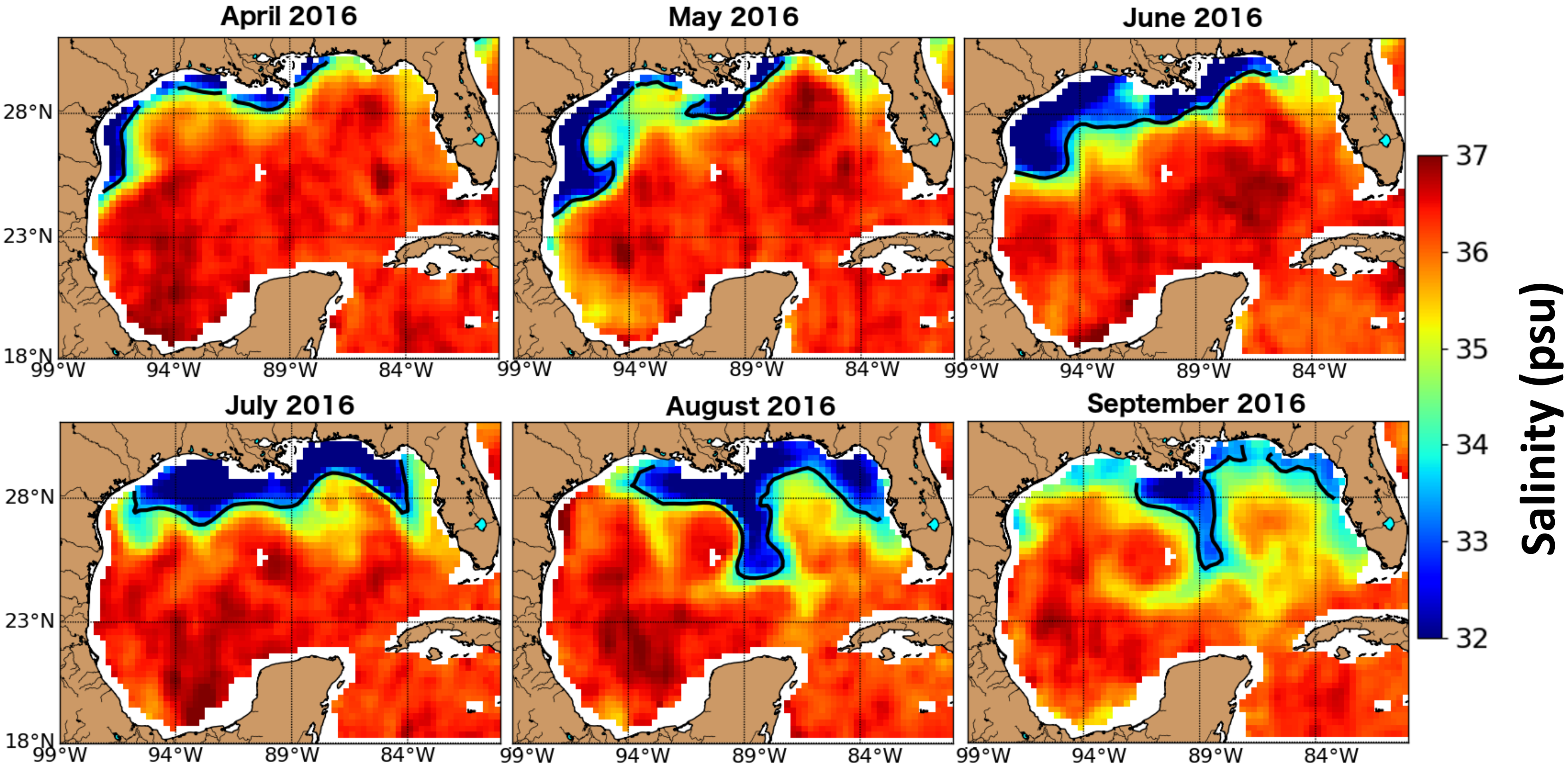
Gulf States Fisheries Commission
70th Annual Meeting
Oct 16th 2019

Bonnet Carré Spillway 2019 event: Environmental Impacts in Mississippi Bight?

B. Dzwonkowski, J. Coogan, J. Lehter, J. Wilson, G. Lockridge, S. Dykstra, A. Hagemeyer, A. Robertson, M. Miller, J. Krause, J. DeBose, and R. Pickering

Motivation

- Mississippi Bight is a region of fresh water influence



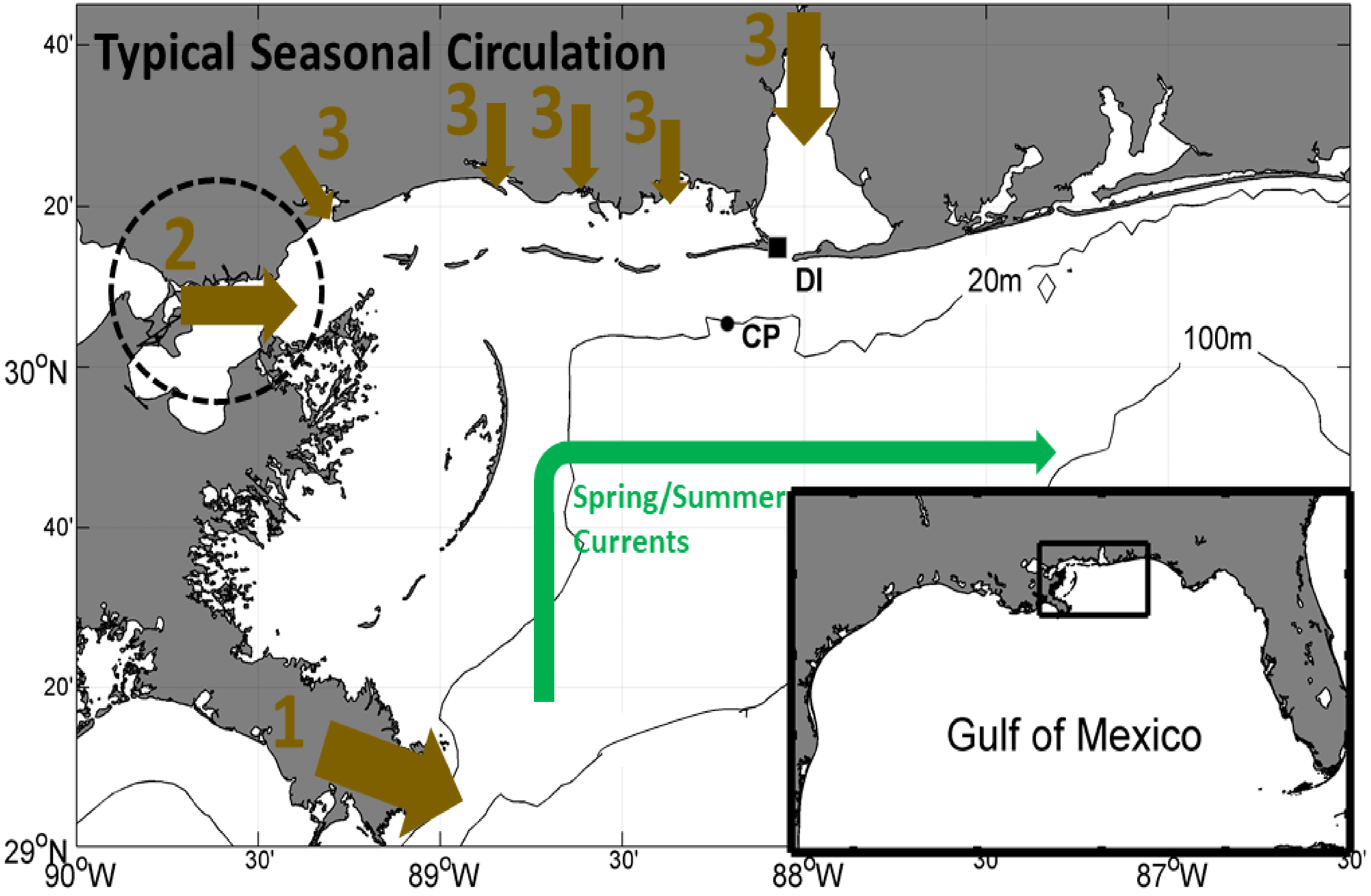
Dzwonkowski et al. CSR 2018

Motivation

- Freshwater sources
  - Local rivers*
  - MS River water

  *Dominant source? (Sanial et al. 2019)
- Role of Bonnet Carré Spillway water in Mississippi Bight is not clear
- Mississippi River water has a much higher nutrient load then local sources
- Presents water quality and public health risk

  e.g. Hypoxia (low dissolved oxygen)
- Can cause major economic loss to fisheries and tourism



Freshwater inputs to the Mississippi Bight

1. Misssissippi River Delta (Birds Foot) 2. Bonnet Carre Spillway Opening 3. Local Systems

Objectives

- Goal: Quantify any compounding impacts of a large-scale anthropogenic river diversion (e.g. opening of the Bonnet Carré Spillway) occurring in conjunction with the natural flooding period of local rivers.
  - Will this change coastal circulation?
  - How much fresher are the shelf waters?
  - Will we have a ‘Dead Zone’ on the shelf?

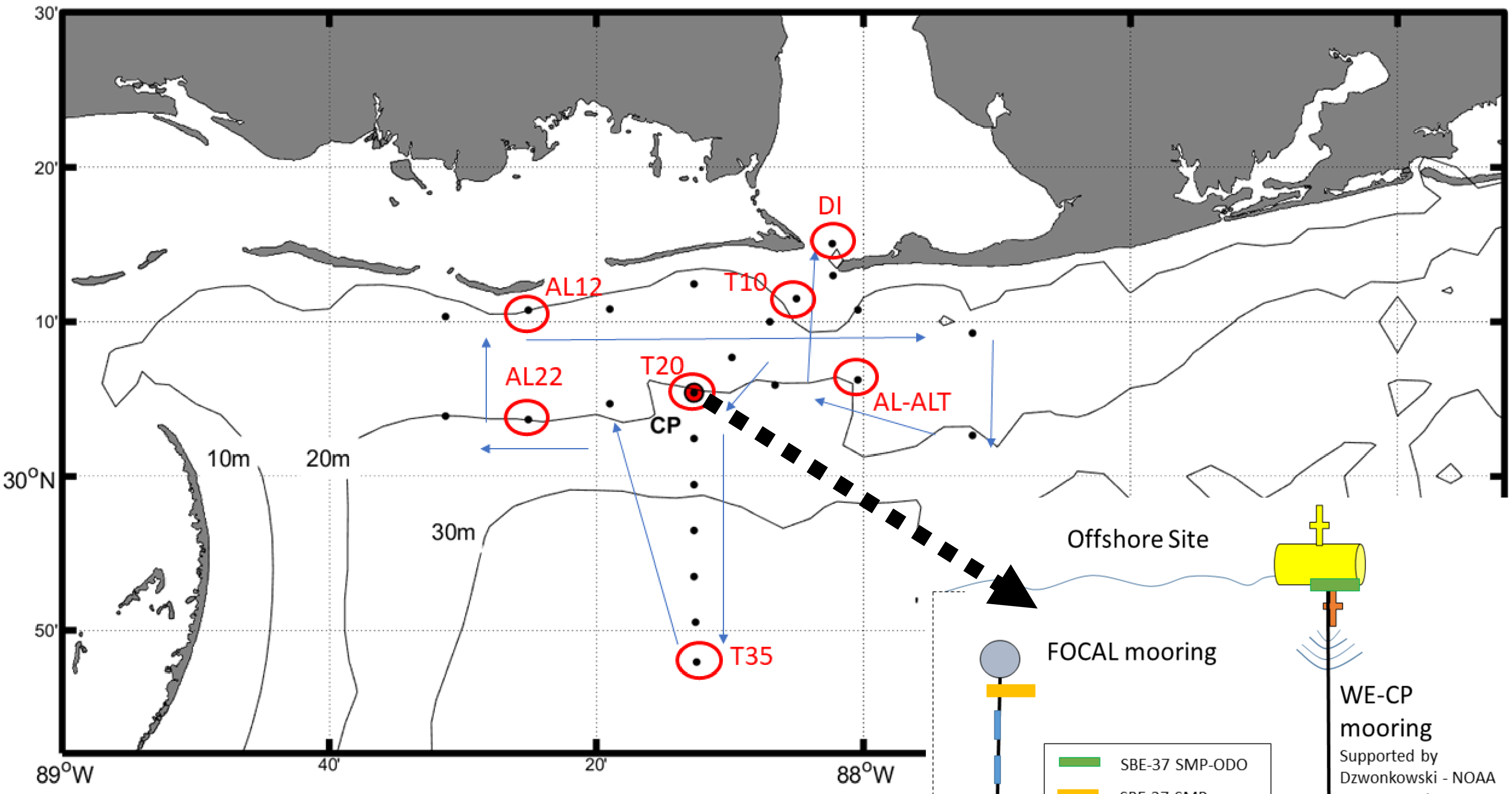
- Focus on Alabama shelf

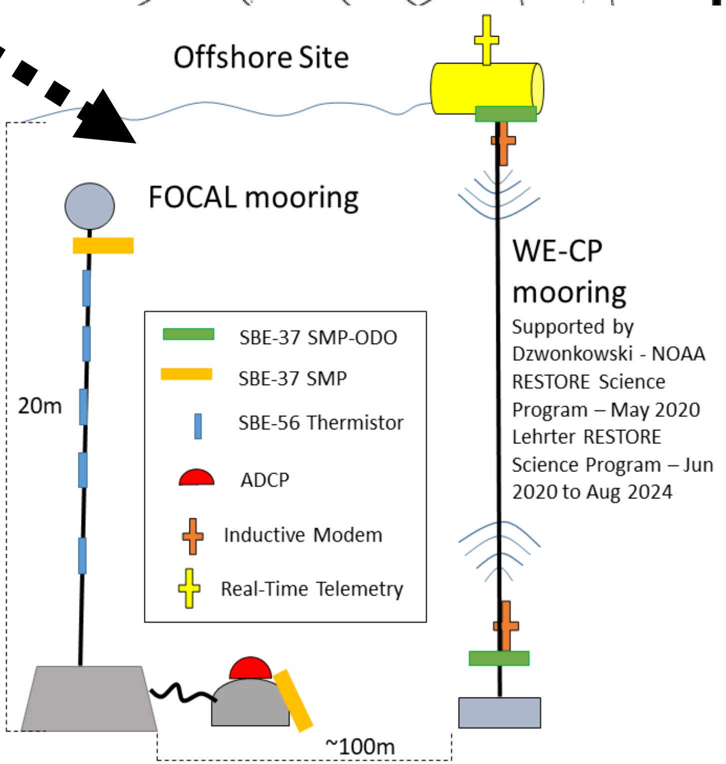
Data

- Spatial data (●)
  - CTD survey
  - Water Samples

- Temporal data
  - River discharge
  - Wind
  - Currents
  - Temperature
  - Salinity
  - Dissolved Oxygen

- Sampling incorporate locations with historical data





Alabama Coastal Real-time Observing System
https://arcos.disl.org/

Formerly know as www.mymobilebay.com

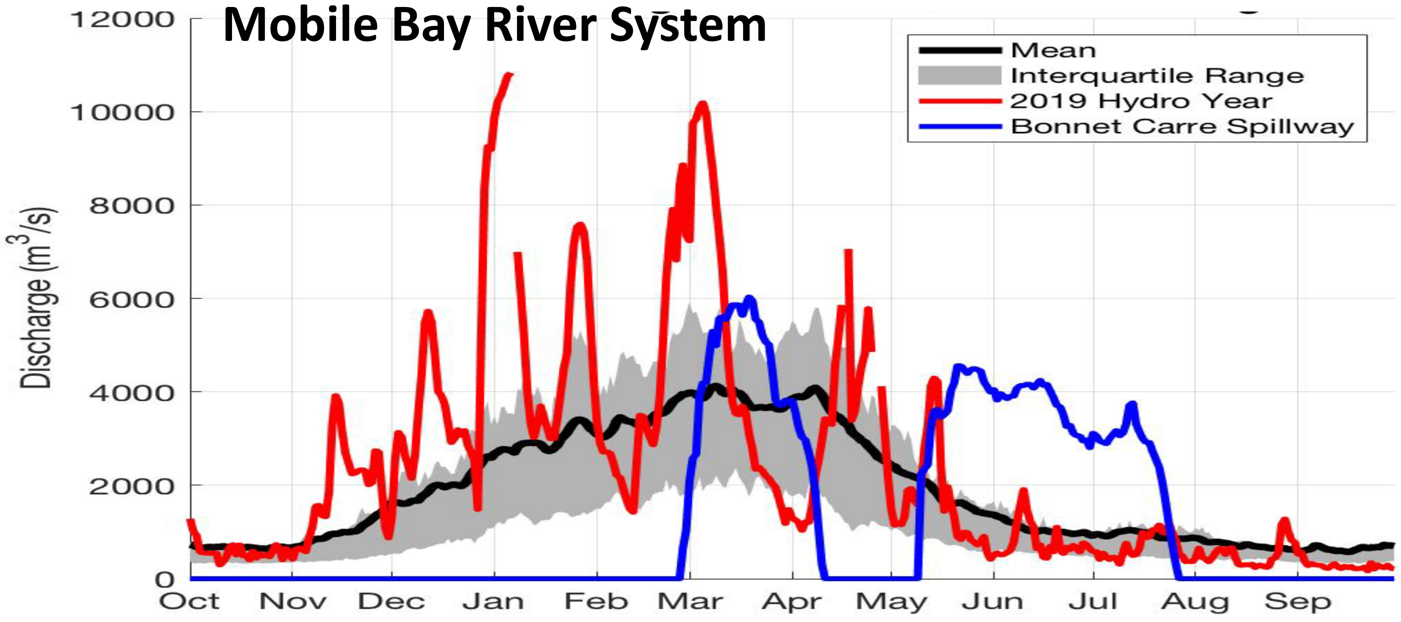
Progression of Spillway opening

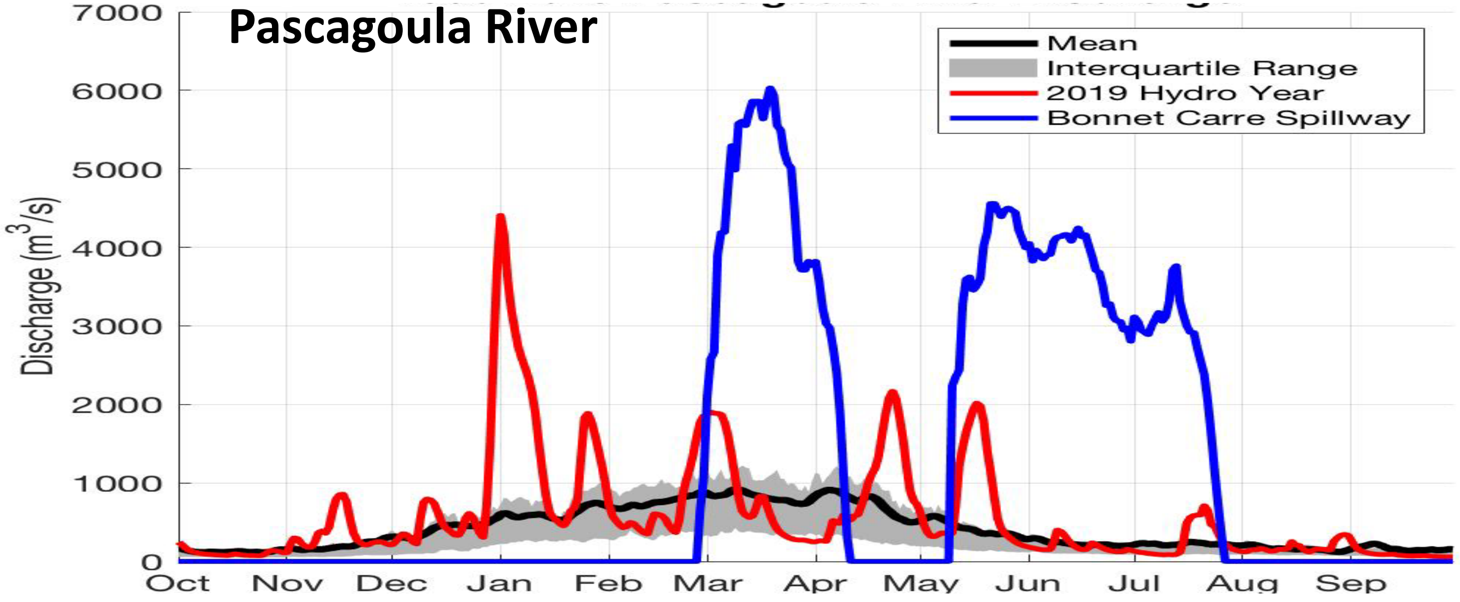
- Local sources relative to bonnet Carré Spillway
- Big opening in early Spring
- Moderate but very long opening in late Spring through summer
- Typical spring discharge from local sources :

  ~48 X 10^9 m^3 fresh water

  Both Spillway opening:

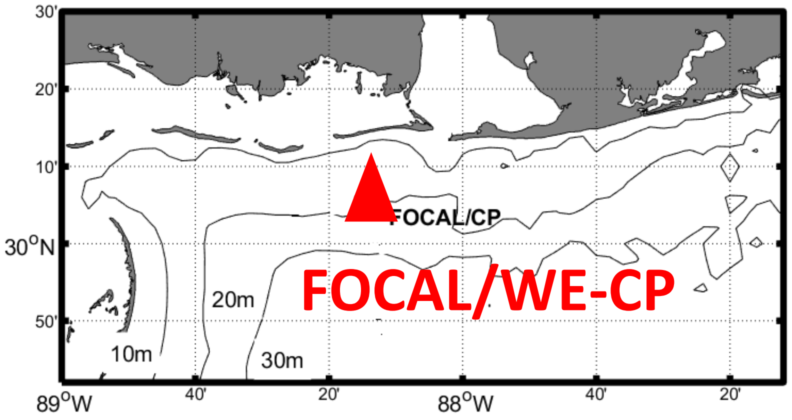
  ~ ~38 X 10^9 m^3 fresh water
- Effective addition ~80% more fresh water into the system relative to typical year



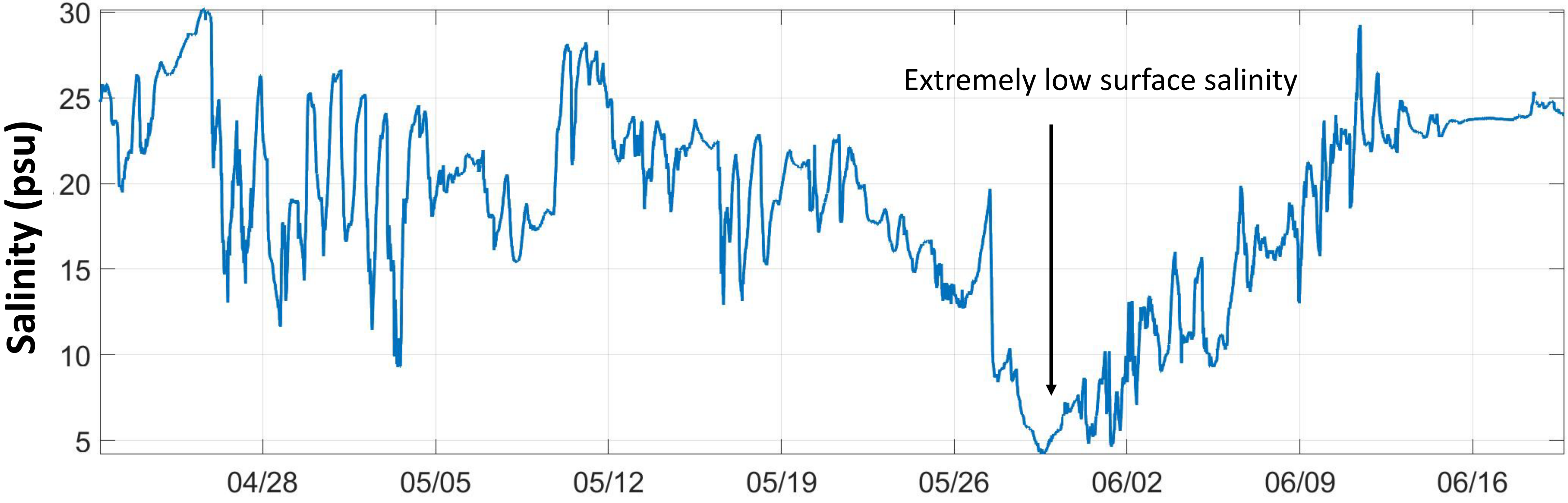


Time series

- Coastal Environmental Conditions



- Surface Salinity data
- Dramatic drop in salinity in May on uncorrelated to wind forcing



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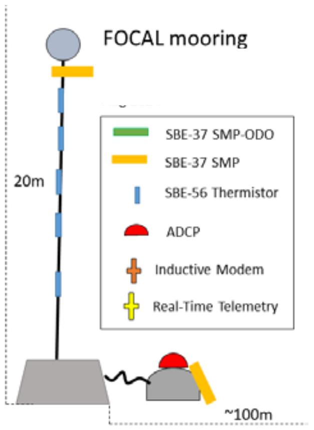
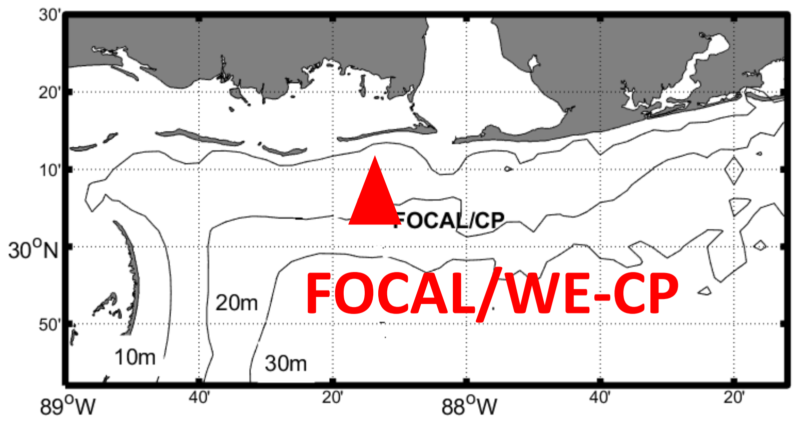
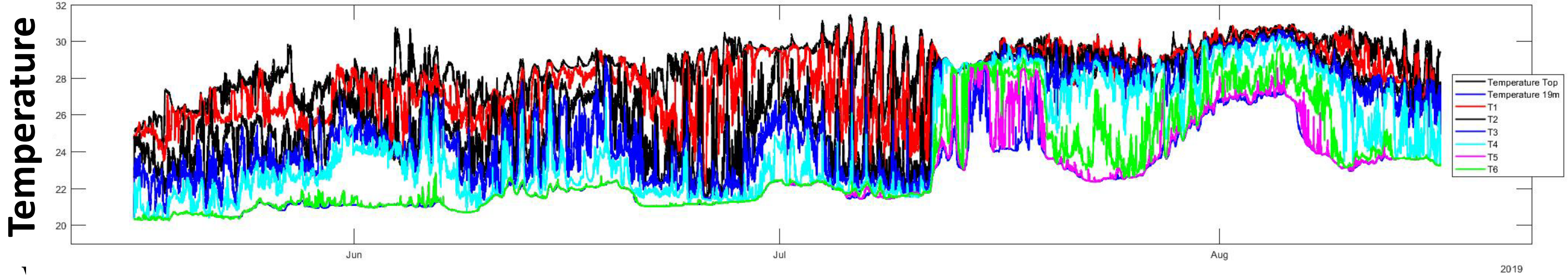
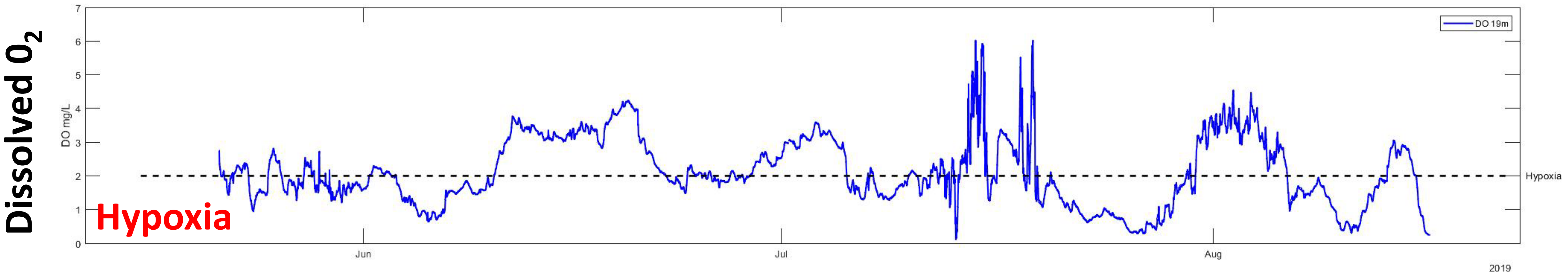




- Strong stratification for most of the summer





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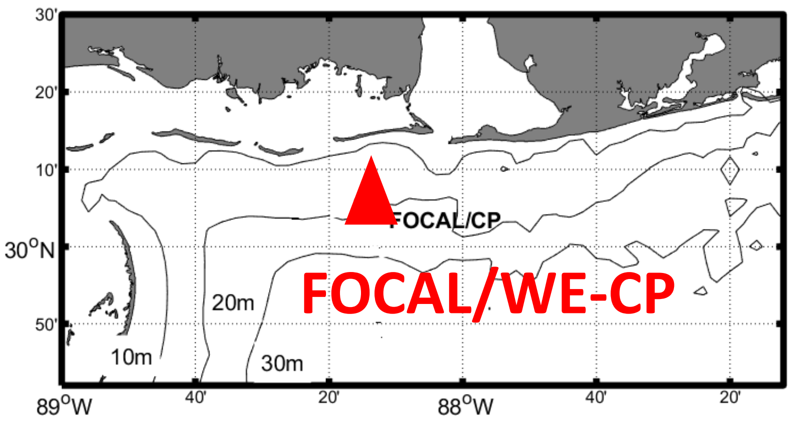
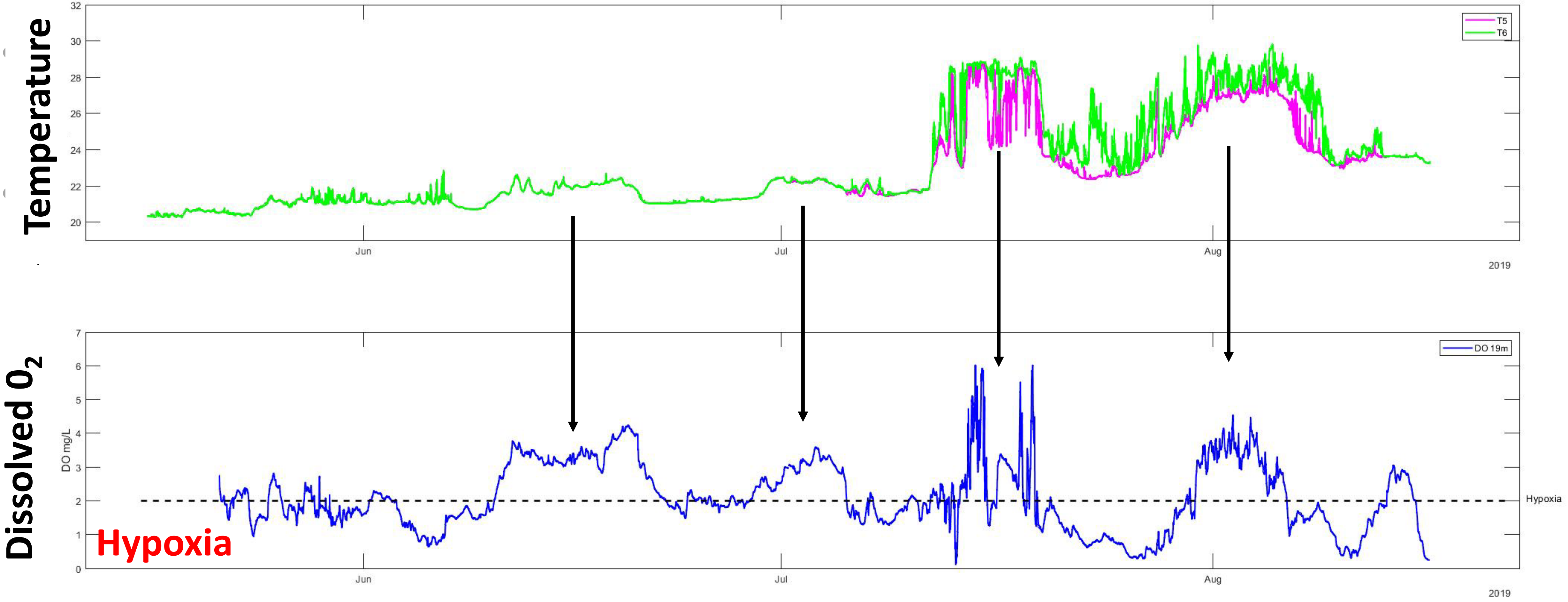


- Bottom temperature correspond to change in bottom DO



Wind-driven shelf circulation

Downwelling

Wind-blows along the coast

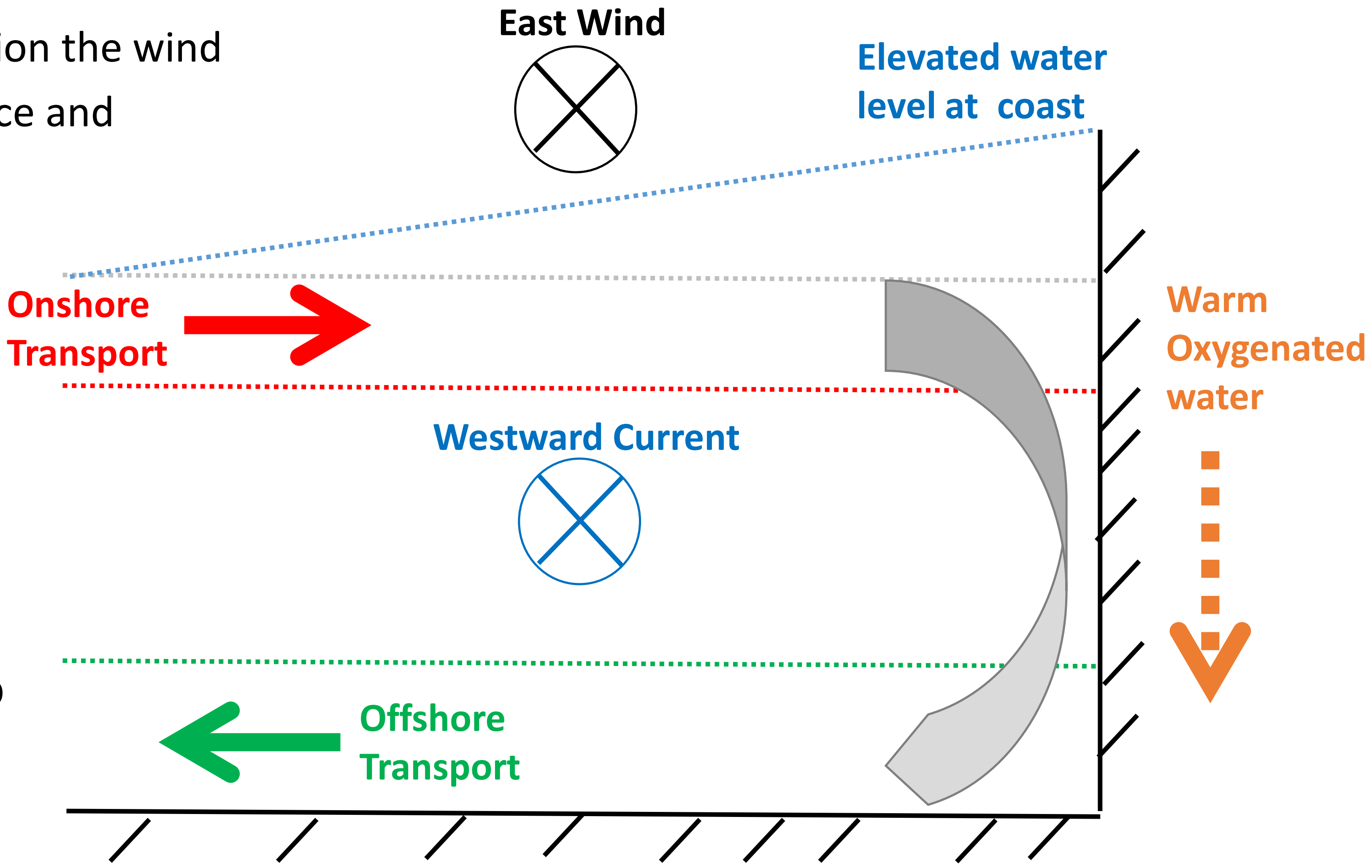
Along-shelf flow in the direction the wind

Across-shelf flow in the surface and bottom boundary layers

Increased water level at the coastal

Increase water level inside estuarine

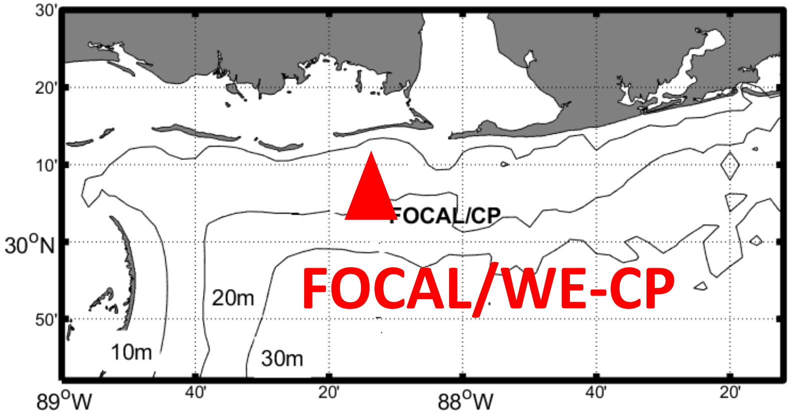
Pumps coastal water into the estuary

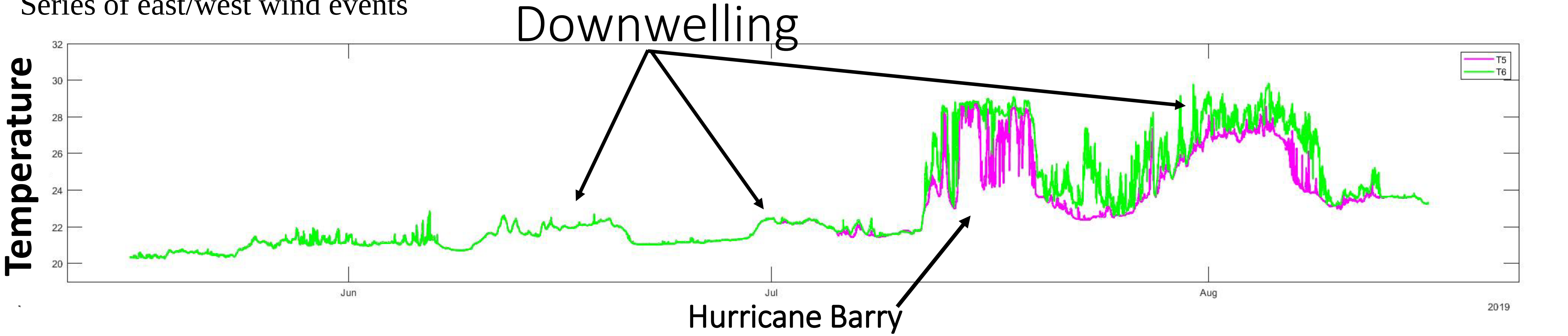


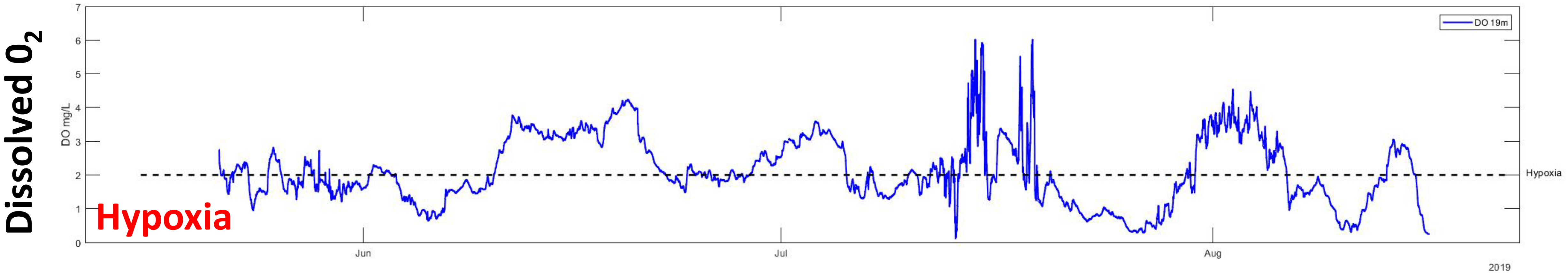
Time series

- Coastal Environmental Conditions

- Series of east/west wind events



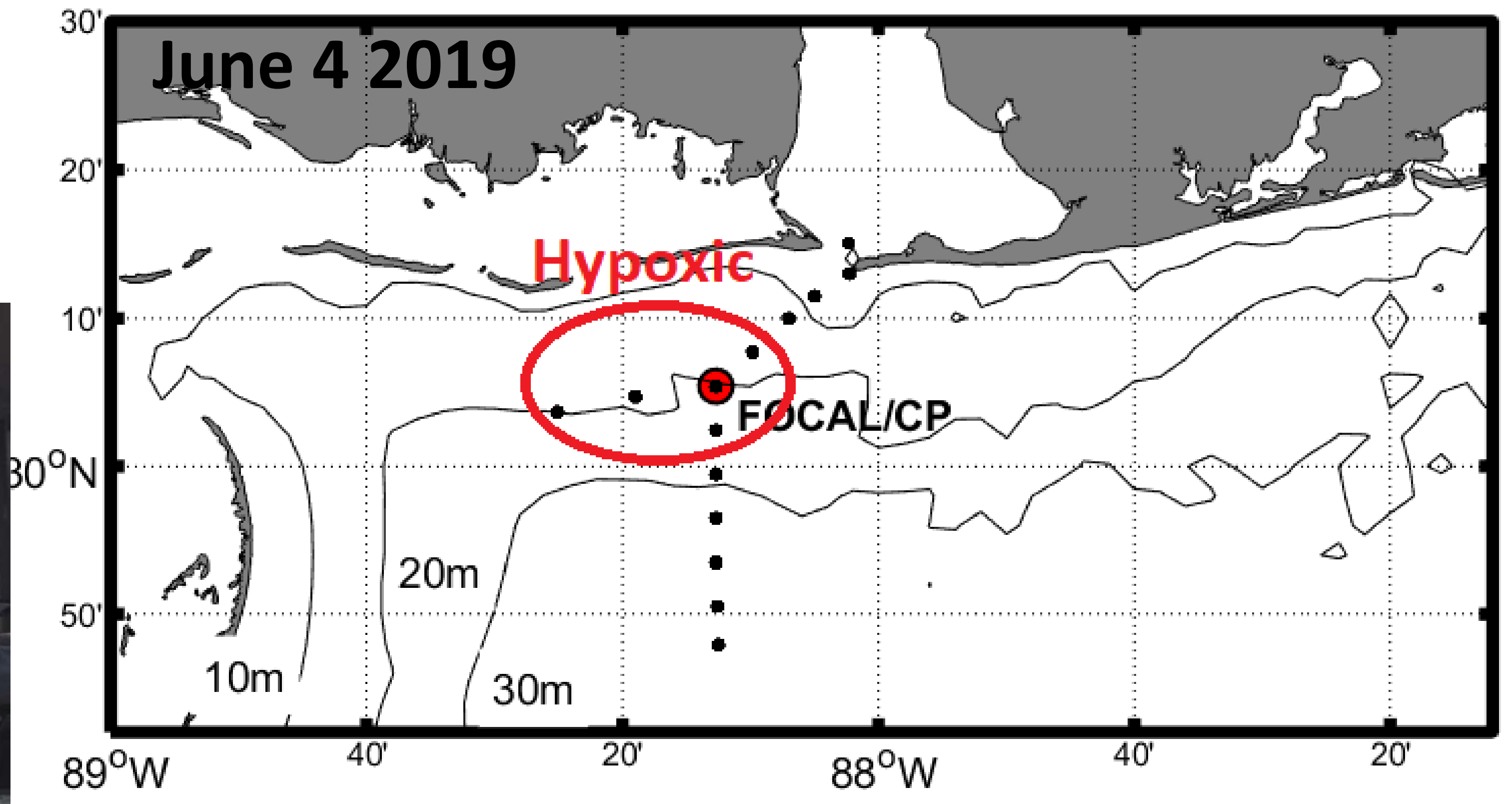


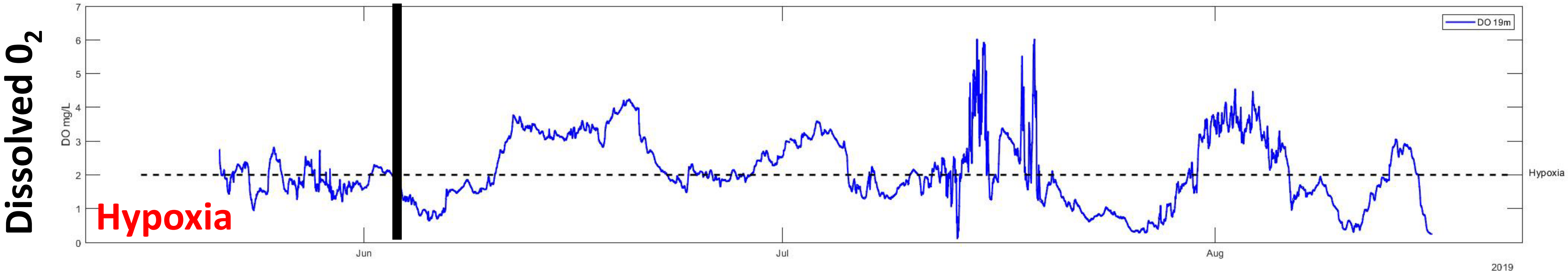


Spatial Structure

- Coastal Environmental Conditions

Jack Wilson CTD casting (Photo Credit: Clay Bennett)





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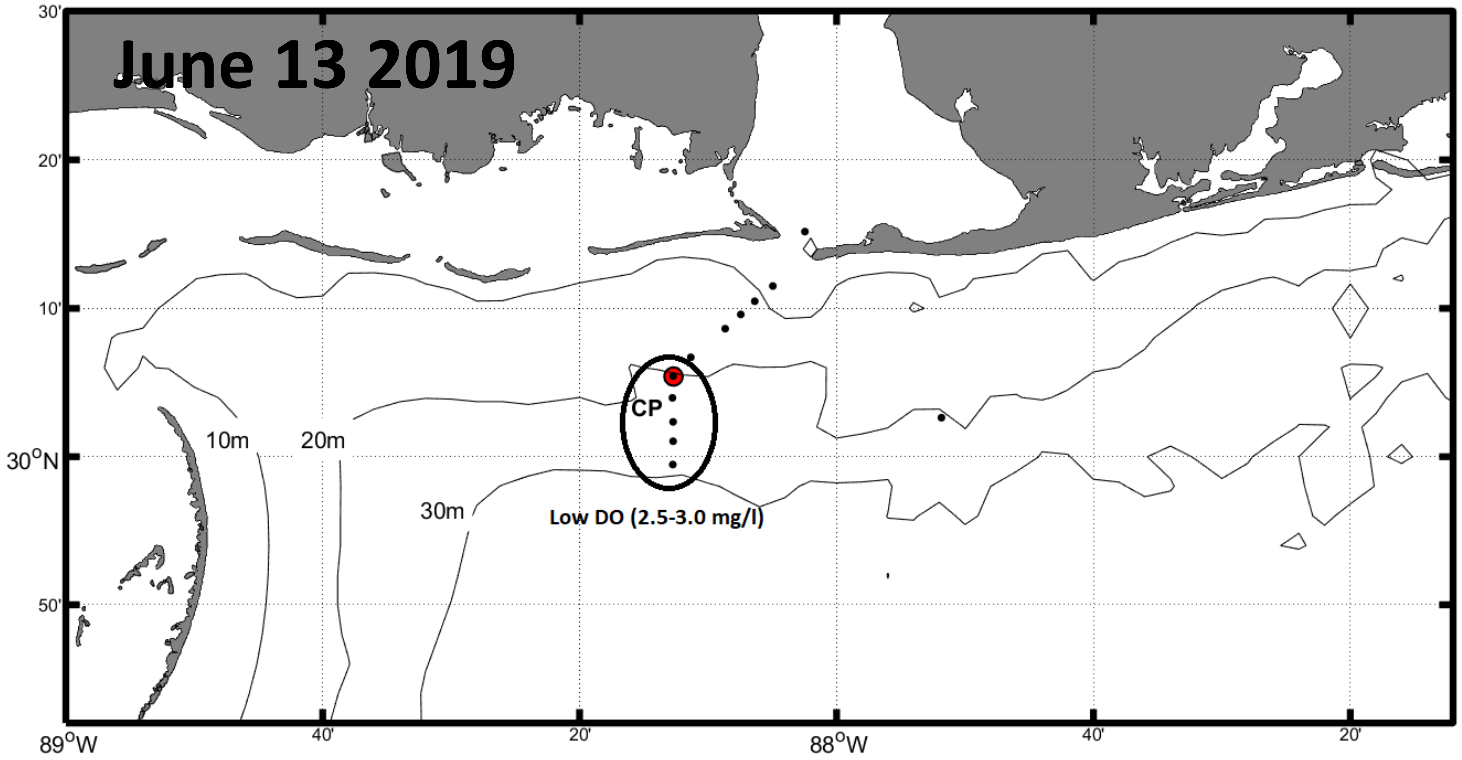

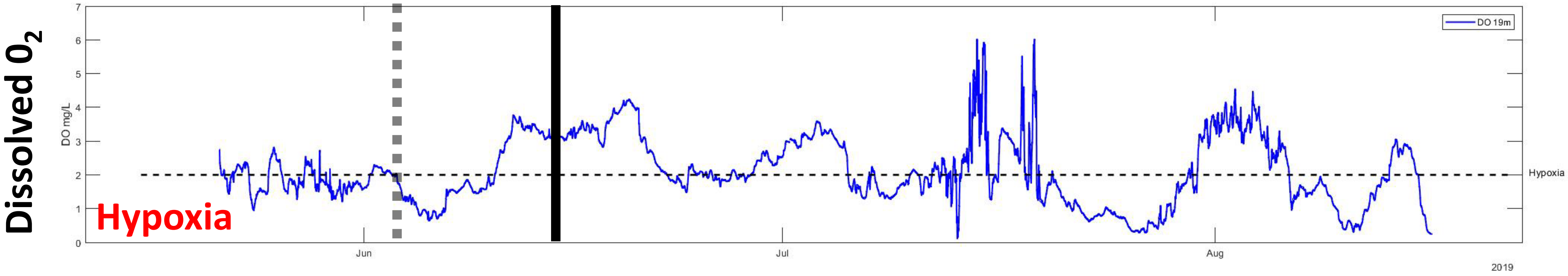

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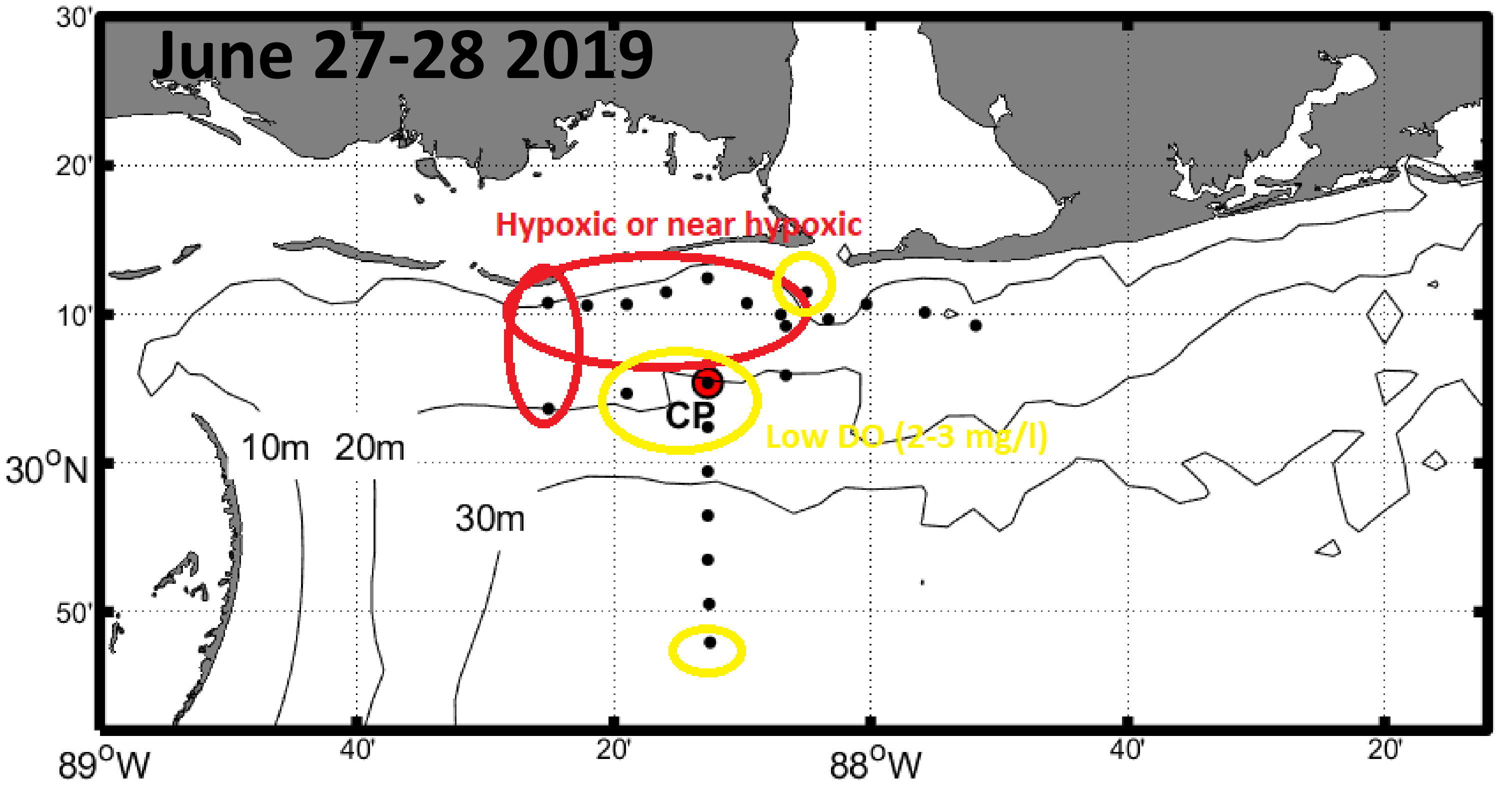

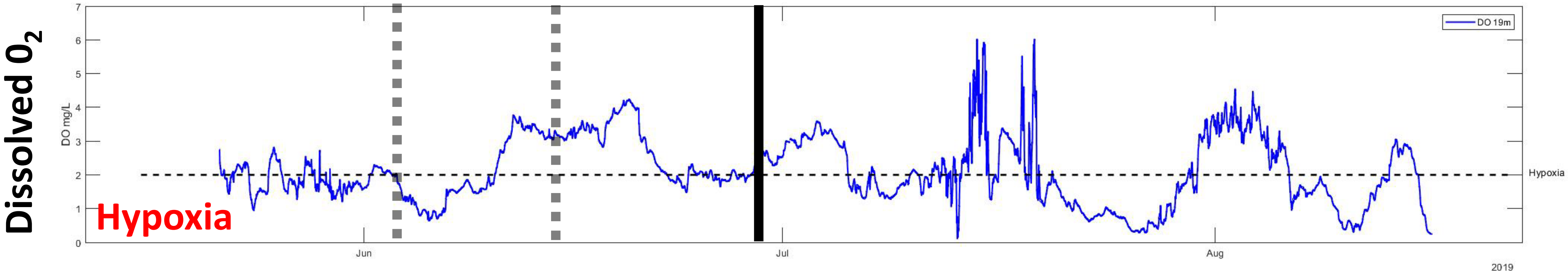

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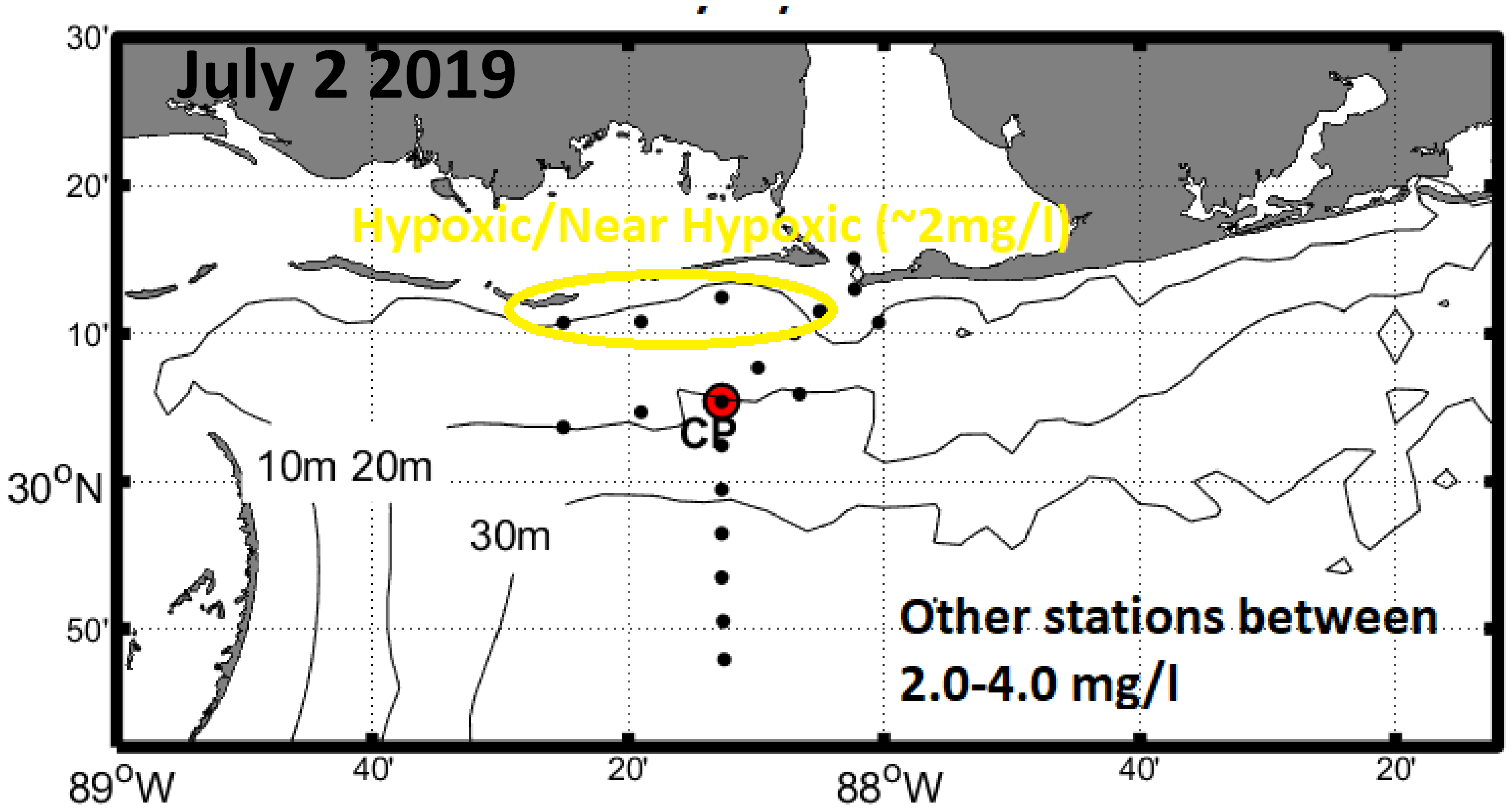

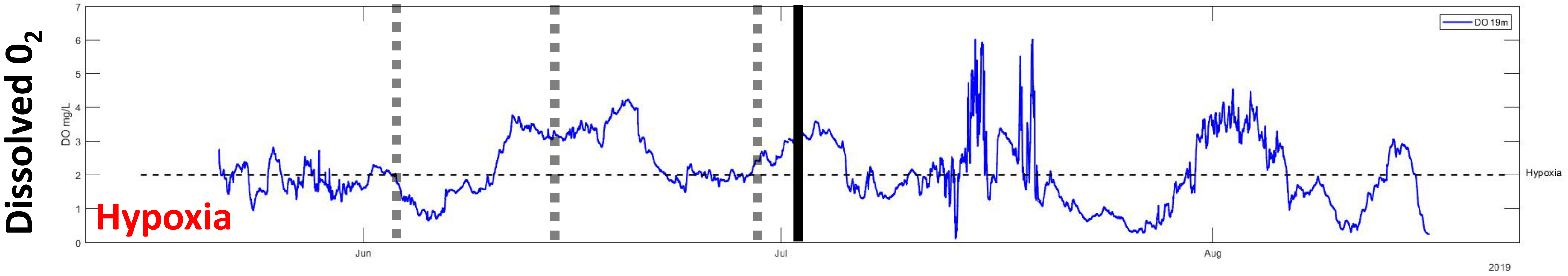

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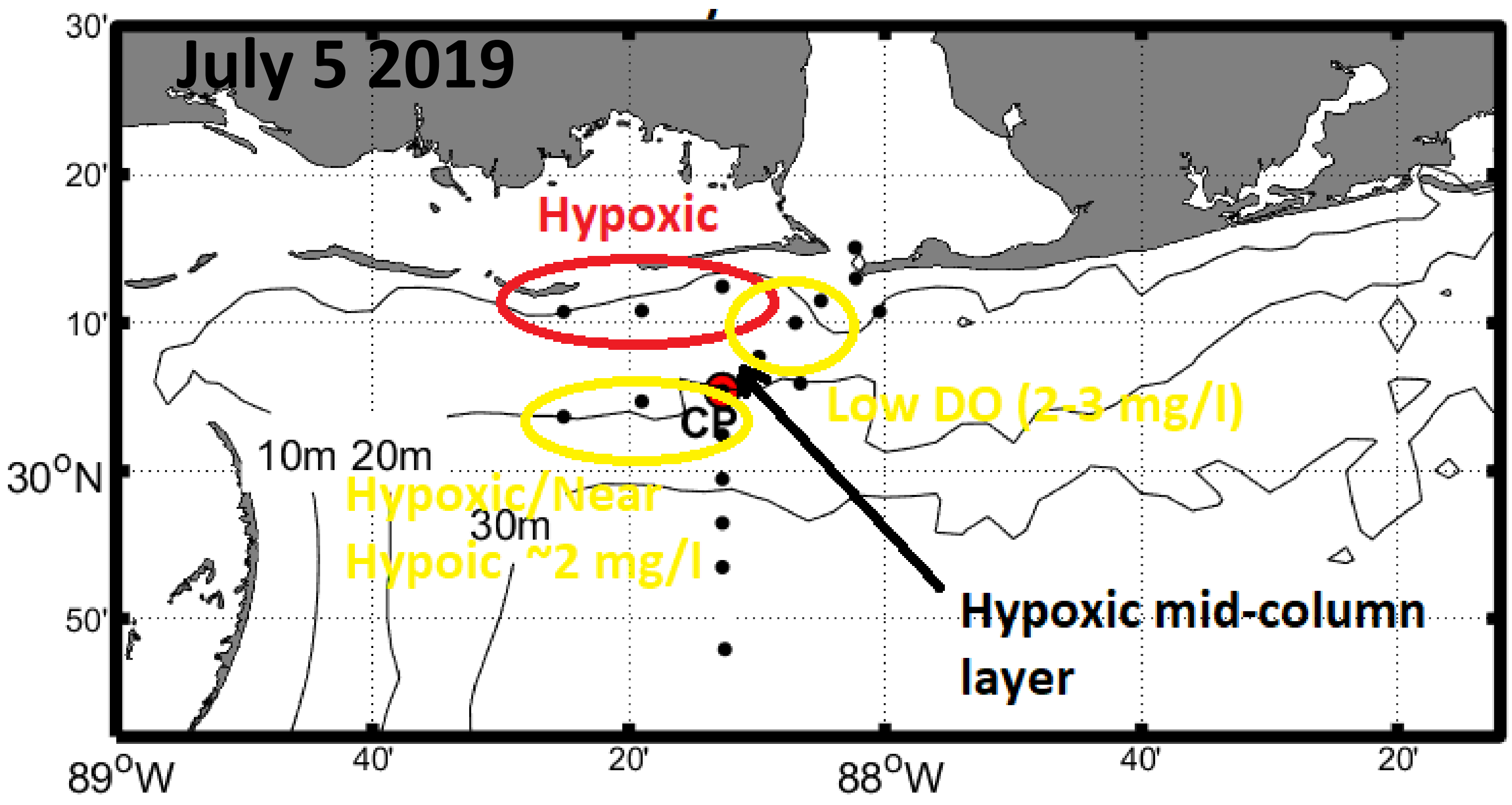

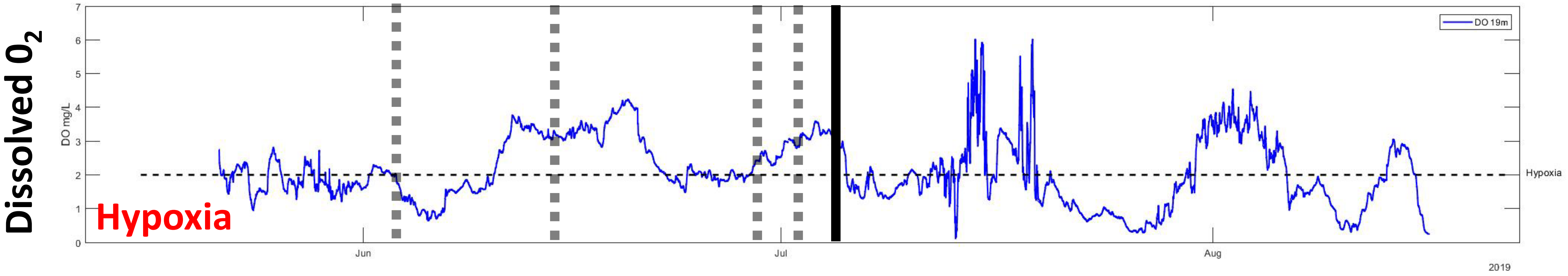

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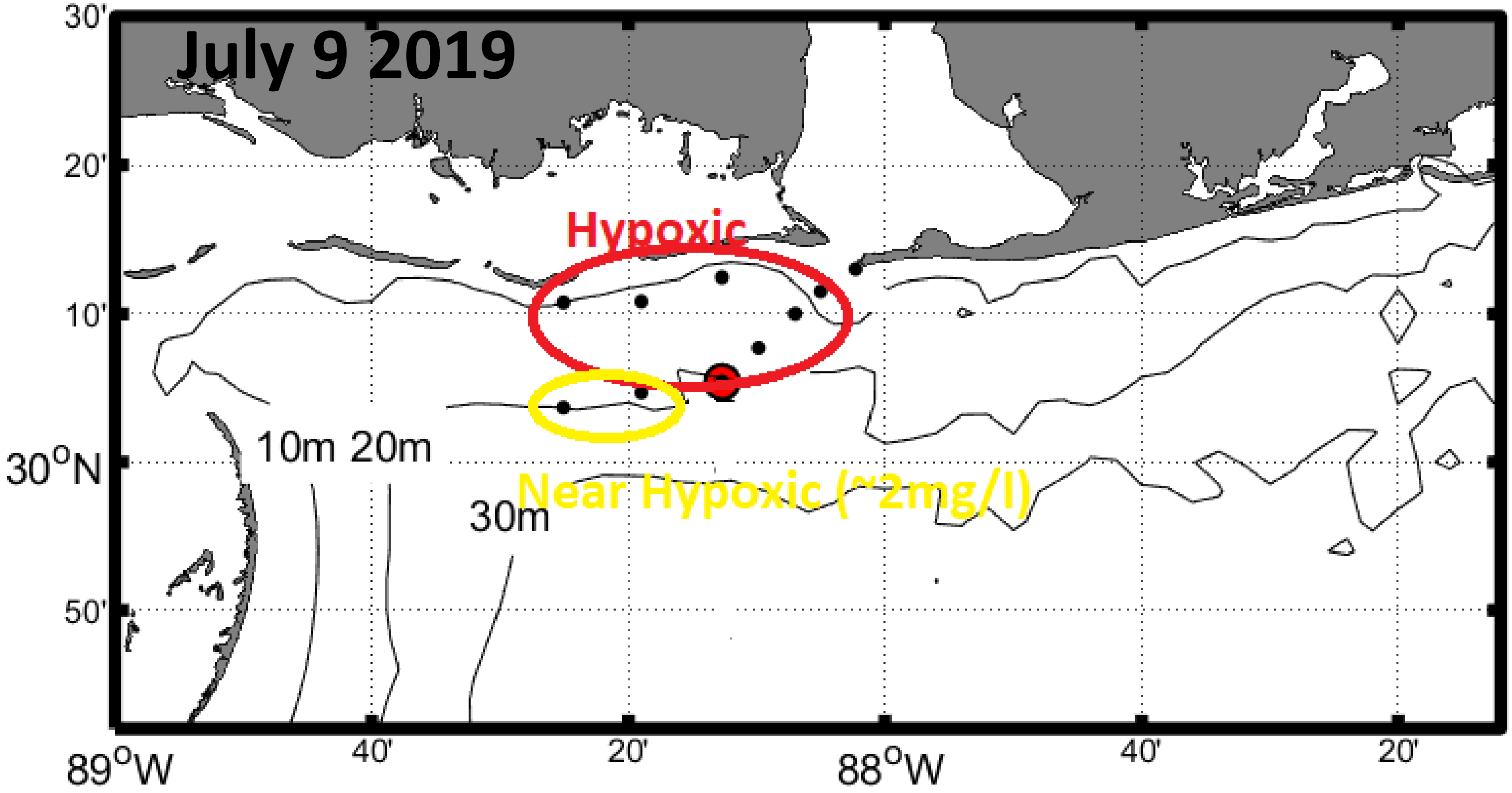

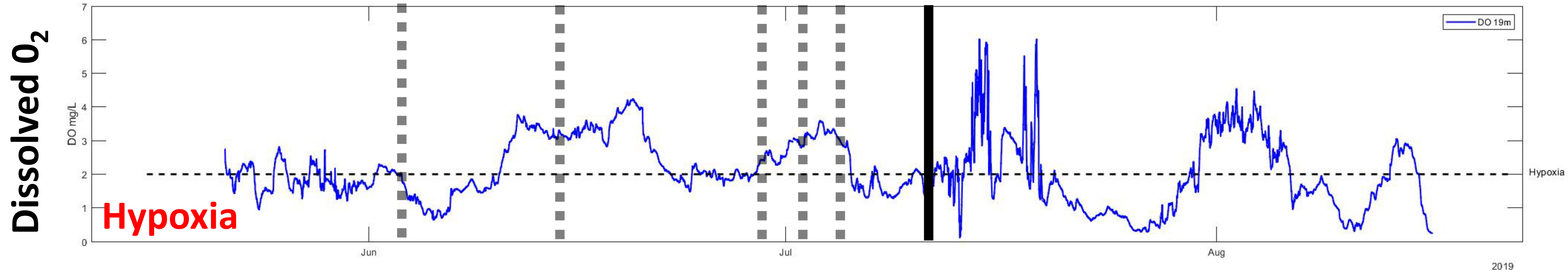

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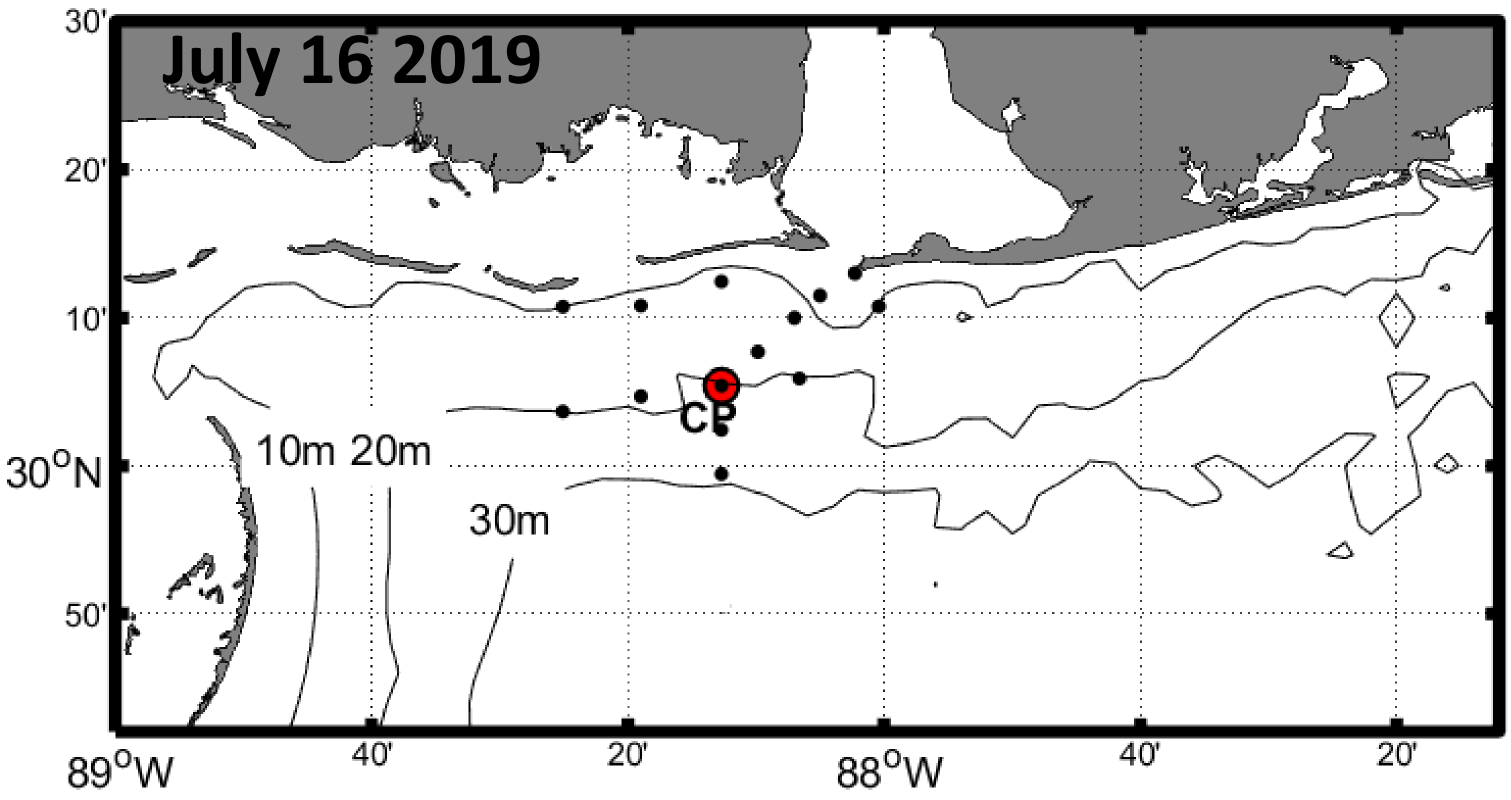

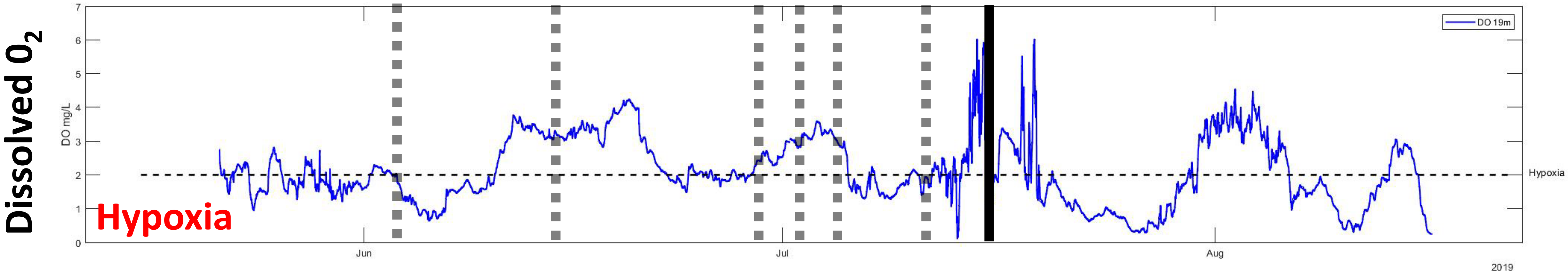

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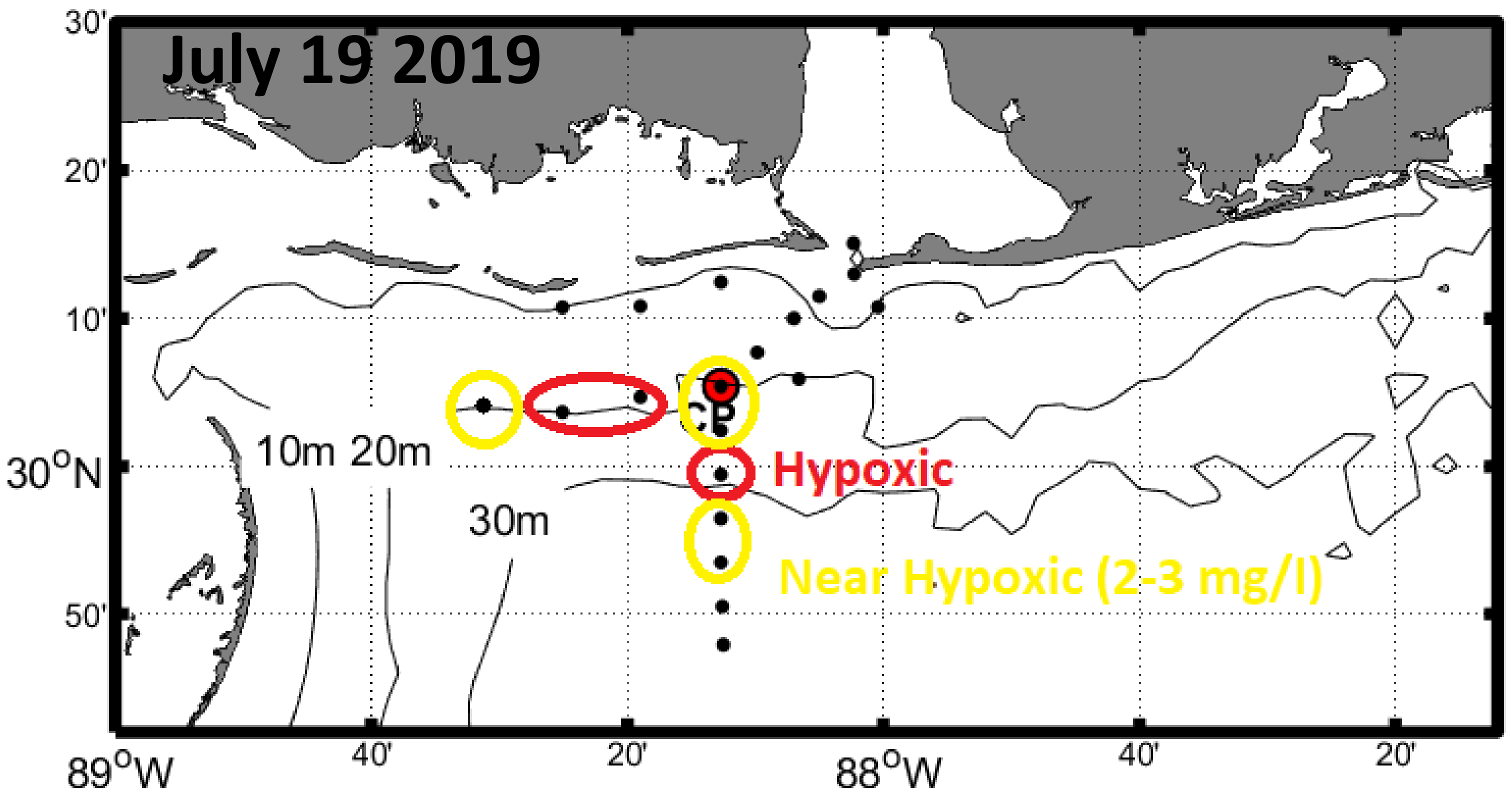

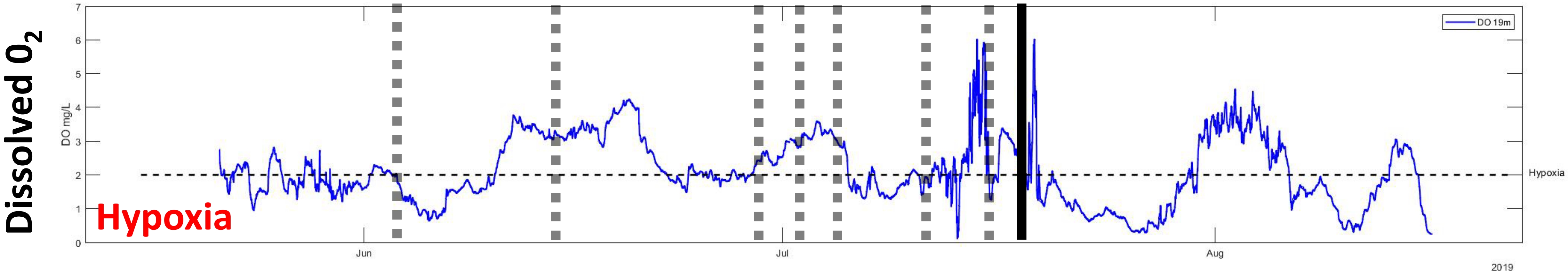

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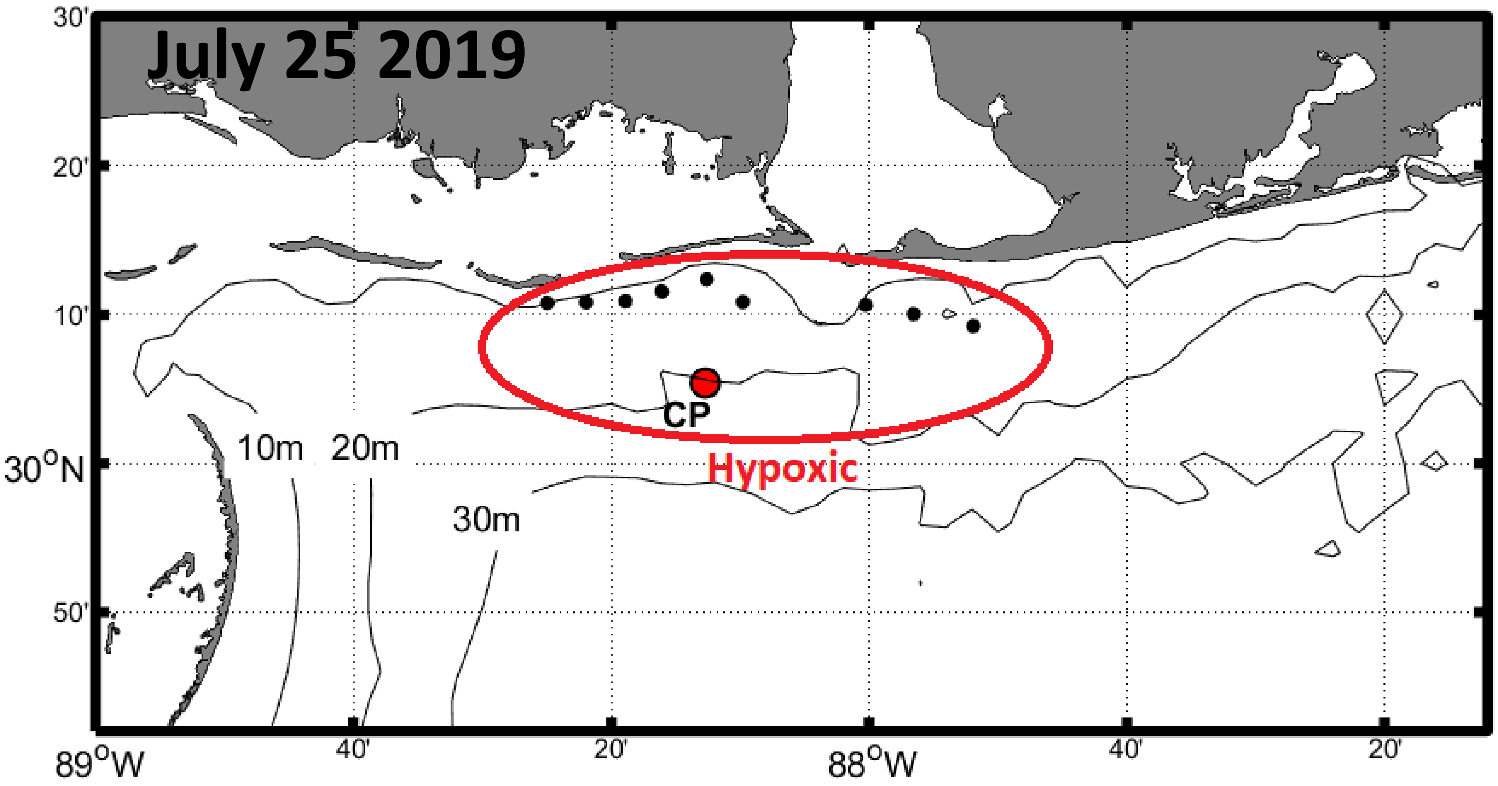

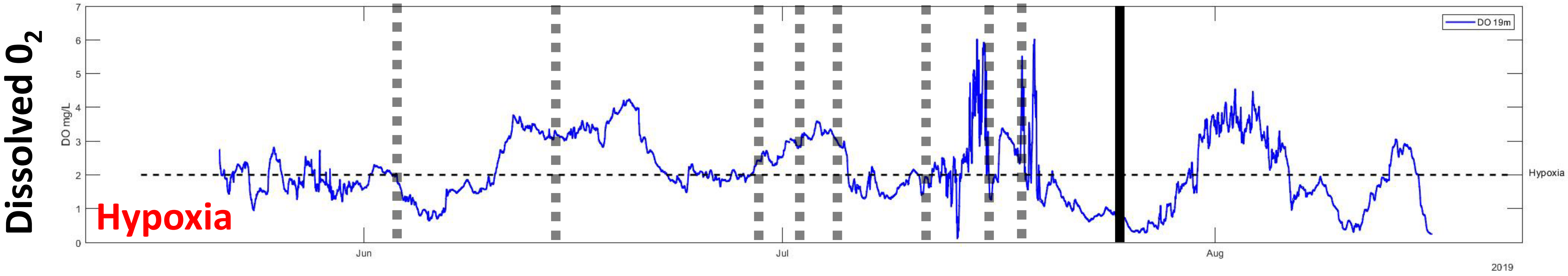

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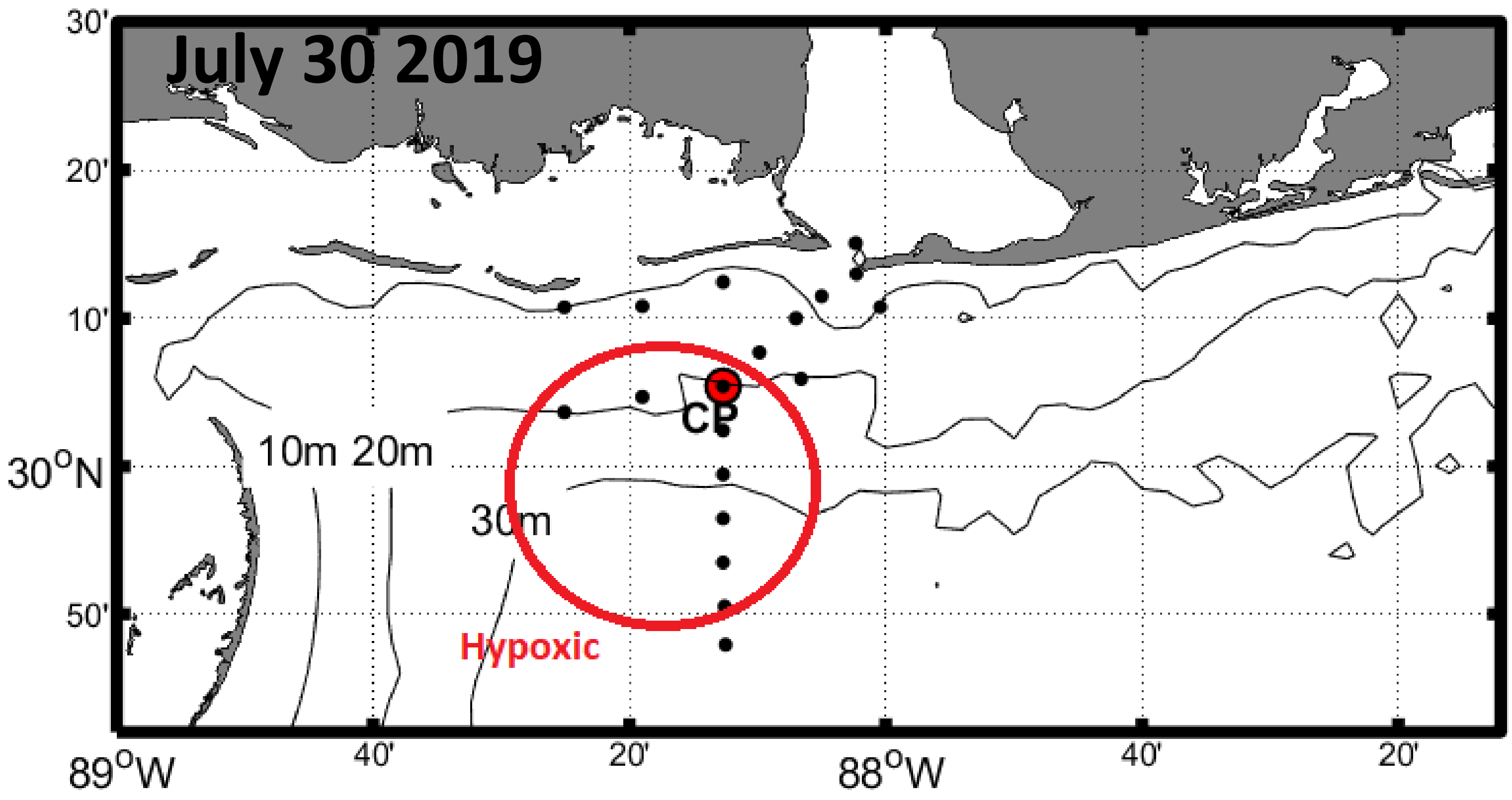

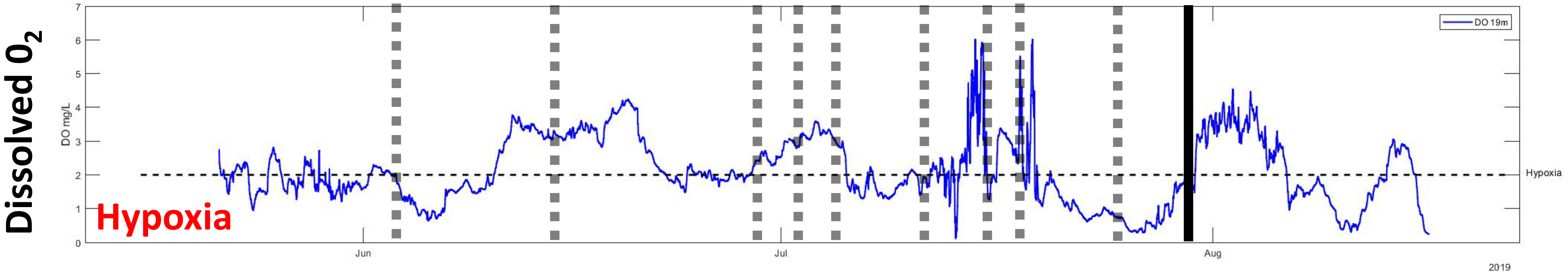

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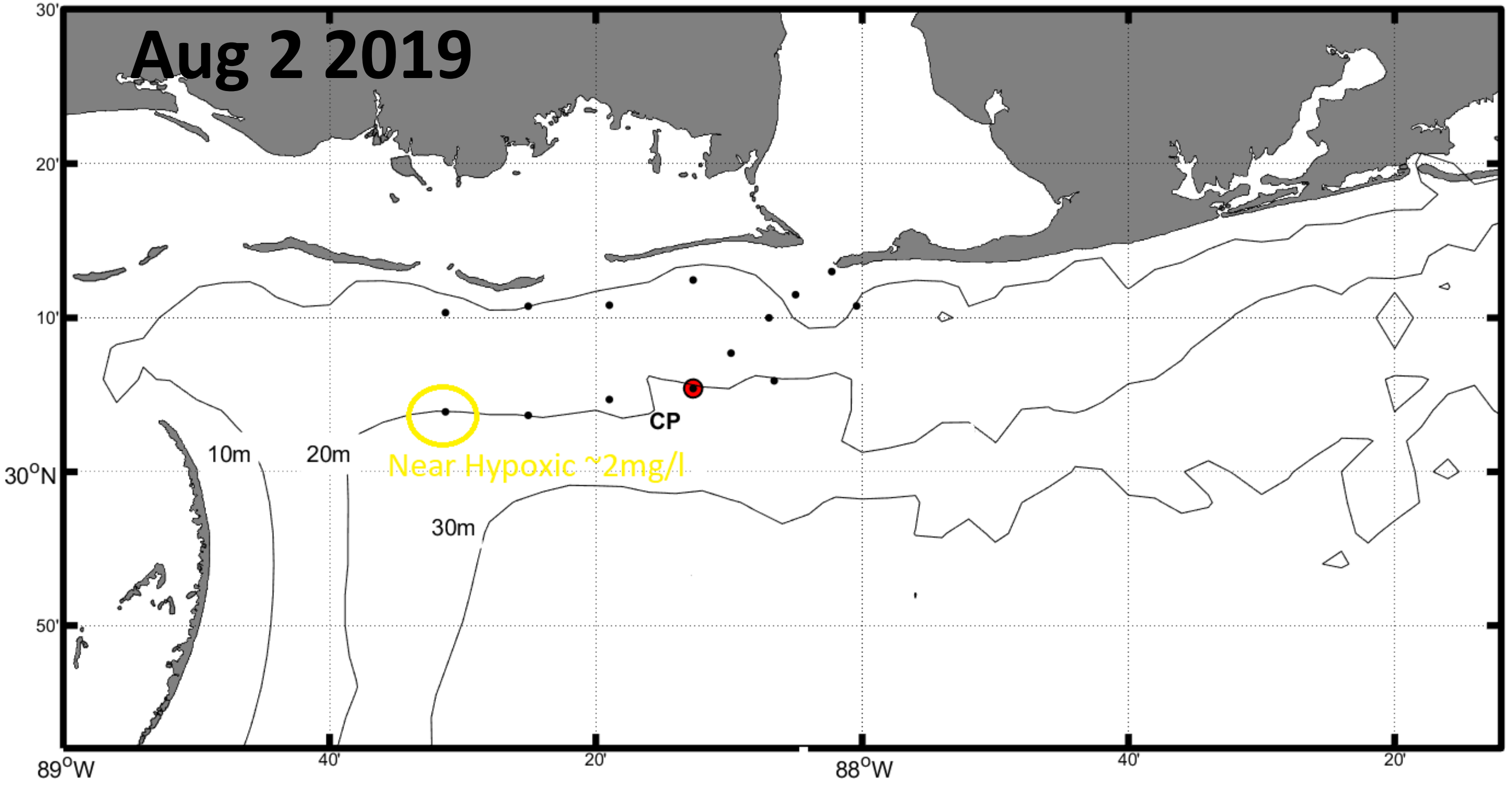

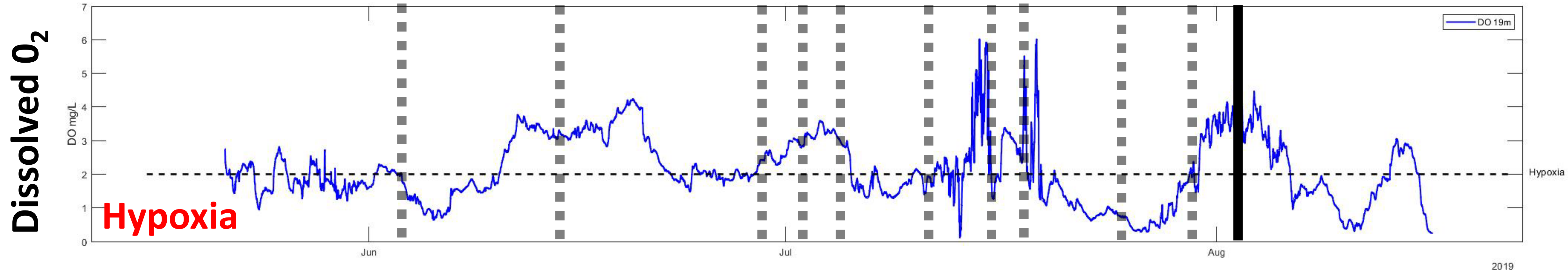

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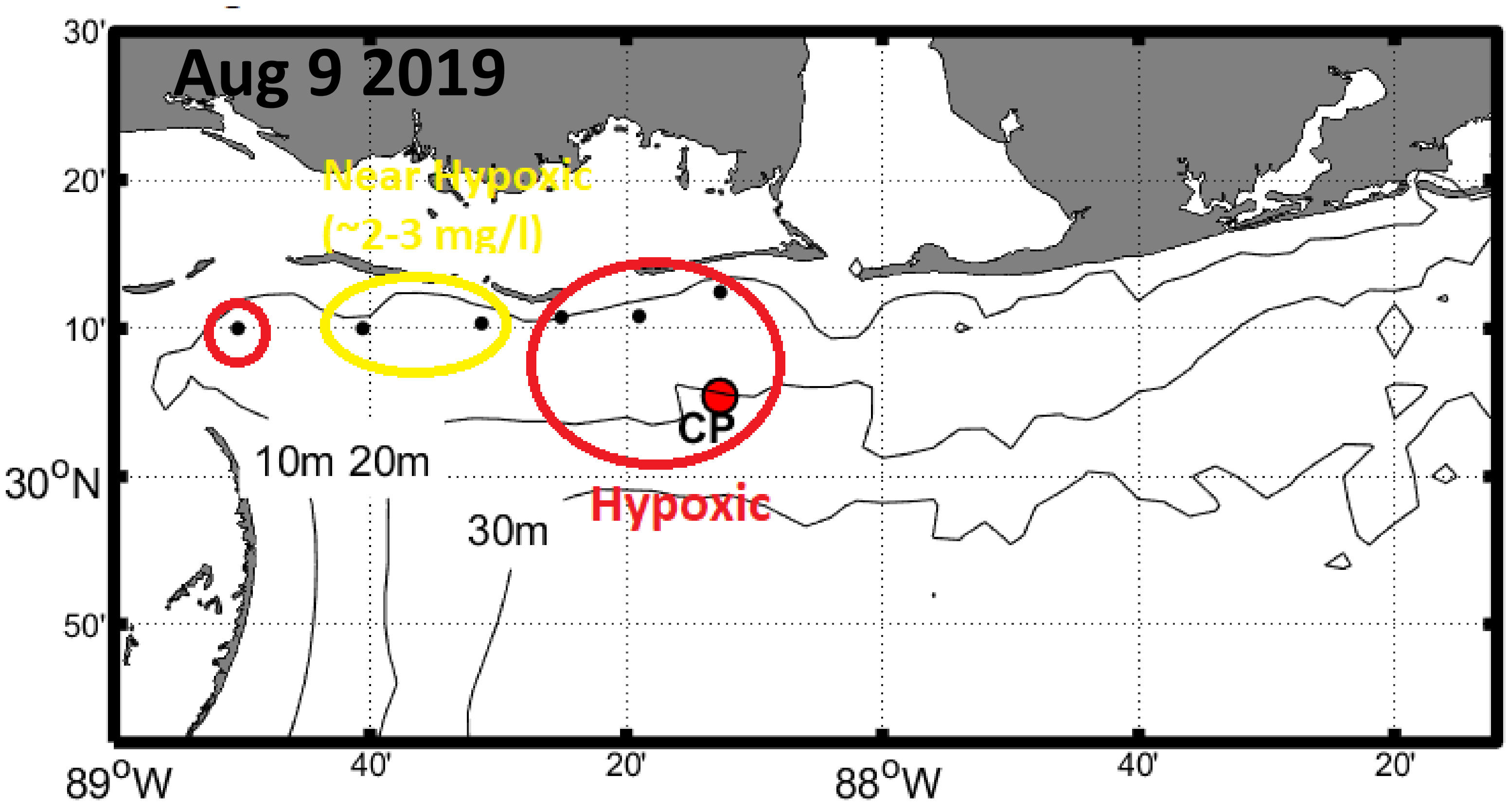
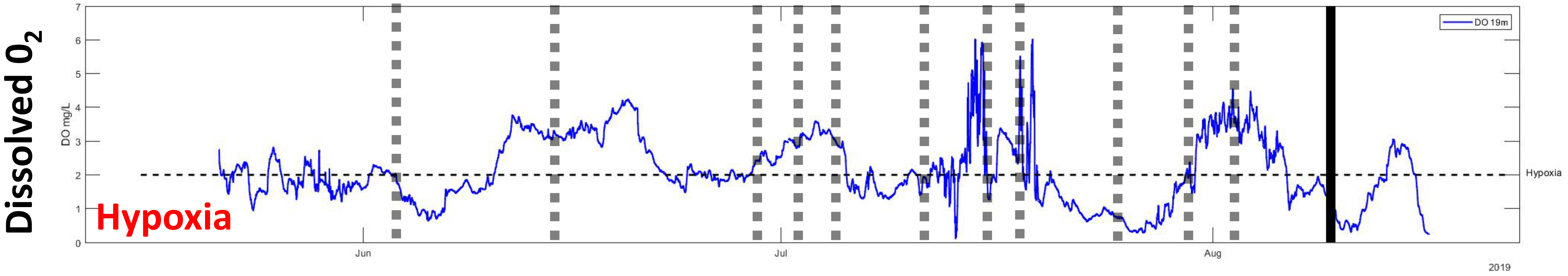
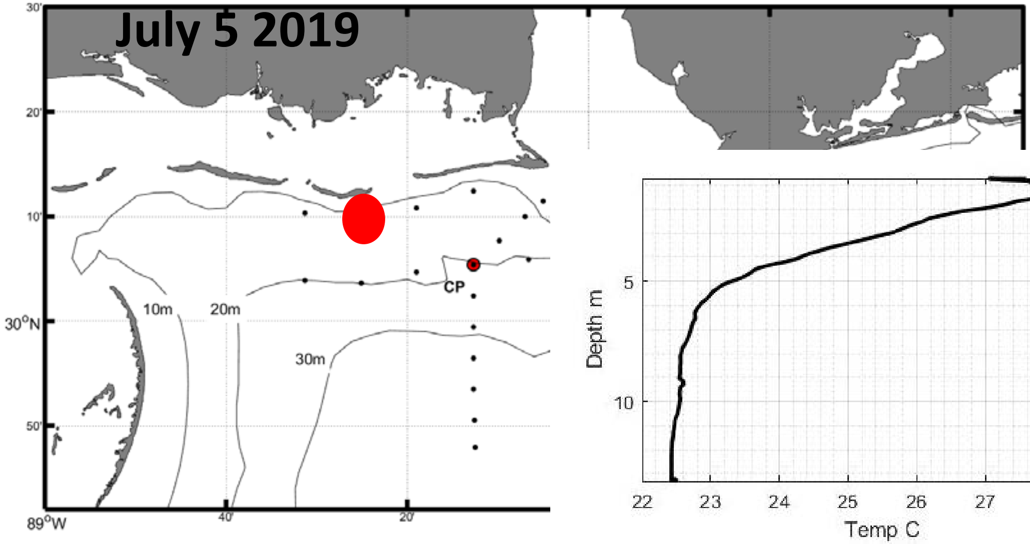
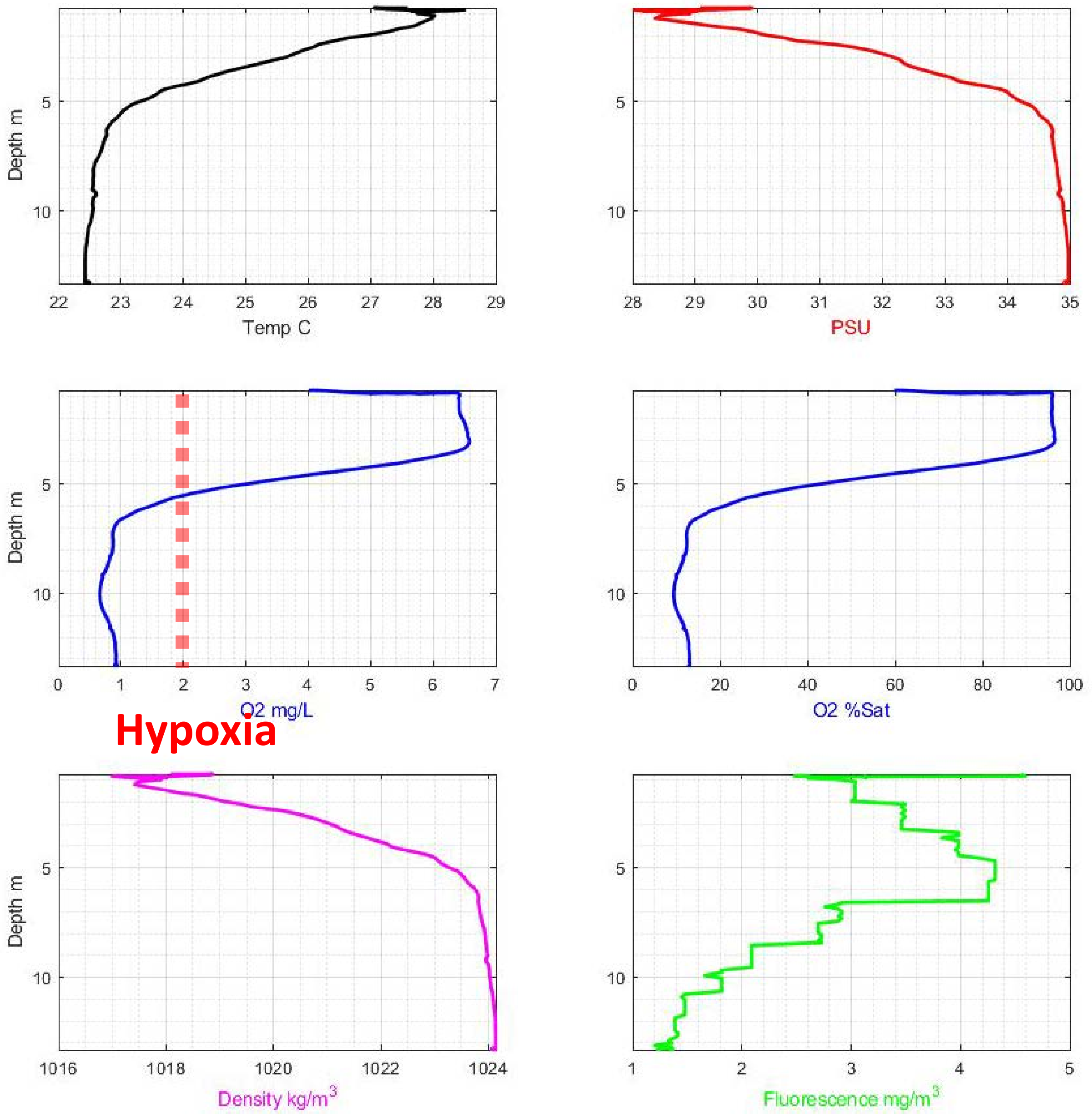




Spatial Structure

- Vertical features
  - Layer thickness can be determined from profile data
  - Extensive hypoxic in some regions
    - >50% of the water column in extreme cases

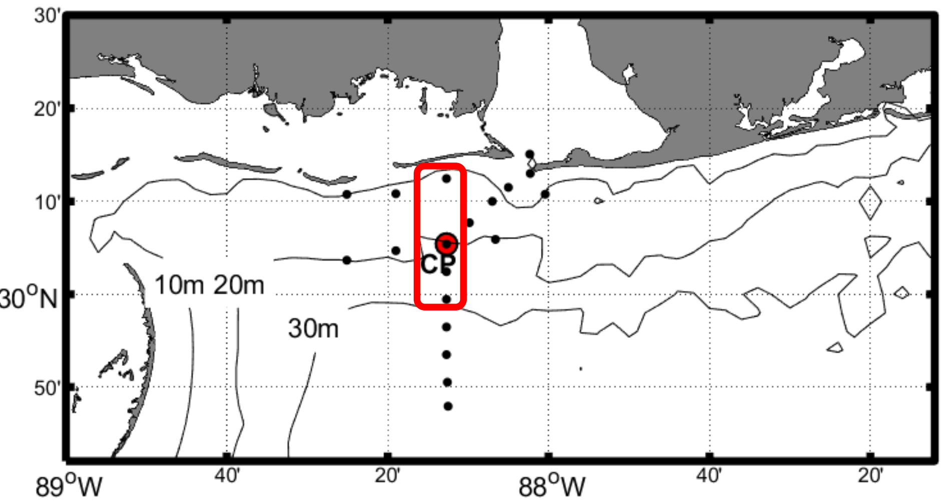


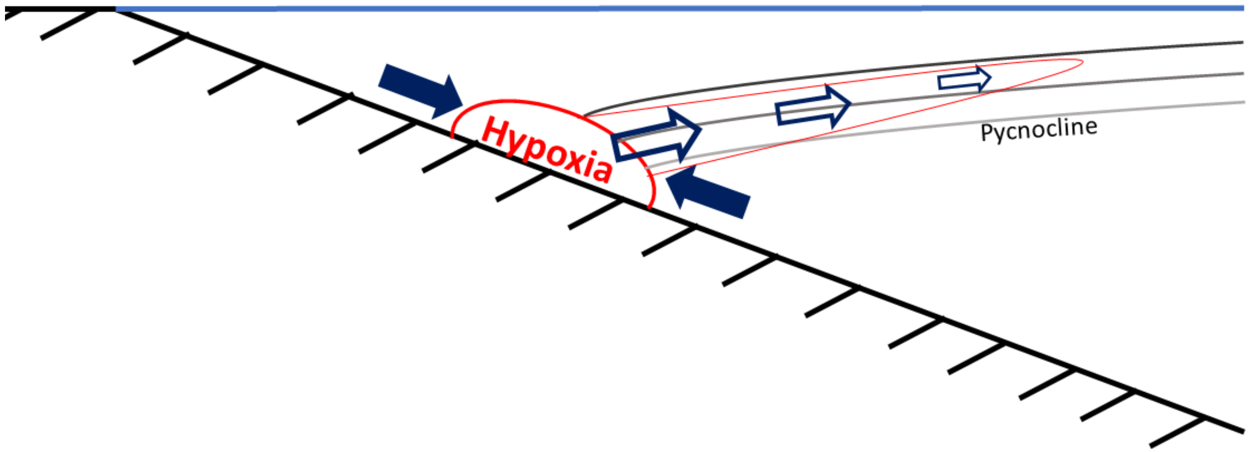


CTD profile data salinity data at FOCAL mooring

Spatial Structure

- Vertical features
  - Mid-depth minimum
  - Bottom boundary convergence?

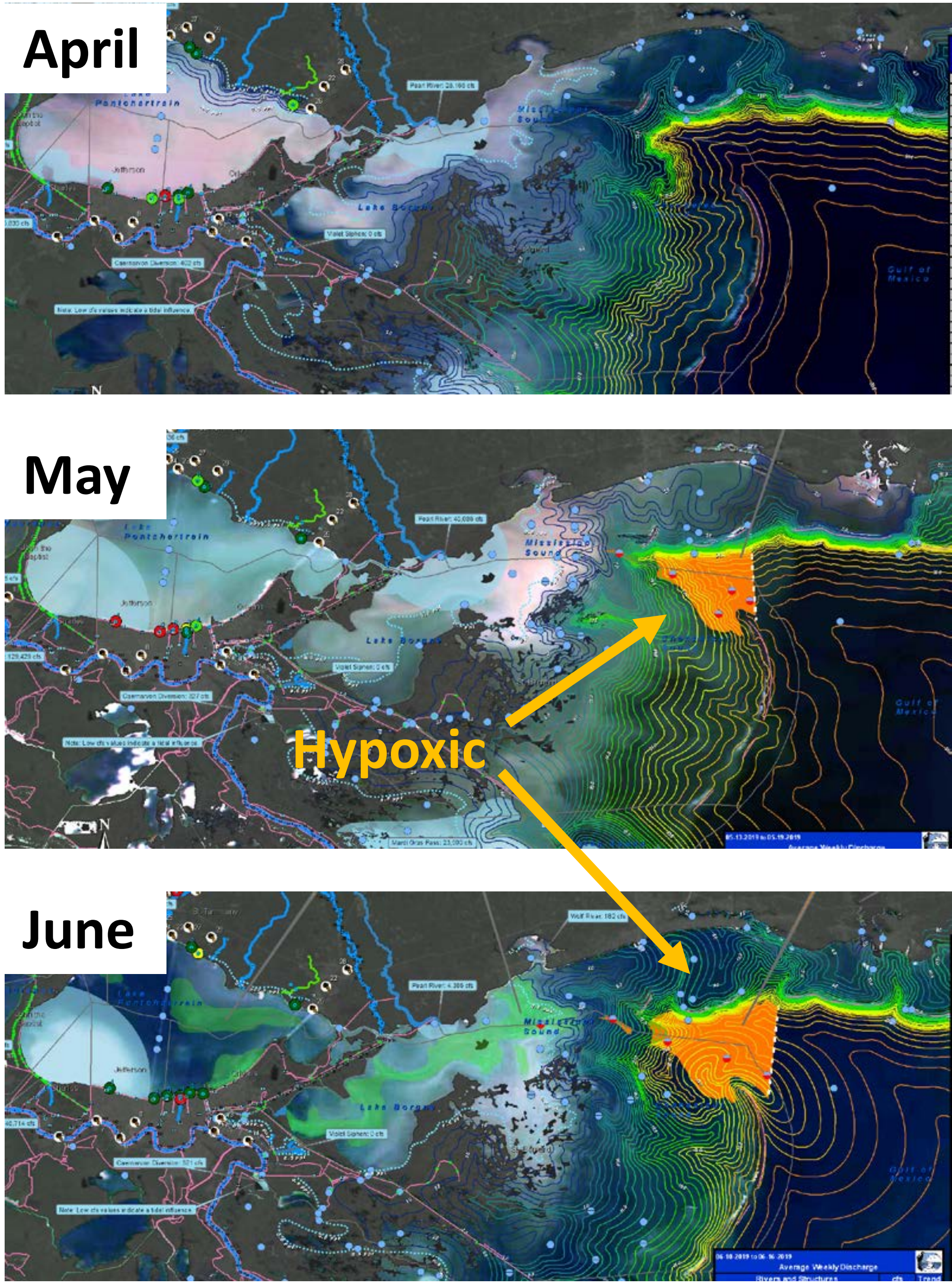




Progression of Hypoxia?

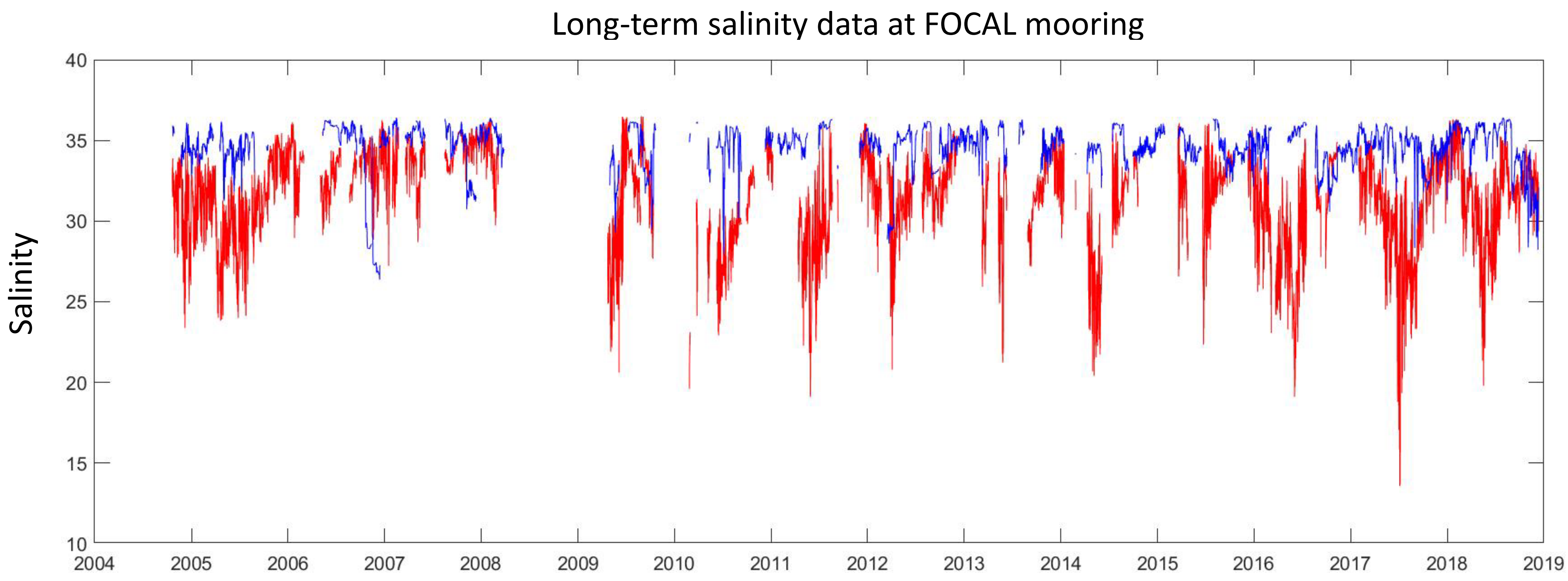
- What is source of hypoxia
  - Local generations ?
  - Advected into the region
    - Offshore vs. Along-shelf source

Hydrocoast Maps show persistent pocket of hypoxic water
(Courtesy of the Lake Pontchartrain Basin Foundations)
https://saveourlake.org/lpbf-programs/coastal/hydrocoast-maps/



Work in progress?

- Comparison to historical data at FOCAL mooring location
  - Time series of salinity (4-5 m depth)
  - CTD survey data (+80 casts during summer months since 2004)
  - Nutrient data – more limited



Conclusions

- May 2019 extremely low salinity values that normalized thereafter
- Summer 2019 had extensive periods of hypoxia on the shelf
- Hypoxia at FOCAL highly correlated with bottom temperature change
- Wind events appear to be key control on DO on the inner/mid-shelf transition
- Spatial patterns suggest broad areas of the shelf were hypoxic during summer 2019
- Understanding the coastal circulation patterns and physical conditions may help improve the management of these types of event going forward
- Still lots of analysis to be done on this data!!!!

Acknowledgements

- NOAA programs:
  Mississippi Alabama Sea Grant Consortium, Program Development Award
  NOAA Restore Science Program
  National Centers for Coastal Ocean Science, Harmful Algal Bloom Event Response award
- Tech Support Group at the Dauphin Island Sea Lab
- Lehrter and Robertson Labs

- Related Publications:

Dzwonkowski, B., S. Fournier, J.T. Reager, S. Milroy, K. Park, A. Greer, A. Shiller, I. Soto, S.L. Dykstra, and V. Sanial (2018) Tracking the sea surface salinity and dissolved oxygen on a seasonally stratified shelf, Mississippi, northern Gulf of Mexico, *Continental Shelf Research*, 169, 25-33. doi.org/10.1016/j.csr.2018.09.009

Coogan, J., B. Dzwonkowski, and J. Lehrter (Accepted 2019), Effects of coastal upwelling and downwelling on hydrographic variability and dissolved oxygen in Mobile Bay, *Journal of Geophysical Research*

Dzwonkowski, B., S. Fournier, K. Park, S. Dykstra*, and J.T. Reager (2018) Water column stability and the role of velocity shear on a seasonally stratified shelf, Mississippi Bight, Northern Gulf of Mexico, *Journal of Geophysical Research.* 123, https://doi.org/10.101029/2017JC013G24.