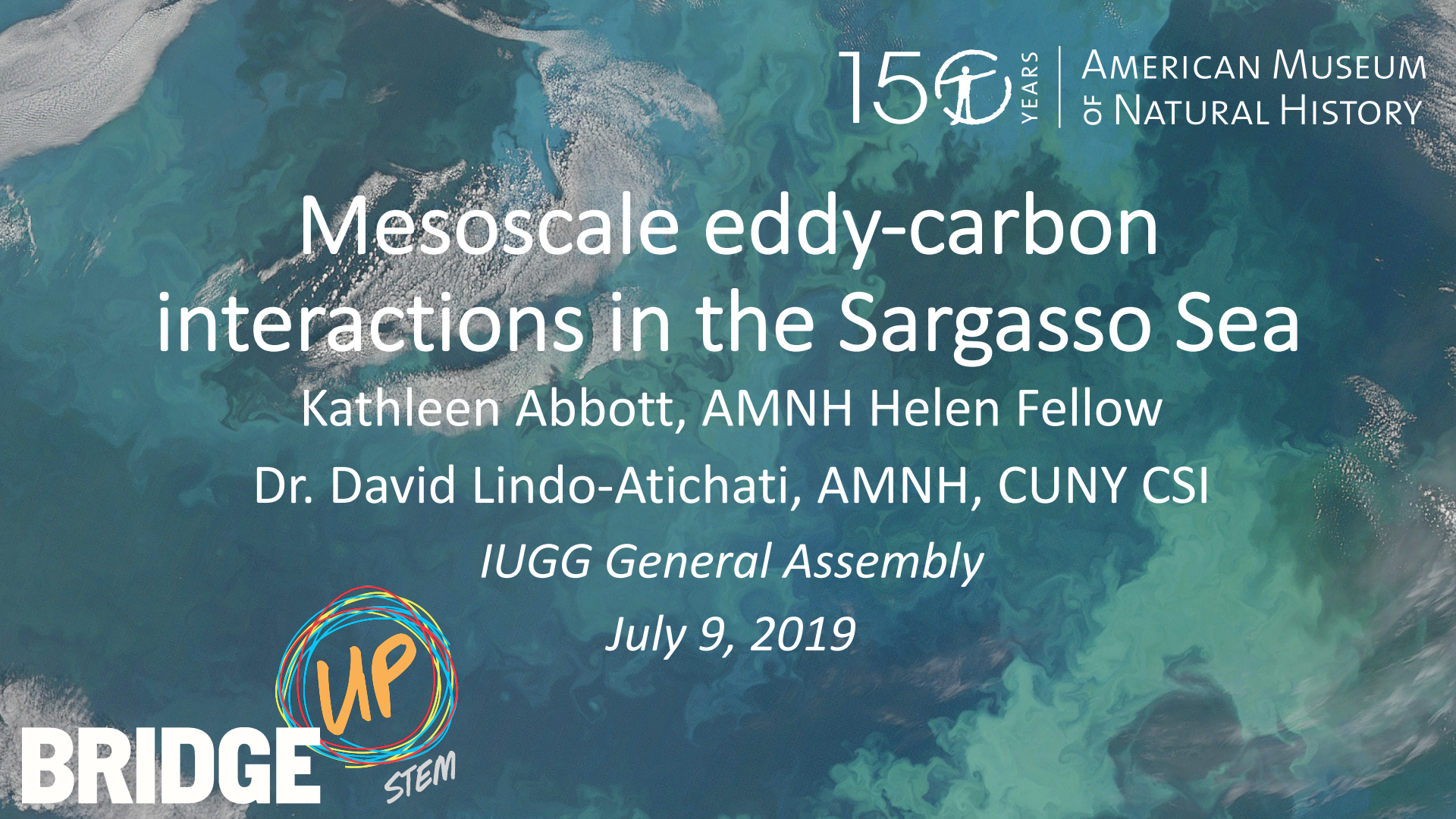

Mesoscale eddy-carbon interactions in the Sargasso Sea

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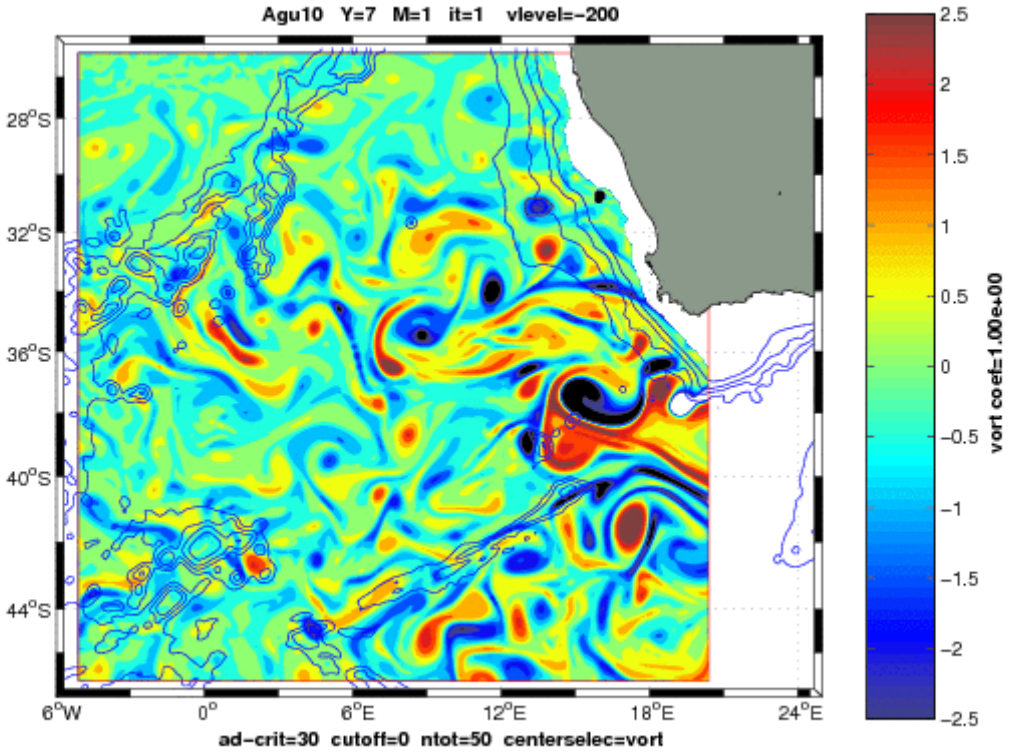
Dr. David Lindo-Atichati, AMNH, CUNY CSI

IUGG General Assembly

July 9, 2019

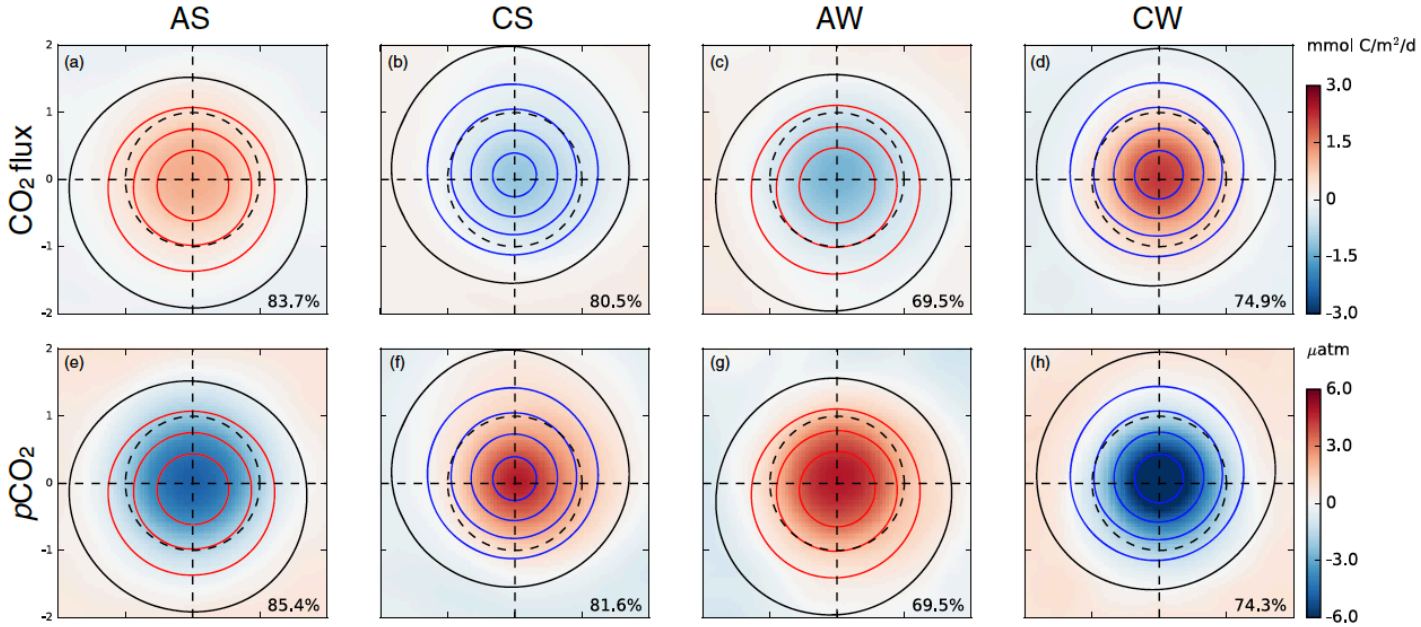
BRIDGE UP STEM

Mesoscale eddy-tracking and relative vorticity



Doglioli et al. (2006), South Atlantic

How can eddies modulate ocean carbon?

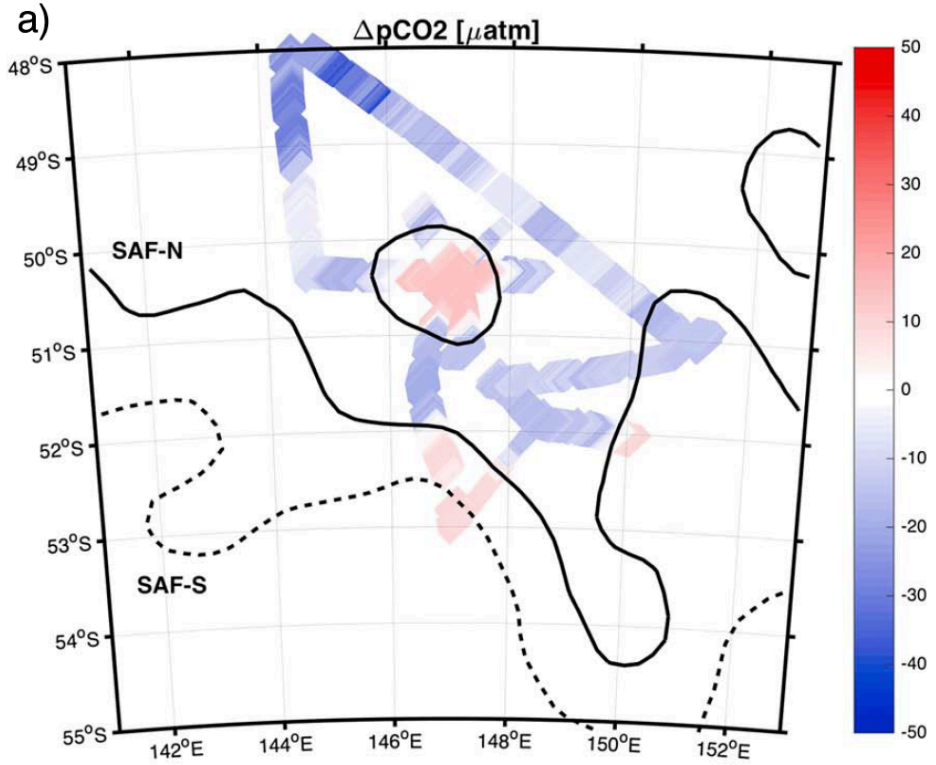


Song et al. (2016): Anticyclonic, cyclonic eddies drive seasonal pCO2 and CO2 flux anomalies along Drake Passage

How can eddies modulate ocean carbon?

Moreau et al. (2017):

- Tracked cyclonic eddy in Southern Ocean released more CO_2 into atmosphere than surrounding waters



Mechanism	Anticipated effect on pCO_2	
	Anticyclonic	Cyclonic
Temperature change	+	-
Eddy pumping	-	+
Photosynthesis (blooms)	+	-
Other	--	--

Motivating question

1. Do eddies of different polarities play a role in regulating air-sea CO_2 exchange in the Sargasso Sea?
2. If so, what is the temporal and spatial dependence of that modulation?

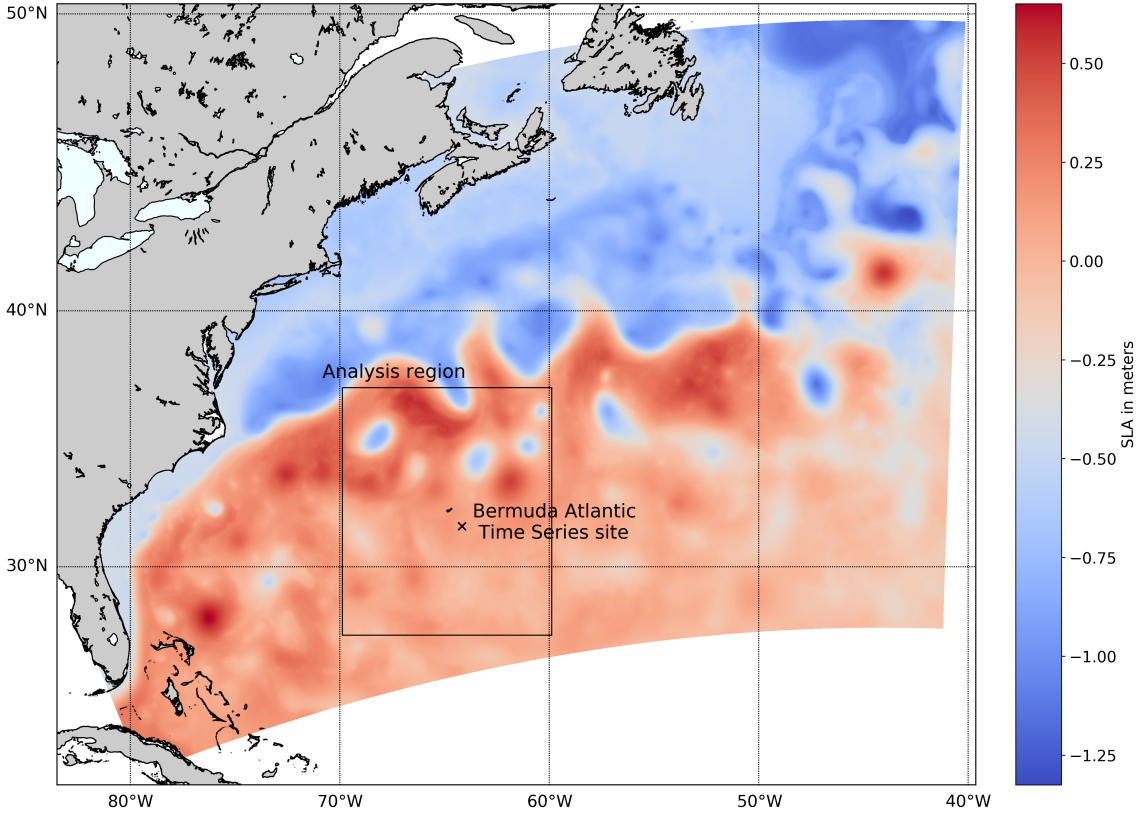
(Sub)mesoscale eddy dynamics in the Sargasso Sea

Study region

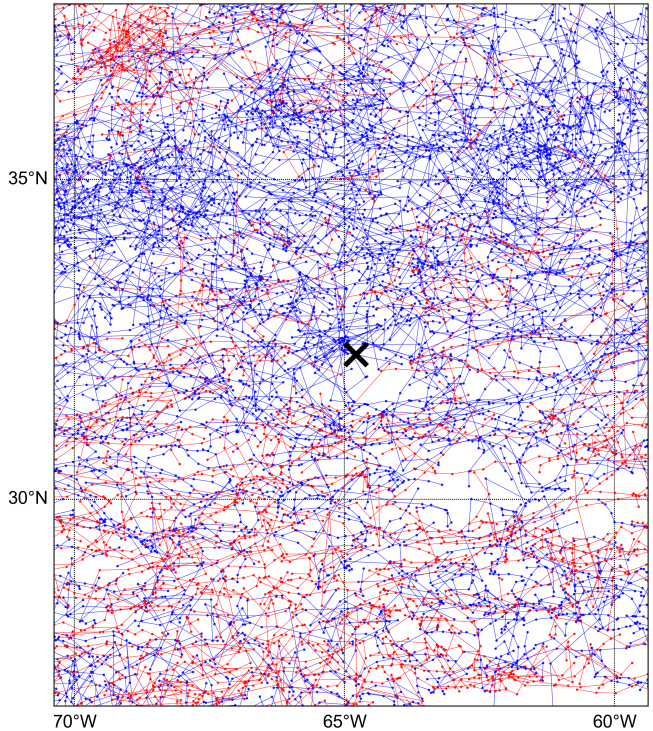
Sea level anomaly data from:

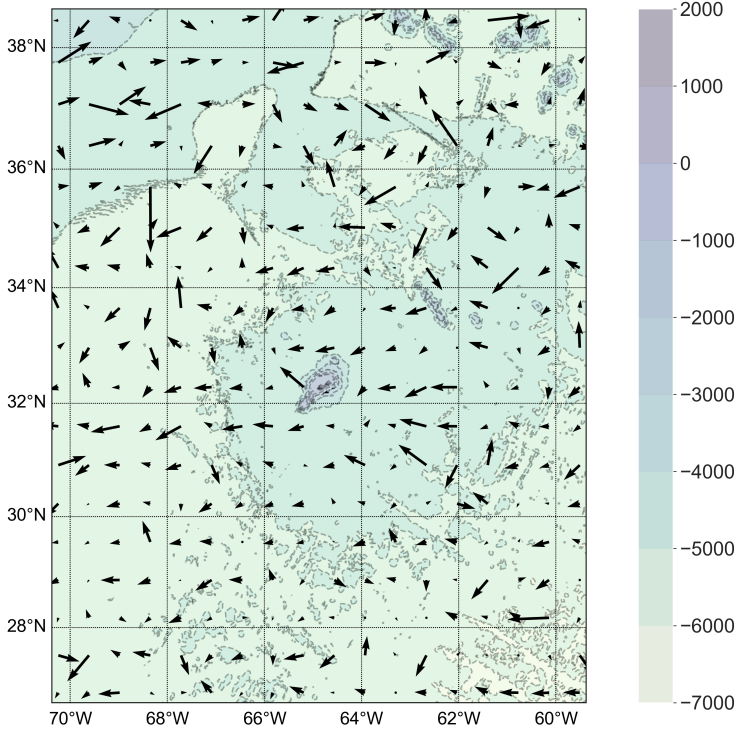
- Regional Ocean Modeling System model data (Gula et al. 2015)

Eddies identified with py-eddy-tracker (Mason et al. 2014)

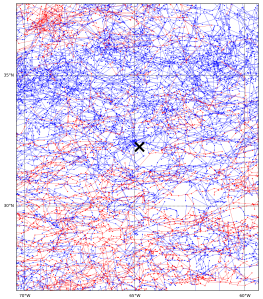


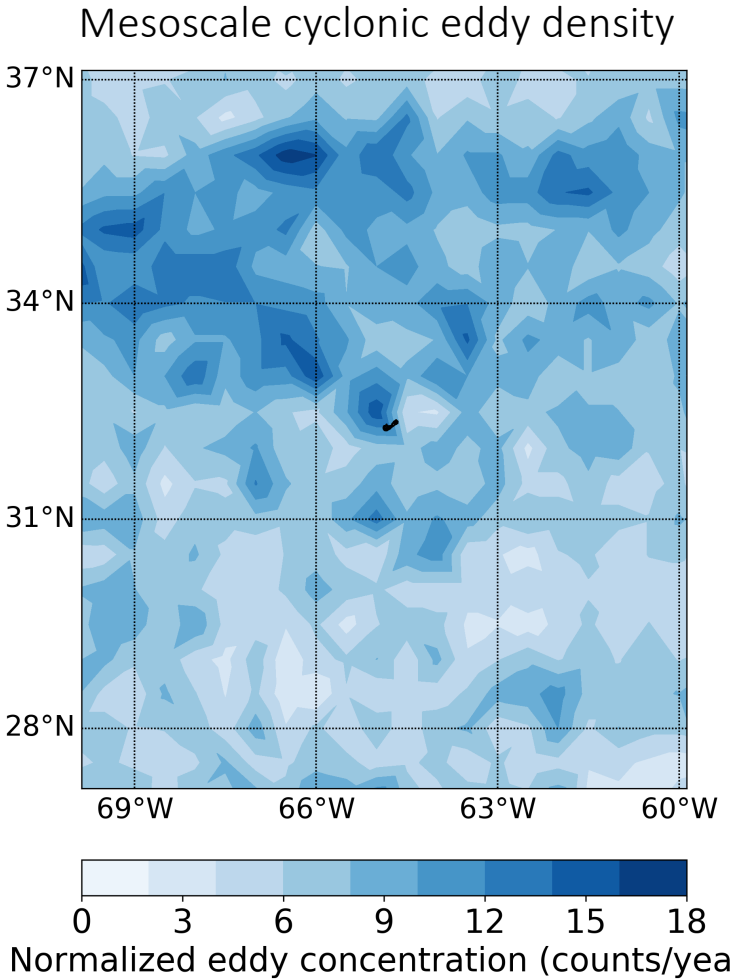
Eddies in study region from model

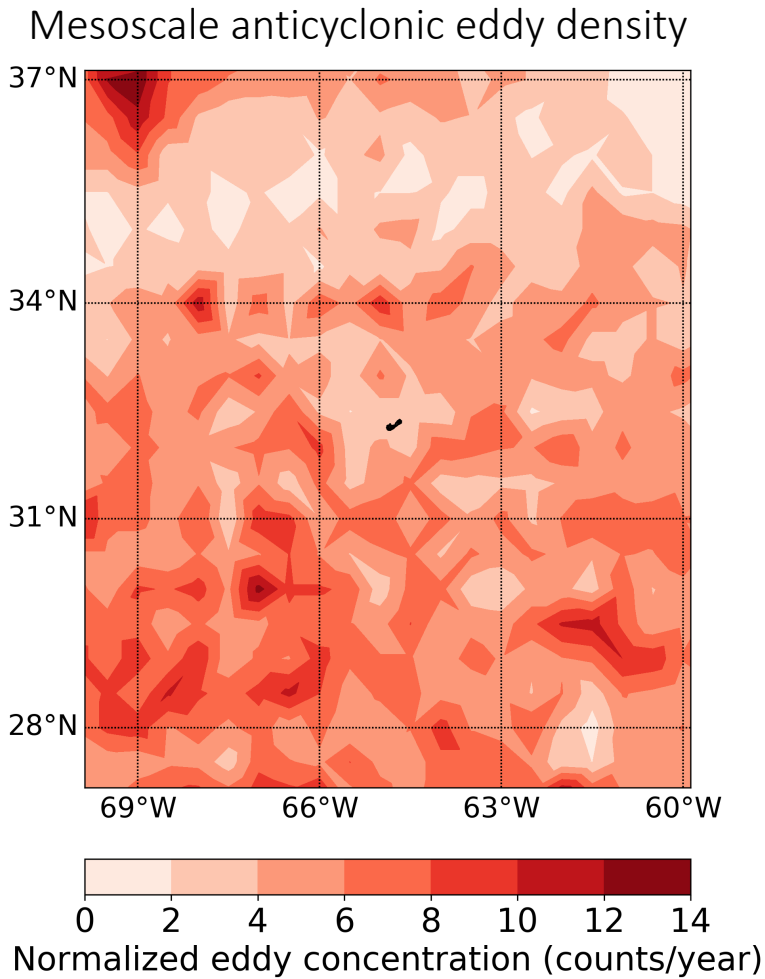




Left: 18 years of cyclonic and anticyclonic eddy tracks near Bermuda. **Right**: Average propagation direction of eddies.

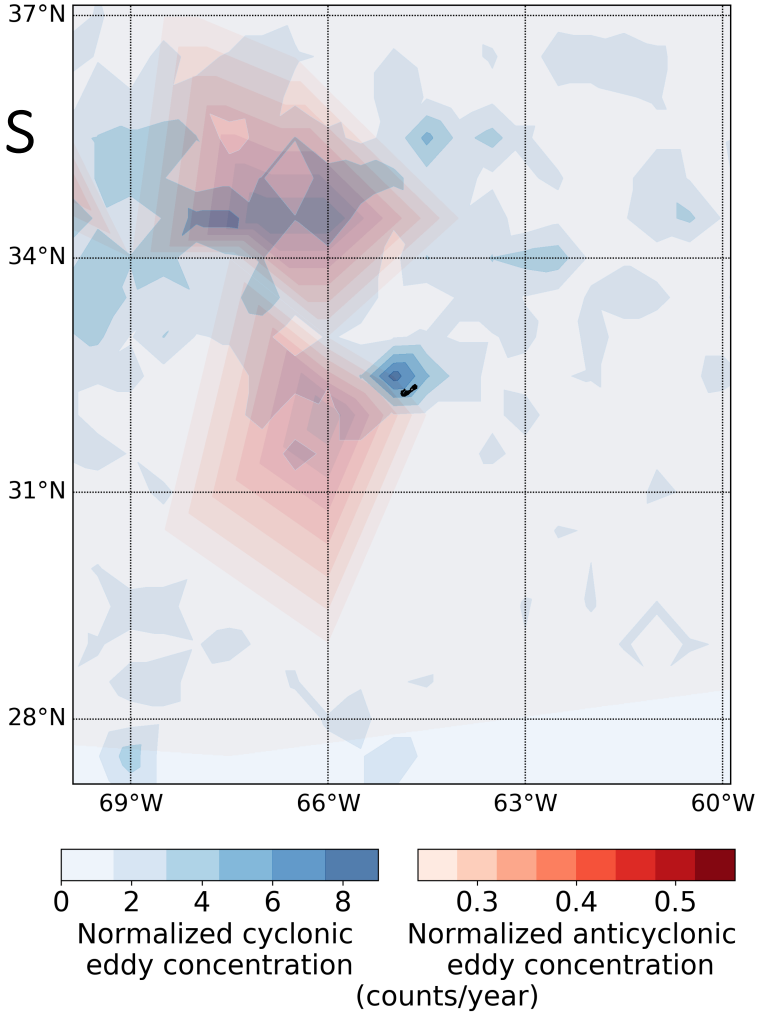



Mesoscale cyclonic eddy density
37°N
34°N
31°N
28°N
69°W
66°W
63°W
60°W
0
3
6
9
12
15
18
Normalized eddy concentration (counts/year)


Mesoscale anticyclonic eddy density
37°N
34°N
31°N
28°N
69°W
66°W
63°W
60°W
0
2
4
6
8
10
12
14
Normalized eddy concentration (counts/year)

Annual submesoscale eddies

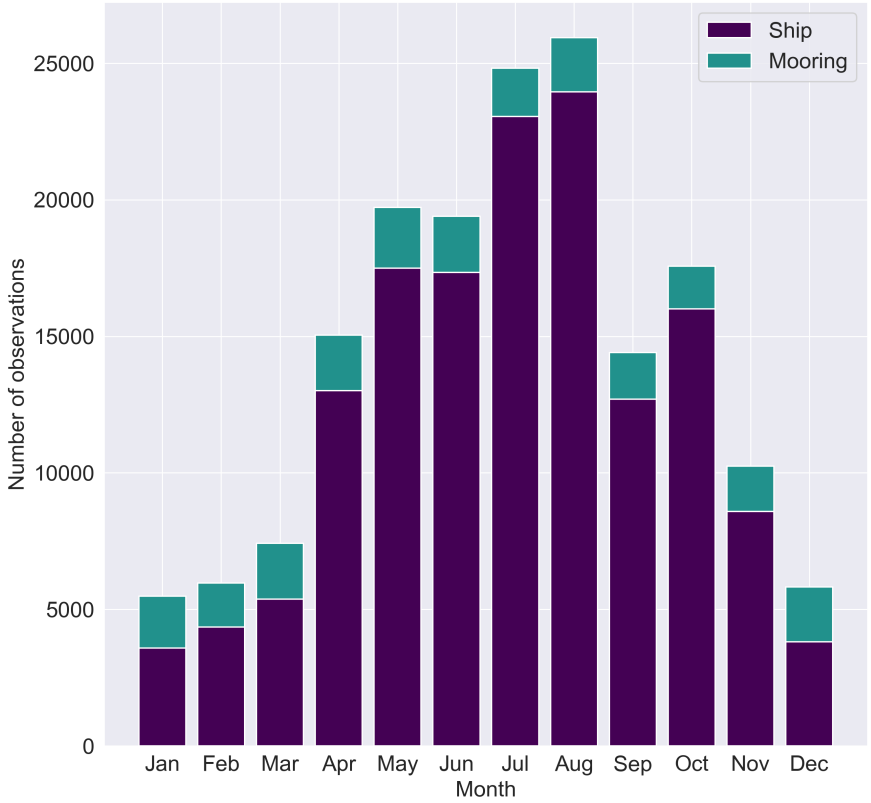
- Submesoscale: <10 km
- Satellite resolution is .25°
  - ~30 km
- ROMS model ~2.5 km



CO_2 flux modulation by (sub)mesoscale eddies

Data

- **More than 100k observations** of surface ocean fCO_2 from Surface Ocean Carbon Atlas
- 1993 to 2017
- AVISO sea level anomaly data



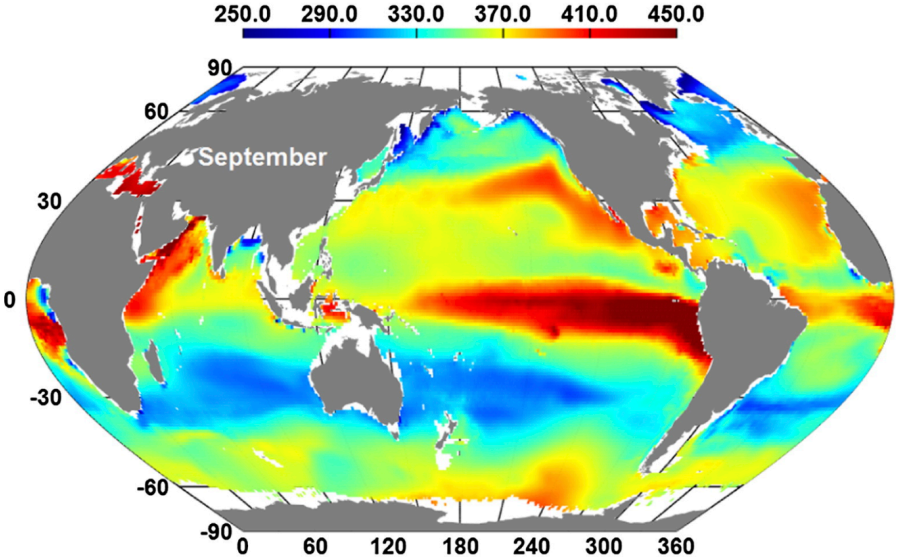
Methods

Processing:

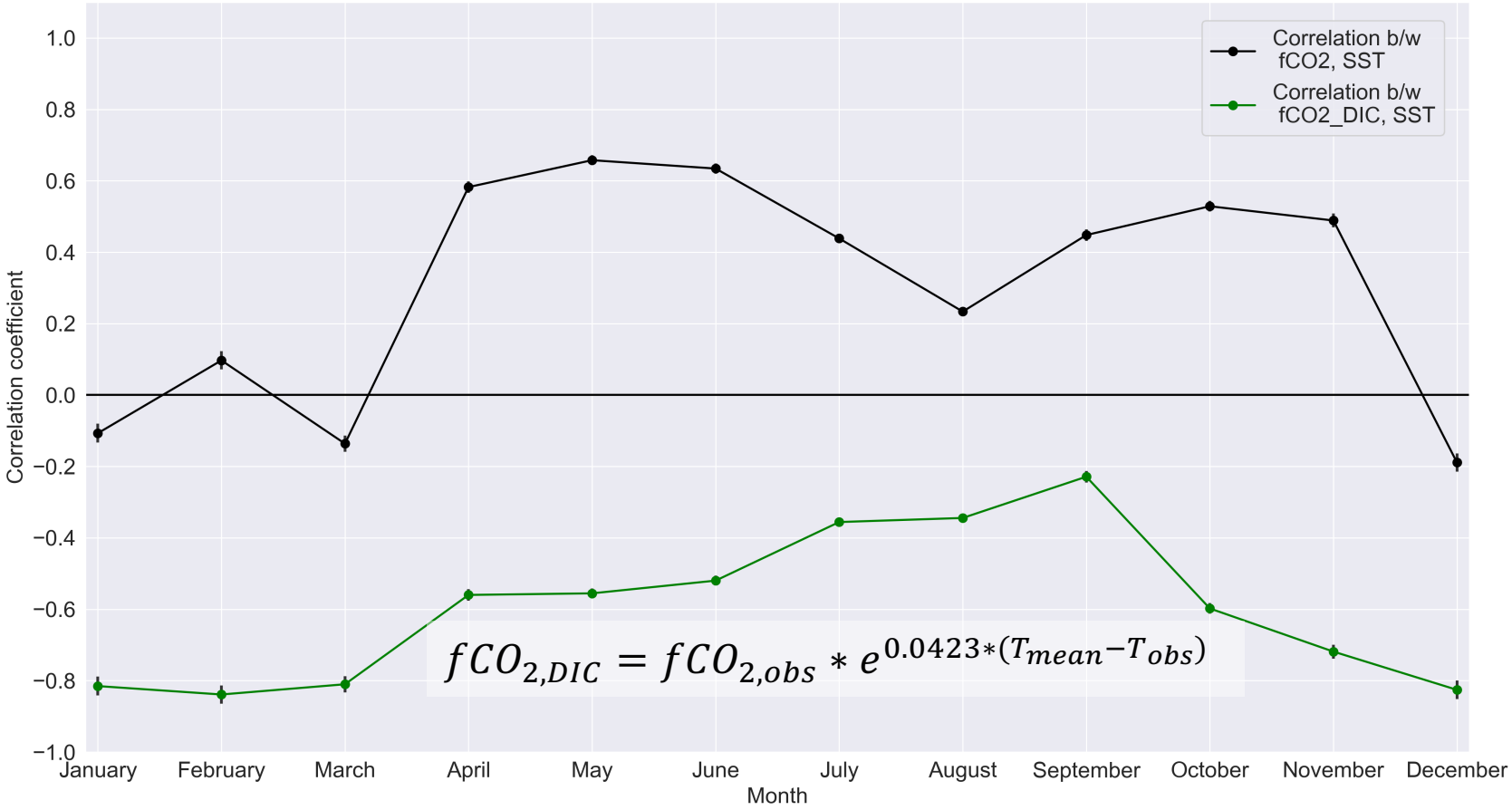
- Calculate fCO2, SST anomalies using fCO2 climatology from Zeng et al. (2014)

Analysis:

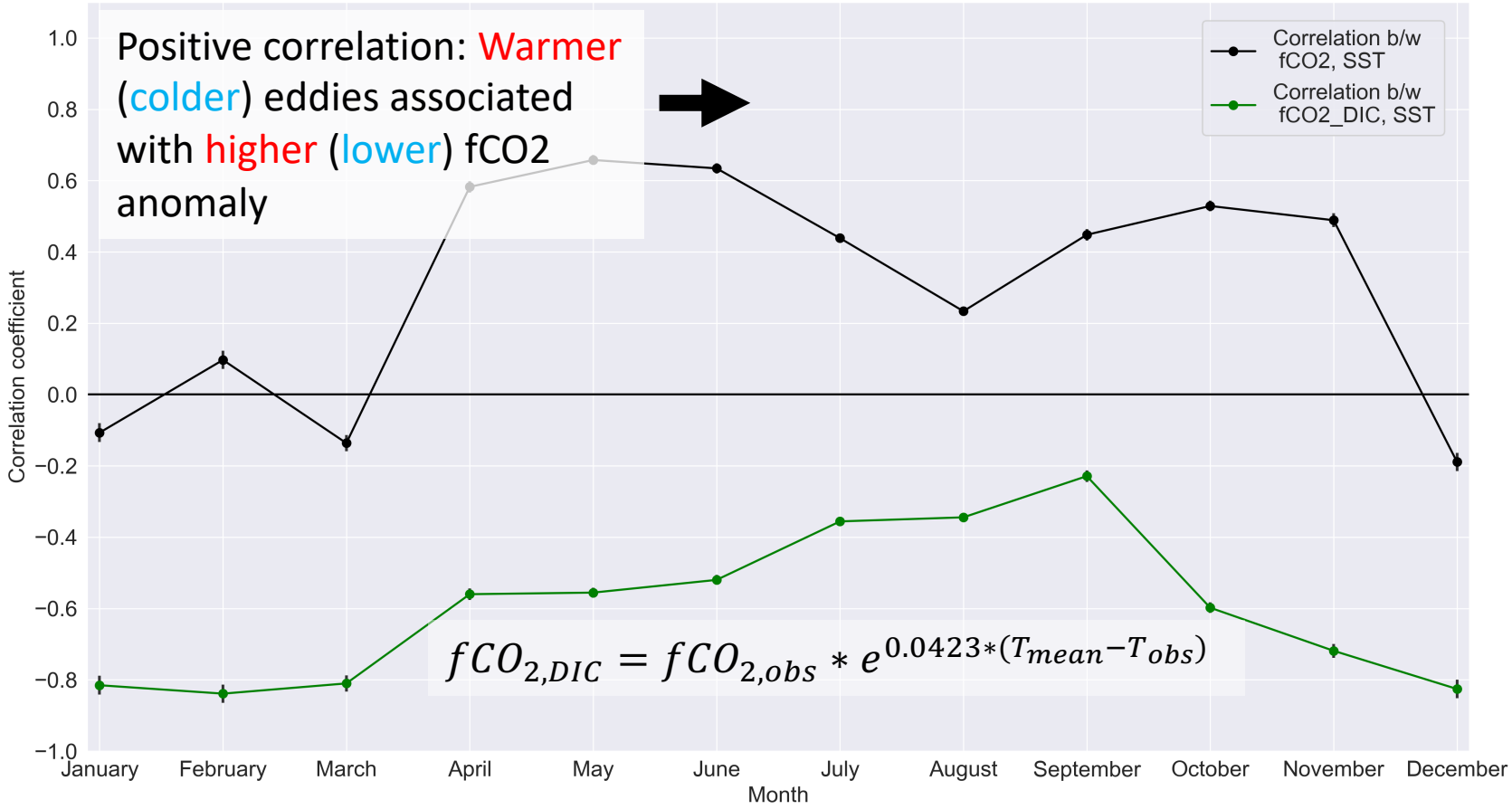
- Monthly correlations
- Spatial composites
- Individual eddy composite



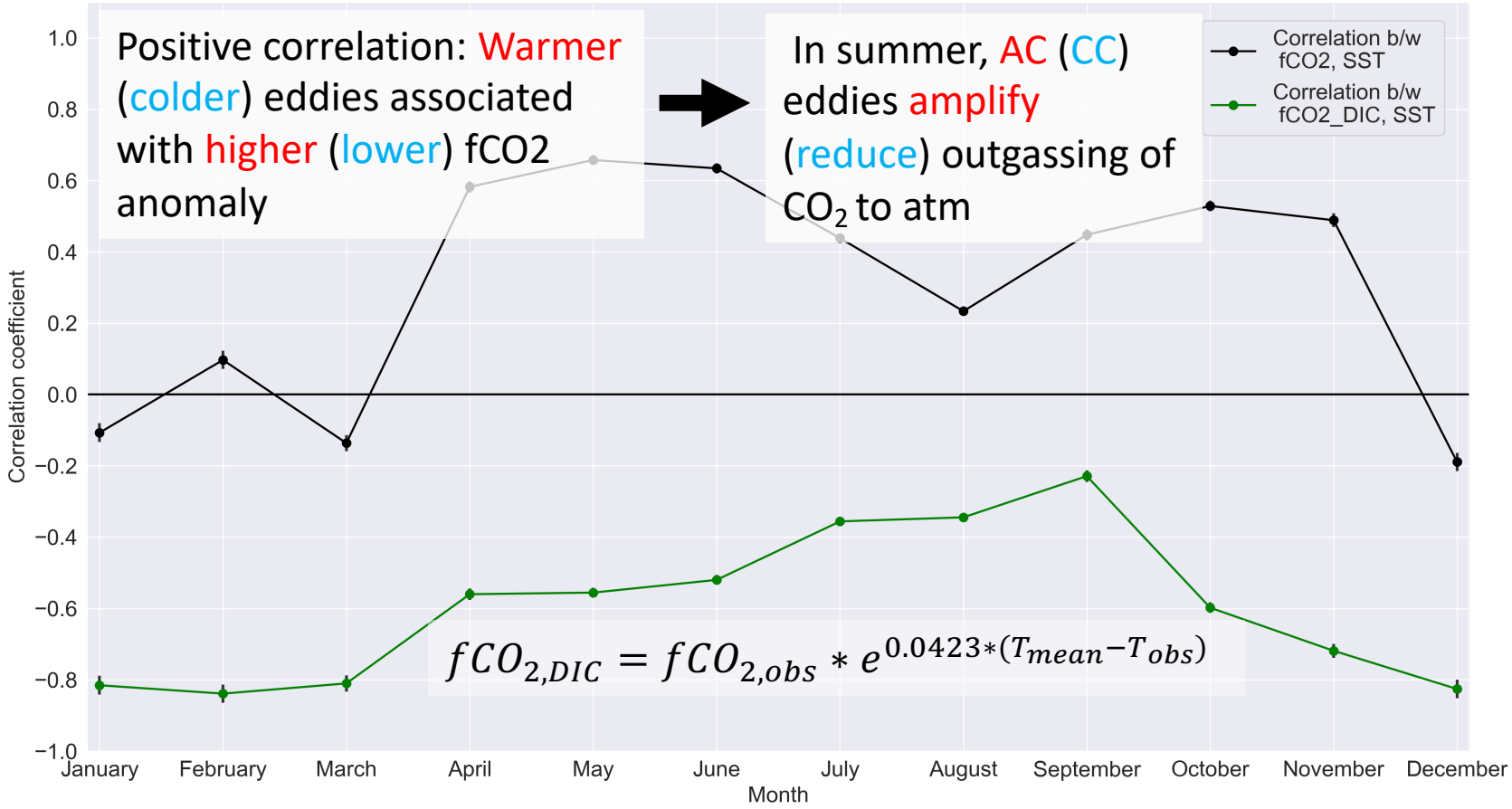
September fCO_2 climatology (1° x 1°) from Zeng et al. (2014)



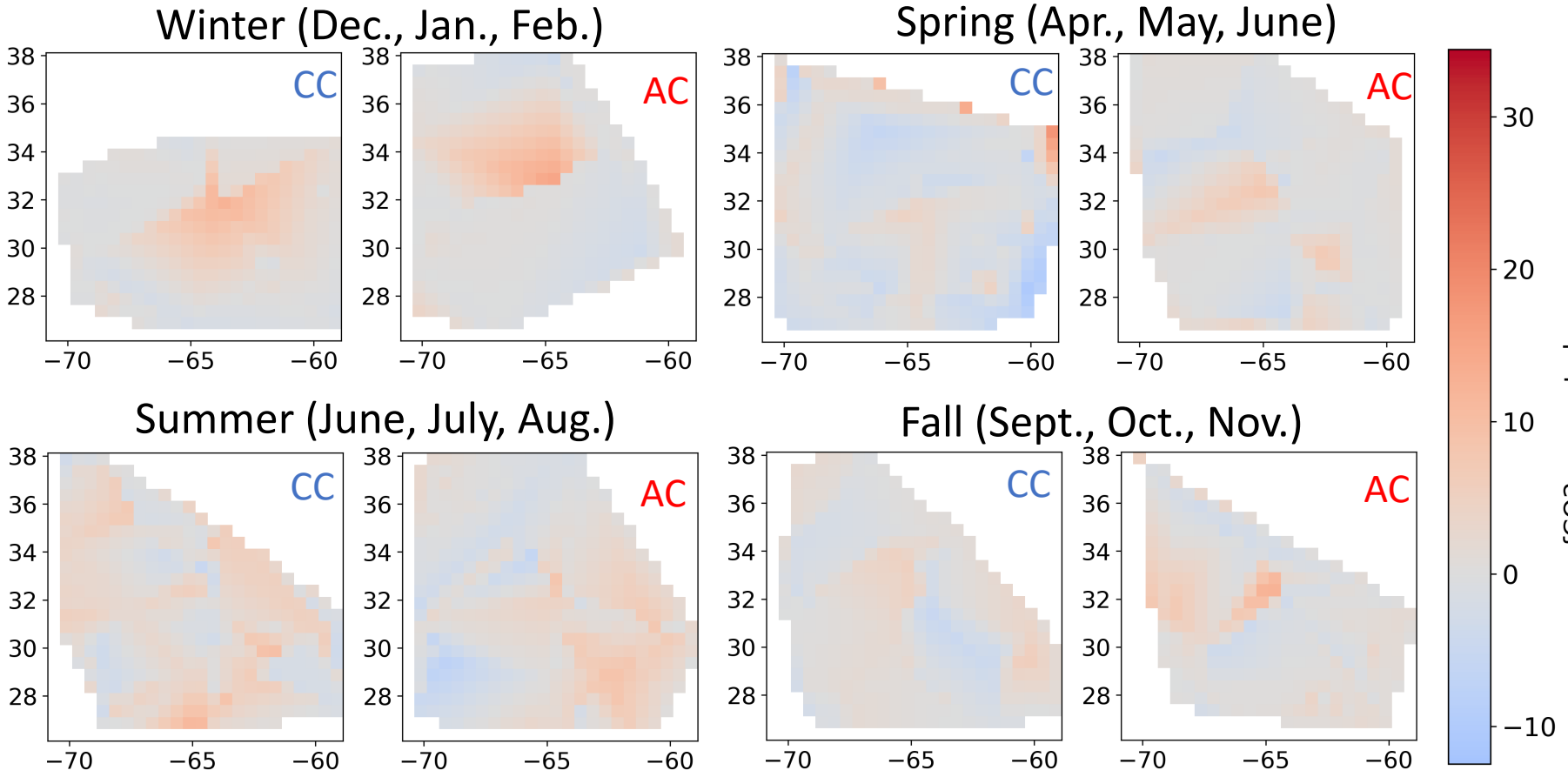
Monthly correlation between SST anomaly, fCO_2 anomaly



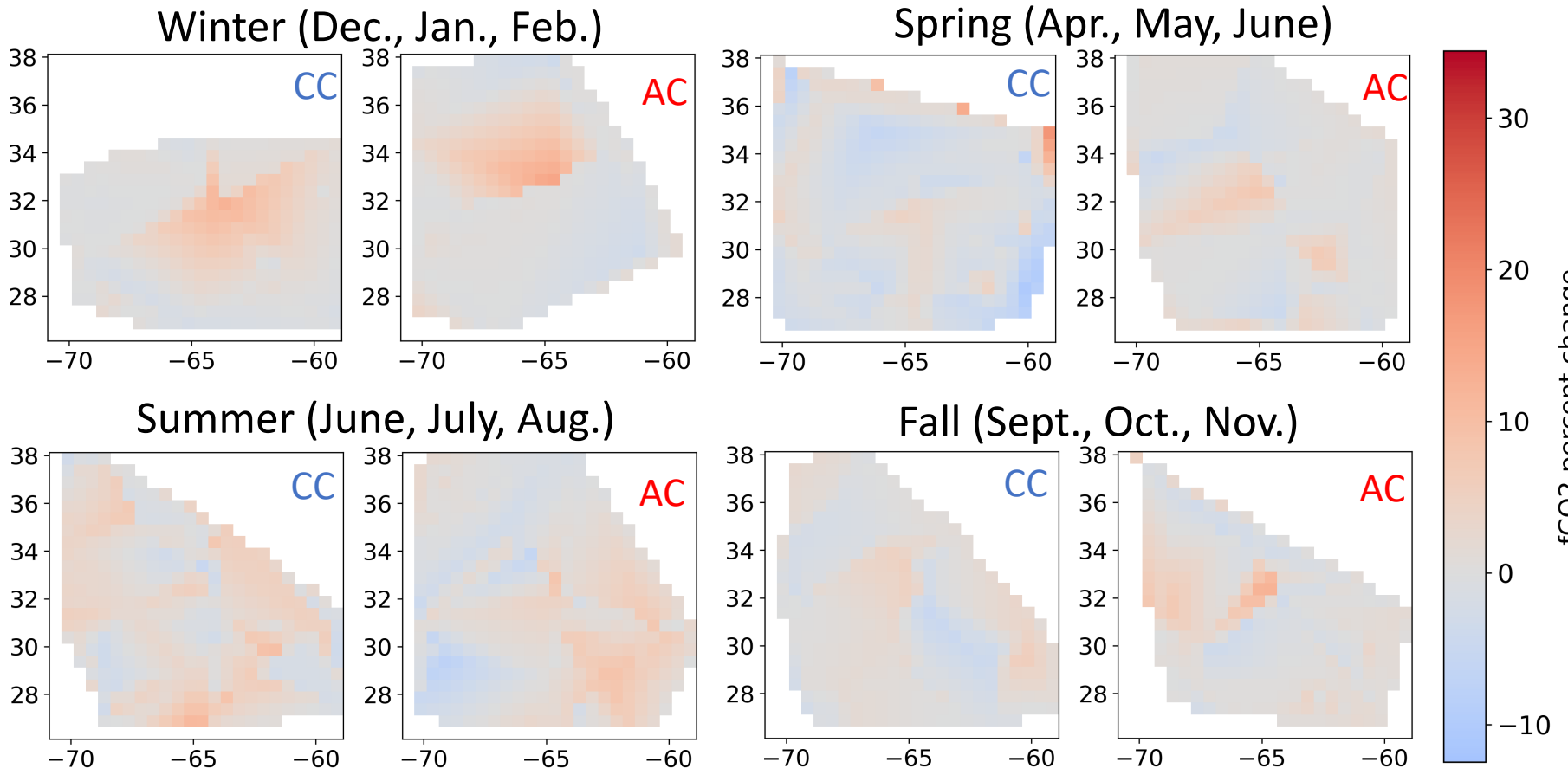
Monthly correlation between SST anomaly, fCO_2 anomaly



Monthly correlation between SST anomaly, fCO_2 anomaly



Spatial composites: $\boldsymbol{\delta}fCO_2$ in eddy cores (0 to 0.5 normalized radius)

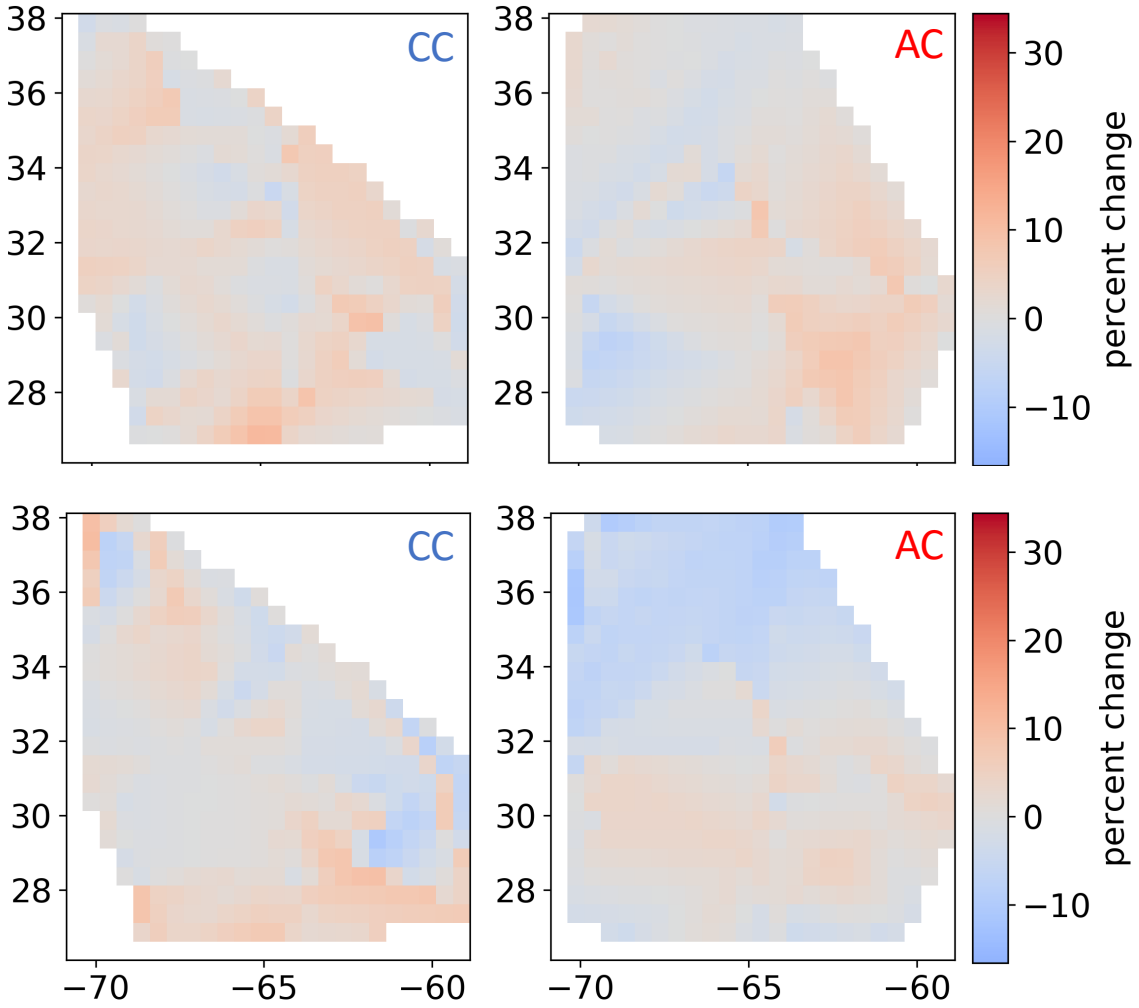


Spatial composites → Small but positive δfCO_2 within eddy cores

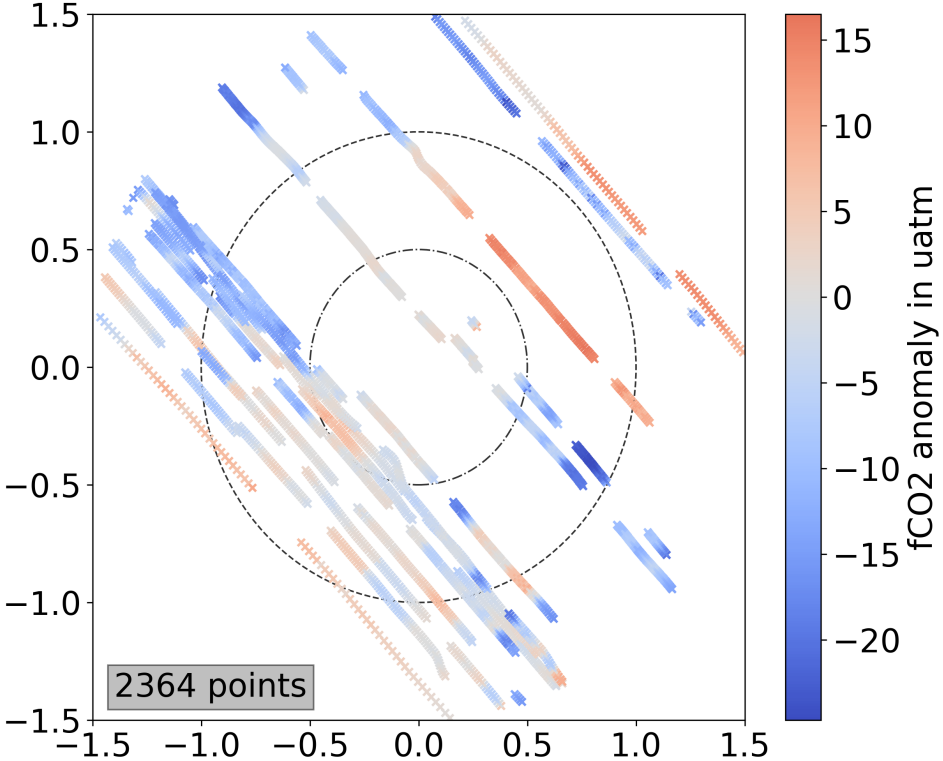
Spatial composites within eddy cores

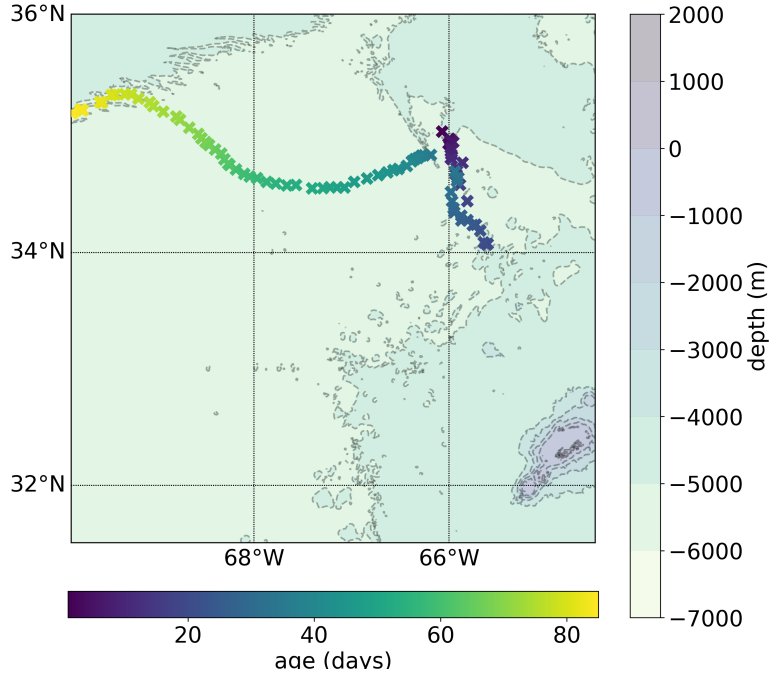
fCO_2 anomalies in summer (June, July, August)

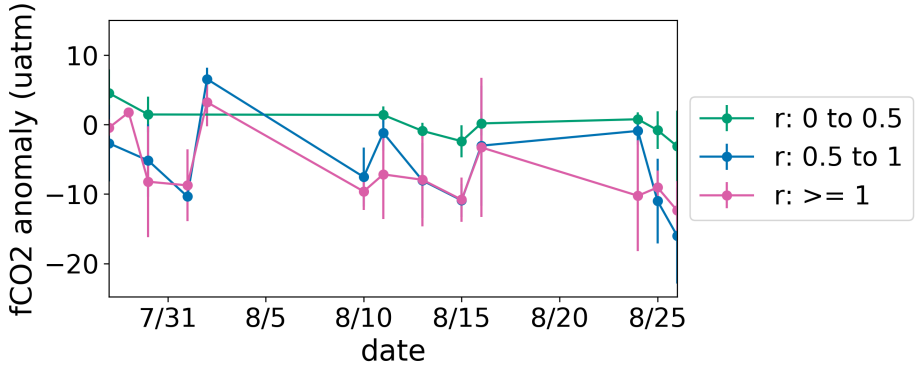
$fCO_{2,DIC}$ anomalies in summer (June, July, August)



Cyclonic eddy: July 13, 2014 to Sept. 21, 2014







Conclusions

- Evidence of eddy-driven changes in fCO_2 near Bermuda
  - Overall slightly positive fCO_2 anomaly, with seasonal variability
- Upwelling, temperature mechanisms may cancel out fCO_2 change within different polarity eddies
- Seasonality, eddy radius likely play important roles

Next steps

- Calculate air-sea CO_2 flux from anomalies
- Integrate biochemical data to untangle effects of different eddy mechanisms
- Couple biogeochemical model with physical (ROMS) model

Acknowledgements

- Helen Gurley Brown Revocable Trust
- Evan Mason, Jon Gula and Jim McWilliams
- Supervisors: Louise Crowley and Yvonne De La Peña