



# California's Toxic Spring: Understanding the 2025 HAB event and the role of nutrients

*Ventura Surfrider Foundation*

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Necropsy results revealed that domoic acid toxin was linked to the death of a Huntington Beach humpback whale. (Pacific Marine Mammal Center)



Department of Atmospheric  
& Oceanic Sciences



Photo Credit: Channel Islands Marine & Wildlife Institute

# 'Unprecedented' toxic algae bloom continues to kill Southern California whales and other wildlife

By [Makenna Sievertson](#)  
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A male minke whale died after circling the Long Beach Harbor for nearly a week.

Scientists caring for a sick dolphin along the California coast.  
(Pacific Marine Mammal Center)

# 'Horrific' Scene On The California Coast: Largest Algae Bloom On Record Is Killing Thousands Of Marine Animals

Centers are overwhelmed as disoriented animals wash ashore, victims of a fast-growing bloom fueled by warming waters and pollution.



## Surfer faced the 'unsettling ferocity' of a sick sea lion in Southern California

The March incident highlights an ongoing deadly outbreak as a neurotoxin ravages wildlife in Southern California.



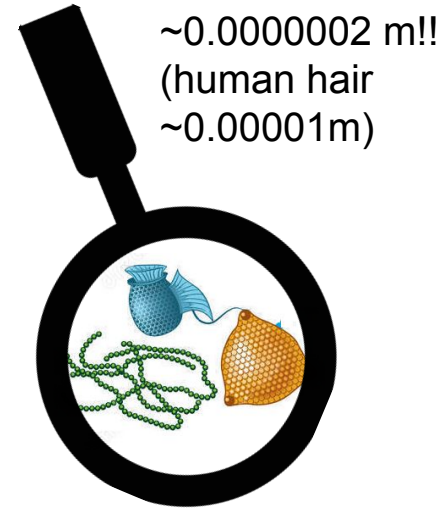
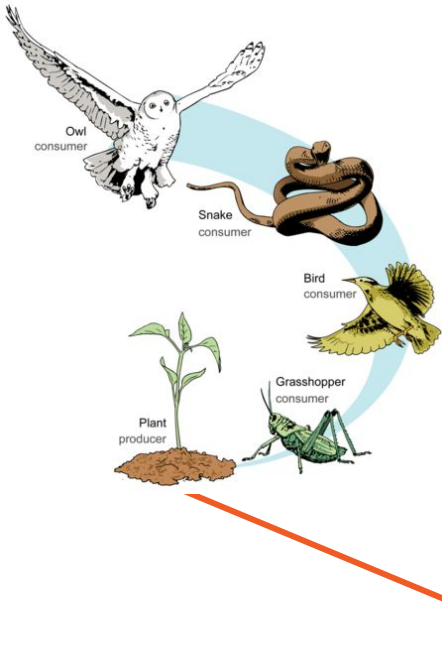
Sick California sea lion | David Swanson / AFP via Getty |



RJ LaMendola gives the hang loose sign after being treated for a bite from a sea lion Friday, March 21, 2025, in the emergency room of St. John's Regional Medical Center in Oxnard. He had been surfing in Oxnard Shores when the animal attacked him. PROVIDED BY RJ LAMENDOLA

"I encountered the Ventura County Star, part of the USA TODAY Network, of the March encounter. "It was a real strong battle, but I wasn't going to give up."

# Micro...algae?



Autotrophs! "self-" (auto-) "nourishing" (troph)

Phytoplankton: (phyton), meaning 'plant', and (planktos), meaning 'wanderer' or 'drifter'



# Micro...algae?



-Diatoms -  
Dinoflagellates -  
Cyanobacteria -  
Raphidophyceae

*Alexandrium  
catenella*

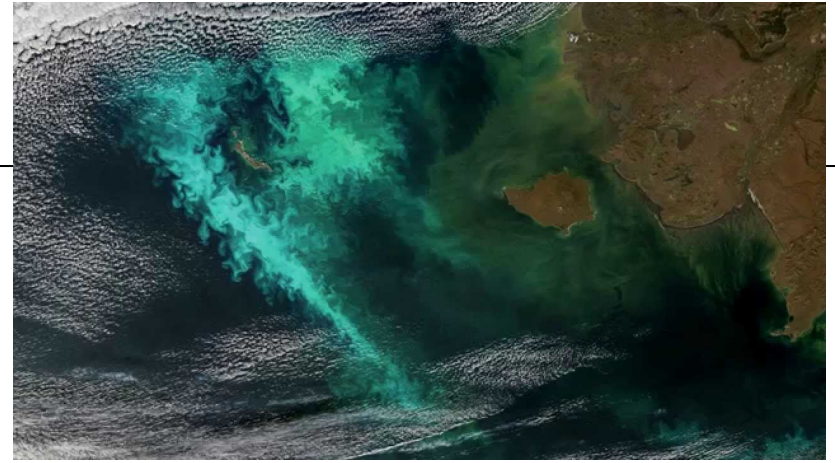




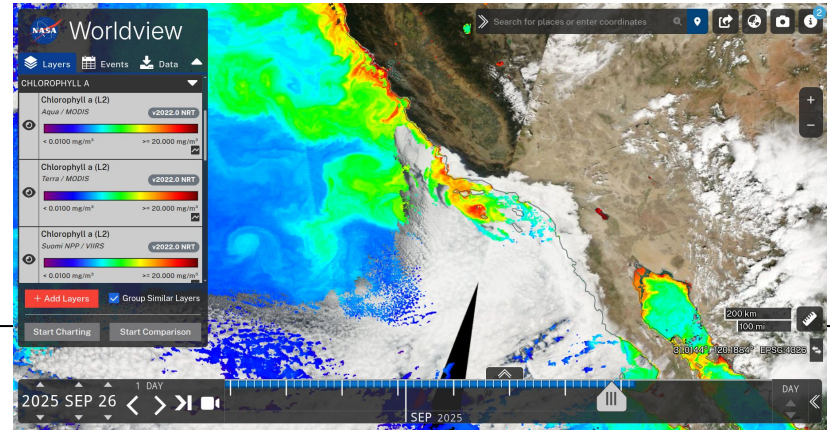
# Blooms



Flowering desert in the Chilean Atacama Desert



Flowering, Proliferation or “Bloom” of phytoplankton



# Why Harmful ?



Harmful: causing or likely to cause harm.

Negative impacts of HABs arise from various factors

- Sharp coverings
- High biomass leading to subsurface oxygen depletion
- Release of toxic secondary metabolites (phycotoxins)



Why toxins?

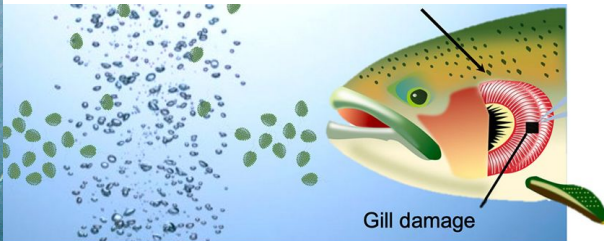
- To poison predators or alter their taste
- To outcompete other phytoplankton
- To capture more nutrients
- Many more...

Negative effects of HABs:

- Public health
- Fishing and aquaculture activities
- Social: Unemployment and mistrust
- Tourism



*Chaetoceros concavicornis*



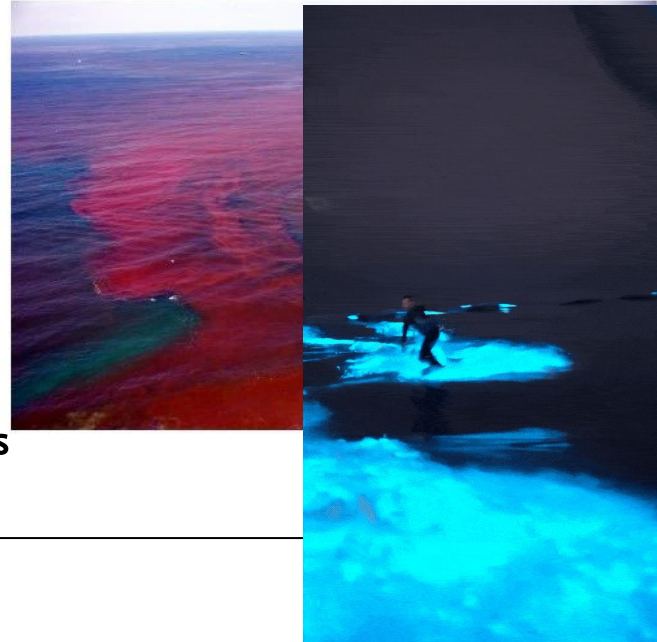
Main poisons:

- Paralytic Shellfish Poison (PSP)
- Diarrhetic Shellfish Poison (DSP)
- Amnesic Shellfish Poison (ASP)

O<sub>2</sub> depletion

# Definition: Harmful Algal Bloom (HAB)

- ❑ *"Proliferation of microalgae in marine or brackish waters that can cause the massive death of fish, contaminate shellfish with toxins and alter ecosystems in ways that **humans perceive as harmful** , as it generates negative effects on public health, fishing activities, aquaculture and tourism" (Clément & Lembeye, 1994, HAB Program UNESCO/IOC, 2005).*
- ❑ Favorable environmental conditions
- ❑ Red Tide → HAB
- ❑ ~5000 species of marine phytoplankton
  - ~300 bloom in high densities and color the waters
  - ~80 potent toxins.



San Diego

*Lingulodinium  
polyedra*

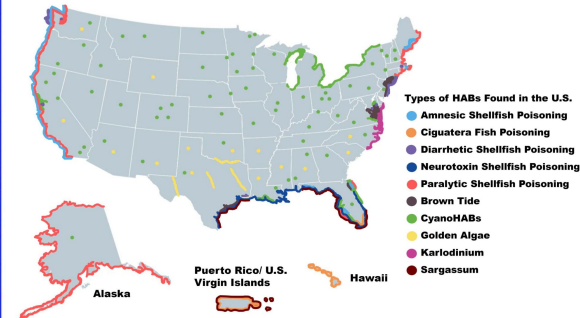
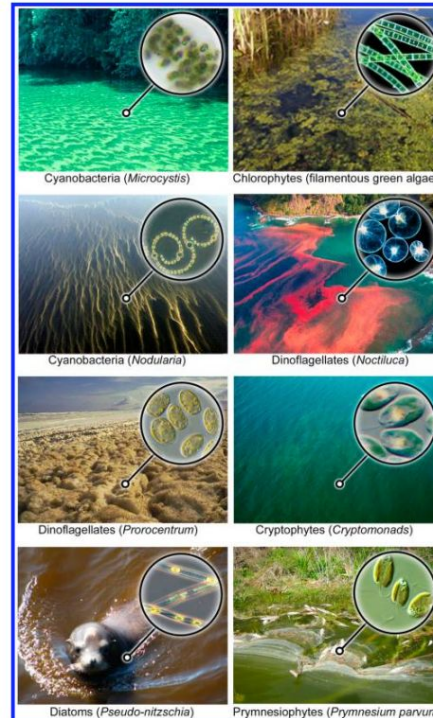


# Recipe for making a HAB

First....In general, what characteristics are common to the organisms that produce HABs?

NONE!

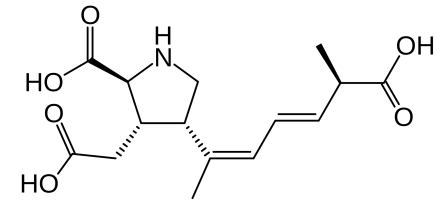
- Organisms can be large or small.
- Organisms can swim or not.
- Organisms can be toxic or not.
- Organisms can be autotrophic or mixotrophic.
- Organisms can generate different colorations.



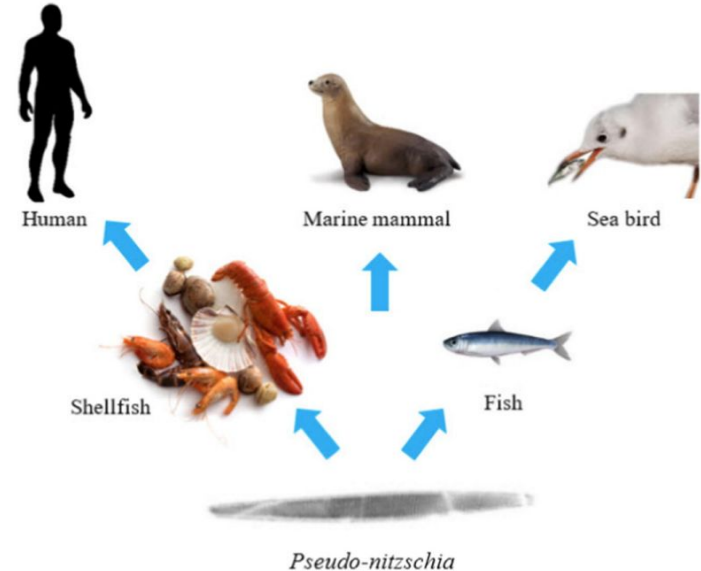
But we do know something about some common HABs in California...

Figure 2. Harmful algal bloom species representative of major taxonomic algal groups along the freshwater-to-marine continuum.

# Domoic Acid (DA) HAB

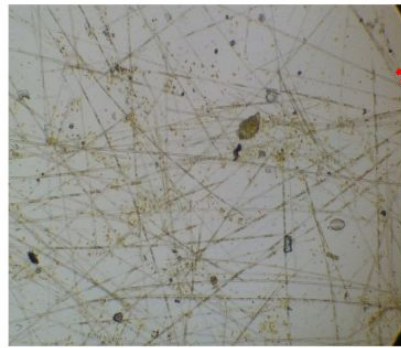


- ❑ HAB in the West Coast of the US: Diatom *Pseudo-nitzschia* spp. (PN) which produces domoic acid (DA).
- ❑ Bioaccumulation and progress up the food chain.
- ❑ Particles with DA can sink reaching the sediments.
  - ❑ Benthic feeders



Saeed *et al.*, 2017

# Marine Mammals Can't Avoid DA



Planktivorous fish



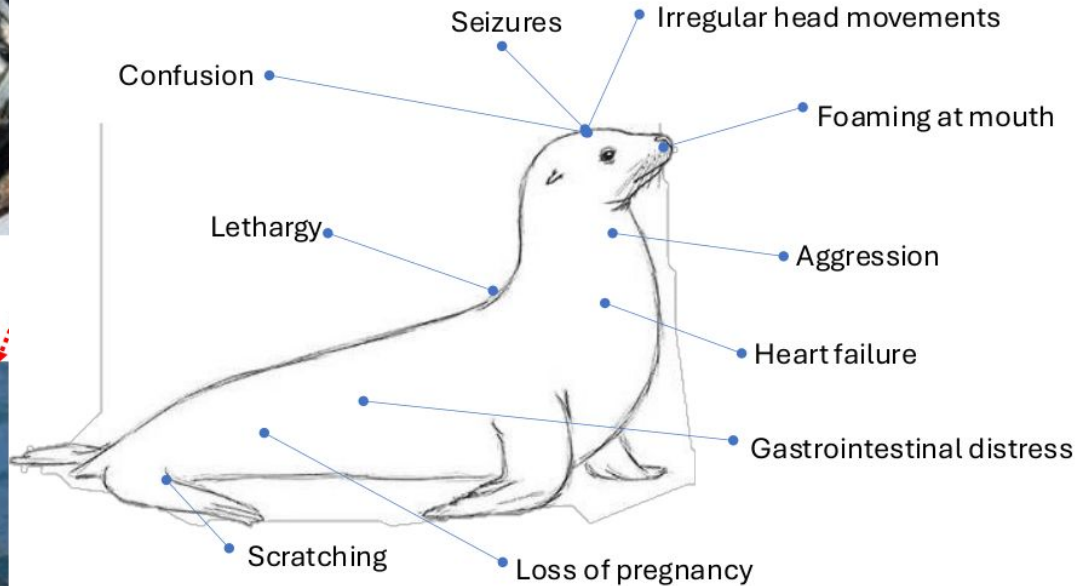
Shellfish



10-25lbs seafood/day



20-50lbs fish/day





# What is a “Stranded” Marine Mammal?

- ❑ Animal on the shore and unable to return to the water
- ❑ Animal in need of apparent medical attention or trapped away from their normal habitat
- ❑ A dead marine mammal on the beach or in the water



Report a stranded animal (West Coast)

**Marine Mammal Stranding Network** 1-866-767-6114



Photo Credit: Channel Islands Marine & Wildlife Institute



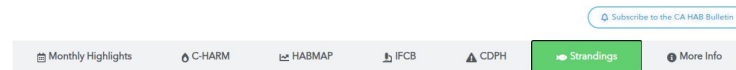
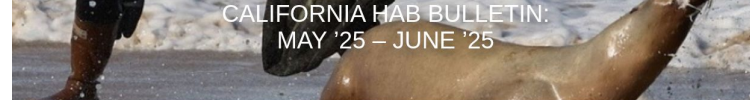
Photo Credit: Channel Islands Marine & Wildlife Institute



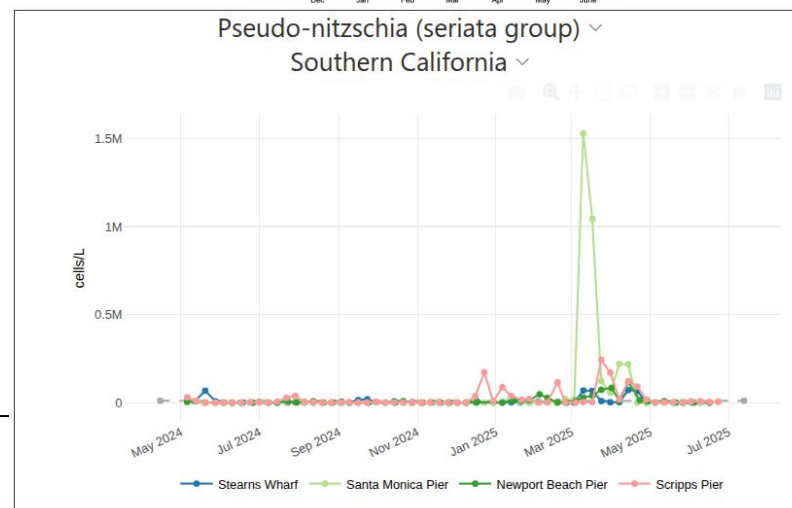
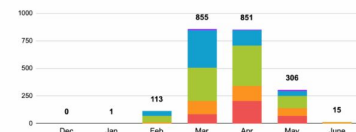
Photo Credit: Channel Islands Marine & Wildlife Institute

# HAB this year

- ❑ Severe HAB event (Dec 2024–Apr 2025): DA and PSP (*Alexandrium*) blooms across California.
- ❑ Unusually early season: Event early in December 2024, starting in Baja California and spreading into Southern California by January. March was the worse.
- ❑ Rescue centers overwhelmed.
- ❑ 'Do Not Eat' warnings: sport-harvested bivalve shellfish from Santa Barbara to San Diego and a closure for the take of commercial and recreational sardines from Pt. Conception to the US/Mexico border.

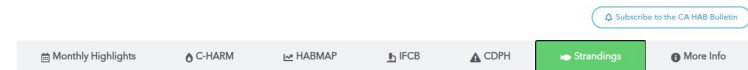
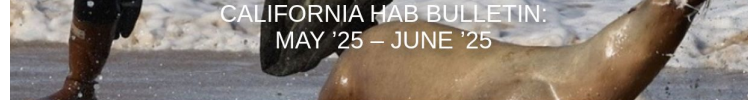
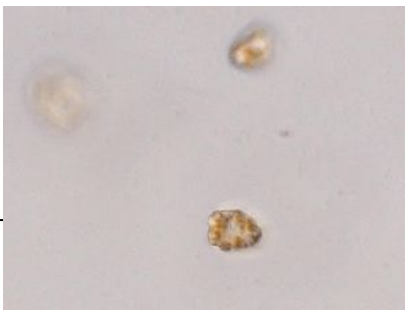


>2,130  
Total DA-related strandings in the 2025

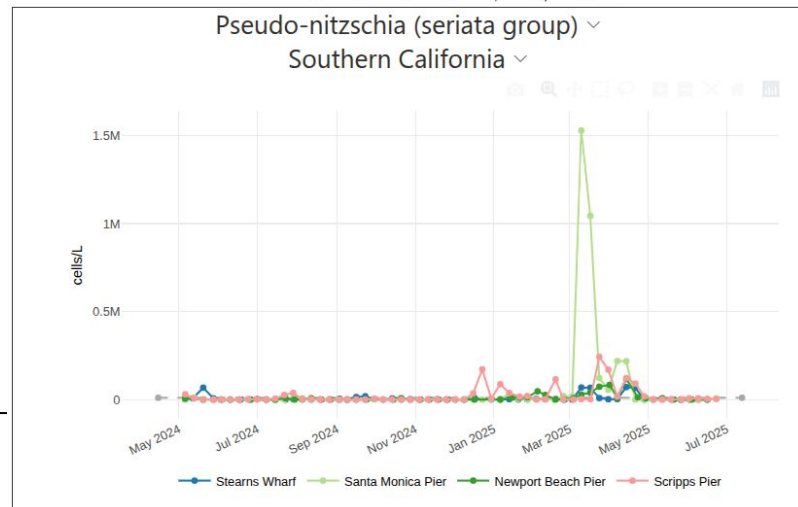
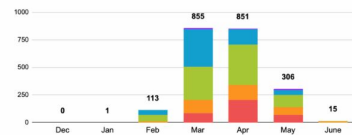


# HAB this year

- ❑ Event decline
- ❑ Marine mammal strandings dropped
- ❑ DA advisory for sardines in May, reflecting toxin accumulation in the food web
- ❑ *Heterosigma akashiwo* (toxic red tide species; “flying potato.”): dense blooms in Santa Barbara Channel (mid-March–June) linked to reports of human symptoms (inhalation, skin irritation) in Ventura County.



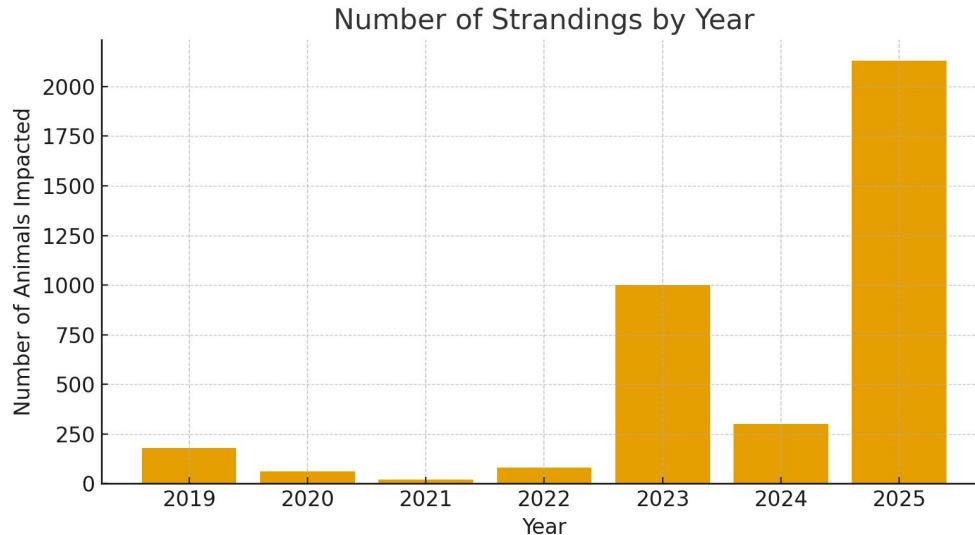
**>2,130**  
Total DA-related strandings in the 2025





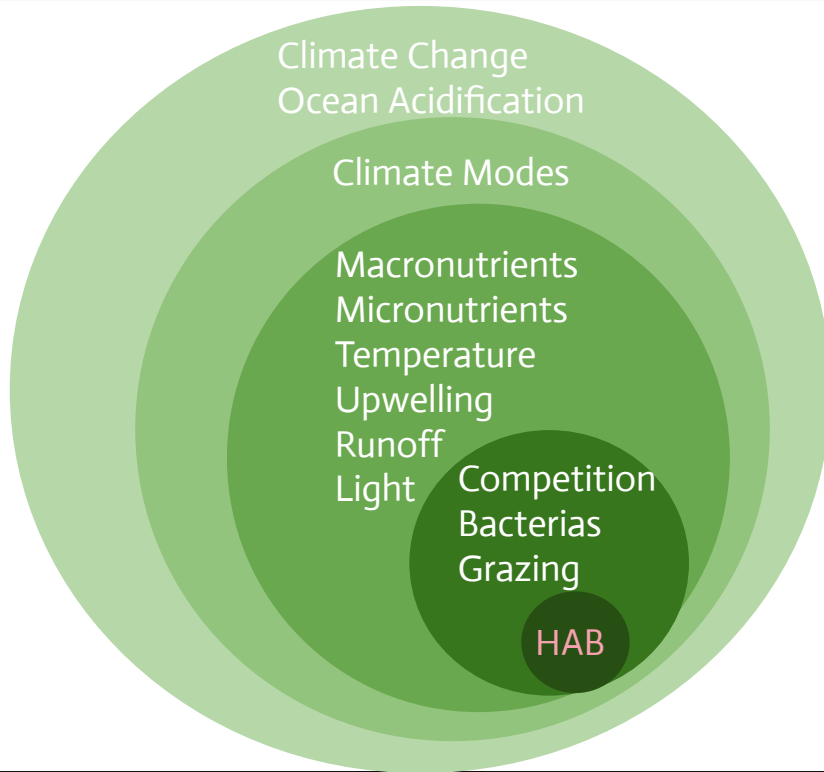
# How Does This Year Compare to Others?

- ❑ This Year is among the largest DA-related marine mammal stranding events in Southern California in the last 15 years

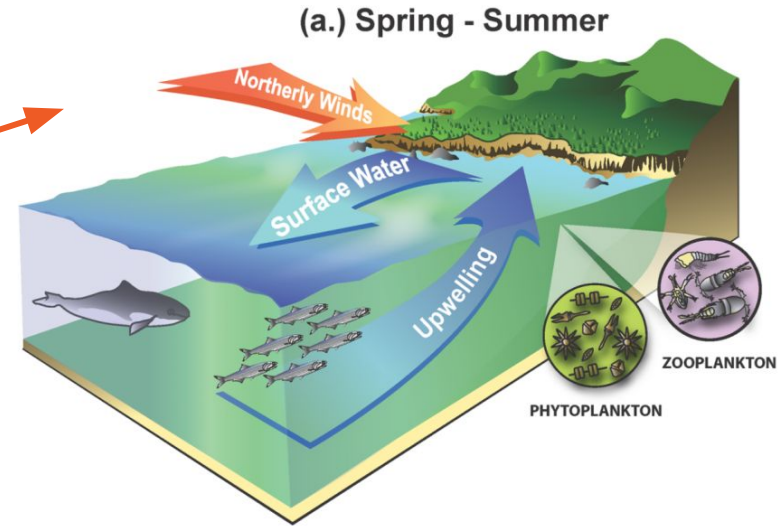
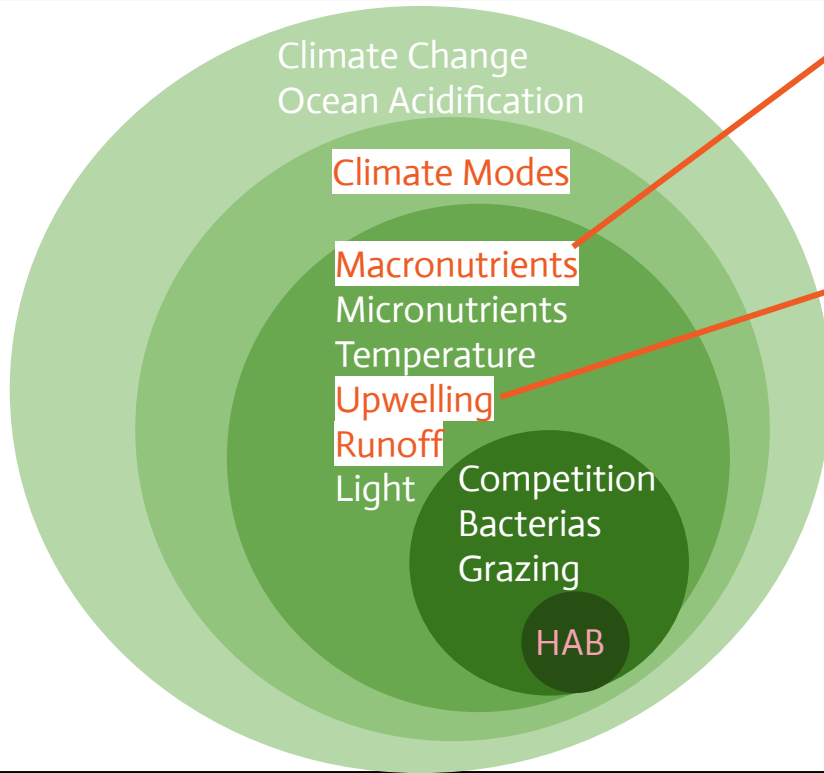


- ❑ Pregnant marine mammals were especially vulnerable; **no rescued pregnant sea lions gave birth to live pups.**
- ❑ Long-term environmental impact after four years in a row during breeding season

# DA HAB: Factors

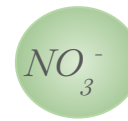


# DA HAB: Factors





# DA HAB: Factors



Nitrate



Ammonium



Silicic acid



Phosphate

Climate Change  
Ocean Acidification

Climate Modes

Macronutrients

Micronutrients

Temperature

Upwelling

Runoff

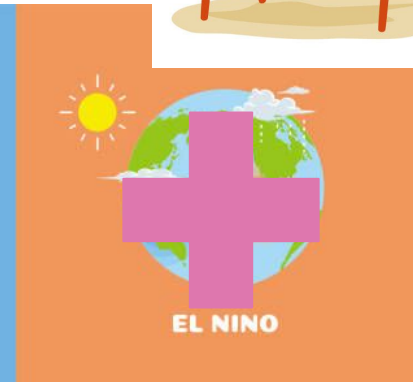
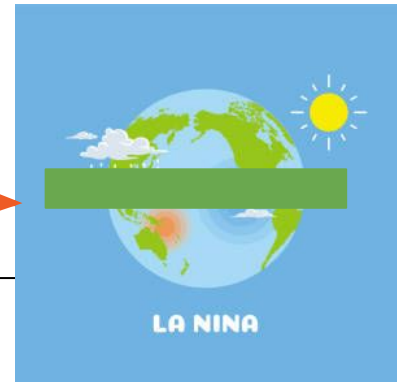
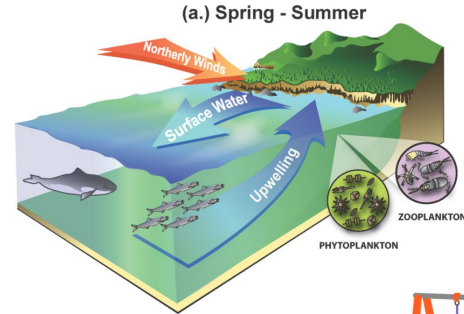
Light

Competition

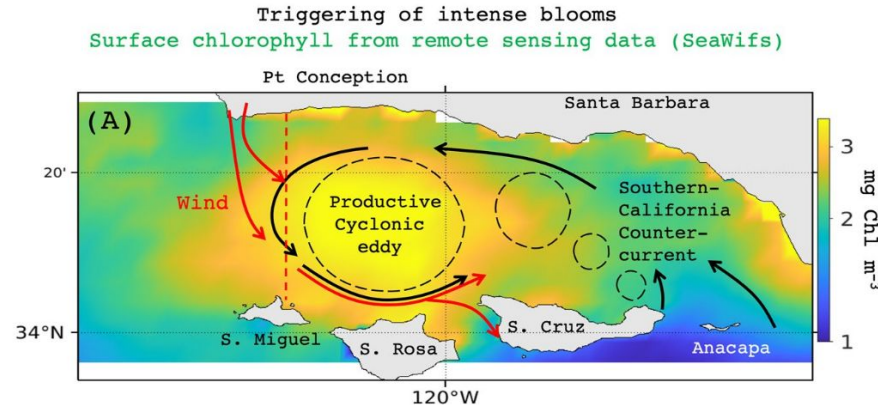
Bacterias

Grazing

HAB



# What about SBC?

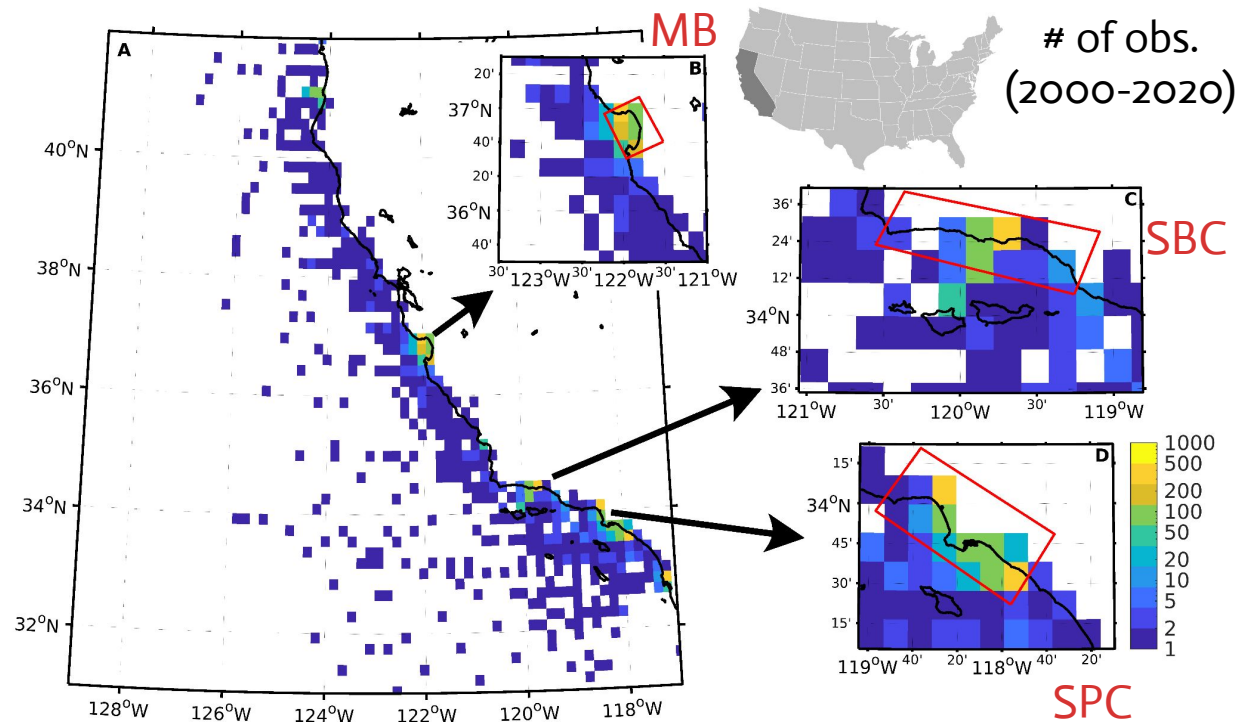


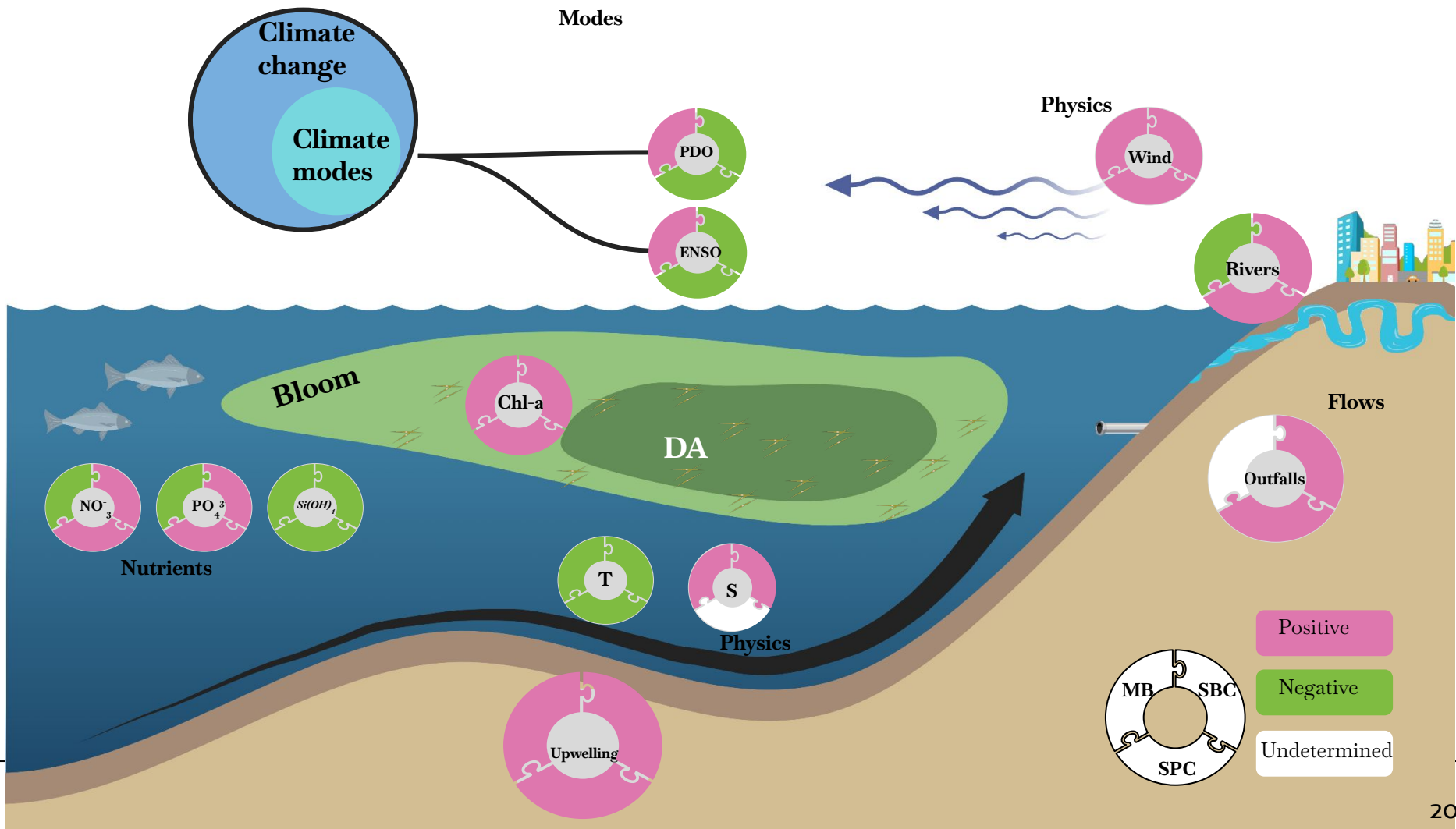
<https://oceancolor.gsfc.nasa.gov/>

- ❑ A known hotspot where events often start early in the season.
- ❑ Coastline curvature-driven upwelling
- ❑ Cyclonic eddies/retention: concentrate PN
- ❑ Subsurface structure
- ❑ Nearshore signals lag or differ.

# Data compilation

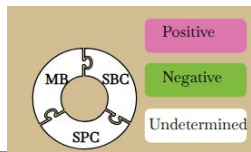
□ 2000-2020.





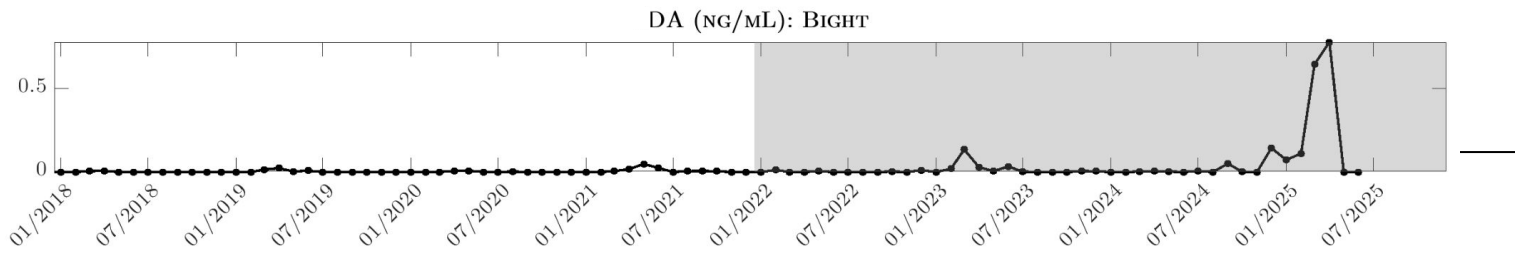


# HAB this year

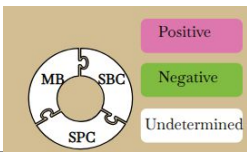


- [Humboldt Bay](#)
- [Bodega Bay](#)
- [Santa Cruz Wharf](#)
- [Monterey Wharf](#)
- [Cal Poly Pier](#)
- [Stearns Wharf](#)
- [Santa Monica Pier](#)
- [Newport Pier](#)
- [Scripps Pier](#)

A La Niña-driven cold water episode, longest since 2011, promoted:

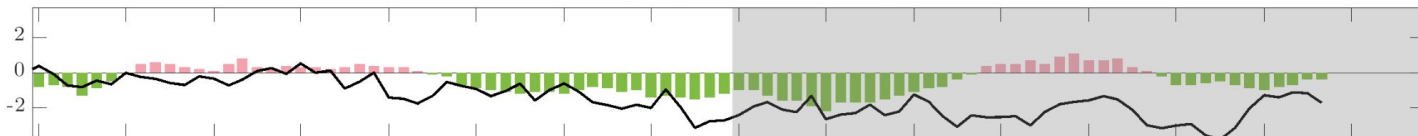


# HAB this year

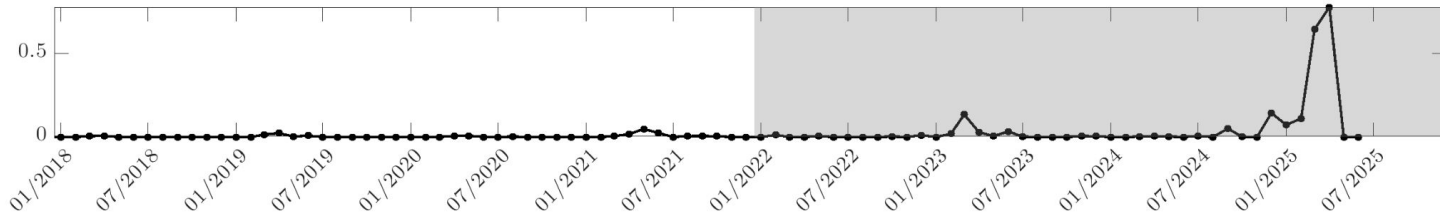


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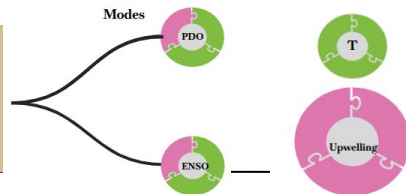
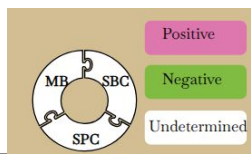
PDO (LINE) AND ENSO (BARS)



DA (NG/ML): BIGHT

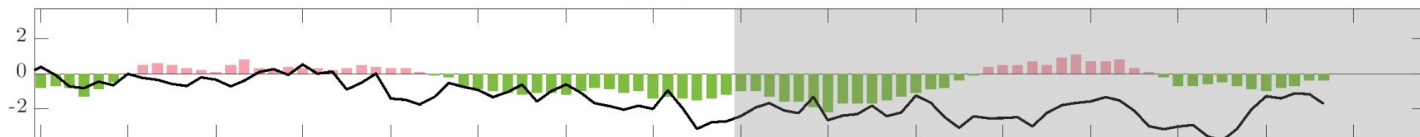


# HAB this year

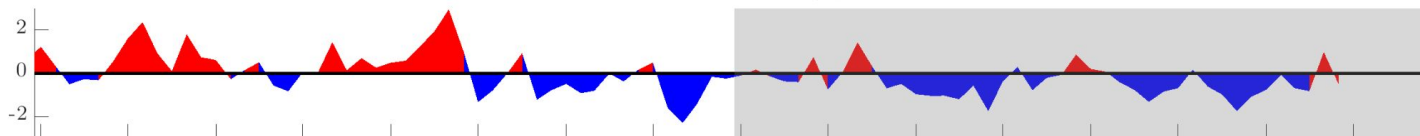


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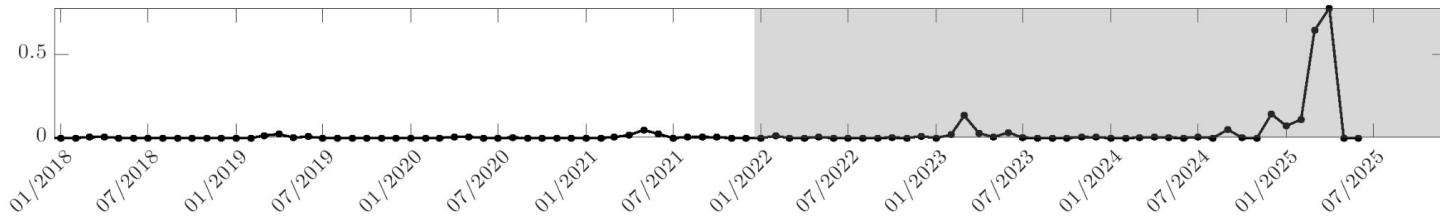
PDO (LINE) AND ENSO (BARS)



TEMPERATURE ANOMALY (C): BIGHT



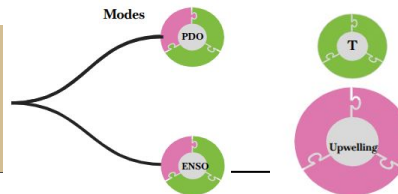
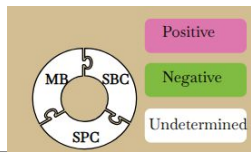
DA (NG/ML): BIGHT



A La Niña-driven cold water episode, longest since 2011, promoted:

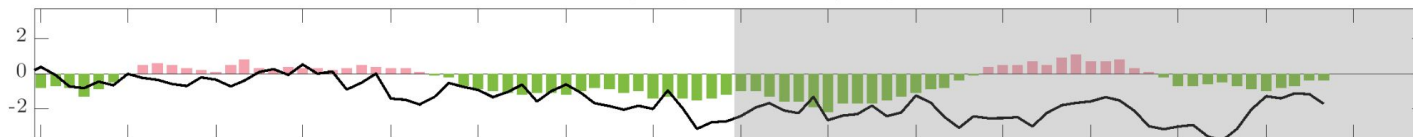
- Early upwelling, helping sustain blooms from Dec–Apr.

# HAB this year

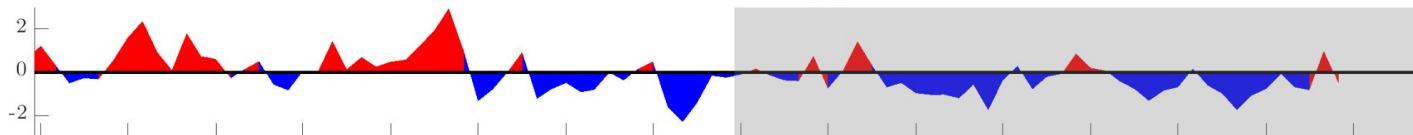


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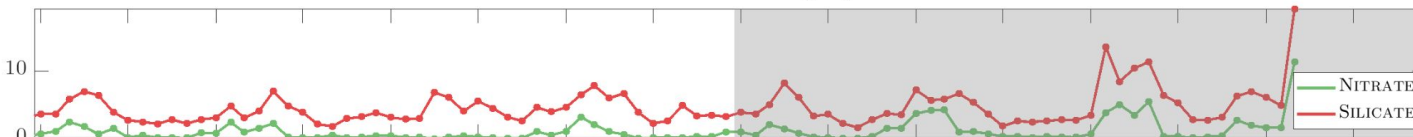
PDO (LINE) AND ENSO (BARS)



TEMPERATURE ANOMALY (C): BIGHT



SILICATE NITRATE ( $\mu\text{M}$ ): BIGHT



DA (NG/ML): BIGHT

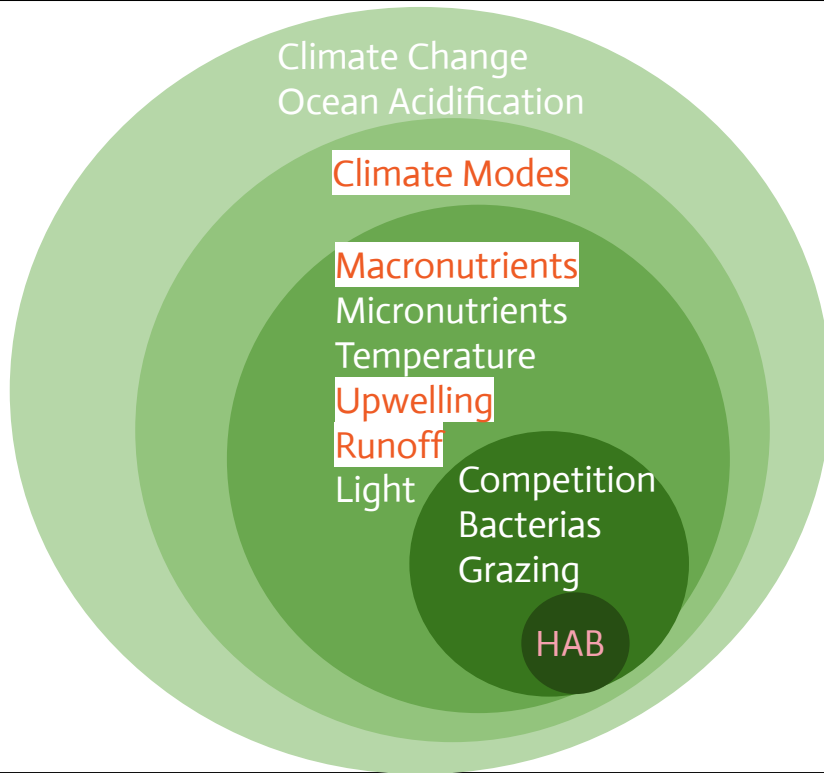


A La Niña-driven cold water episode, longest since 2011, promoted:

- Early upwelling, helping sustain blooms from Dec–Apr.
- Elevated silicic acid and nitrate.
- Event decline and La Niña shift to normal



# DA HAB: Factors



.....but it's complicated

Multiple drivers, e.g.,

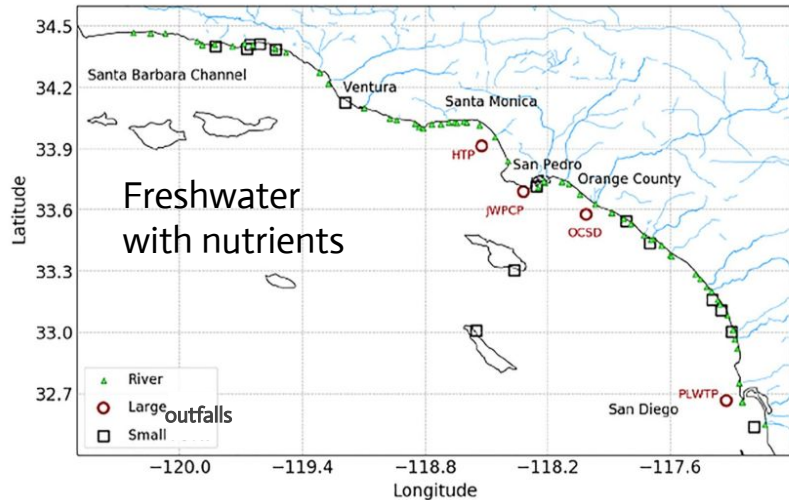
- Warming and climate change
- Climate regime (El Niño versus La Niña)
- Nutrient ratios (iron, silicate)

Combination of natural and human influences

Interacting effects

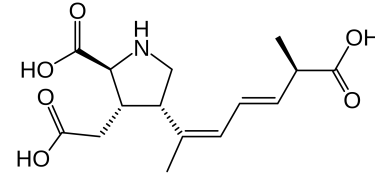
# Anthropogenic sources

- ❑ Nutrients from land-based inputs (nitrate, ammonium) drive a 79% increase in phytoplankton biomass in the Southern California Bight.
- ❑ Land inputs potentially stimulate toxic blooms.



*How do DA HABs dynamics in the Bight respond to anthropogenic inputs?*

# Modelling of DA



- Domoic Acid (DA) production  $\propto$  nutrient limitation term (Moreno et al., 2022):

- P, Si limitation  $\rightarrow$  DA
- N limitation  $\rightarrow$  no DA

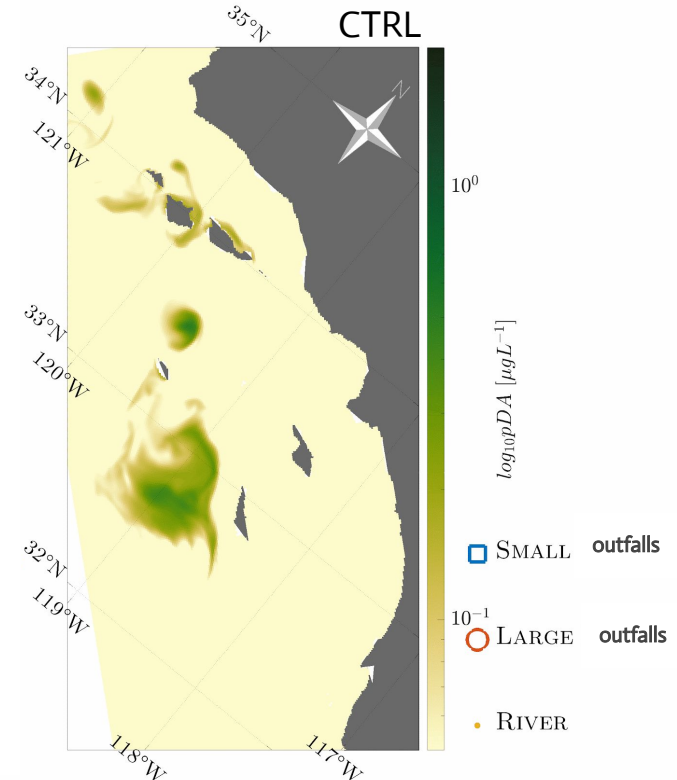


A lot of nutrients from outfalls, but more N compared to Si and P



# Bight Model and experiment

- ❑ 2006 to 2017
- ❑ CTRL: natural oceanic cycles nutrients and freshwater



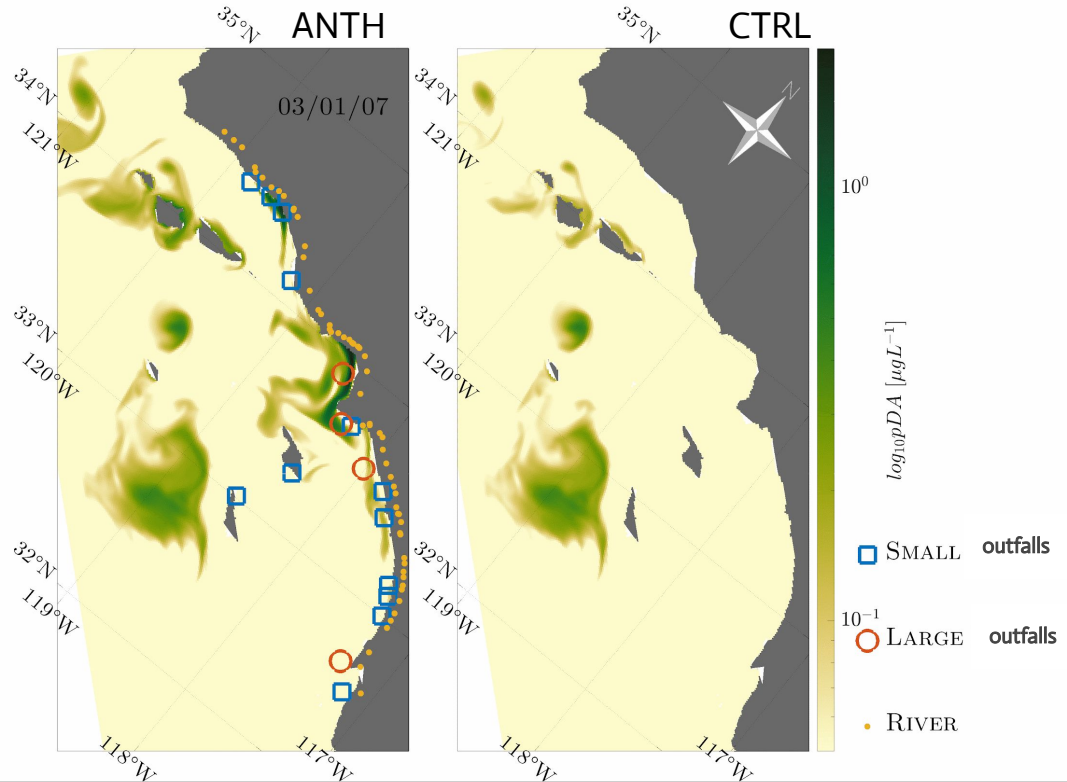


# Bight Model and experiment

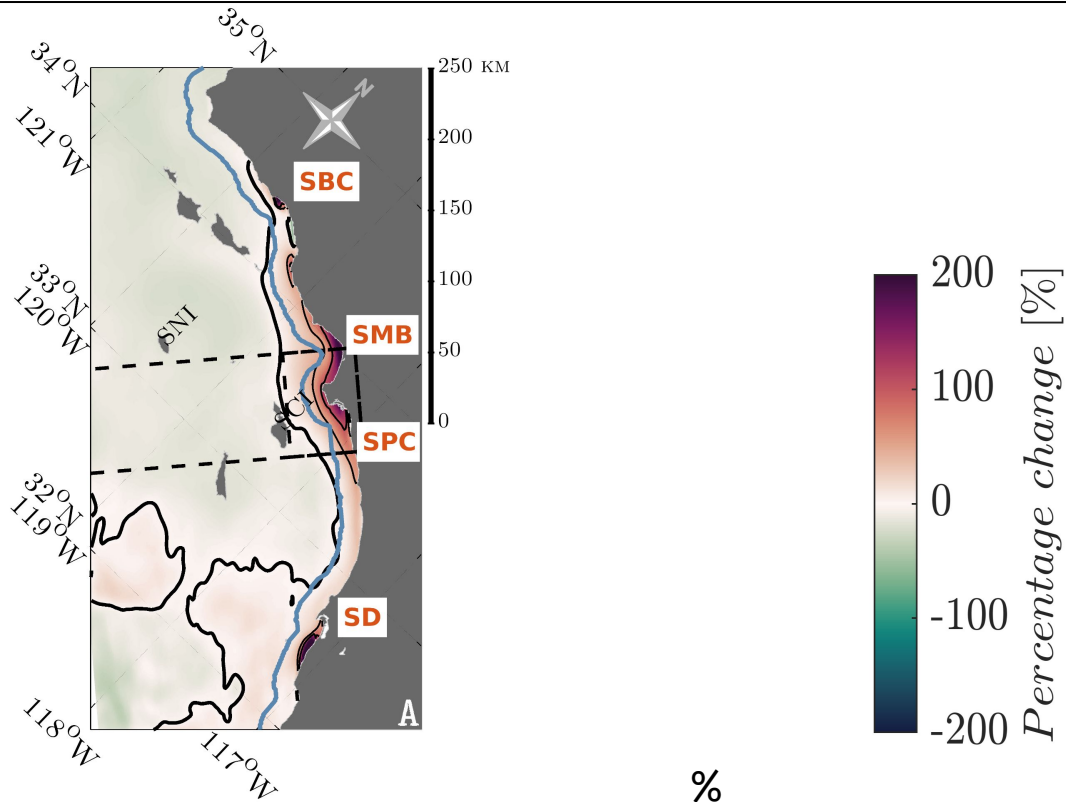
- 2006 to 2017
- CTRL: natural oceanic cycles nutrients and freshwater
- ANTH: supplements with nutrient inputs from terrestrial sources.

- Relative difference:

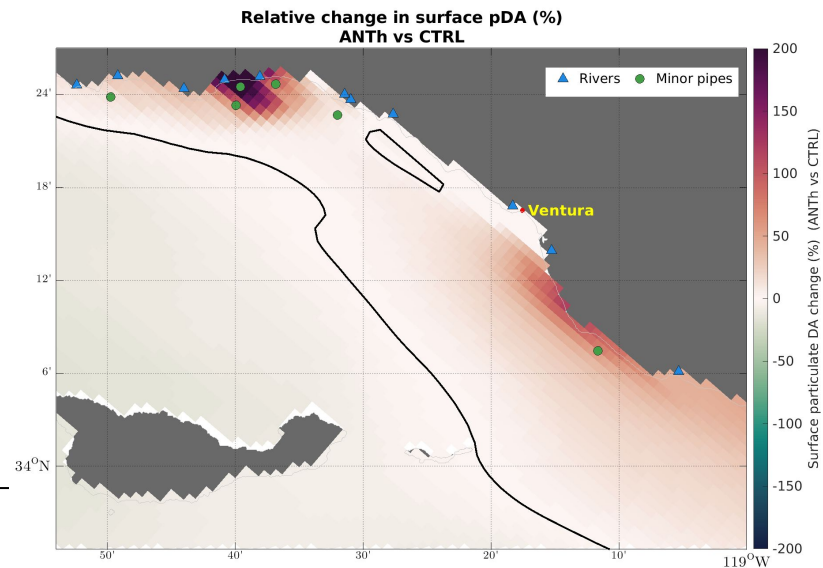
$$\left( \frac{ANTH - CTRL}{CTRL} \right) \times 100\%$$



# Experiment: relative difference



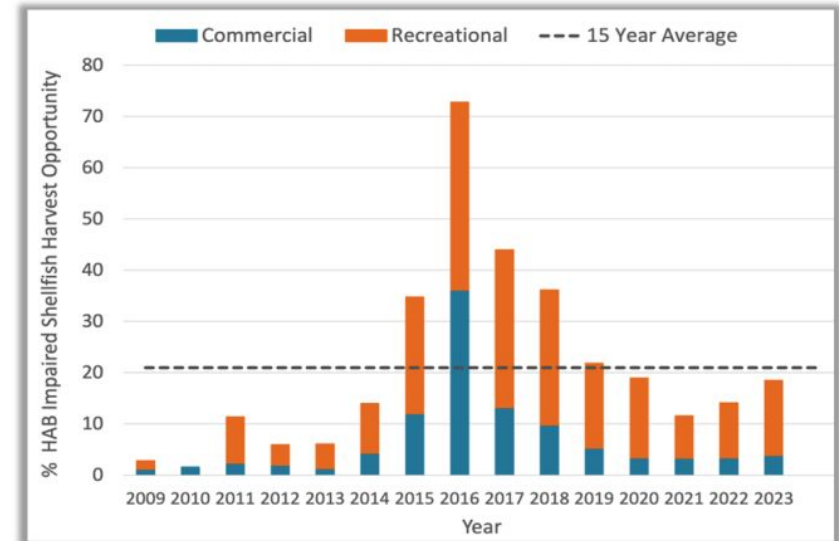
- At the surface
- Within the first 15 km of the coast.
- > ~25% on average



# All Signs Point to Marine HABs Getting Worse

- ❑ Larger blooms
  - ❑ Events intensifying and lasting longer since ~2015
- ❑ Longer duration/shifts in timing
  - ❑ 2025 bloom lasted around 5 months
  - ❑ Summer 2023 bloom persisted for nearly 6 weeks
- ❑ Increased toxin levels and impacts
  - ❑ Multi-month or multi-year fishery closures
  - ❑ Cetaceans are more frequently affected
  - ❑ California sea lion attacks on humans are increasing
  - ❑ Multiple toxins are now threatening animal health

CA OPC Ocean Health Report Card:  
California Coastal HAB Impaired Shellfish Harvests



Source: Smith et al. in prep

# Take-home messages

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- ❑ Toxic algal blooms are common along the California coast.
  - ❑ They happen in most years, but the Santa Barbara Channel is a hotspot where blooms often start early.
  - ❑ Offshore eddies and retention zones mean strandings can appear even when beaches look “normal.”
- ❑ What drives these events?
  - ❑ Blooms are fueled by upwelling and nutrient imbalances, and are shaped by climate cycles (El Niño, La Niña).
- ❑ What’s changing?
  - ❑ Blooms are becoming larger, longer, and more toxic, with record events in recent years.
  - ❑ Climate change is expected to make conditions more favorable for future HABs.

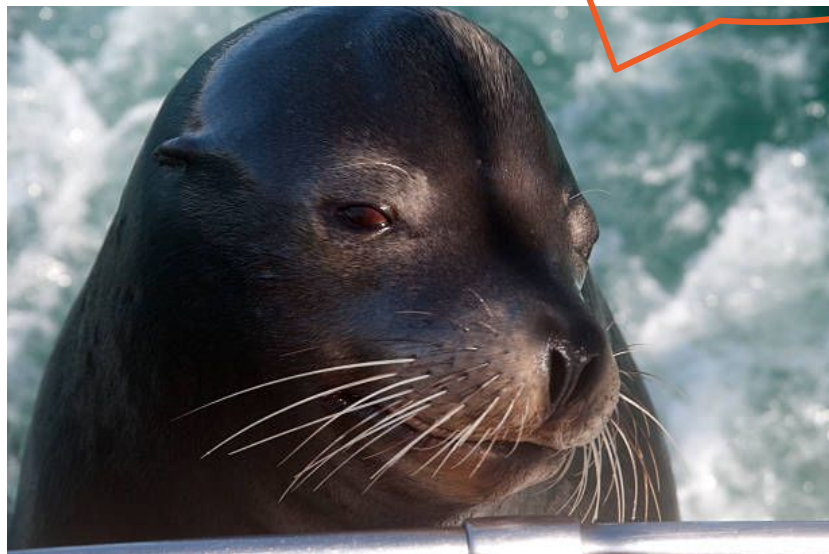


# Take-home messages

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- ❑ Human influence matters.
  - ❑ Positive relationships between water flow from rivers and wastewater outfalls and DA
  - ❑ Nutrients from rivers and wastewater increase concentrations by ~25% in coastal Southern California.
  
- ❑ What can we do?
  - ❑ Support local monitoring — especially offshore and community reporting [local community action].
  - ❑ Advocate for better nutrient management in watersheds and upgraded stormwater/sewage and treatment plants [federal investment].
  - ❑ Stay informed through the California HAB Bulletin and advisories [individual responsibility].

# Questions?



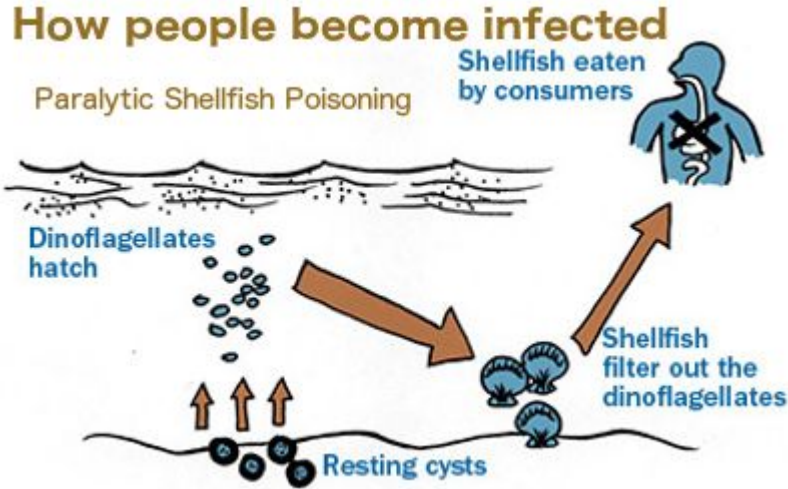
Marco Sandoval-Belmar  
(marcsandovalb@atmos.ucla.edu)

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**Additional slides**

# How can we get sick ?

Their color, flavor, smell, or appearance do not change.



Seafood poisoning only occurs when you eat seafood, not when you touch it.

Mussels, clams, scallops, abalones, snails, shrimp, crabs, and lobsters, sea urchins, tunicates, anchovy, sardine



BUT

# Recipe for making a HAB

But speaking of cooking... Can you cook and eat them?

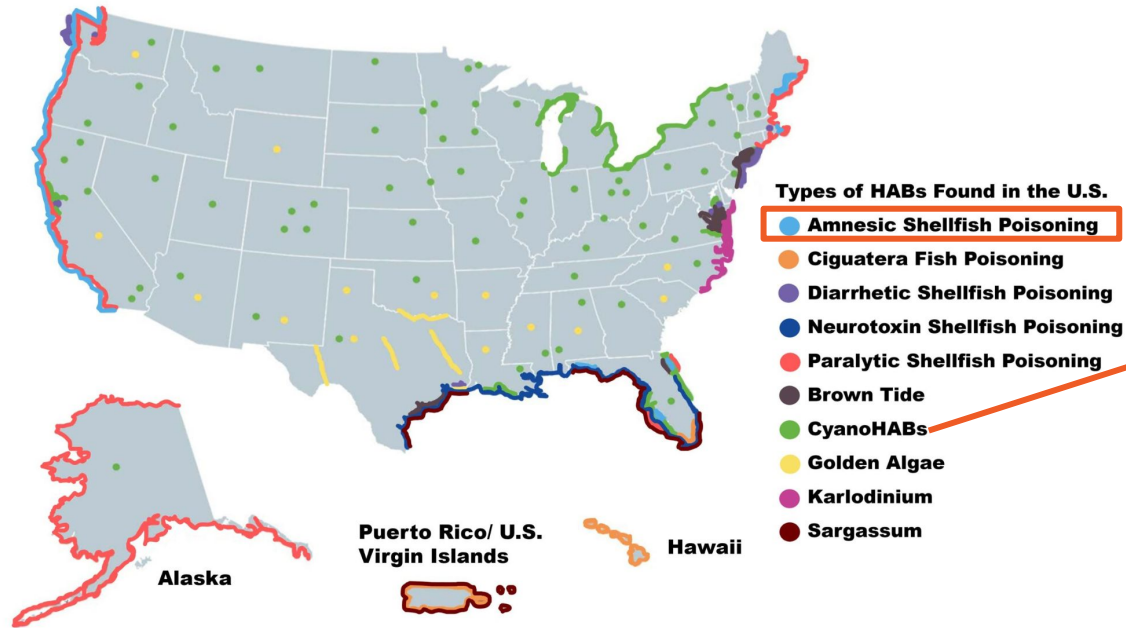
No!! Heat doesn't eliminate the toxin, nor does adding lemon, vinegar, or alcohol! Always know where it comes from and if it has the proper permits and sanitary measures!

# No!





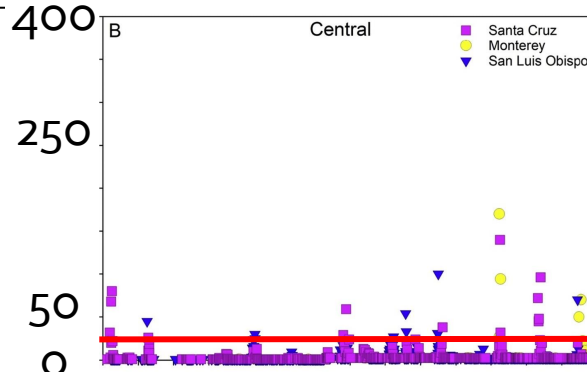
# Types of HABs in the US



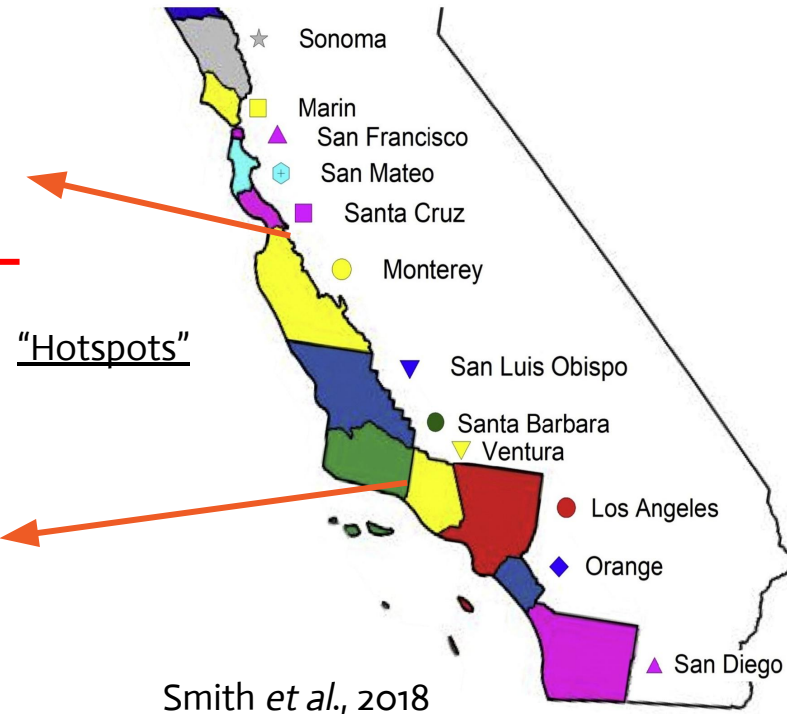
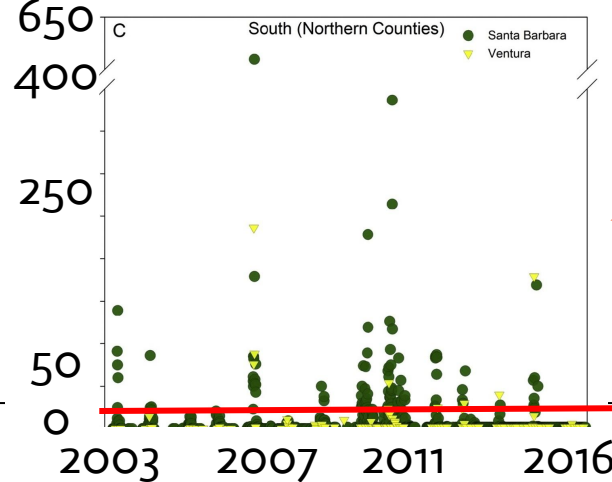
Some freshwater and estuarine varieties of cyanobacterial HABs taint water bodies green and produce toxins (microcystins) poisonous to wildlife and humans

# California DA HAB

DA in shellfish  
tissue ( $\mu\text{g/g}$ ).



Shellfish beds are  
closed to harvesting  
when reaches  $20 \mu\text{g/g}$

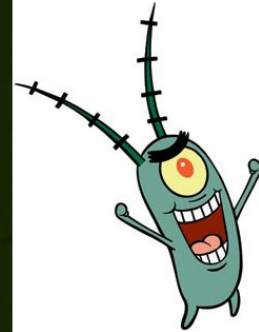


# Some Numbers: (Sutula et al., 2021)

- ❑ The SCB receives  $\sim 4050 \text{ kg N km}^{-2} \text{ yr}^{-1}$ , among the highest globally.
- ❑  $\sim 95\text{--}97\%$  of coastal nitrogen is anthropogenic.
- ❑ Point sources (mainly wastewater outfalls) deliver  $\sim 70\%$  of freshwater and  $\sim 97\%$  of nitrogen; rivers supply the remaining  $\sim 30\%$  freshwater /  $\sim 5\%$  nitrogen.
- ❑ Of that riverine nitrogen,  $<1\%$  is natural — the rest is urban or wastewater-derived.
- ❑  $\sim 92\%$  of total N comes from wastewater outfalls, mostly ammonium ( $\text{NH}_4^+$ ;  $\sim 80\%$ ) from primary/secondary treatment.
- ❑ Central Bight (SMB–SPC) receives  $\sim 60\%$  of all anthropogenic N, doubling nearshore N levels.
- ❑ Smaller outfalls ( $\sim 20\%$  of N) discharge into the euphotic zone, with direct effects on blooms.

# DA purpose: hypothesis

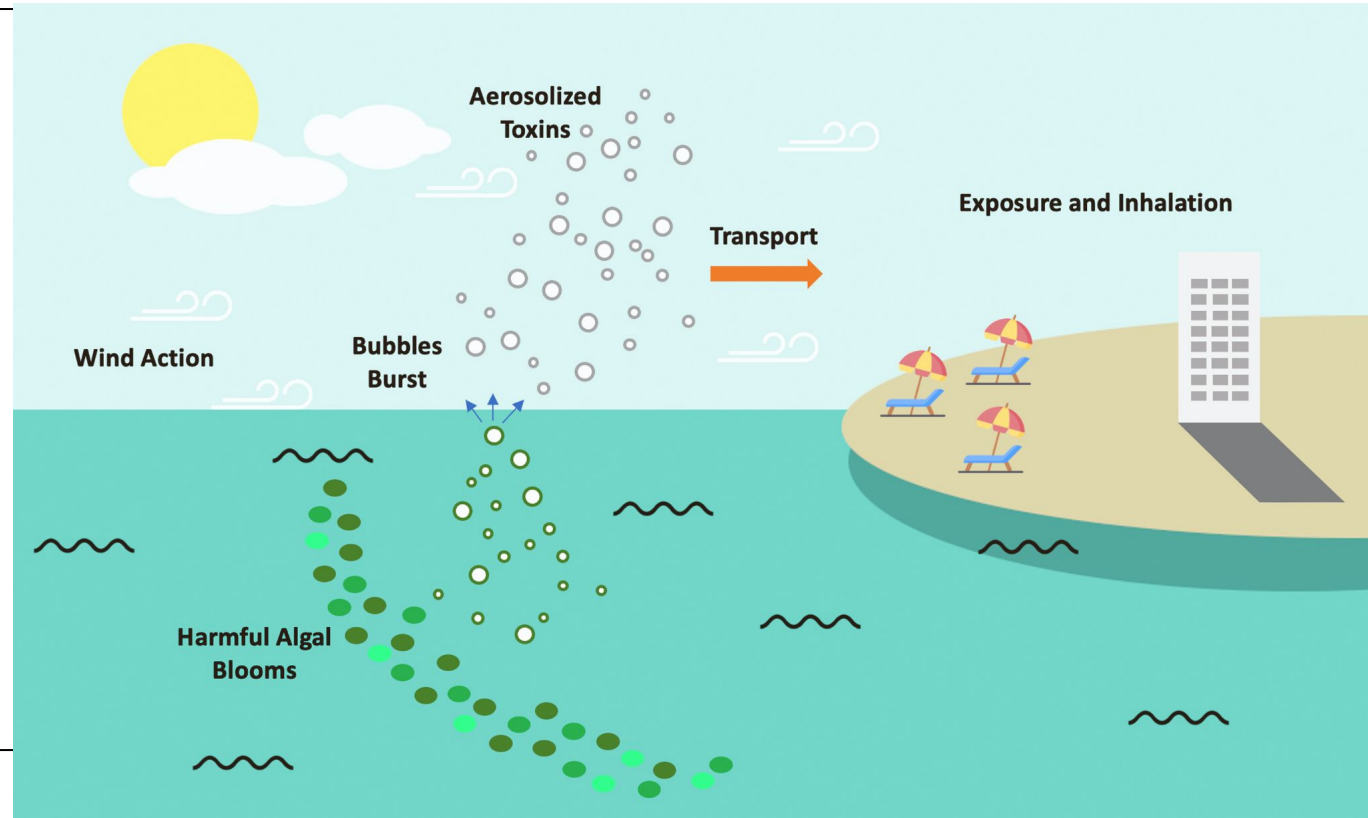
- ❑ Maintaining such a costly trait suggests that DA production must provide some advantages under certain conditions:
  - ❑ Defense mechanism against grazers.
  - ❑ Outcompete other phytoplankton.
  - ❑ Oxidative stress protection.
  - ❑ Nutrient scavenging and iron chelation.
  - ❑ Cu toxicity.
  - ❑ Metabolic byproduct.



“copepodamides”

# Harmful Algal Bloom (HAB): Airborne Algae

"Harmful algal bloom aerosols and human health" Review by Lim et al (2023), eBioMedicine



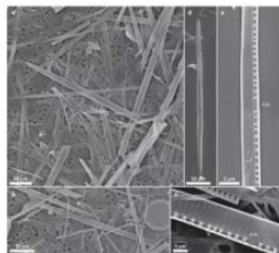




Santa Cruz Sentinel front page from  
**Aug 18, 1961** (Covello photography)



Alfred Hitchcock's 1963  
film "The Birds"



Scanning electron  
microscopy images of  
zooplankton gut contents  
collected in **July–August  
1961** from Monterey Bay,  
California (CalCOFI  
Program, SIO; Bargu et al.  
2012 *Nature*).

- 1961:** Seabird deaths retroactively associated with DA (Bargu et al., 2012 *Nature*)
- 1991:** First brown pelican and Brandt's cormorant mortality associated with DA (Fritz et al. 1992)
- 1998:** First California Sea Lion mortalities published as DA (Scholin et al., 2000 *Science*)
- 2007:** Large CSL/dolphin mortality event
- 2014:** Large CSL mortality event
- 2015:** Largest recorded food web impacts
- 2022:** 450+ CSL strandings
- 2023:** 1000+ CSL/pinniped/dolphin strandings
- 2024:** 500+ CSL/pinniped/dolphin strandings
- 2025:** 1670+ CSL/pinniped/dolphin strandings

Food Web Impacts known *at least* since the 1960s

- Pseudo-nitzschia* spp. recorded in sediments for over 1000 yrs (Barron et al. 2013)
- Increases substantially after YR 2000 with onset of more shellfish poisoning records

From C. Anderson, 2025

# Are they increasing?

---

- ❑ Cyst bank expansion
- ❑ Nutrient enrichment in closed systems
- ❑ Ballast water discharge
- ❑ Improved detection and increased aquaculture usage:
  - ❑ Enhanced molecular tools and the higher use of coastal waters for aquaculture may also lead to higher recorded occurrences of HABs.
- ❑ Climate change effects:
  - ❑ Warmer conditions and reduced summer rainfall favor dinoflagellates.

# HAB and climate change

---

- ❑ HAB species becoming more competitive relative to non-HAB species within plankton assemblages.
  - ❑ Temperature: cyst, window of opportunity, growth rate. pH, pCO<sub>2</sub>.
  
- ❑ Enhanced toxin production by toxic HAB species
  - ❑ pH, more stress (nutrients, temperature, light).
  - ❑ PN is MORE toxic at high temps (R. Kudela).
  
- ❑ Increased likelihood and severity of high biomass HABs developing due to changes in hydrology.
  - ❑ Dry/wet, change stratification.

## 46

# Fate of Stranded Marine Mammals

- NOAA Network covers entire coast
  - 8 within southern California
- Live strandings are rescued & treated
  - Most rehabilitated animals are returned to the ocean
- Dead animals are also collected
  - Species, sex, and level of decomposition cataloged

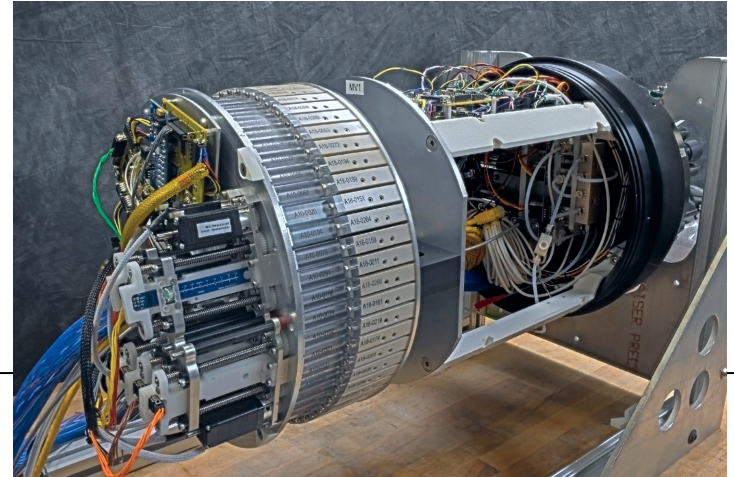
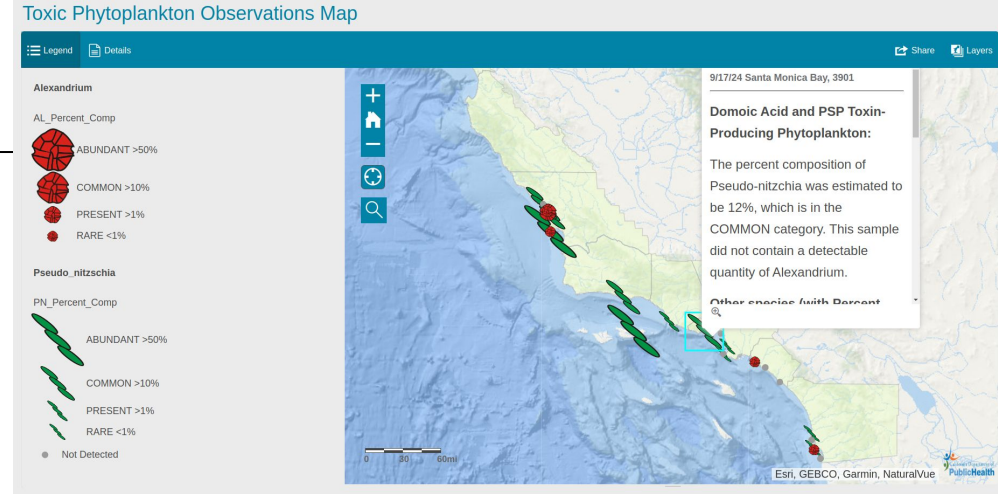




# Sampling

- ❑ Harmful Algal Bloom Monitoring and Alert Program (HABMAP): weekly at 9 locations
- ❑ P&B cruises in SBC.
- ❑ California Harmful Algal Bloom (HAB) Portal.
- ❑ Freshwater Monitoring.
- ❑ SCCOOS and CeNCOOS.
- ❑ San Francisco Estuary Institute (SFEI) and U.S. Geological Survey (USGS).
- ❑ California Ocean Protection Council (OPC) Initiatives.
- ❑ The California Department of Public Health (CDPH)

Environmental Sample Processor  
(ESP)



# HAB data

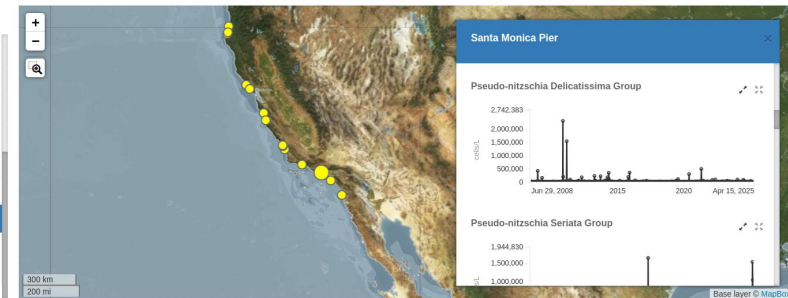
- [https://data.caloos.org/#dashboards/layer/59cb173d-9fab-44d0-9a13-5e1c35a10f1b/location\\_name?location\\_name=Santa%20Monica%20Pier](https://data.caloos.org/#dashboards/layer/59cb173d-9fab-44d0-9a13-5e1c35a10f1b/location_name?location_name=Santa%20Monica%20Pier)
- <https://erddap.sccoos.org/erddap/tabledap/HABs-SantaMonicaPier.html>

## CalHABMAP

Learn more about CalHABMAP by clicking [here](#)

### Location

- Santa Cruz Wharf
- Monterey Wharf
- Morro Bay Front Bay
- Morro Bay Back Bay
- Cal Poly Pier
- Steamers Wharf
- Santa Monica Pier**
- Newport Beach Pier
- Scagg's Pier



## ERDDAP > tabledap > Data Access Form

Dataset Title: **CalHABMAP - HABs Santa Monica Pier data**

Institution: CalHABMAP (Dataset ID: HABs-SantaMonicaPier)

Information: Summary | License | FGDC | ISO 19115 | Metadata | Background | Subplot | Make a graph

Variable	Optional Constraint #1	Optional Constraint #2	Minimum or a List of Values	Maximum
<input checked="" type="checkbox"/> Location, Cite	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Latitude (degrees, north)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Longitude (degrees, east)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Depth (m)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Sampled	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Time (UTC)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Temp (Sea water temperature, degree, C)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Air_Temp (Air temperature, degree, C)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Salinity (Salinity (PSU))	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Chl_Volume_Filament (mg, L)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Chl1 (mg/m3)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Chl2 (mg/m3)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Aum_Chloro (mg/m3)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

**Download Options:**

- .asc** - View OPeNDAP-style ISO-8859-1 comma-separated text.
- .csv** - Download a ISO-8859-1 comma-separated text table (line 1: names; line 2: units; ISO 8601 times).
- .csvp** - Download a ISO-8859-1 .csv file with line 1: name (units). Times are ISO 8601 strings.
- .csvd** - Download a ISO-8859-1 .csv file without column names or units. Times are ISO 8601 strings.
- .dataTable** - A JSON file formatted for use with the Google Visualization client library (Google Charts).
- .das** - View the dataset's metadata via an ISO-8859-1 OPeNDAP Dataset Attribute Structure (DAS).
- .dds** - View the dataset's structure via an ISO-8859-1 OPeNDAP Dataset Descriptor Structure (DDS).
- .dods** - OPeNDAP clients use this to download the data in the DODS binary format.
- .dodsCov** - Download a ISO\_8859\_1 .csv file for ESR's ARGIS 9.x and below (separate date and time columns).
- .fgdc** - View the dataset's UTF-8 FGDC .xml metadata.
- .geojson** - Download longitude, latitude, otherColumns data as a UTF-8 GeoJSON .json file.
- .graph** - View a Make A Graph web page.
- .help** - View a web page with a description of tabledap.
- .html** - View a OPeNDAP-style HTML Data Access Form.
- .htmlTable** - View a UTF-8 .html web page with the data in a table. Times are ISO 8601 strings.
- .iso19115** - View the dataset's ISO 19115-2/19139 UTF-8 .xml metadata.
- .ix** - Download an ISO-8859-1 Igo Text File. Each response column becomes a wave.
- .json** - View a table-like UTF-8 .JSON file (missing value = 'null'; times are ISO 8601 strings).
- .jsonCSV1** - View a UTF-8 .JSON Lines CSV file with column names on line 1 (row = 'null'; times are ISO 8601 strings).
- .jsonCSV2** - View a UTF-8 .JSON Lines CSV file without column names (row = 'null'; times are ISO 8601 strings).
- .htmlTable** - View a UTF-8 .html web page with the data in a table. Times are ISO 8601 strings.

Just generate the URL

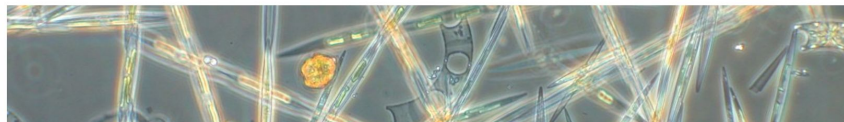
Documentation / Bypass this form

Select the type of file you want to download.

## California HABMAP

A Statewide HAB Network and Forecasting System

About CalHABMAP | HAB Species | HAB Forecast | Bulletin and News | Data | Resources | Ocean Observations



## HABMAP

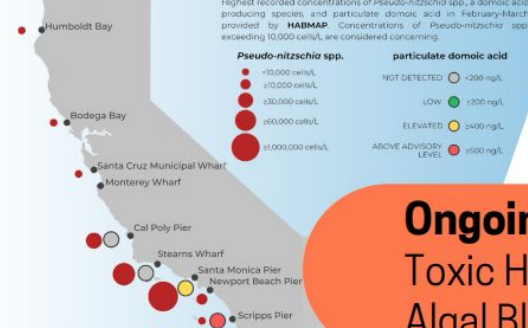
The Harmful Algal Bloom Monitoring and Alert Program collects weekly phytoplankton and water quality data at nine locations along the California coast. HABMAP provides timely updates on marine HAB events, and aids in understanding the timing, extent, and impact of these events on humans and the marine ecosystem.

For information on freshwater HABs in California, visit the [CA HAB Portal](#).

### RECENT POSTS

- California HAB News: April 2015
- California HAB News: March 2025
- California HAB News: February 2025





## Ongoing Event: Toxic Harmful Algal Bloom (HAB)

### By the Numbers

**Feb. 21**  
first DA  
stranding

**1,500+**  
suspected DA  
strandings

**9**  
seafood  
advisories

### Why is this event so severe?

- Two different types of marine algae are present. Each produce a unique **neurotoxin** that can cause **illness & death** in marine mammals/seabirds, and can also **harm humans**:
  - Domoic Acid (DA)** → Amnesic Shellfish Poisoning
  - Saxitoxin** → Paralytic Shellfish Poisoning (PSP)
- This is the **4th consecutive year** of major DA-related marine mammal mortality events in Southern CA.
- High DA levels** are detected at our shore stations and in animal samples. High toxin levels lead to larger numbers of strandings, deaths, and more **severe neurological effects**, which have led to inadvertent altercations with humans.
- This year's HAB severity may be exacerbated by **La Niña conditions**, and **potentially** ash from the **recent LA fires**.
- CA rescue centers report this **DA event** has caused **more dolphin and seabird strandings** than the past 3 years, as well as affecting CA Sea Lions; Initial mammal stranding numbers have surpassed the last three years of HAB events.
- CDPH has issued **shellfish harvest advisories** in Southern CA due to **DA + PSP** surpassing the critical safety threshold.



Report a stranded animal (West Coast)

**Marine Mammal Stranding Network 1-866-767-6114**

- Unprecedented multiple-toxin event
- Significant bloom with high DA toxicity
- Severe marine mammal + seabird strandings
- PSP impacts on seafood + public health



**Above:** Stranded Common bottlenose dolphin, in a photo from LA Lifeguards.  
**Below:** CA sea lion being treated for DA poisoning.



### CA HAB Bulletin

SCCOOS publishes a bimonthly online bulletin that summarizes CA HAB events & forecasts

See more at [SCCOOS.org](https://www.sccoos.org)

UC San Diego

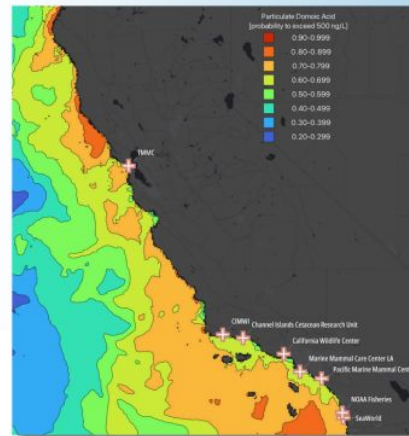
SCRIPPS INSTITUTION OF OCEANOGRAPHY

SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

CENTRAL & NORTHERN CALIFORNIA OCEAN OBSERVING SYSTEM

IOOS Integrated Ocean Observing System

Last Updated: 4/30/2025



**Above:** Rescue centers overlayed with NOAA Coastwatch C-HARM model predicted probability of particulate domoic acid output for 3/19/25-4/19/25

**Below:** Diver services an IFCB that detects phytoplankton and HAB blooms in real-time.



### Data-User Testimonials

"The SCCOOS and CeNCOOS HAB data is an invaluable tool that offers our response, clinical and pathology teams critical information to better evaluate if stranded marine mammals are affected by domoic acid intoxication in order to administer the best possible care and treatment for these animals."

— Dr. Dominic Travis, Chief Programs Officer,  
**The Marine Mammal Center**

"Channel Islands Marine & Wildlife Institute (CIMWI) uses SCCOOS and CeNCOOS HAB data, C-HARM model, & CA HAB Bulletin to monitor domoic acid along the California coast in order to be at the ready to respond to marine mammals affected by increased levels of domoic acid."

— Ruth Dover, Managing Director,  
**Channel Islands Marine & Wildlife Institute**

## Monitoring + Prediction Harmful Algal Blooms (HABs)

Marine mammal rescue centers and public health officials rely on HAB monitoring infrastructure + data products

### Recent HAB Events



Date	Animals Reported
Aug 2022	100
May-Aug 2023	1,000+
Jul-Aug; Sep-Oct 2024	231; 87
(ongoing) Feb-Apr 2025	<b>1509 and counting</b>

### California's HAB Monitoring Infrastructure

SCCOOS & CeNCOOS HAB-detecting + monitoring assets include:

- Automated in-situ Imaging FlowCytobots** (IFCBs; pictured left) are advanced systems that capture real-time images of phytoplankton in the water, providing immediate data access to ongoing blooms.
- HAB Monitoring and Alert Program** (HABMAP) weekly water samples and plankton cell counts collected at coastal sites.
- California Underwater Glider Network** autonomous gliders are deployed 24/7 to inform researchers about changes in ocean conditions (e.g. upwelling) that drive HABs.

### Forecasting CA HAB Conditions: The C-HARM Model

The **C-HARM model** predicts the likelihood of algal blooms and harmful domoic acid levels using numerical models, ecological forecasts, & satellite ocean color imagery. Nowcast/forecast maps generated daily (image above)



UC San Diego

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SOUTHERN CALIFORNIA COASTAL OCEAN OBSERVING SYSTEM

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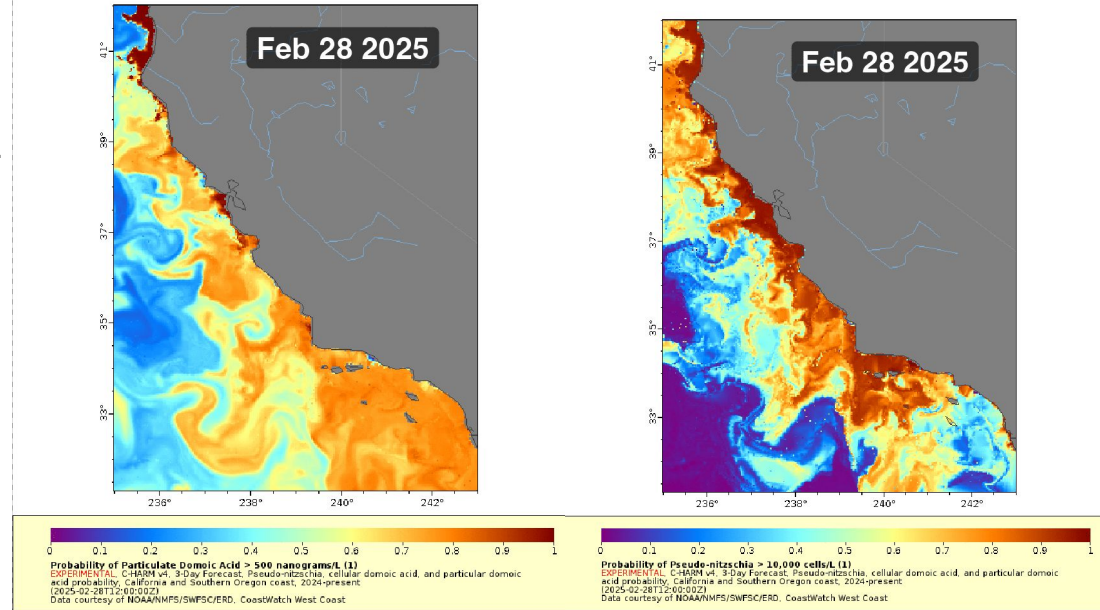
# HAB forecast

- NOAA capabilities include research and services that provide observations and forecasts of HAB risk.
- HAB early warnings support management decisions
- “Operational” indicates a finalized system, process, product, service or tool.
- “Developmental” indicates a product is undergoing research and development.



# HAB forecast

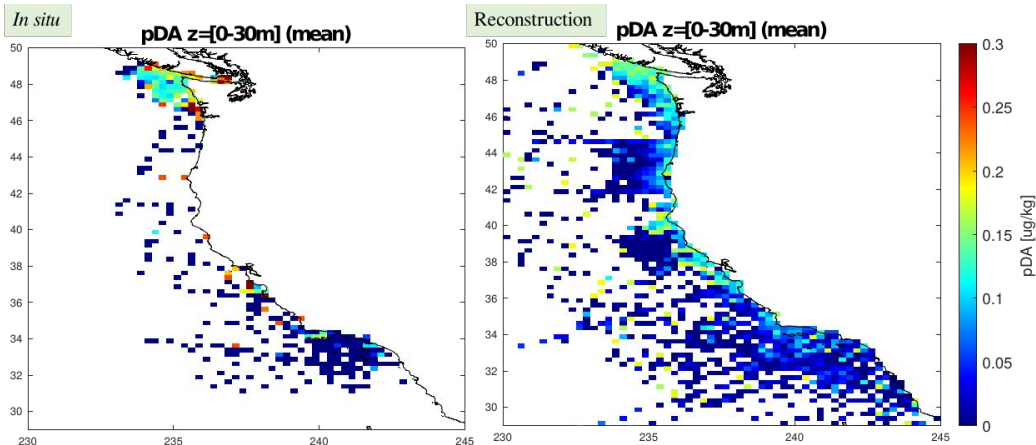
- ❑ C-HARM v4 Model: nowcast and forecast probabilities for:
  - ❑ PN concentrations > 10,000 cells/L
  - ❑ pDA > 500 ng/L
  - ❑ Cellular DA > 10 pg/cell
- ❑ Focuses on California and Southern Oregon coastal waters.
- ❑ Inputs:
  - ❑ Near real-time satellite data for chl-a and reflectance fields (486 nm and 551 nm)
  - ❑ salinity, sst, and currents from ROMS



Anderson *et al.* 2009, 2011, 2016

# ML on DA data

Allison Moreno, Ph.D  
Assistant Professor UCSC

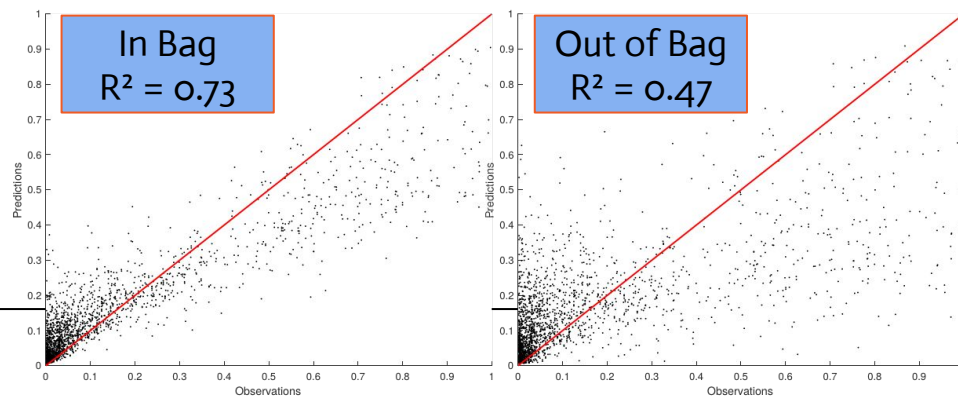


Can we utilize machine learning techniques to predict when a DA HAB event occurs along the US West Coast?

Regression Tree, based on weak and strong event environmental conditions relationships

Predictors: Temp, Salinity, Phosphate, Nitrogen, Silicate, Depth of Sample, Distance from Shore, Chlorophyll

If a DA HAB event occurs, what is the DA concentration?





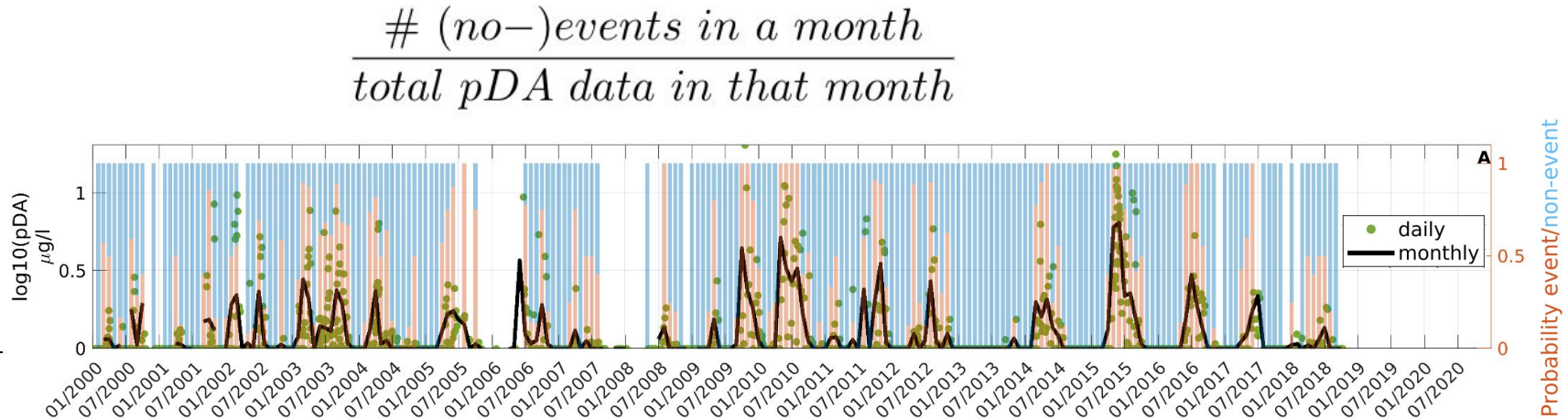
# Data processing: DA events

❑ Event: above detection limit ( $>0.05 \mu\text{g/l}$ )

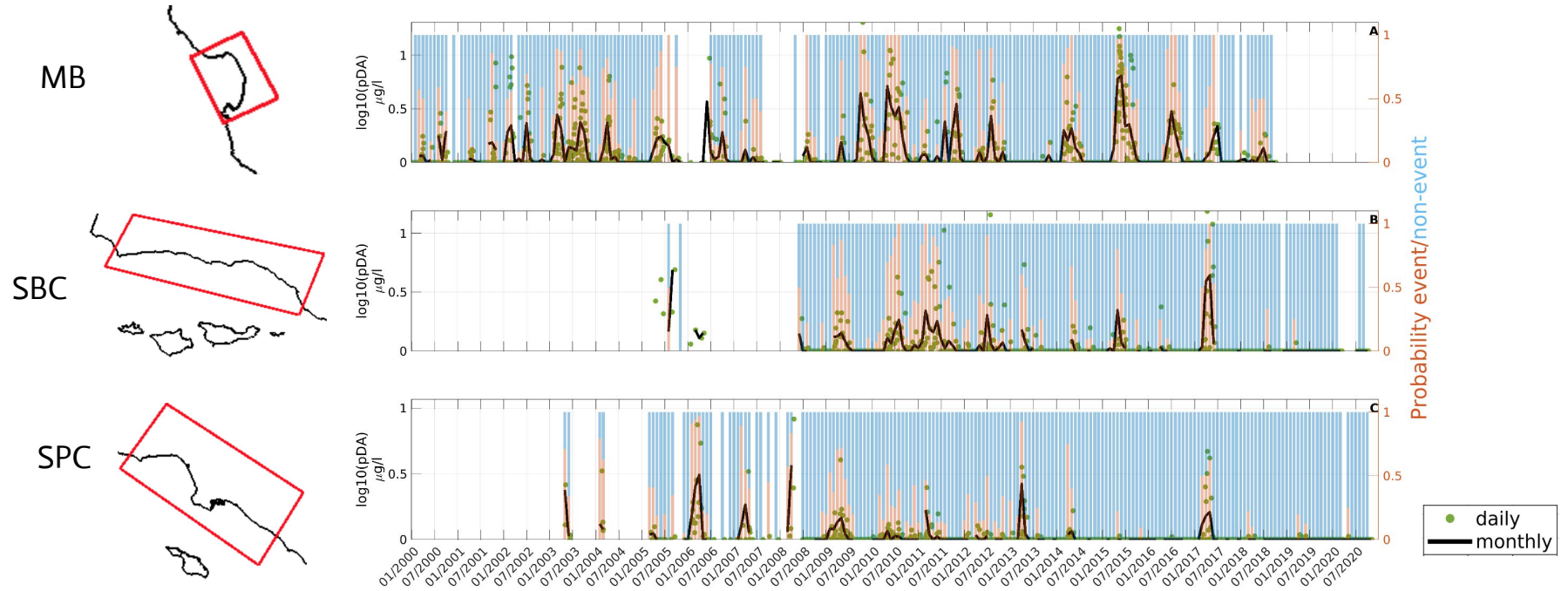
❑ Monthly probabilities:

❑  $\text{Si}^* = \text{Si}(\text{OH})_4 - \text{NO}_3^- \longrightarrow <0$ , limited by Si

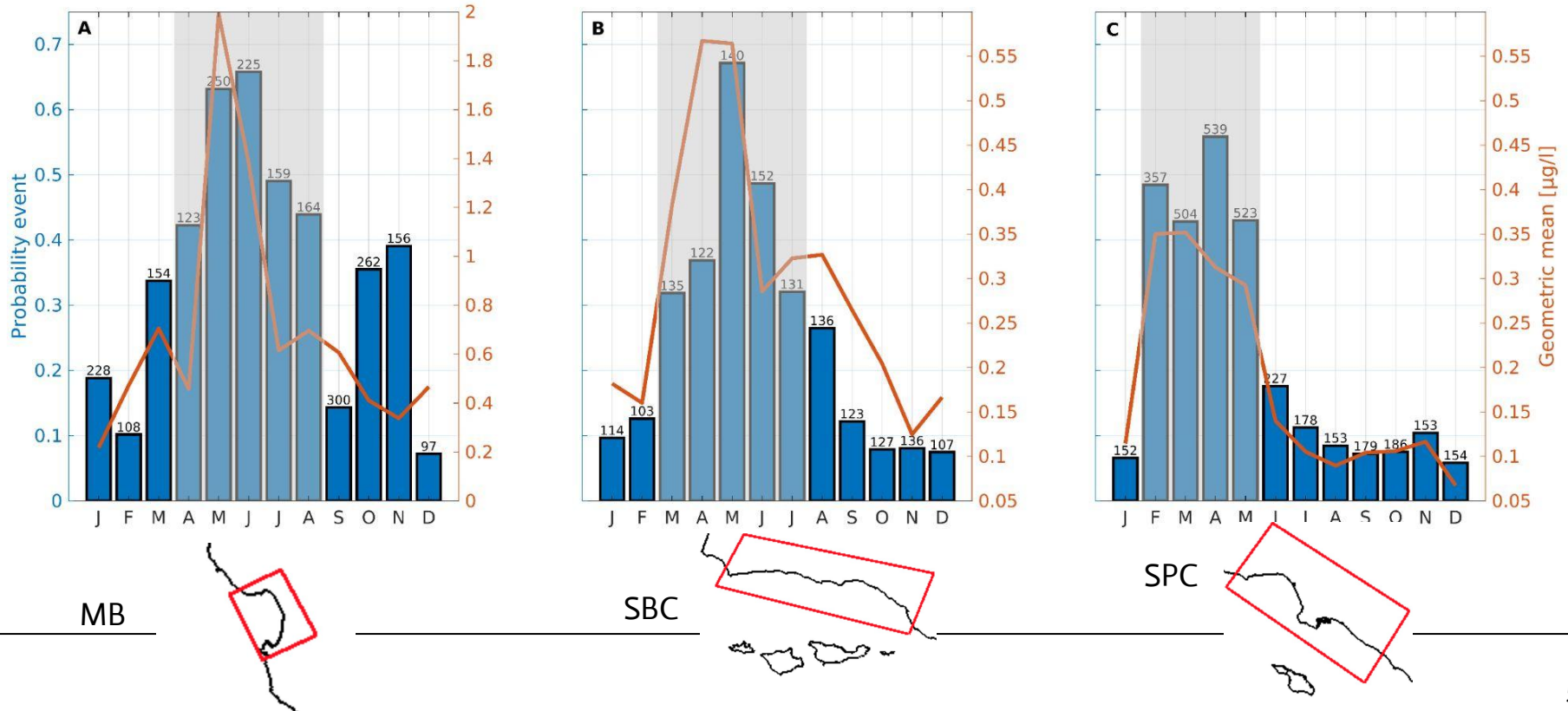
❑ Rivers, pipes, climate indices, upwelling index (UI), Chl-a ( $\sim$  phyto. biomass)



# Time series of pDA

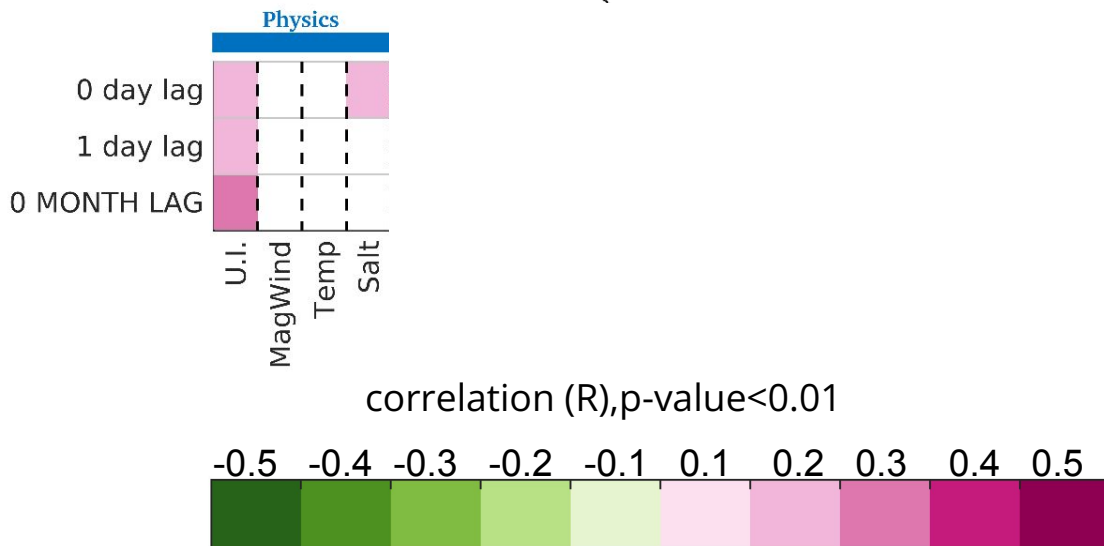


# Histograms pDA



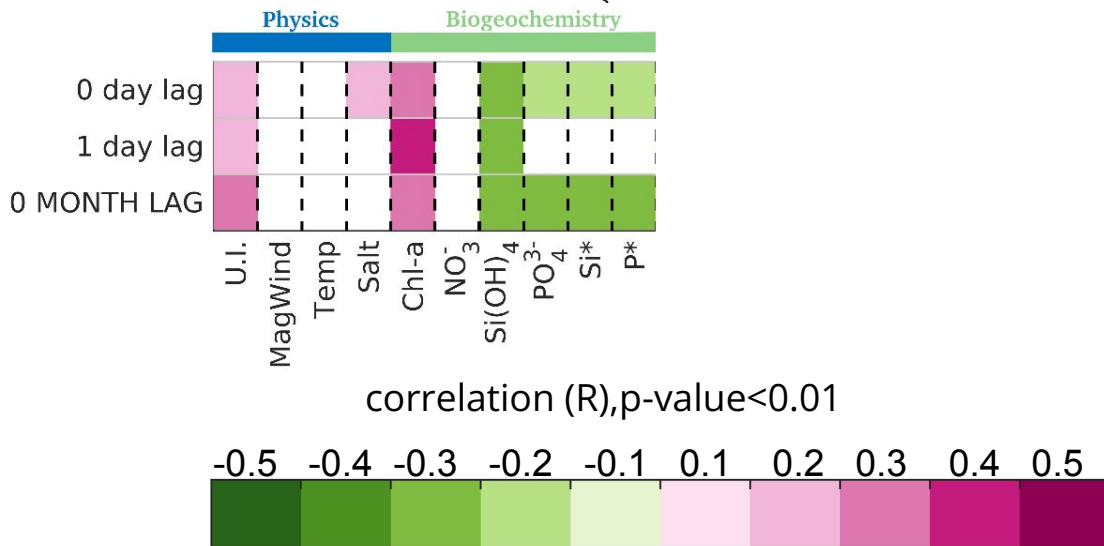
# Correlation: pDA vs factors

Monterey Bay (MB)



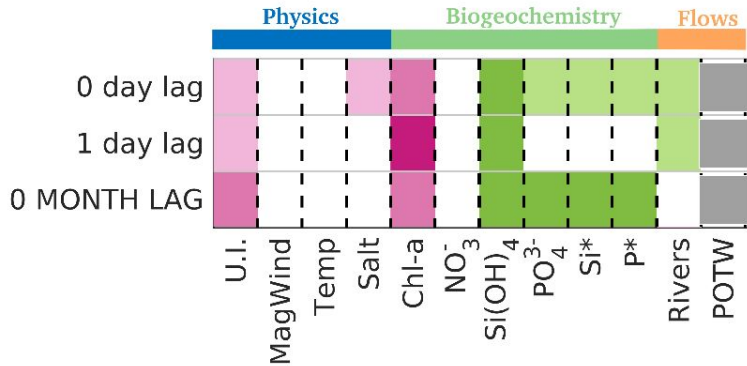
# Correlation: pDA vs factors

Monterey Bay (MB)



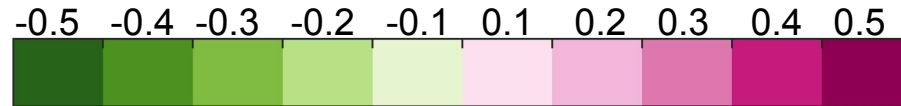
# Correlation: pDA vs factors

Monterey Bay (MB)



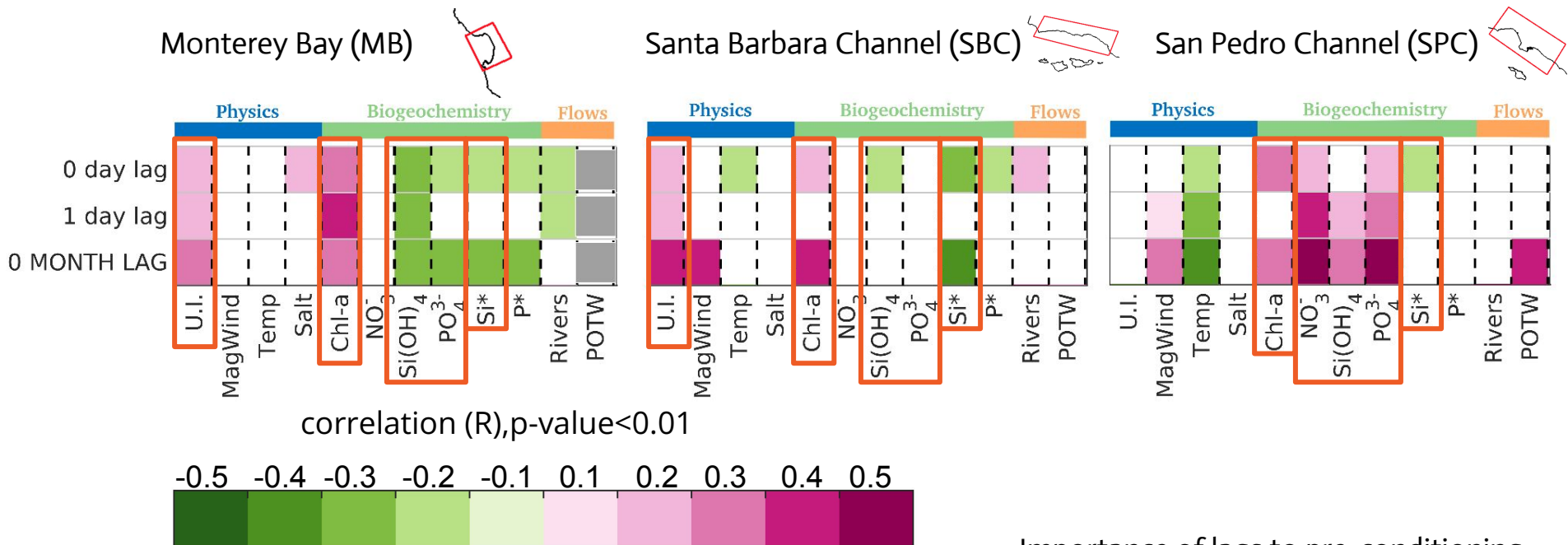
Publicly Owned Treatment Works (POTW) → process wastewater that is transported through pipes.

correlation (R), p-value < 0.01



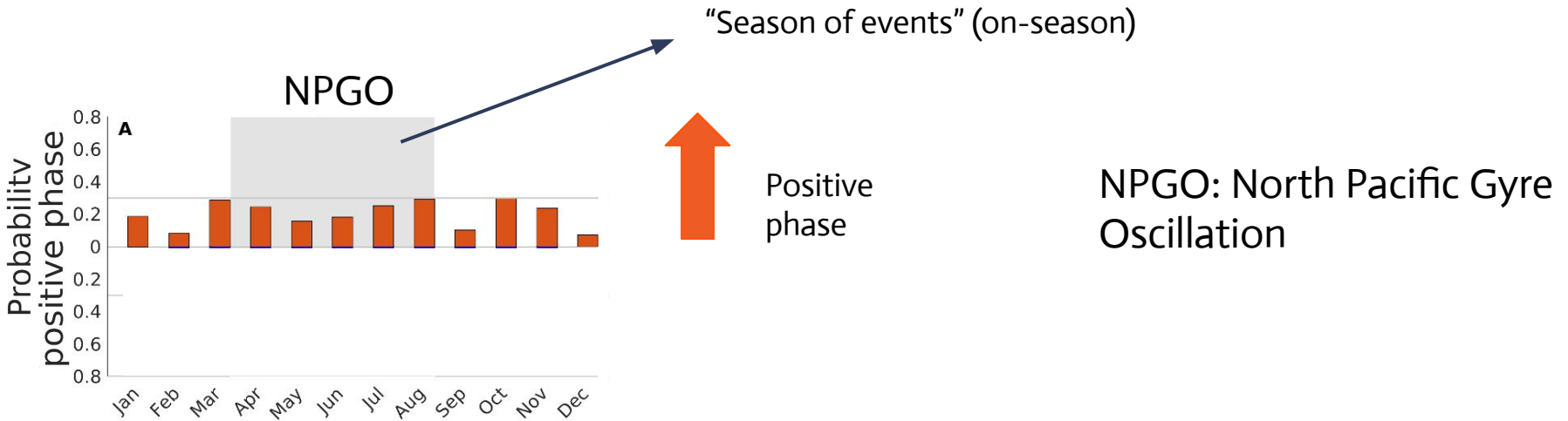


# Correlation: pDA vs factors

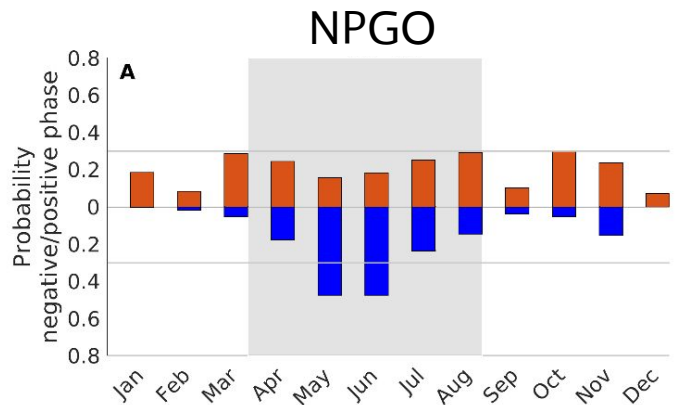


- Importance of lags to pre-conditioning.

# Event probability distribution per climate index phase



# Event probability distribution per climate index phase



Positive  
phase

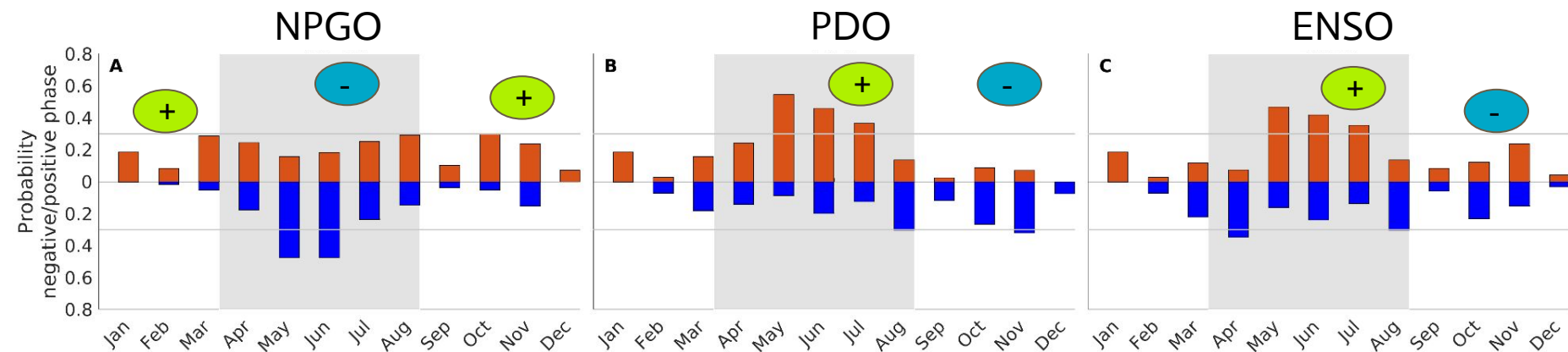
Negative  
phase

NPGO: North Pacific Gyre  
Oscillation

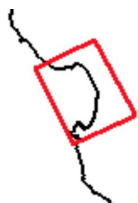
PDO: Pacific Decadal  
Oscillation

ENSO: El Niño-Southern  
Oscillation

# Event probability distribution per climate index phase

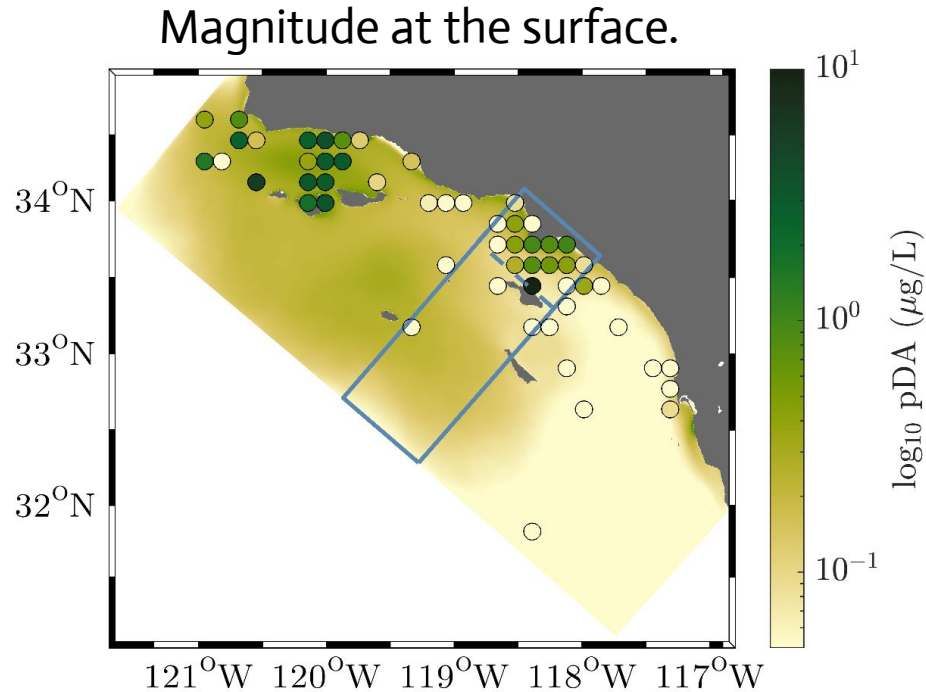


MB

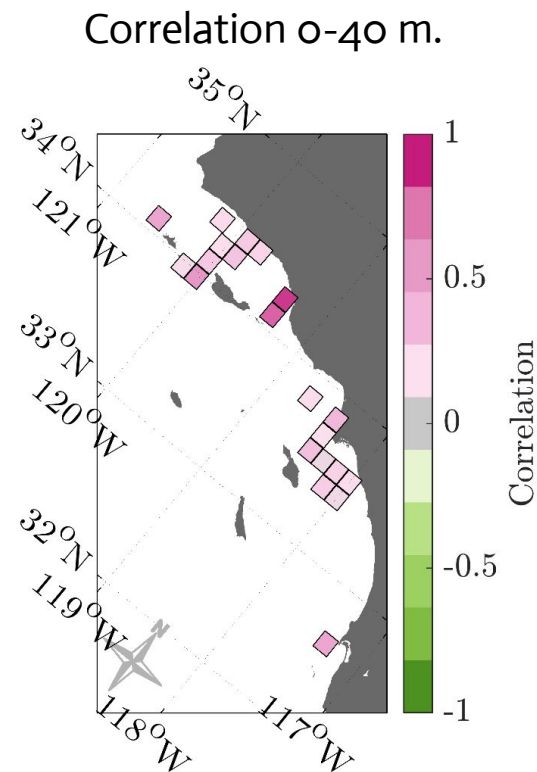
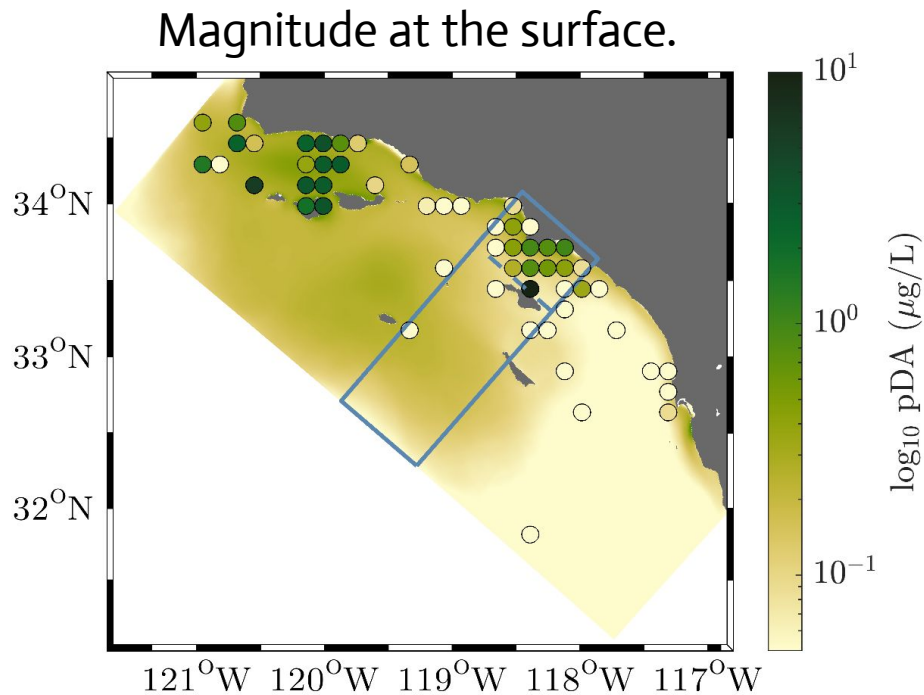


□ Modes related with anomalous circulation or nutrient concentration (+PDO, +ENSO).

# Validation: Magnitude, correlation

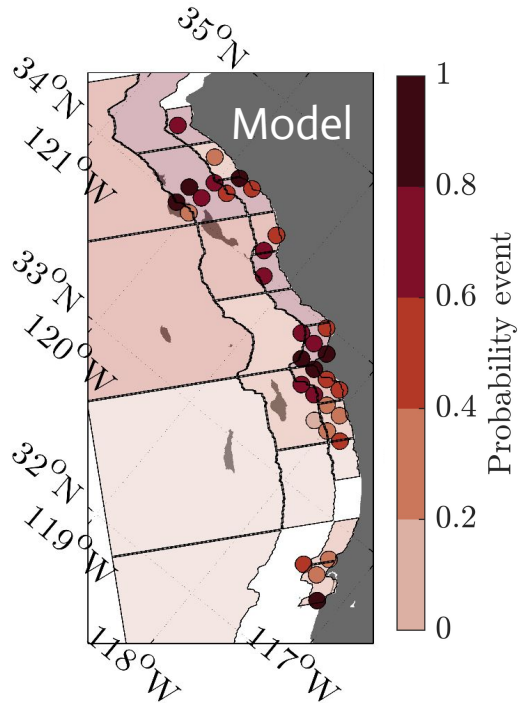


# Validation: Magnitude, correlation

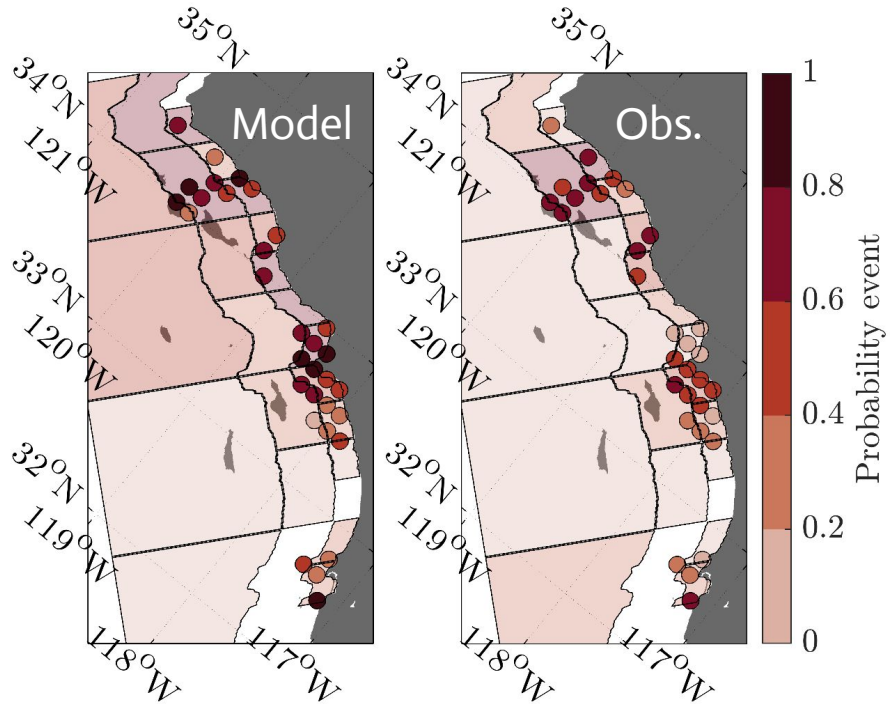




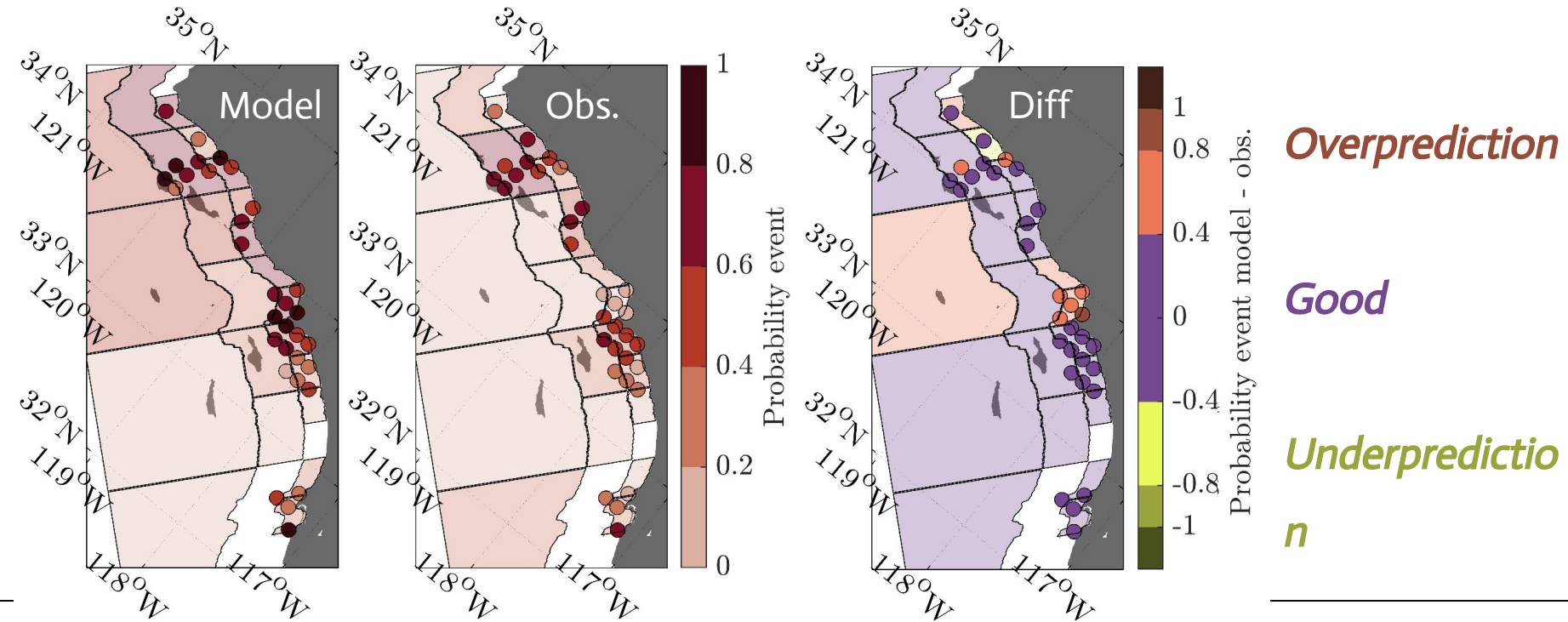
# Validation: Probability of event ( $>0.05 \mu\text{g/l}$ )



# Validation: Probability of event ( $>0.05 \mu\text{g/l}$ )

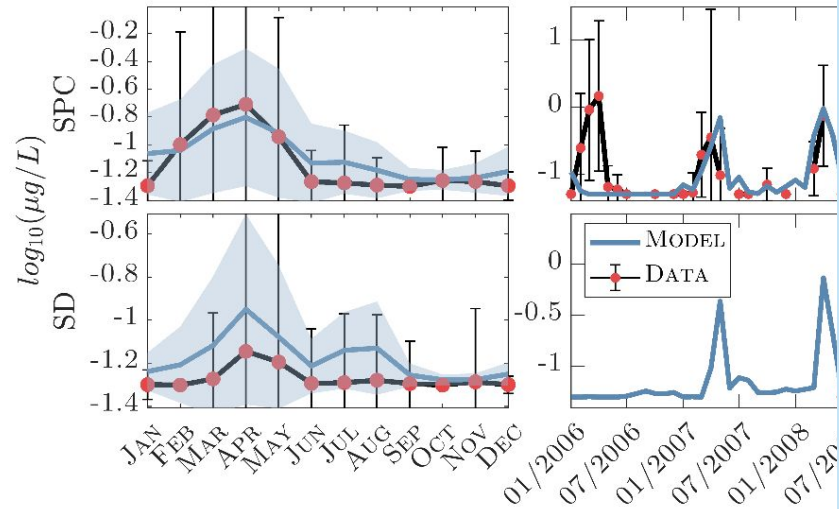


# Validation: Probability of event ( $>0.05 \mu\text{g/l}$ )

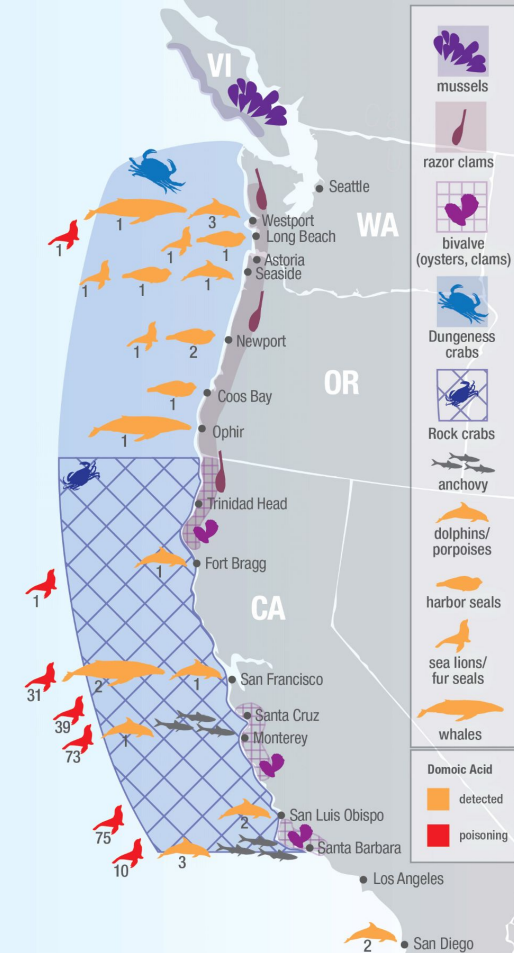


# Validation: Time

- Time series for SPC (well-simulated) and SD

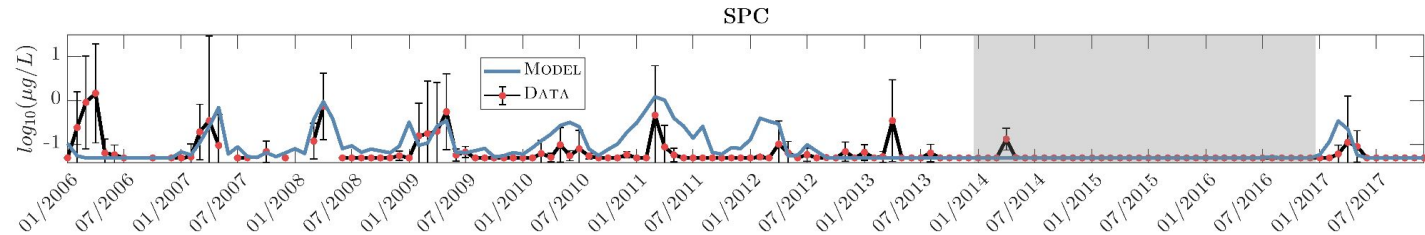


2015	Shellfish Harvest and Fishery Closures with Maximum Domoic Acid Values
7-May	Quinault tribe razor clam harvest closure (WA)
8-May	Commercial, tribal & recreational razor clam harvest closure (WA)
9-May	Razor clam harvest closure (northern OR)
14-May	State wide razor clam harvest closure (OR)
15-May	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



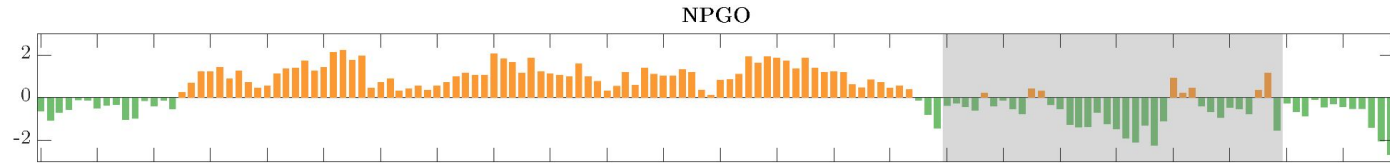
# What about 2015 in SCB?

- ❑ 2014 to 2016 low pDA
- ❑ 2015 warm “blob”

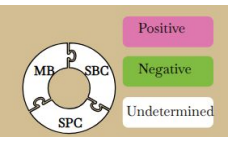
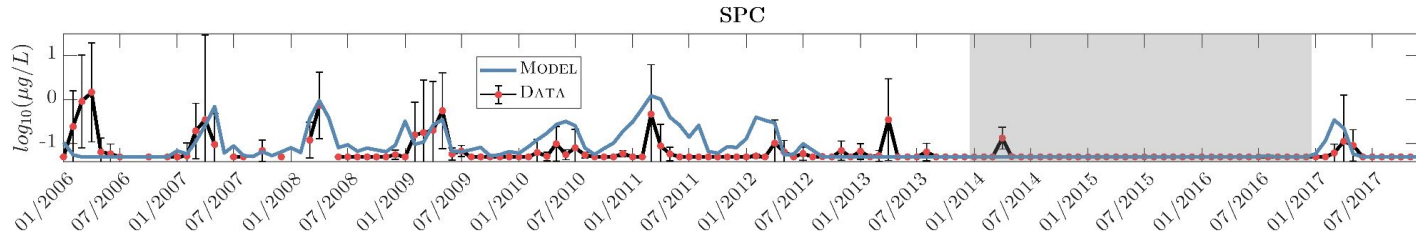
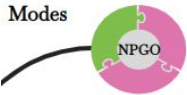


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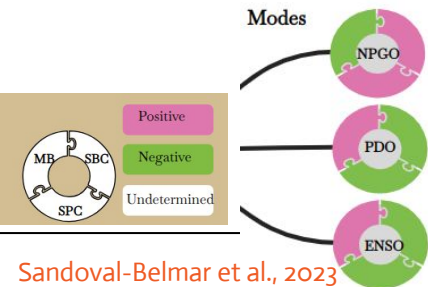
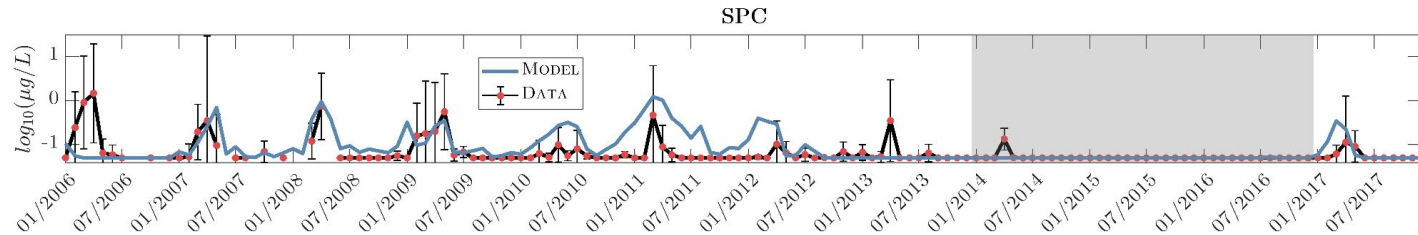
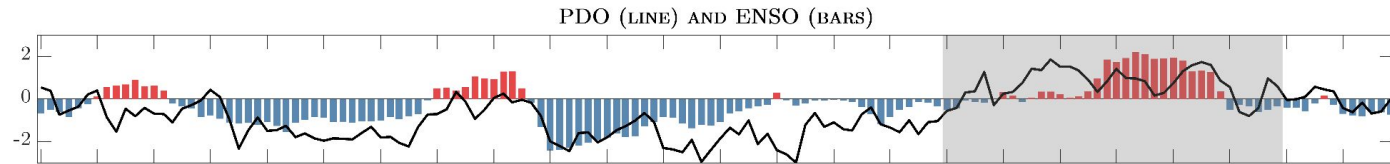
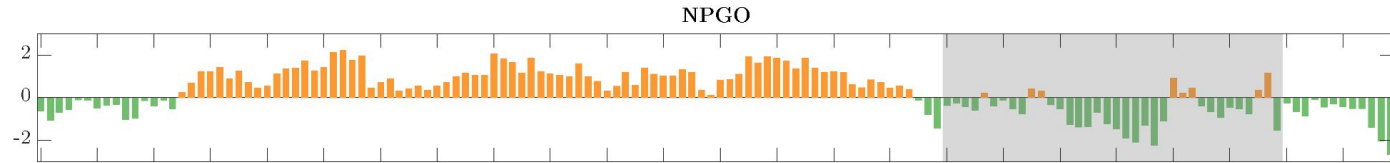
Modes





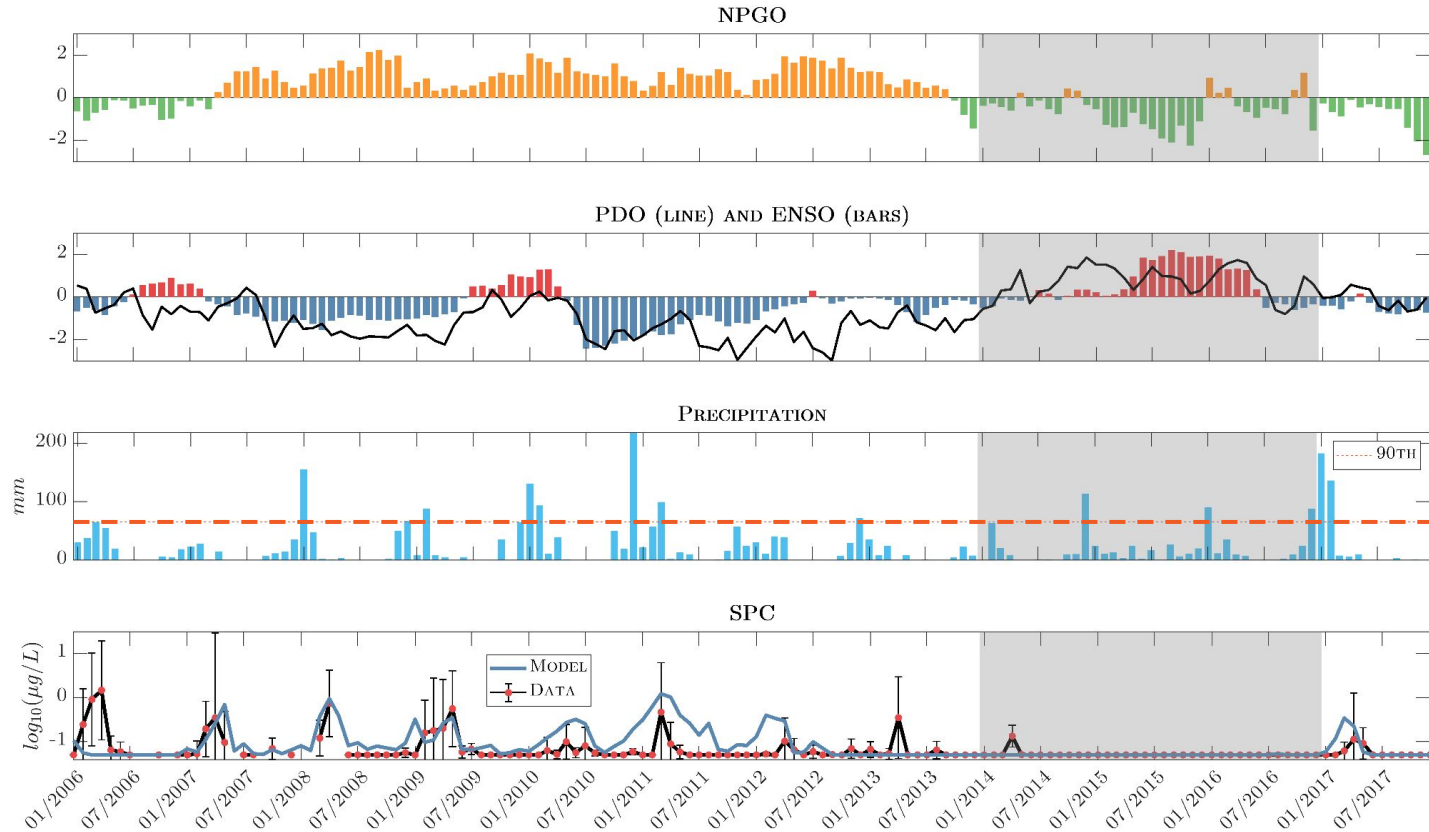
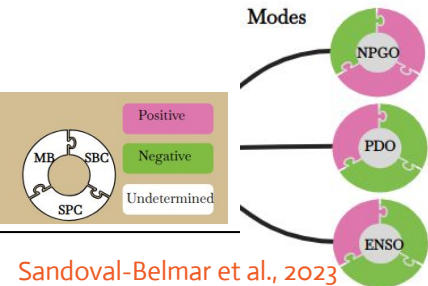
# What about 2015 in SCB?

- 2014 to 2016 low pDA
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- “...water temperature above  $19^{\circ}\text{C}$  did not result in PN dominance or DA production in the SCB...” (Smith et al., 2018b)

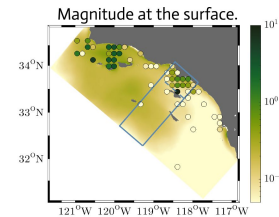


# What about 2015 in SCB?

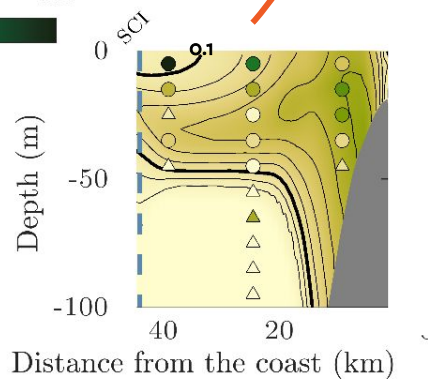
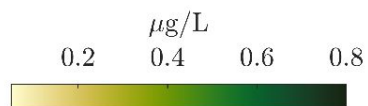
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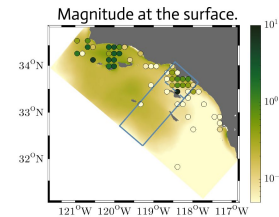
# Validation: Vertical slice



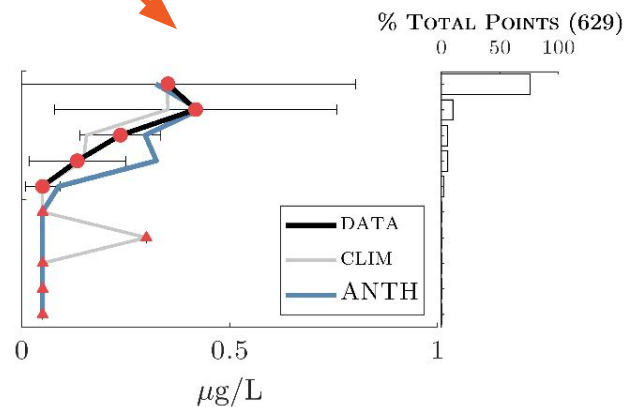
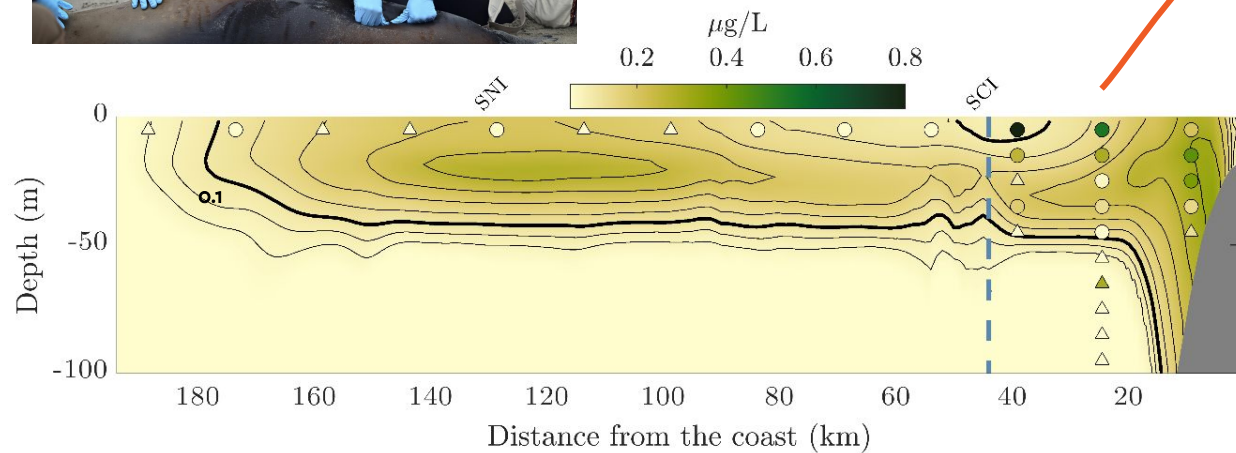
○ *Multi-seasonal and multi-year data*  
△ *Other*



# Validation: Vertical slice



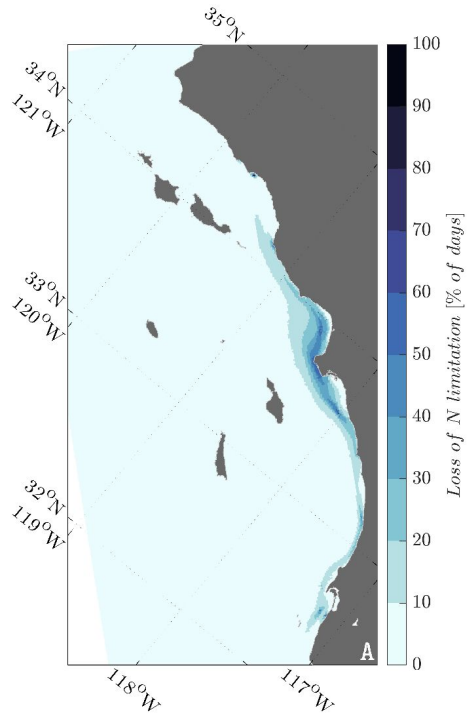
*multi-year data*



# DA production

P, Si limitation → DA

N limitation → no DA

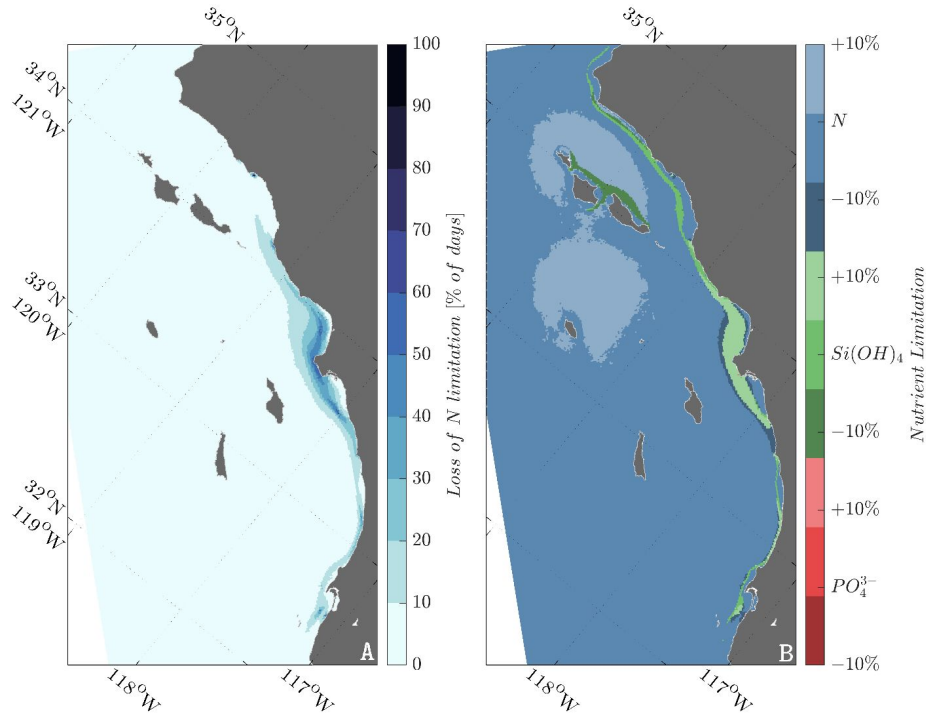


- ❑ Loss of N limitation: % of days where CTRL was N-limited but ANTH was not

# DA production

P, Si limitation → DA

N limitation → no DA



- ❑ Loss of N limitation [% of days].
- ❑ Primary limiting nutrient in ANTH.
  - ❑ **Darker (lighter )** colors indicate at least a 10% **reduction (increase )** in nut limitation in ANTH compared to CTRL



# DA production

P, Si limitation → DA

N limitation → no DA

