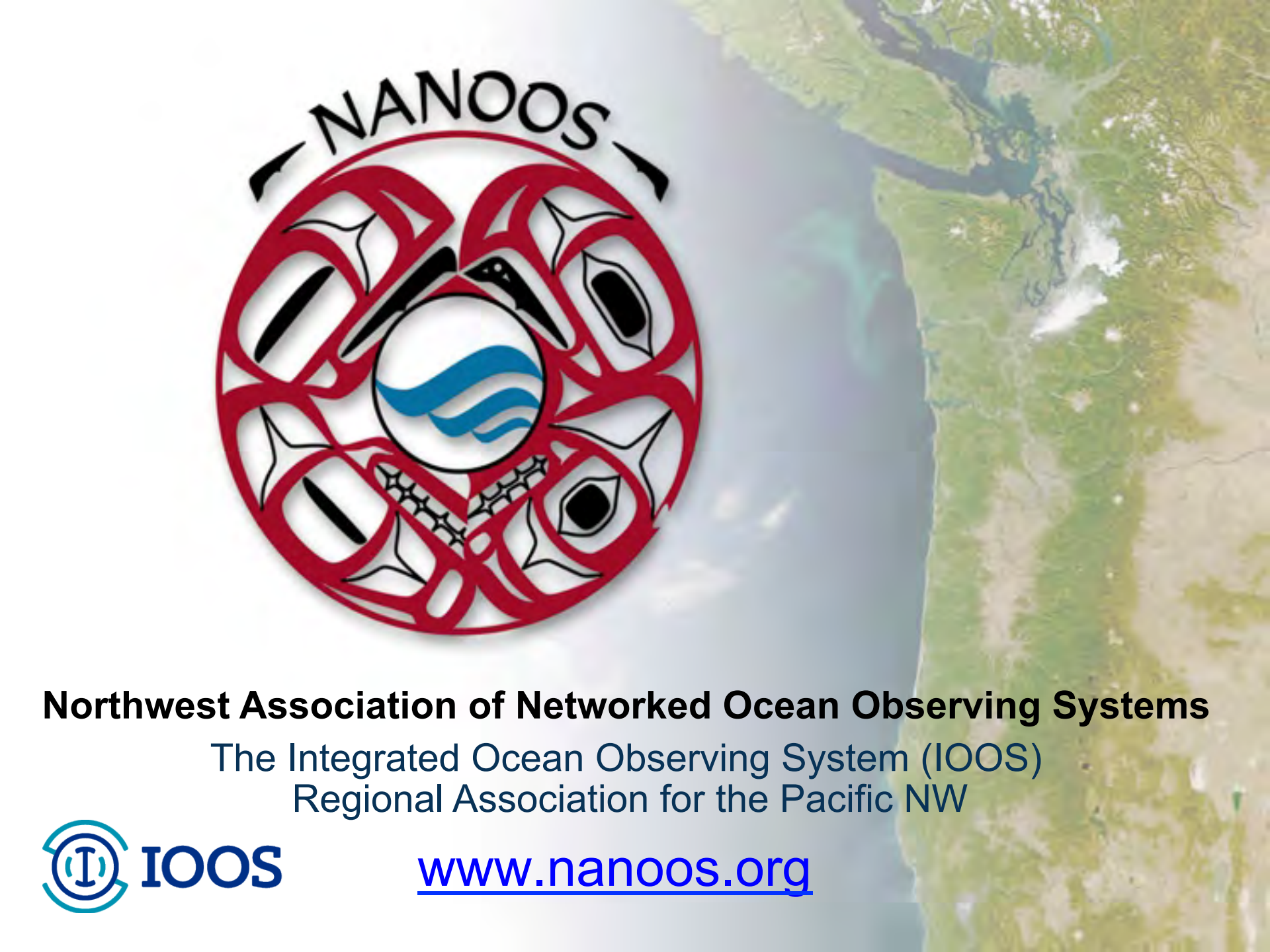


Northwest Association of Networked Ocean Observing Systems

The Integrated Ocean Observing System (IOOS)
Regional Association for the Pacific NW

IOOS

www.nanoos.org

U.S. Integrated Ocean Observing System (IOOS)

- ***IOOS Vision:***

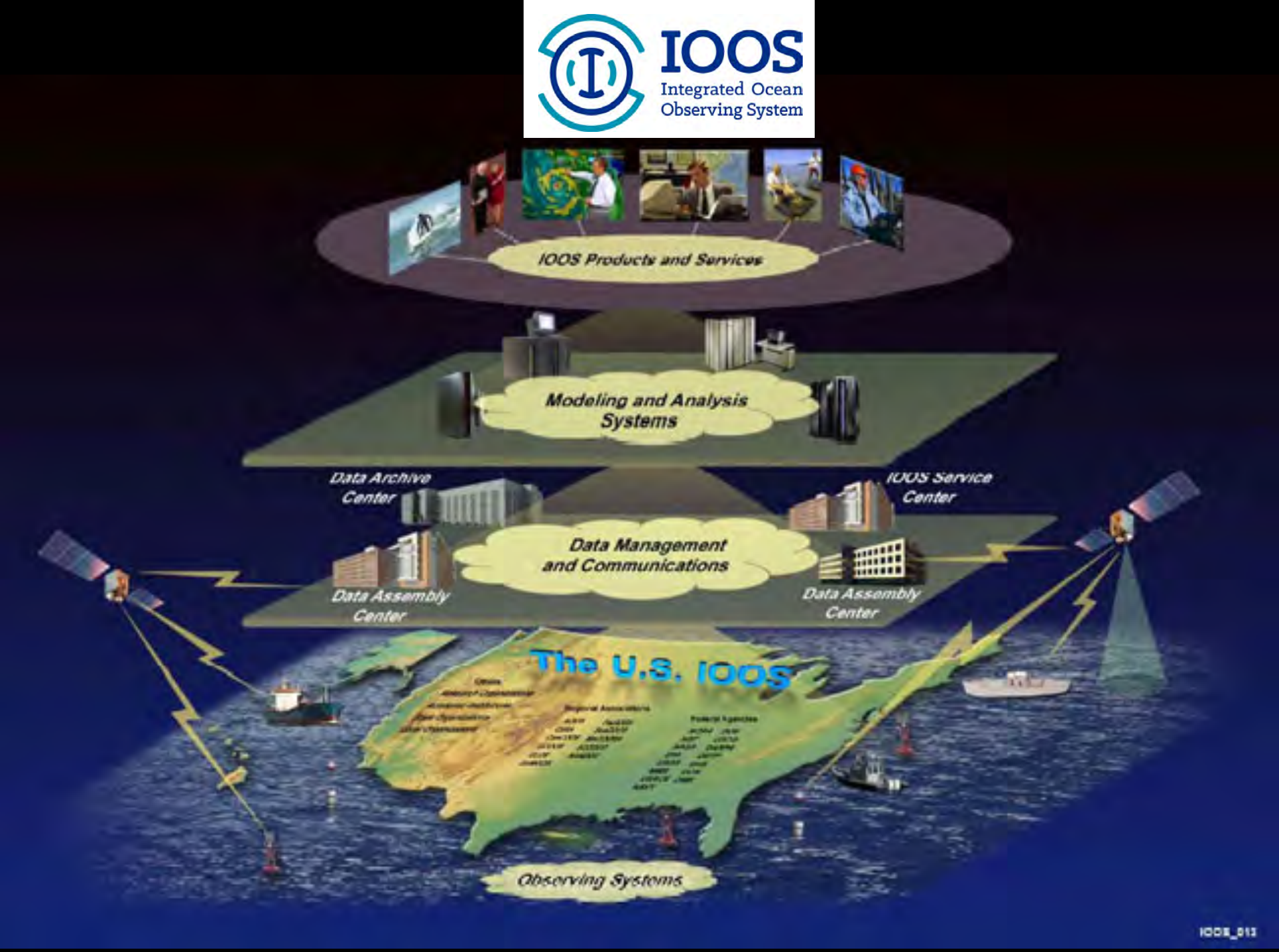
A fully integrated ocean observing system to provide service to the Nation through:

- improved ecosystem and climate understanding;
- sustained living marine resources;
- improved public health and safety;
- reduced impacts of natural hazards and environmental changes; and
- enhanced support for marine commerce and transportation.

- ***IOOS Mission:***

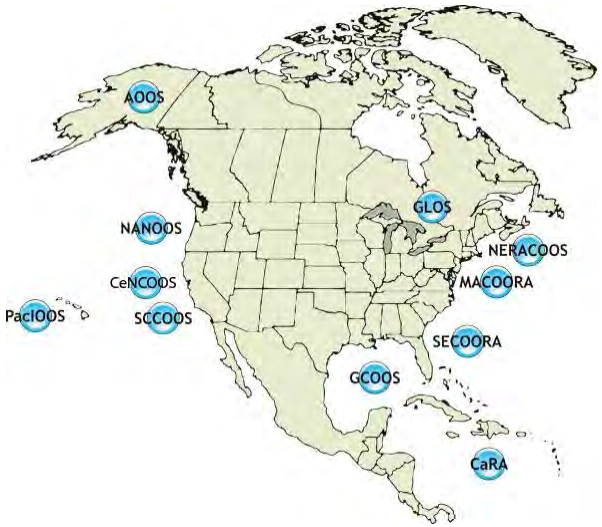
Lead the integration of ocean, coastal, and Great Lakes observing capabilities, in collaboration with Federal and non-Federal partners, to **maximize access to data** and **generation of information products**, ***inform decision making***, and ***promote economic, environmental, and social benefits to our Nation and the world***.

IOOS


IOOS
Integrated Ocean Observing System
IOOS Products and Services
Modeling and Analysis Systems
Data Archive Center
IOOS Service Center
Data Management and Communications
Data Assembly Center
Data Assembly Center
The U.S. IOOS
Observing Systems

IOOS
Integrated Ocean Observing System

CONSISTENT NATIONAL CAPABILITY



assure

Reg. Assn's

engage

Leverage and Link

DIVERSE LOCAL STAKEHOLDERS

NANOOS serves the Pacific Northwest

Coastal ocean:
Northern extent of California Current
Winds, topography, freshwater input, ENSO & other climate cycles

Major inland basins:
Puget Sound-Georgia Basin, Columbia River
Urban centers, nearshore development, climate variation

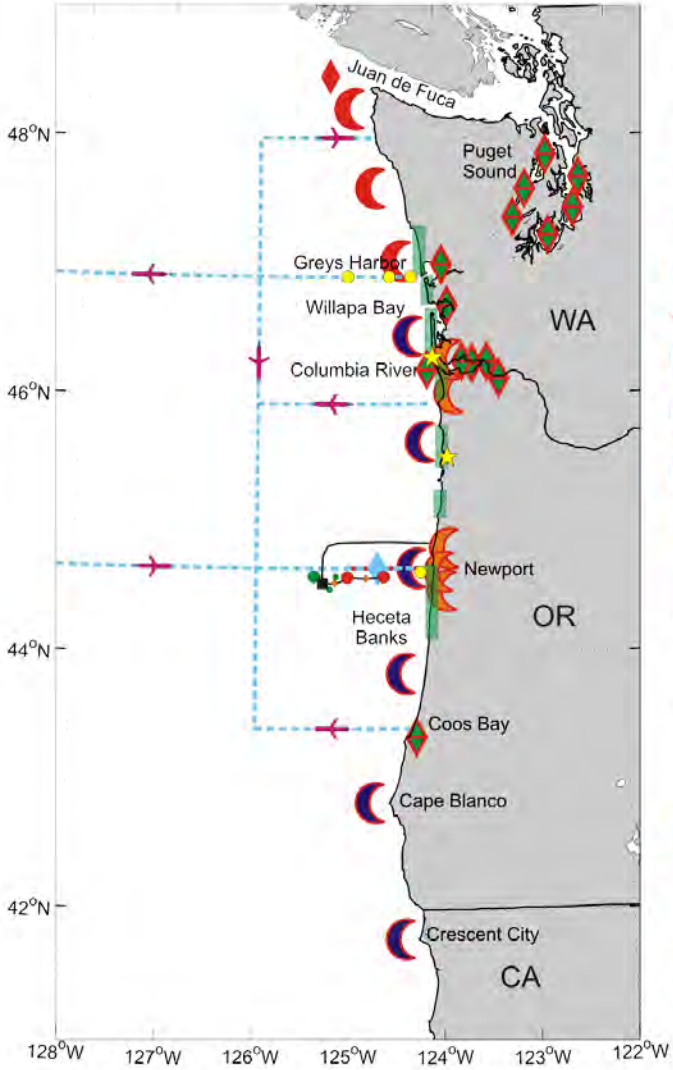
Coastal estuaries:
Willapa Bay, Grays Harbor, Yaquina Bay, Coos Bay
Resource extraction, development, climate

Shorelines:
Rocky to sandy, dynamic: storms, erosion
Winds, development, climate

NANOOS Region User Groups:

Maritime: shipping, oil transport/spill remediation
Fisheries: salmon, shellfish, crab, aquaculture
Environmental management: HABs, hypoxia
Shoreline: erosion, inundation
Hazards: Search and rescue, national security
Educators: formal, informal, research
Marine recreation: boating, surfing, diving

PNW Ocean Observing Systems Design



NANOOS RCOOS Enhancement Conceptual Design

- Proposed new coastal buoy
- Existing coastal buoy to be sustained
- Existing estuarine buoys* to be sustained in partnership
- Existing glider track to be sustained
- Proposed new long-range HF site
- Existing long-range (180 km range) HF site to be sustained in partnership
- Existing standard-range (50 km range) HF site to be sustained in partnership
- Proposed new port wave radars
- Shoreline assessment to be sustained in partnership

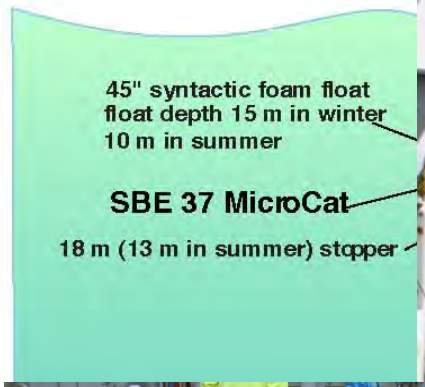
*estuarine buoys are more numerous than symbols

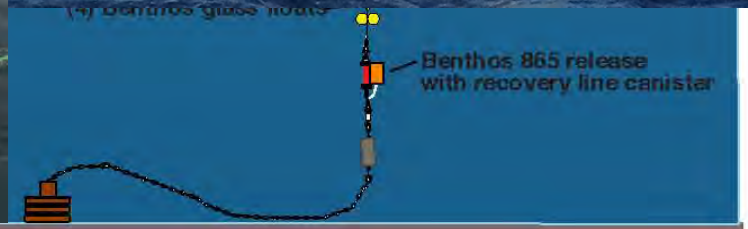
OOI Conceptual Design

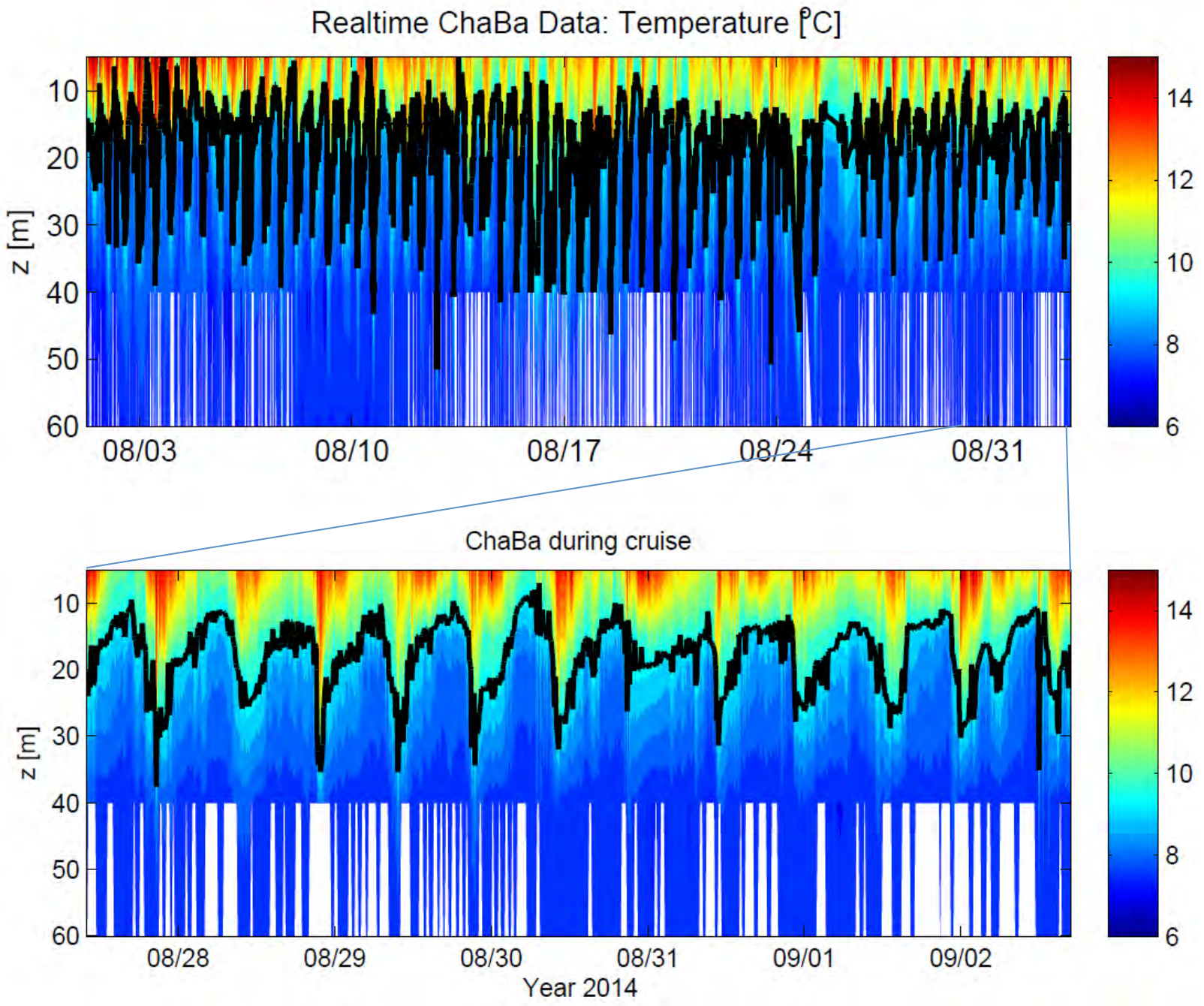
- Coastal mooring
- Cabled mooring
- Deepwater column mooring
- High voltage primary node
- Medium voltage primary node
- RSN cable
- Glider track
- Glider

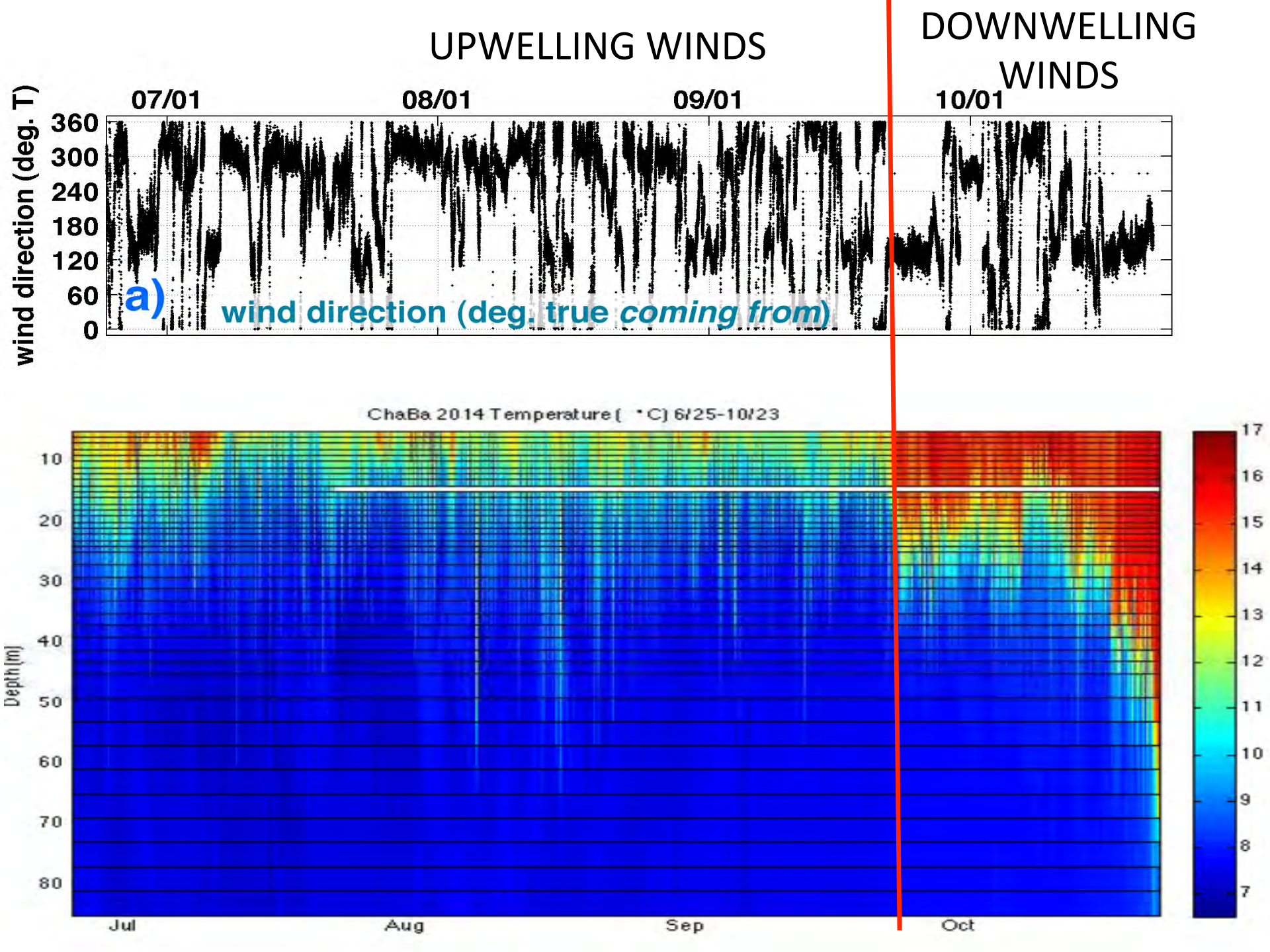
"A multi-platform high-resolution coastal ocean observing sensor array for researching Washington coastal waters and ecosystem response to climate change."

Funded by Murdock Charitable Trust & UW now sustained as part of NANOOS






Realtime ChaBa Data: Temperature [°C]
z [m]
10
20
30
40
50
60
08/03
08/10
08/17
08/24
08/31
14
12
10
8
6
ChaBa during cruise
z [m]
10
20
30
40
50
60
08/28
08/29
08/30
08/31
09/01
09/02
Year 2014
14
12
10
8
6


UPWELLING WINDS
DOWNWELLING WINDS
07/01
08/01
09/01
10/01
wind direction (deg. T)
360
300
240
180
120
60
0
a)
wind direction (deg. true coming from)
ChaBa 2014 Temperature (°C) 6/25-10/23
Depth (m)
10
20
30
40
50
60
70
80
Jul
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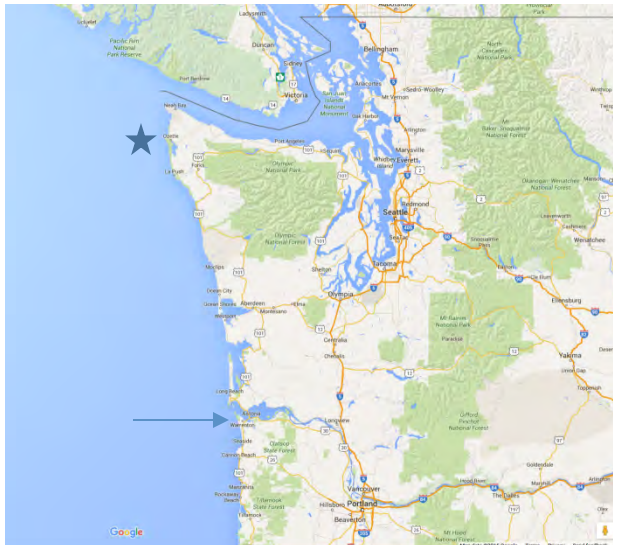
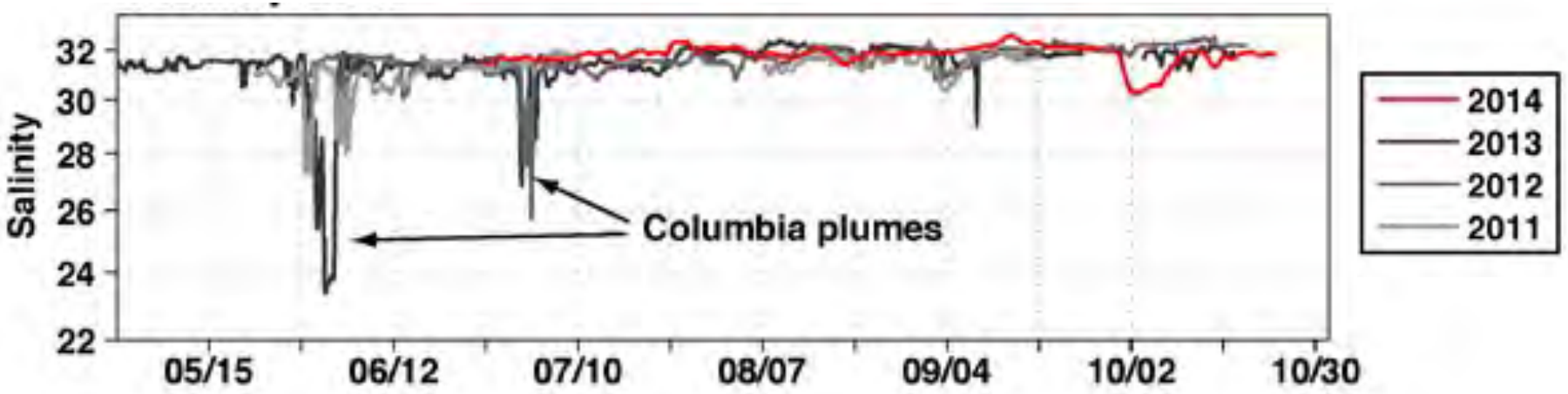
7

Better definition of Columbia River influence





- PSEMP Marine Waters Workgroup. 2015. Puget Sound marine waters: 2014 overview. S. K. Moore, R. Wold, K. Stark, J. Bos, P. Williams, K. Dzinbal, C. Krembs and J. Newton (Eds). URL: *http://www.psp.wa.gov/PSEMP/PSmarinewatersoverview.php.*

Effort:

- Observations
- Modeling/forecasts
- Data management and communication
- Tailored user-driven products
- Outreach
- Education

(All NANOOS assets and data streams)

Data Explorer

Tsunami Evacuation Zones

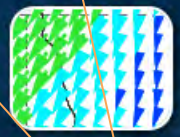
Boaters

Tuna Fishers

Shellfish Growers

Beach and Shoreline Changes

Maritime Operations



High Frequency Radar

Cruises

Gliders

Help

NVS for specific user groups with targeted subsets of the data

Additions & Updates

View Last 3 Months

APL-UW NPB-1 — *Updated on 3 Oct 2014*
Meteorological sensors were redeployed on Oct 1, and are now available on NVS.

CMOP Saturn02 — *Updated on 30 Sep 2014*
Summer-deployment buoy has been recovered, and returned as only a seasonal aid to navigation (no monitoring sensors) during winter. Next sensor deployment will be in late April or May 2015.

CMOP Saturn08 — *Added on 29 Sep 2014*
New monitoring LOBO buoy now on NVS. First deployed Sept 2013.

CMOP Saturn09 — *Added on 29 Sep 2014*

What are people saying about NANOOS?

"NANOOS provides critical life safety information to the public, aiding coastal communities to build resiliency."

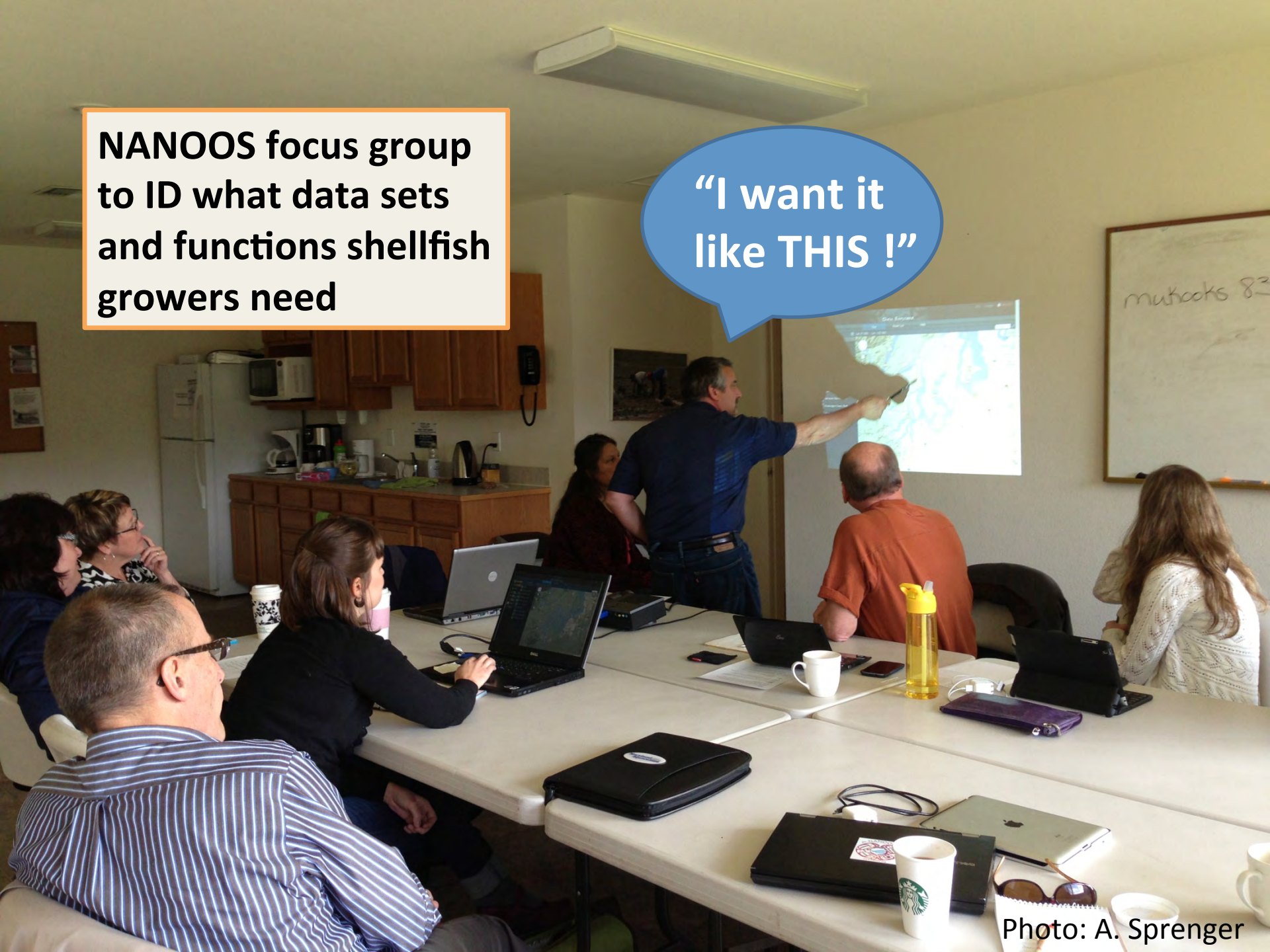
- Jonathan Allan, Coastal Geomorphologist
Oregon Department of Geology and Mineral Industries

"This current generation of shellfish farmer is reliant upon data and services from NANOOS. Checking the NANOOS app before seeding a beach or filling a setting tank has become standard practice."

- Margaret Barrette, Pacific Coast Shellfish Growers Association Director

"Ships crossing the Columbia River Bar face one of the most dangerous harbor entrances in the world. The Columbia River Bar Pilots rely on weather forecasts, real time buoy data along with wave and current models when determining safe times for ships to cross the bar. NANOOS provides an excellent location for us to see and compare all the available data sources."

- Captain Dan Jordan, Columbia River Bar Pilots


NANOOS focus group to ID what data sets and functions shellfish growers need
“I want it like THIS !”
Photo: A. Sprenger

NOAA HOME WEATHER OCEANS FISHERIES CHARTING SATELLITES CLIMATE RESEARCH COASTS CAREERS

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

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'Like putting headlights on a car'

Pacific oysters gain from IOOS® data

Promoting Economic Vitality

About six years ago, production at some Pacific Northwest oyster hatcheries began declining at an alarming rate, posing severe economic impact and challenging a way of life held by shellfish growers for more than 130 years.

By 2008, the oyster harvest at Whiskey Creek, a major Oregon supplier to the majority of West Coast oyster farmers, plummeted 80 percent. At about the same time, corrosive, acidified seawater was hitting the shores of the Pacific.

Something had to be done. Oyster production accounts for more than $84 million of the West Coast shellfish industry, which supports more than 3,000 jobs.

"When you see oyster shells dissolving in water, there's a compelling need to know why," says Bill Dewey of Taylor Shellfish Farms in Washington state.

Thanks to a $500,000 federal investment in monitoring coastal seawater strengthened by data and observational information from the U.S. **Integrated Ocean Observing System** (IOOS®) and the **NOAA Ocean Acidification Program**, oyster hatcheries on the verge of collapse just a few years ago are again major contributors to the $111 million West Coast shellfish industry.

IOOS is a NOAA-led interagency and regional effort aimed at "knowing" — that

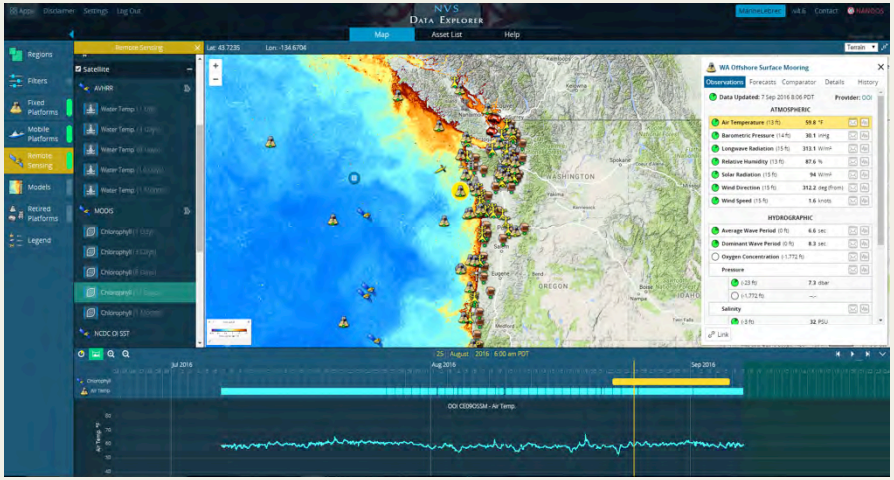
IOOS partners in the Northwest Association of Networked Ocean Observing Systems (NANOOS) deployed this buoy in 2010 as part of a three-piece observing array to assess issues in the Northwest, including **ocean acidification**, **hypoxia and harmful algal blooms**, and **climate change**. The coastal buoy will aid computer models that predict ocean and atmospheric conditions. Known as "Chá bă," the buoy is named for the Native American word (pronounced "chay buh") for "whale tail."

(Photo courtesy of Dr. John Payne, Pacific Ocean Shelf

NANOOS

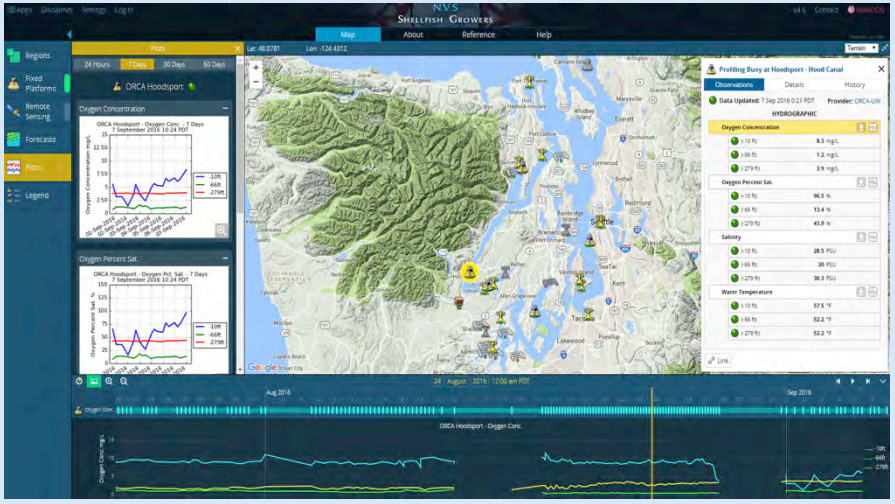
"Putting an IOOS buoy in the water is like putting headlights on a car. It lets us see changing water conditions in real time," says Mark Wiegardt, co-owner of Whiskey Creek Shellfish Hatchery.

Useful tools from NANOOS' data portal, the NANOOS Visualization System (NVS)



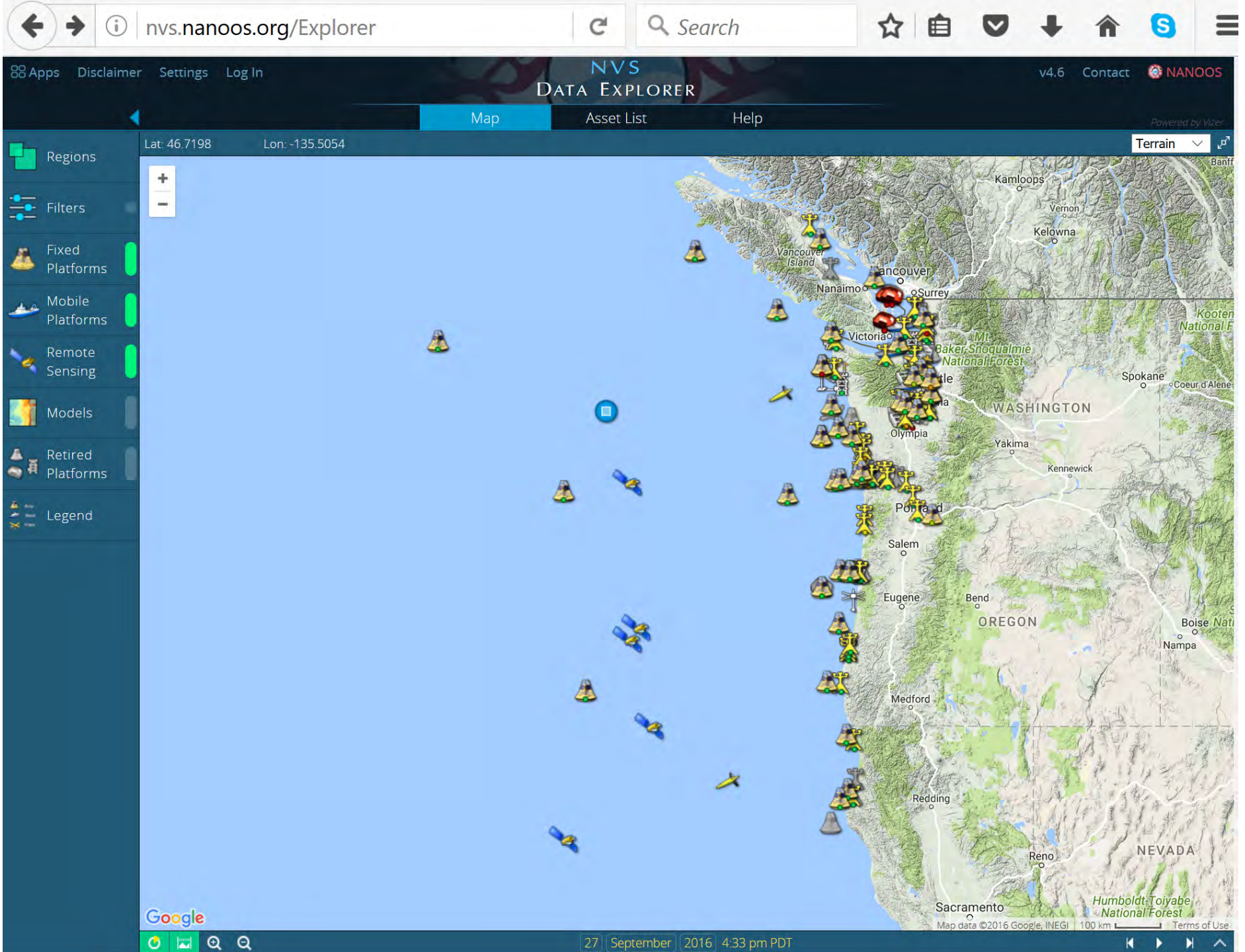
The **NVS Data Explorer** serves hydrographic and atmospheric data from fixed and mobile platforms, satellite imagery, and computer models to provide real-time conditions and forecasts.

http://nvs.nanoos.org/Explorer



The specialized **NVS Shellfish Growers** app provides real-time pH, pCO_2, oxygen, salinity, temperature, and other data, allowing for better management and decision making for the shellfish industry, tribes, and state managers.

http://nvs.nanoos.org/ShellfishGrowers


nvs.nanoos.org/Explorer
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Asset List
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Filters
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
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Terrain
Kamloops
Vernon
Kelowna
Vancouver Island
Nanaimo
Surrey
Victoria
Mt Baker-Snoqualmie National Forest
Spokane
Coeur d'Alene
WASHINGTON
Olympia
Yakima
Kennewick
Salem
Eugene
Bend
OREGON
Boise
Nampa
Medford
Redding
Reno
NEVADA
Sacramento
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Map data ©2016 Google, INEGI
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Terms of Use
27
September
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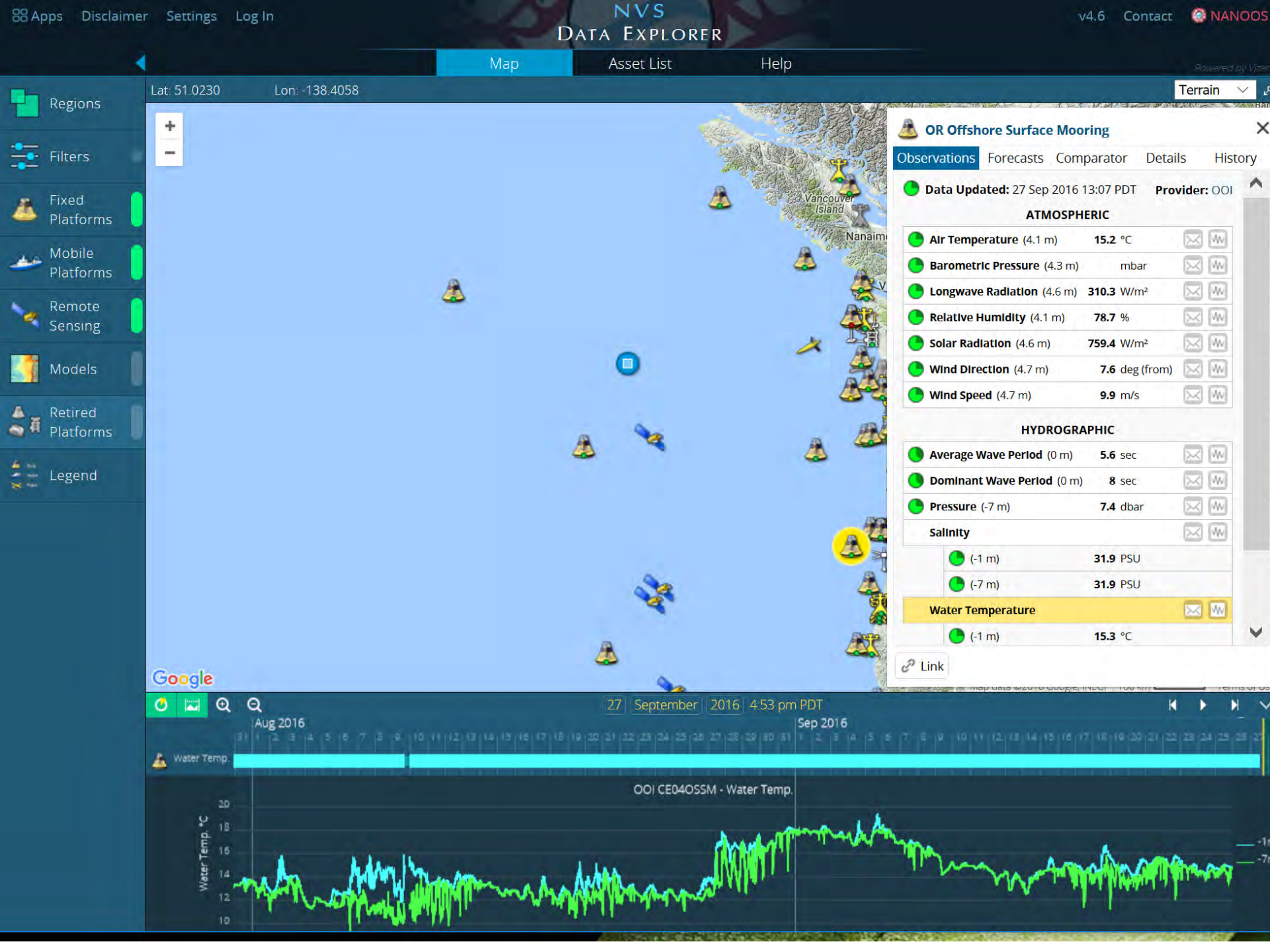
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Legend
Lat: 51.0230
Lon: -138.4058
Terrain
Vancouver Island
Nanaimo
OR Offshore Surface Mooring
Observations
Forecasts
Comparator
Details
History
Data Updated: 27 Sep 2016 13:07 PDT
Provider: OOI
ATMOSPHERIC
Air Temperature (4.1 m) 15.2 °C
Barometric Pressure (4.3 m) mbar
Longwave Radiation (4.6 m) 310.3 W/m²
Relative Humidity (4.1 m) 78.7 %
Solar Radiation (4.6 m) 759.4 W/m²
Wind Direction (4.7 m) 7.6 deg (from)
Wind Speed (4.7 m) 9.9 m/s
HYDROGRAPHIC
Average Wave Period (0 m) 5.6 sec
Dominant Wave Period (0 m) 8 sec
Pressure (-7 m) 7.4 dbar
Salinity
(-1 m) 31.9 PSU
(-7 m) 31.9 PSU
Water Temperature
(-1 m) 15.3 °C
Link
Google
27 September 2016 4:53 pm PDT
Aug 2016
Sep 2016
Water Temp.
OOI CE04OSSM - Water Temp.
Water Temp. °C
20
18
16
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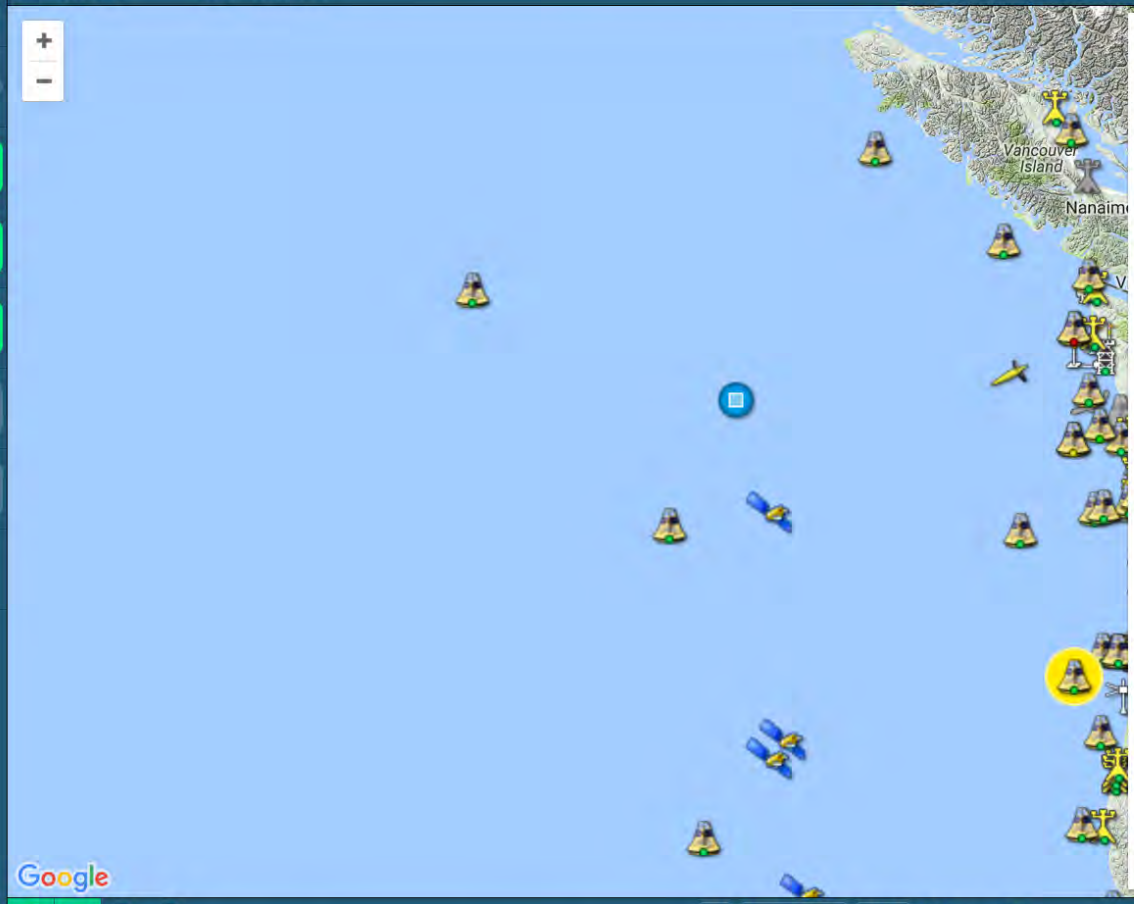
Regions
Filters
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend

Lat: 49.1625 Lon: -124.2554

Terrain



OR Offshore Surface Mooring

Observations Forecasts Comparator Details History

LiveOcean NAM OSU WWIII WAVEWATCH III

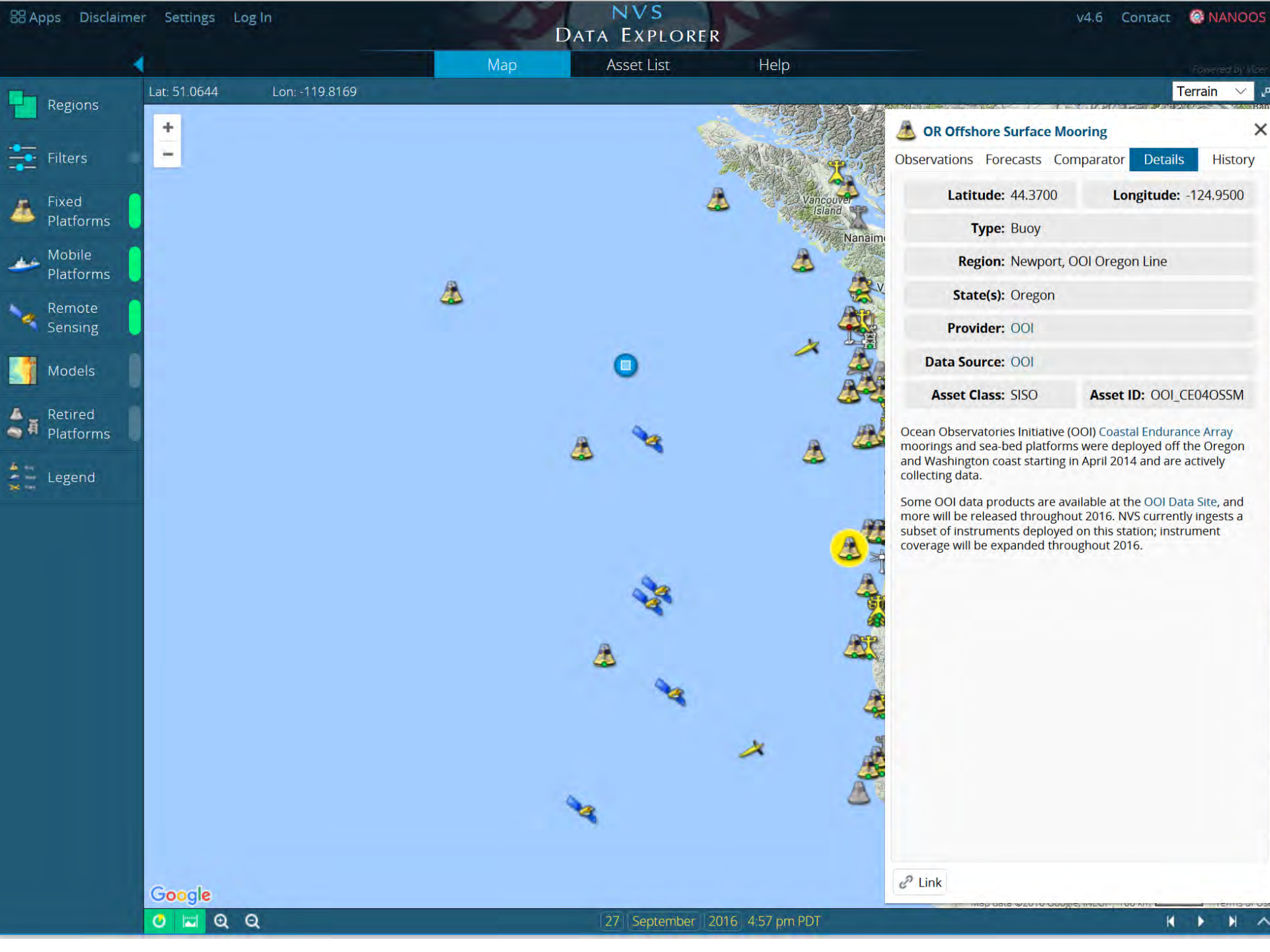
Provider: CMG-UW **Data Source:** CMG-UW/MSAzure

HYDROGRAPHIC

Salinity	
Water Temperature	

Link

27 September 2016 4:55 pm PDT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Regions
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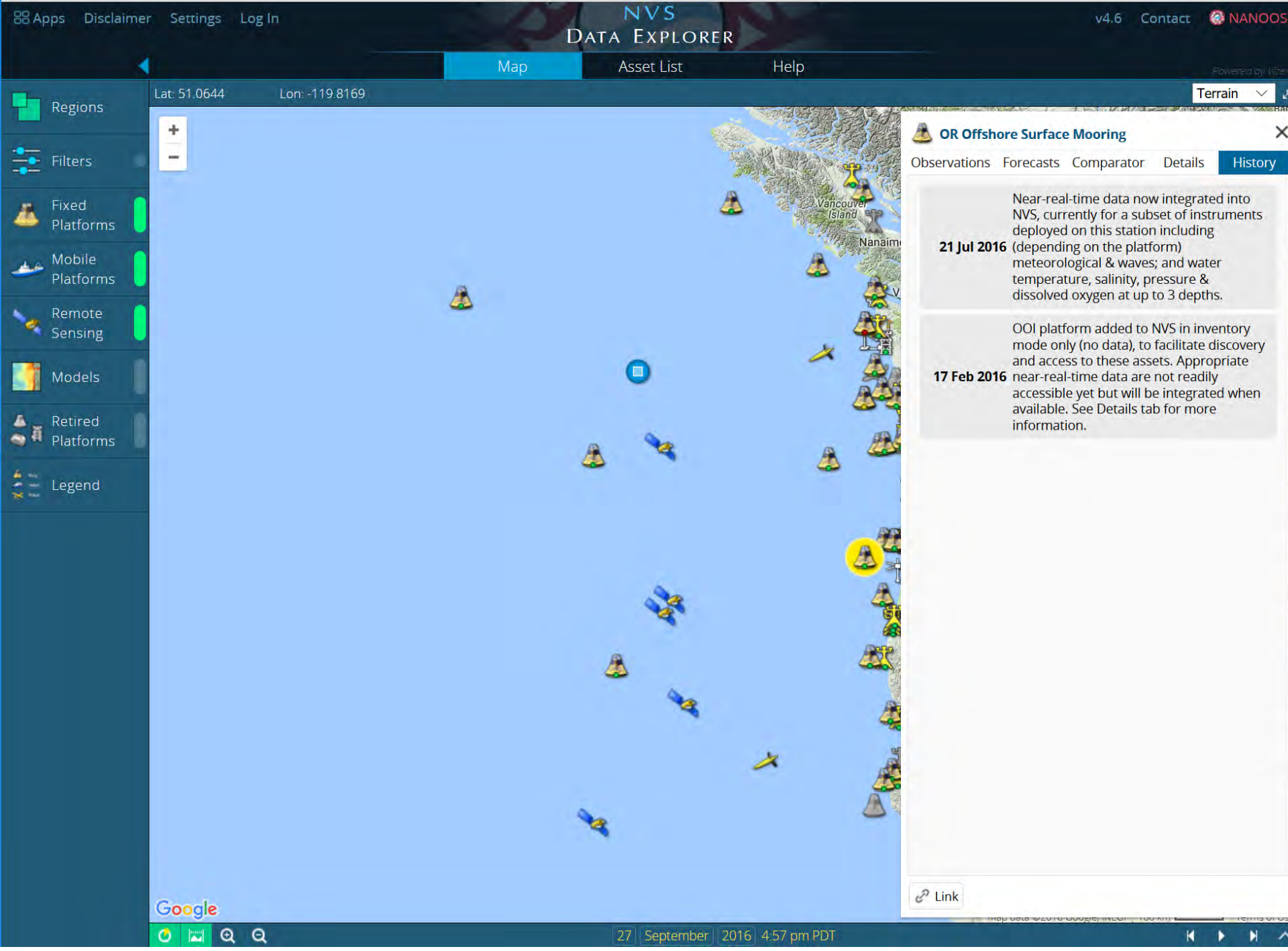
Fixed Platforms
Mobile Platforms
Remote Sensing
Models
Retired Platforms
Legend
Lat: 51.0644
Lon: -119.8169
Terrain
Vancouver Island
Nanaimo
OR Offshore Surface Mooring
Observations
Forecasts
Comparator
Details
History
Latitude: 44.3700
Longitude: -124.9500
Type: Buoy
Region: Newport, OOI Oregon Line
State(s): Oregon
Provider: OOI
Data Source: OOI
Asset Class: SISO
Asset ID: OOI_CE04OSSM
Ocean Observatories Initiative (OOI) Coastal Endurance Array moorings and sea-bed platforms were deployed off the Oregon and Washington coast starting in April 2014 and are actively collecting data.
Some OOI data products are available at the OOI Data Site, and more will be released throughout 2016. NVS currently ingests a subset of instruments deployed on this station; instrument coverage will be expanded throughout 2016.
Link
Google
27
September
2016
4:57 pm PDT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Asset List
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Regions
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Mobile Platforms
Remote Sensing
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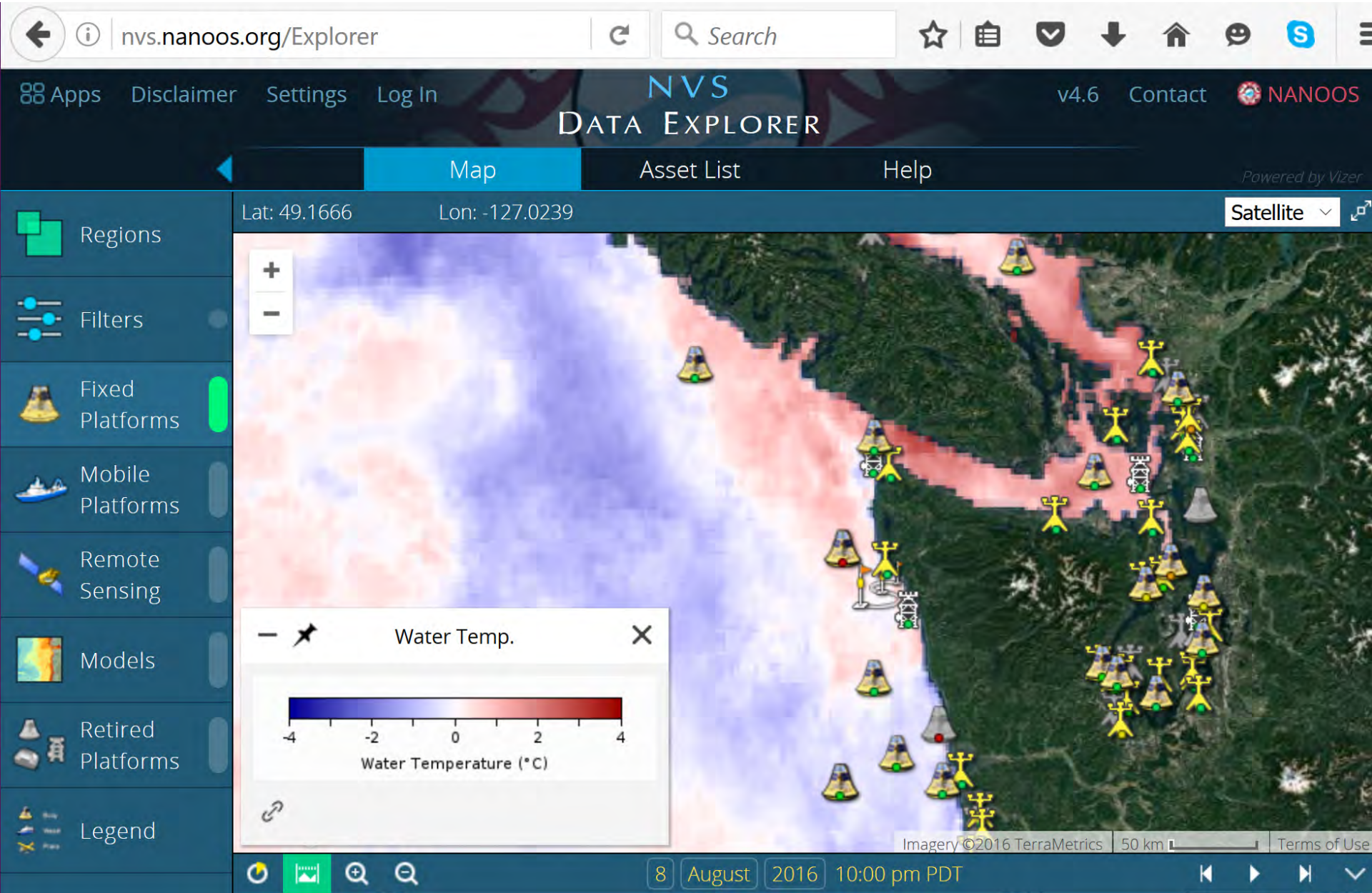
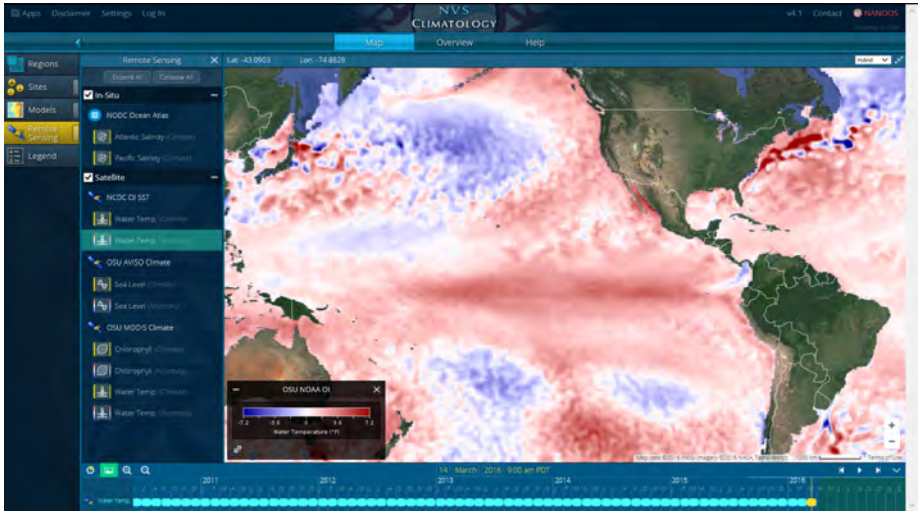
Retired Platforms
Legend
Lat: 51.0644
Lon: -119.8169
Terrain
Vancouver Island
OR Offshore Surface Mooring
Observations
Forecasts
Comparator
Details
History
21 Jul 2016
Near-real-time data now integrated into NVS, currently for a subset of instruments deployed on this station including (depending on the platform) meteorological & waves; and water temperature, salinity, pressure & dissolved oxygen at up to 3 depths.
17 Feb 2016
OOI platform added to NVS in inventory mode only (no data), to facilitate discovery and access to these assets. Appropriate near-real-time data are not readily accessible yet but will be integrated when available. See Details tab for more information.
Link
Google
27 September 2016 4:57 pm PDT

NANOOS observations and data



Recent Advances in NANOOS



Visualizing Climatologies

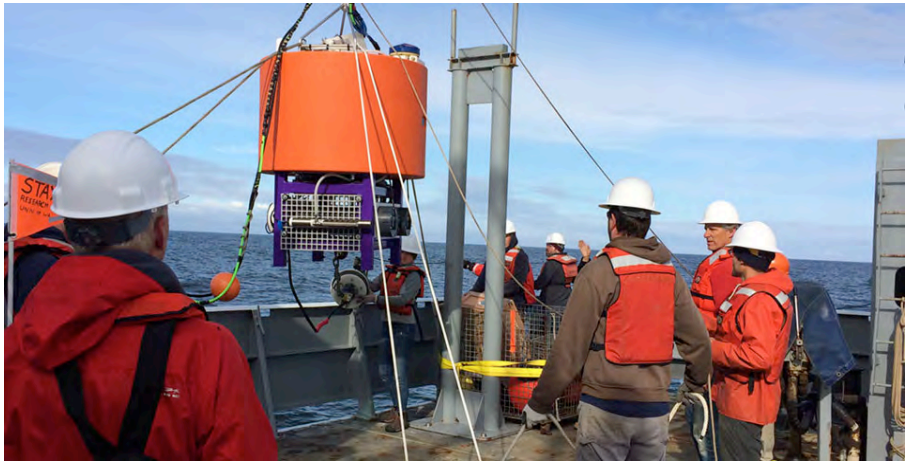
The NVS Climatology app provides users with a rich interface of long-term average conditions (climatology) and present-day departures from average (anomaly). Data visualizations are from buoys, satellites, and weather stations in the Pacific Northwest, enabling users to compare current conditions against conditions measured in the past.

NANOOS hosted a Pacific Anomalies 2 Workshop

Measuring HABs Remotely

The IOOS-supported "**Environmental Sample Processor**" was deployed off La Push at our NEMO buoy and is relaying data on harmful algal bloom (HAB) species and domoic acid toxin concentration through the NVS portal.

"Having the NANOOS automated HAB sampler, with toxin assessment capability gives tribes the forewarning they need to adjust sampling protocols and better protect the health of coastal residents, tribal and non-tribal." - Joe Schumacker, Quinault Indian Nation



Mickett (UW), Moore (NOAA) et al.

Partnerships

with federal, academic, state, industry partners

Cha'ba is a national OA buoy…

www.pmel.noaa.gov/co2/story/Strategy+for+OA+Observations

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PMEL CARBON PROGRAM

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Strategy for OA Observations

PMEL is developing a global network of ocean acidification observations

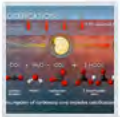
The existing global carbon observatory network of repeat hydrographic surveys, time-series stations and ship-based underway surface observations in the open ocean provide a strong foundation of carbon chemistry observations to begin addressing the problem of ocean acidification. Indeed, much of our present understanding of the long-term changes in the carbon system is derived from the repeat ocean sections and time-series measurements.

A major project for our group is to **expand the global moored and ship-based network by adding pH and other biogeochemical measurements** to provide important information on the changing conditions in the open ocean and coastal waters. See the map of planned monitoring sites to the right. This network will provide a better understanding of the temporal and spatial scales of variability in ocean carbon chemistry and biology and the observational basis for developing predictive models for future changes in ocean acidification and its consequences for marine ecosystems.

Location of planned OA monitoring and research sites and affiliated NOAA labs.

U.S. **coastal and estuarine environments** do not currently have coordinated carbon observing networks, as in the open ocean, and are presently grossly under-sampled. There is a critical need for intensive time series measurements on moored buoys and repeat hydrographic cruises in high productivity coastal and estuarine systems as CO_2 and carbonate ion concentrations in these waters can vary substantially on timescales from hours to decades due to tides, photosynthesis, and river or ground water inputs. In response to that need, we are adding carbon and pH sensors to

RELATED STORIES



Ocean Acidifica …
Fundamental changes in seawater chemistry are occurring throu …

NOAA OA Plan
NOAA researchers and managers are working to

NOAA-UW-NANOOS

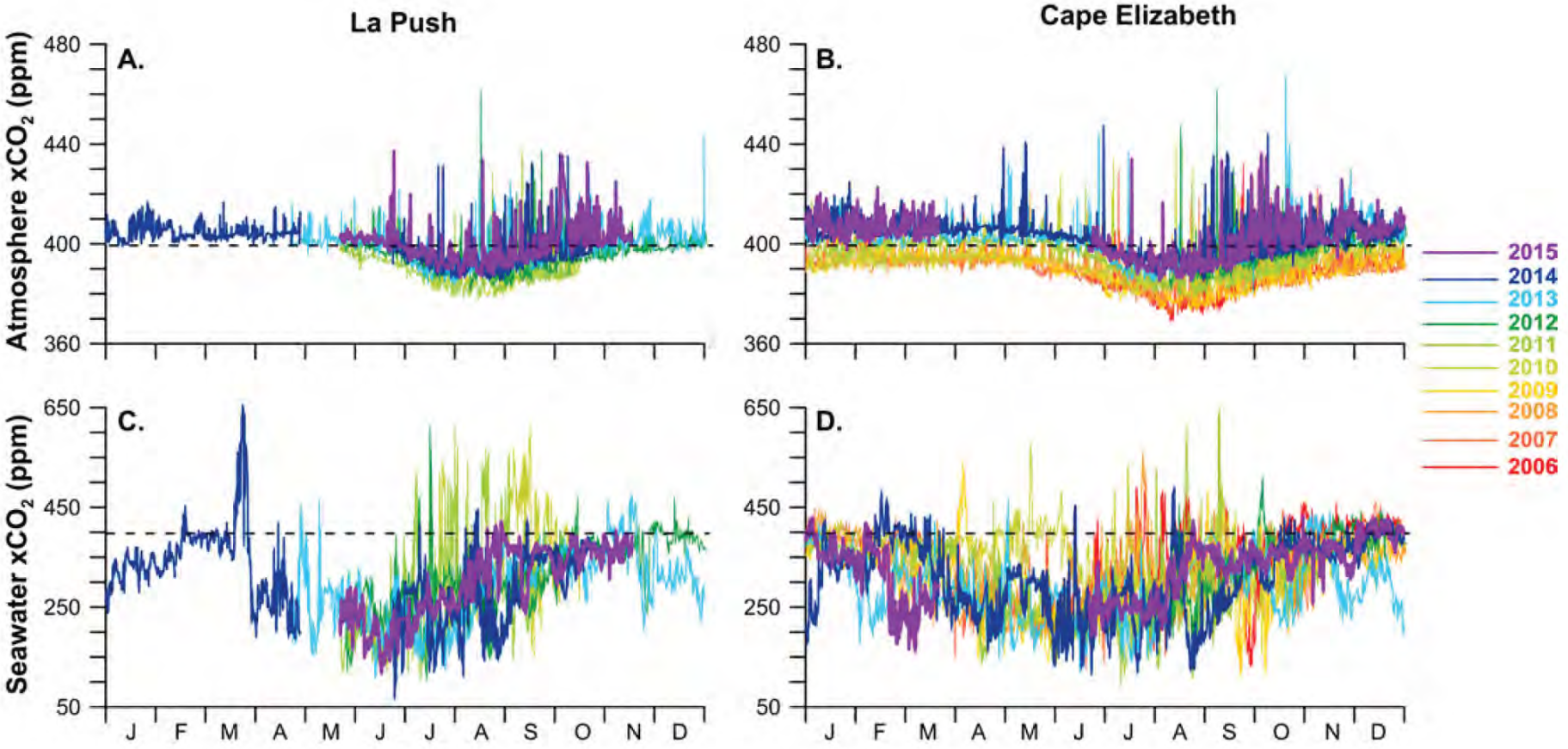
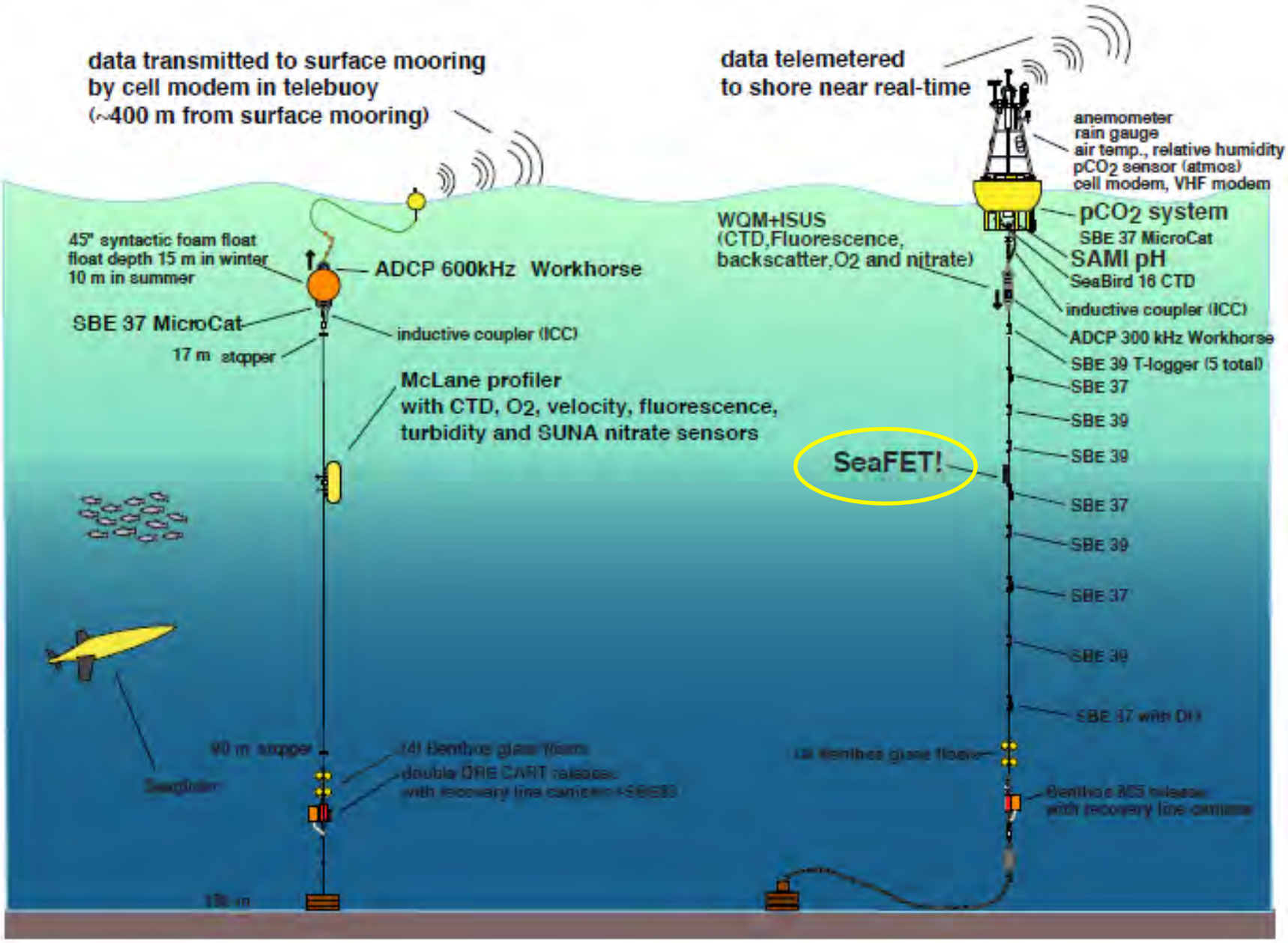


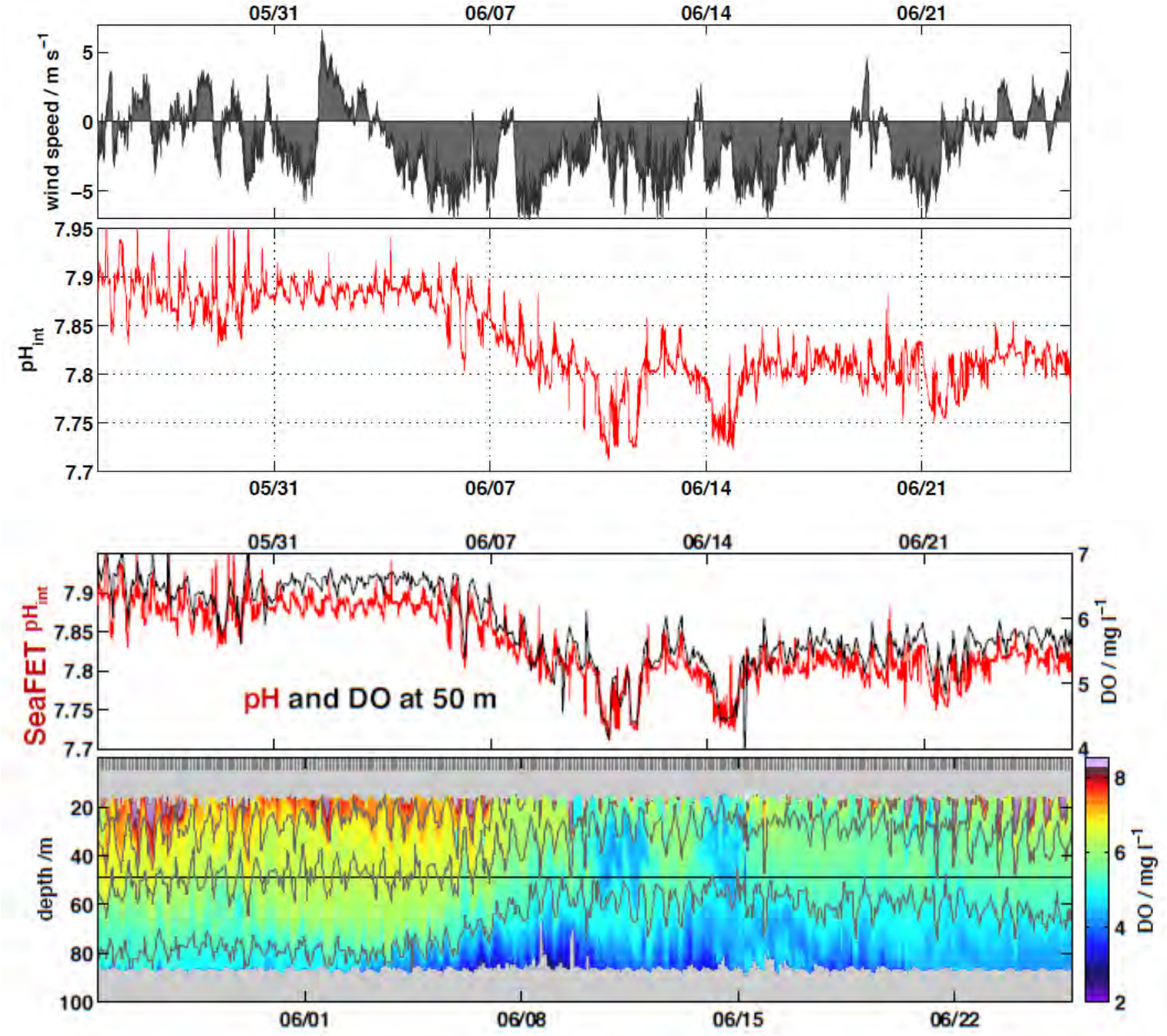
Figure 9. The mole fraction of carbon dioxide (xCO_2) in air at 1.5 m above seawater and in surface seawater at 0.5 m depth on the surface Chá Bă mooring off La Push, WA, and on the NDBC mooring 46041 off Cape Elizabeth, WA. Globally averaged marine surface air 2015 annual mean xCO_2 value of 399 ppm is indicated with a dashed line in each panel. Typical uncertainty associated with quality-controlled measurements from these systems is < 2 ppm for the range 100–600 ppm.

Simone Alin, 2016


data transmitted to surface mooring
by cell 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 39
SBE 37
SBE 39
SBE 37
SBE 39
SBE 37 with DO
WQM+ISUS
(CTD,Fluorescence,
backscatter,O2 and nitrate)
SeaFET!
45" syntactic foam float
float depth 15 m in winter
10 m in summer
ADCP 600kHz Workhorse
SBE 37 MicroCat
inductive coupler (ICC)
17 m stopper
McLane profiler
with CTD, O2, velocity, fluorescence,
turbidity and SUNA nitrate sensors
Benthos AIS release
with recovery line camtilever

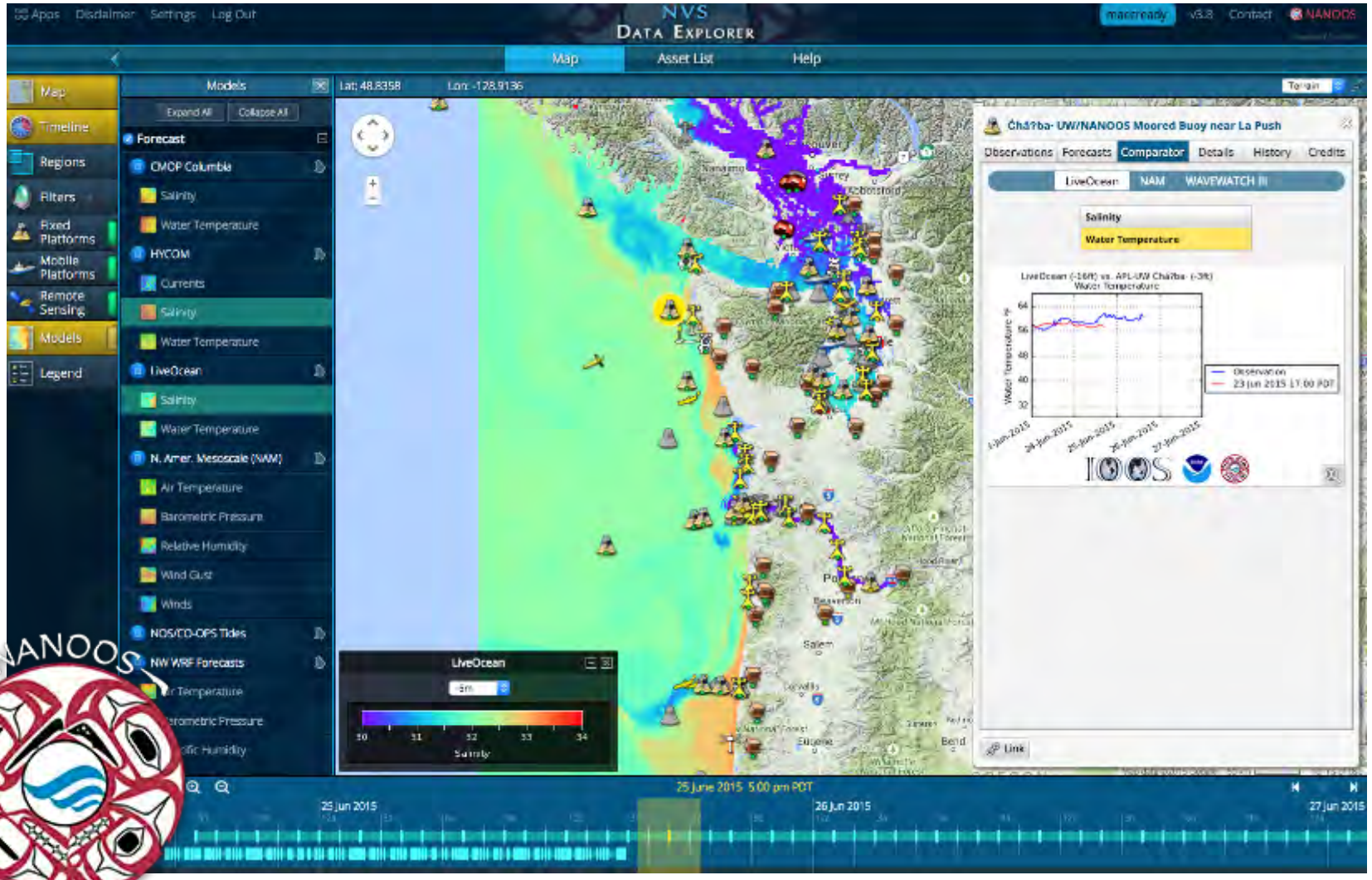
Wind

pH


05/31
06/07
06/14
06/21
wind speed / m s^{-1}
5
0
−5
7.95
7.9
7.85
7.8
7.75
7.7
pH$_{int}$
SeaFET pH$_{int}$
pH and DO at 50 m
DO / mg l^{-1}
7
6
5
4
depth /m
20
40
60
80
100
8
6
4
2
06/01
06/08
06/15
06/22

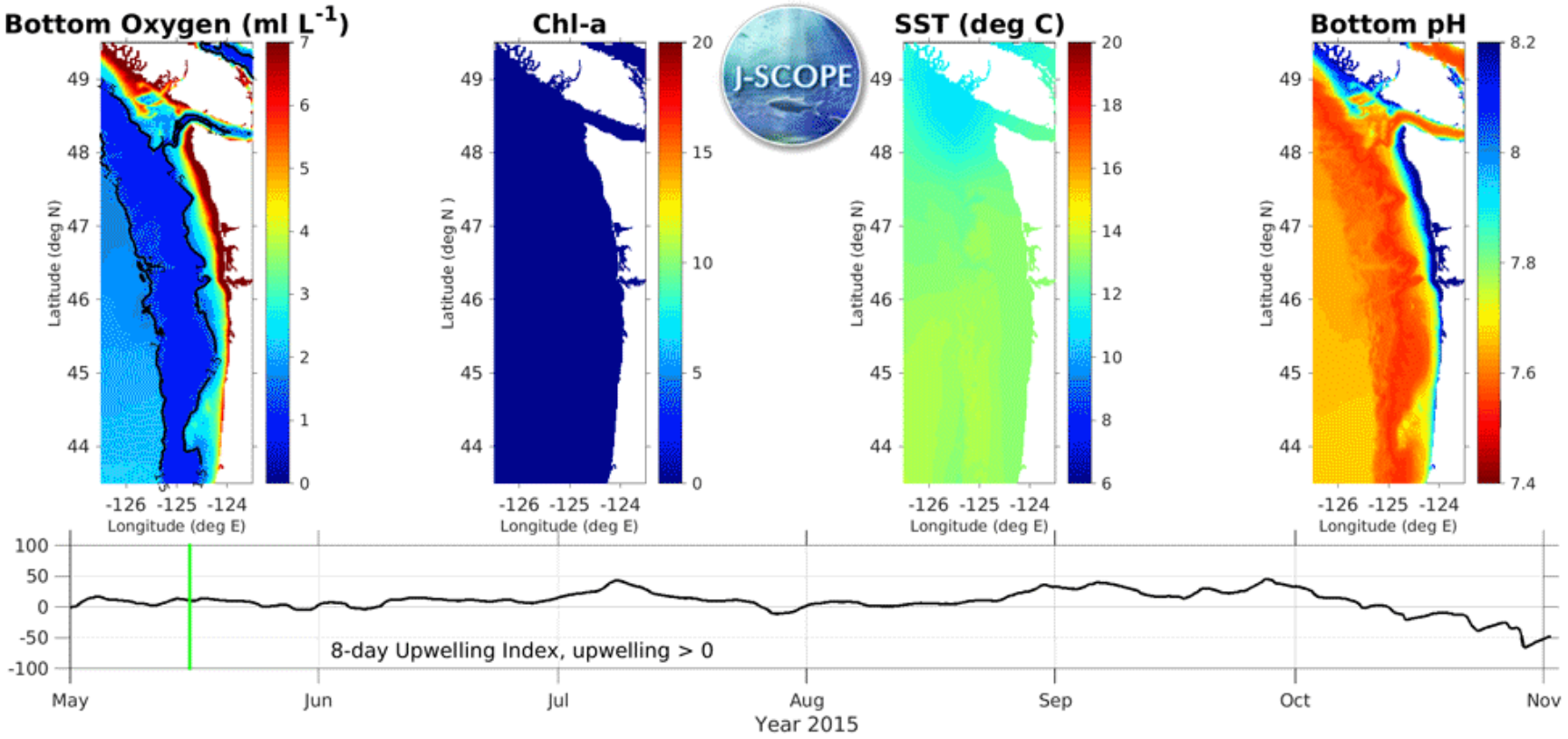
Near-term predictions of OA in Washington

3-Day forecast appears daily on NANOOS



WA OA Center: Parker MacCready, Samantha Siedlecki, UW

Breaking ground to seasonal ecosystem forecasting: hypoxia, OA, sardines

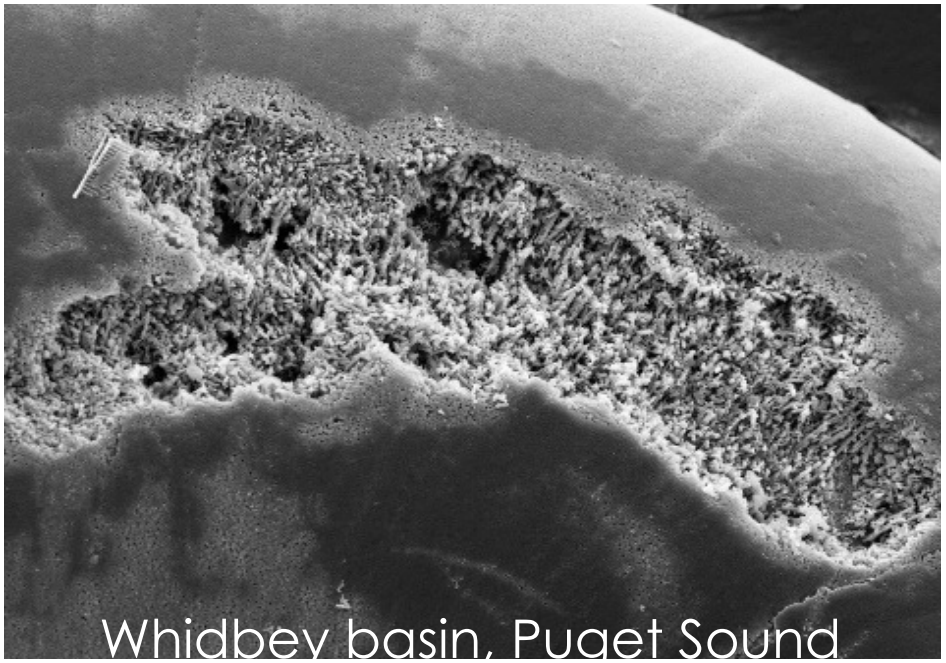


NOAA FATE: Siedlecki et al., UW

WA OA Center monitoring: *bioindicator*

- Pteropod shells show signs of dissolution
- Patterns in time and space help us understand impacts and drivers


La Push, coastal WA

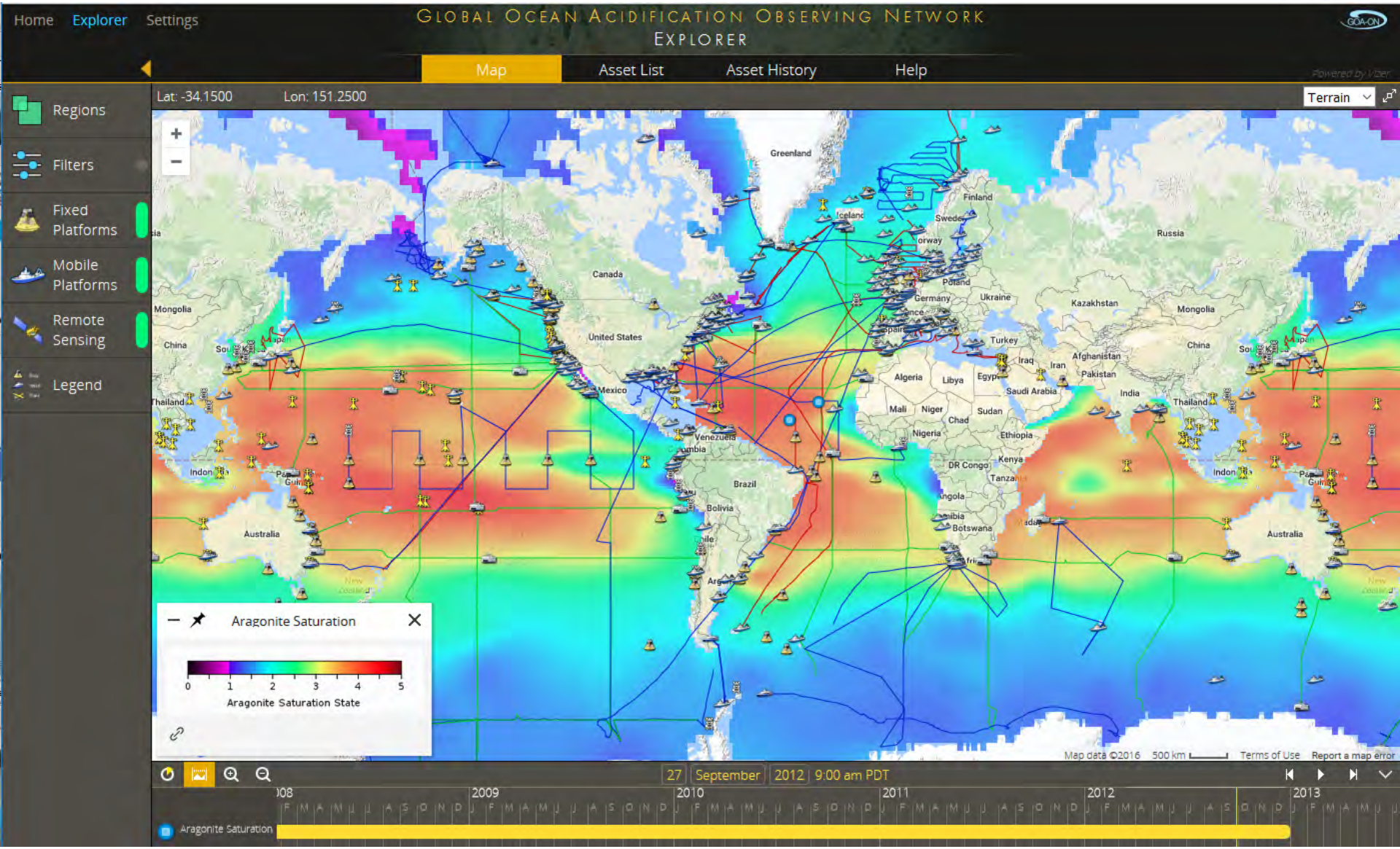

Whidbey basin, Puget Sound

Photos: Johnson & Bednarsek

The GOA-ON interactive data portal

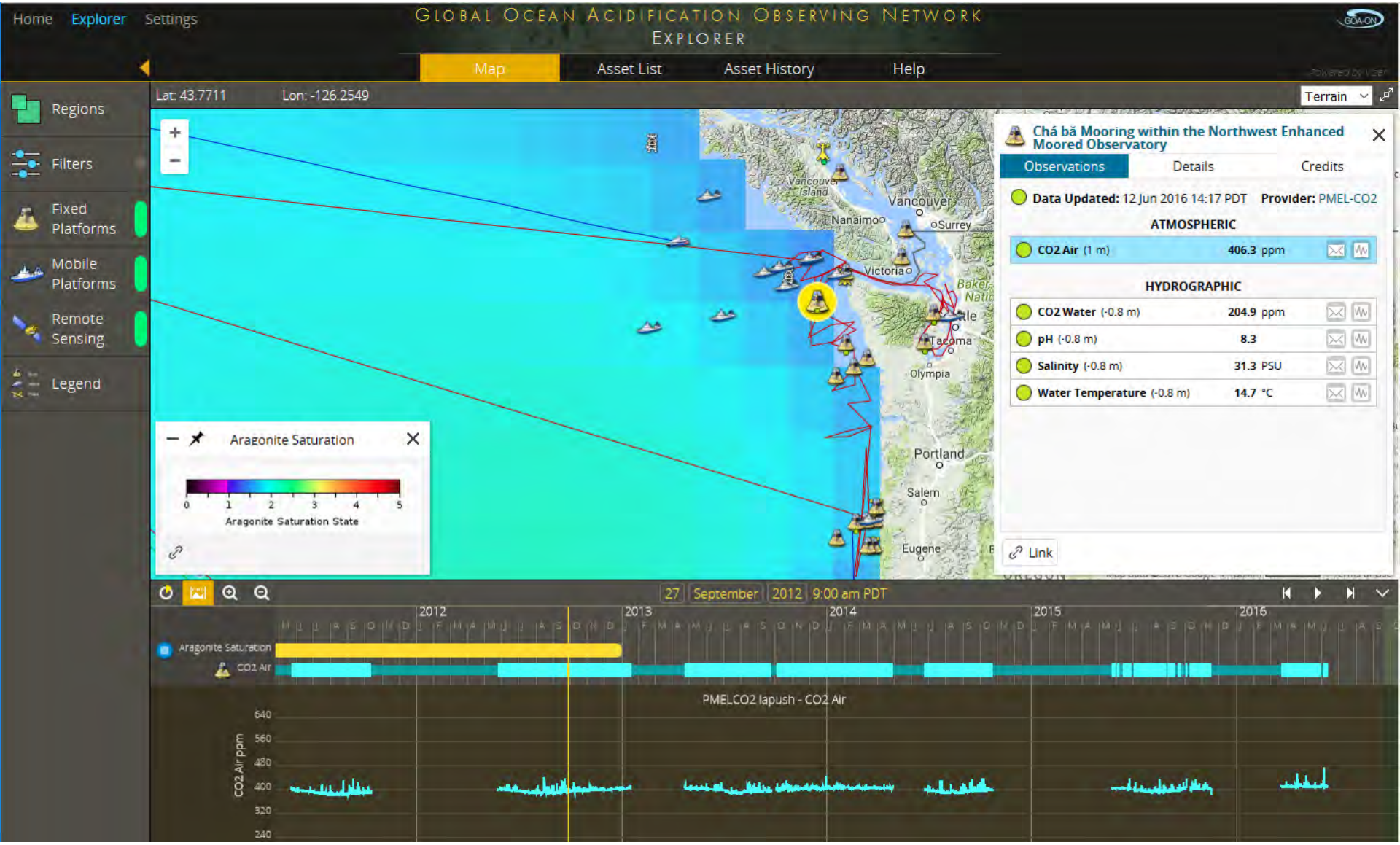
Featuring global OA data, asset inventory, metadata, data synthesis products, etc.

GOA-ON
Global Ocean Acidification Observing Network



The GOA-ON interactive data portal

GOA-ON
Global Ocean Acidification Observing Network




complex area…