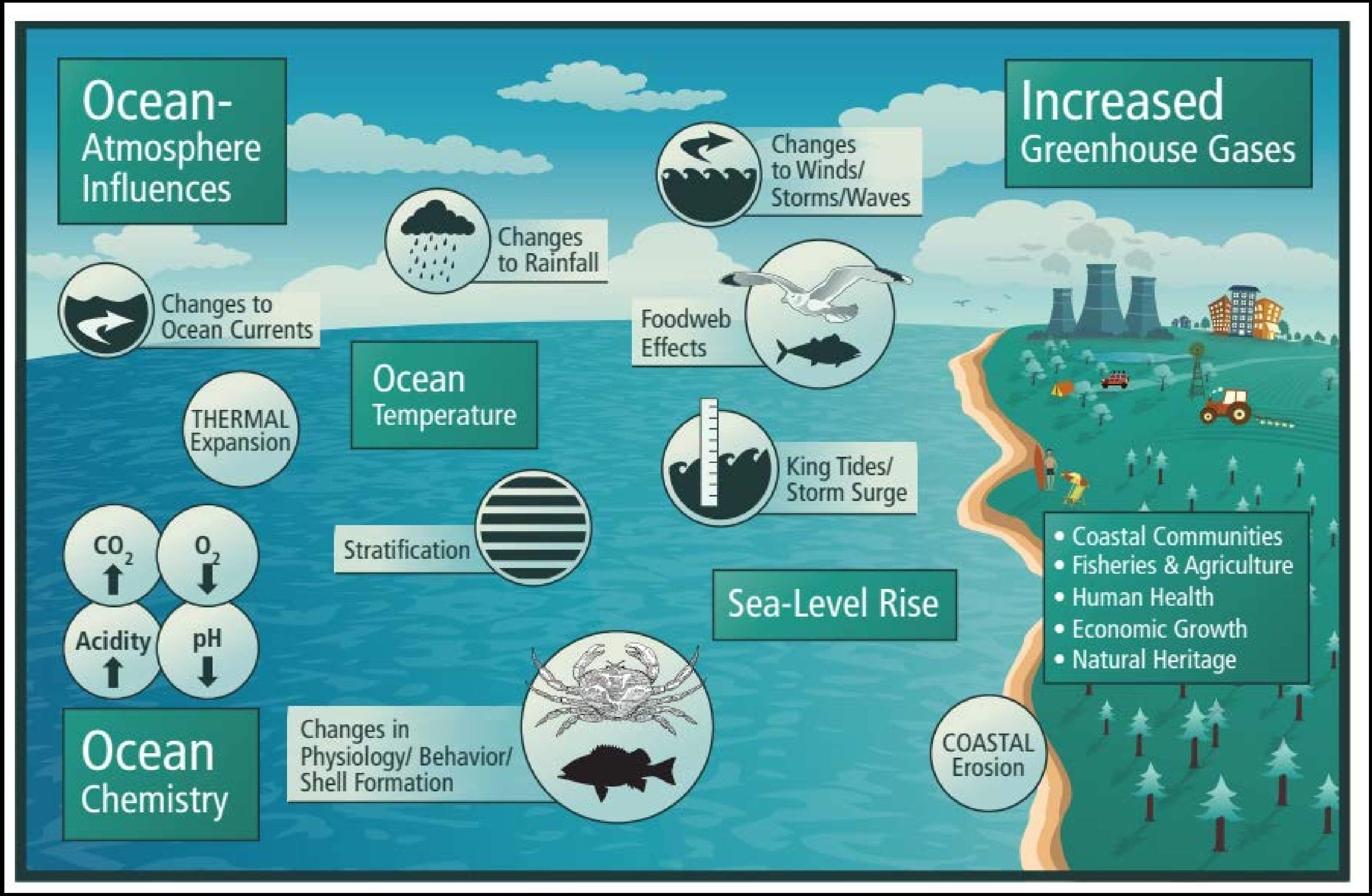
Ocean Acidification: Impacts & Responses

Carina Fish, UC Davis Bodega Marine Lab
Tessa Hill, UC Davis Bodega Marine Lab

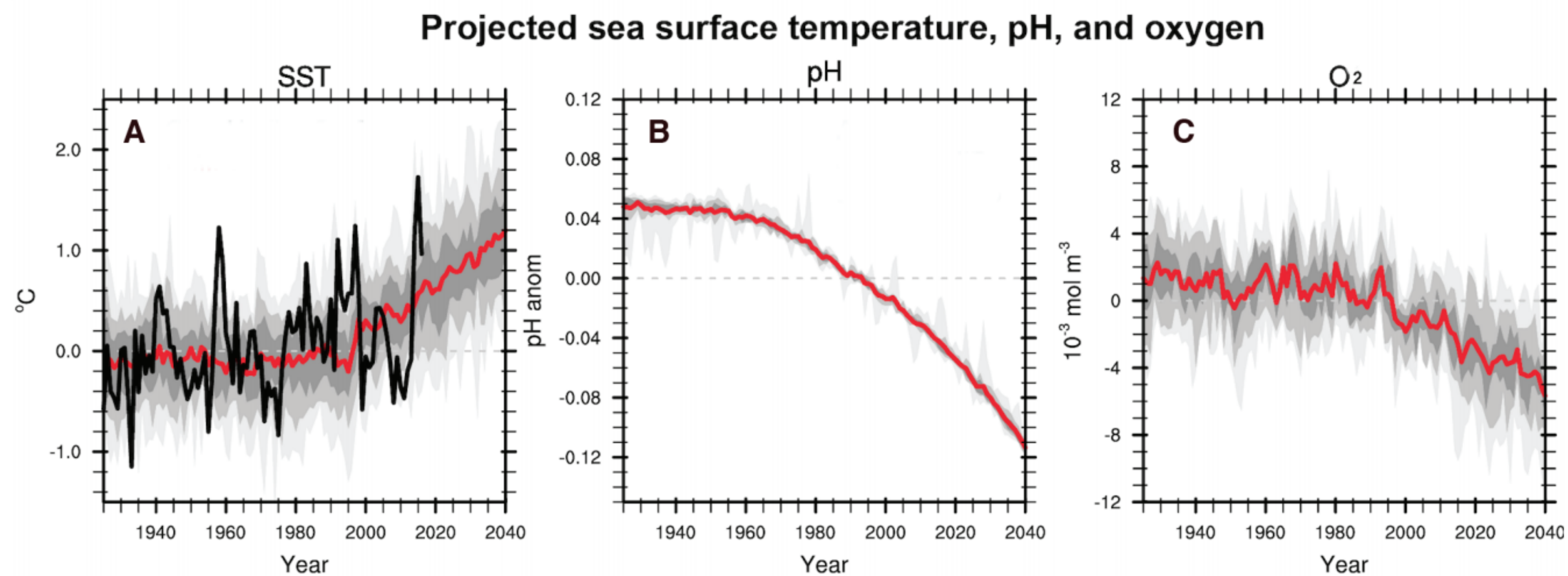
BODEGA MARINE LABORATORY
UC DAVIS COASTAL & MARINE SCIENCES INSTITUTE

An ocean of change



CA Fourth Climate Assessment, 2018

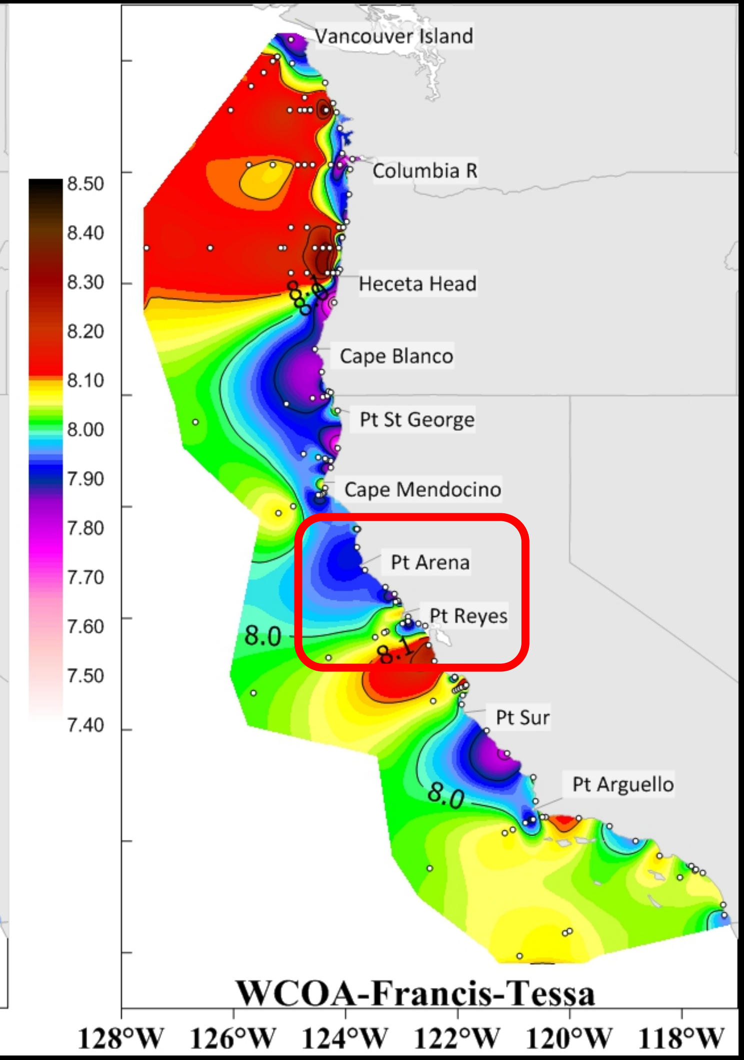
We understand broad scale trends & predictions



Models project rapid future changes in ocean temperature, pH, and dissolved oxygen for the California Current System under a "business as usual" greenhouse gas emissions scenario (RCP 8.5). (A) The observed sea surface temperature is shown in the black line for 1920-2016, while the average of 28 different climate model simulations is shown by the red line. The gray band indicates the full range of temperatures from the 28 different climate model simulations. The projections include a human-caused warming trend of ~0.5 to 1.5 C by 2040, and 2-4C by 2100, with no clear indication of a change in the range of annual variability (Alexander et al. 2018). (B)(C) Historical records for pH anomaly and dissolved oxygen are not as complete as those for ocean temperature so are not shown for these variables. The model projections show rapid declines in California Current pH anomaly and dissolved oxygen concentrations. (Figure source: James Scott, NOAA Earth System Research Lab, Physical Sciences Division, Boulder, CO).

CA Fourth Climate Assessment, 2018

However, we observe large variability in pH within this complex system



'Mosaic' of pH elucidated by partnerships between Federal Agency & University Researchers

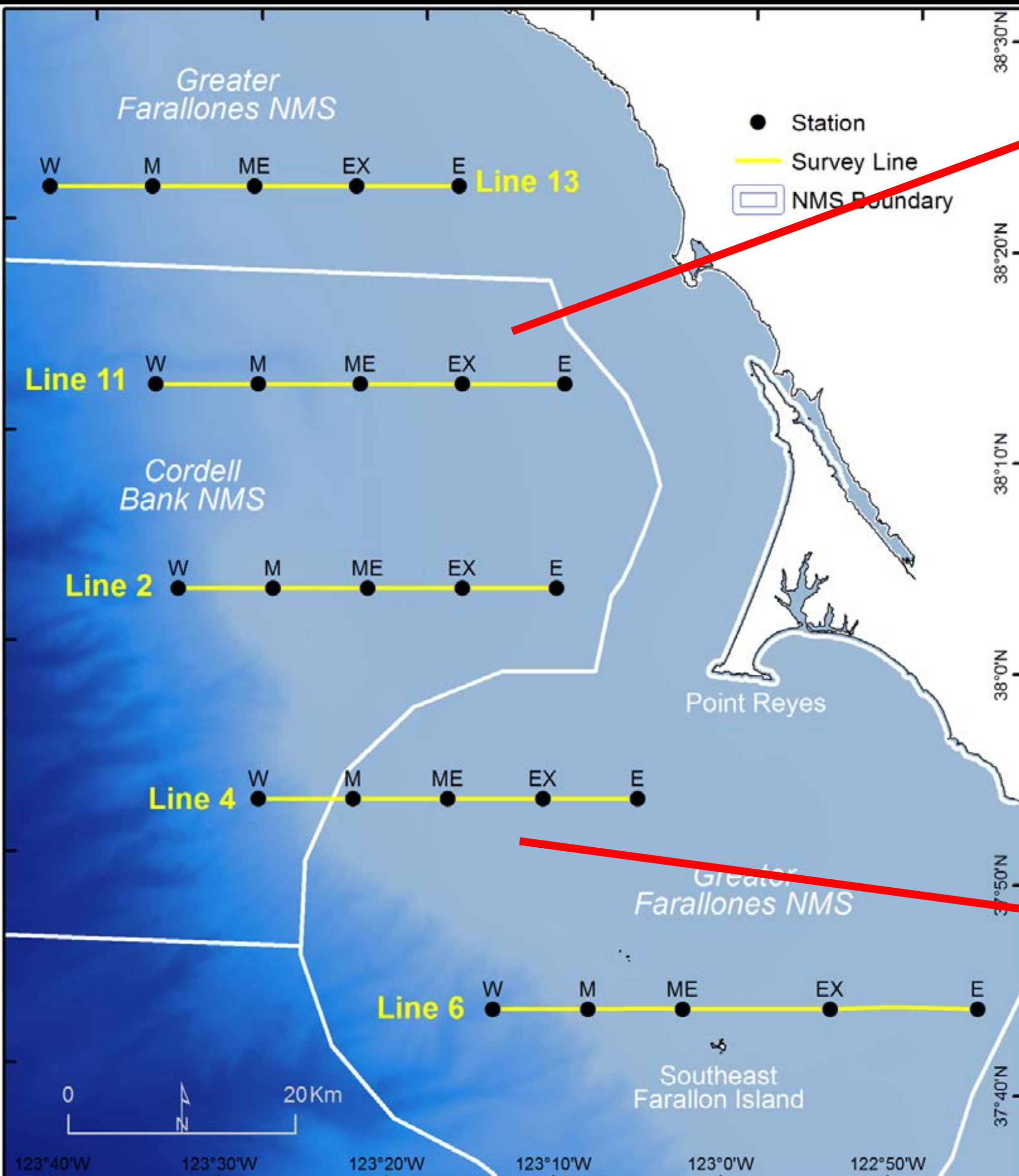
Natural laboratory and opportunities to understand adaptation

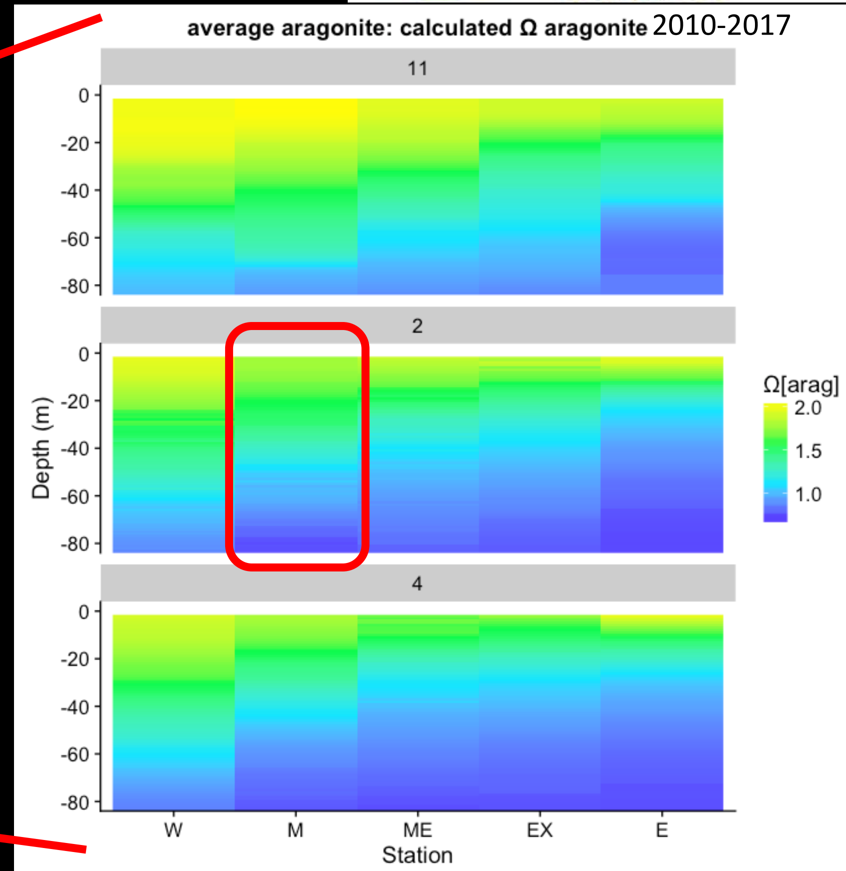
Data from: NOAA (R. Feely), NSF-OMEGAS and UCDavis; Feely et al., 2016; Hill et al. in prep.

Local chemistry variability: ACCESS Cruises

National Marine Sanctuaries

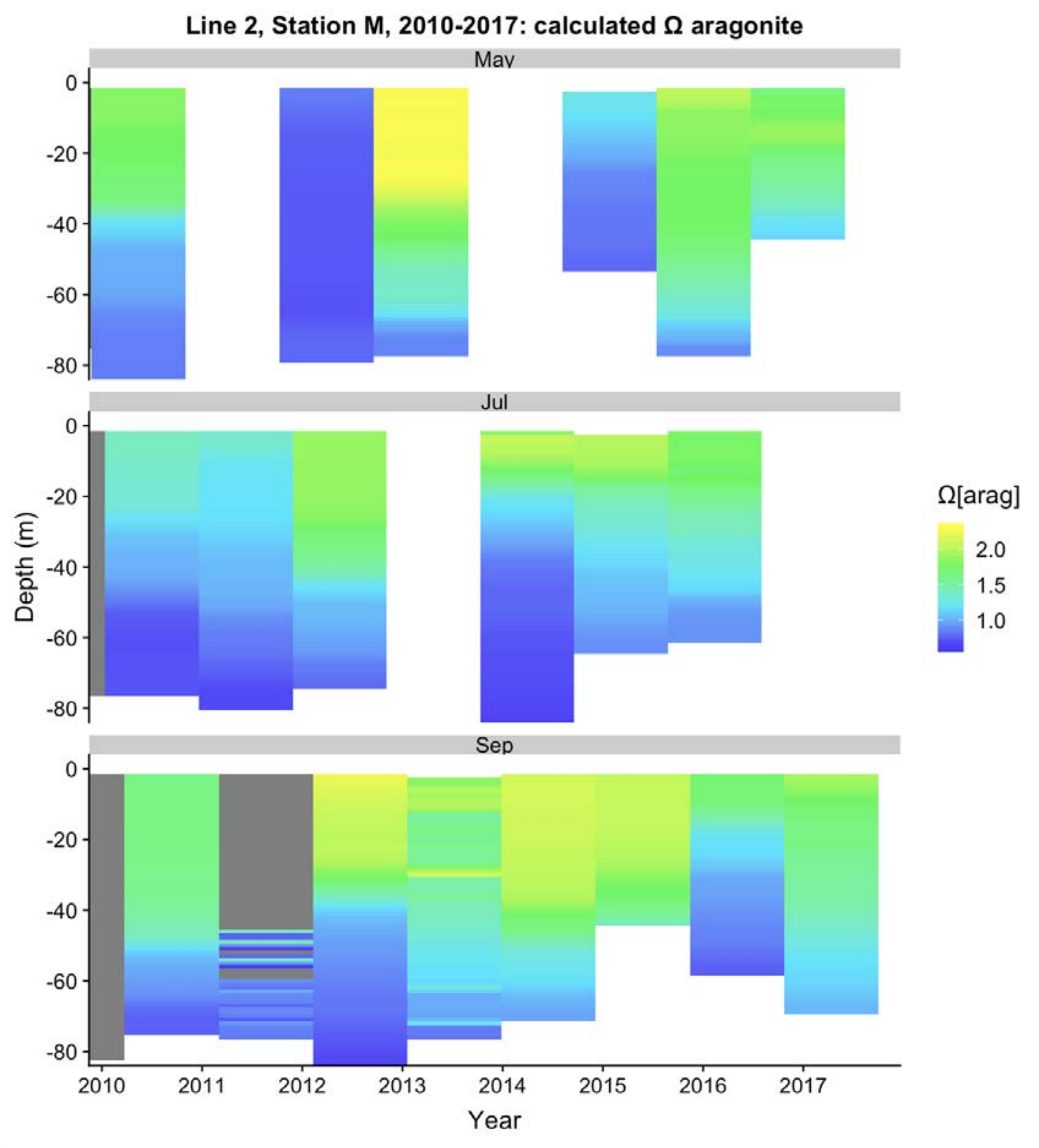
Point Blue Conservation Science





Ω_{arag} horizon shallower nearshore due to upwelling

Temporal variability in chemistry

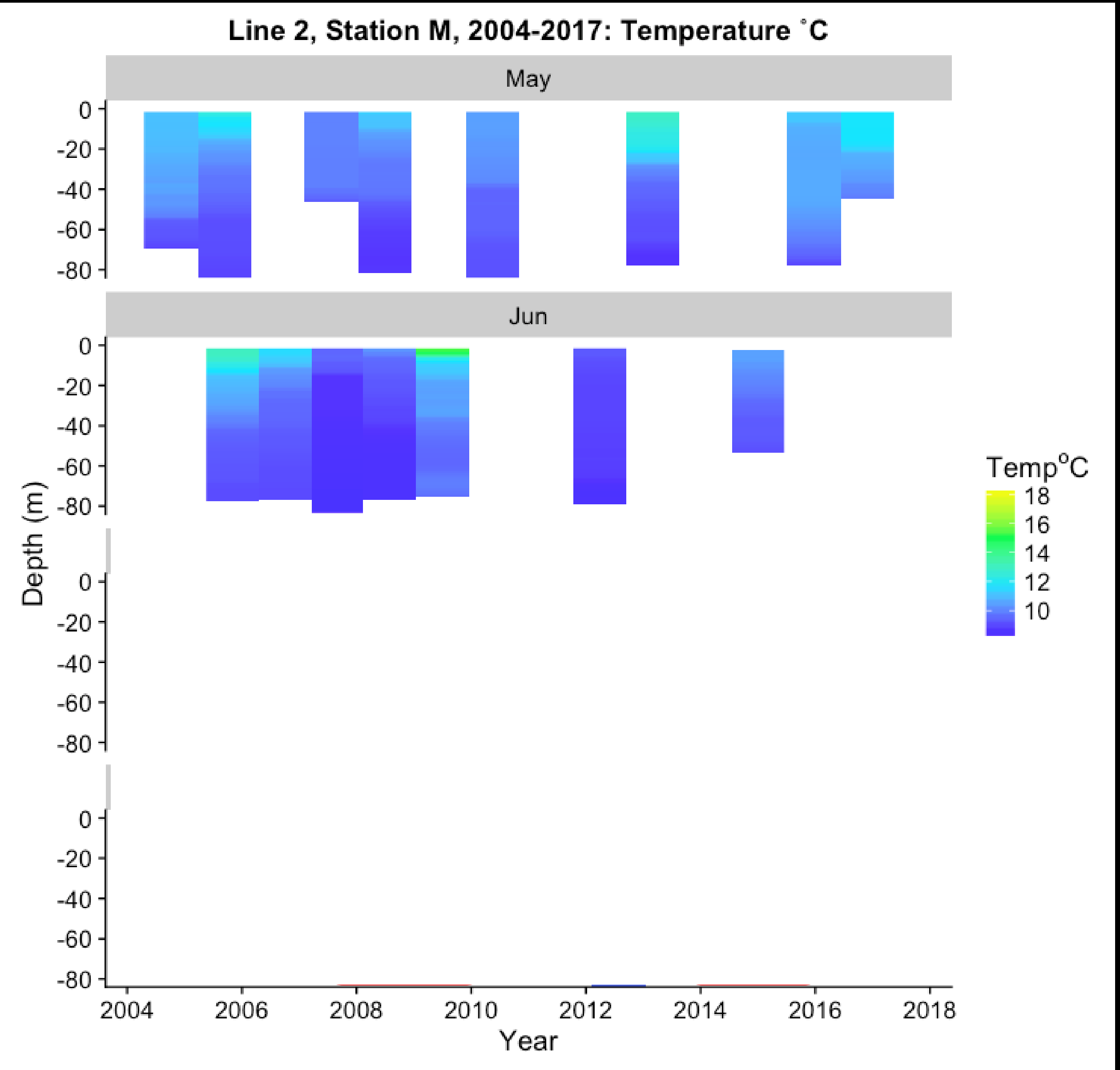


Depth of Ω_{arag} horizon is dynamic, shoals & deepens frequently exposing organisms to a variety of conditions.

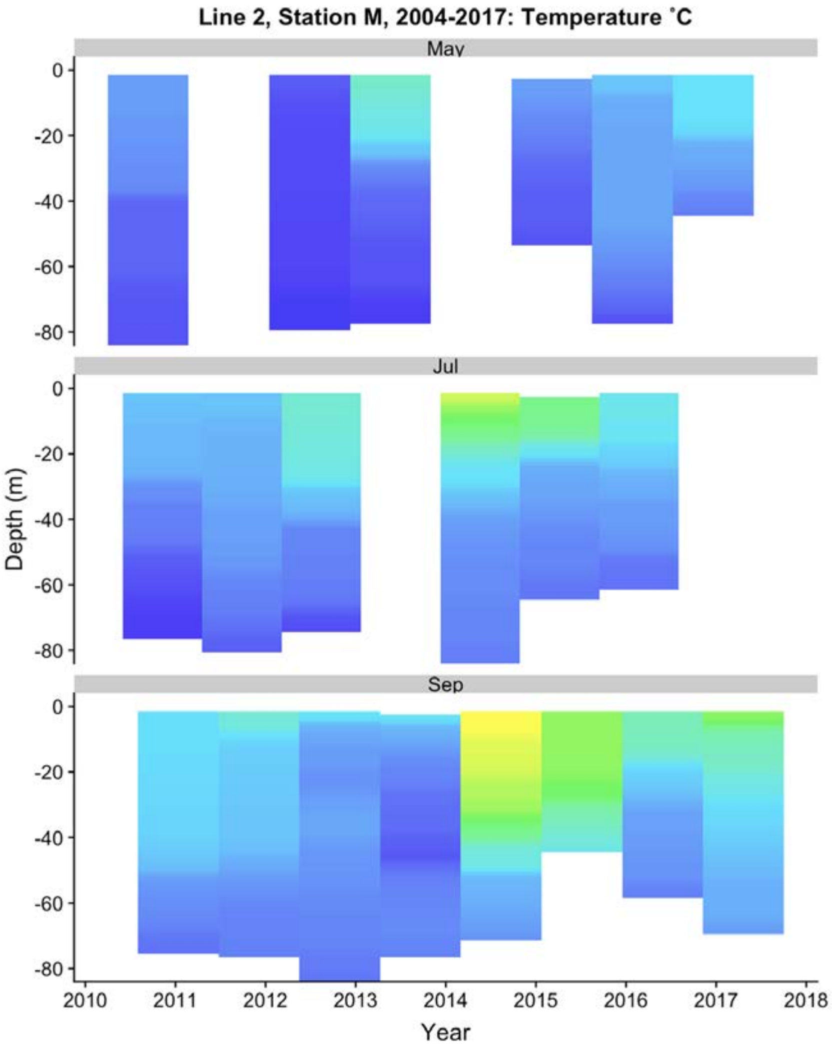
Ω_{arag} shoals when colder, deepens when warm

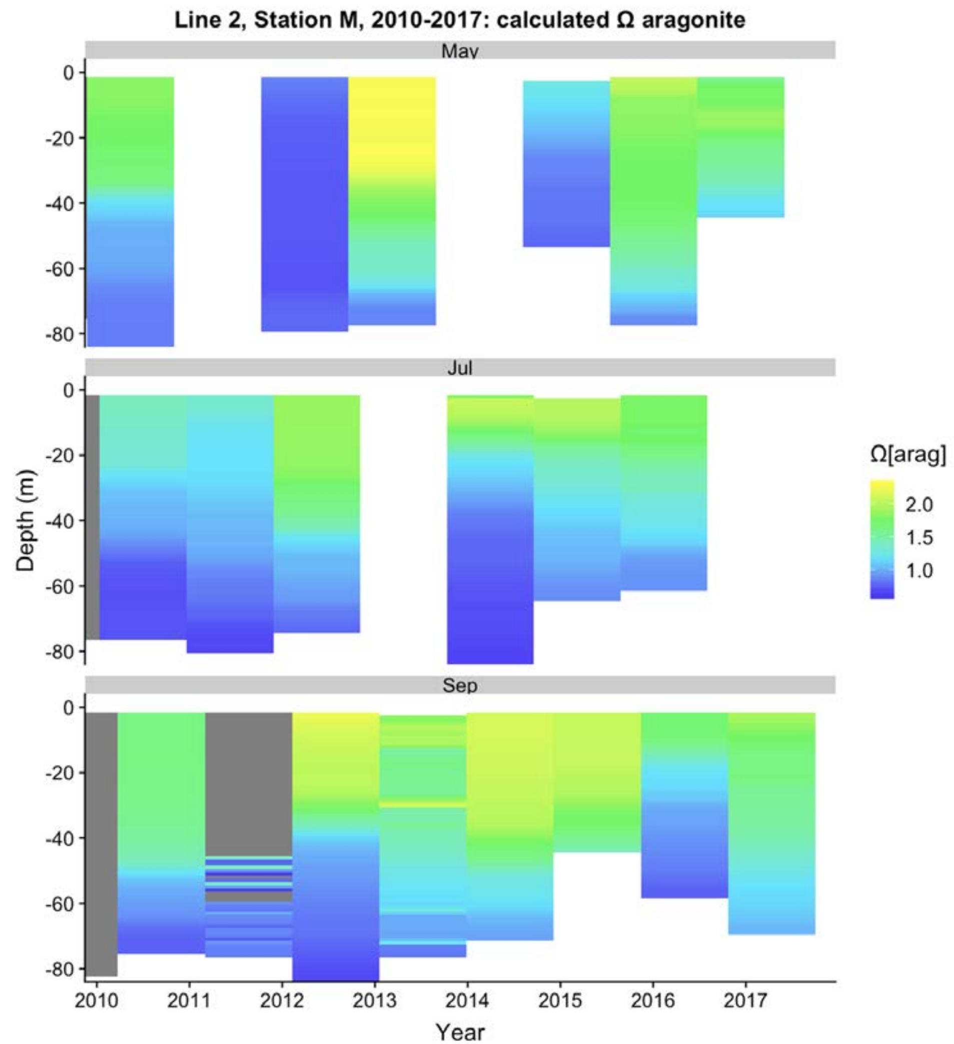
Well-mixed water column (upwelling)

Stratified water column



Complexity of conditions is important, and stressors don't always overlap...





Temperature

Ω_{arag}

Deep sea corals in Cordell Bank NMS: Archive of present and past ocean chemistry

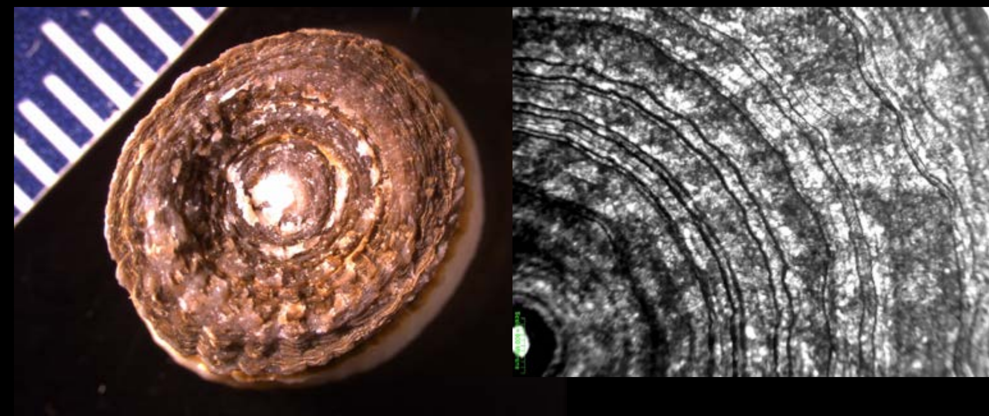


Photo Credit: NOAA/OET/Nautilus

A need for a network of observations

Despite the central importance of data for detecting long-term changes in the ocean's carbon system, coordinated observing networks in the US coastal and estuarine waters did not exist until recently. Historically, assessments of changes to the carbonate system relied on a handful of data records worldwide (none of which operated in California waters, and the longest of which began only in the early 1980's) (Bates et al., 2014).

OEHHA
SCIENCE FOR A HEALTHY CALIFORNIA

Local scale solutions & actions matter

- Seagrass meadows and salt marshes provide an opportunity to remove carbon

- We are investigating the long and short term impacts of carbon storage

Sea Grant California

State of California Ocean Protection Council

Needs & visions for CA

Long term investigations are essential

Complexity of conditions along the coast matter

We need to understand impacts of OA from multiple perspectives

Partnerships are critical

New perspectives on OA

Whitney Berry
Ocean Protection Council

Jessica Williams
Ocean Science Trust

Jan Freiwald
Reef Check Foundation

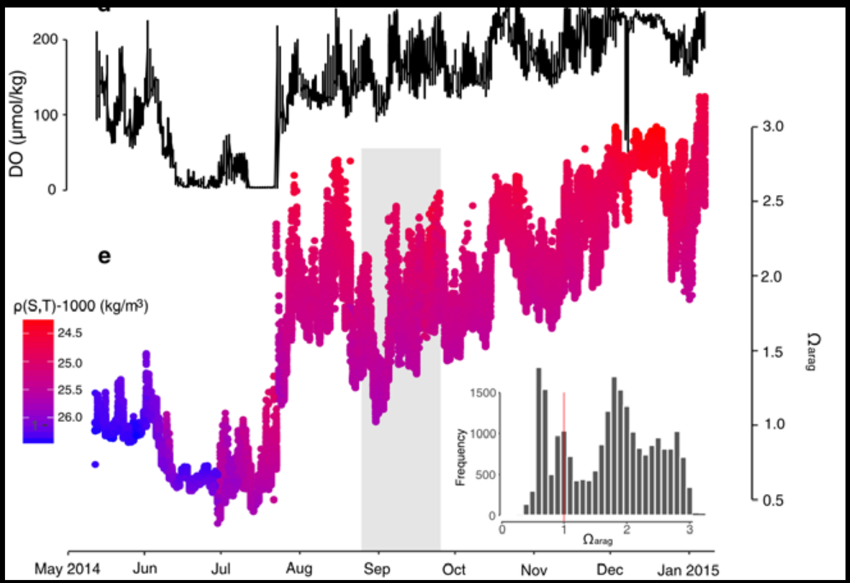
Terry Sawyer
Hog Island Oyster Company

Mary Miller
Exploratorium

What have we learned so far, what do we need to know, what actions can we take?

Reconstructing ocean acidification using empirical relationships w/ T, S, DO

Aragonite saturation and DO at BML Mooring, 2014



Measured T, S, DO and carbonate chemistry used to develop relationships; reconstruct past OA trends (see papers by Juranek, Alin, and Davis)

Catherine Davis et al., 2018, *Estuaries and Coasts*