



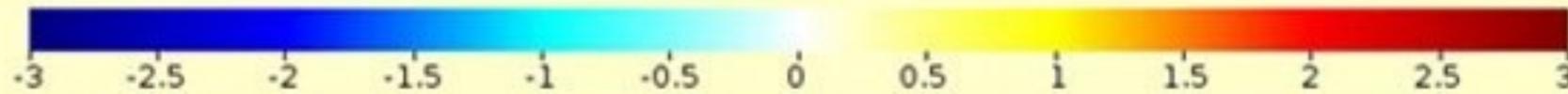
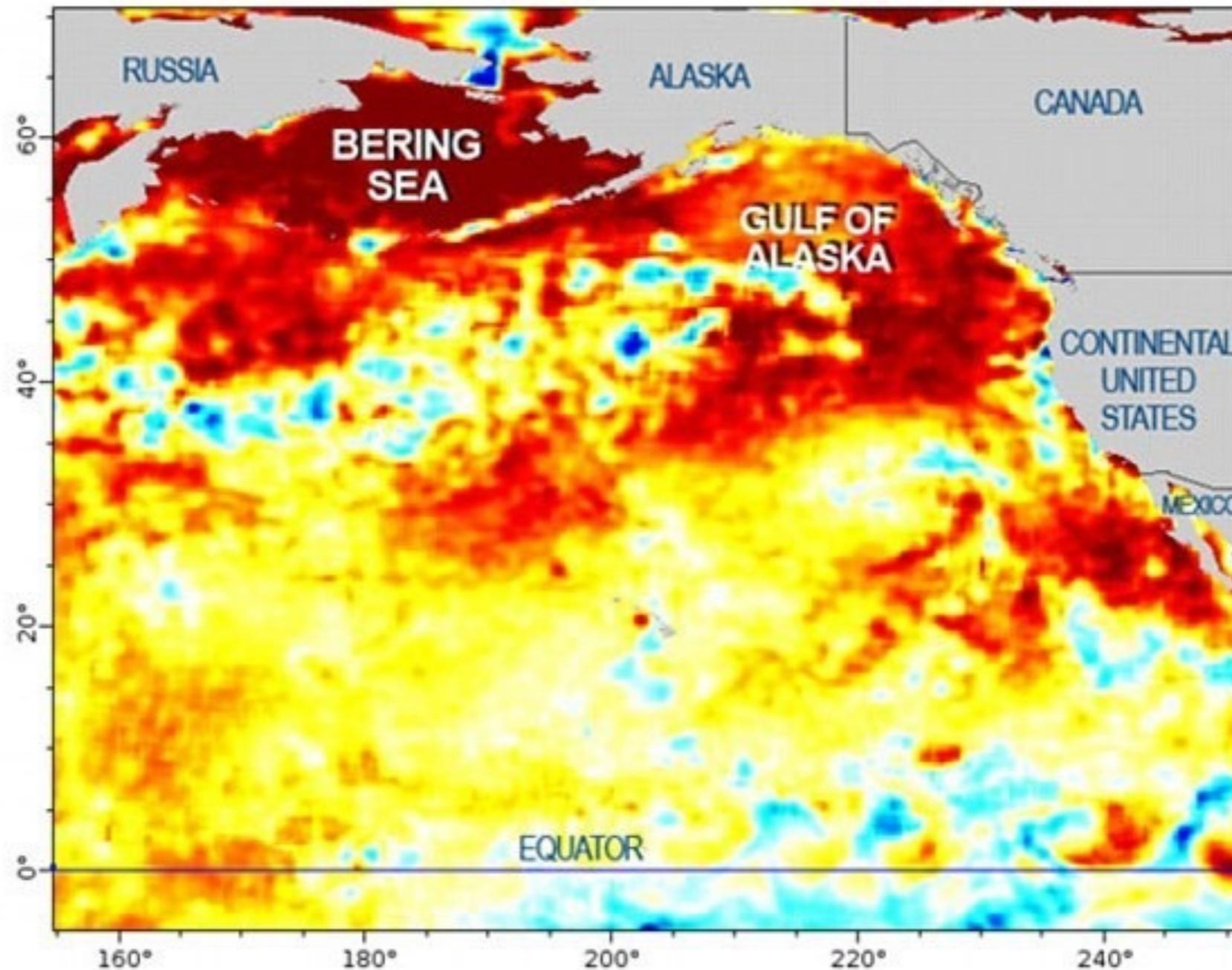
IMPACT OF THE BLOB  
ON THE NORTHEAST  
PACIFIC OCEAN  
BIOGEOCHEMISTRY  
AND ECOSYSTEMS

---



*Samantha Siedlecki*

*Eric Bjorkstedt, Richard Feely, Adrienne  
Sutton, Jessica Cross, & Jan Newton*



**Daily Sea Surface Temperature Anomalies (degree C)**  
SST, Daily Optimum Interpolation (OI), AVHRR Only, Version 2, Final+Preliminary  
(2014-09-01T00:00:00Z, Altitude=0.0 m)  
Data courtesy of NOAA NCDC

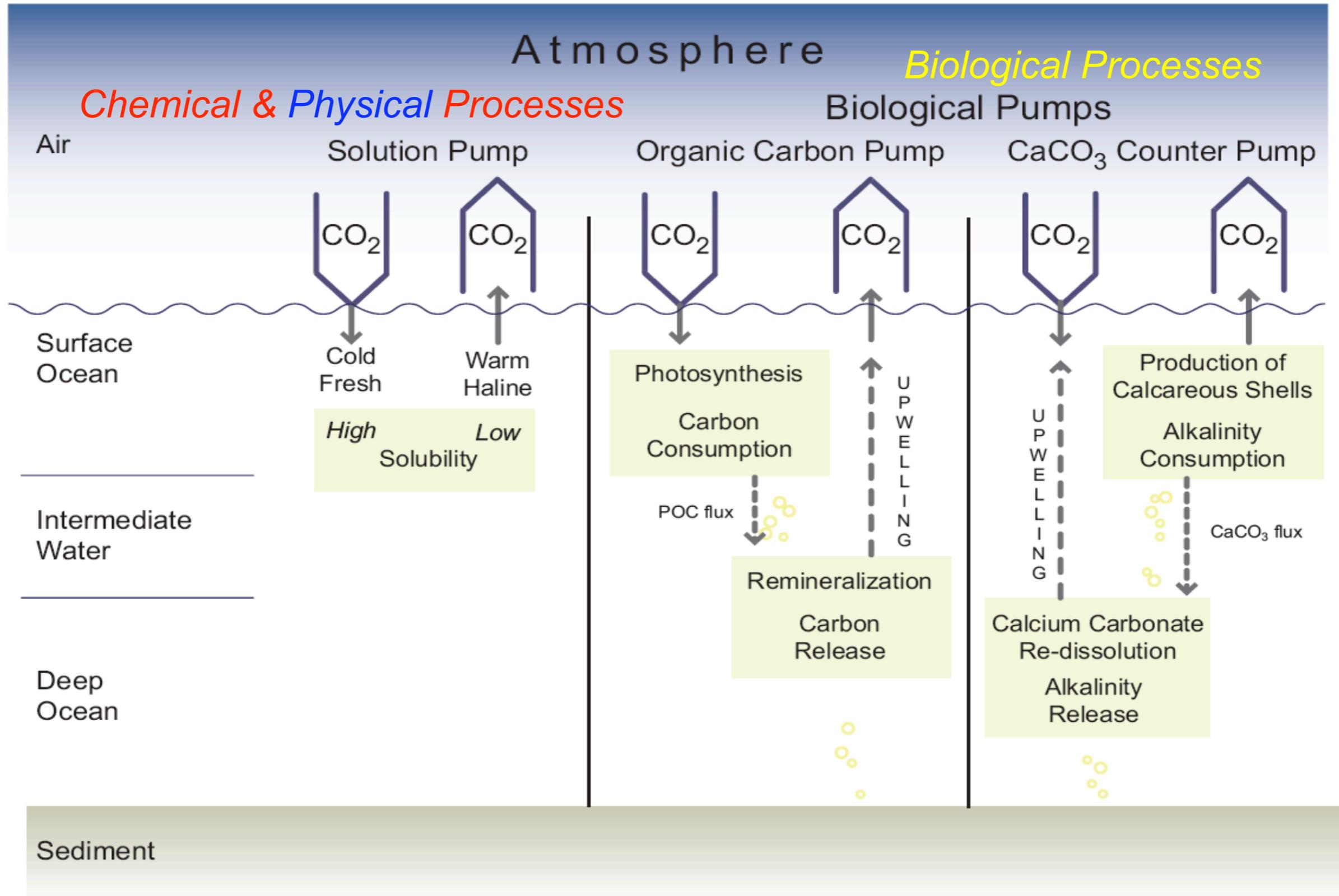
*September,  
2014*

# THE IMPORTANCE OF TEMPERATURE TO CHEMISTRY AND BIOTA IN THE OCEAN

---

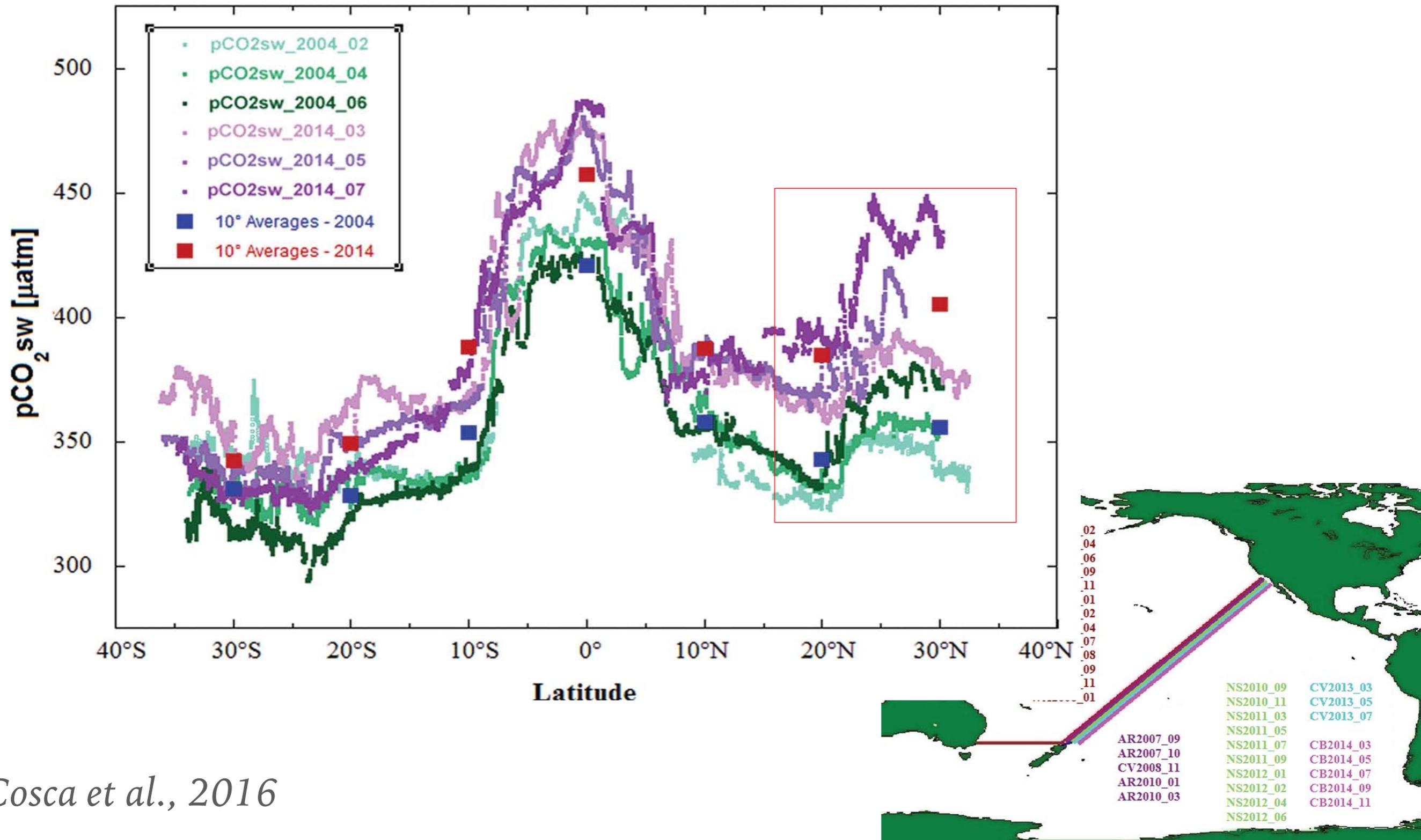
- Solubility of gases (like CO<sub>2</sub> and oxygen) decreases with increasing temperature - warm water holds less gas
- Stratification of the water column changes with temperature, which alters the vertical exchange of nutrients, oxygen, and carbon throughout
- Temperature defines habitats, cues reproduction, and influences metabolism, life cycles, and behavior

# THE IMPORTANCE OF TEMPERATURE TO CHEMISTRY IN THE OCEAN



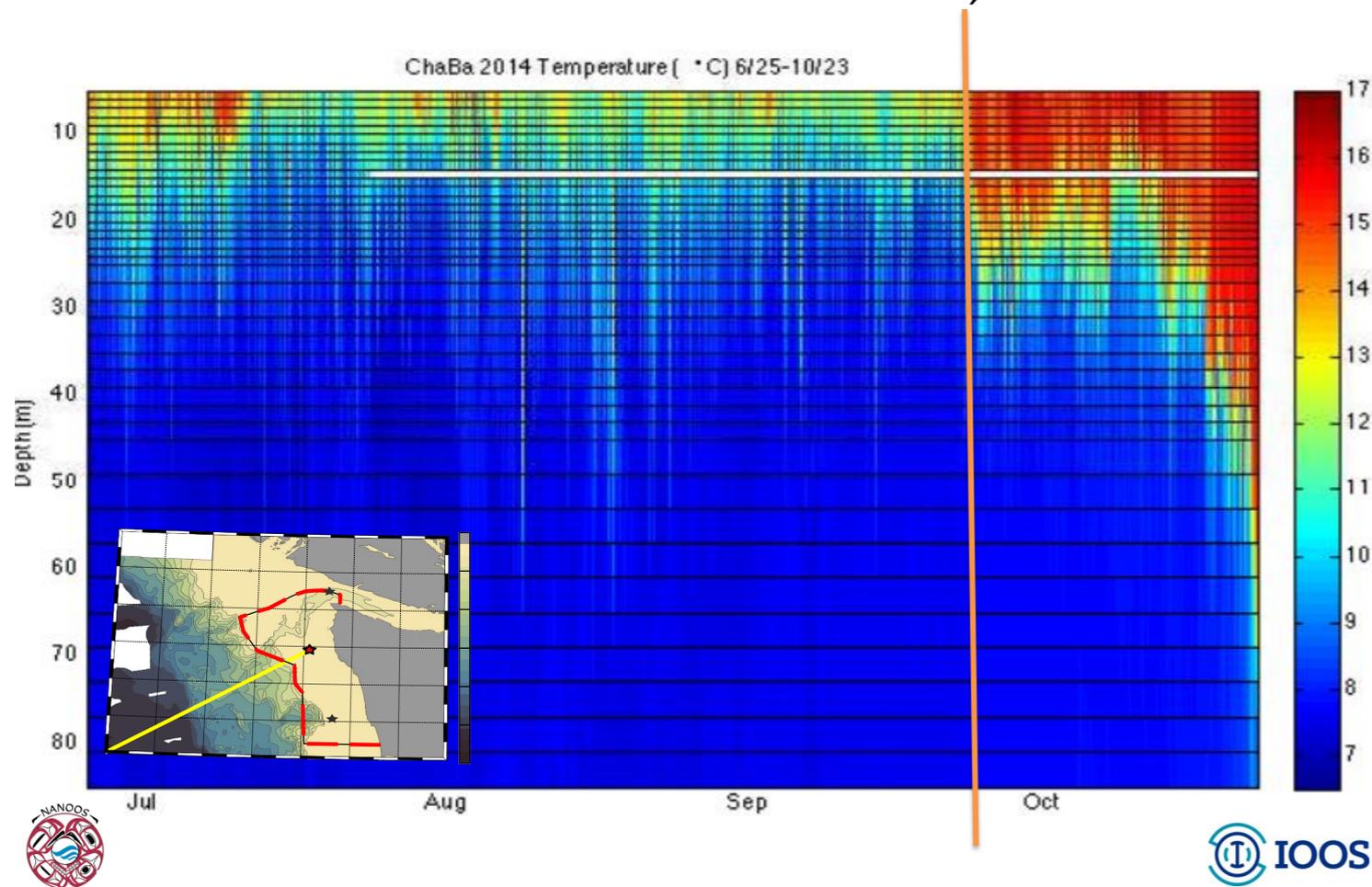
# OPEN OCEAN RESPONSE: PCO<sub>2</sub> HIGHER AT THE SURFACE IN “THE BLOB”

pCO<sub>2</sub> sw Measurements - Long Beach to New Zealand (2004 and 2014)

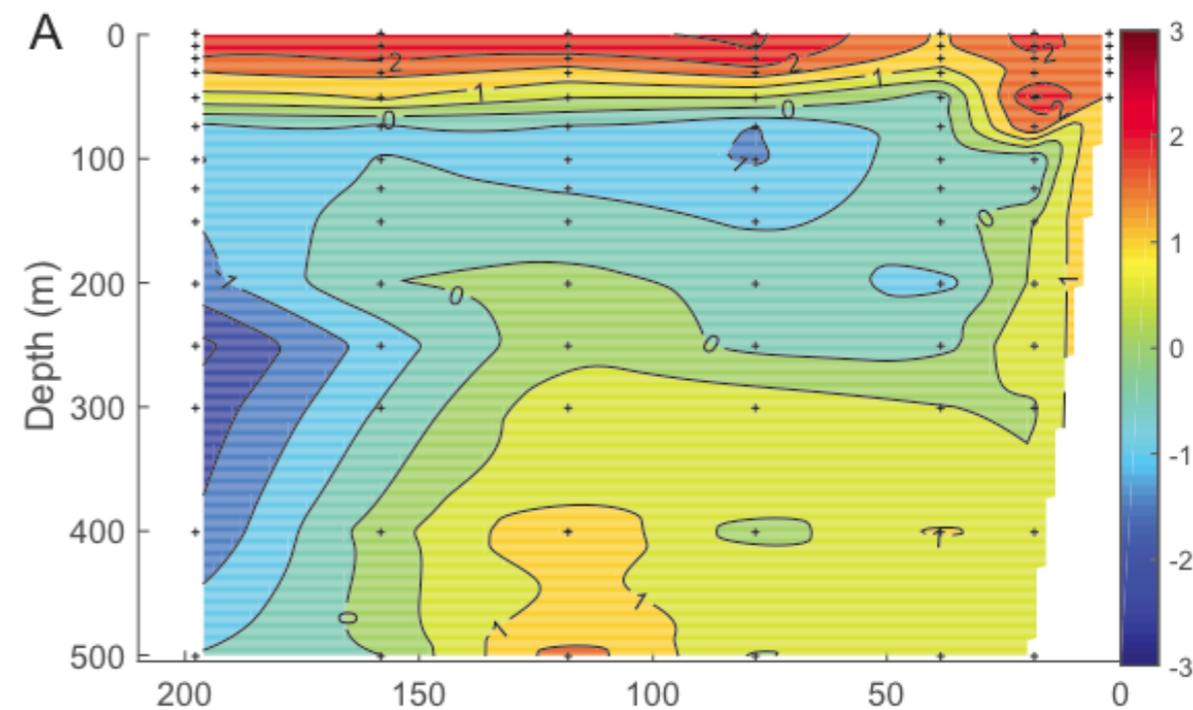


# COASTAL OCEAN RESPONSE: STRATIFICATION CHANGES ALTER UPWELLING

2014 SHIFT TO DOWNWELLING SUDDEN (ON SEPT. 25)  
EVIDENT AT CHA'BA OFF LA PUSH, WA

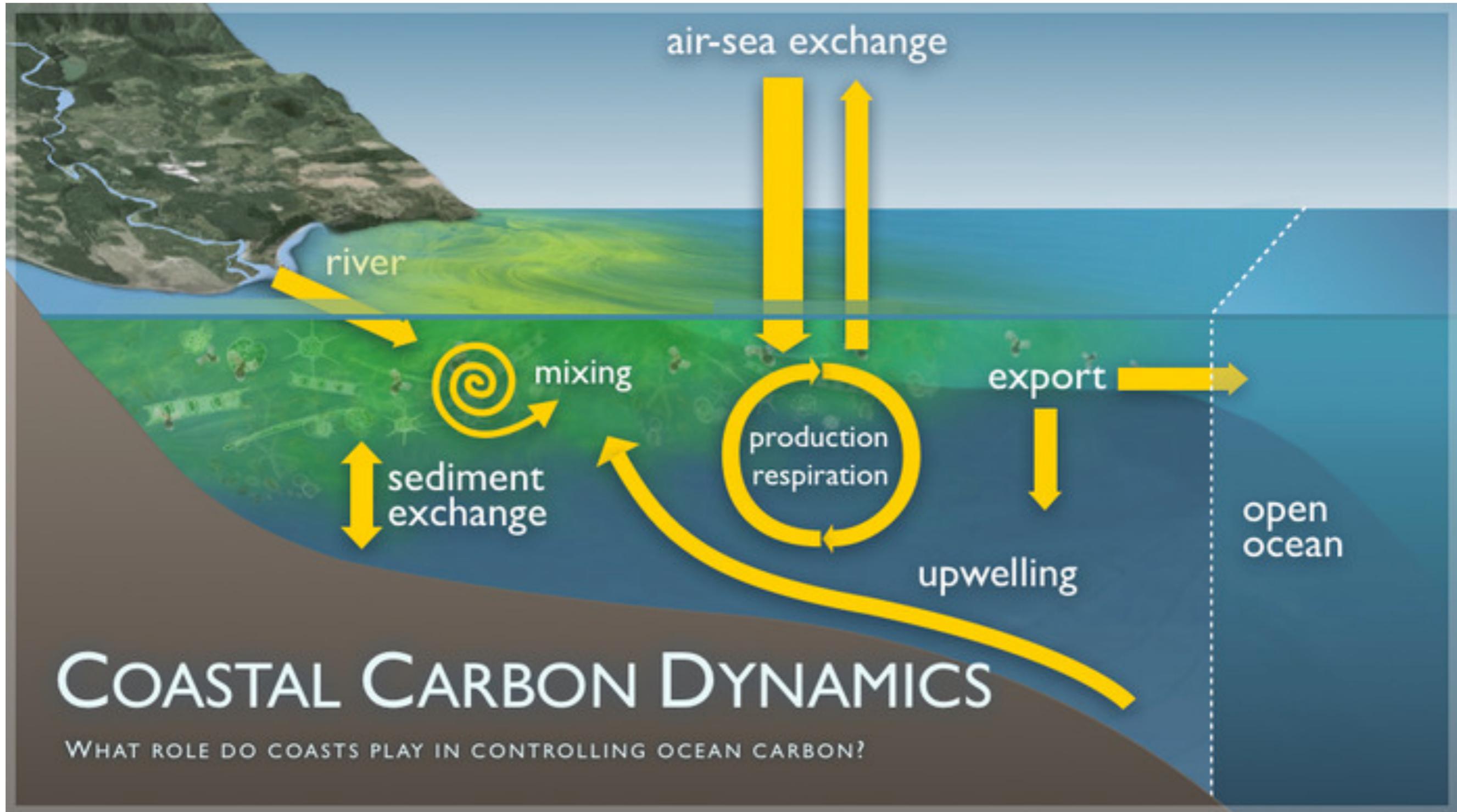


CALCOFI Line 80  
normalized temperature anomaly,  
2014-2015

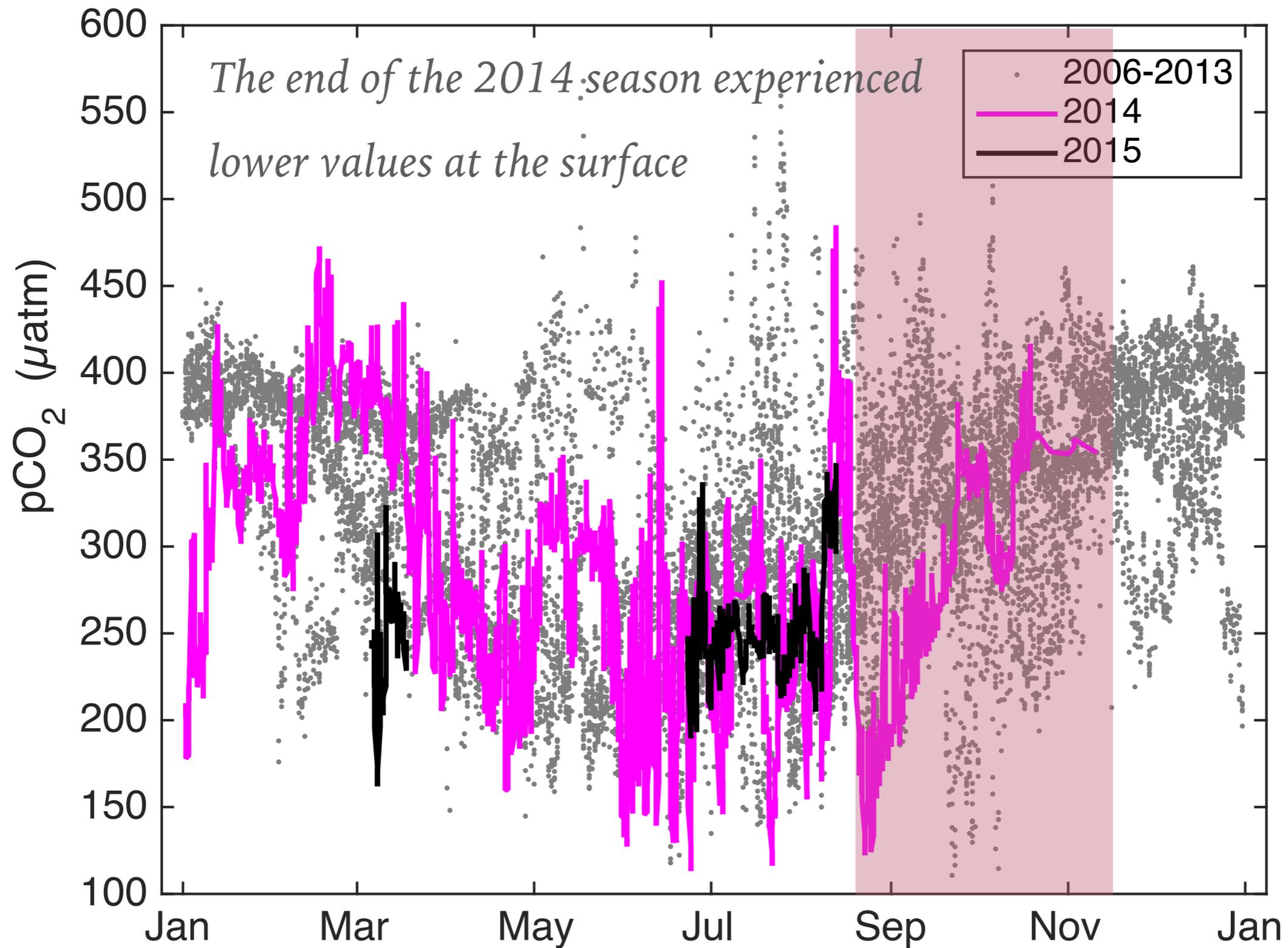


- Upwelling kept warm waters offshore in 2014, but 2015 experienced anomalously warm upwelling

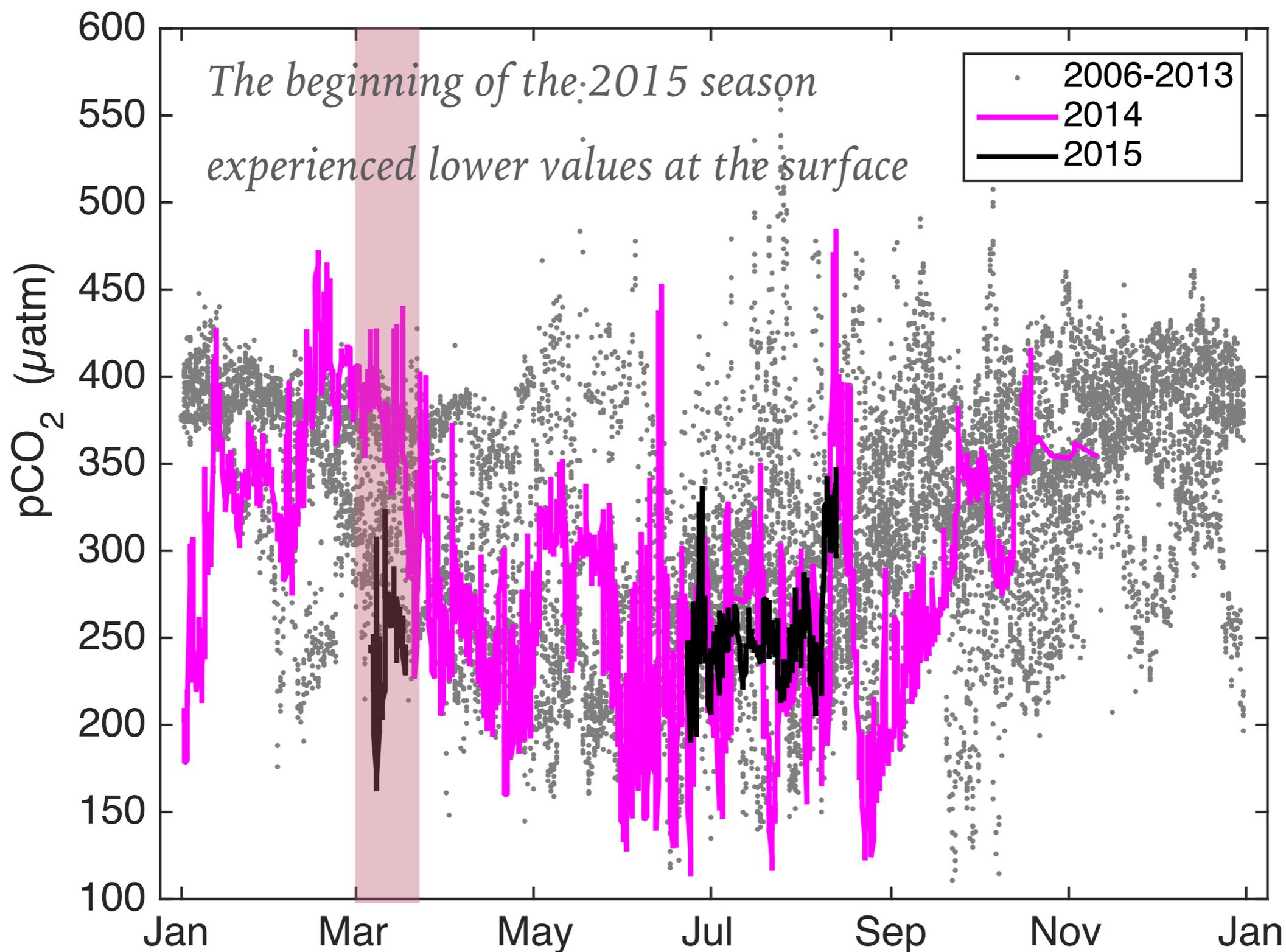
# Coastal Processes That Influence BOTH Oxygen and Carbon Dynamics



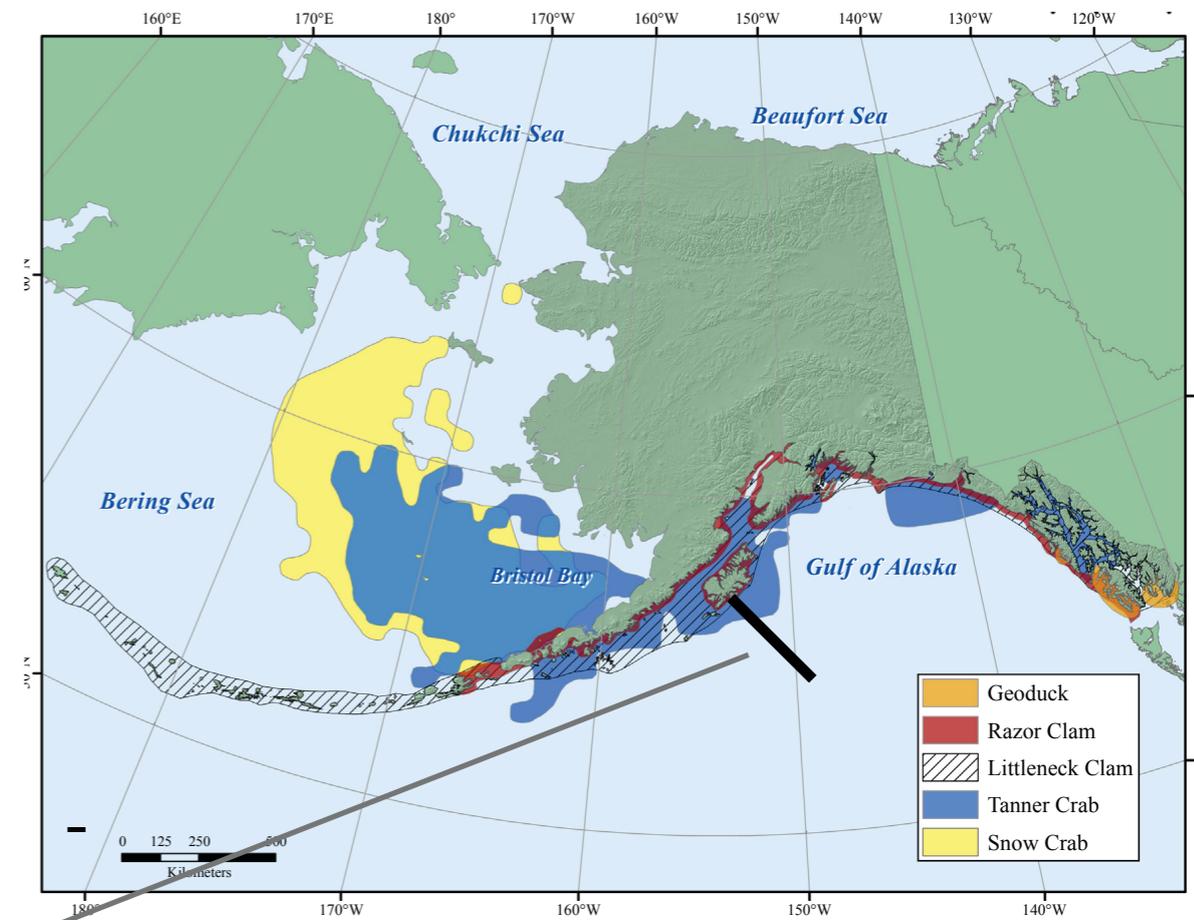
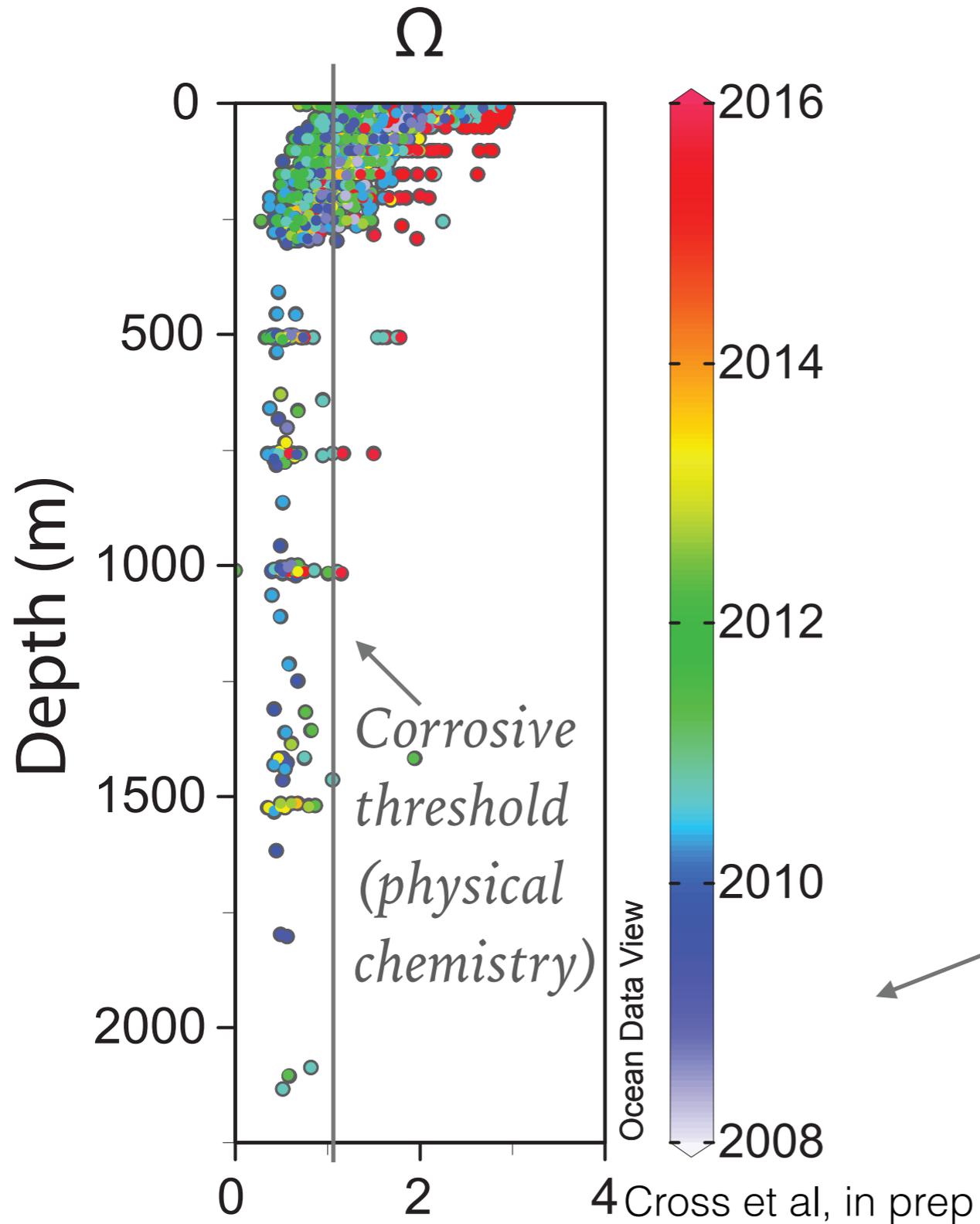
# COASTAL OCEAN CARBON RESPONSE TO "THE BLOB"



# COASTAL OCEAN RESPONSE: STRATIFICATION CHANGES ALTER UPWELLING

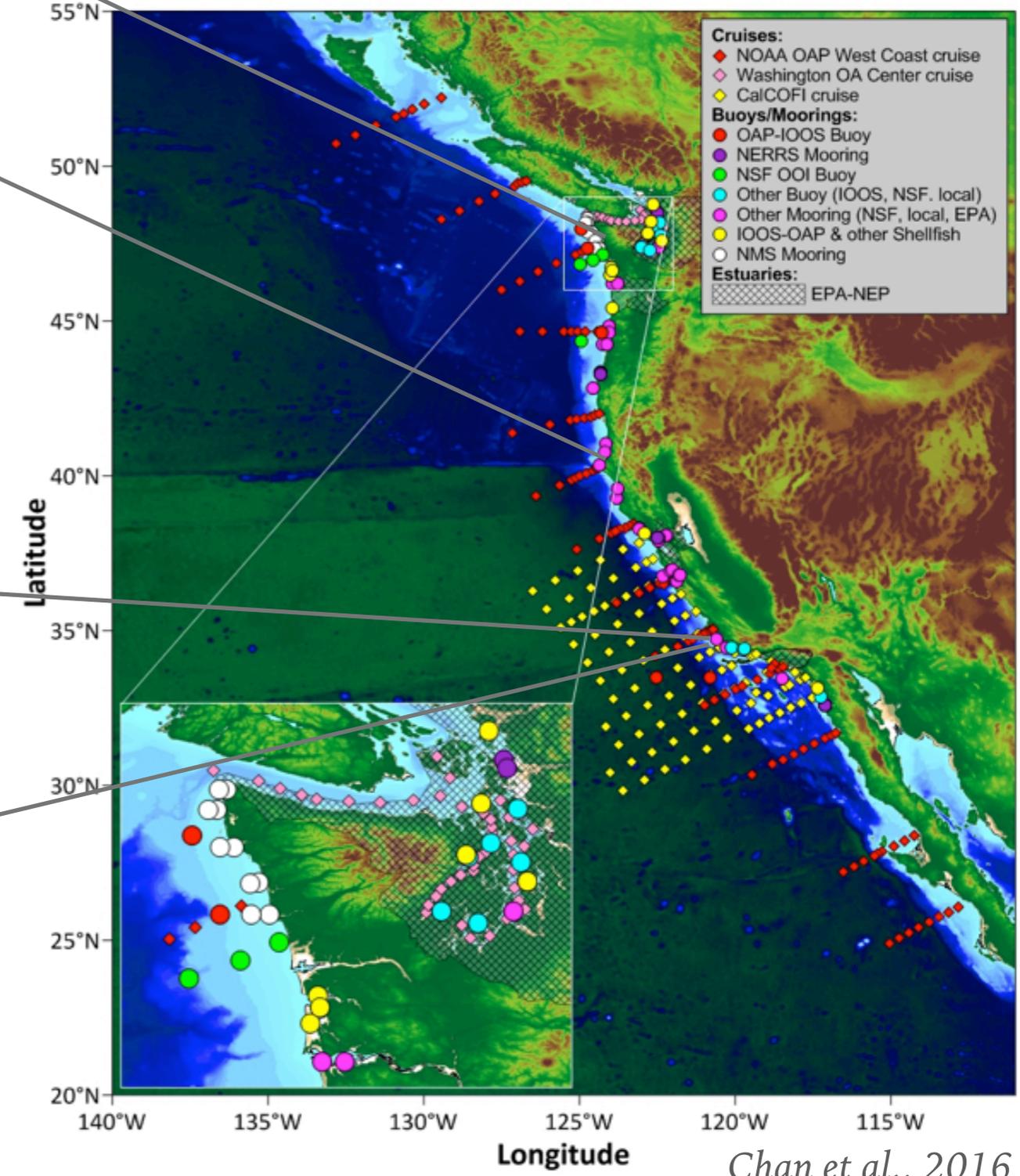
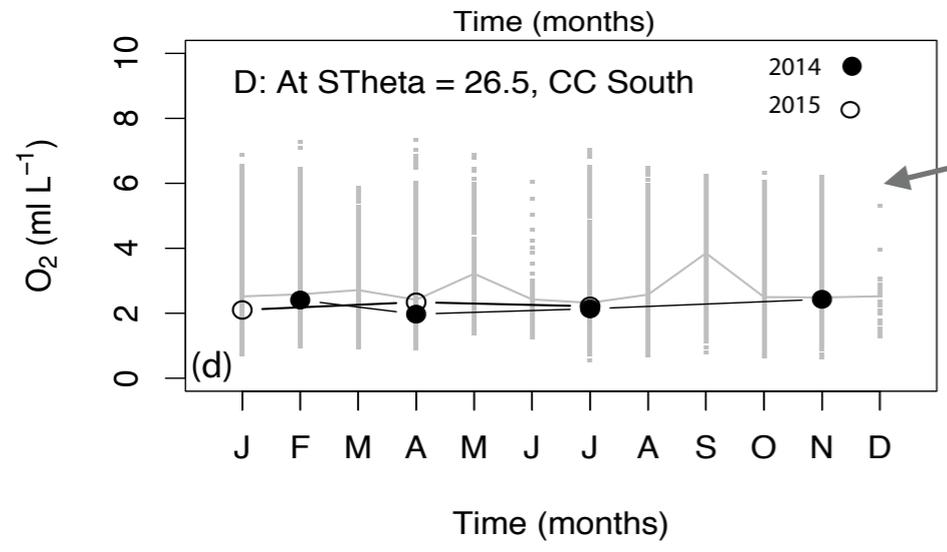
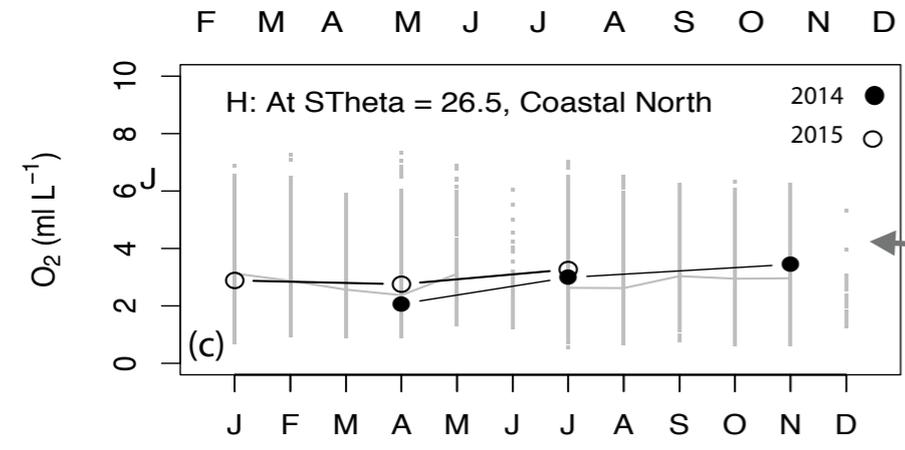
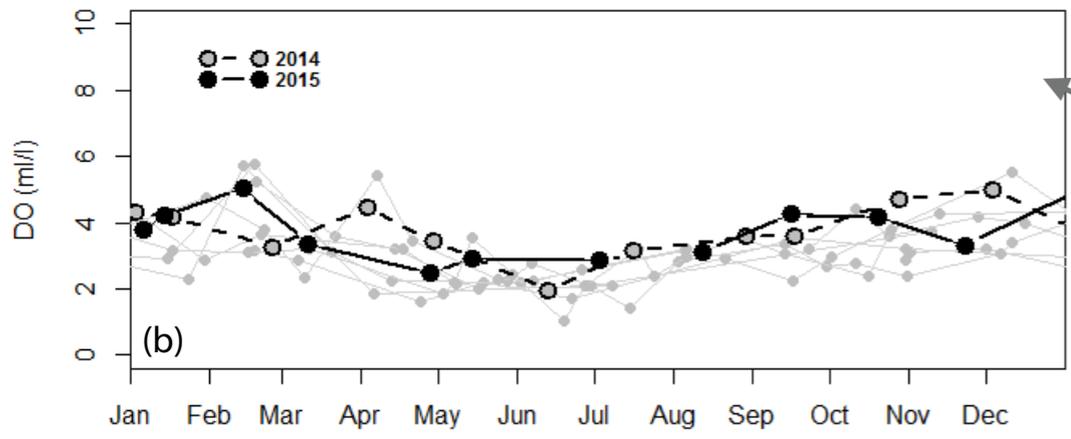
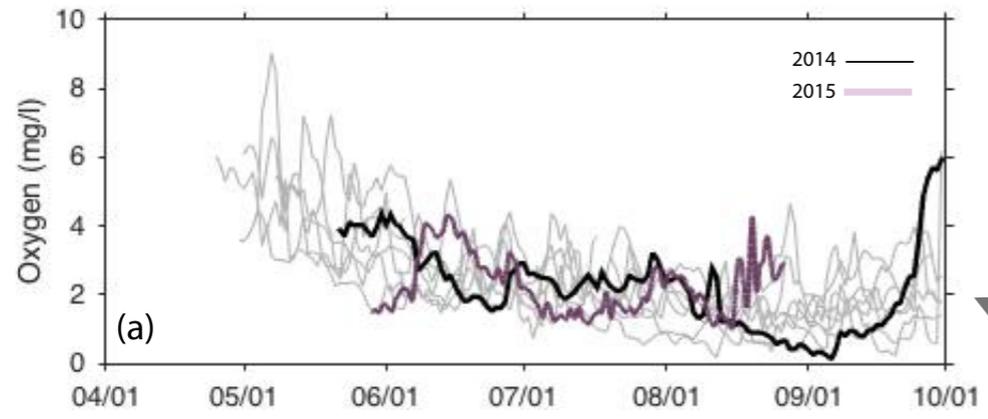


# COASTAL OCEAN RESPONSE: LESS CORROSIVE CONDITIONS IN GOA



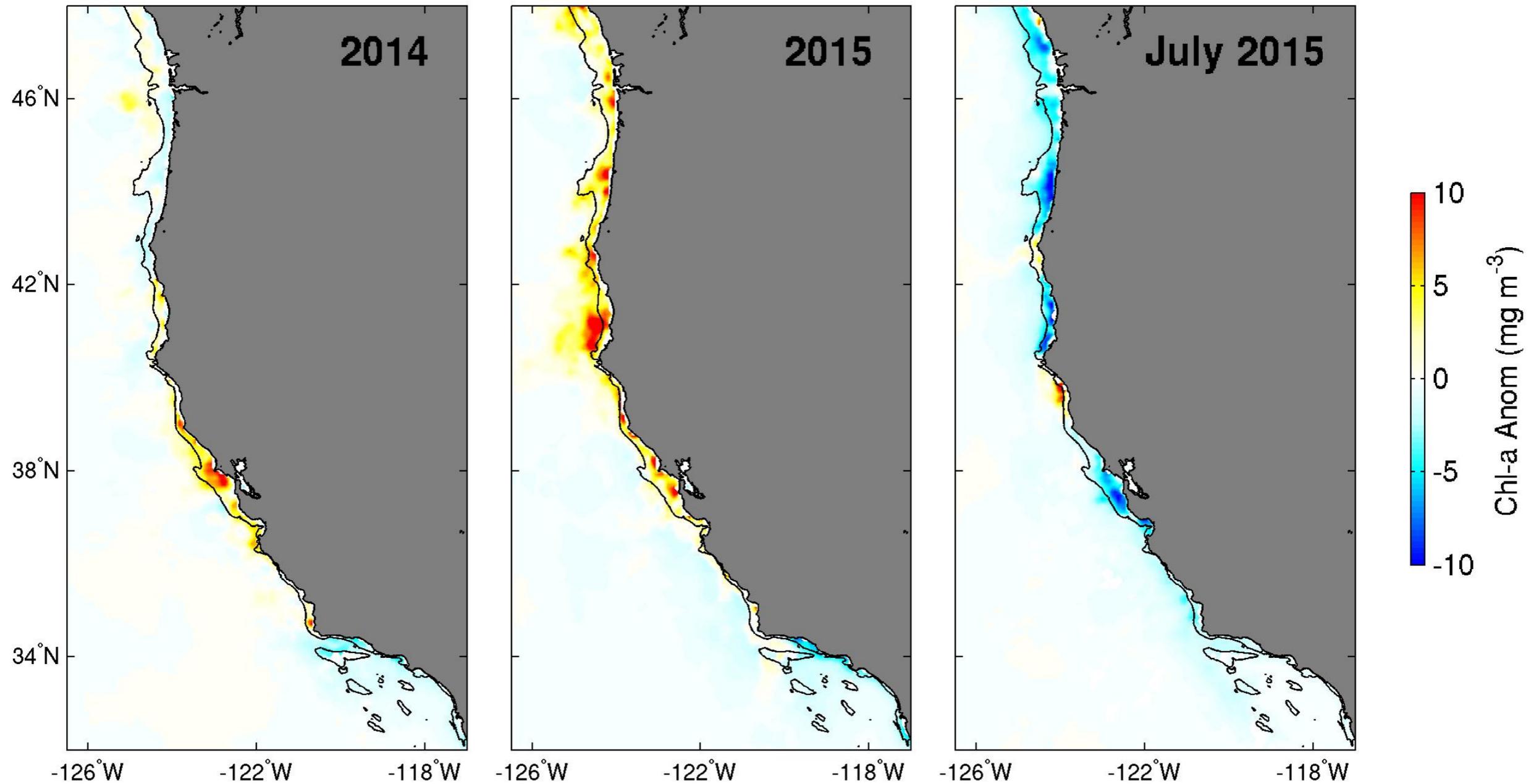
*Seward line observations*

# COASTAL OCEAN RESPONSE: MORE NORM-OXIC THAN PRIOR YEARS



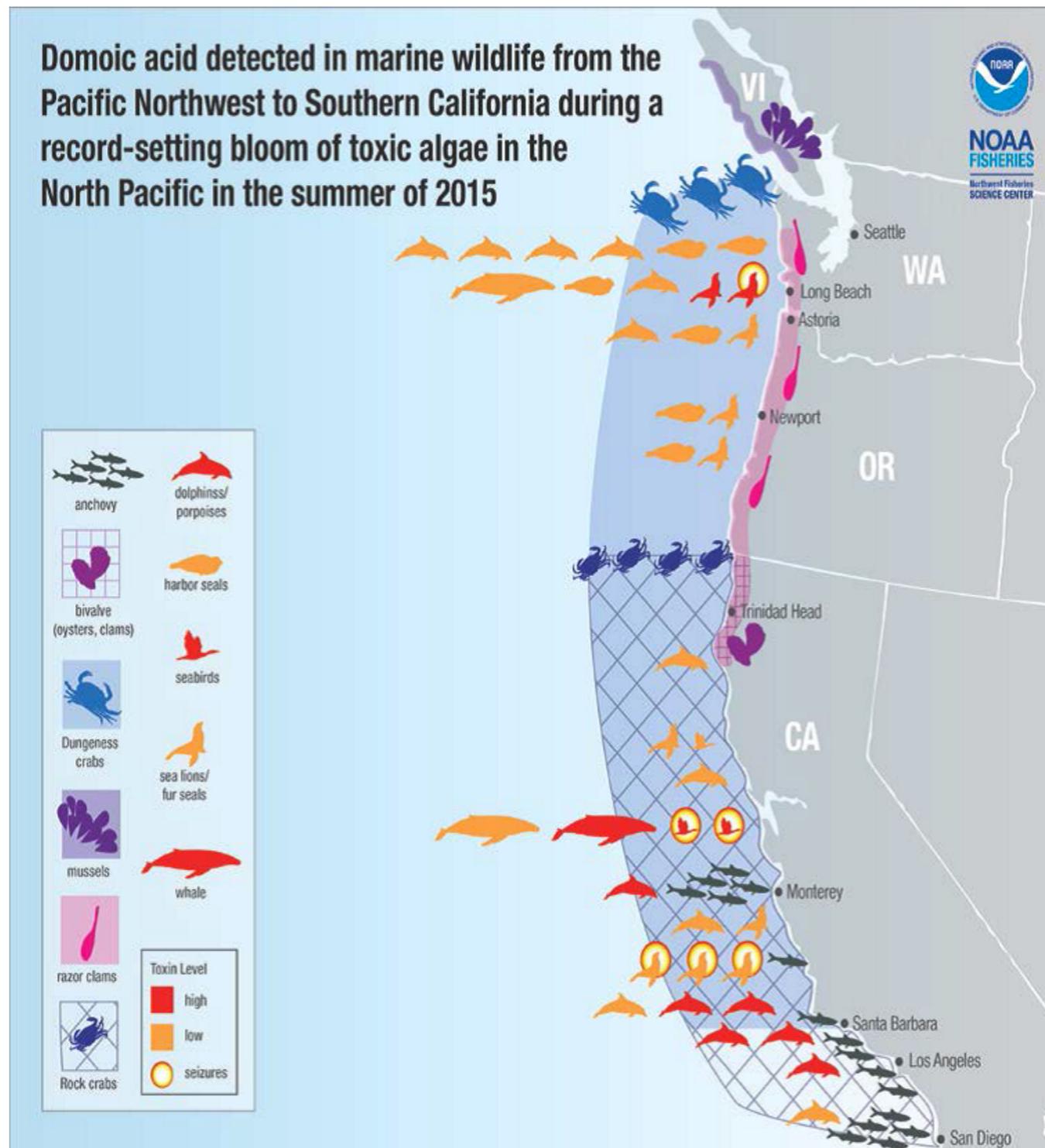
# COASTAL OCEAN RESPONSE: LOW CHL IN 2014 AND LATE 2015

STATE OF THE CALIFORNIA CURRENT  
CalCOFI Rep., Vol. 56, 2015



*Leising et al., 2015*

# COASTAL OCEAN RESPONSE: TOXIC ALGAE



for more information: <https://coastalscience.noaa.gov/news/habs/california-ocean-protection-council-briefed-west-coast-hab-impacts/>

*West Coast HAB Bloom Impacts, 2015: Kudela and Trainer, unpublished*

# COASTAL OCEAN RESPONSE: CHANGE IN COPEPOD SPECIES

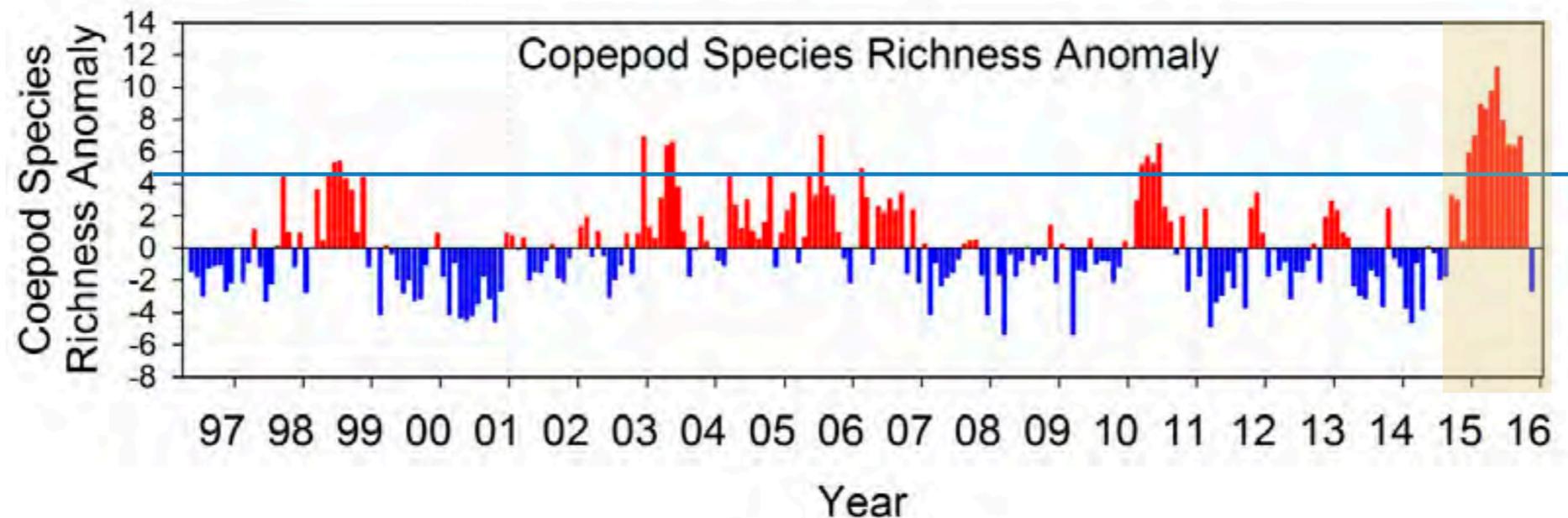
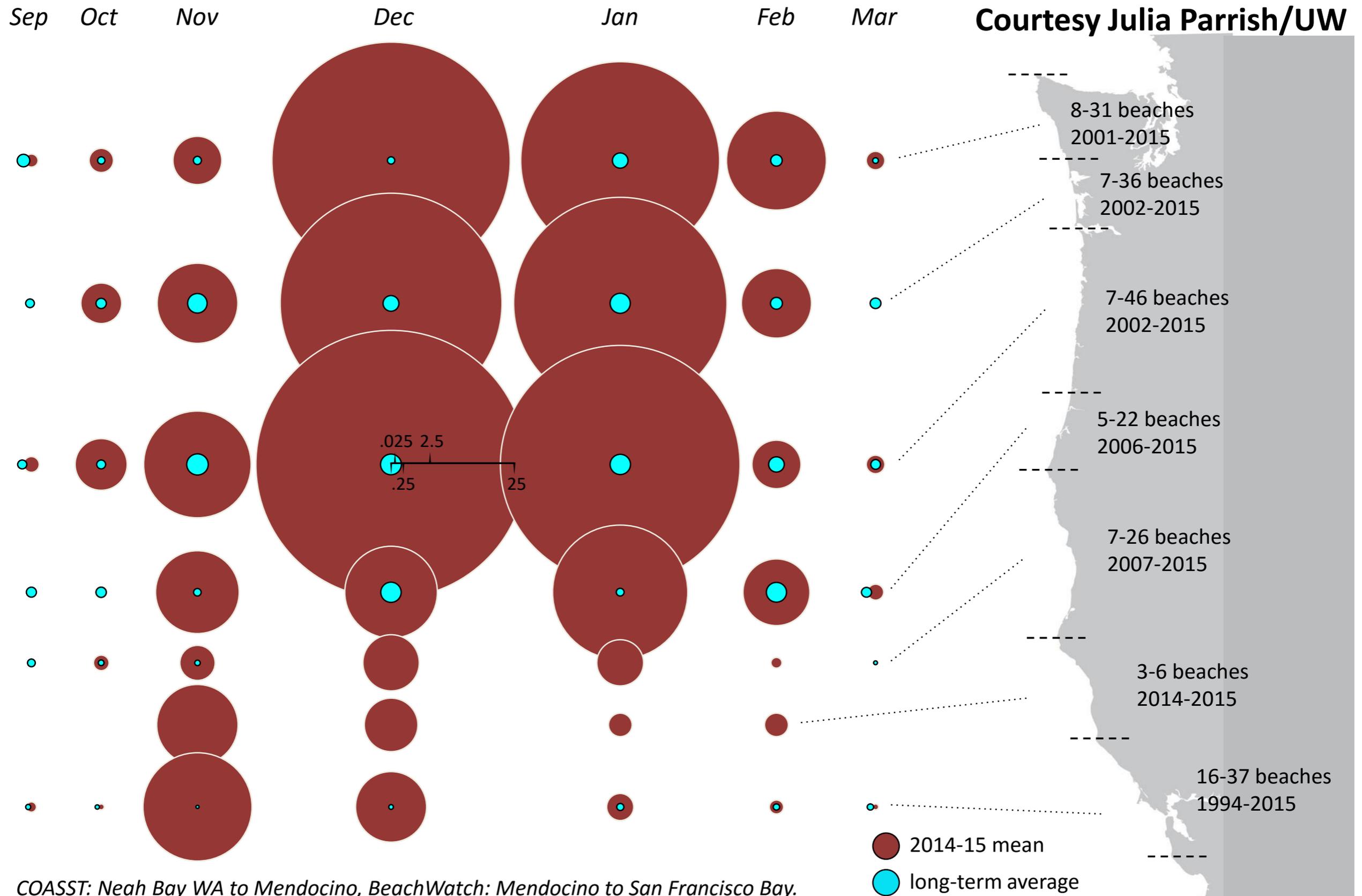


Fig. 4 The anomaly of copepod species richness (i.e., the number of species in a sample) at a station 5 miles (8 km) off the coast of Oregon along the Newport Hydrographic Line. The averaging period is 1996–2014. The horizontal blue line indicates a + 5 species anomaly, one that is commonly seen during the positive phase of the Pacific Decadal Oscillation (PDO) and El Niño events. Note that the peak anomaly of >10 species was seen in May 2015 in association with the Blob. The November 2015 sample (– 2 species anomaly) contained the ‘normal’ number of species seen during winter.

# Unprecedented Mass Mortality Event (~100,000 dead Cassin's Auklets)



COASST: Neah Bay WA to Mendocino, BeachWatch: Mendocino to San Francisco Bay.

Data are Cassin's Auklets carcasses/km, new finds only. Sample size is number of beach sites over the listed year range.

*Parrish et al, in prep*

for more information: [http://www.nanoos.org/resources/anomalies\\_workshop/workshop2.php](http://www.nanoos.org/resources/anomalies_workshop/workshop2.php)

# COASTAL OCEAN RESPONSE: DECLINE IN PELAGIC FORAGE FISH

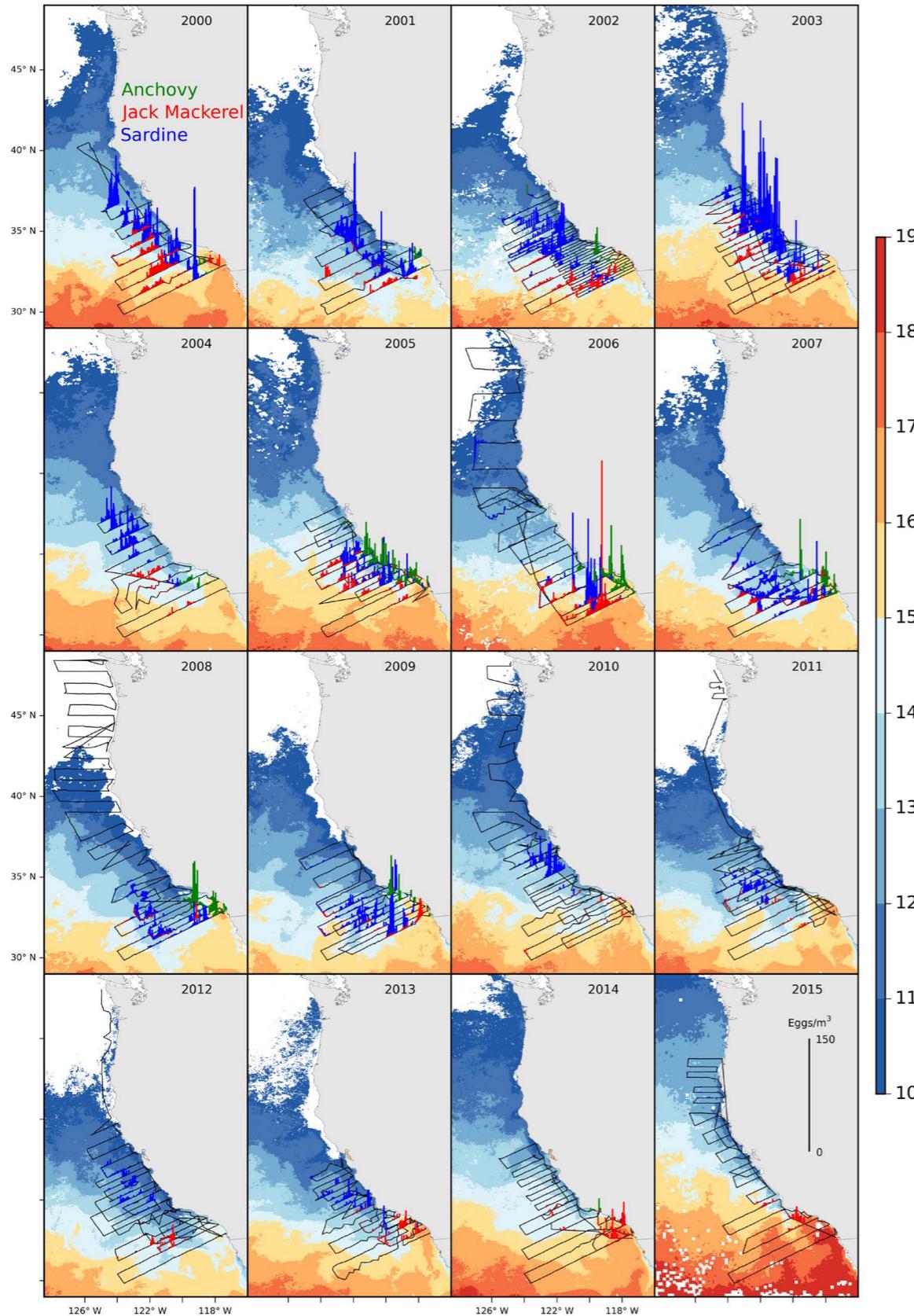


Figure 23. Density of eggs of sardine (blue), anchovy (green), and jack mackerel (red) collected with the continuous underway fish egg sampler (CUFES) overlaid on satellite sea surface temperatures ( $^{\circ}\text{C}$ ) derived from a monthly composite of April Pathfinder 5.5-km resolution (2000–08) or AVHRR 1.4 km resolution (2009–15) imagery. Ship track is shown by the black line.

# COASTAL OCEAN RESPONSE: DECLINE IN PELAGIC FORAGE FISH

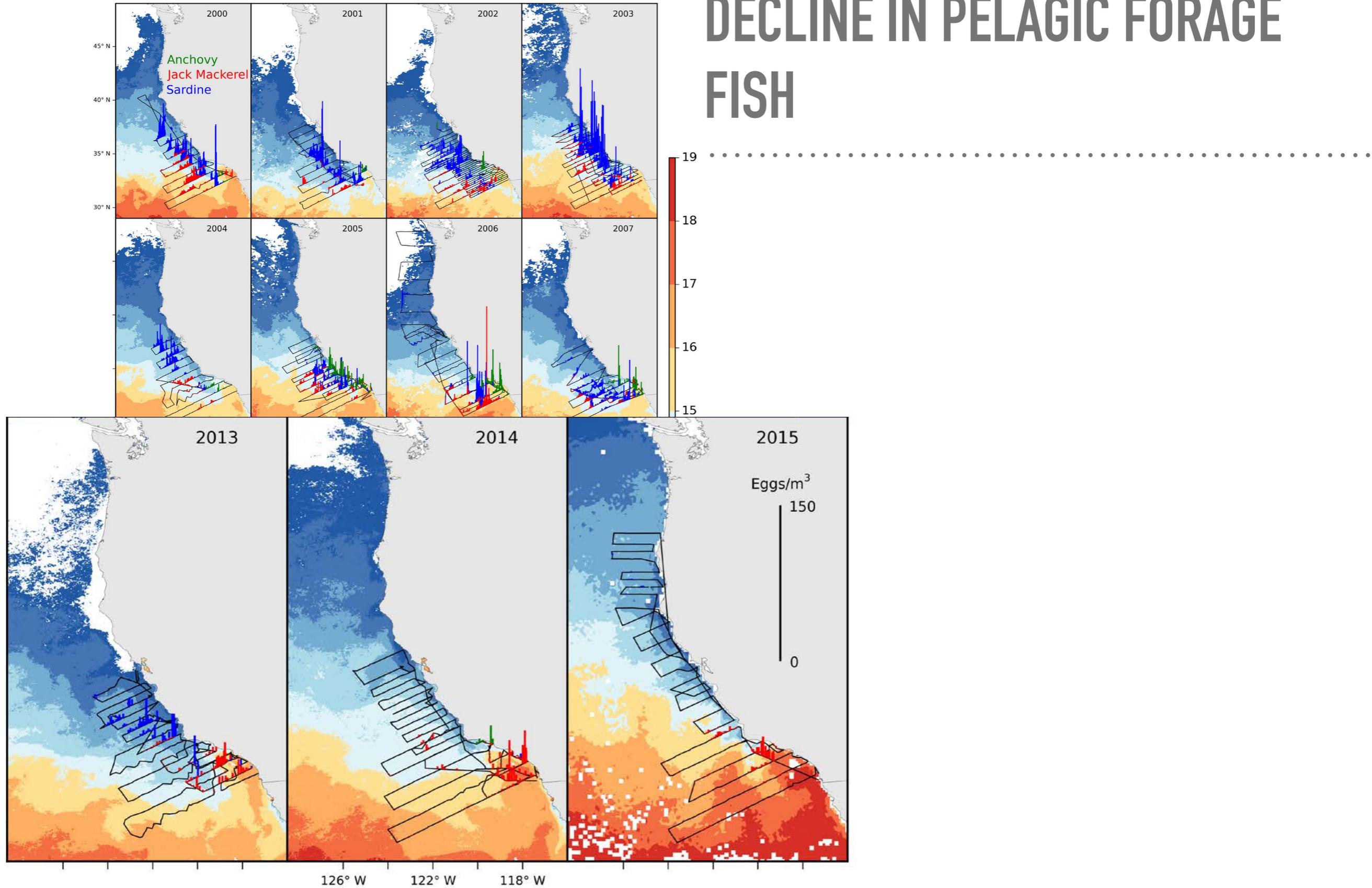


Figure 2. Density of eggs of sardine (blue), anchovy (green), and jack mackerel (red) collected from the continuous underway water egg sampler (CUFES) overlaid on satellite sea surface temperatures (°C) derived from a monthly composite of April Pathfinder 5.5-km resolution (2000–08) or AVHRR 1.4 km resolution (2009–15) imagery. Ship track is shown by the black line.



Southwest Fisheries Science Center, NOAA Fisheries Service

*Biogeographic anomalies- warm water species found in Gulf of Alaska!*

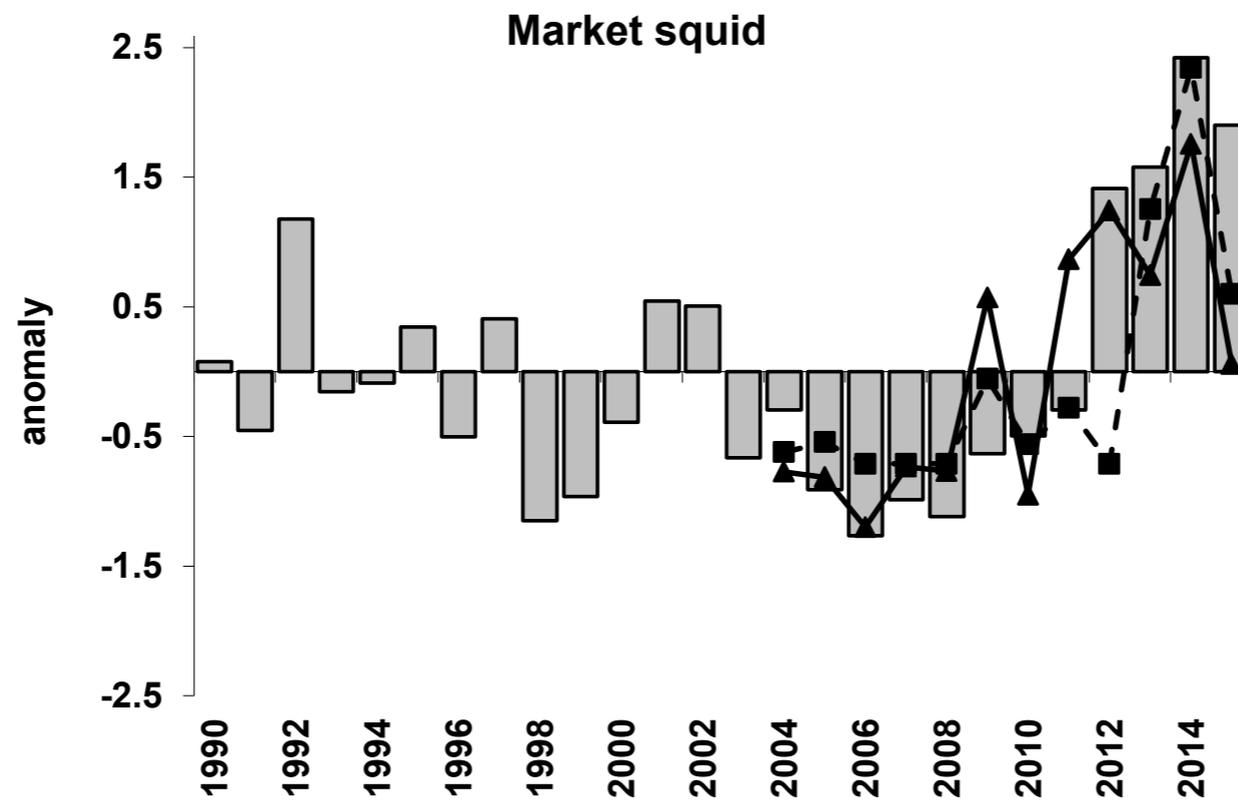
# CONCLUSIONS

---

- The Blob had major effects beyond temperature
- Open ocean response differed from the coastal ocean response
- Blob could have altered a region of the central Pacific from a sink to a source for carbon to the atmosphere
- Blob brought warm, high oxygen, low carbon water to the coastal regions of the CCS and GOA - possibly by changing the upwelling structure.
- Ecosystems shifted northward, HAB dominated massive phytoplankton bloom.
- Lasting impacts still being observed and determined

# COASTAL OCEAN RESPONSE: INCREASE IN SQUID

---



# OA and Hypoxia West Coast Observing Network - Summary from West Coast OAH Science Panel

*The Pacific Coast Collaborative and the State of California have requested a strategic framework for monitoring that will provide rigorous decision-support to policy-makers and managers at a west coast, regional scale.*

A fully-realized OAH monitoring network will have the capability to:

- track changes in physical conditions (e.g., salinity and temperature),
- water chemistry (e.g., oxygen, pH,  $p\text{CO}_2$ , aragonite and calcite saturation states),
- and biological processes that can modulate changes in chemistry (e.g., production and remineralization rates, species distributions, predator-prey relationships, biogeochemical responses).

