Thinking about OAD + Hypoxia

Kate Hewett
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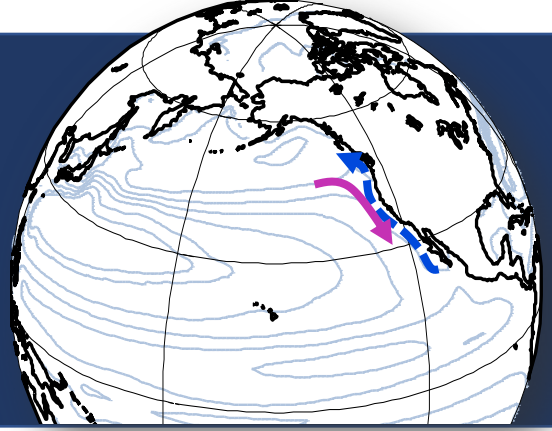
OA = Ocean Acidification
D = Deoxygenation
Hypoxia = low oxygen stress

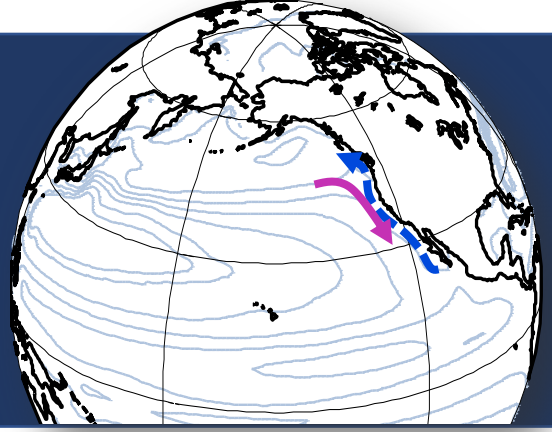
Hewett 2020



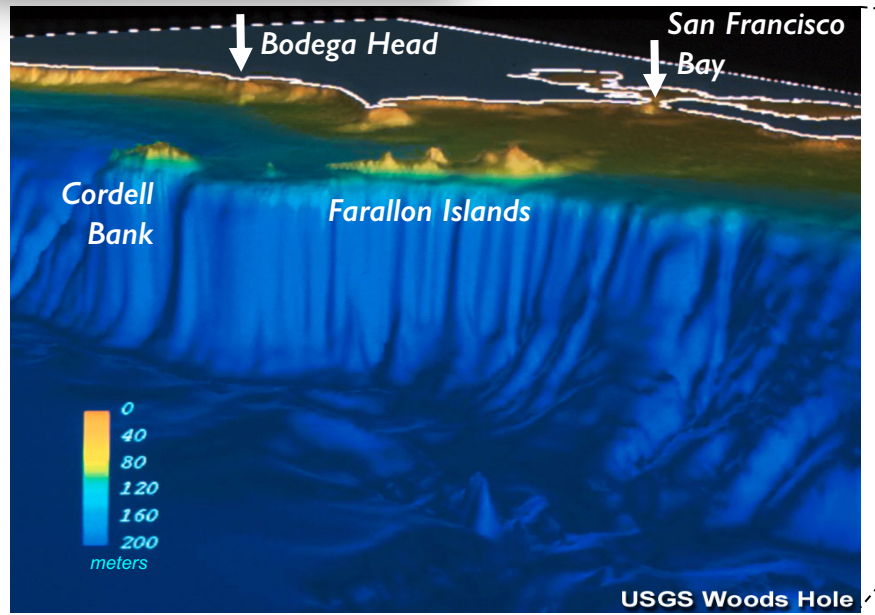
The California Current System

1. North Pacific Current
2. California Current
3. California Undercurrent
4. Coastal Jet
5. Freshwater influence (northern >> southern)

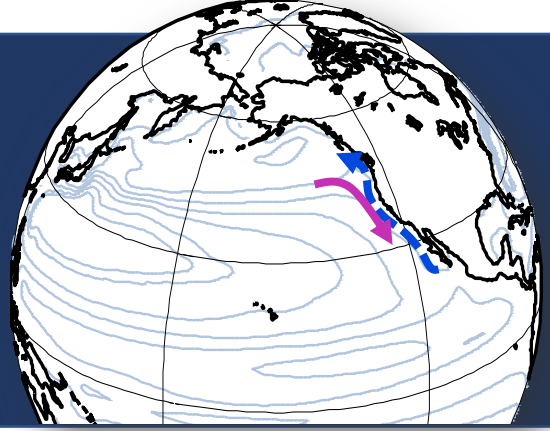
(right) Hewett 2020; (left) Pozo Buil et al. [2017].



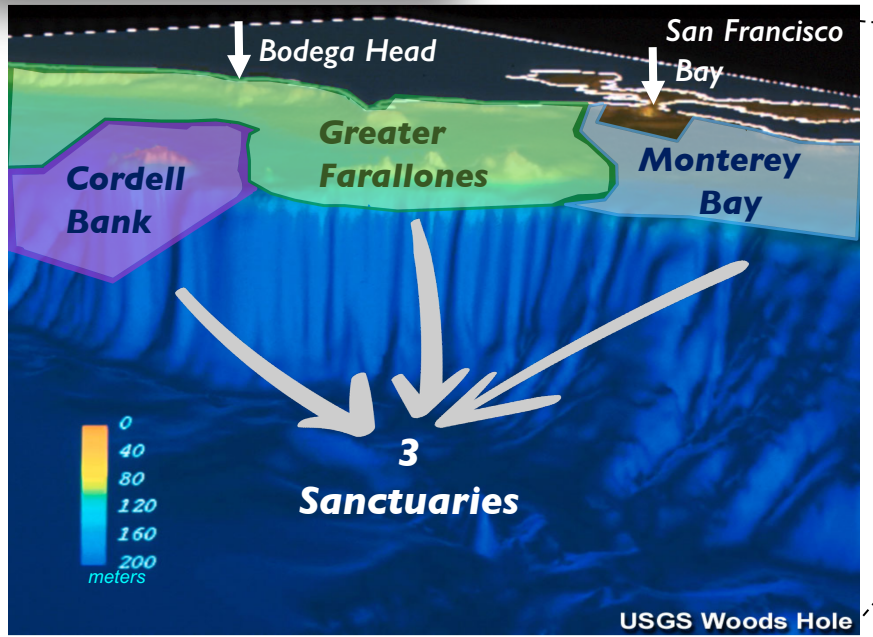
The California Current System



(right) Hewett [2020]; (left) Pozo Buil et al. [2017]; USGS Woods Hole .



The California Current System



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Natural Reserve System
UNIVERSITY OF CALIFORNIA

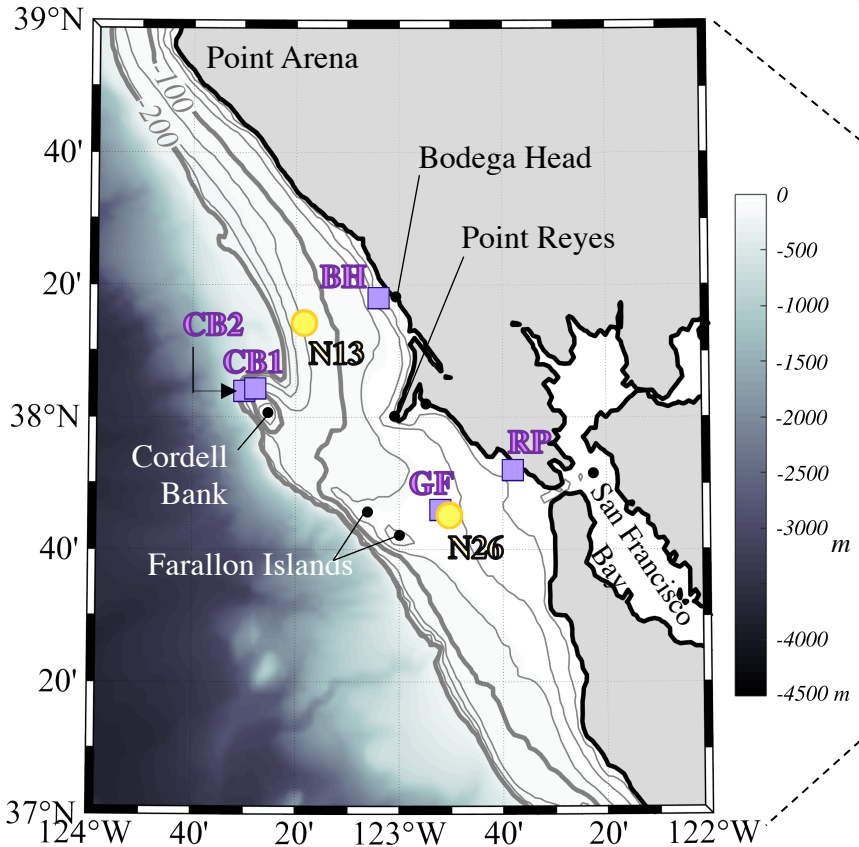
NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

NATIONAL MARINE SANCTUARIES

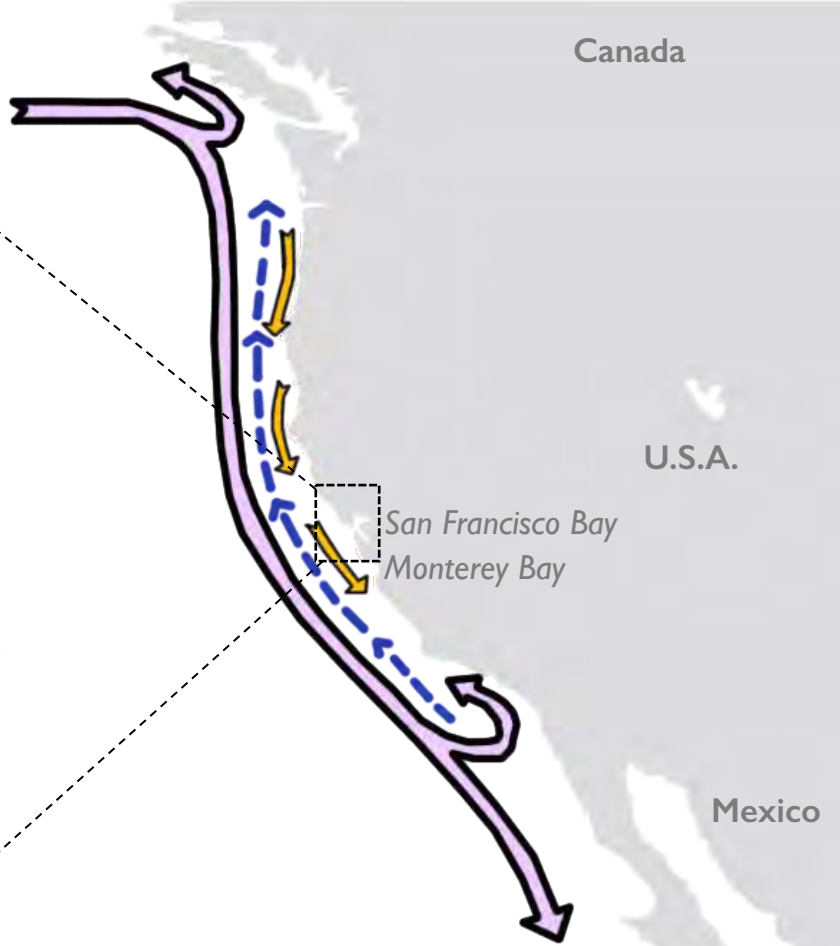
Sea Grant California

BODEGA MARINE LABORATORY UC DAVIS COASTAL & MARINE SCIENCES INSTITUTE

Cordell Marine Sanctuary Foundation



Moored instrument locations



(right) modified from Hickey & Banas [2008]; Checkley & Barth [2009]

What I'm going to tell you …

- We observed seasonal & interannual variation in upwelled water supplied to shelf

What I'm going to tell you …

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- DO in sub-thermocline water over the shelf declines with increasing stratification
  → hypoxic events

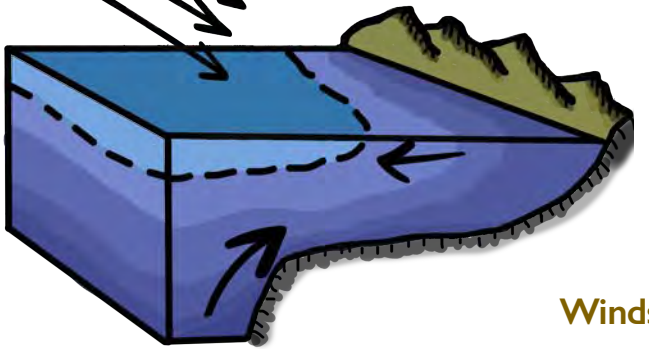
What I'm going to tell you …

- We observed seasonal & interannual variation in upwelled water supplied to shelf

- DO in sub-thermocline water over the shelf declines with increasing stratification
  → hypoxic events

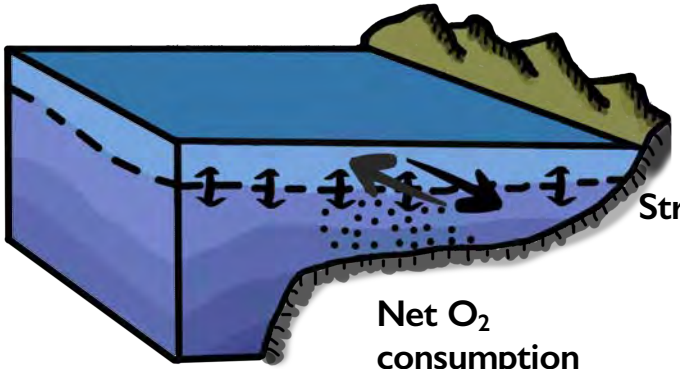
- Deoxygenation can lead to more frequent and more severe hypoxia

Upwelling favorable winds



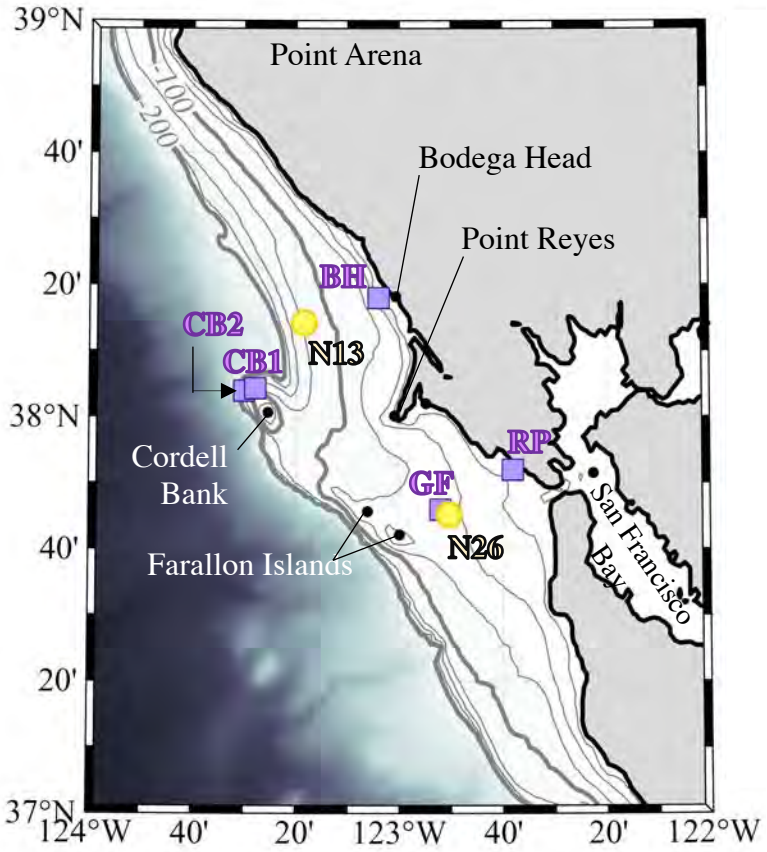
Oxygen-poor, low pH
water upwelled on to
the shelf

Winds relax



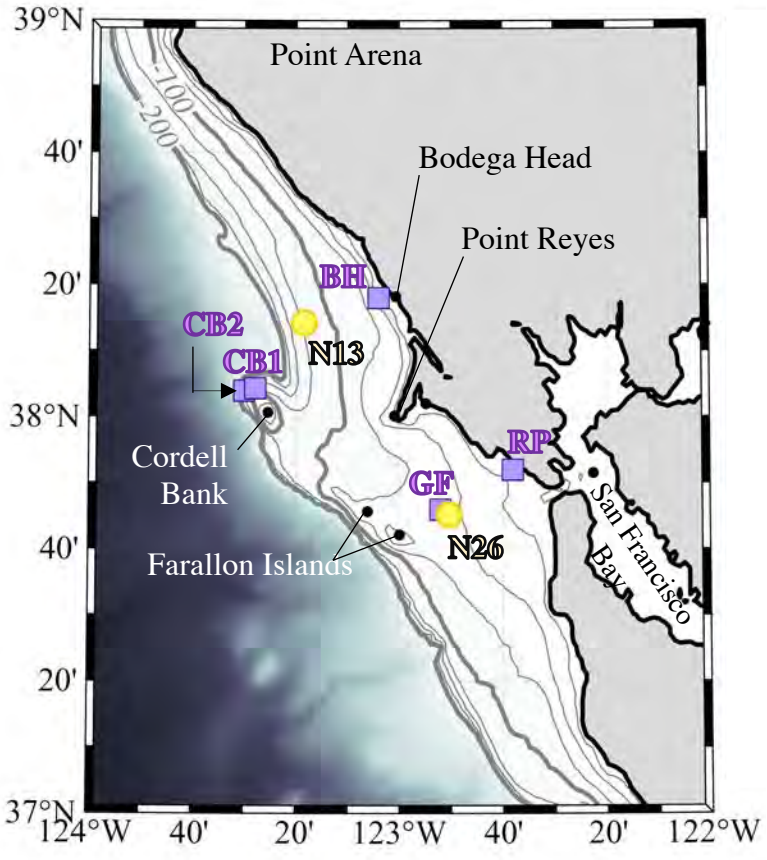
Stronger vertical
stratification

Net O_2
consumption



Hypoxia categories & associated O_2 concentrations

Hypoxia Category	ml O_2 L^{-1}	µmol O_2 kg^{-1}
Mild	2.45	107
Intermediate	1.4	61
Severe	0.5	22



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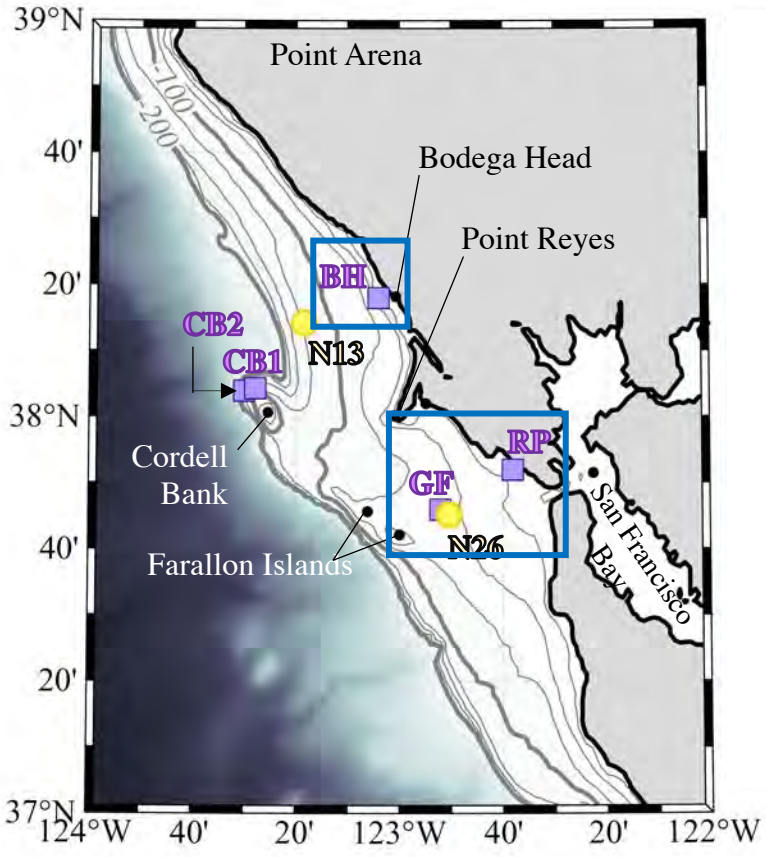
**** Mild hypoxia during each deployment***

**** Surface (BH) & near bottom-water (all) observations: lasting hours to days***



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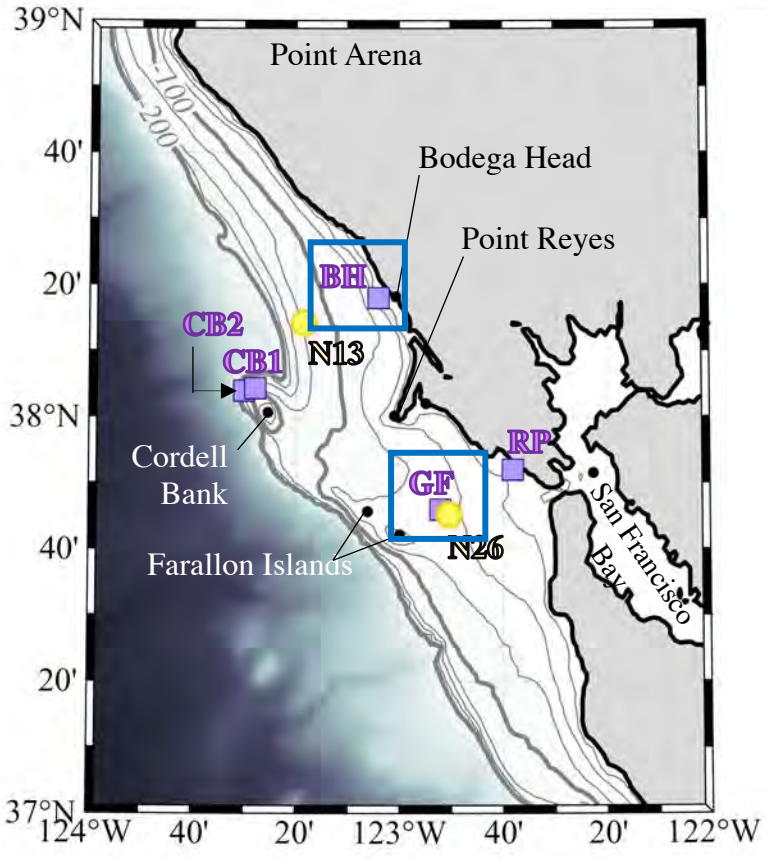
* *Intermediate hypoxia*
* *Near bottom-water observations: lasting hours to ~1 - 6 day(s).*



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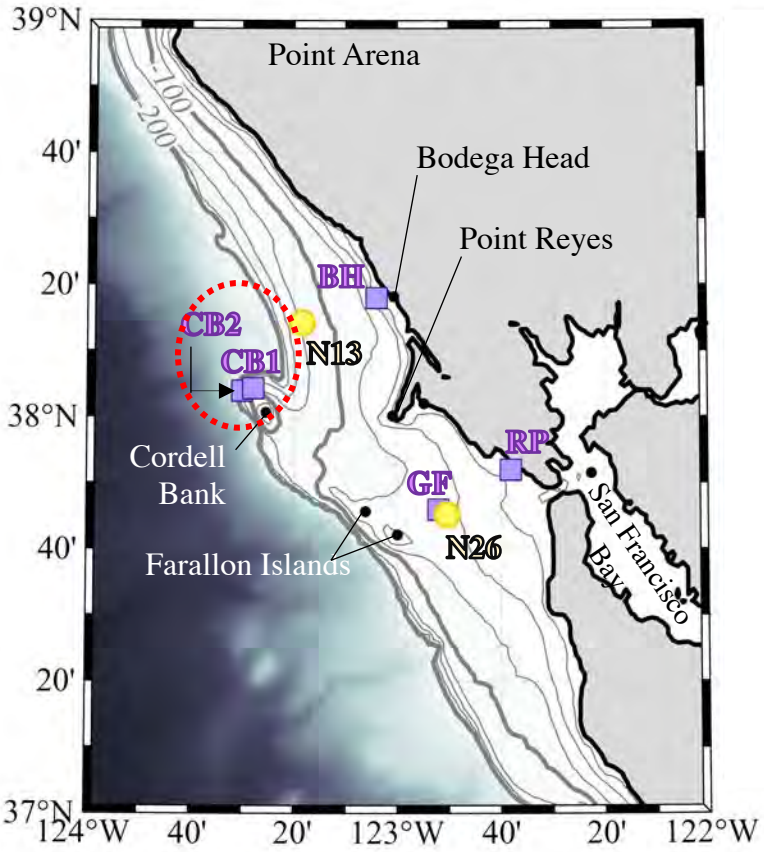
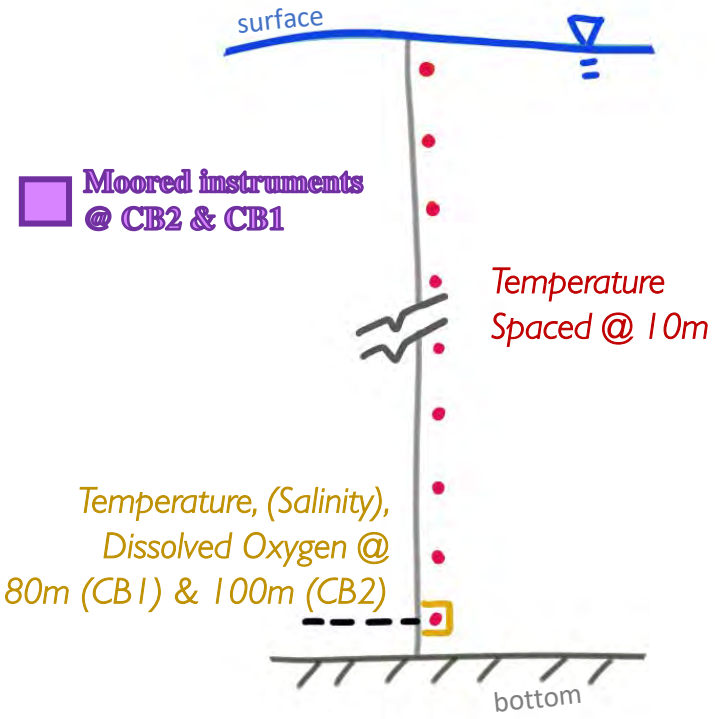
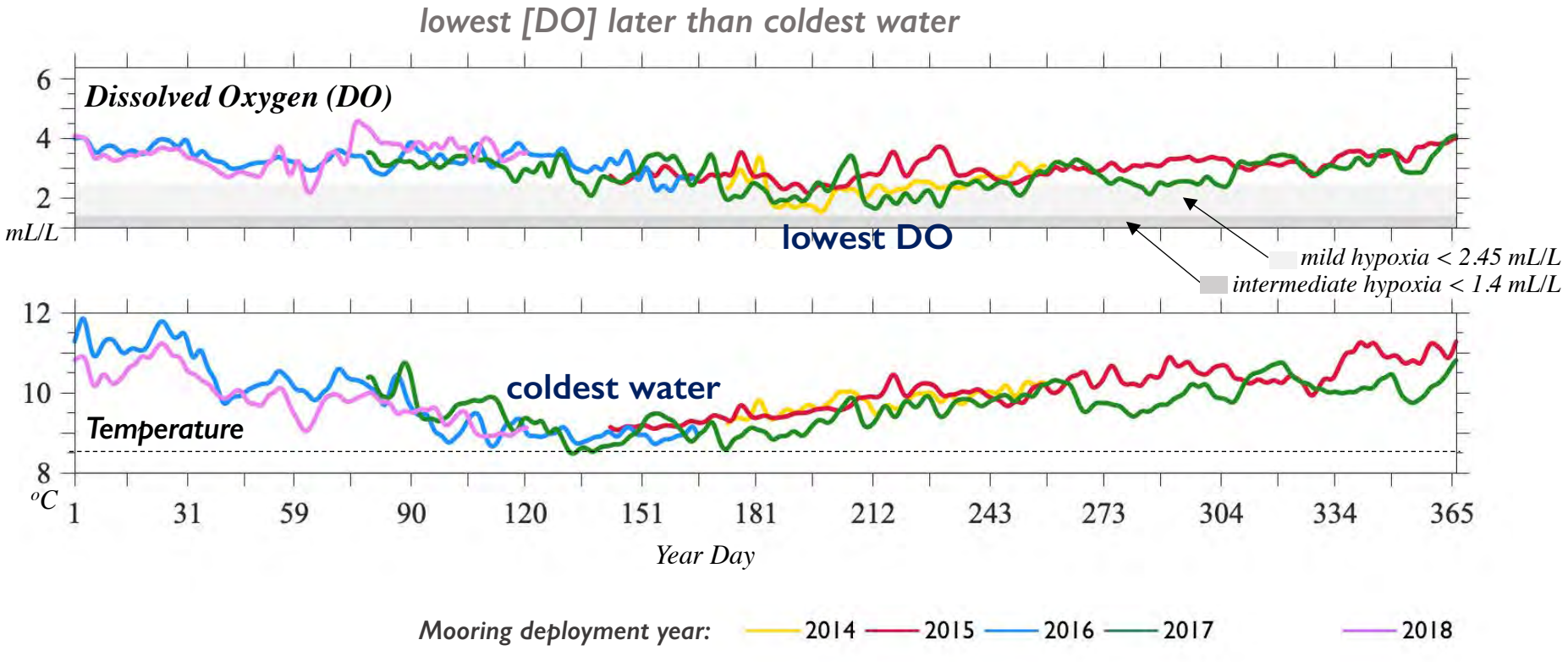
* *Short episodes of severe hypoxia in 2015*
* *Near bottom-water observations: BH (< 4 hours) & GF (~2 hours)*

Cordell Bank; outer shelf moorings





CB2 DO and T
100 m depth
Cordell Bank (2014 – 2018)



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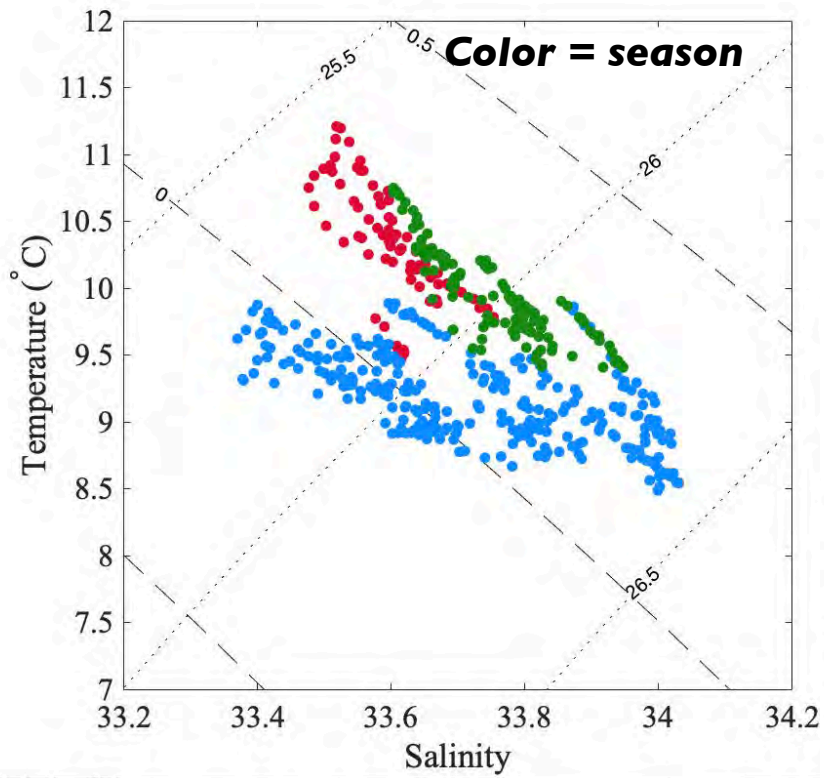
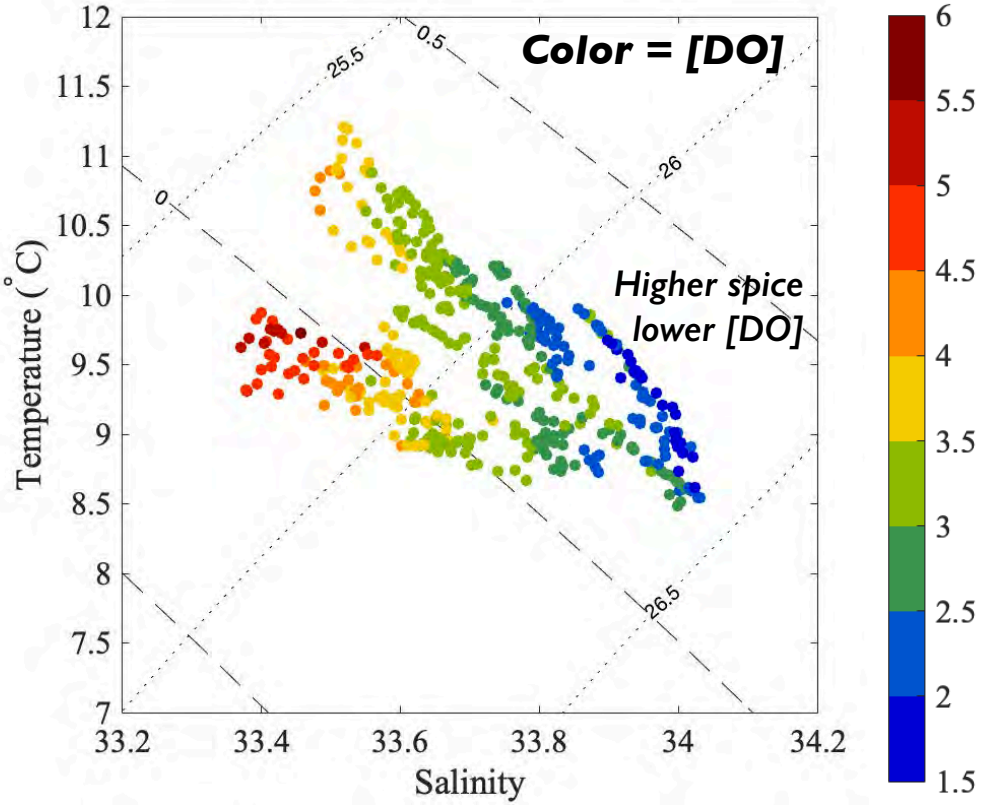
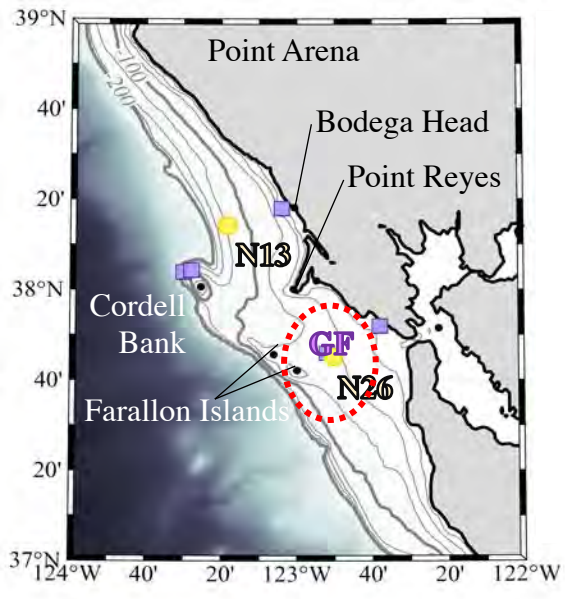


Storm Season
December - March

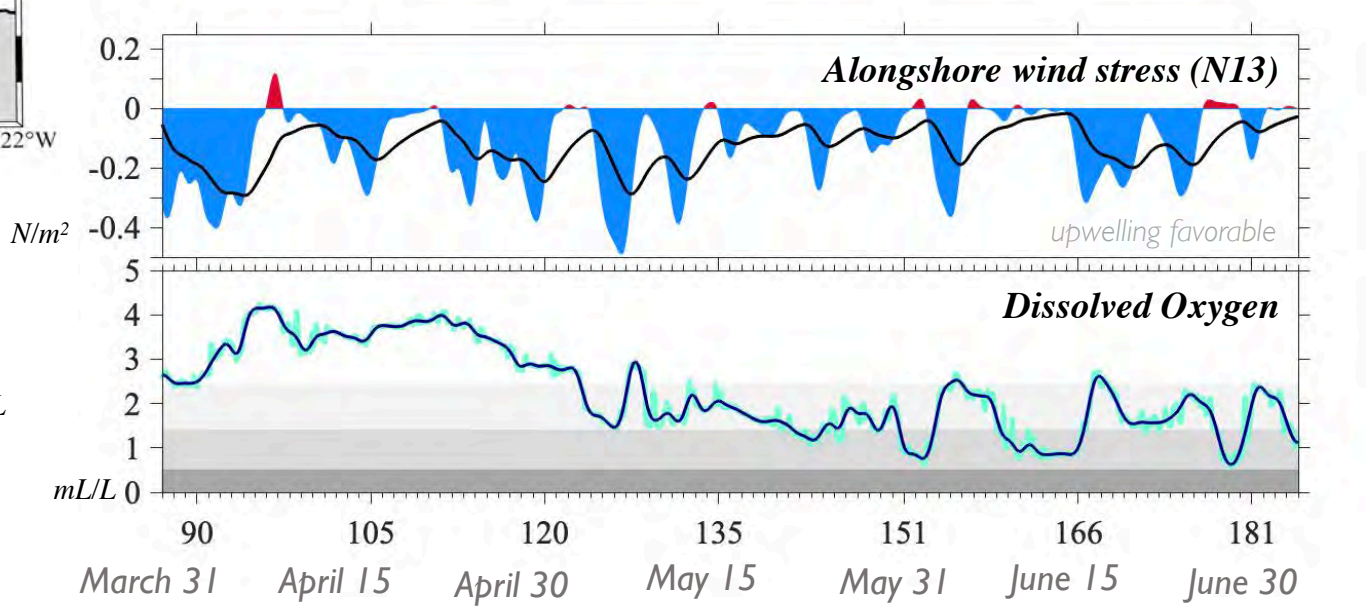
Upwelling Season
April - July

Relaxation Season
August – November





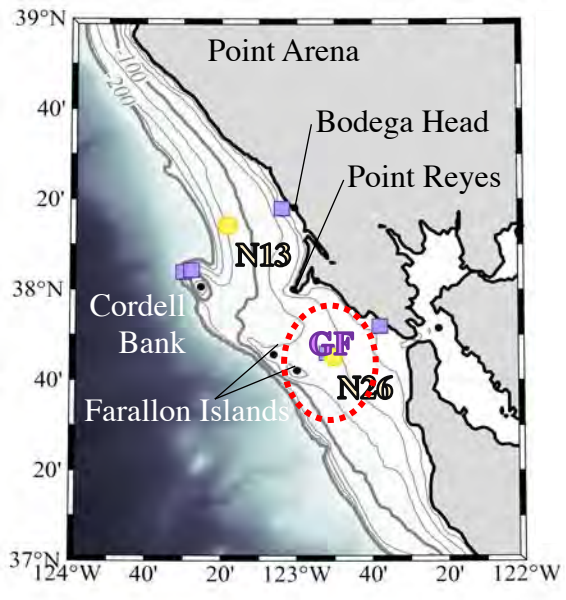
Gulf of the Farallones; mid shelf mooring (54m)



mild hypoxia < 2.45 mL/L

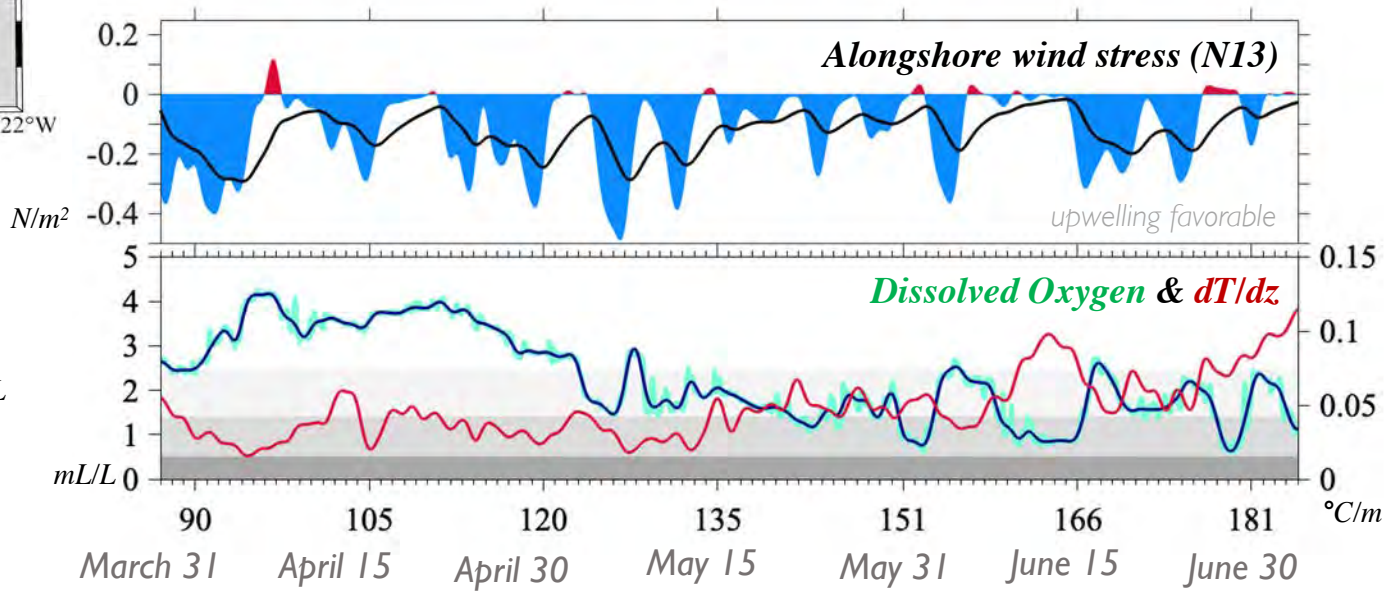
intermediate hypoxia < 1.4 mL/L

severe hypoxia < 0.5 mL/L



Gulf of the Farallones; mid shelf mooring (54m)

DO declines during relaxation events



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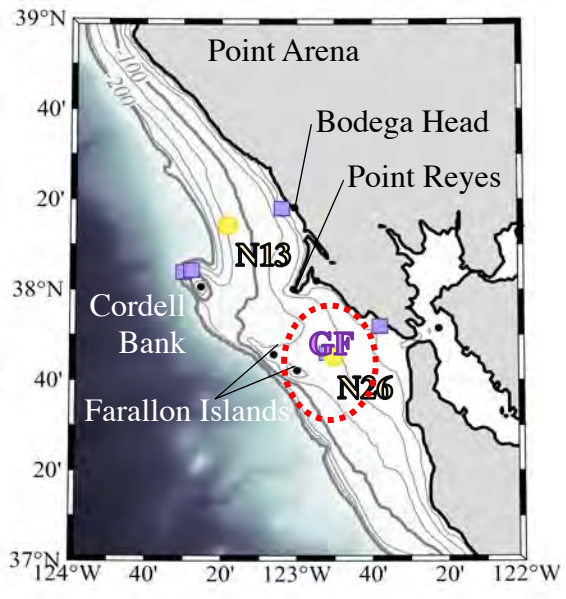

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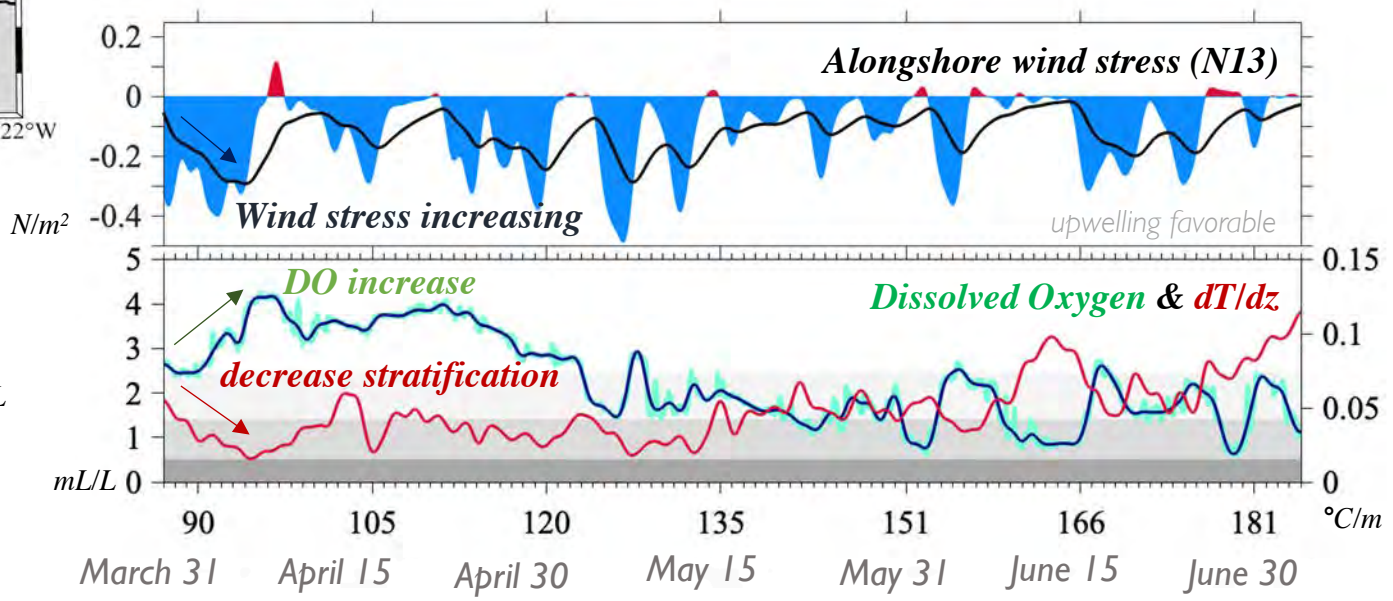

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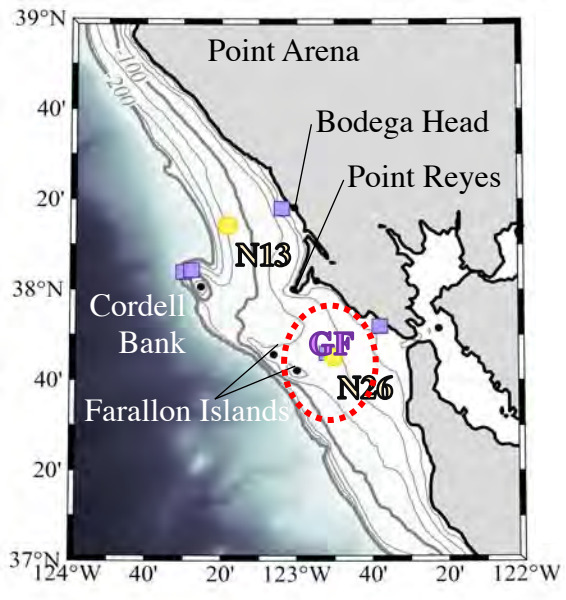
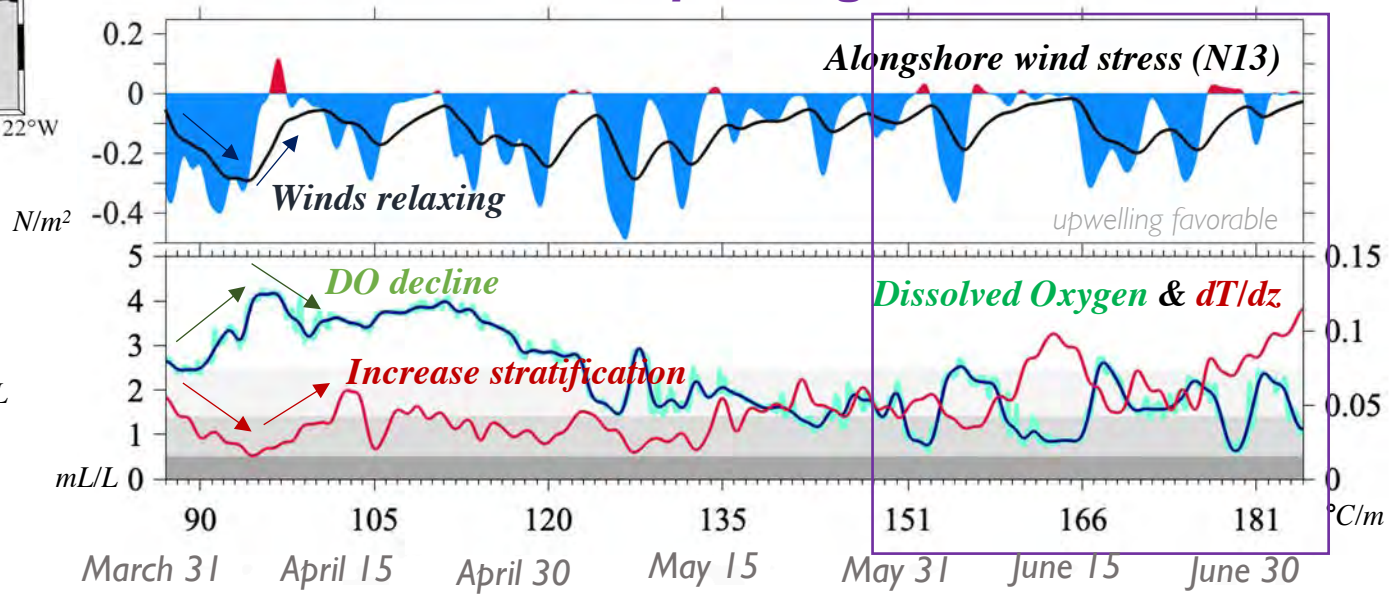


Gulf of the Farallones; mid shelf mooring (54m)

Later in upwelling season; lower DO



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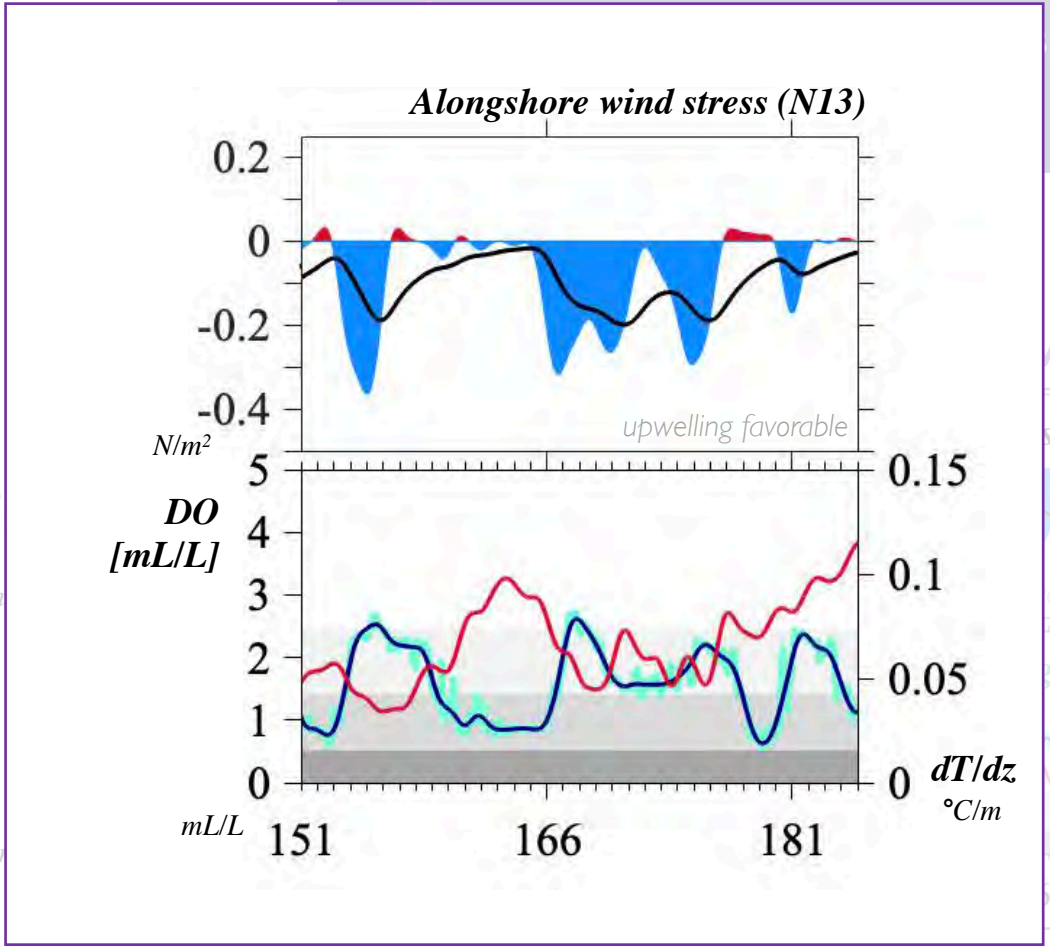
Upwelling Season

April - July

Point Arena
Bodega Head
Point Reyes
N13
Cordell Bank
GF
N26
Farallon Islands
39°N
40'
20'
38°N
40'
20'
37°N
124°W
40'
20'
123°W
40'
20'
122°W


Alongshore wind stress (N13)
0.2
0
-0.2
-0.4
N/m²
upwelling favorable
DO
[mL/L]
5
4
3
2
1
0
mL/L
0.15
0.1
0.05
0
dT/dz
°C/m
151
166
181

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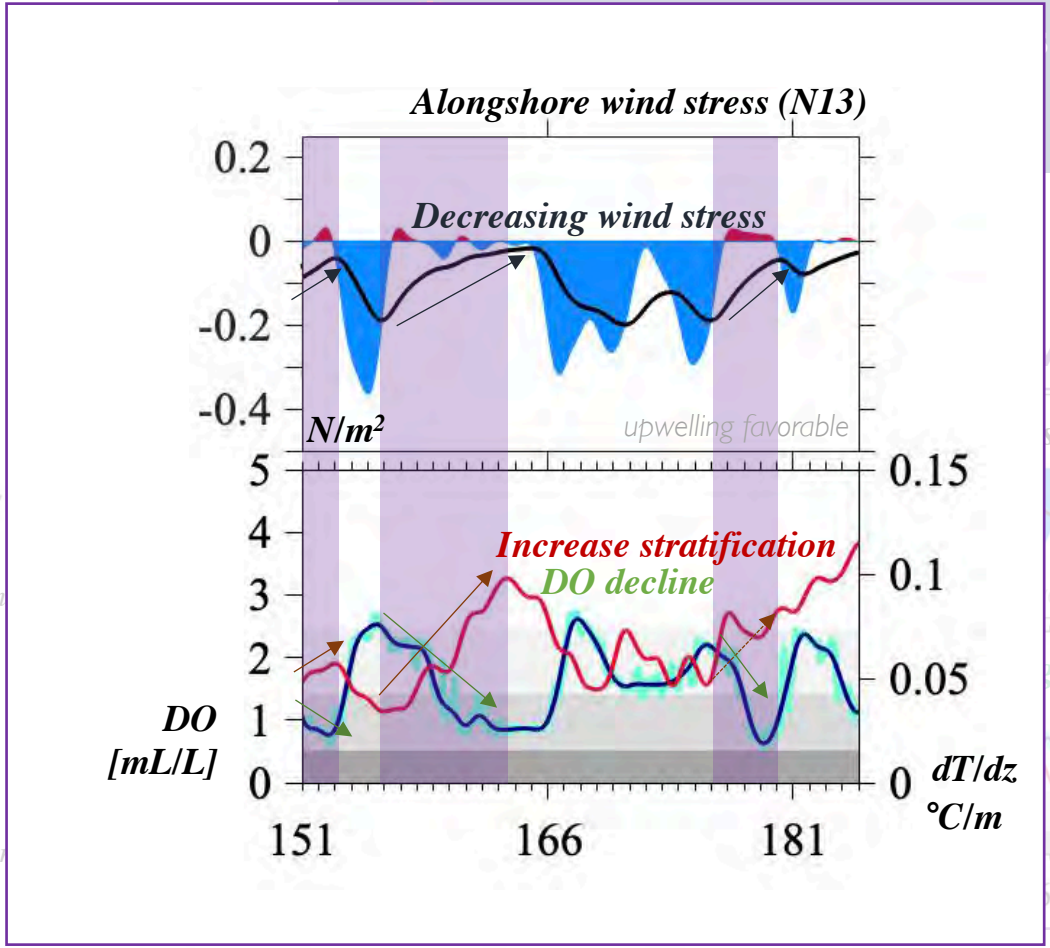

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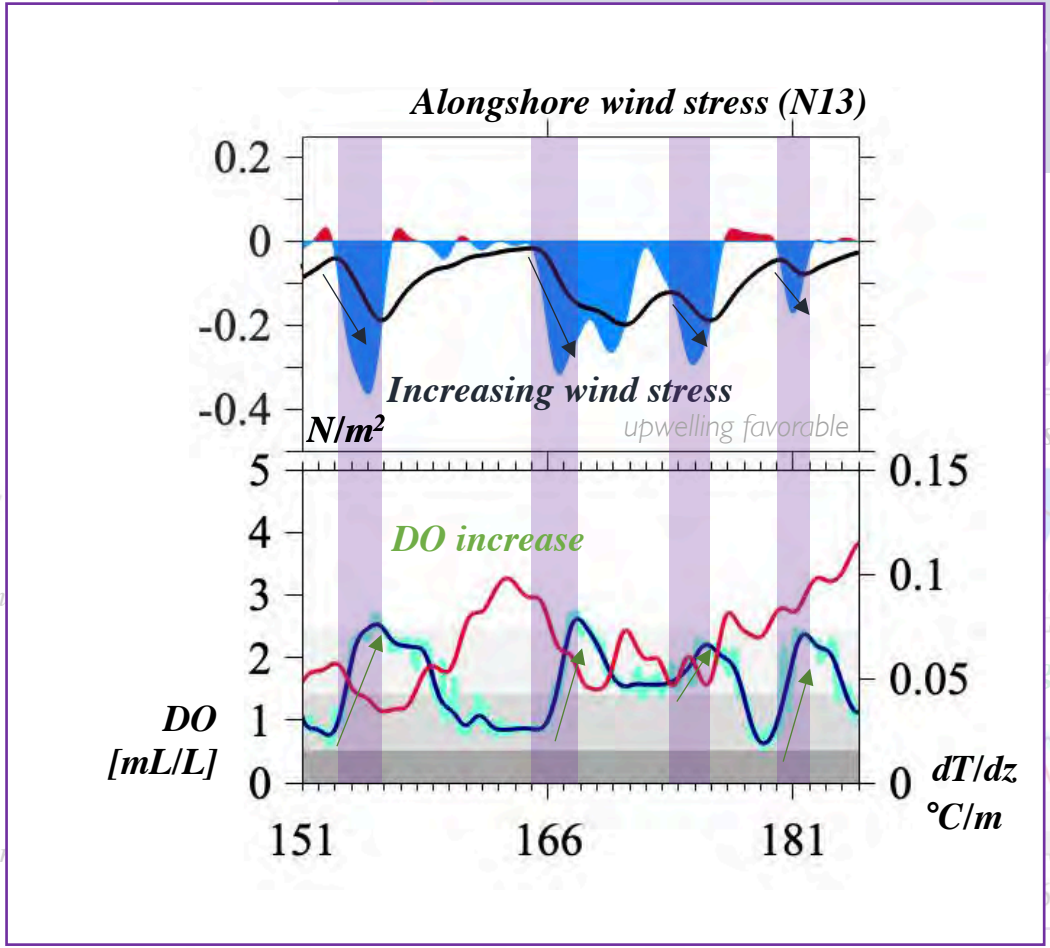

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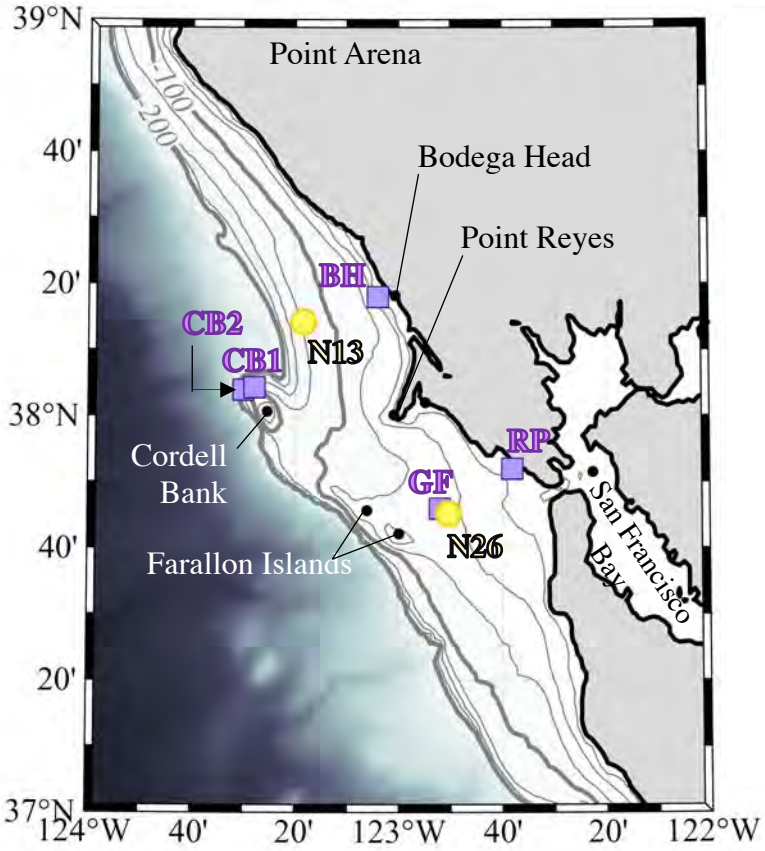
39°N
40'
20'
38°N
40'
20'
37°N
124°W
40'
20'
123°W
40'
20'
122°W
Point Arena
-100
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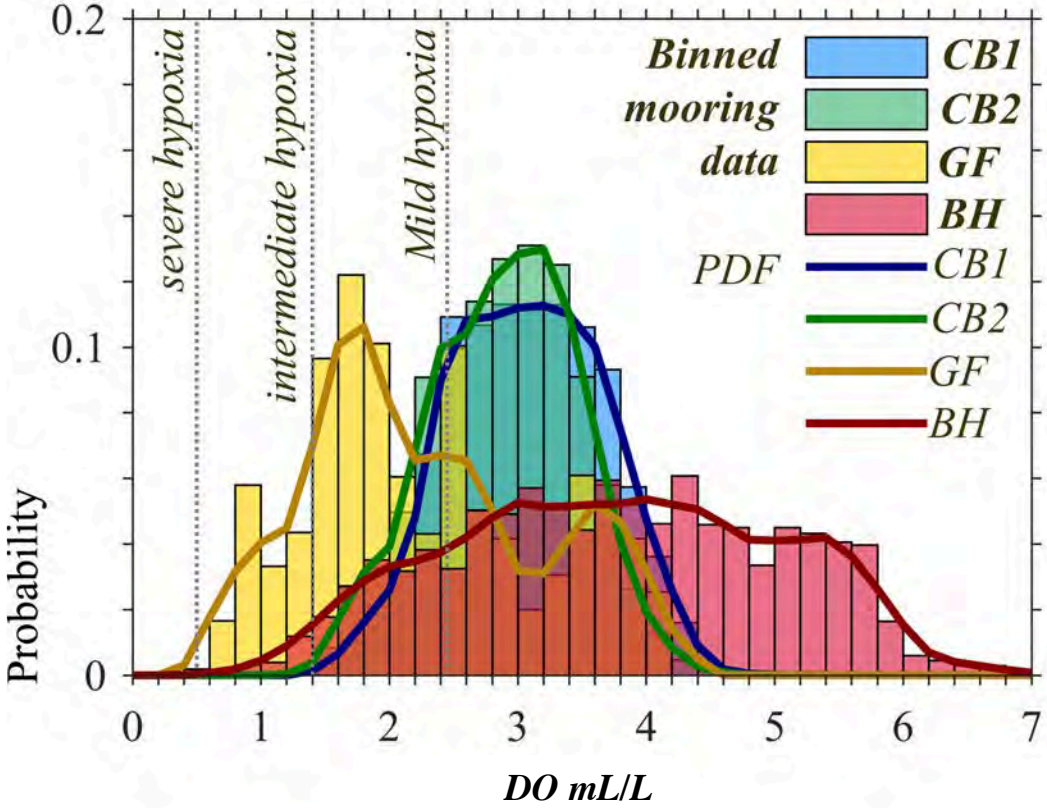
BH
CB2
CB1
N13
Cordell
Bank
RP
GF
N26
Farallon Islands
San Francisco
Bay


0.2
0.1
0
Probability
severe hypoxia
intermediate hypoxia
Mild hypoxia
Binned
mooring
data
CB1
CB2
GF
BH
PDF
CB1
CB2
GF
BH
0
1
2
3
4
5
6
7
DO mL/L