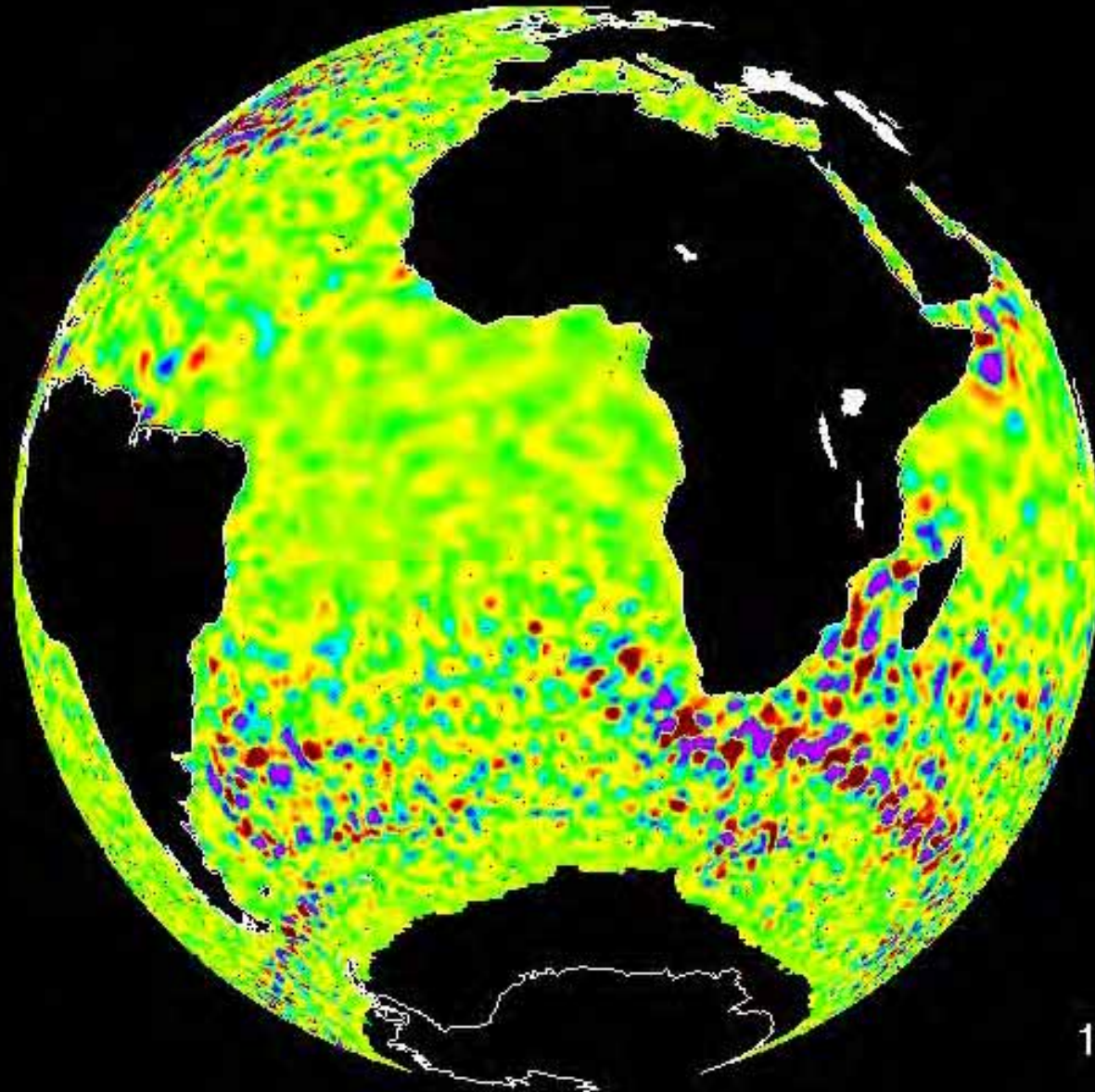


Observations of Nonlinear Mesoscale Eddies

SSH from the merged altimetry data (Ducet *et al.*, 2000, Chelton *et al.*, 2011b)

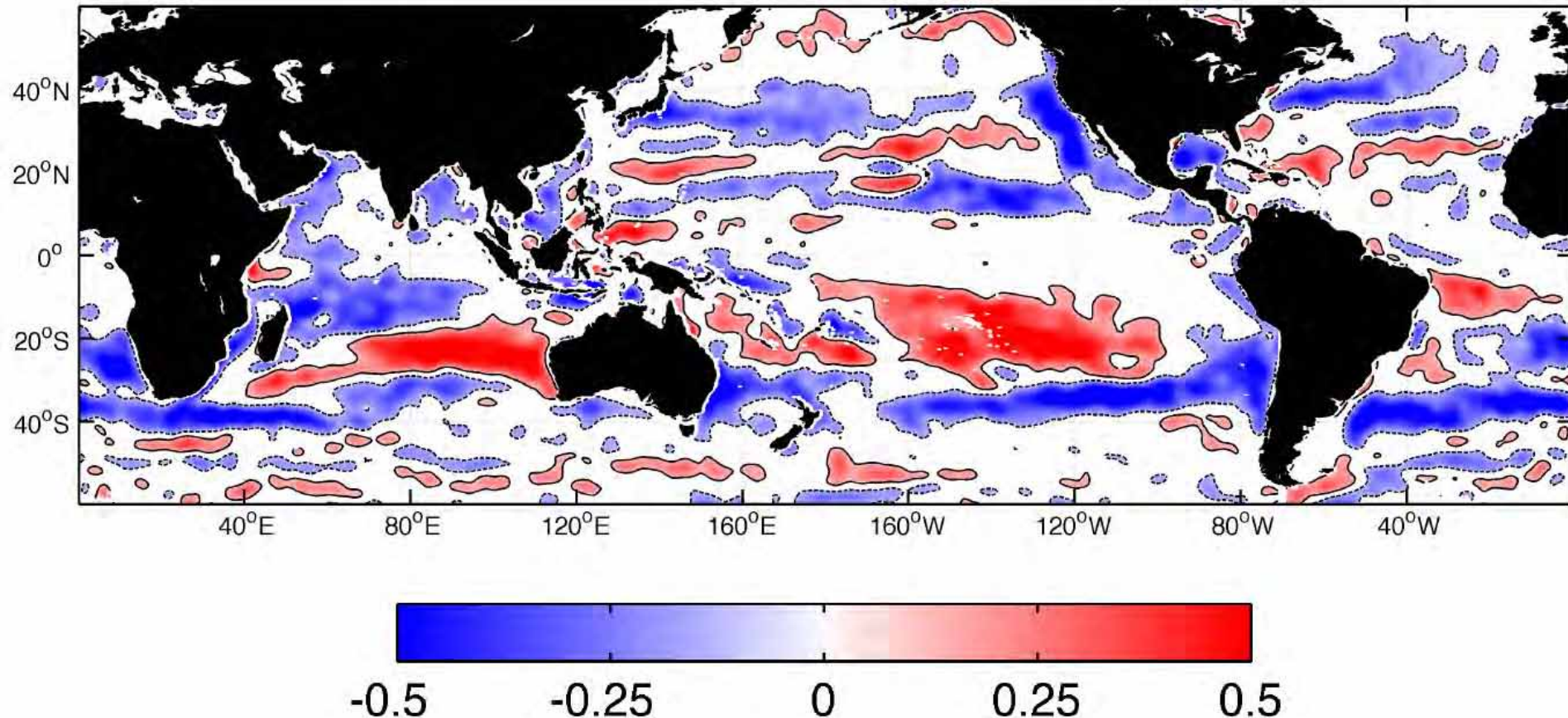


1992-10-14

Regional variations in the influence of mesoscale eddies on near-surface chlorophyll

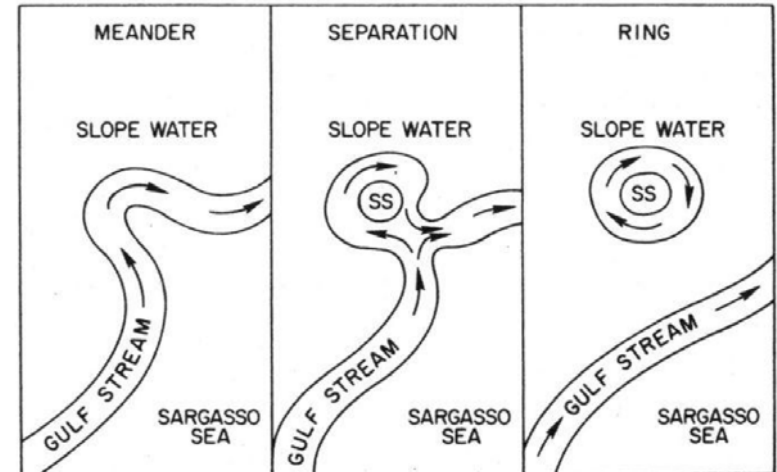
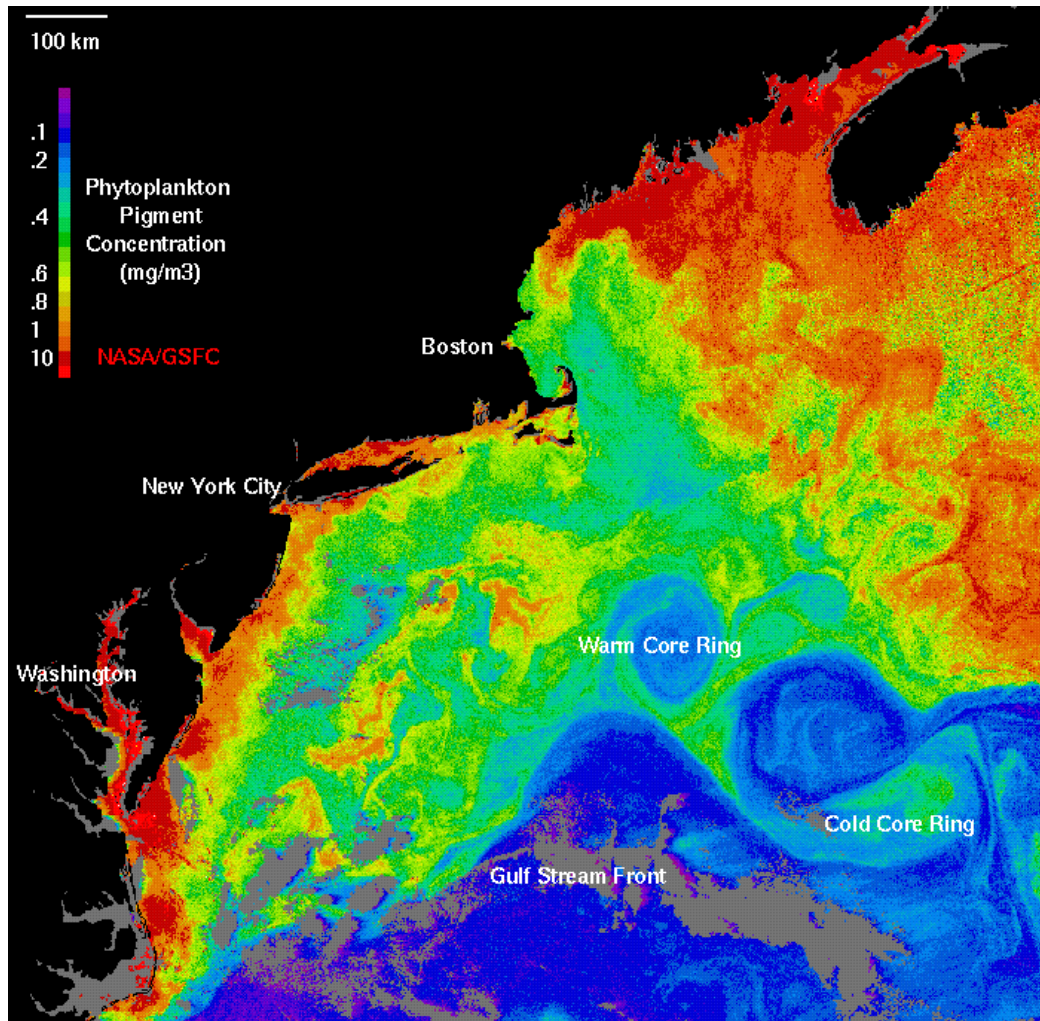
Peter Gaube, Dennis McGillicuddy, Dudley Chelton,
Michael Behrenfeld, Pete Strutton

Cross correlation of SSH and CHL anomalies $r_0(\text{SSH}, \text{CHL}')$



Mechanisms of mesoscale physical-biological interaction:

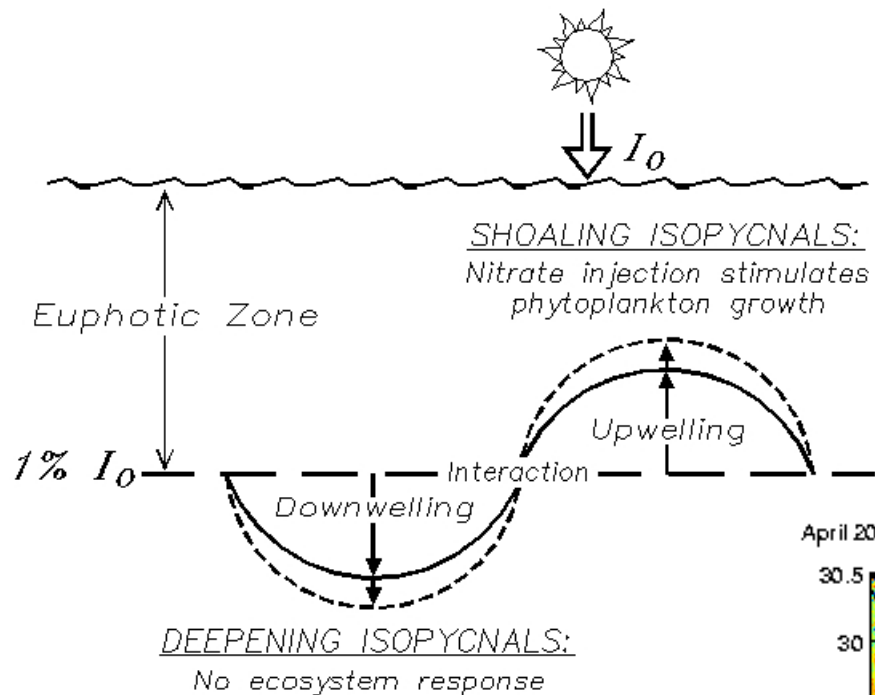
1. Trapped ecosystems



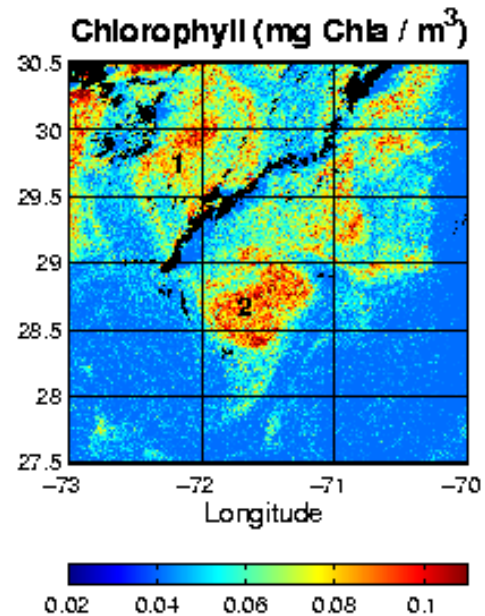
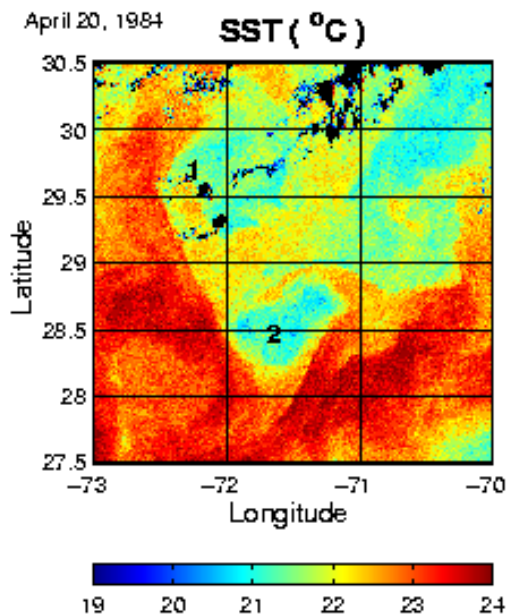
Warm Core Ring Executive Committee, 1982

Mechanisms of mesoscale physical-biological interaction:

2. Eddy formation / intensification



McGillicuddy and Robinson, 1997

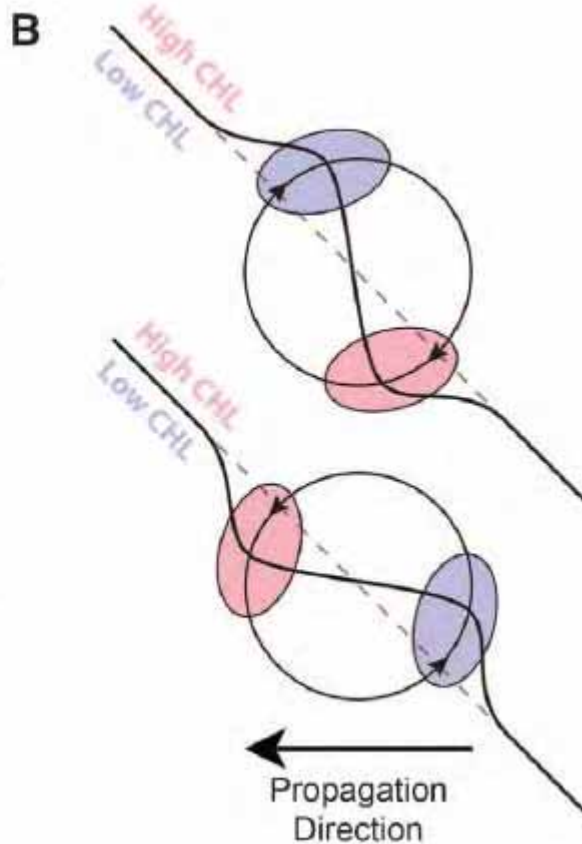
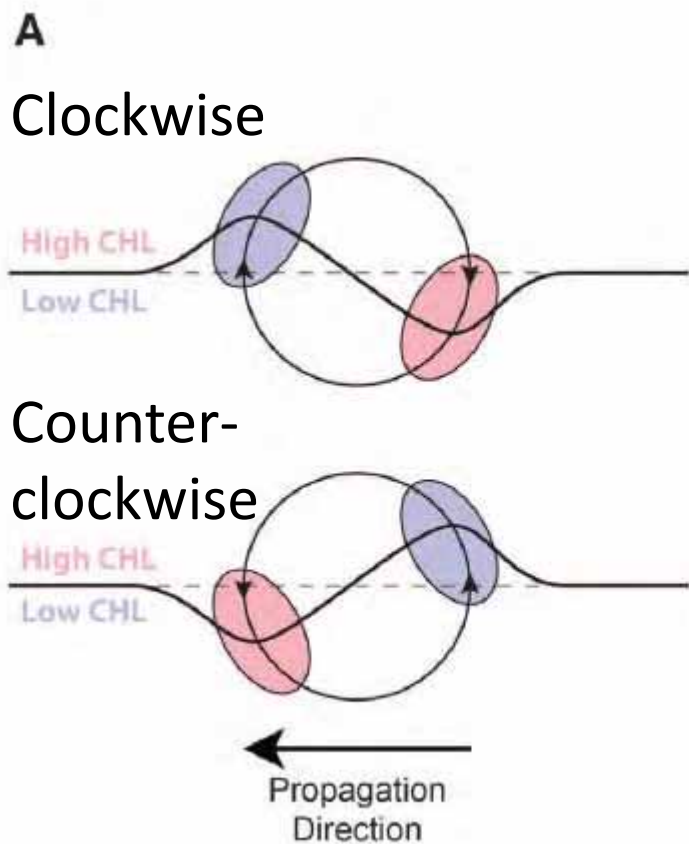


McGillicuddy et al., 2001

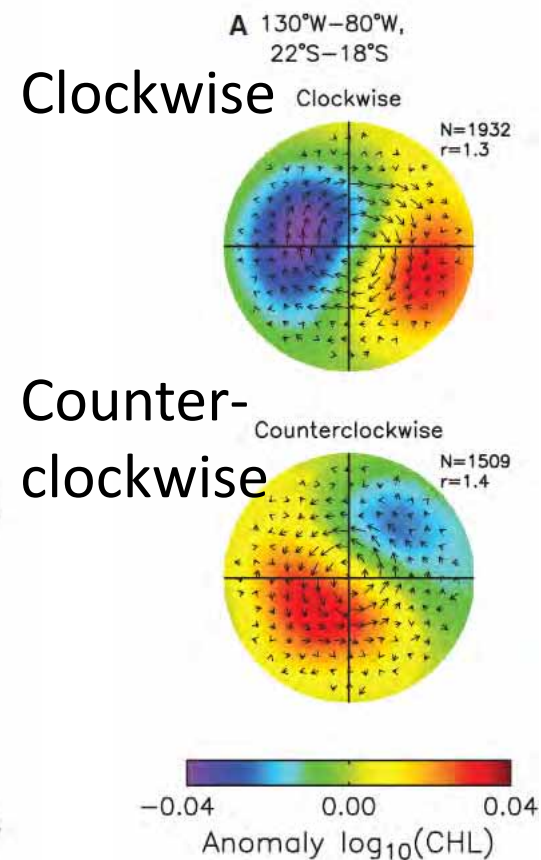
Mechanisms of mesoscale physical-biological interaction:

3. Eddy stirring

Theory

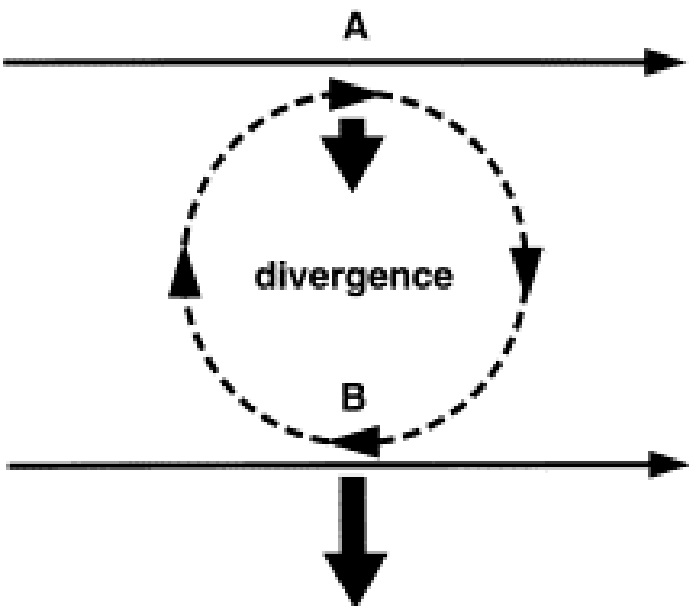


Observations



Mechanisms of mesoscale physical-biological interaction:

4. Eddy-induced Ekman pumping



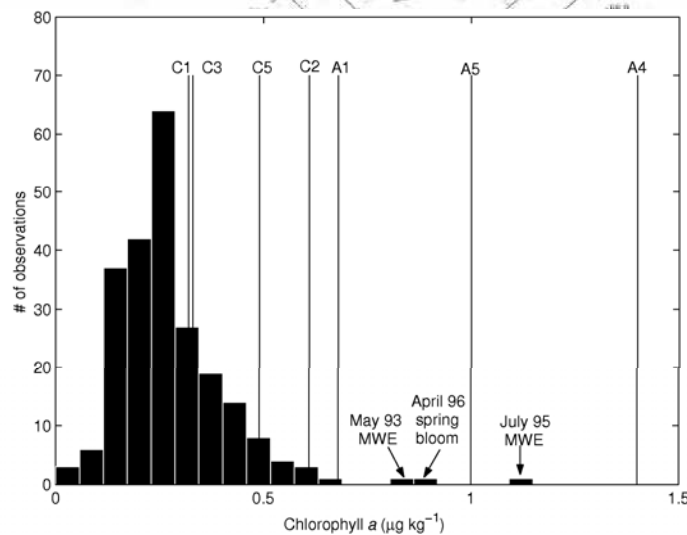
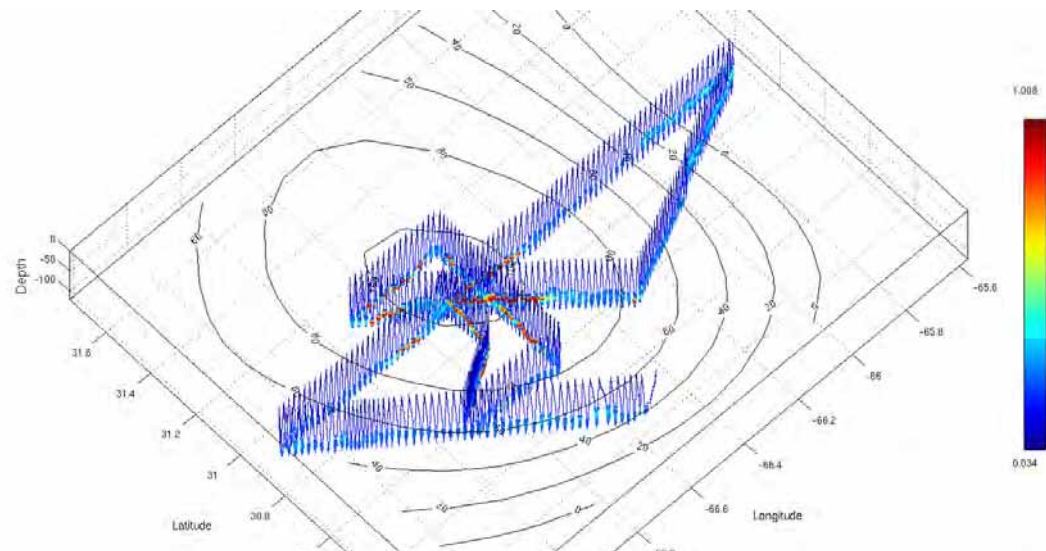
Key:

wind 

eddy current 

Ekman transport 

Dewar and Flierl, 1987
Martin and Richards, 2001

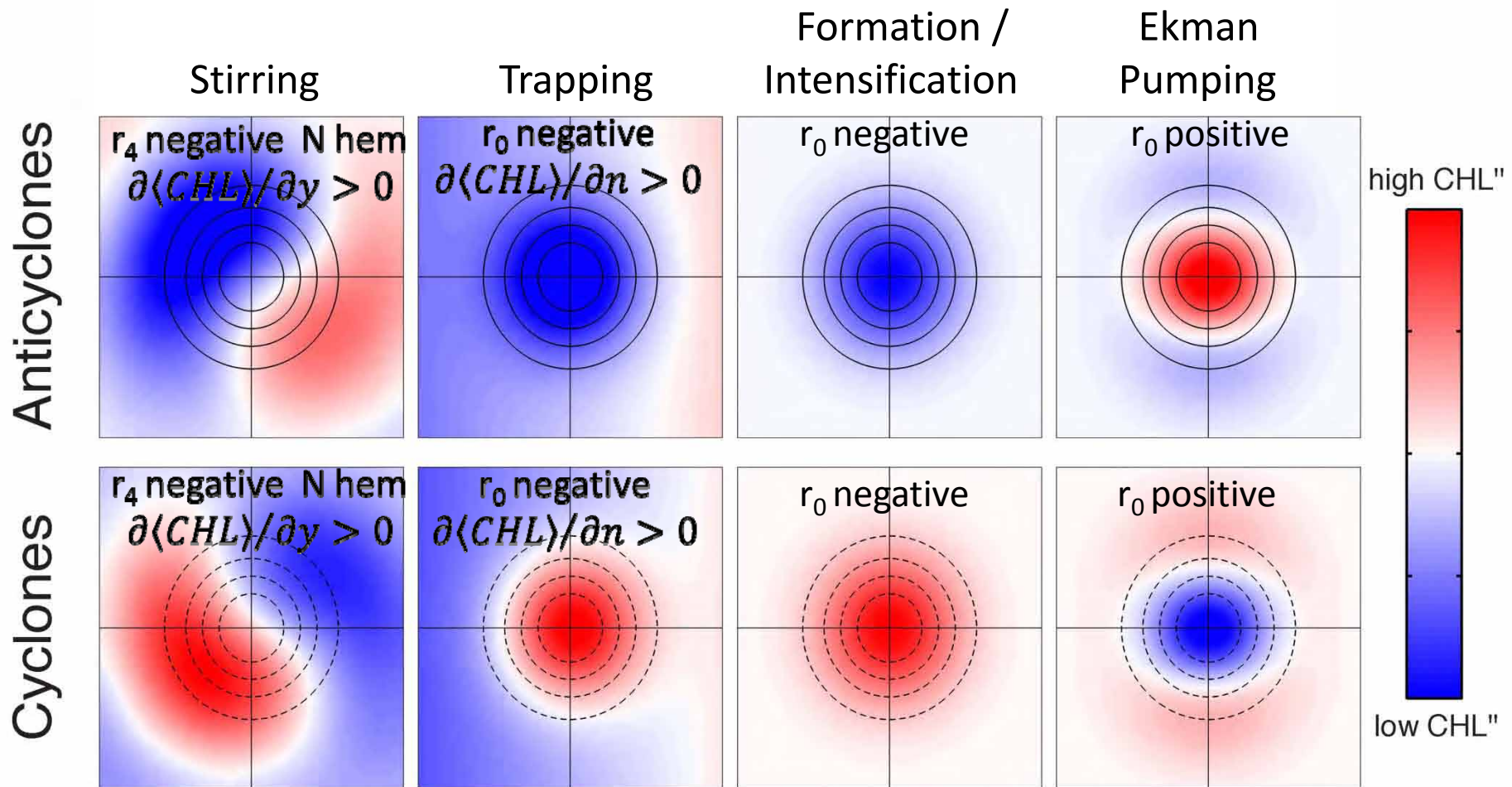


BATS Chl a 1988-2003

Fluorescence
 $\mu\text{g Chl } a \text{ L}^{-1}$

McGillicuddy et al., 2007

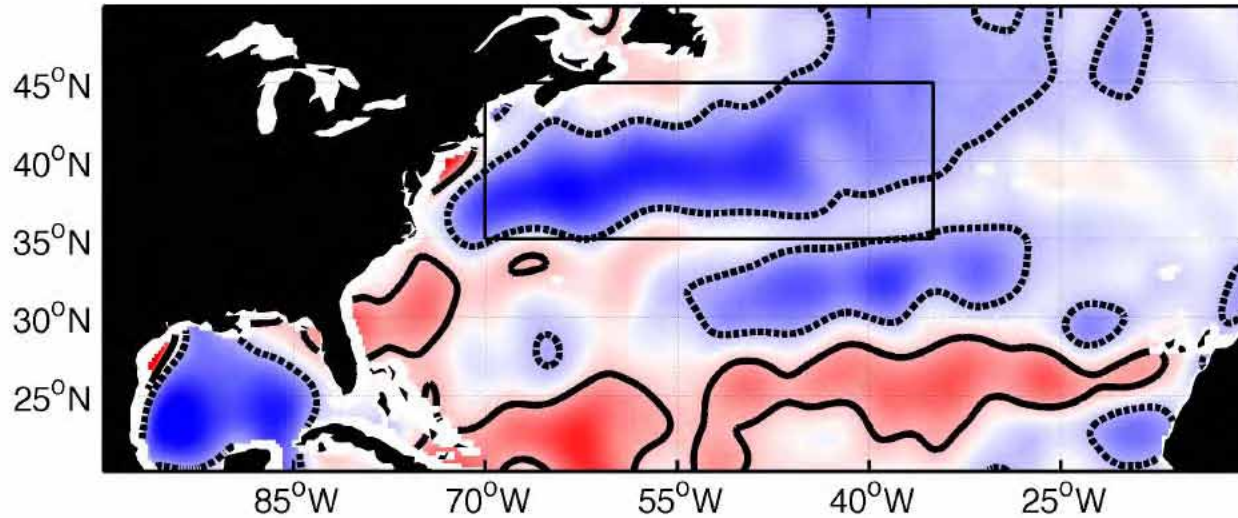
Manifestations of the four mechanisms in CHL and r_0 (SSH,CHL)



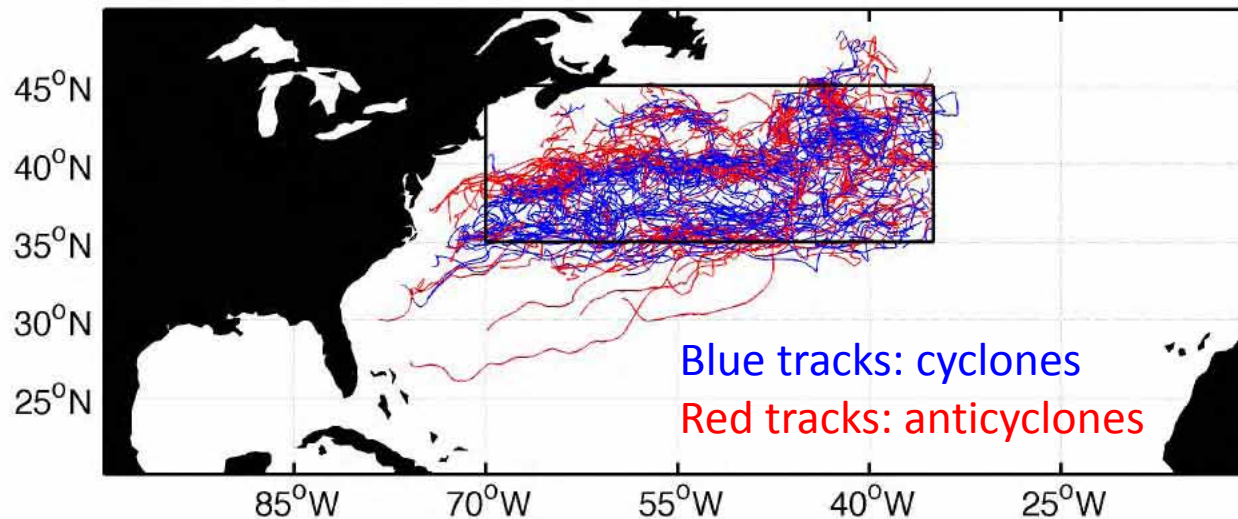
Positive SSH shown as solid contours, negative as dashed contours

Eddies of the Gulf Stream

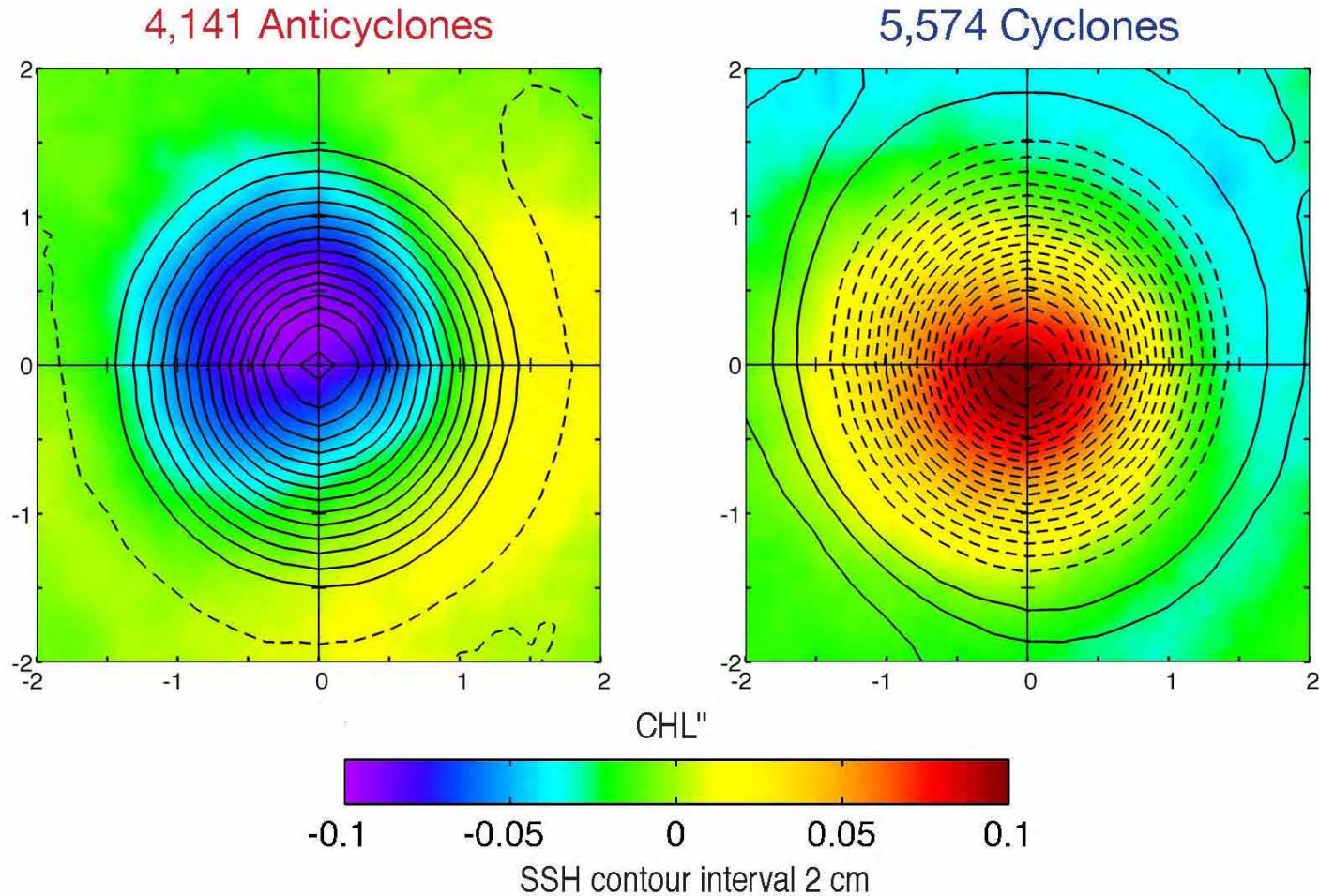
Cross correlation of SSH and CHL anomalies



Eddy Trajectories



Gulf Stream region: Eddy-centric composites of CHL''



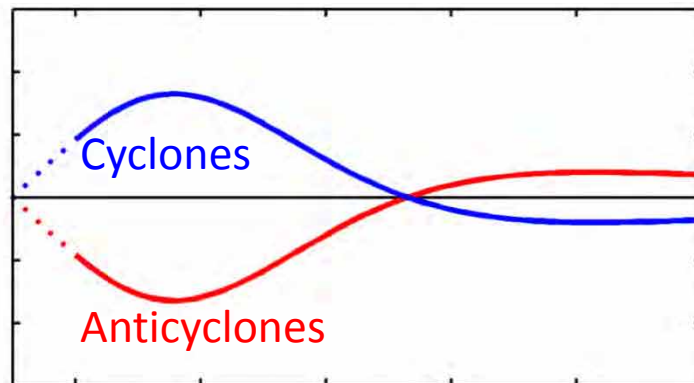
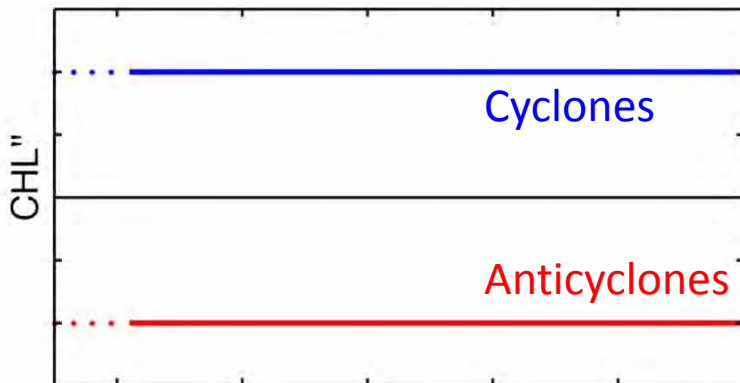
$r_0(\text{SSH}, \text{CHL}') \text{ negative: (1) trapping, (2) formation/intensification}$

Temporal evolution of CHL''

Trapping

Formation/Intensification

Theory

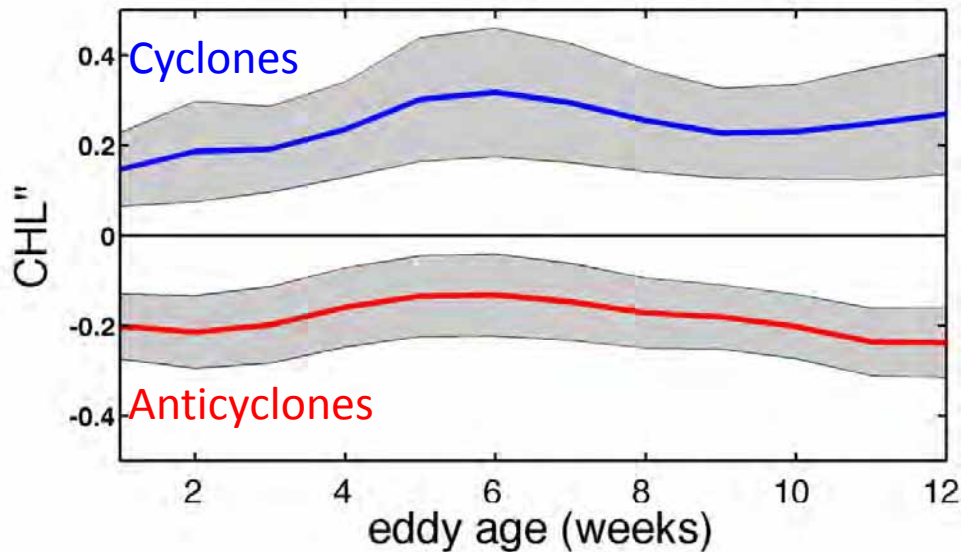


Time (arbitrary units)

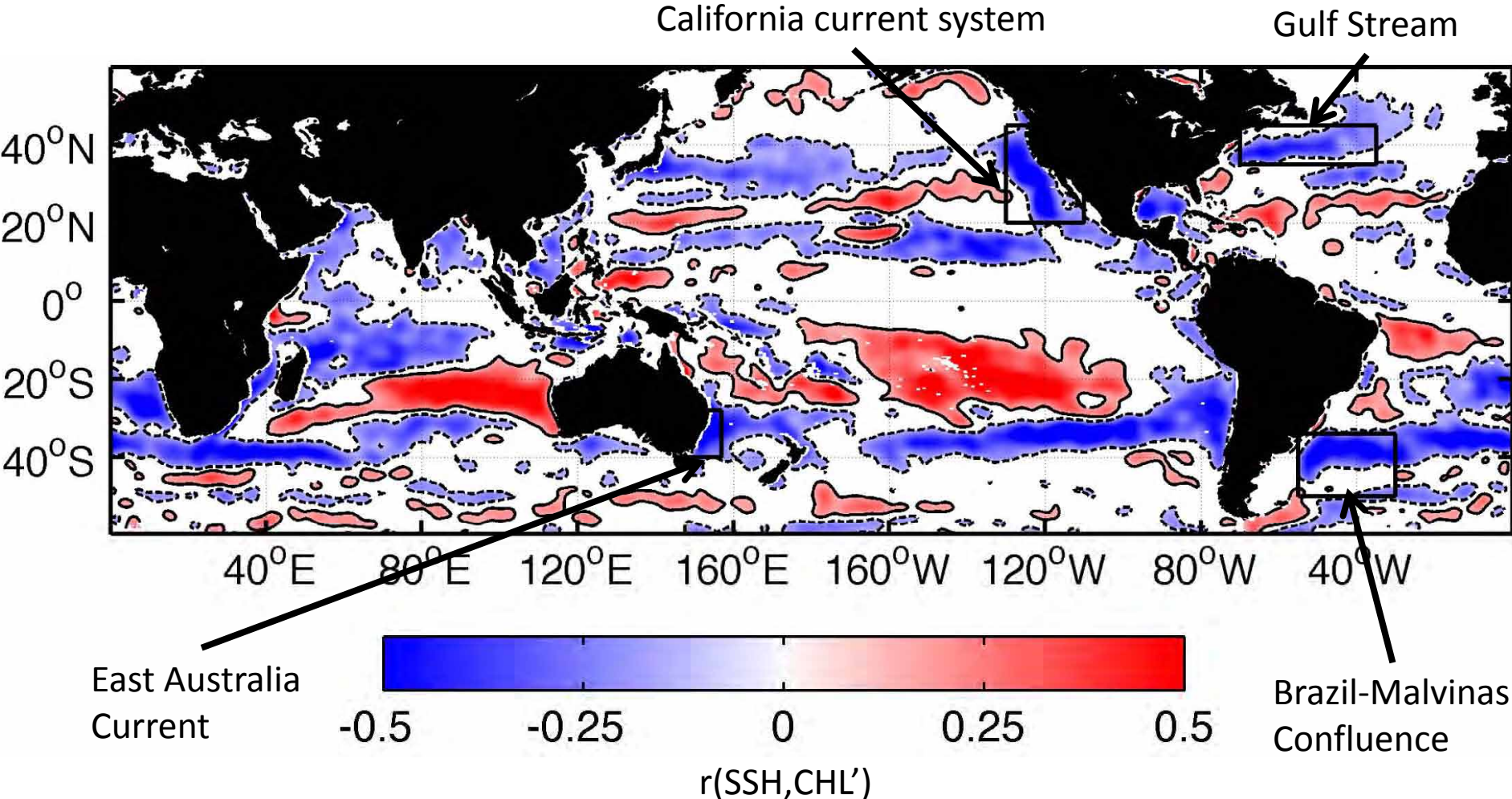
Time (arbitrary units)

CHL'' Time Series of Gulf Stream Eddies

Observation

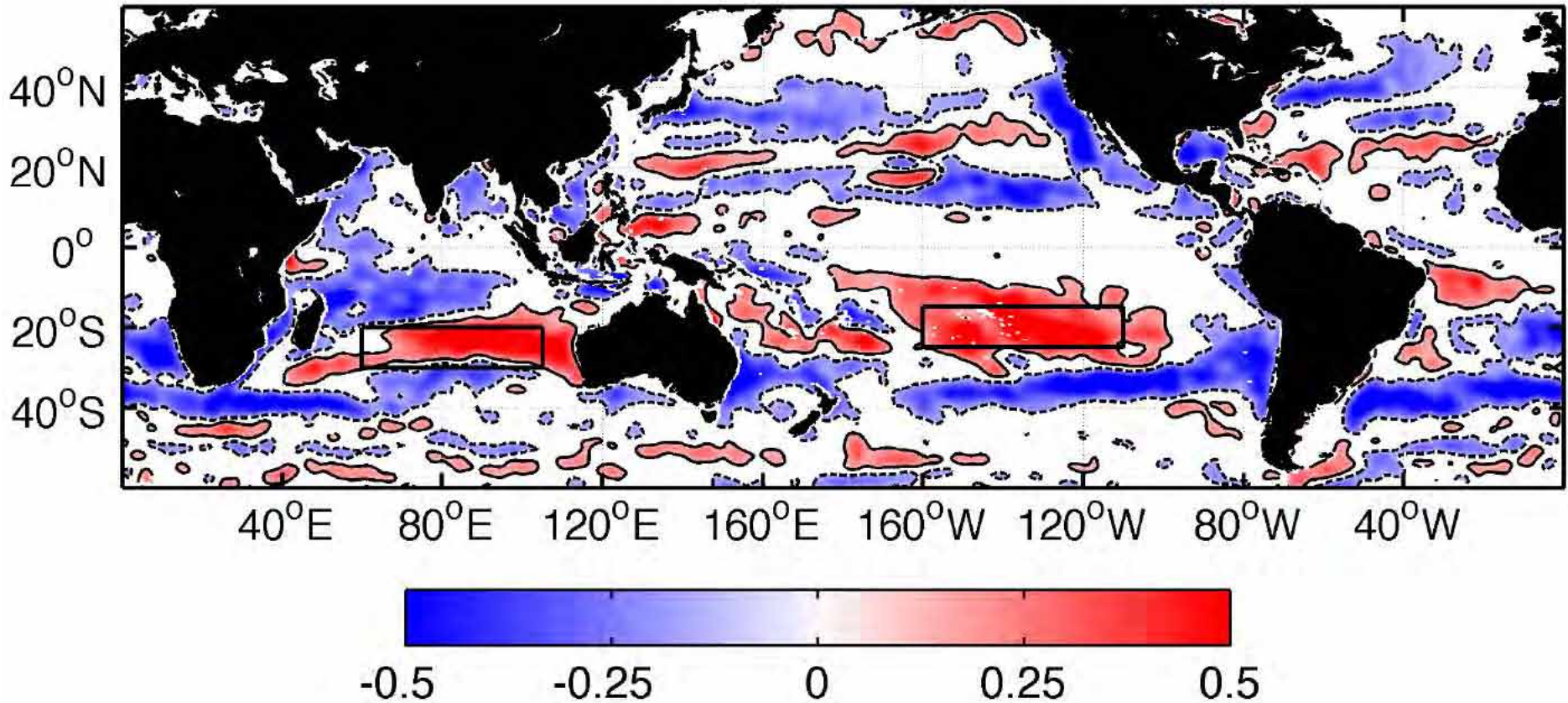


Negative correlation in boundary current systems: both trapping and formation/intensification are active



Regions of Positive Cross Correlation

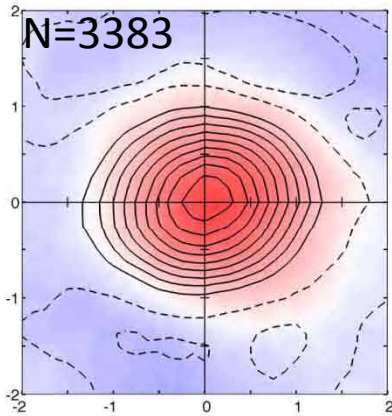
Cross correlation of SSH and CHL anomalies



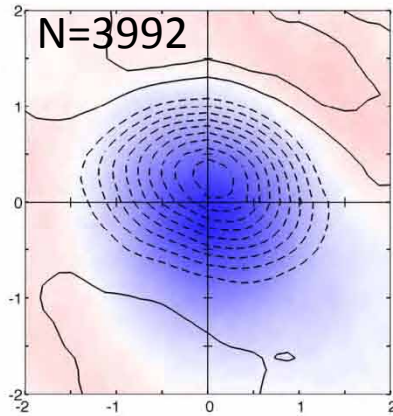
Eddy-centric composites reveal eddy-induced Ekman pumping

South Indian Ocean

Anticyclones

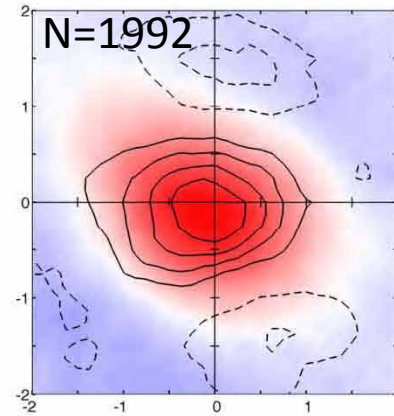


Cyclones

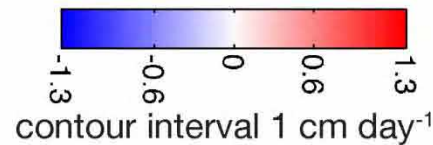
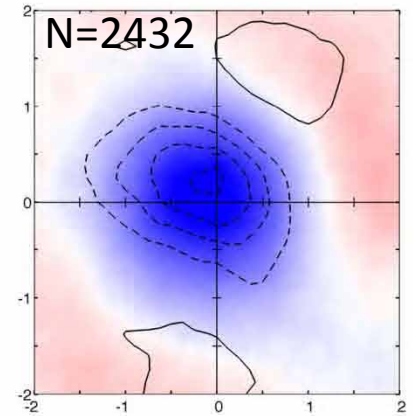


South Pacific Ocean

Anticyclones



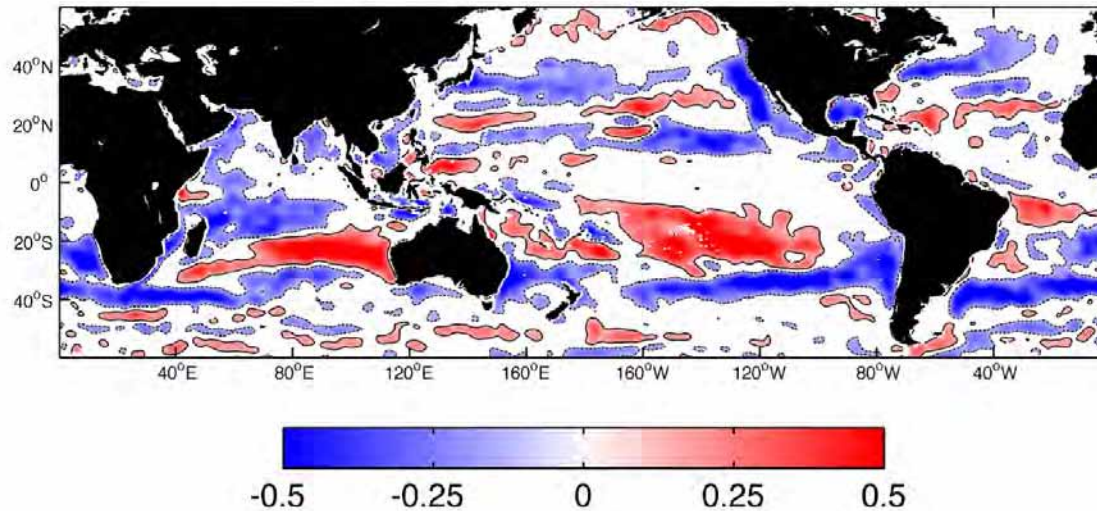
Cyclones



* wintertime only

Conclusions

Cross correlation of SSH and CHL anomalies



1. The influence of eddies on CHL varies regionally.
2. Multiple mechanisms can act simultaneously.
3. Resolution of the ambiguity among multiple mechanisms not possible with satellite observations alone.
4. Future OSTST research: combination of satellite data, *in situ* observations (Argo floats), and numerical models.