Ocean Observing and Marine Ecosystem Challenges in the Pacific Northwest

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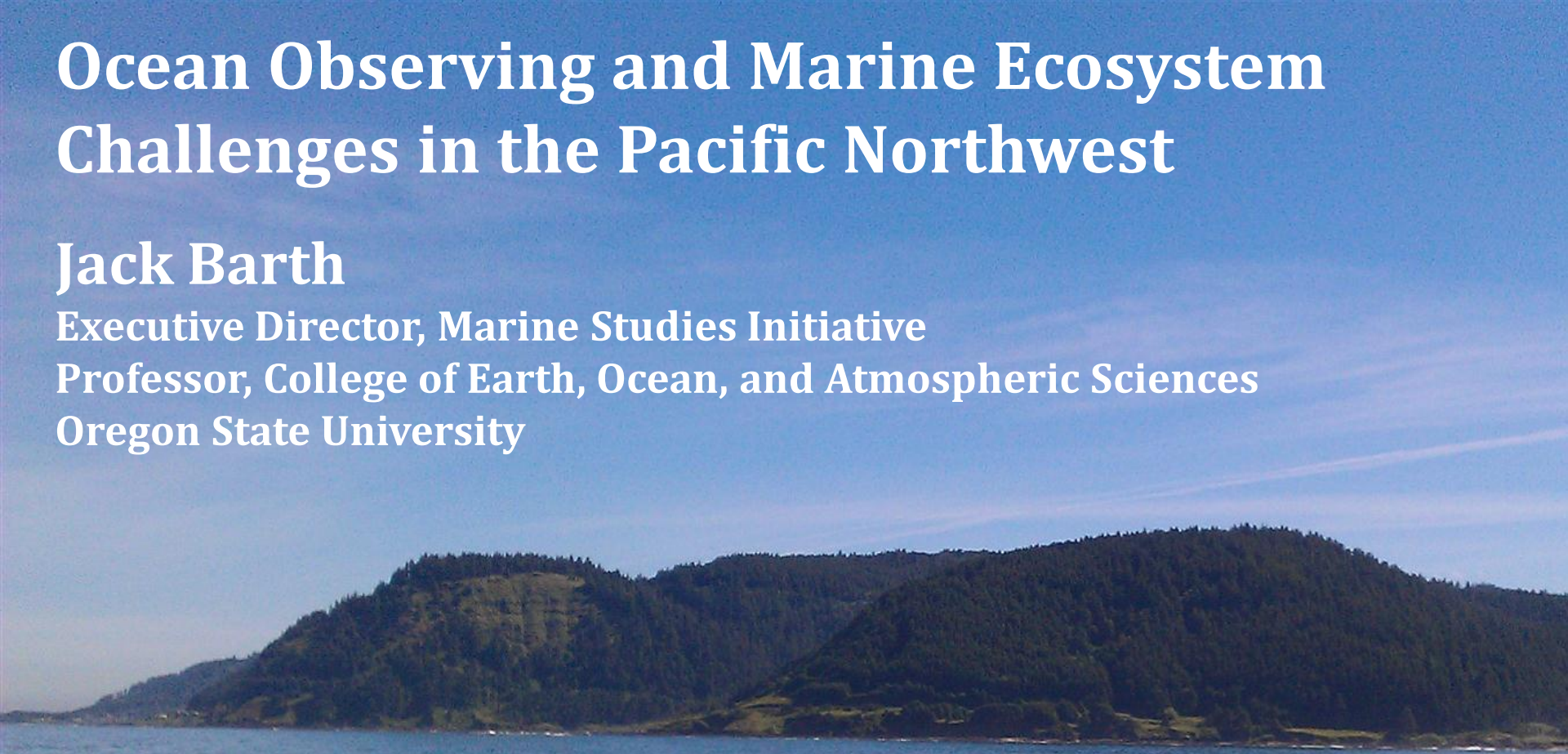

- (Brief) Introduction to Pacific Northwest waters
- Marine ecosystem challenges
  - warming, hypoxia, ocean acidification, HABs, …
- Northeast Pacific ocean observing partnerships
  - Ocean Observatories Initiative (NSF)
  - Northwest Association of Networked Ocean Observing Systems (NANOOS)

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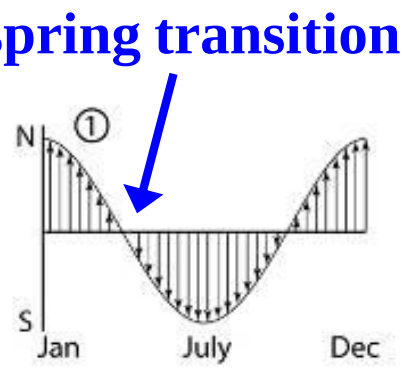
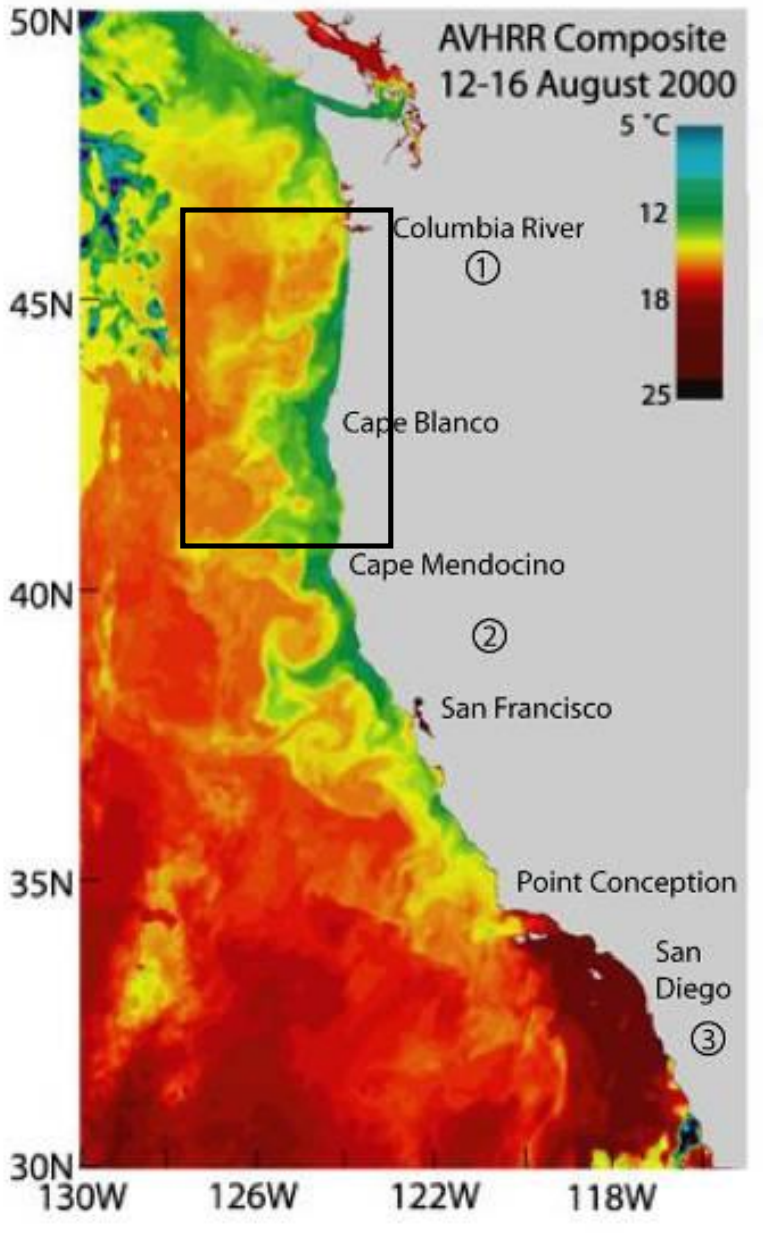
Photo by Ata Suanda

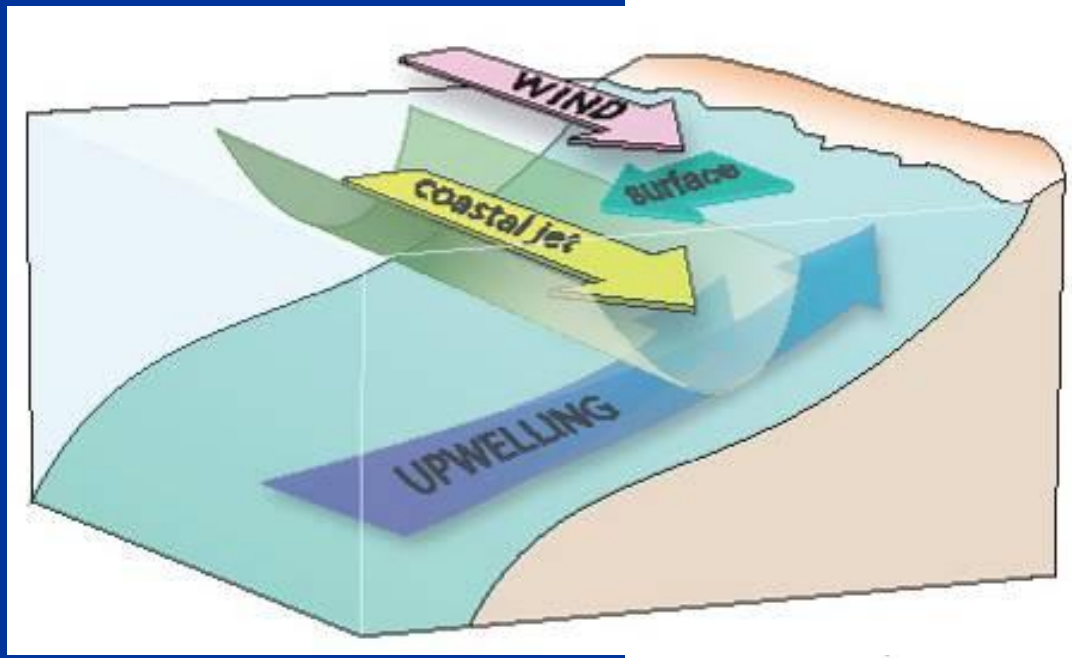
upwelling

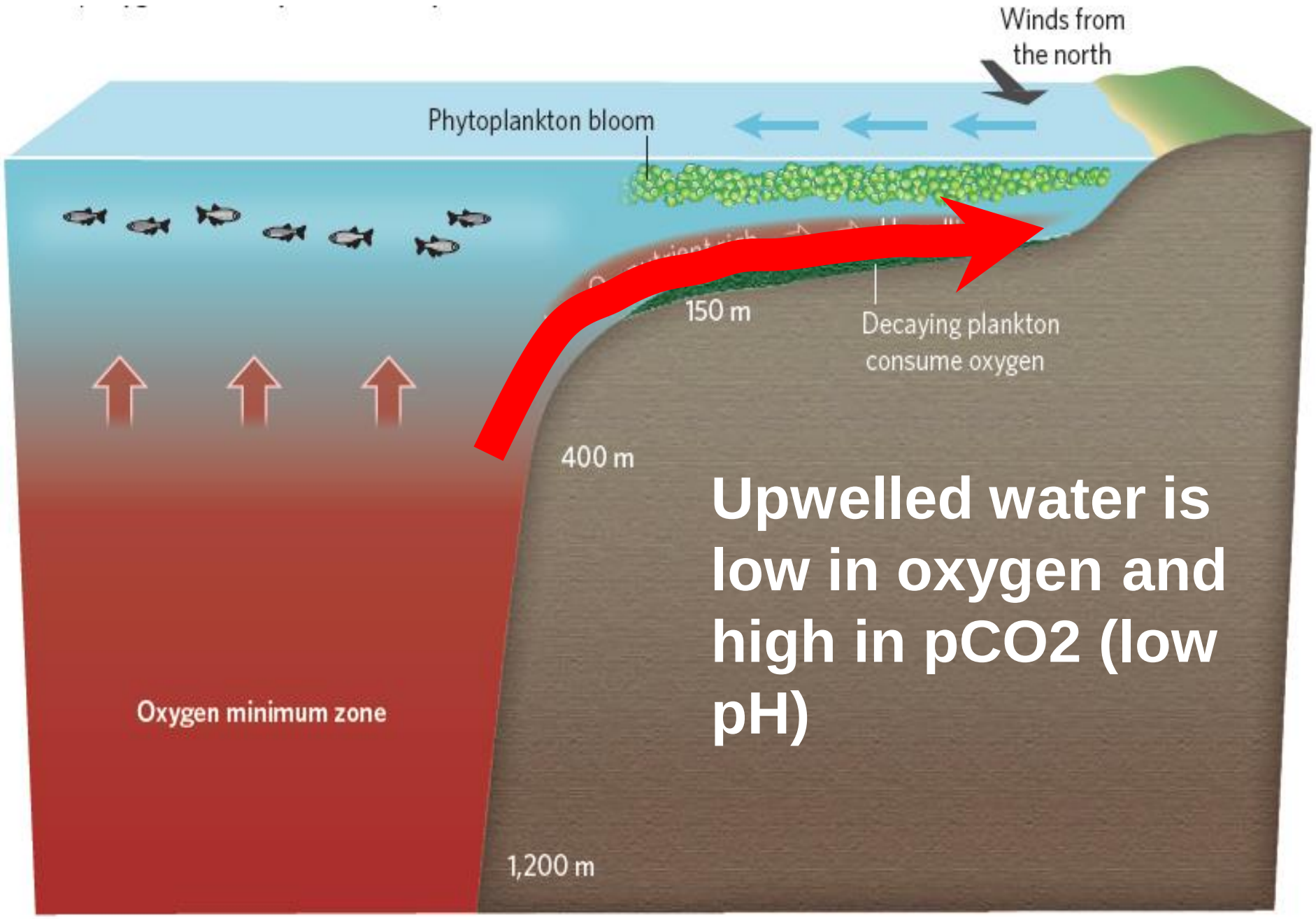
Seasonal cycle of winds



Sea-surface temperature







Modified from Gewin (*Science*, 2011)

Ecosystem impacts of hypoxia

Normal Inner-Shelf Rockfish Community

July 2002

Dungeness crab piles in intertidal

2004

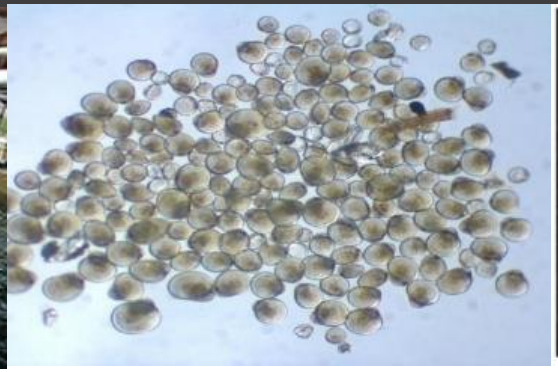
Invertebrate die-offs & anoxia

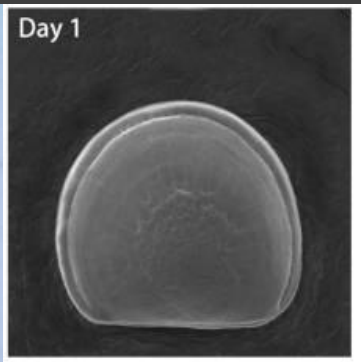
2006

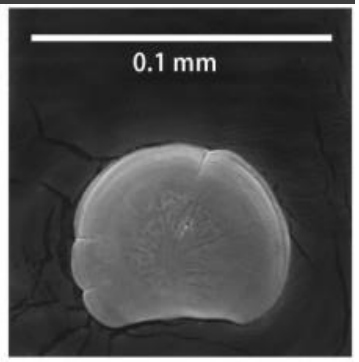
Grantham et al. (2004); Chan et al. (2008)

West Coast shellfish aquaculture: $270 Million annually

Whiskey Creek Shellfish Hatchery: 2007 larval class failures

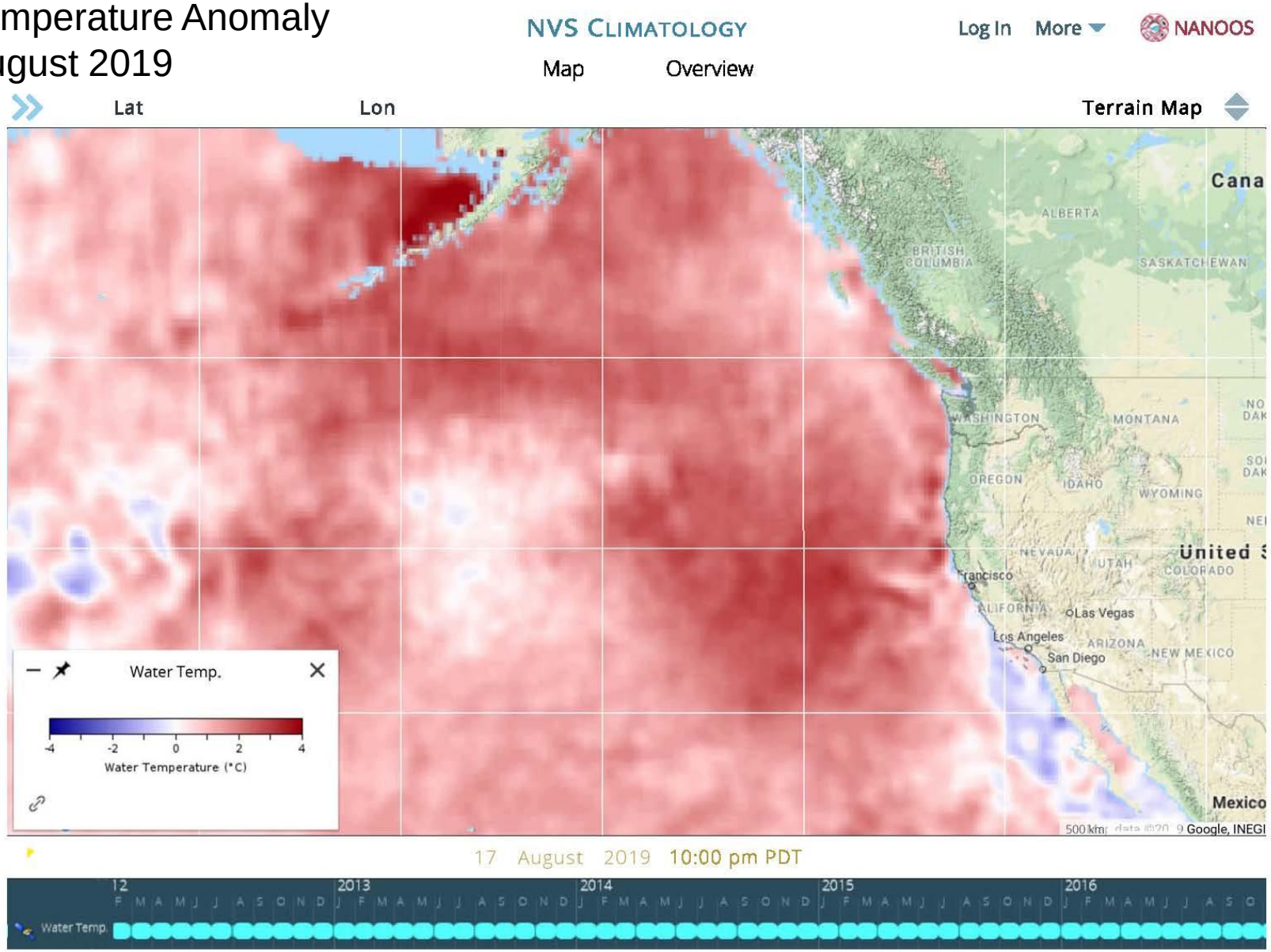






Ocean warming

Temperature Anomaly
August 2019



Harmful Algal Blooms (HABs) Close Fisheries

Clam opener canceled due to high toxin count

OLYMPIA — The first razor clam dig of the fall season has been postponed due to elevated levels of marine toxins on Washington's Beaches affected by the health closure include Long Beach, Twin Harbors, Copalis, Mocrocks and Kalaloch.

Southern coast closed to all Dungeness crab fishing due to increase in marine toxins

Originally published June 9, 2015 at 8:08 am | *Updated June 8, 2015 at 1:49 pm*

chlorophyll (mg/m^3)

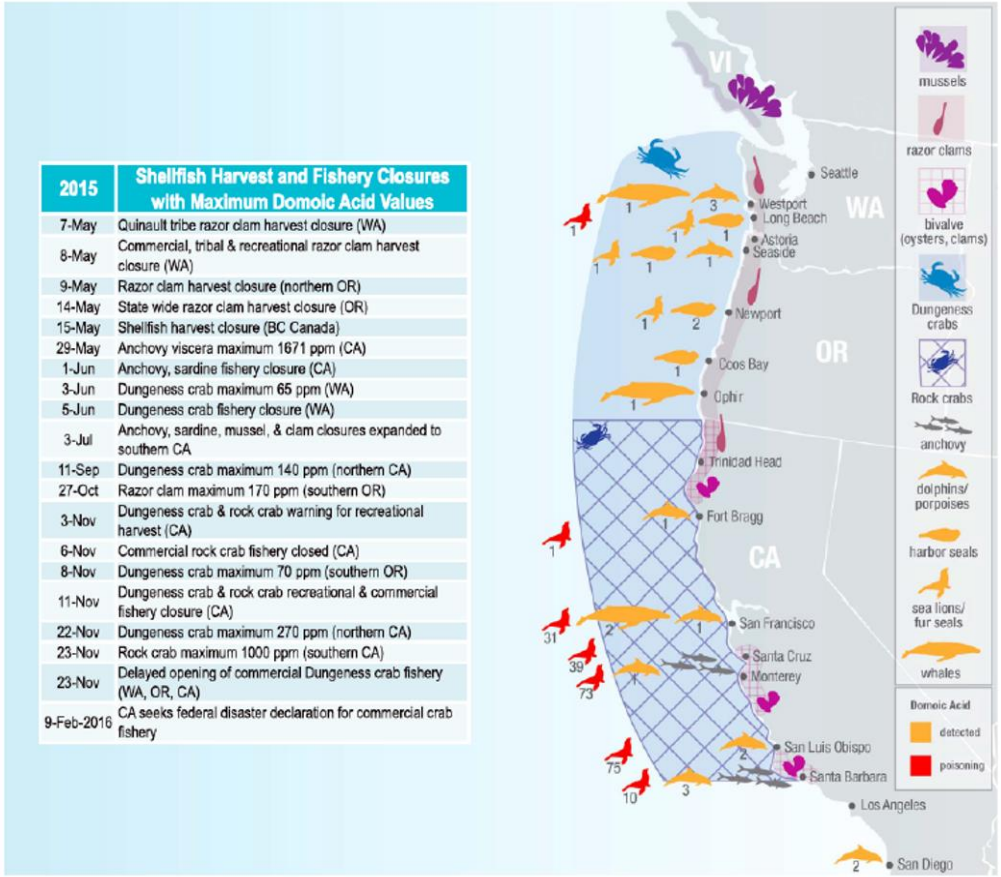
0 0.05 30

What happened during the Warm Blob?

1. Persistent warm waters
2. HABs – record bloom, high domoic acid in shellfish
3. Closures, Delays in Commercial Fisheries
4. Krill declines, Inshore movement of prey
5. Late set of commercial crabbing gear
6. Record number of whale entanglements in CA

Biological Impacts in the California Current

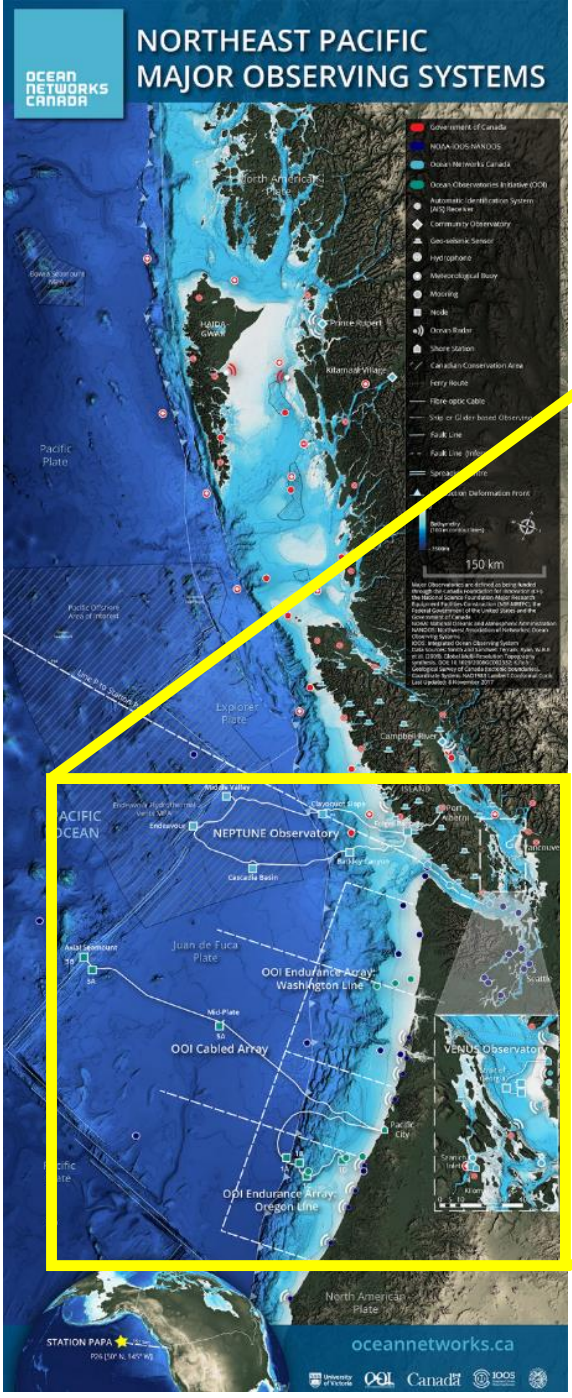
2015	Shellfish Harvest and Fishery Closures with Maximum Domoic Acid Values
7-May	Quinault tribe razor clam harvest closure (WA)
8-May	Commercial, tribal & recreational razor clam harvest closure (WA)
9-May	Razor clam harvest closure (northern OR)
14-May	State wide razor clam harvest closure (OR)
15-May	Shellfish harvest closure (BC Canada)
29-May	Anchovy viscera maximum 1671 ppm (CA)
1-Jun	Anchovy, sardine fishery closure (CA)
3-Jun	Dungeness crab maximum 65 ppm (WA)
5-Jun	Dungeness crab fishery closure (WA)
3-Jul	Anchovy, sardine, mussel, & clam closures expanded to southern CA
11-Sep	Dungeness crab maximum 140 ppm (northern CA)
27-Oct	Razor clam maximum 170 ppm (southern OR)
3-Nov	Dungeness crab & rock crab warning for recreational harvest (CA)
6-Nov	Commercial rock crab fishery closed (CA)
8-Nov	Dungeness crab maximum 70 ppm (southern OR)
11-Nov	Dungeness crab & rock crab recreational & commercial fishery closure (CA)
22-Nov	Dungeness crab maximum 270 ppm (northern CA)
23-Nov	Rock crab maximum 1000 ppm (southern CA)
23-Nov	Delayed opening of commercial Dungeness crab fishery (WA, OR, CA)
9-Feb-2016	CA seeks federal disaster declaration for commercial crab fishery

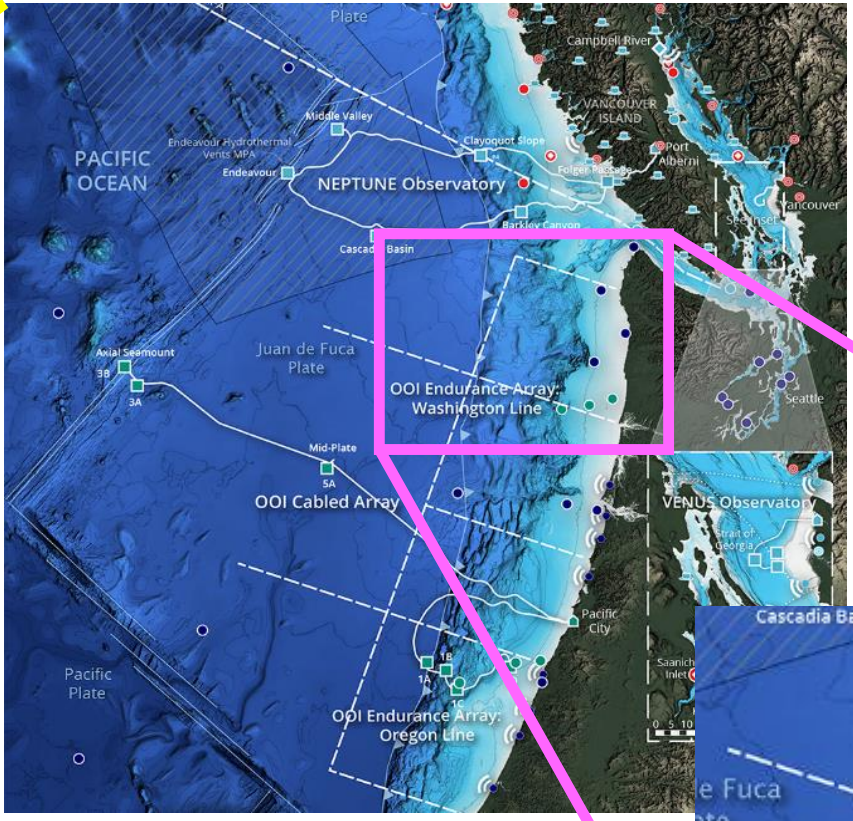


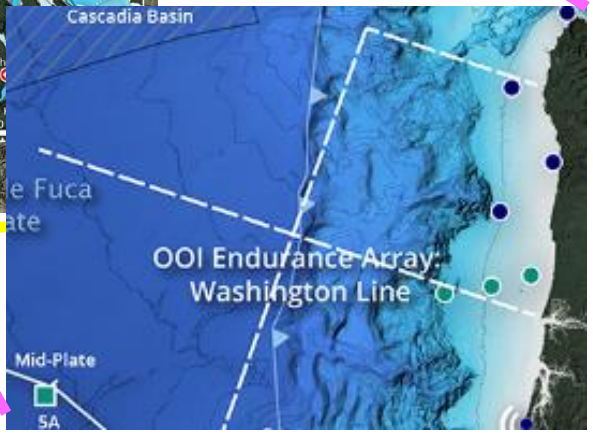
McCabe et al. (2016)

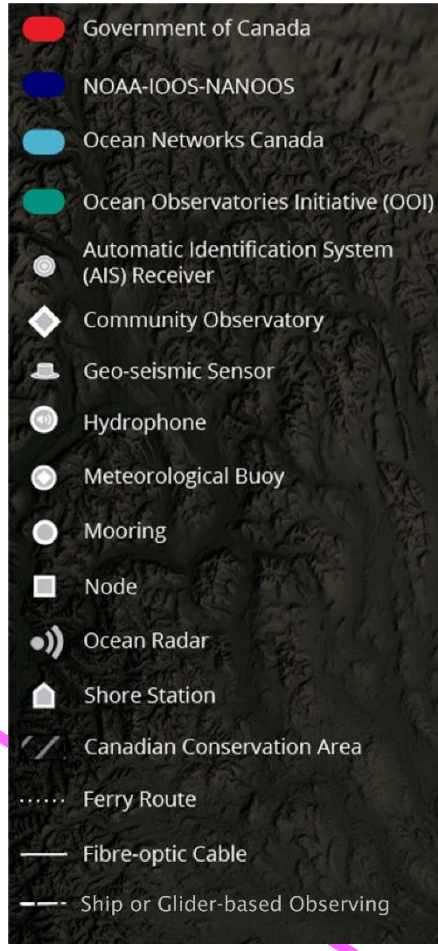
“Better Regional Ocean Observing Through Cross-National Cooperation: A Case Study From the Northeast Pacific”

Frontiers in Marine Science (2019)

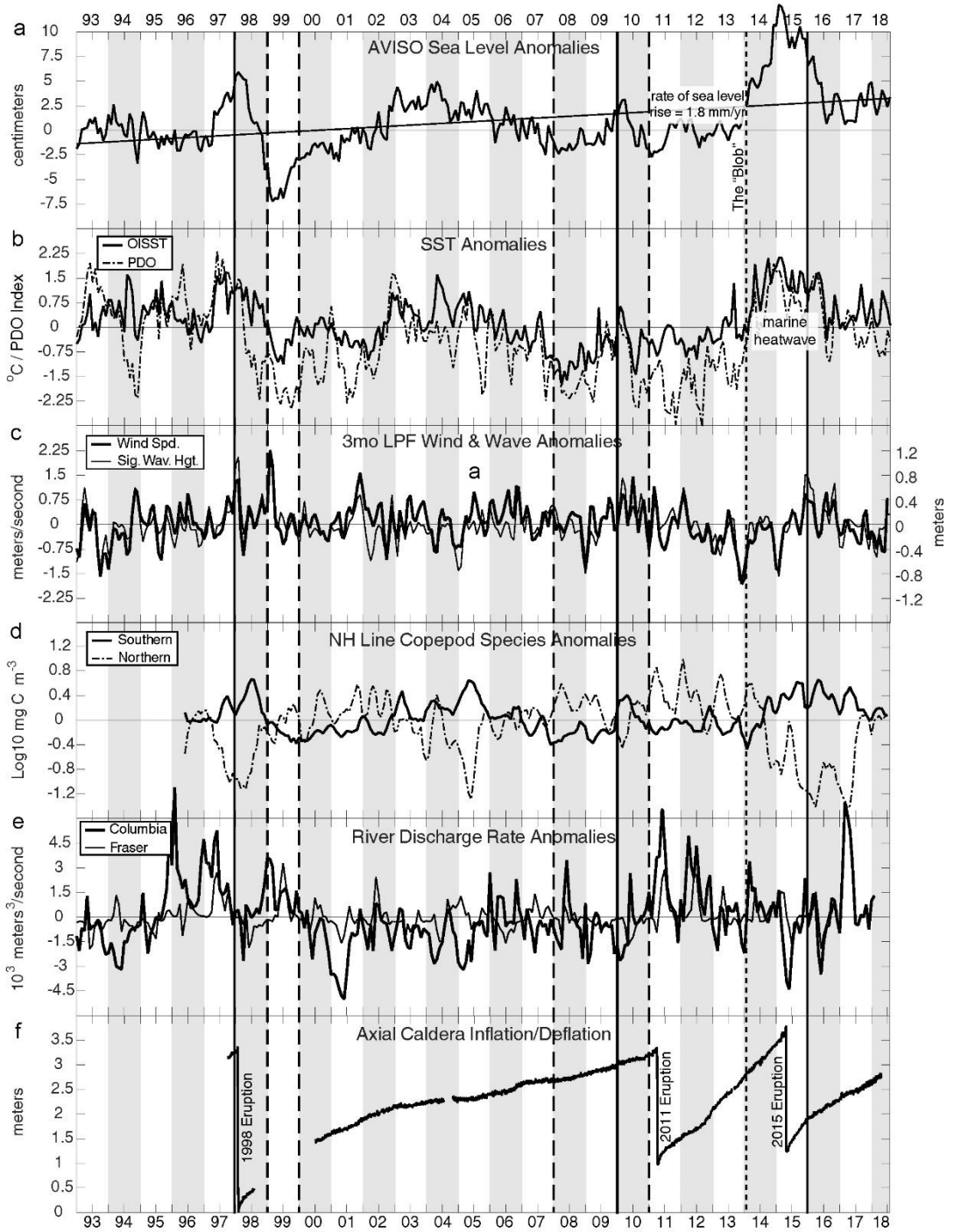








Barth et al., (2019)



Sea Level Anomaly

SST Anomaly (solid)
PDO (dashed)

Wind speed (thick)
Wave height (thin)

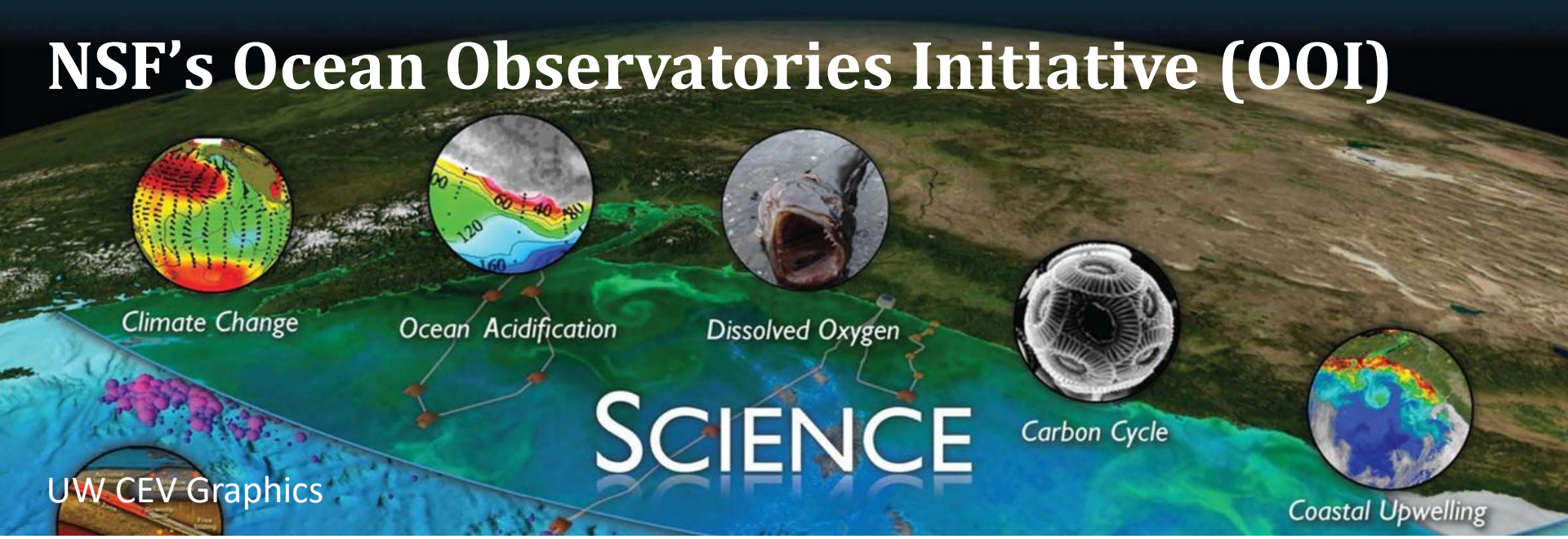
NH Line Copepod
Northern (thick)
Southern (thin)

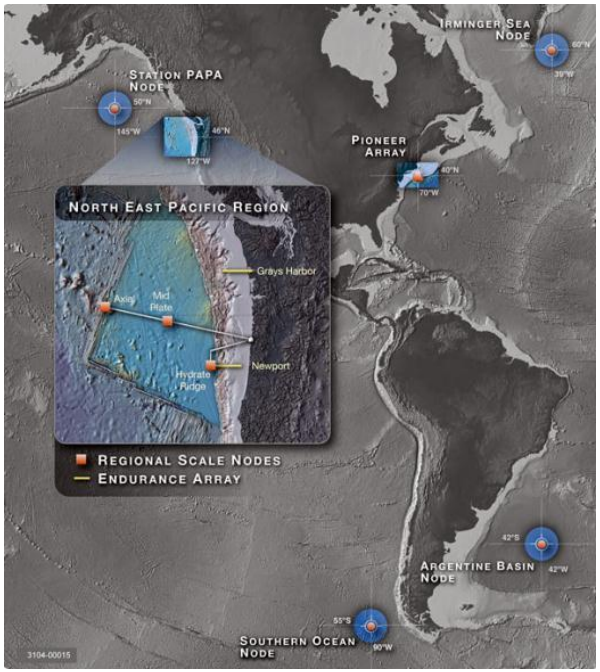
River Discharge
Columbia (thick)
Fraser (thin)

Axial Volcano
Inflation/deflation

Barth et al. (2019)

NSF's Ocean Observatories Initiative (OOI)





- **Global Biogeochemistry and Carbon Cycling**
- **Ocean-Atmosphere Exchange**
- **Ocean Circulation, Mixing and Ecosystems**
- **Climate Variability and Ecosystems**
- **Coastal Ocean Dynamics and Ecosystems**
  - **Hypoxia on Continental Shelves**
  - **Shelf/Slope Exchange**

OOI in the Pacific Northwest

Endurance

Hydrate
dge

800+ km cable installed and connected to shore, July 2011

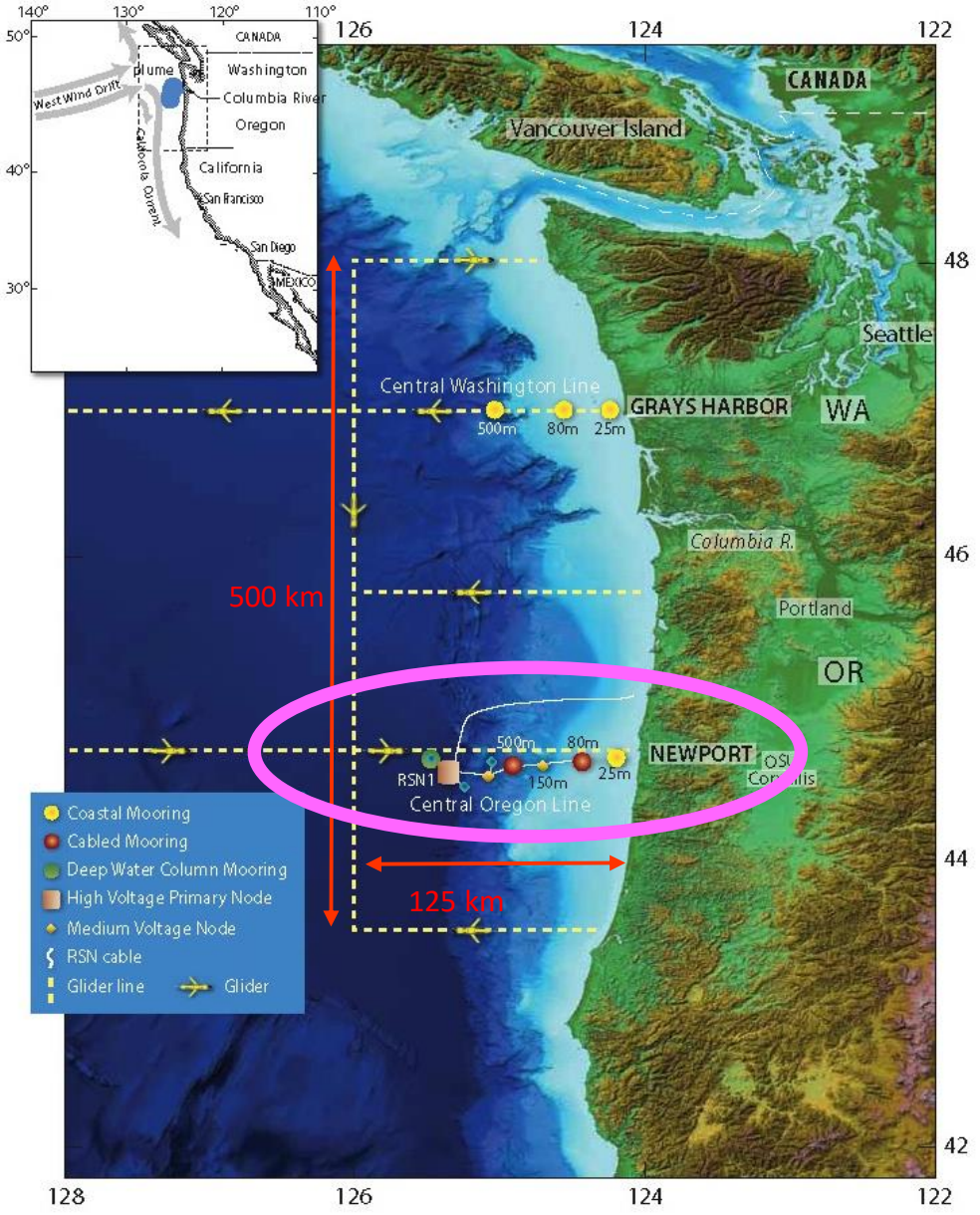
0
Meters
3500

Primary Node
Low Voltage Node
Coastal Mooring

Endurance Array and Cabled Array

Endurance Array

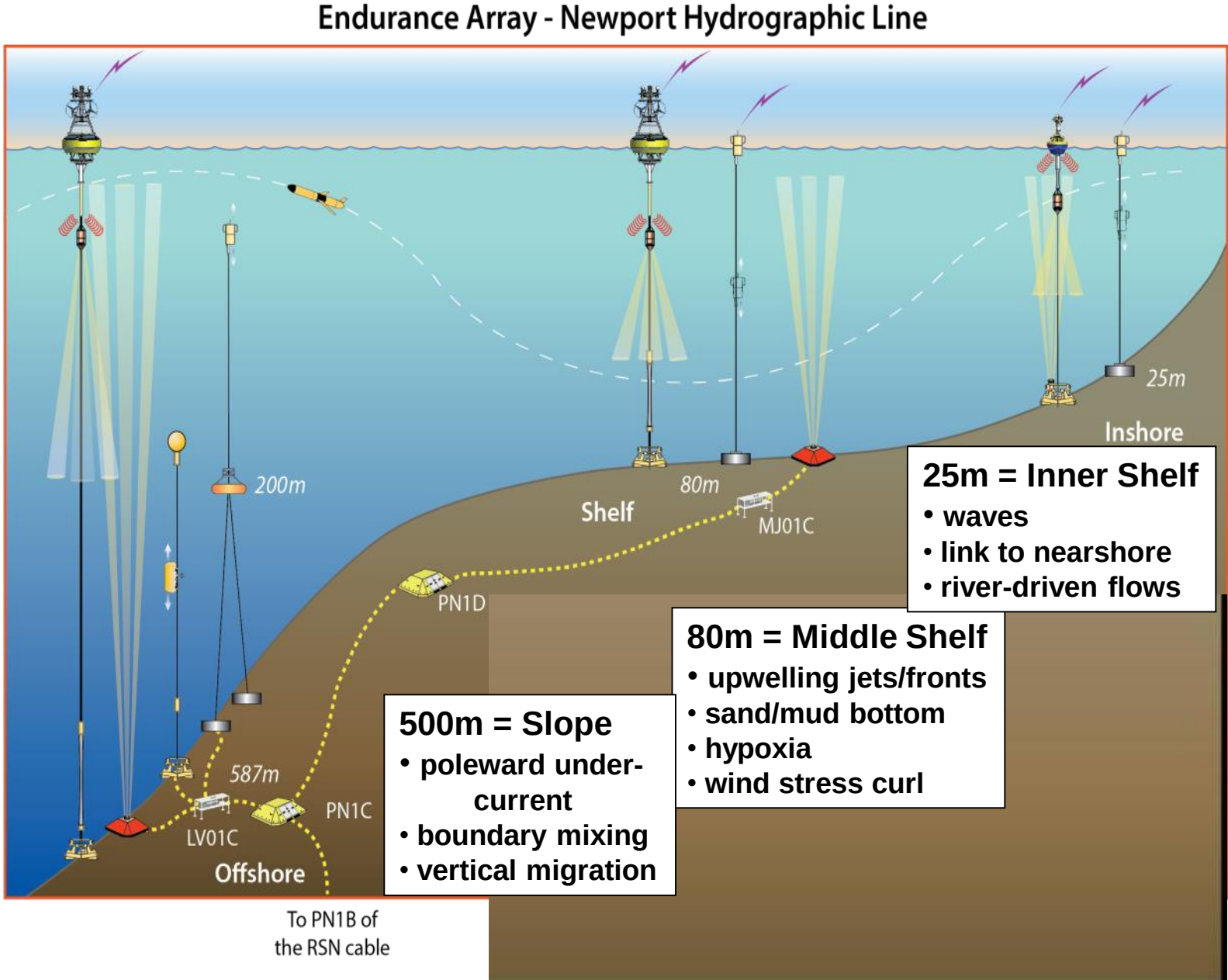
- Cross-shelf mooring lines at Newport and Grays Harbor
  (N & S of Columbia River)
- Oregon Line connected to the Cabled Array
- 6 deployed gliders year-round
- 20 platforms:
  - EA ~240 sensors
  - Cabled EA ~39 sensors
- Locations chosen based on existing long-term data



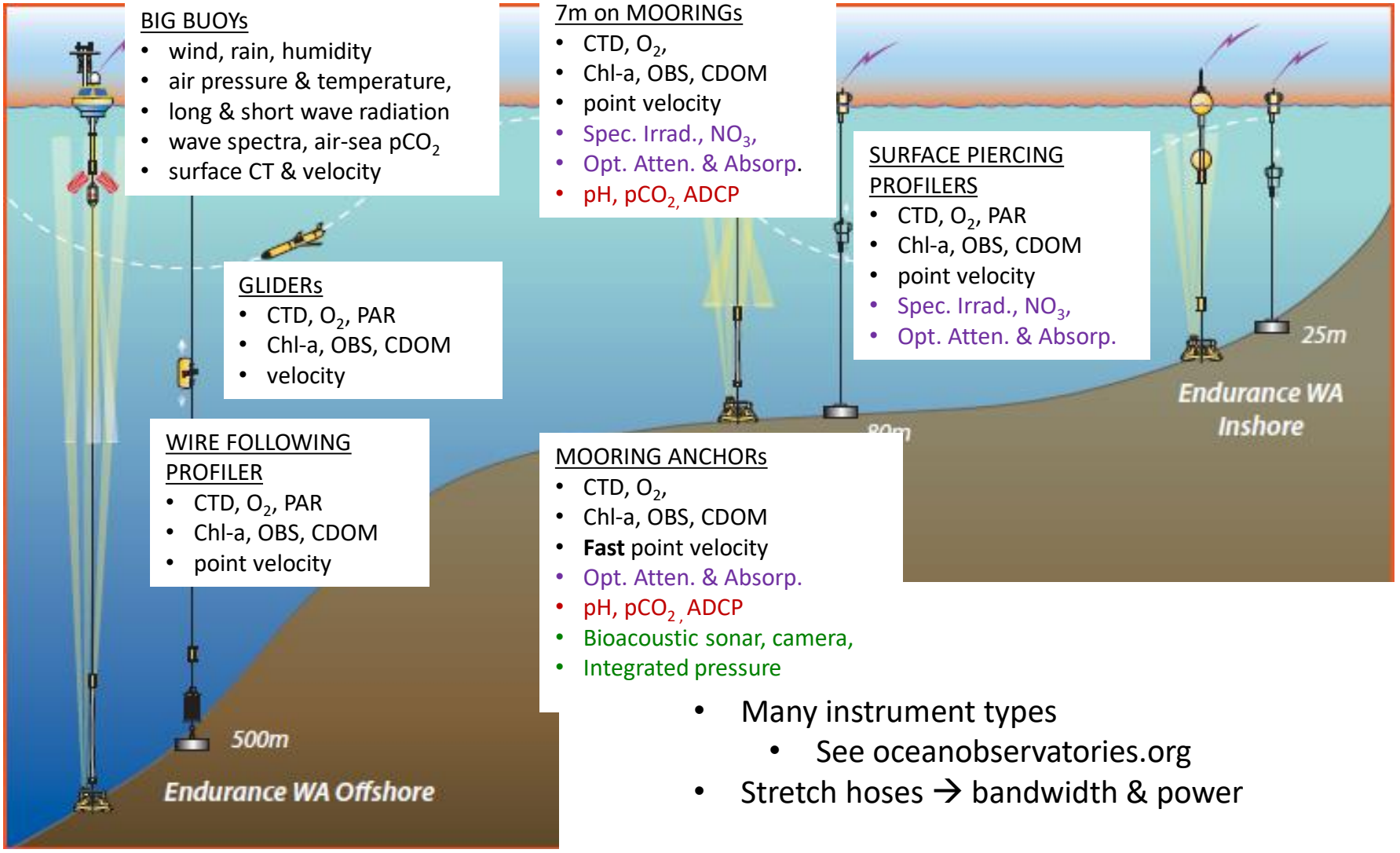
Endurance Array: Oregon Line

As designed:

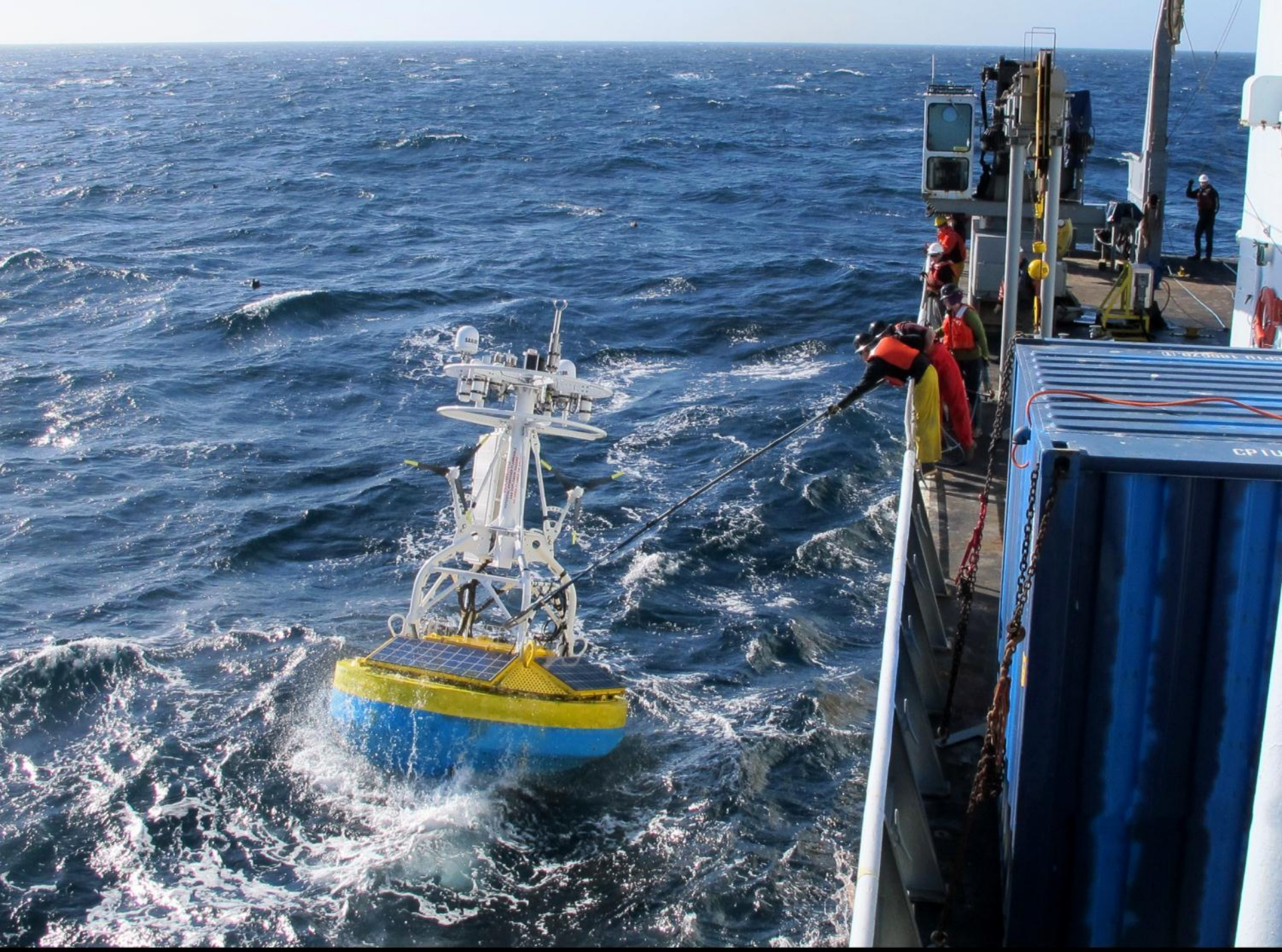
- Full water column
- Cross-shelf resolution
- High power, high bandwidth via cable to 80 & 500m
- Benthic platforms



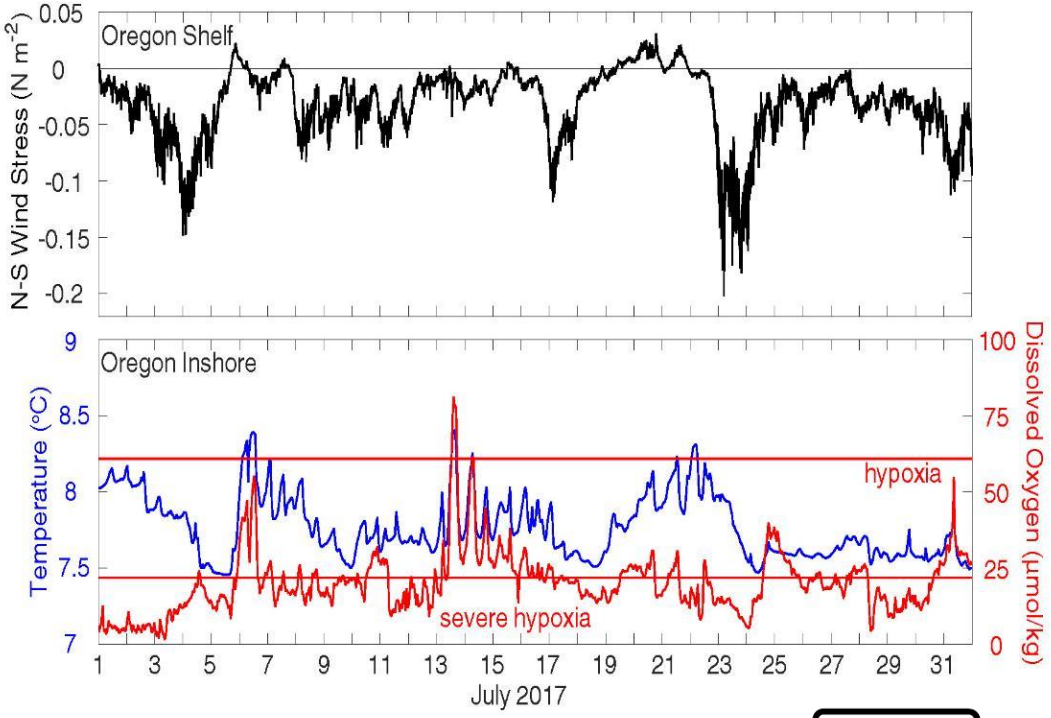
Endurance Array: Washington Line



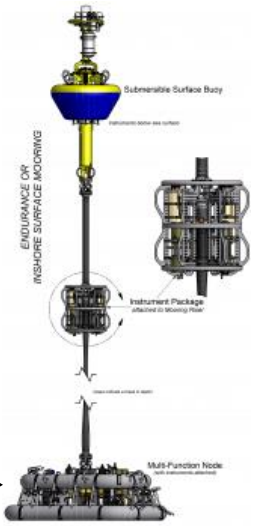
- Many instrument types
  - See oceanobservatories.org
- Stretch hoses → bandwidth & power



Severe hypoxia kills Dungeness crabs – summer 2017



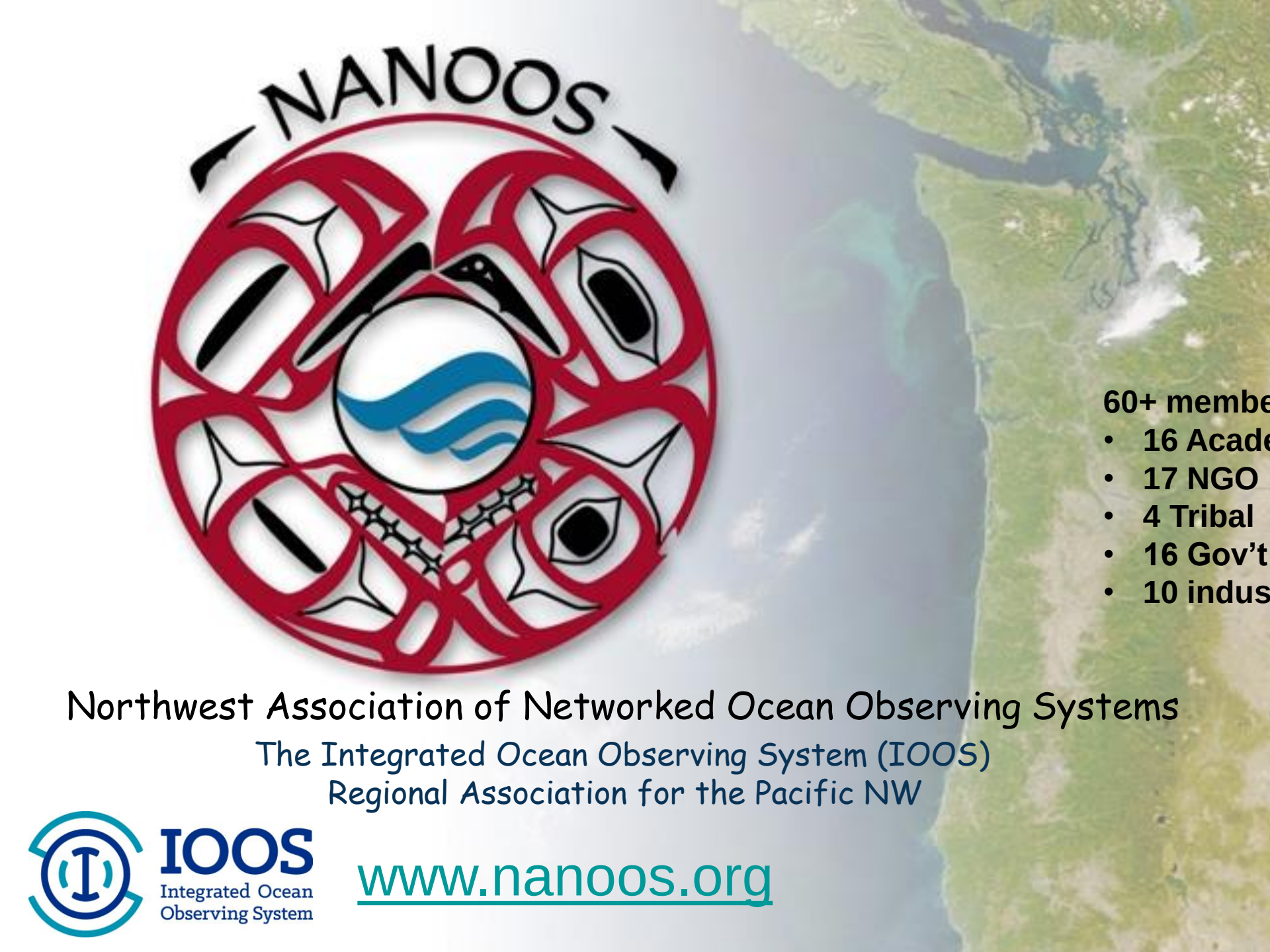
Ocean Observatories Initiative



25 m

OREGON Fish & Wildlife

Barth et al., *Oceanography*, 2018



60+ membe
- 16 Acade
- 17 NGO
- 4 Tribal
- 16 Gov't
- 10 indus

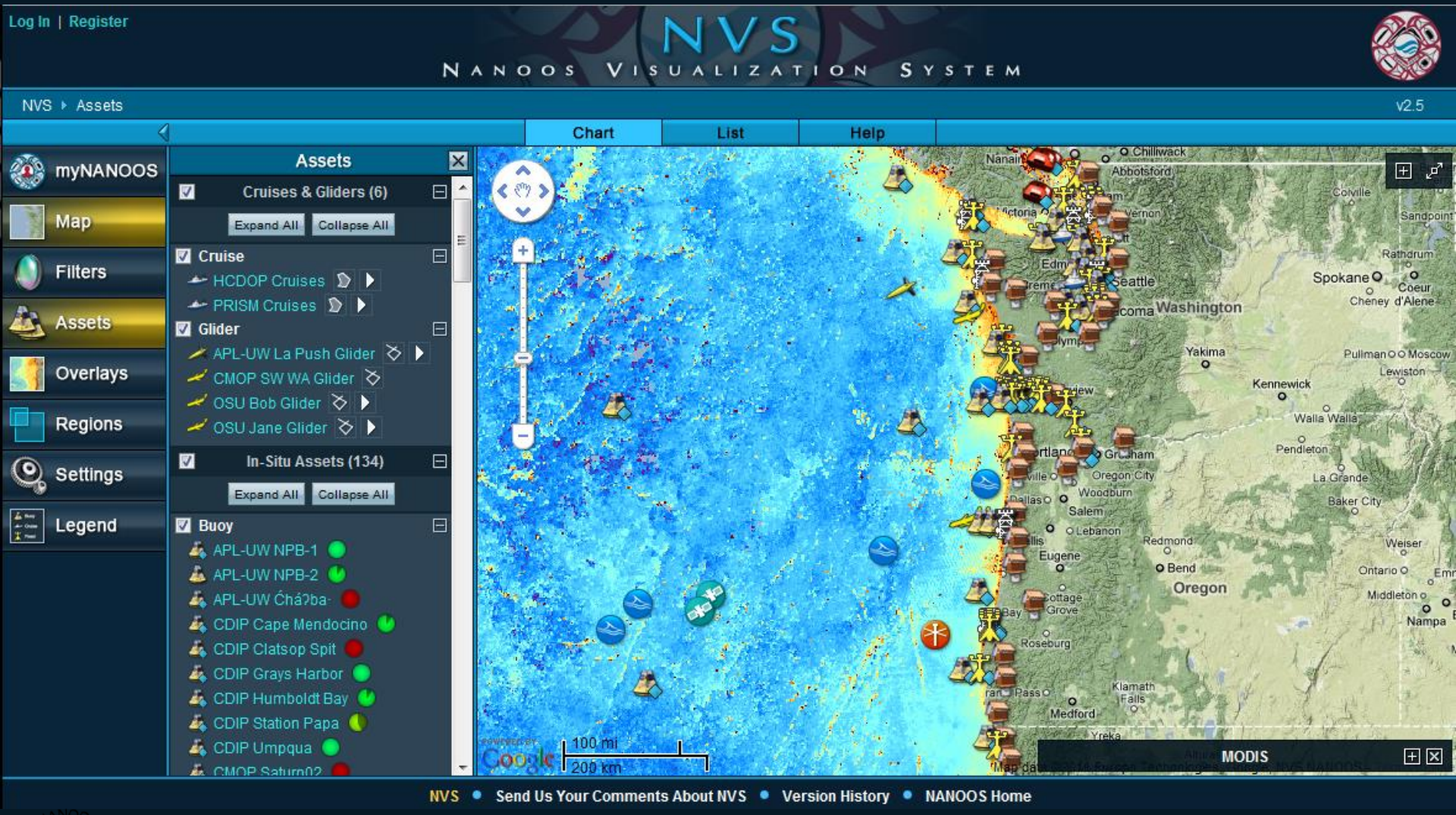
Northwest Association of Networked Ocean Observing Systems

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

IOOS
Integrated Ocean Observing System

www.nanoos.org

NANOOS Visualization System (NVS)

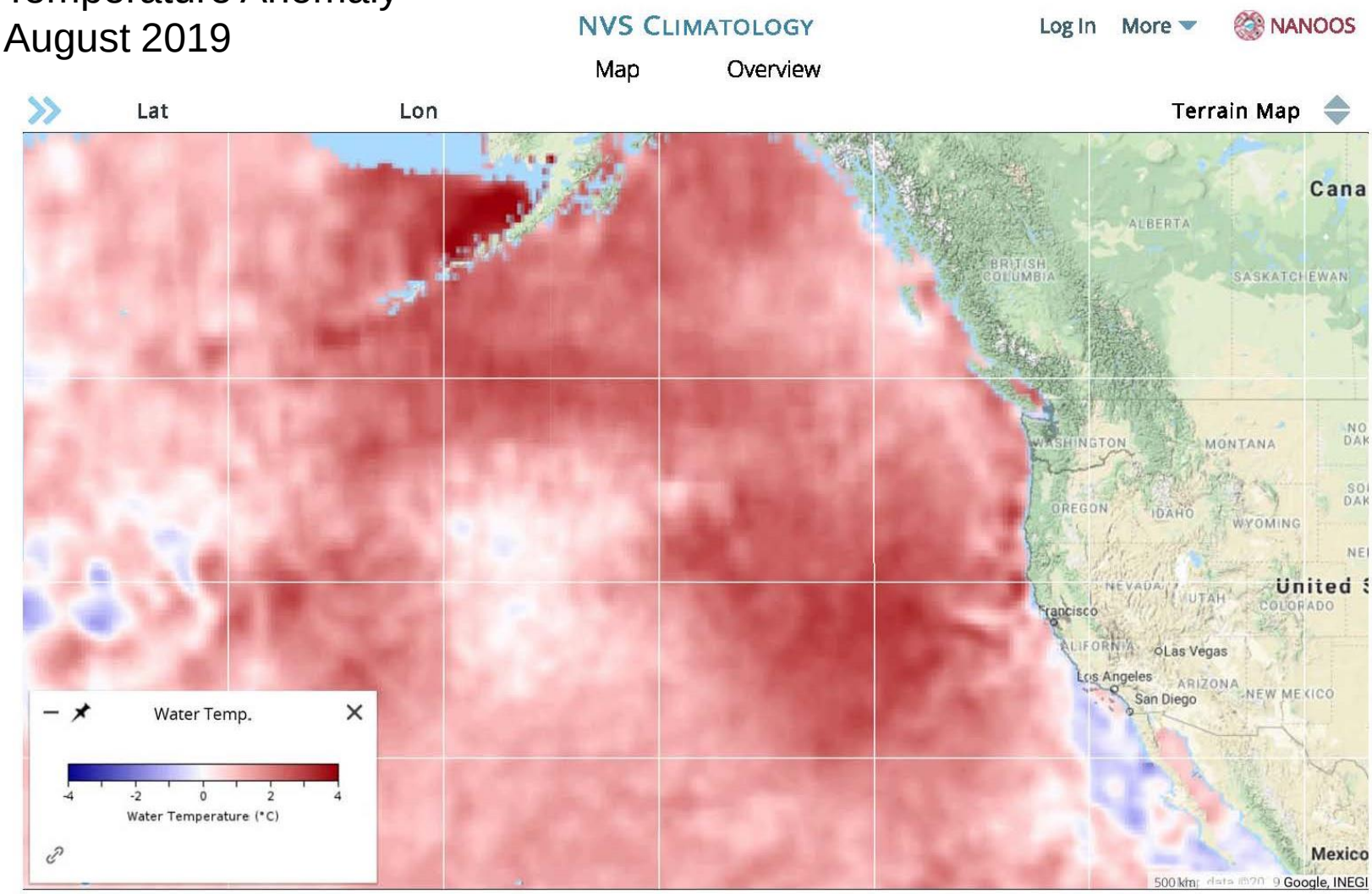


nvs.nanoos.org

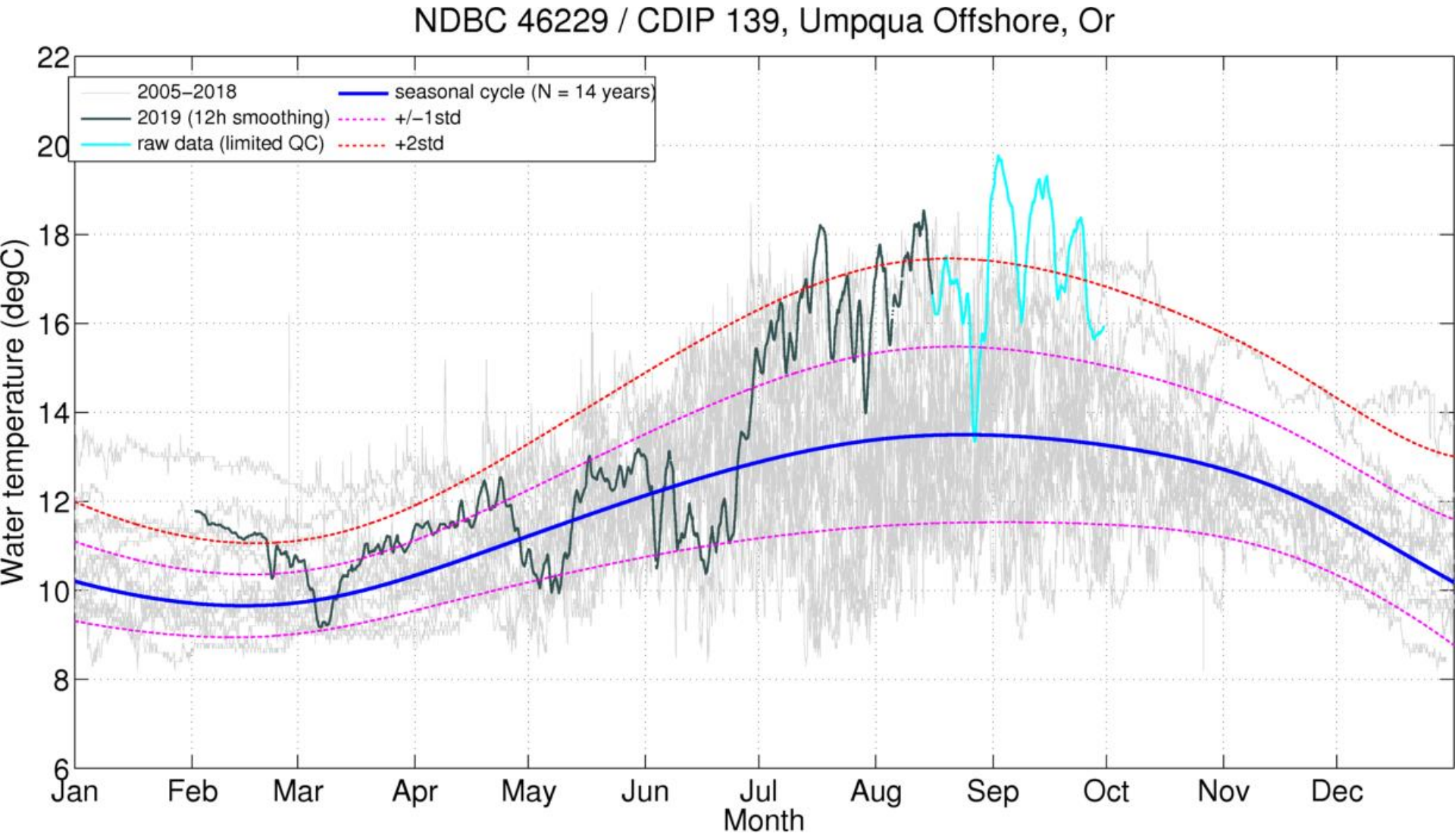
NANOOS climatology app

(Thanks to Craig Risien, OSU)

Temperature Anomaly
August 2019

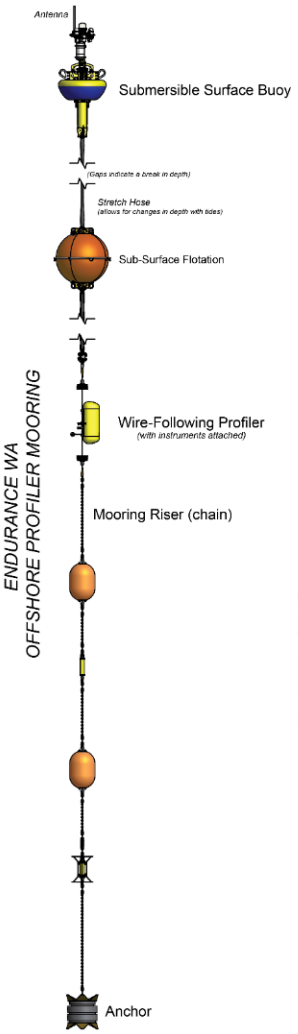


surface water is warm …



Vertical profiler mooring observations

(3 times per day; > 11,000 profiles)

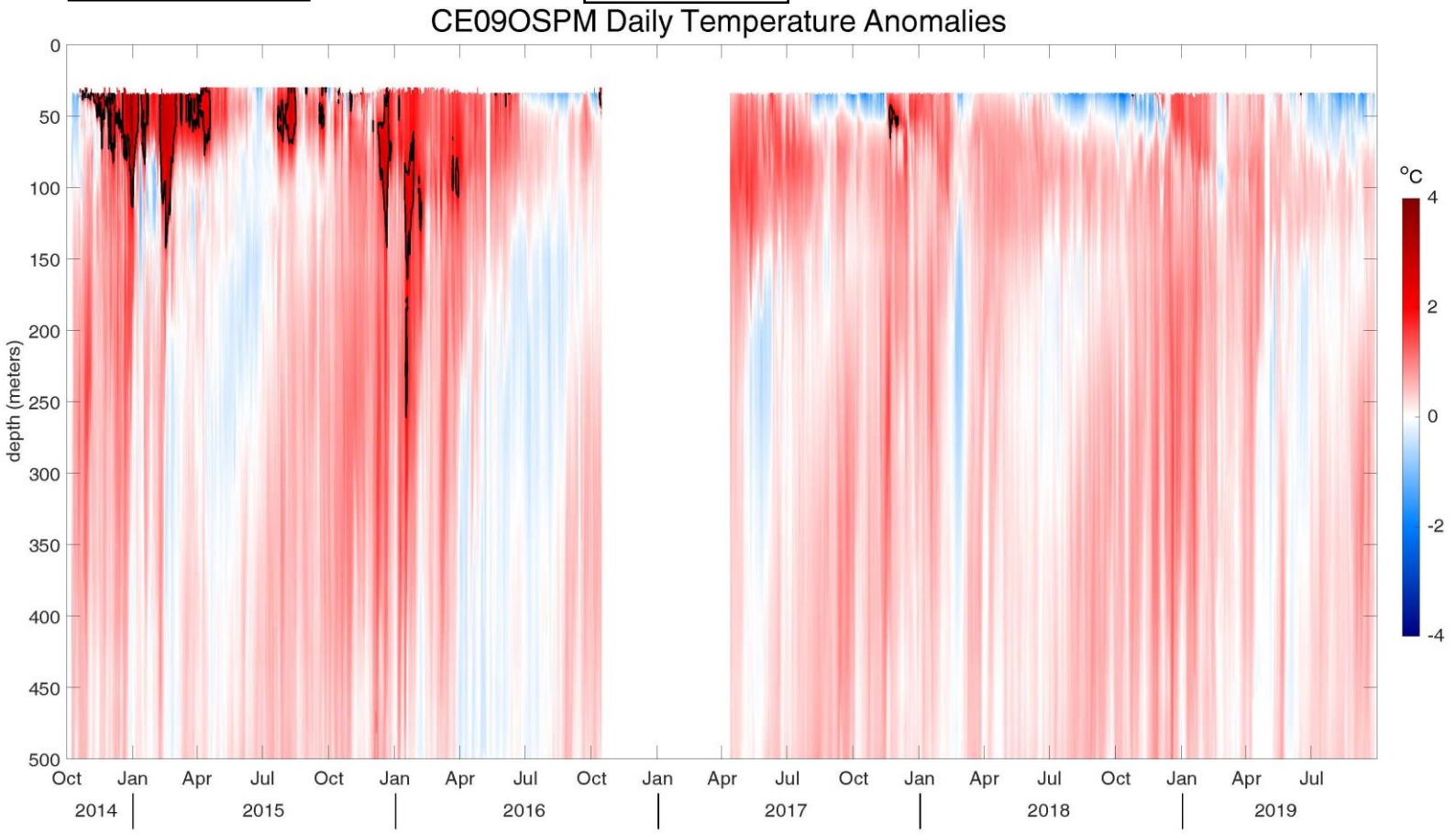


warm blob

El Niño

winter storm took out mooring

El Niño



Ocean Observatories Initiative


Questions?
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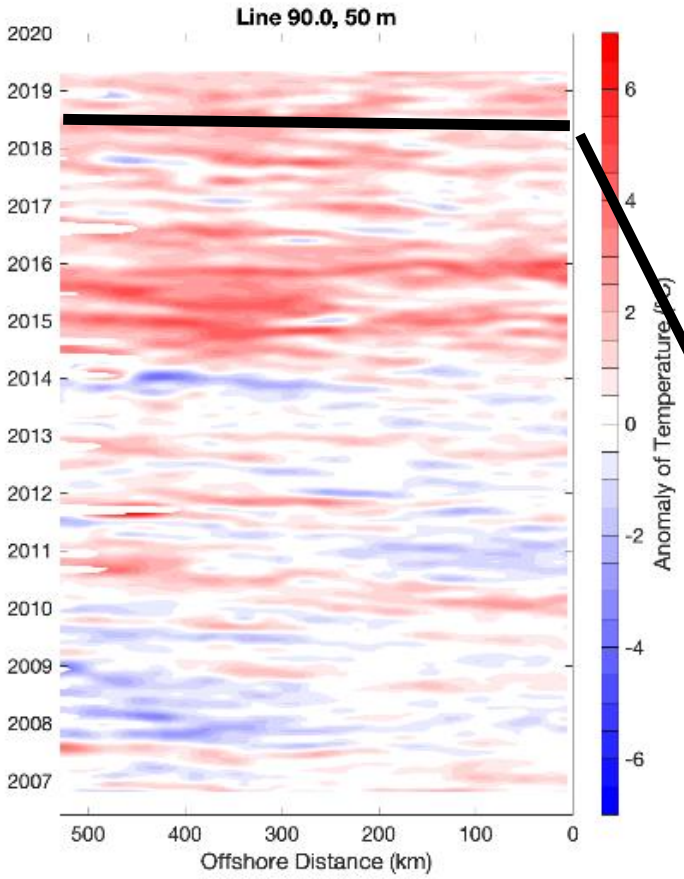
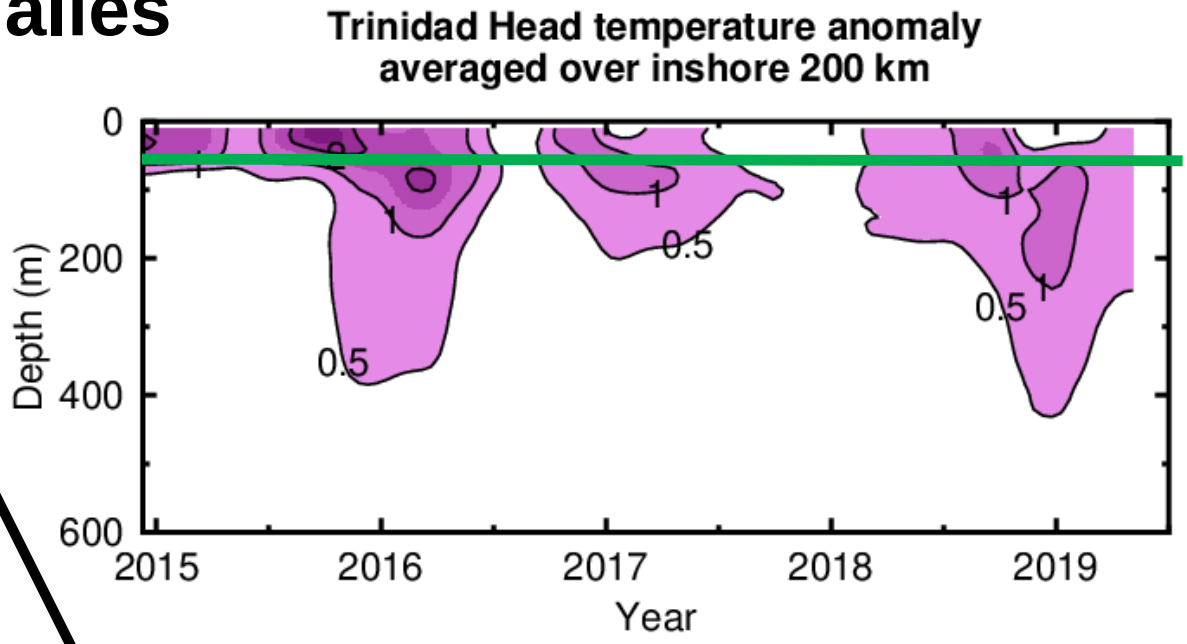
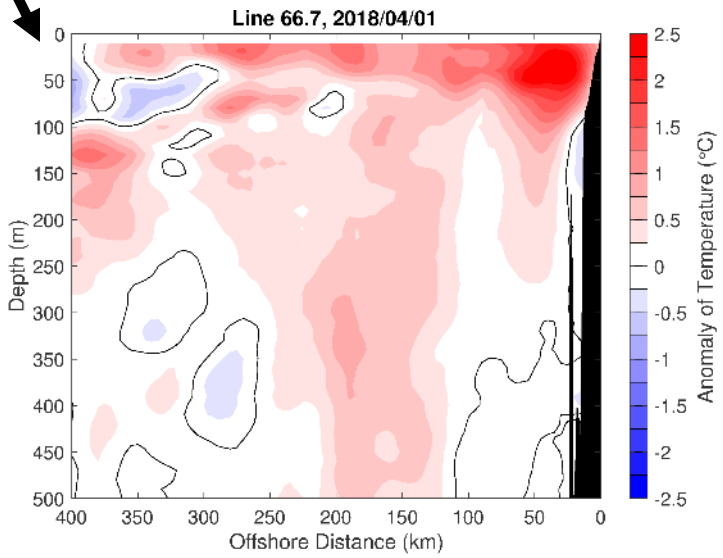
Photo by Ata Suanda

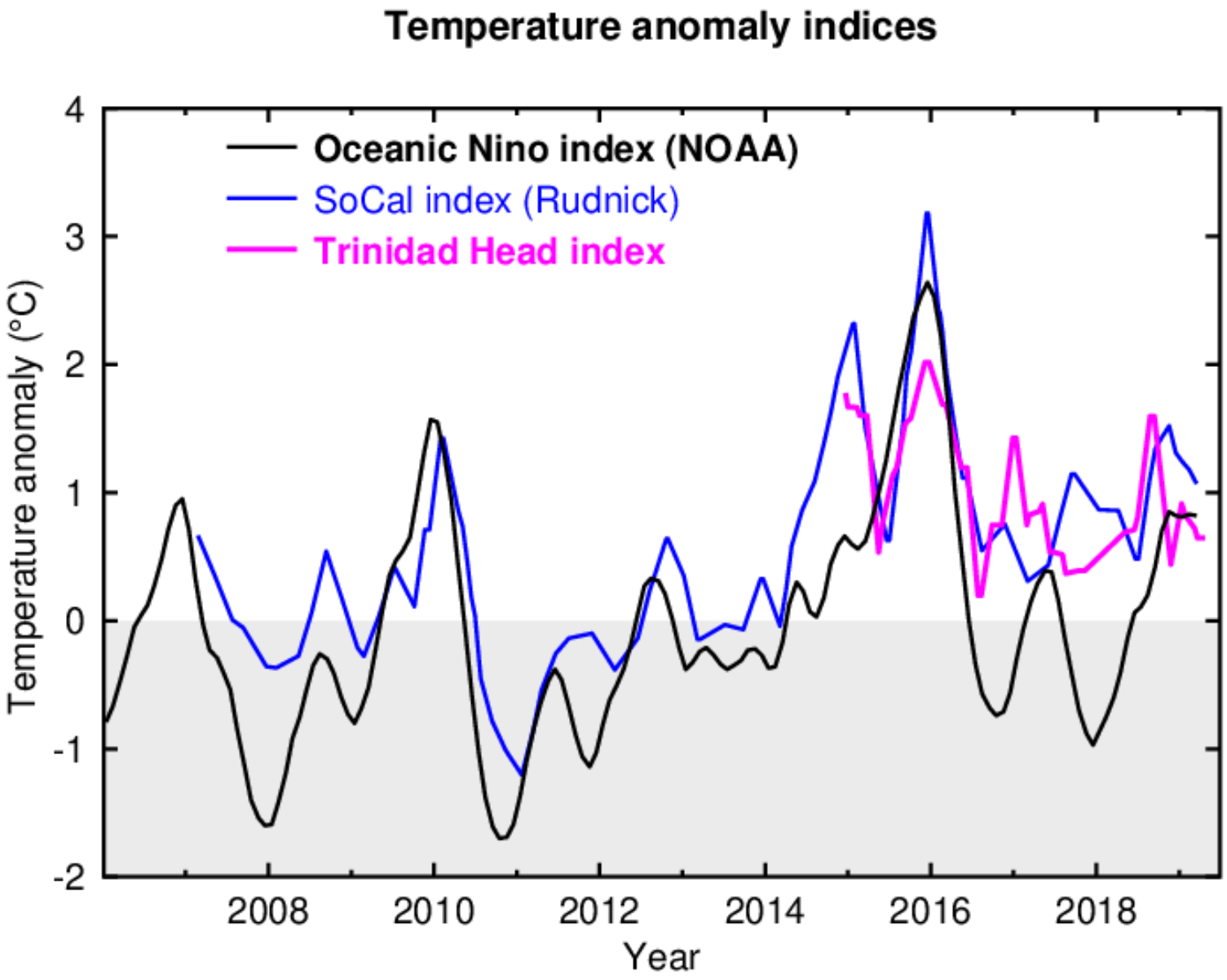
Using gliders to track subsurface temperature anomalies







The California Current remains warm



50-m

0-200 km offshore