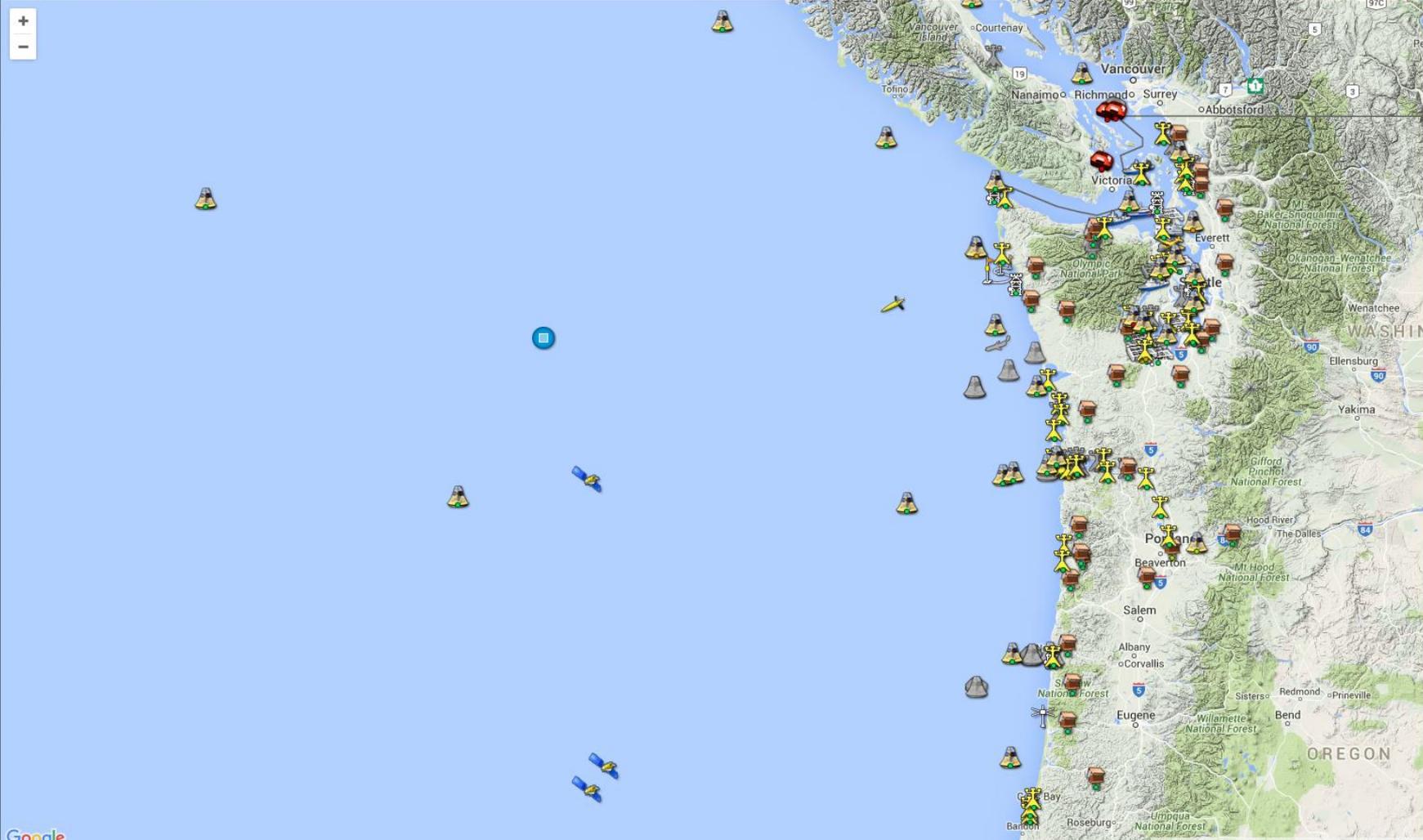
BE A HAB FORECASTER

WHAT DATA CAN HELP US?

Lat: 49.0523 Lon: -135.6592

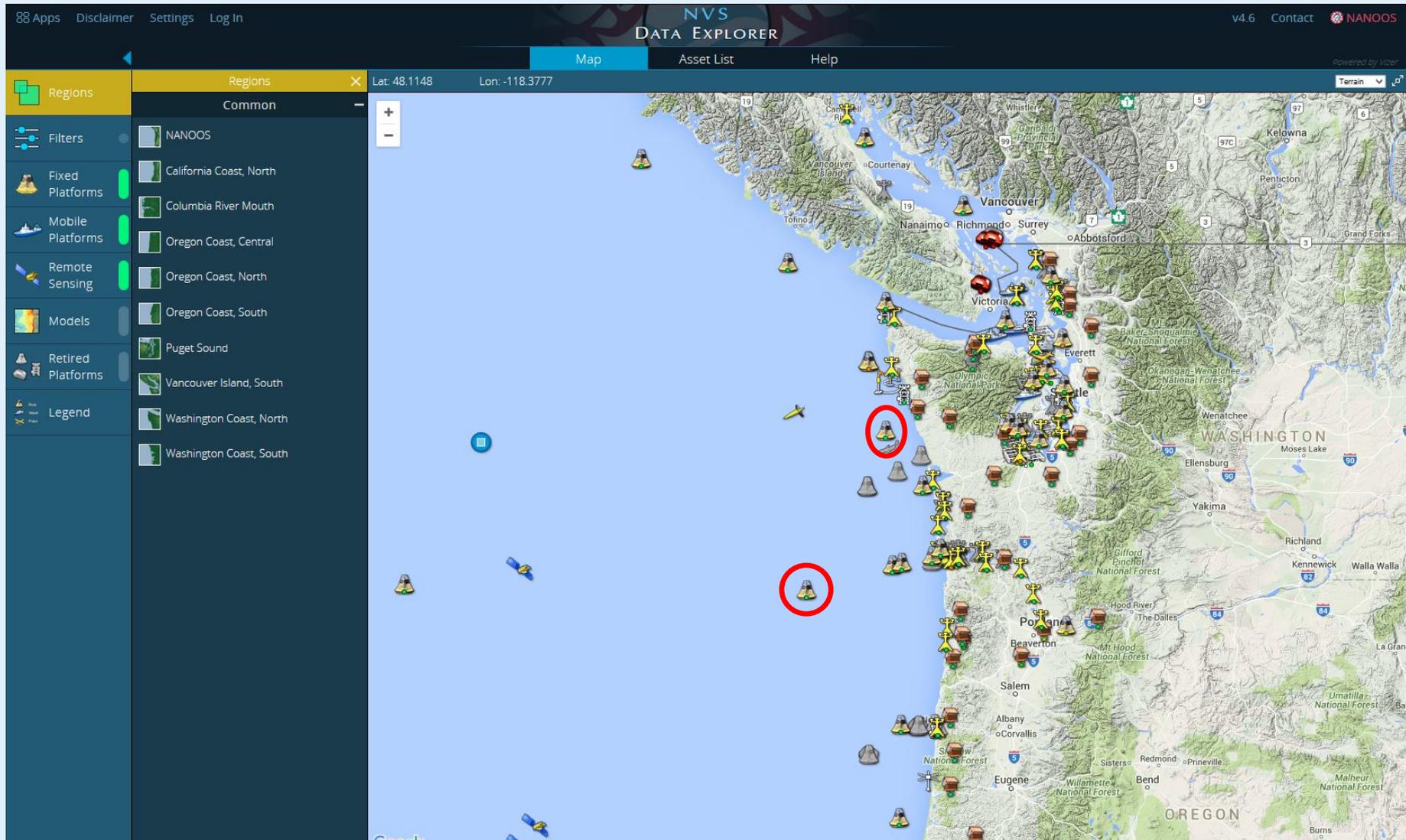
Terrain

- Regions
- Filters
- Fixed Platforms
- Mobile Platforms
- Remote Sensing
- Models
- Retired Platforms
- Legend



WATER TEMPERATURE at 2 Buoys

If there is upwelling, which buoy may show warmer water?



Regions

Regions × Lat: 49.8592 Lon: -123.6731

Common

Filters

- NANOOS
- California Coast, North
- Columbia River Mouth
- Oregon Coast, Central
- Oregon Coast, North
- Oregon Coast, South
- Puget Sound
- Vancouver Island, South
- Washington Coast, North
- Washington Coast, South

Fixed Platforms

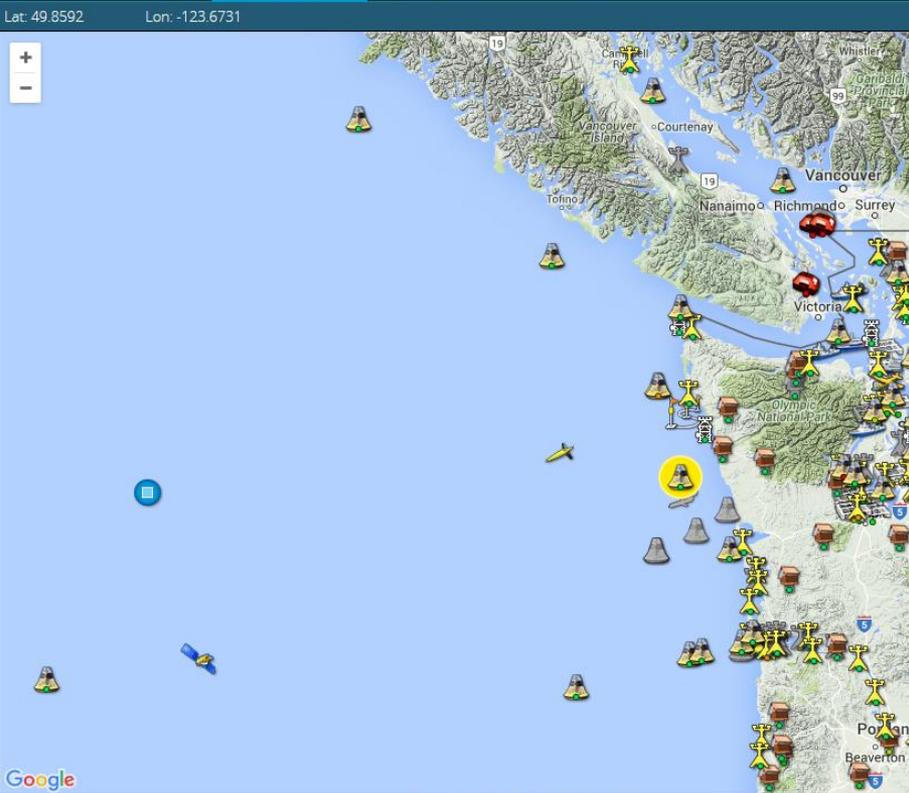
Mobile Platforms

Remote Sensing

Models

Retired Platforms

Legend



NDBC 46041 - Cape Elizabeth - 45NM NW of Aberdeen

Observations Forecasts Comparator Details History Credits

Data Updated: 27 Jun 2016 9:50 PDT **Provider:** NDBC

ATMOSPHERIC

Air Temperature (13 ft)	56.3 °F	↓	↔
Barometric Pressure (0 ft)	30.2 inHg	↓	↔
CO2 Air (7 ft)	413.6 ppm	✉	↔
Wind Direction (16 ft)	330 deg (from)	↓	↔
Wind Gust (16 ft)	11.7 knots	↓	↔
Wind Speed (16 ft)	9.7 knots	↓	↔

HYDROGRAPHIC

Average Wave Period (0 ft)	5.6 sec	↓	↔
CO2 Water (0 ft)	356.8 ppm	✉	↔
Dominant Wave Period (0 ft)	7 sec	↓	↔
pH (0 ft)	8.1	✉	↔
Salinity (0 ft)	32.3 PSU	✉	↔
Water Temperature (-2 ft)	55.9 °F	↓	↔
Wave Height (0 ft)	5.6 ft	↓	↔
Wave Mean Direction (0 ft)	305 deg (from)	↓	↔

[Link](#)



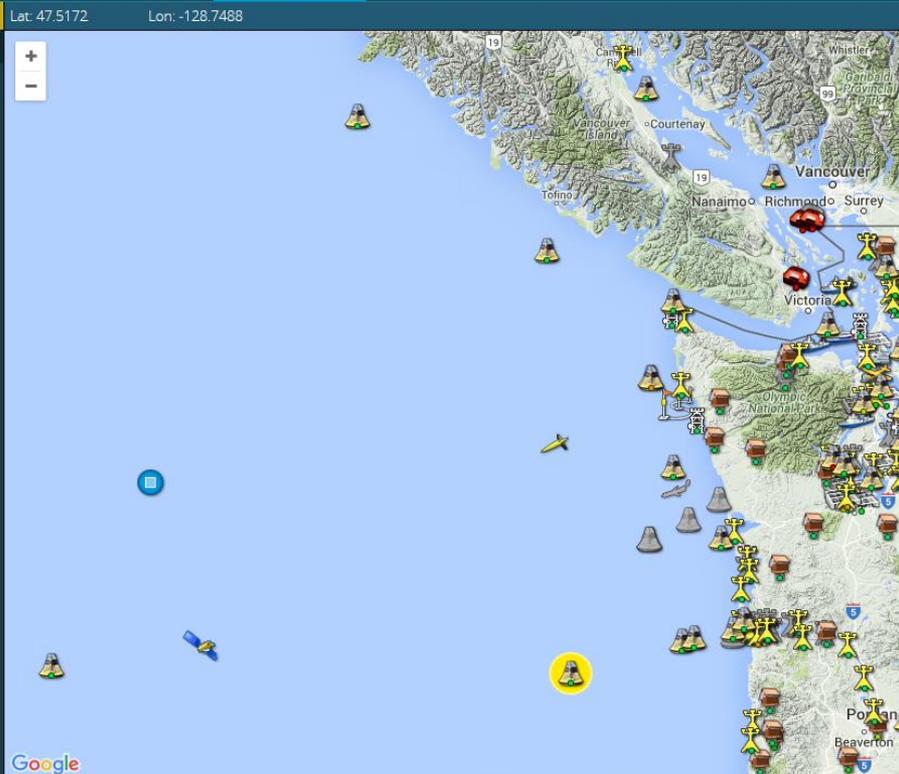
Regions

Common

- NANOOS
- California Coast, North
- Columbia River Mouth
- Oregon Coast, Central
- Oregon Coast, North
- Oregon Coast, South
- Puget Sound
- Vancouver Island, South
- Washington Coast, North
- Washington Coast, South

Filters

- Fixed Platforms
- Mobile Platforms
- Remote Sensing
- Models
- Retired Platforms
- Legend



NDBC 46089 - Tillamook - 85 NM WNW of Tillamook

Observations Forecasts Comparator Details History

Data Updated: 27 Jun 2016 9:50 PDT Provider: NDBC

ATMOSPHERIC

Air Temperature (13 ft)	58.3 °F	⬇️ ⬆️
Barometric Pressure (0 ft)	30.3 inHg	⬇️ ⬆️
Wind Direction (16 ft)	340 deg (from)	⬇️ ⬆️
Wind Gust (16 ft)	17.5 knots	⬇️ ⬆️
Wind Speed (16 ft)	13.6 knots	⬇️ ⬆️

HYDROGRAPHIC

Average Wave Period (0 ft)	5.6 sec	⬇️ ⬆️
Dominant Wave Period (0 ft)	6 sec	⬇️ ⬆️
Water Temperature (-2 ft)	60.3 °F	⬇️ ⬆️
Wave Height (0 ft)	5.6 ft	⬇️ ⬆️
Wave Mean Direction (0 ft)	347 deg (from)	⬇️ ⬆️

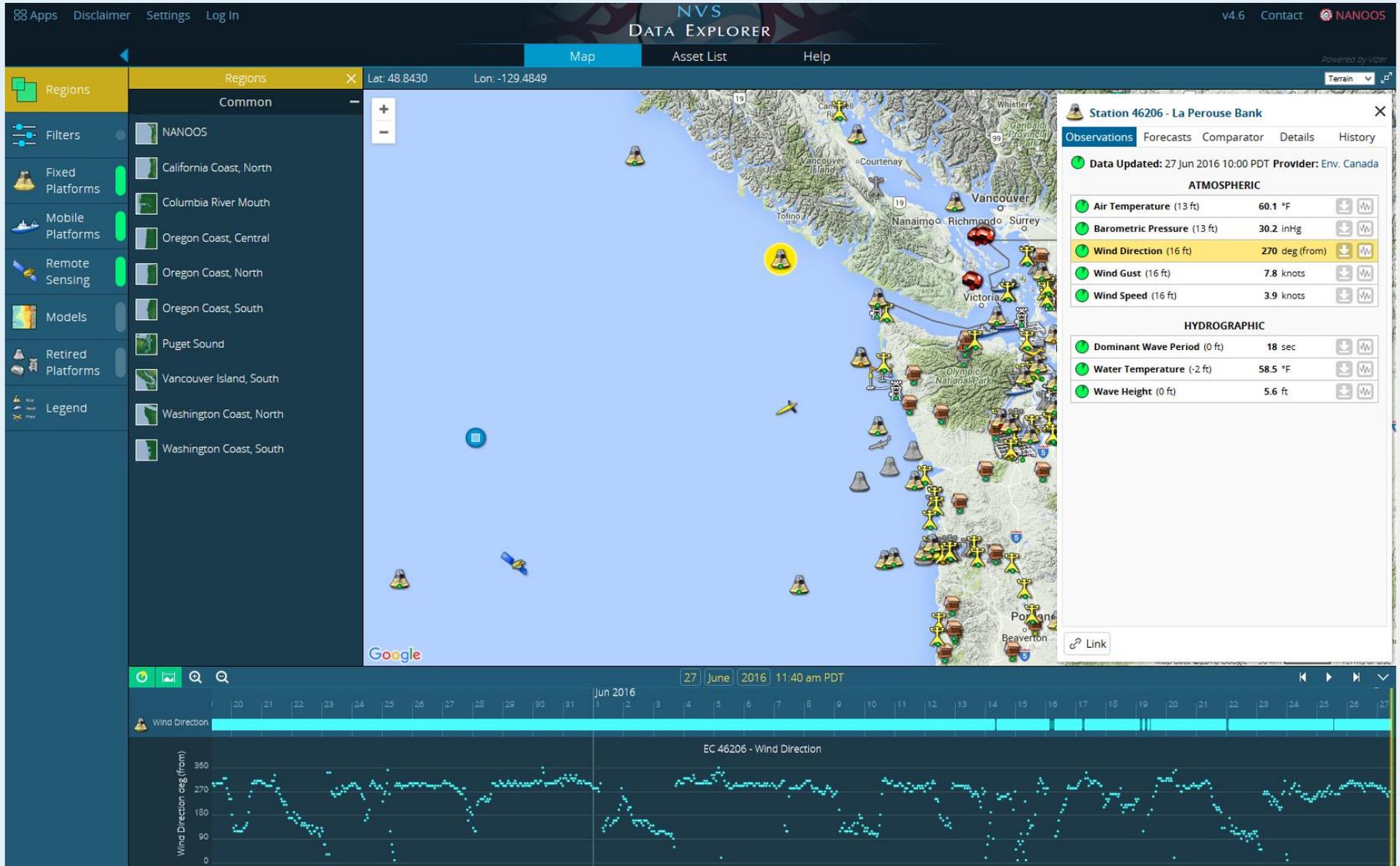
Link



WIND DIRECTION

Real Time and Forecast

WIND DIRECTION



- Regions
- Filters
- Fixed Platforms
- Mobile Platforms
- Remote Sensing
- Models
- Retired Platforms
- Legend

- Regions
- Common
- NANOOS
 - California Coast, North
 - Columbia River Mouth
 - Oregon Coast, Central
 - Oregon Coast, North
 - Oregon Coast, South
 - Puget Sound
 - Vancouver Island, South
 - Washington Coast, North
 - Washington Coast, South



Station 9442396 - La Push

Observations Forecasts Comparator Details

Data Updated: 27 Jun 2016 11:24 PDT Provider: NOS/CO-OPS

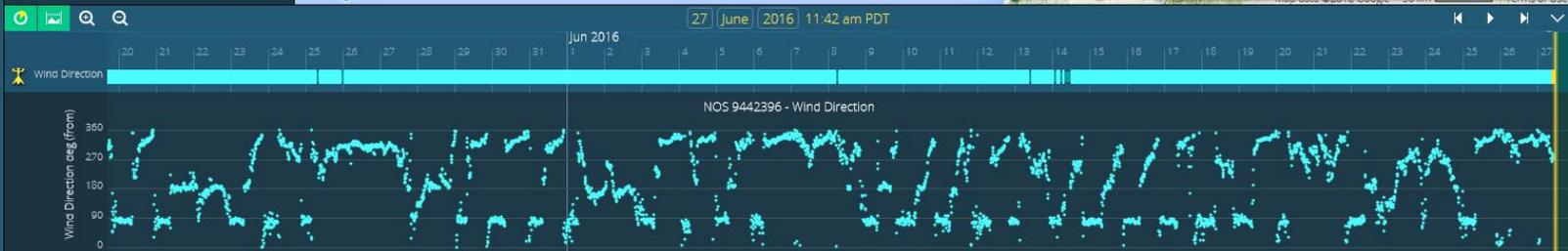
ATMOSPHERIC

Air Temperature (10 ft)	55 °F	↓	W
Barometric Pressure (15 ft)	30.2 inHg	↓	W
Wind Direction (39 ft)	284 deg (from)	↓	W
Wind Gust (39 ft)	4.5 knots	↓	W
Wind Speed (39 ft)	3.3 knots	↓	W

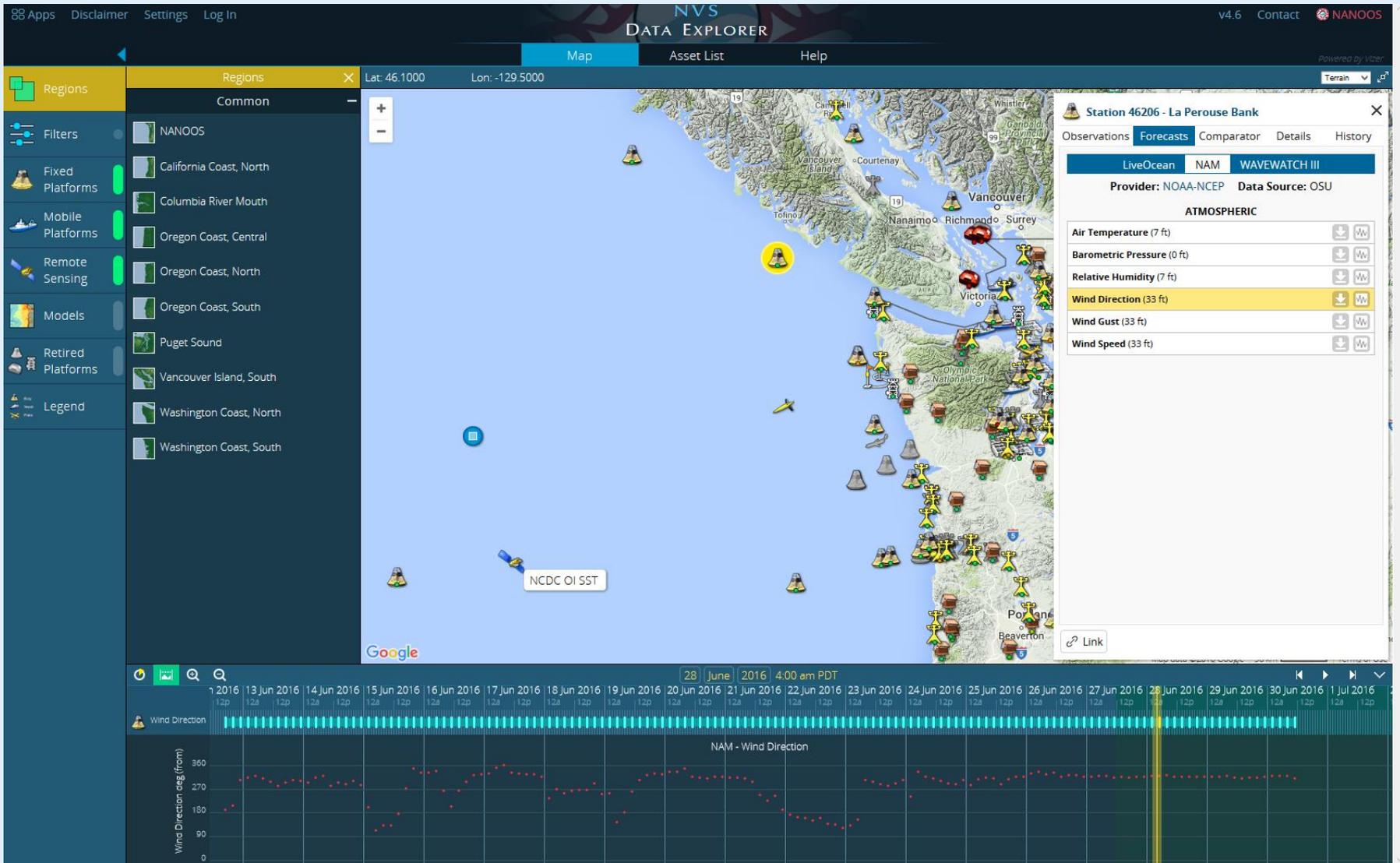
HYDROGRAPHIC

Water Level (0 ft)	0.3 ft	↓	W
Water Temperature (0 ft)	57 °F	↓	W

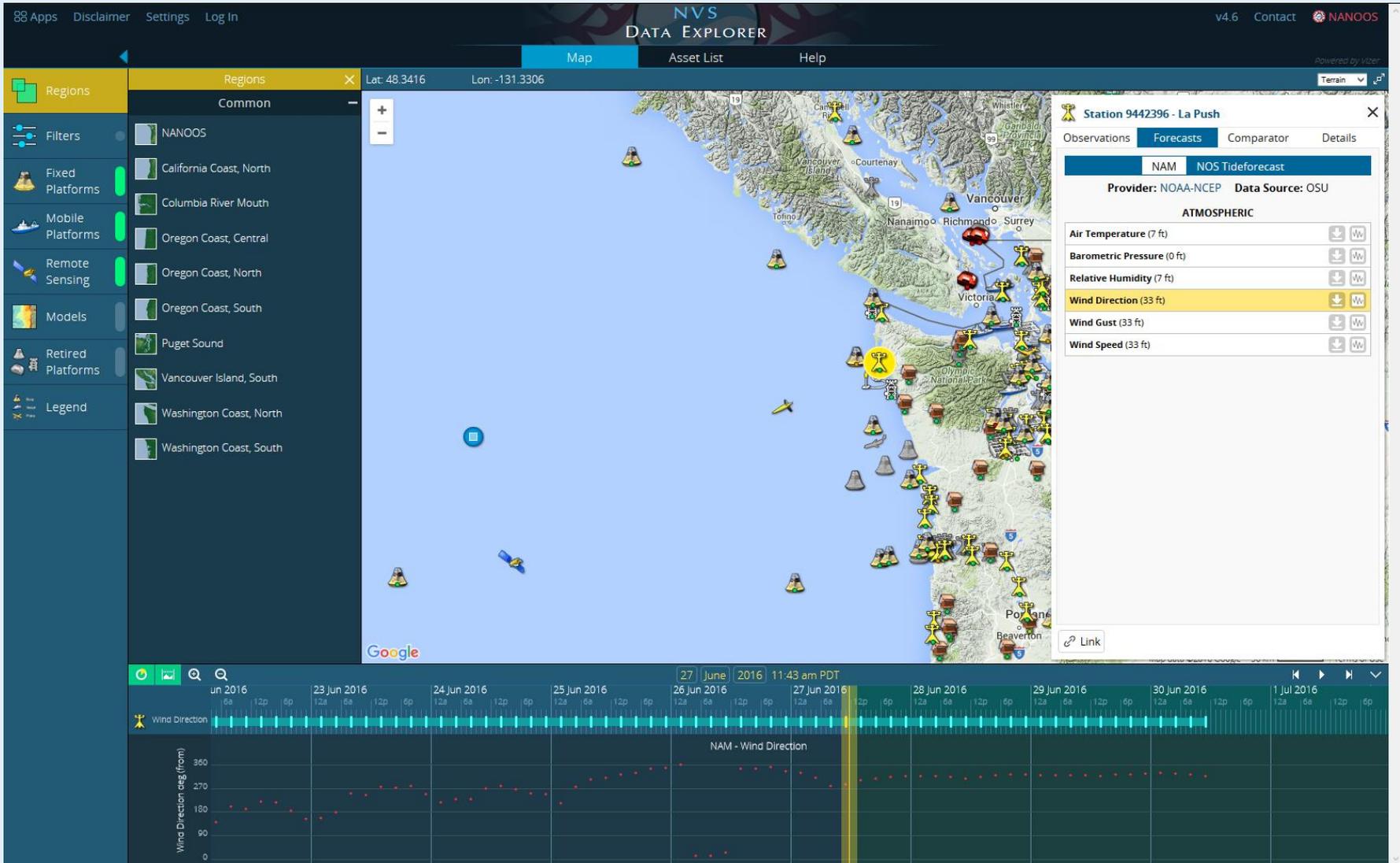
Link



WIND FORECAST



WIND FORECAST

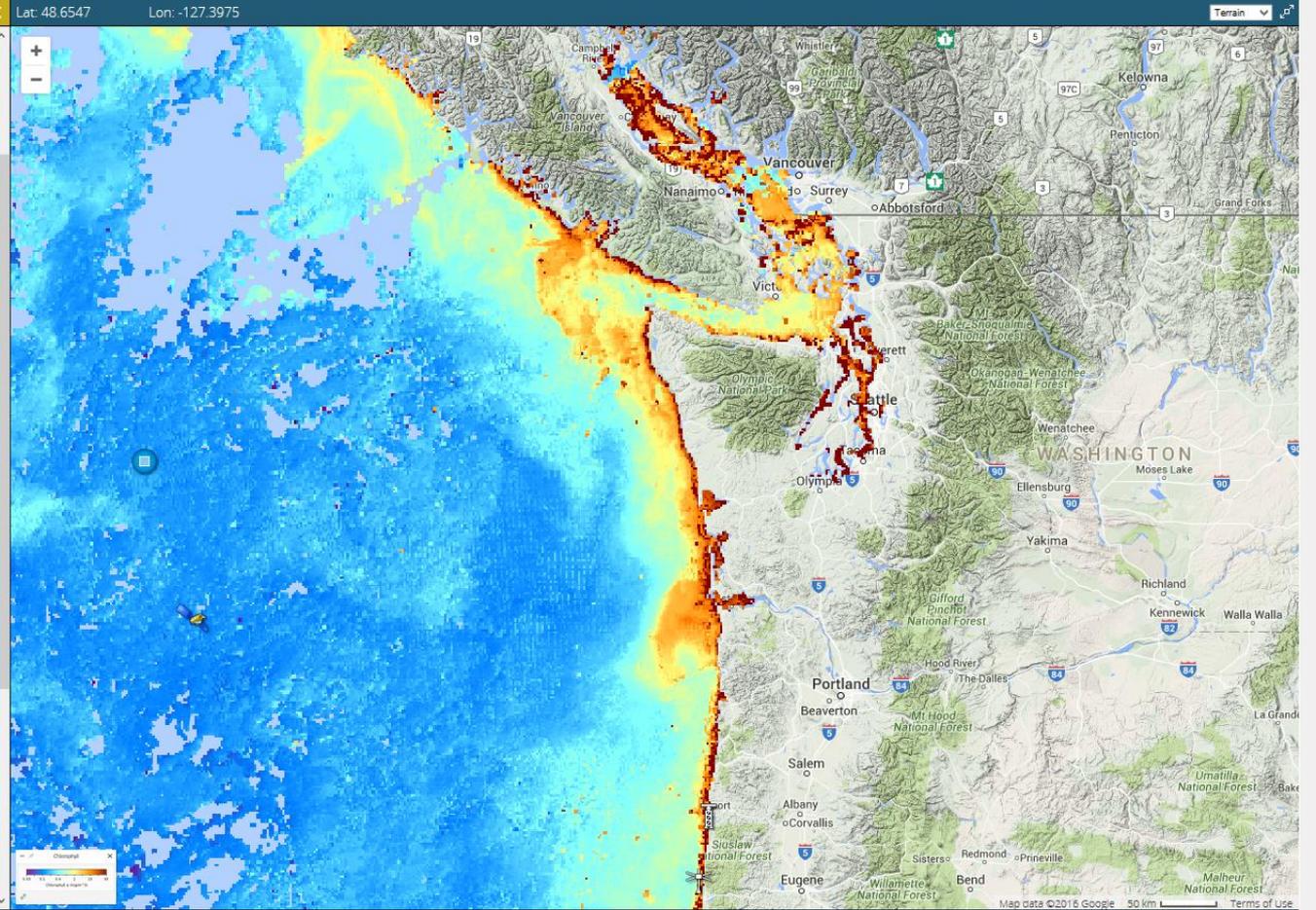


CHLOROPHYLL

Regions Remote Sensing Lat: 48.6547 Lon: -127.3975

Remote Sensing

- Radar
 - HF Radar
 - Surface Currents
 - OSU X-Band Radar
- Satellite
 - AVHRR
 - Water Temp. (1 Day)
 - Water Temp. (3 Days)
 - Water Temp. (8 Days)
 - Water Temp. (14 Days)
 - Water Temp. (1 Month)
 - MODIS
 - Chlorophyll (1 Day)
 - Chlorophyll (3 Days)
 - Chlorophyll (8 Days)**
 - Chlorophyll (14 Days)
 - Chlorophyll (1 Month)
 - NCDC OI SST
 - Water Temp. (Climate)
 - Water Temp. (Anomaly)
 - OSU AVISO Climate



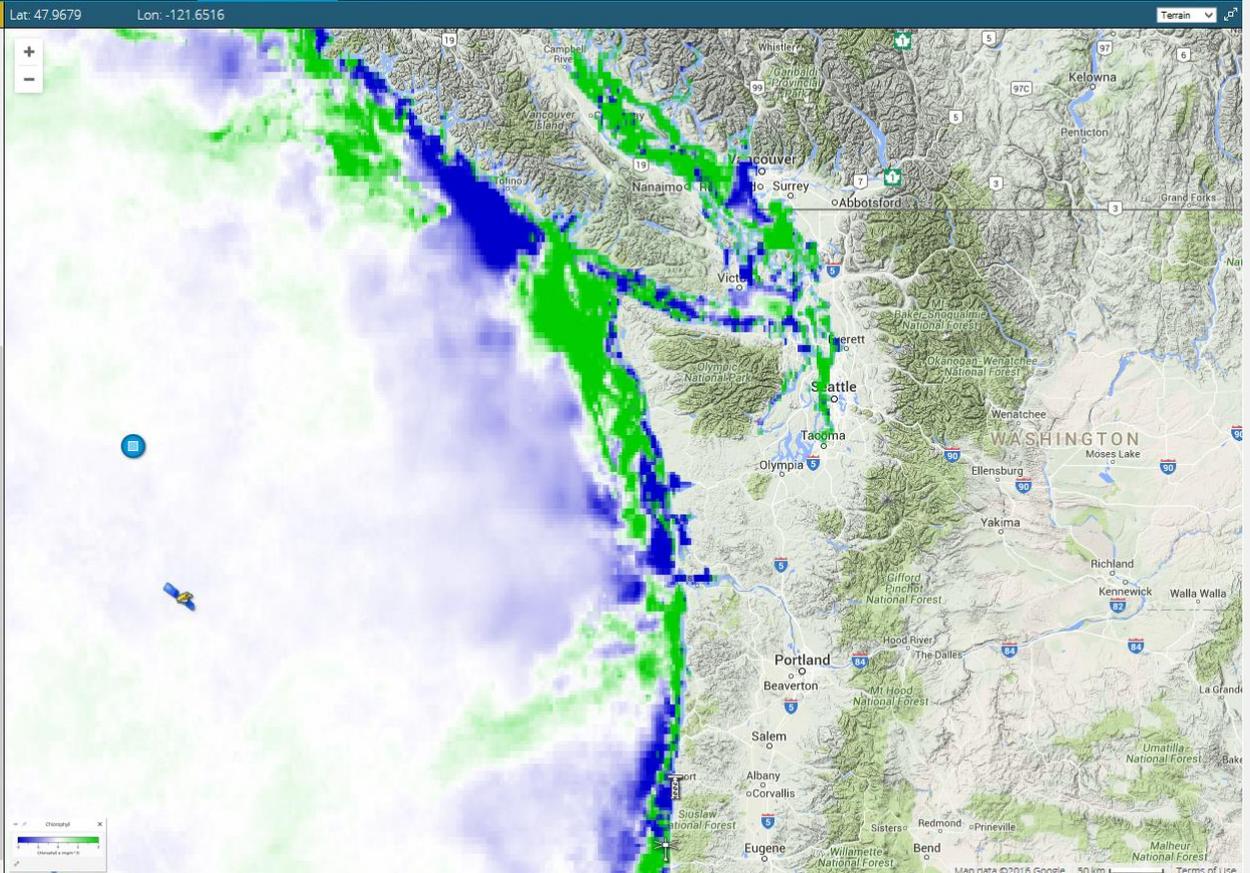
25 June 2016 1:00 pm PDT

18 Jun 2016 19 Jun 2016 20 Jun 2016 21 Jun 2016 22 Jun 2016 23 Jun 2016 24 Jun 2016 25 Jun 2016 26 Jun 2016 27 Jun 2016

12p 6p 12a 6a 12p 6p 12a 6a

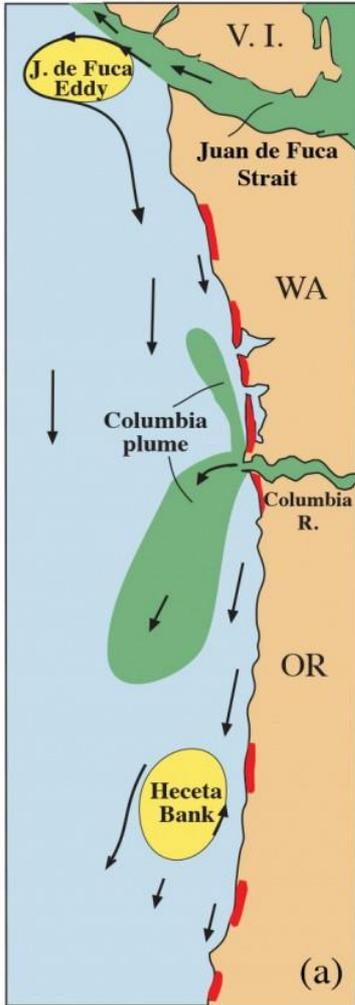
Chlorophyll

- Regions
- Remote Sensing
 - Water Temp. (8 Days)
 - Water Temp. (14 Days)
 - Water Temp. (1 Month)
 - MODIS
 - Chlorophyll (1 Day)
 - Chlorophyll (3 Days)
 - Chlorophyll (8 Days)
 - Chlorophyll (14 Days)
 - Chlorophyll (1 Month)
 - NCDC OI SST
 - Water Temp. (Climate)
 - Water Temp. (Anomaly)
 - OSU AVISO Climate
 - Sea Level (Climate)
 - Sea Level (Anomaly)
 - OSU MODIS Climate
 - Chlorophyll (Climate)
 - Chlorophyll (Anomaly)
 - Water Temp. (Climate)
 - Water Temp. (Anomaly)
- Filters
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- Mobile Platforms
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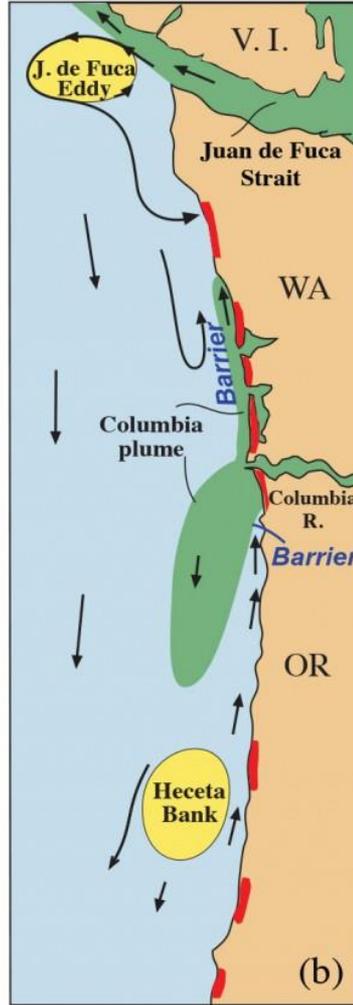


COLUMBIA RIVER PLUME

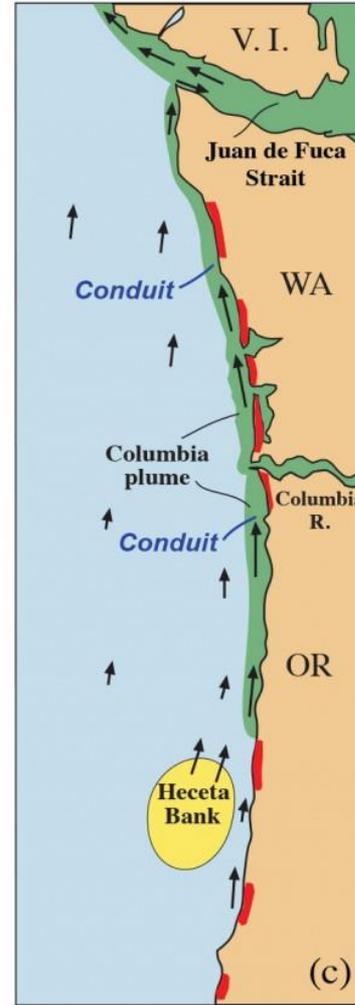
**Summer/Fall
good weather**



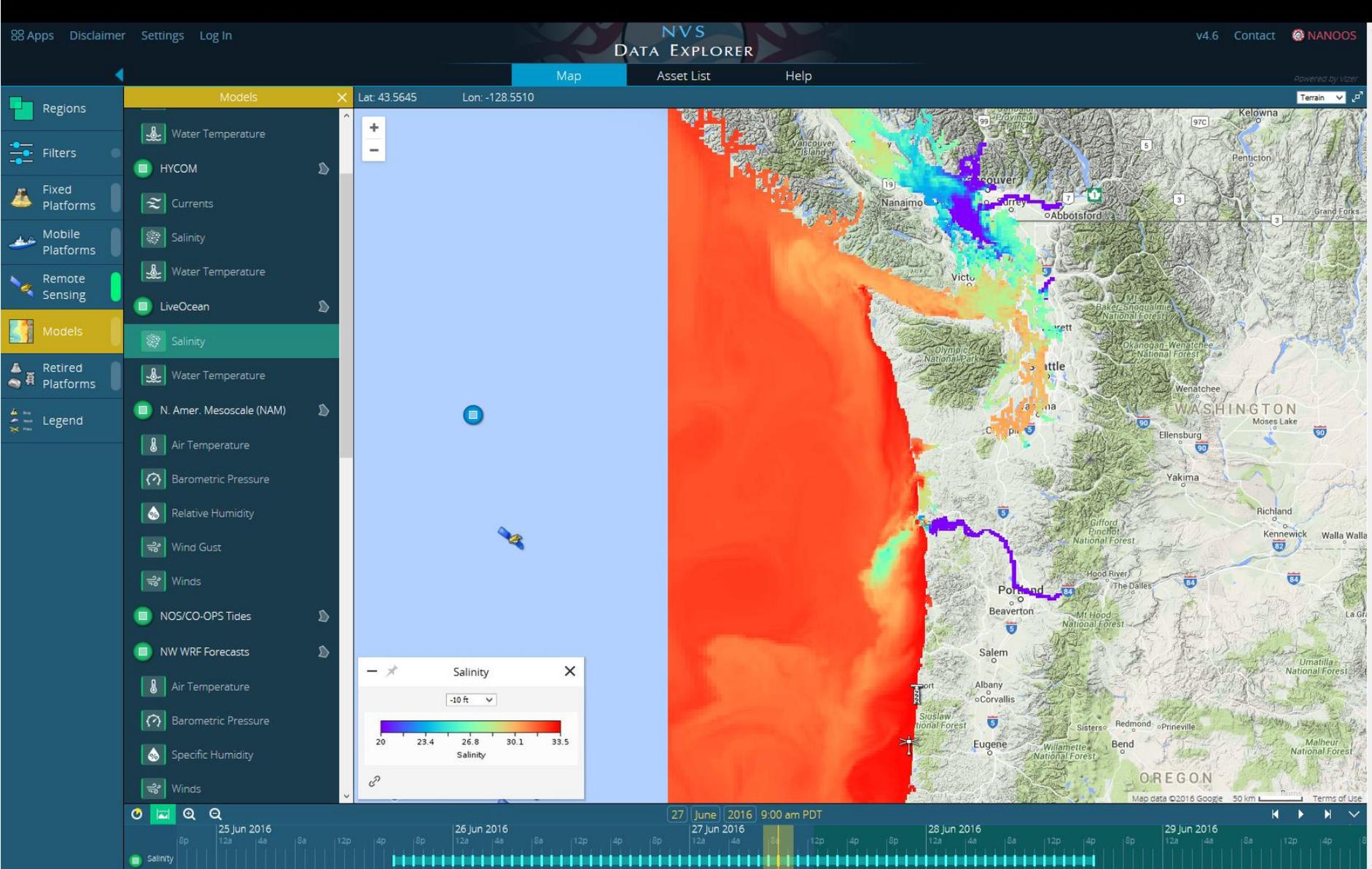
**Summer/Fall
weak storms**



**Winter/ Early Spring
strong storms**



LiveOcean Salinity @ -10ft



ESP DATA

