Hypoxia in CBNMS and GFNMS

Results from Recent Monitoring

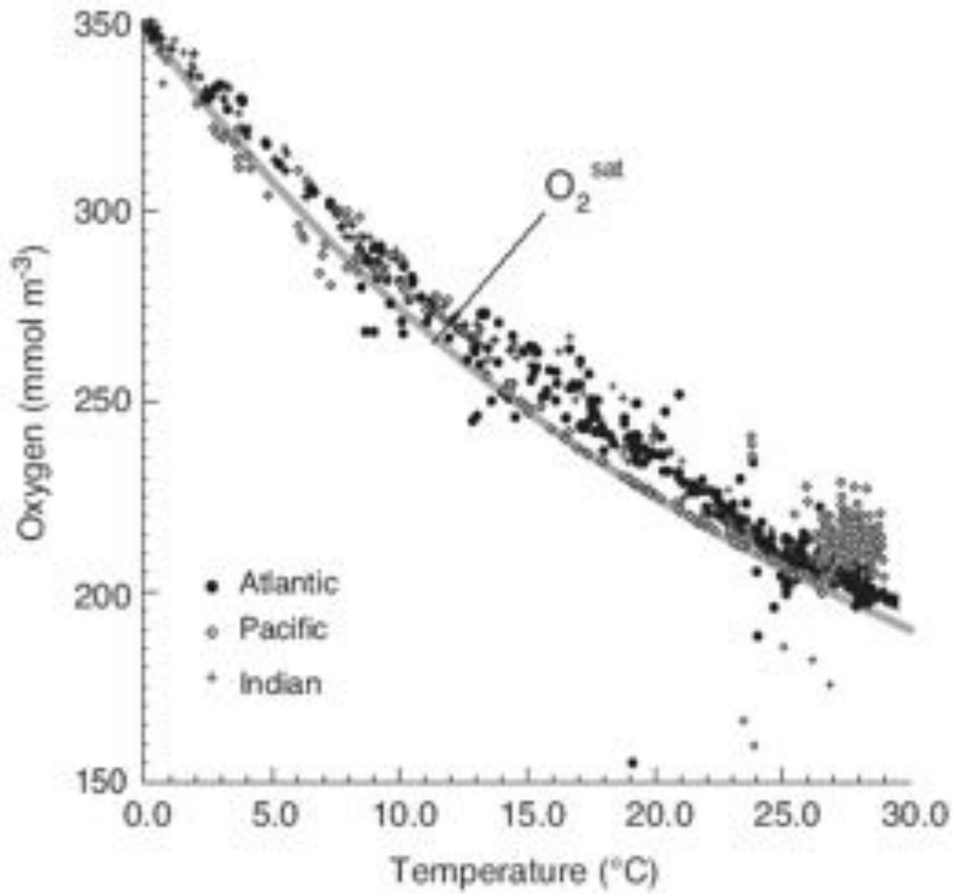
John Largier
in collaboration with Kate Hewett, Dani Lipski, Jaime Jahncke and others

25 August 2016

Hypoxia

Oxygen dissolves in water. Saturation or equilibrium state depends on T and S and P … in equilibrium with atmosphere

$[O_2]$ ~ 250 mmol/m^3 or 8 mg/L (at ~ 15°C or 59°F)

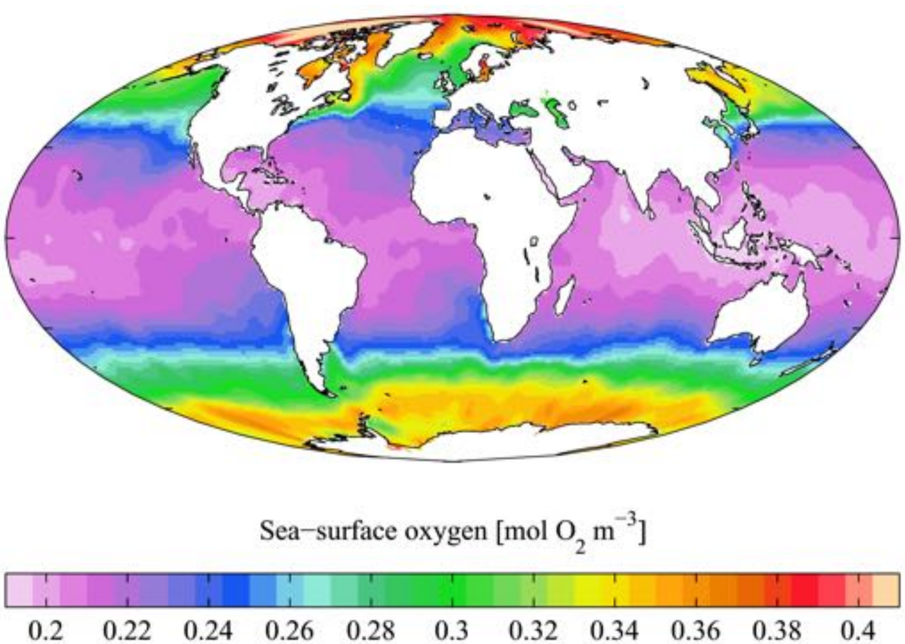


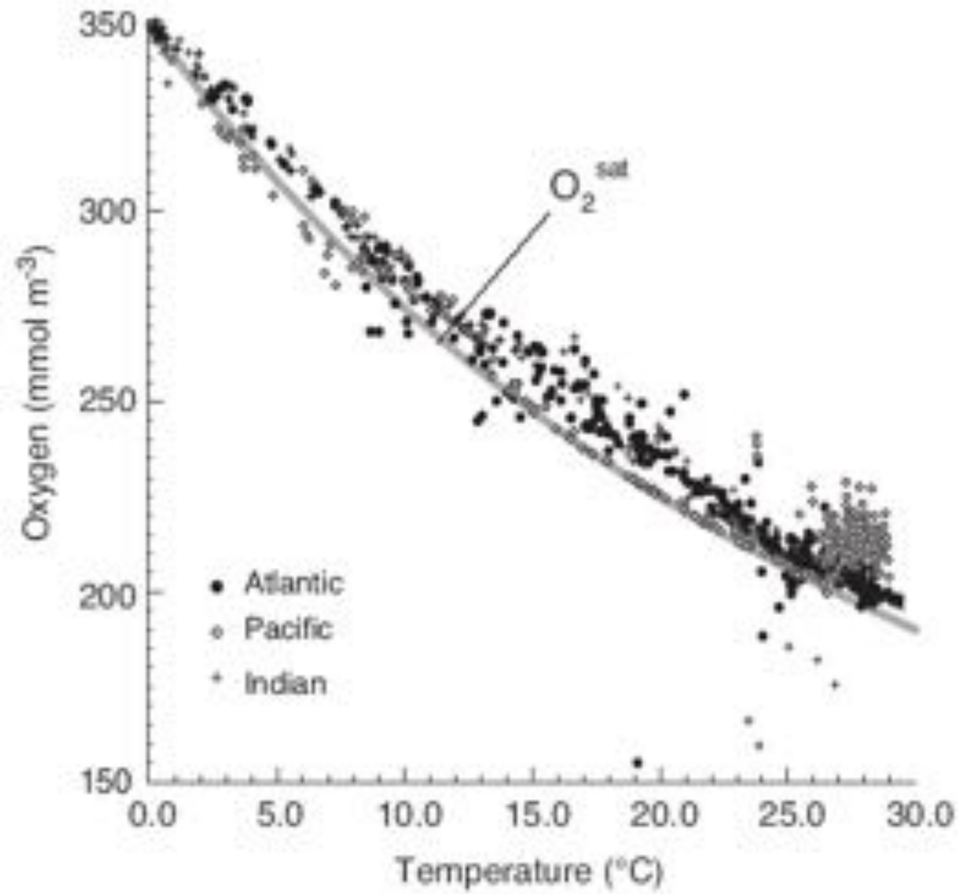
Hypoxia

Oxygen dissolves in water. Saturation or equilibrium state depends on T and S and P

… in equilibrium with atmosphere

[O_2] ~ 250 mmol/m^3 or 8 mg/L (at ~ 15^{o}C or 59^{o}F)





Hypoxia

Oxygen dissolves in water. Saturation or equilibrium state

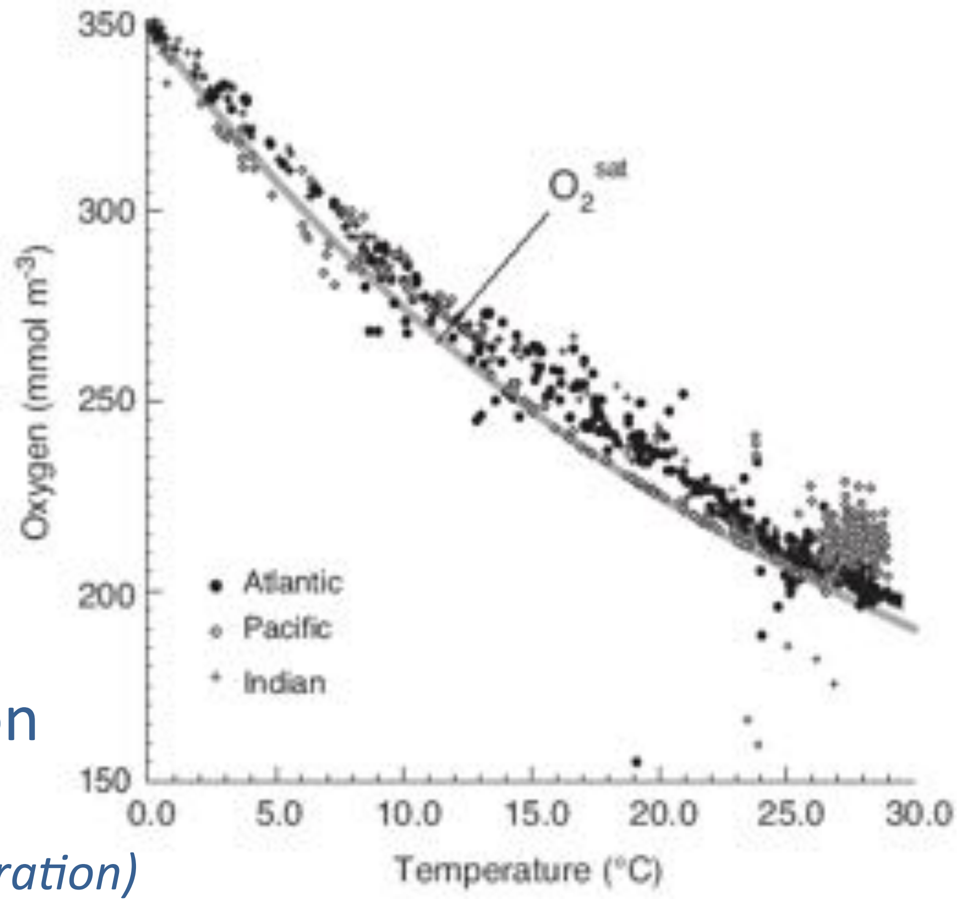
depends on T and S and P

… in equilibrium with

atmosphere

$[O_2]$ ~ 250 mmol/m^3 or 8 mg/L

(at ~ 15^oC or 59^oF)



Oxygen levels can be above

or below equilibrium

… primarily due to production

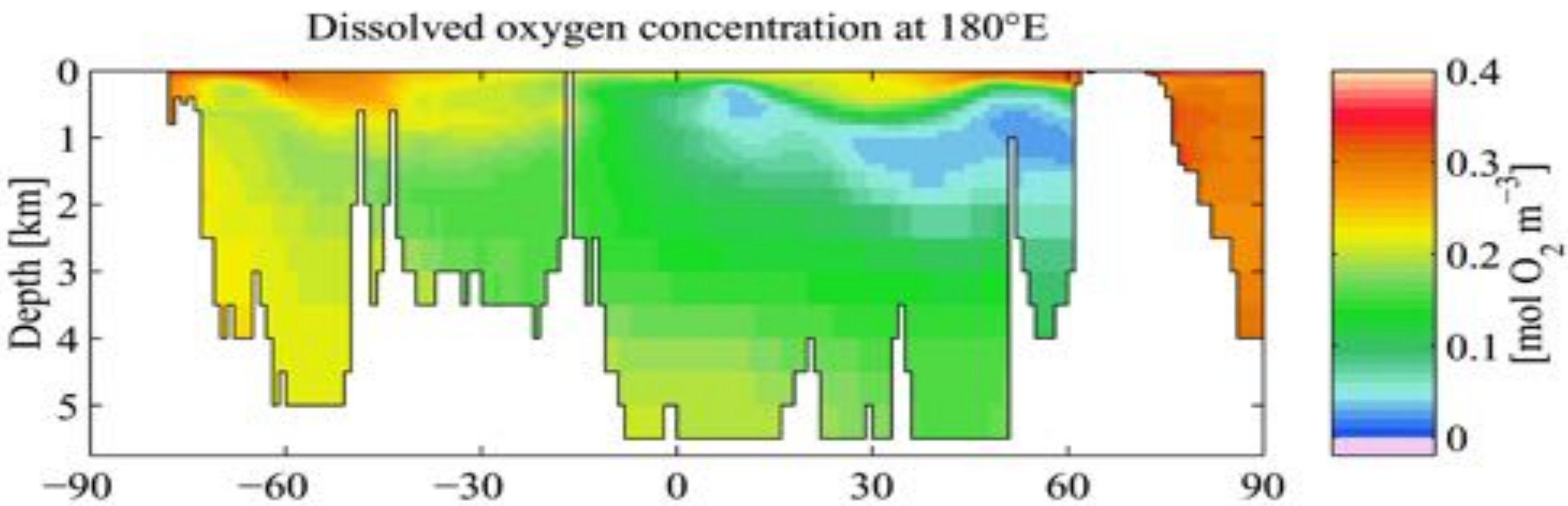
and remineralization

(photosynthesis & respiration)

Hypoxia typically defined as $[O_2]$ < 2 mg/L

Hypoxia

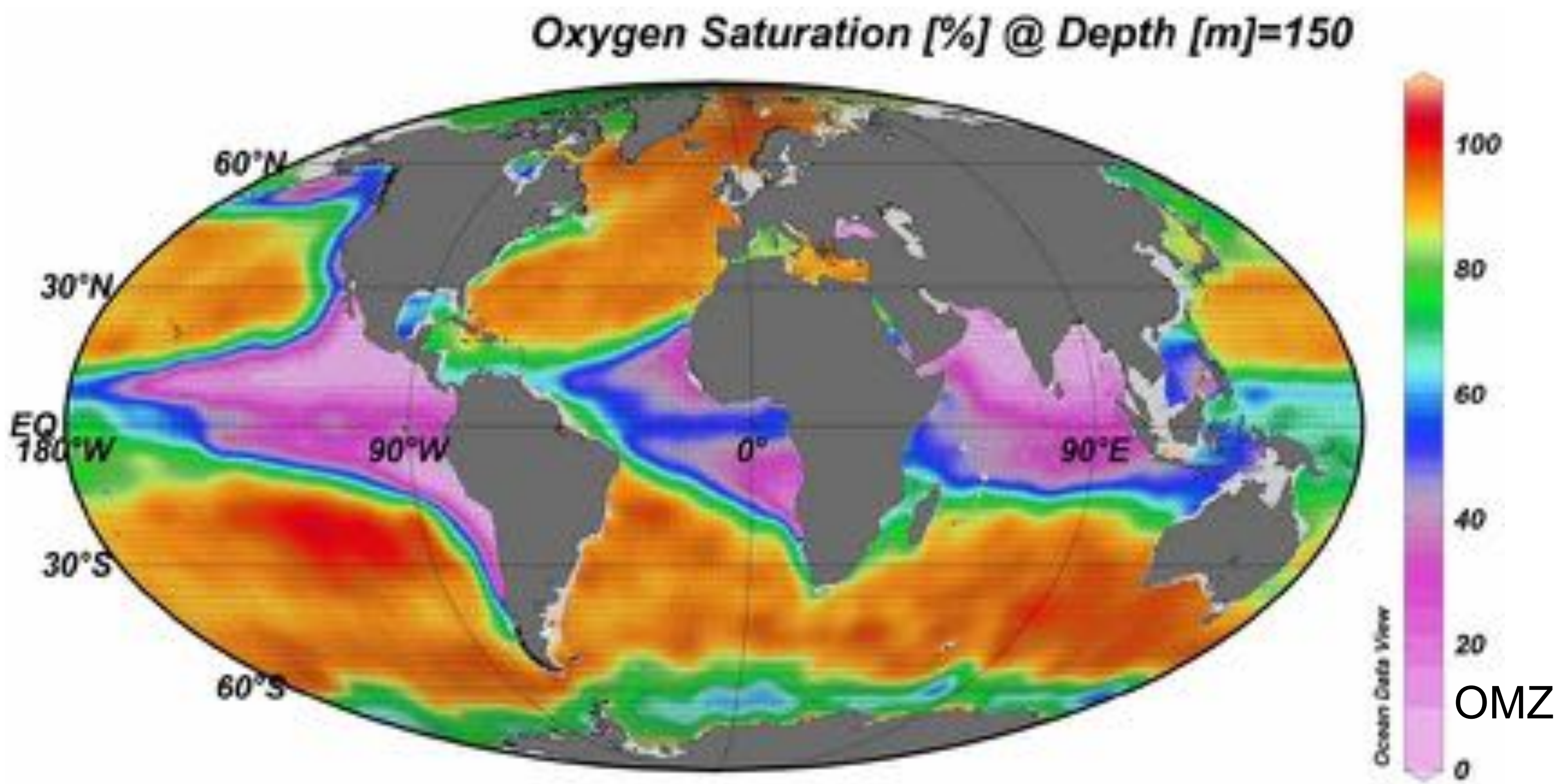
Hypoxia occurs naturally where oxygen is taken up faster than it can be replenished by photosynthesis or flux from atmosphere.



Oxygen Minimum Zone

Hypoxia

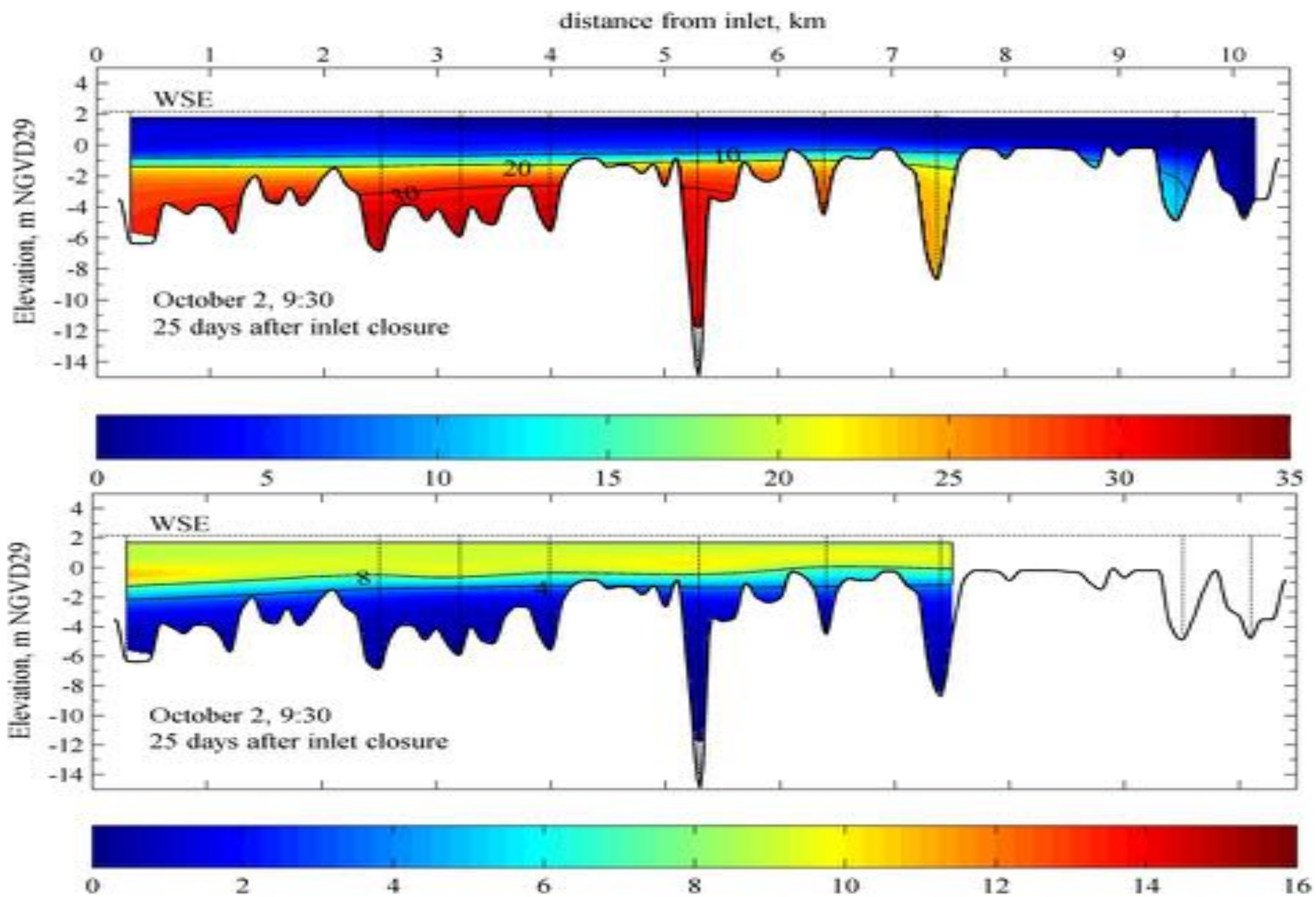
Hypoxia occurs naturally where oxygen is taken up faster than it can be replenished by photosynthesis or flux from atmosphere.



Hypoxia

Hypoxia occurs naturally where oxygen is taken up faster than it can be replenished by photosynthesis or flux from atmosphere.

Russian River Estuary …



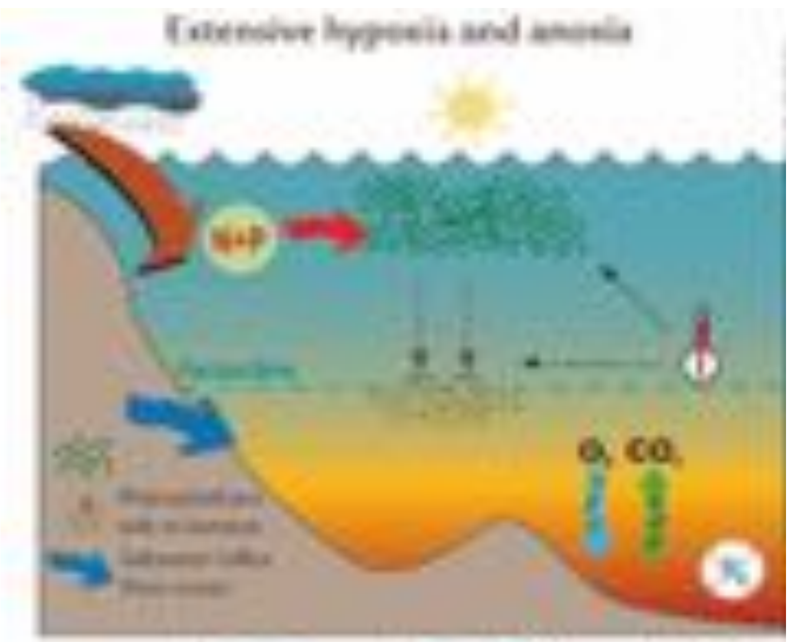
RRE Salinity

RRE Oxygen

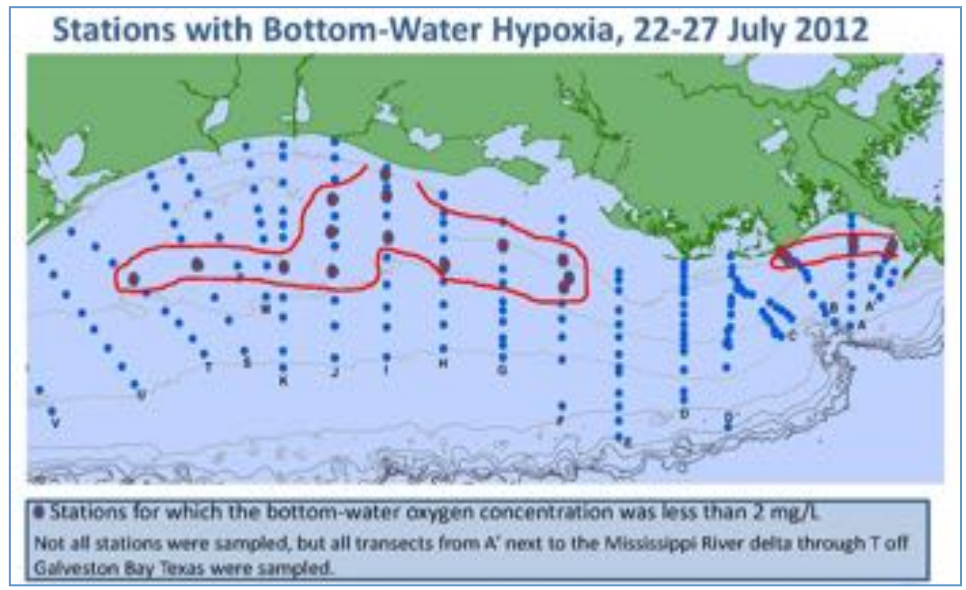
De-oxygenation

Concern is for "deoxygenation" – a trend towards lower oxygen
(and associated ecological impacts)

Well recognized in context of local eutrophication



Chesapeake Bay



Mississippi River Plume

De-oxygenation

Concern is for "deoxygenation" – a trend towards lower oxygen (and associated ecological impacts)

New concern with global-scale deoxygenation …

- Expansion/intensification of OMZ
  - Surface warming and lower oxygen in surface waters
  - Surface warming and less ventilation through mixing
- Enhanced upwelling – changes in wind
- Upwelling source waters
  - Local enrichment (respiration)
  - Changes in deep circulation
- Oxygen uptake over shelf – sediment/circulation
- Local eutrophication
- Local stratification (runoff)

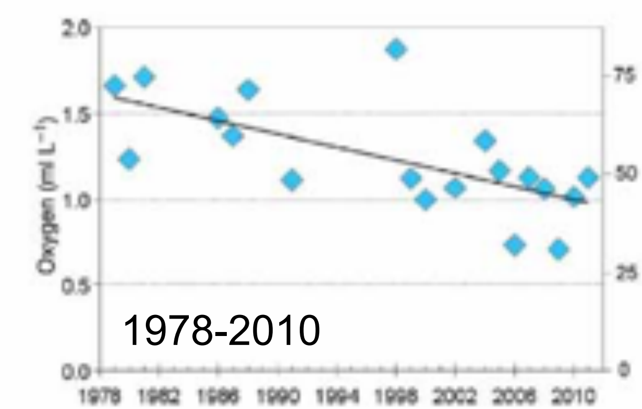
De-oxygenation

Concern is for “deoxygenation” – a trend towards lower oxygen (and associated ecological impacts)

New concern with global-scale deoxygenation …

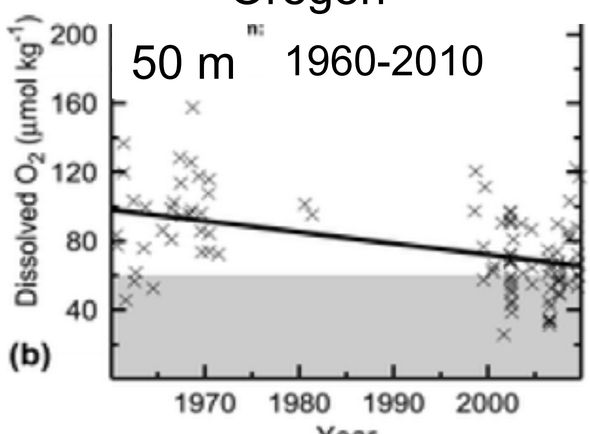
Oxygen decline in NE Pacific over last 50 years.

British Columbia



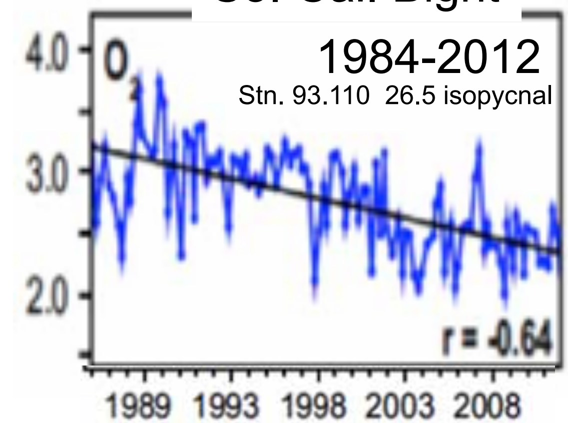
Crawford and Pena 2013

Oregon



Pierce et al. 2012

So. Cal. Bight



Bograd et al. 2015

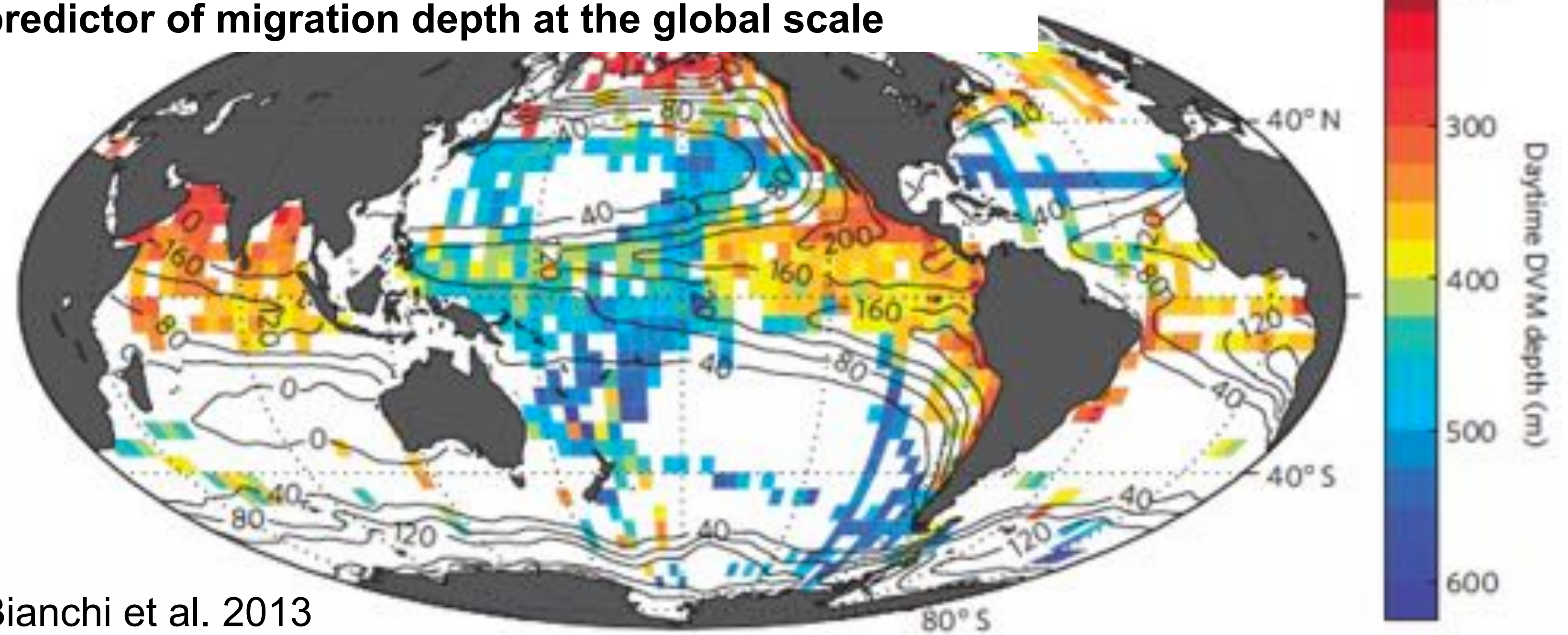
De-oxygenation

Concern is for "deoxygenation" – a trend towards lower oxygen
(and associated ecological impacts)

New concern with global-scale deoxygenation …

DVM depth set by oxygen … habitat compression

seawater oxygen concentration is the best single predictor of migration depth at the global scale

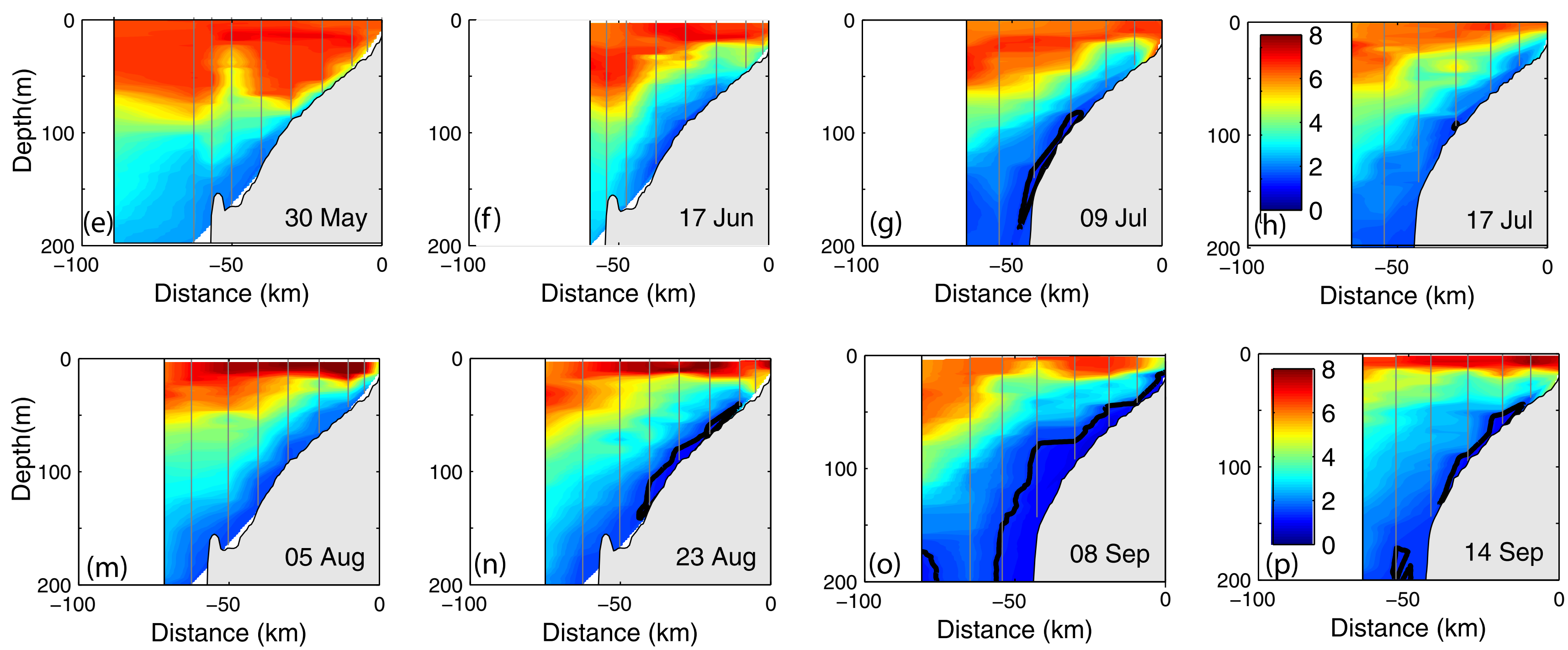


Bianchi et al. 2013

De-oxygenation

Low oxygen observed over OR and WA shelf (mortality events)
– upwelling plus oxygen demand of sediment and water column respiration … the longer water retained, the worse it gets.

2005 ECOHAB-PNW observations (units mL/L and bold line at 1.4 mL/L) … Siedlecki et al (2015)



Monitoring GFNMS and CBNMS

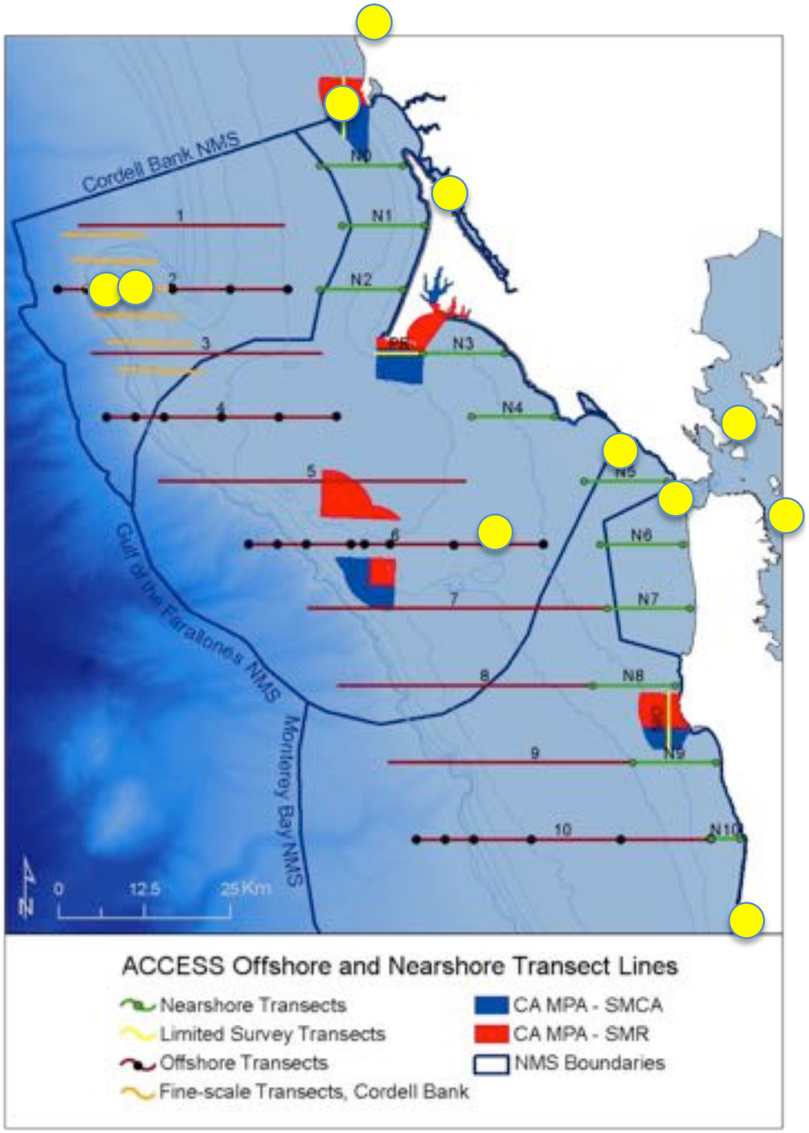
ACCESS profile data from 2010

BML surface oxygen from 2010
& sub-surface oxygen from 2013

Tomales Bay oxygen from 2014

Cordell Bank oxygen from 2014

Gulf of Farallones in 2015

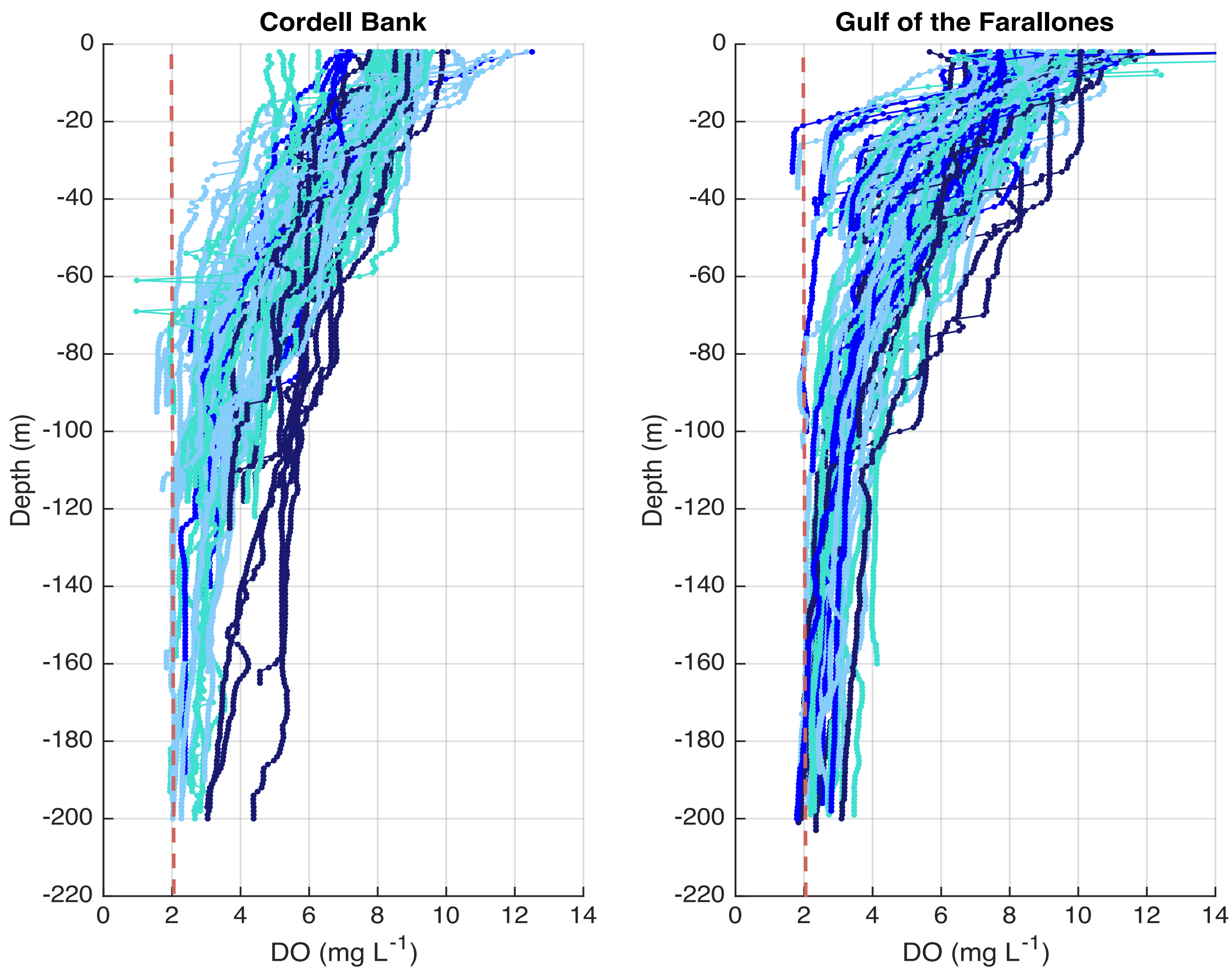


Monitoring GFNMS and CBNMS

ACCESS profile oxygen data

2010-2014
Line 2 (CB)
Line 6 (GF)

Also profile data at Bodega Head and in Tomales Bay shows low DO.



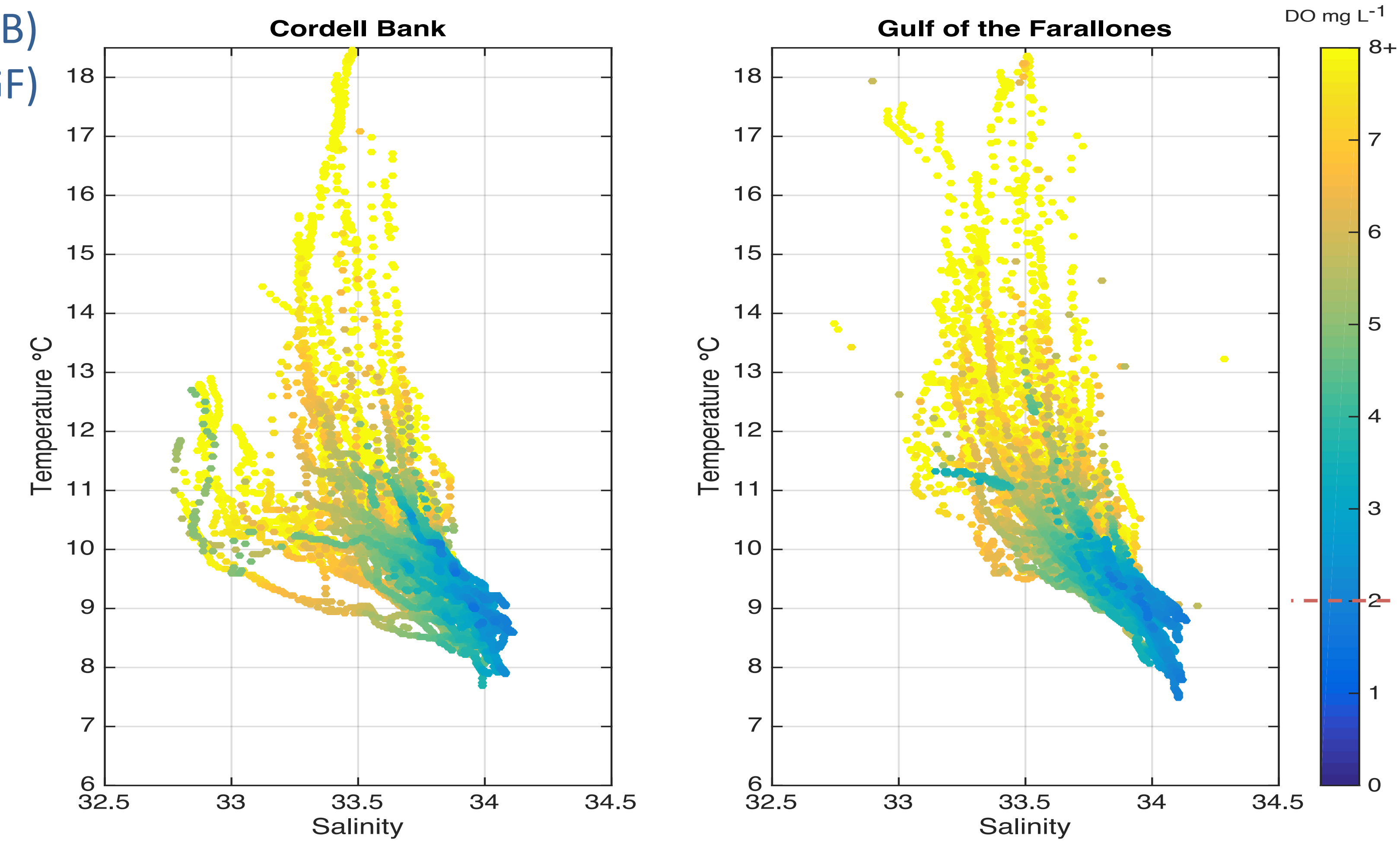
Monitoring GFNMS and CBNMS

ACCESS profile oxygen data

2010-2014

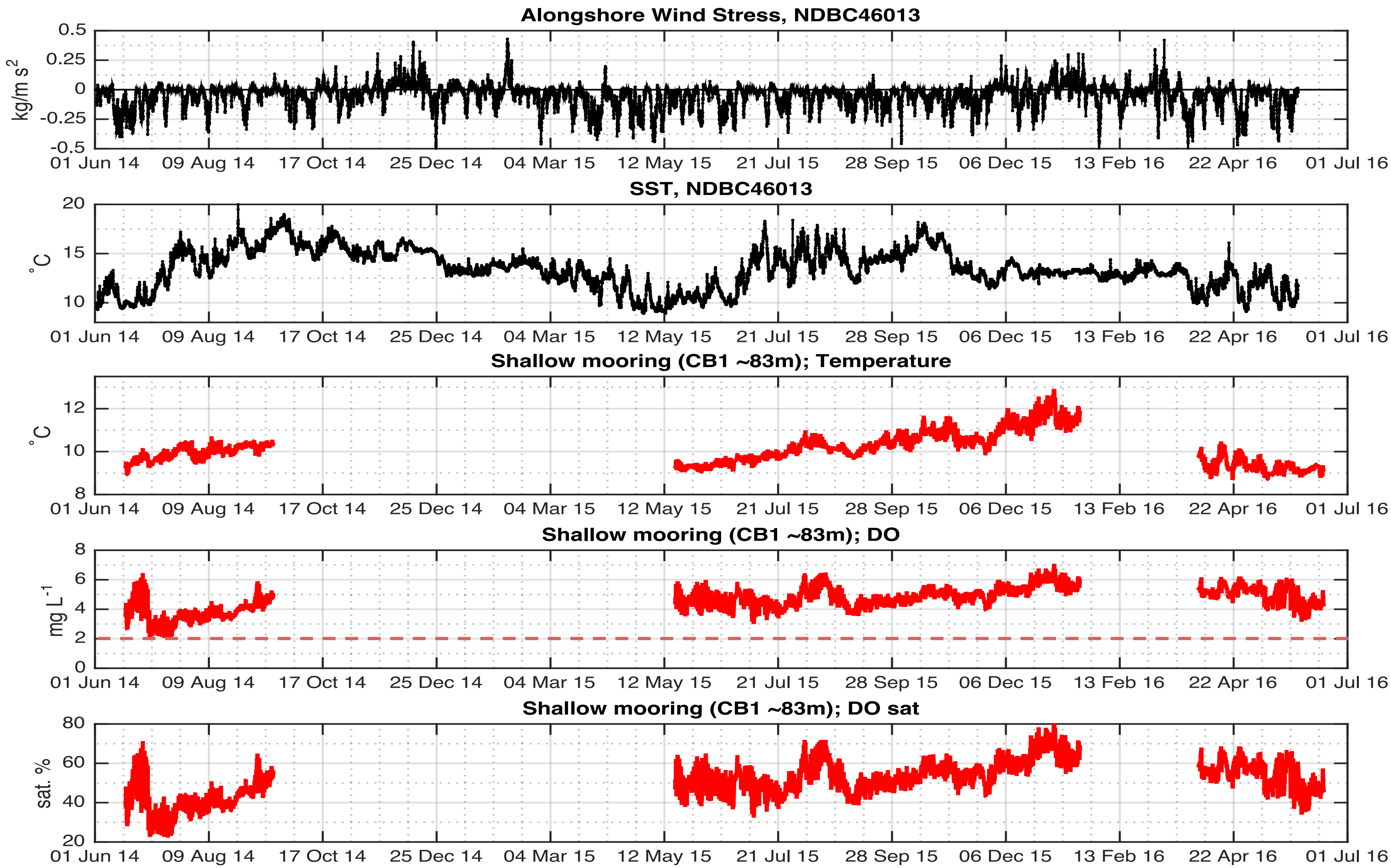
Line 2 (CB)

Line 6 (GF)



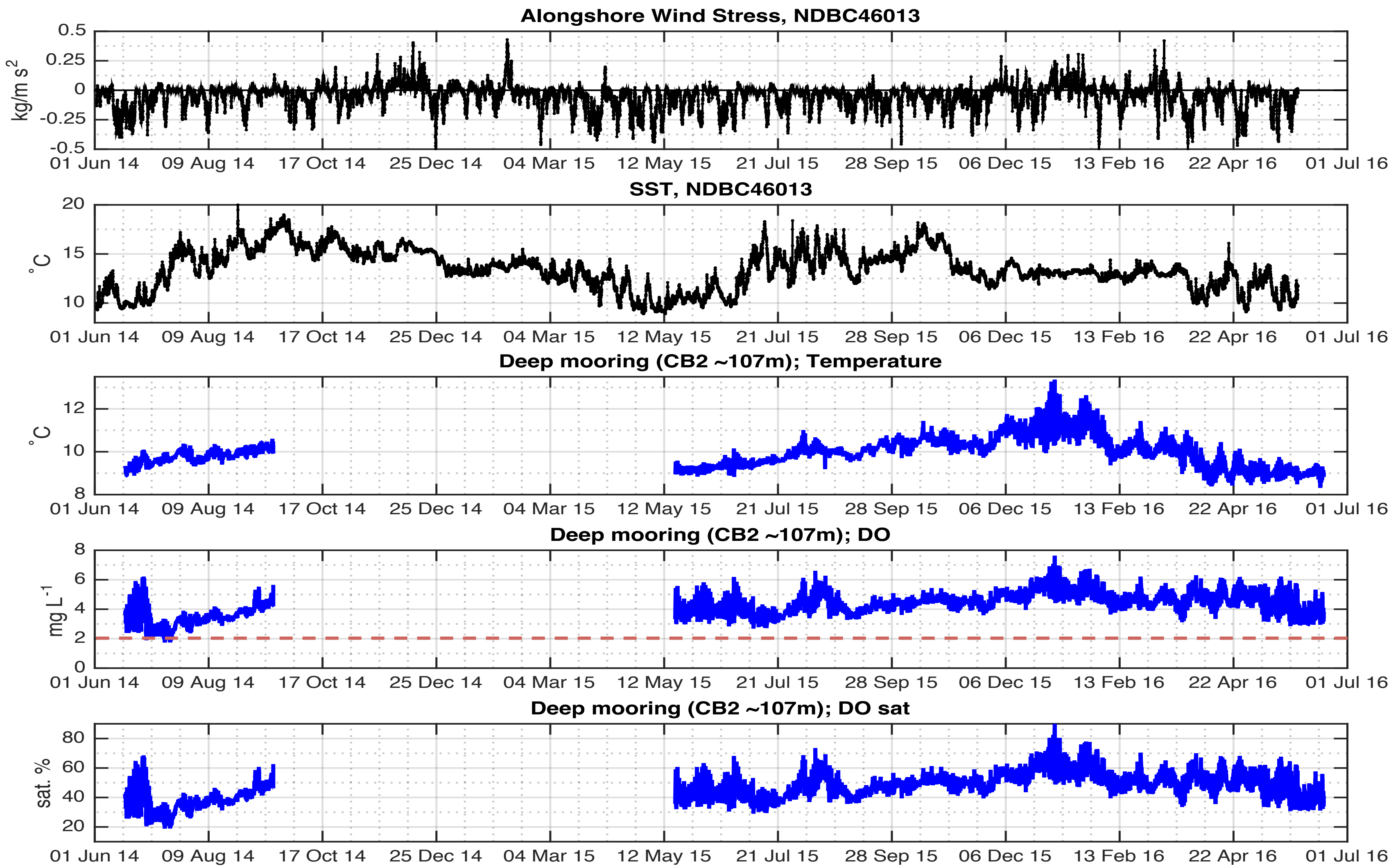
Monitoring GFNMS and CBNMS

CBNMS mooring data – shallower mooring CB1 (2014-2016)



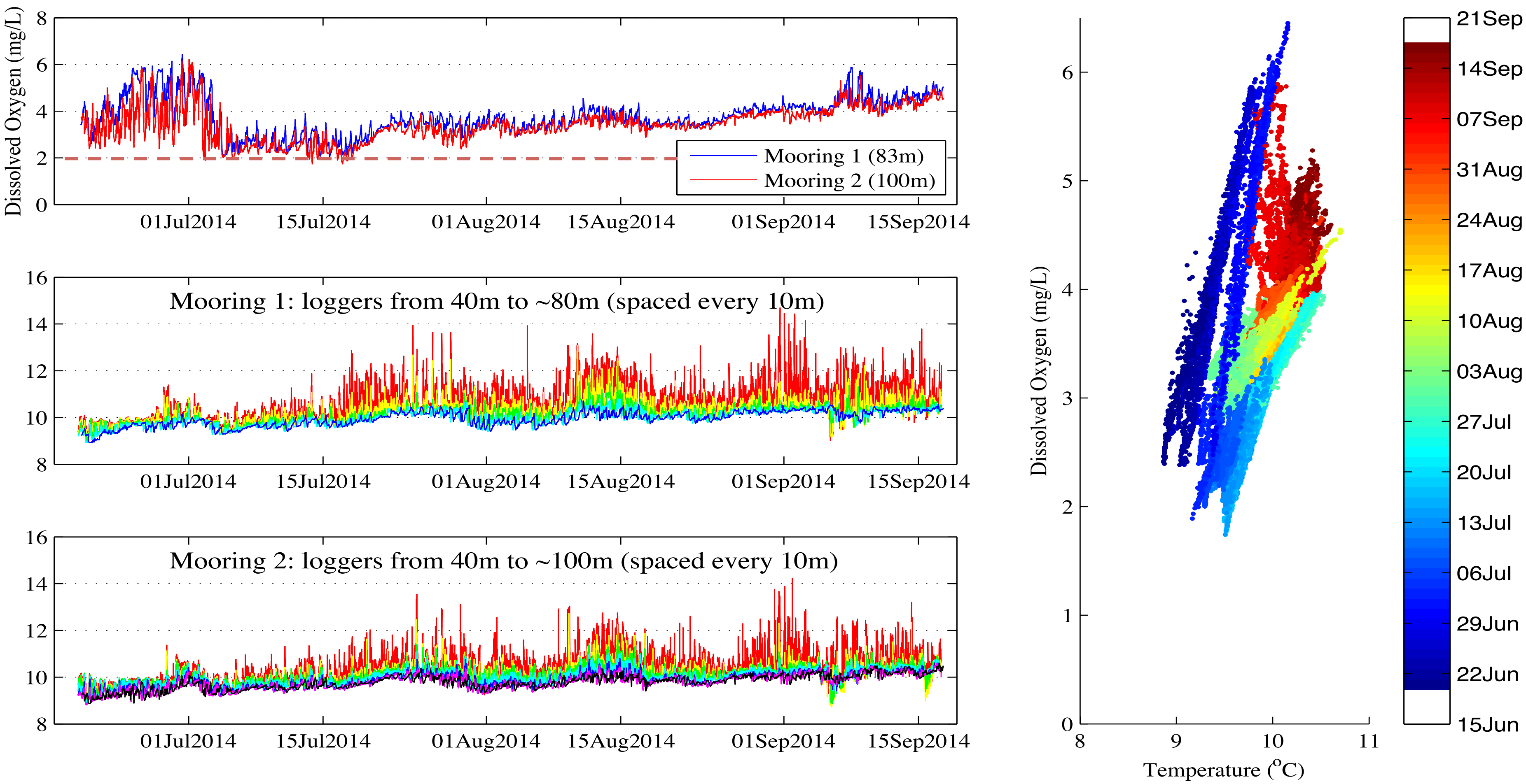
Monitoring GFNMS and CBNMS

CBNMS mooring data – deeper mooring CB2 (2014-2016)



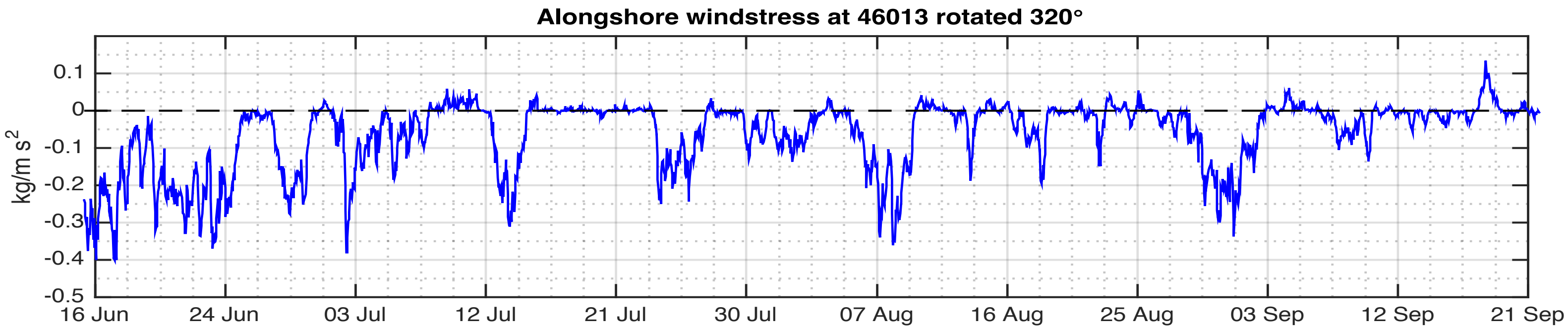
Monitoring GFNMS and CBNMS

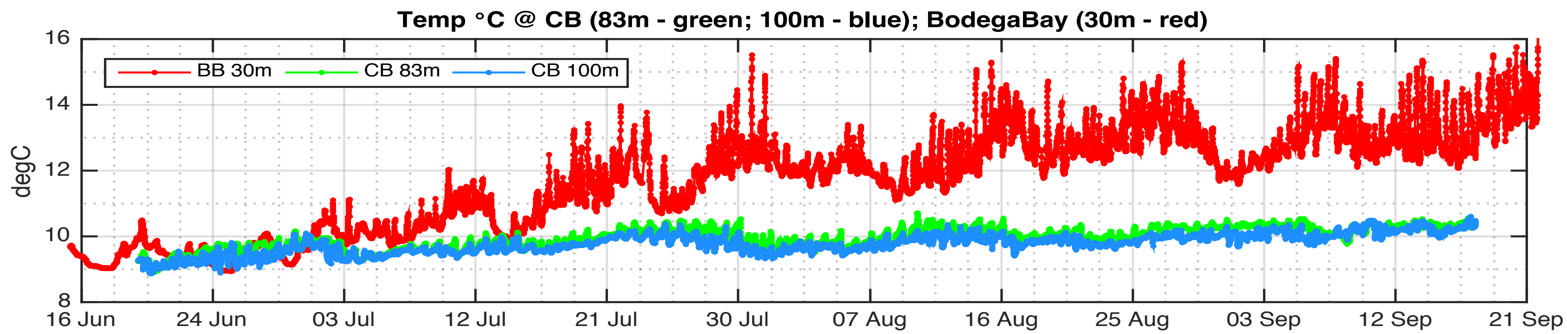
CBNMS mooring data – comparing sites in 2014

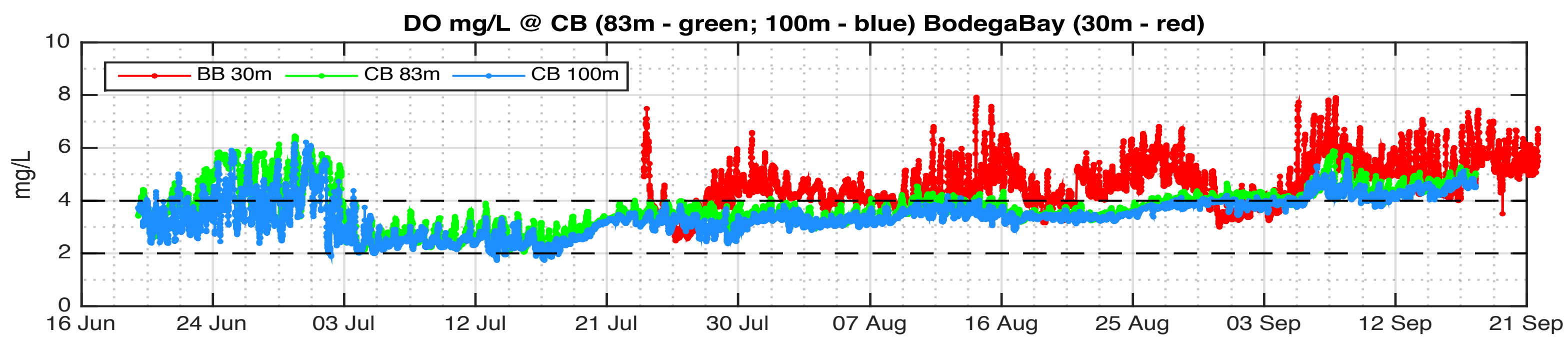


Monitoring GFNMS and CBNMS

CBNMS mooring data compared with BML data for 2014

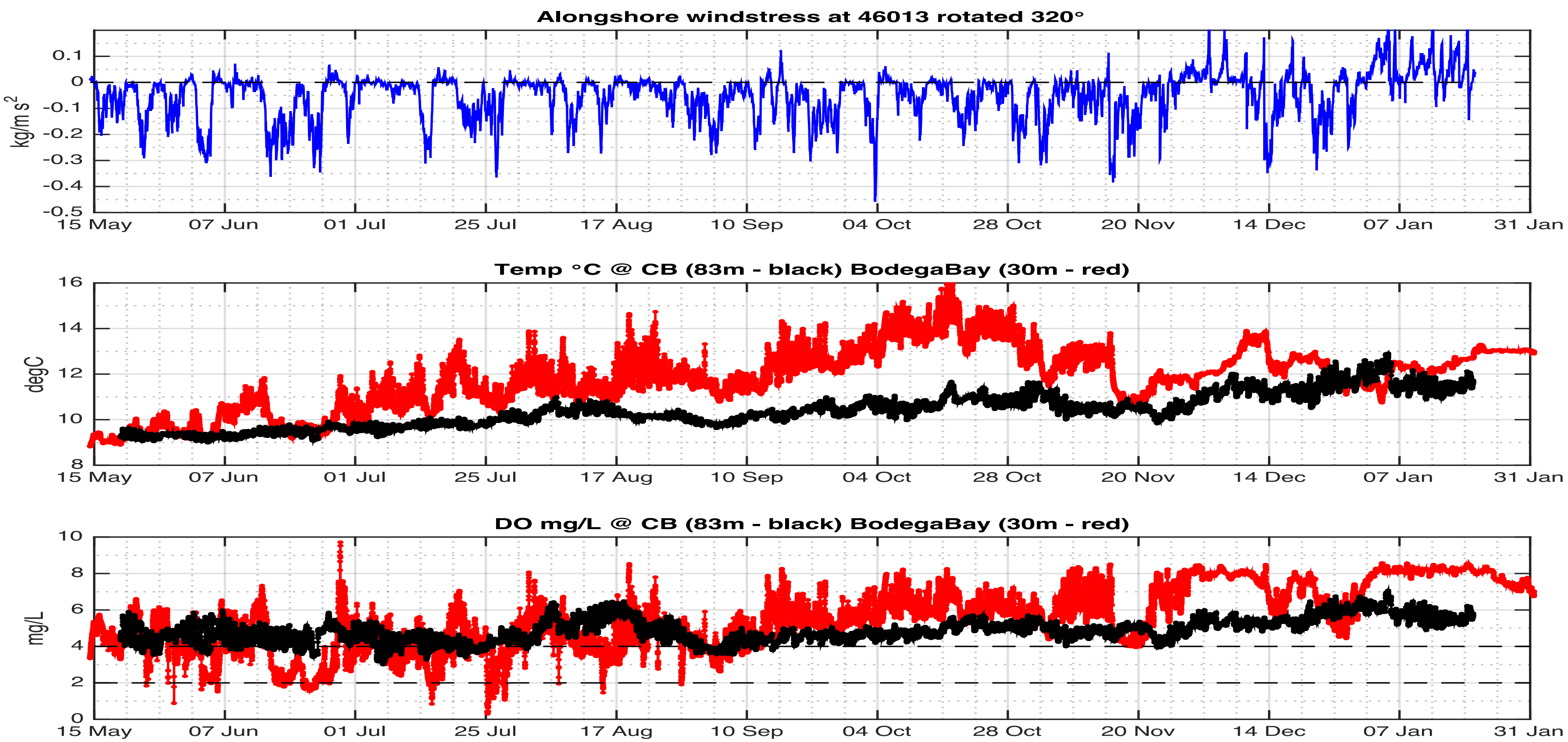






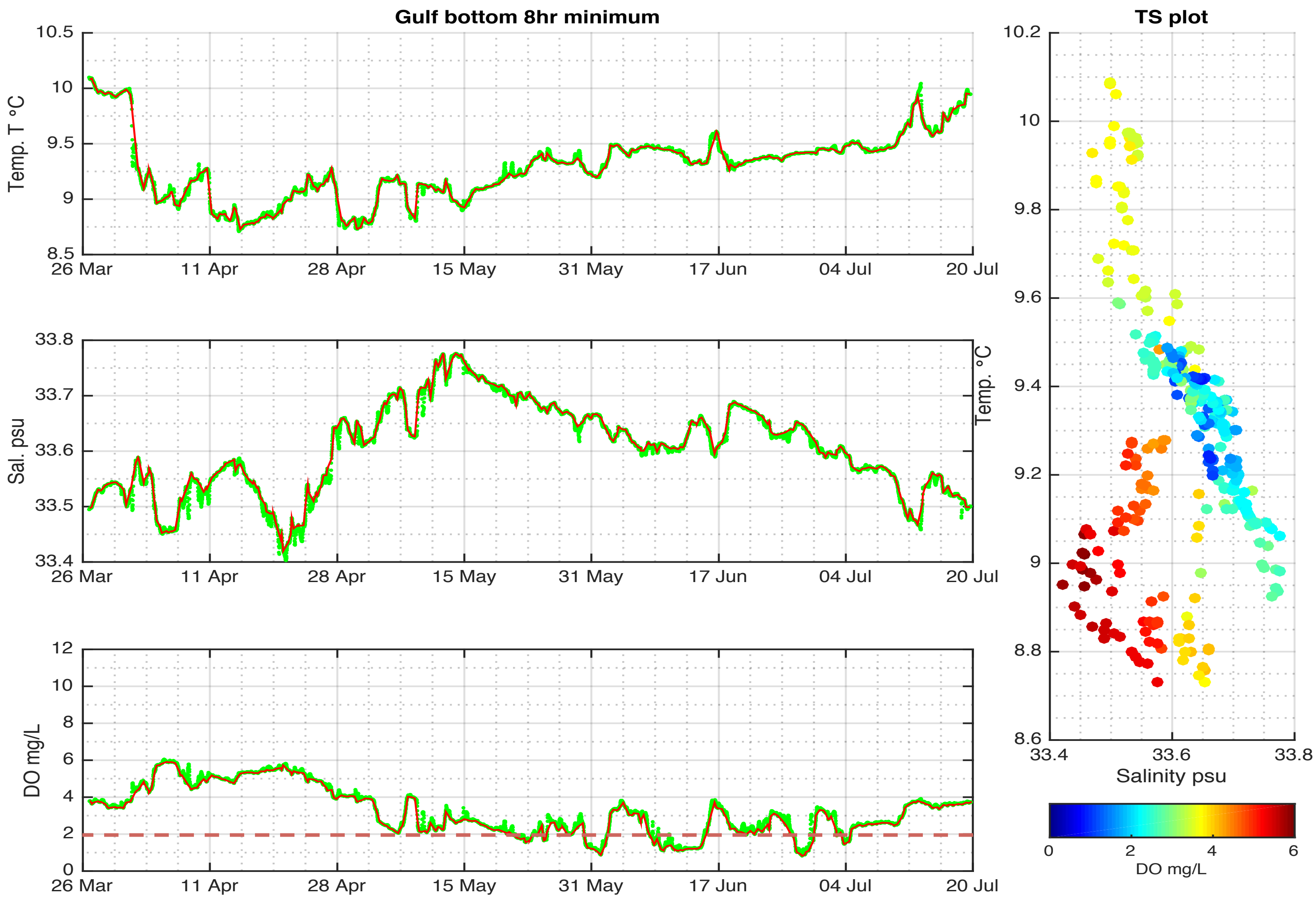
Monitoring GFNMS and CBNMS

CBNMS mooring data compared with BML data for 2015



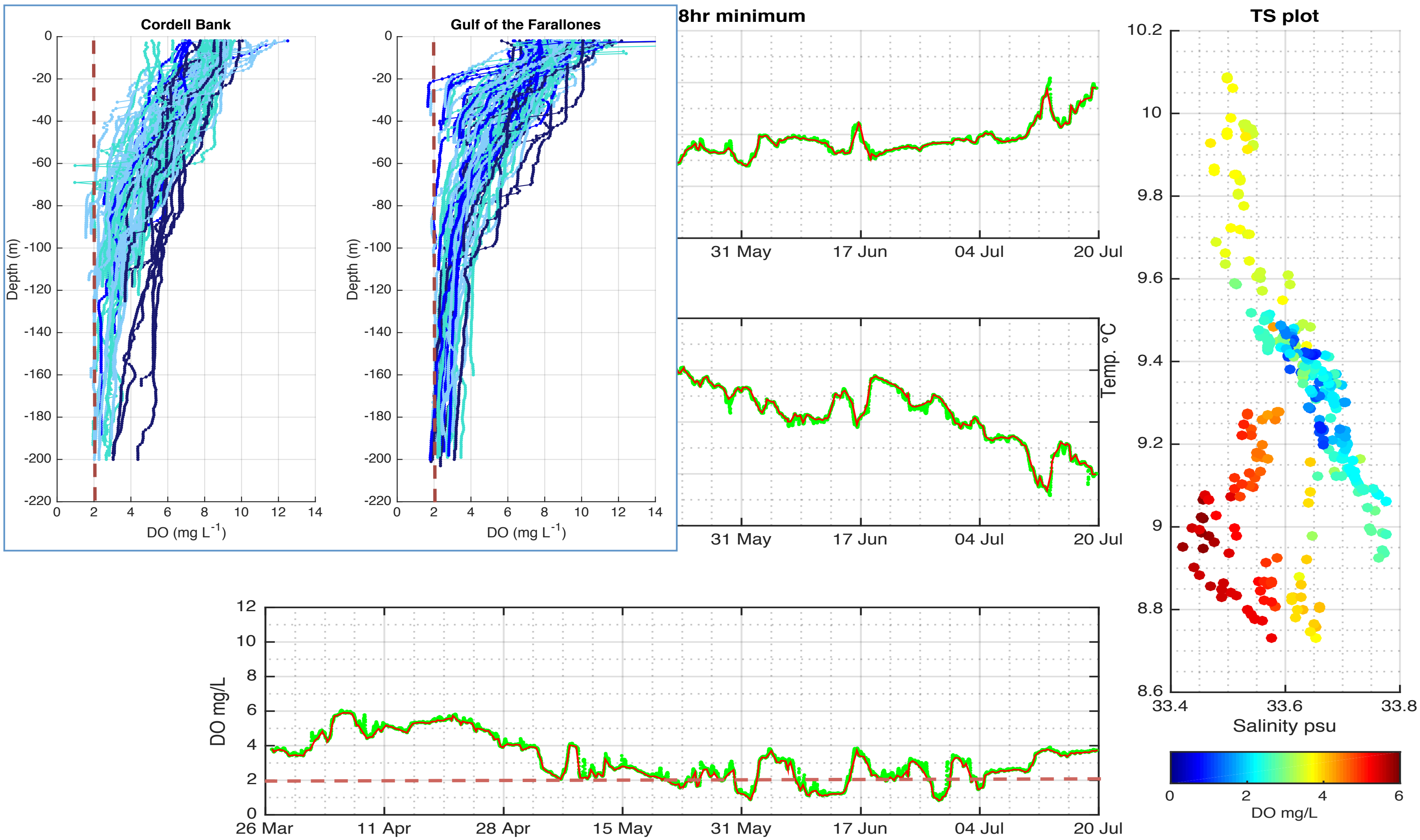
Monitoring GFNMS and CBNMS

GFNMS mooring data – site near NDBC 46026 in 2015



Monitoring GFNMS and CBNMS

GFNMS mooring data – site near NDBC 46026 in 2015



Looking forward –

This is just the beginning.

Key questions …

- Has oxygen concentration changed in the Sanctuaries?
- If so, why has it changed?
- What does this change mean for the ecosystem?

Work going forward …

- Analysis of existing data (including historical data).
- Ongoing monitoring in Sanctuaries.
- Potential for modeling of changing conditions.
- Linking to large-scale NE Pacific fluctuations.