Mesoscale physical-biological interactions as revealed in satellite observations and eddy resolving models: from regional to global scales

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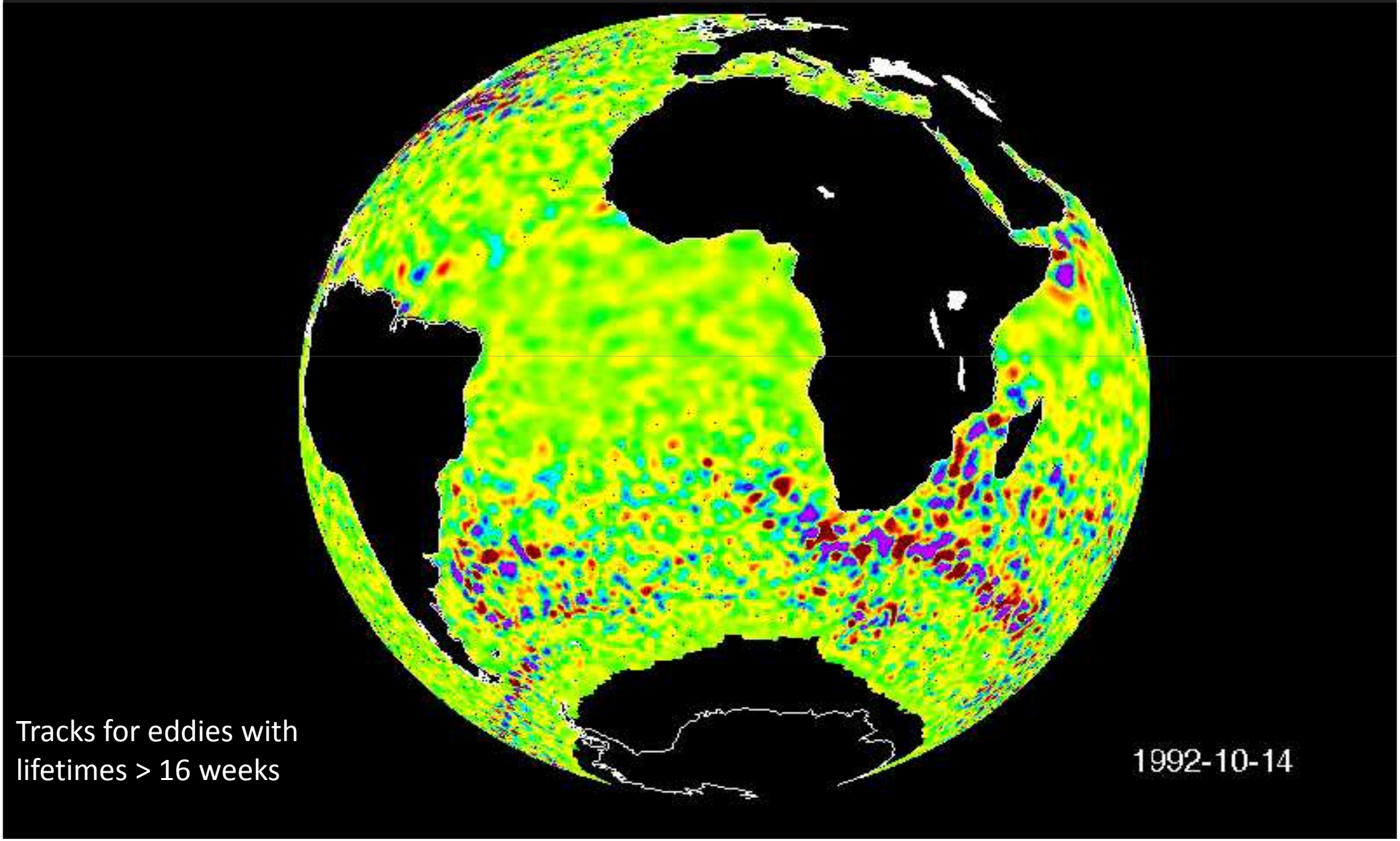
SeaWiFS Chlorophyll: 32-day composites

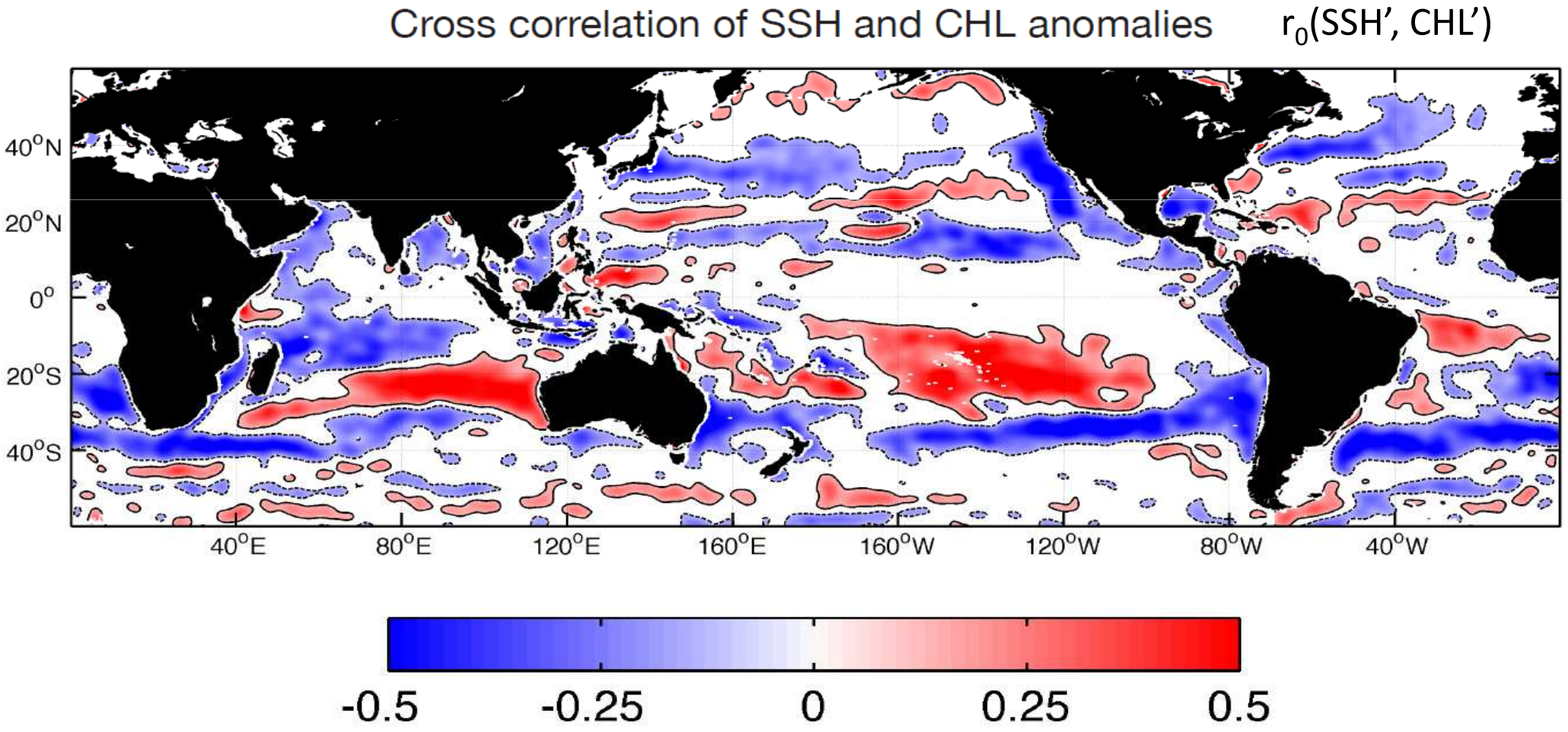
Observations of Nonlinear Mesoscale Eddies

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

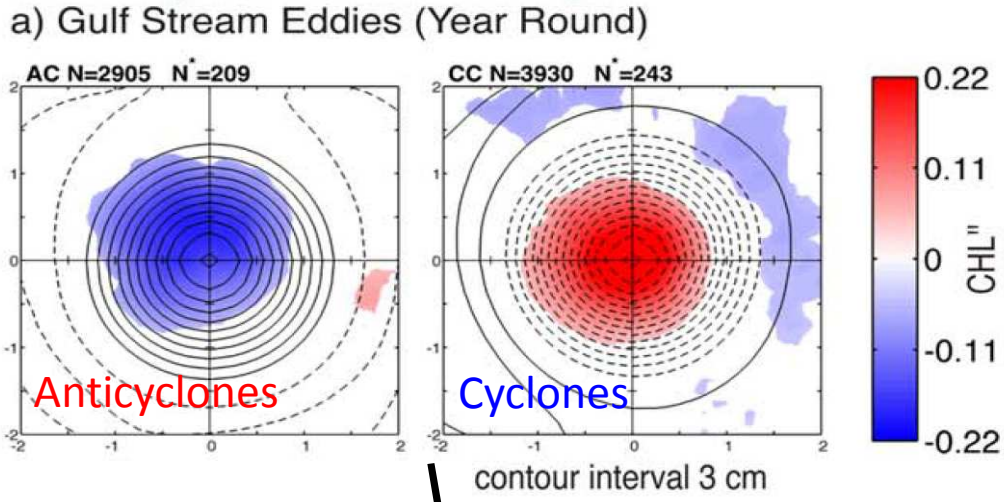


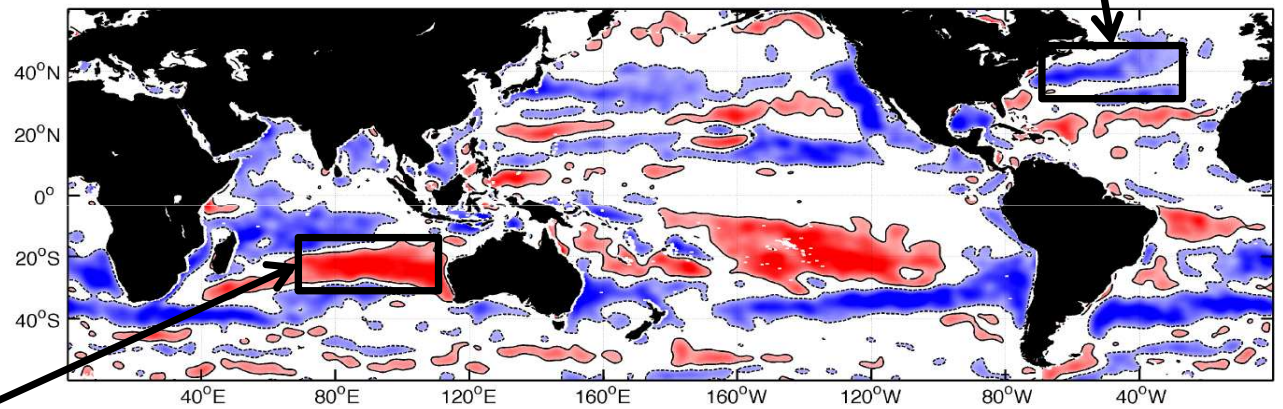
Regional variations in the influence of mesoscale eddies on near-surface chlorophyll

Gaube et al. 2014

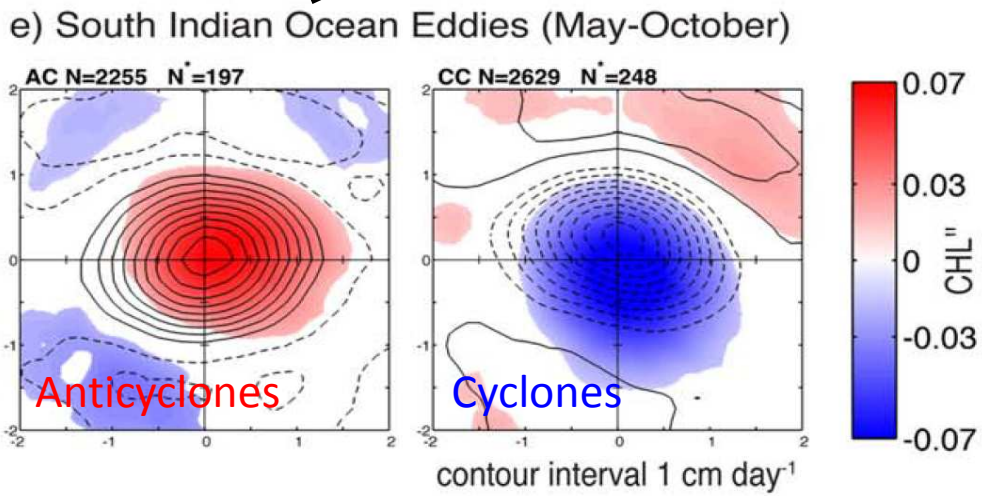


SSH – CHL correlation and eddy-centric composites





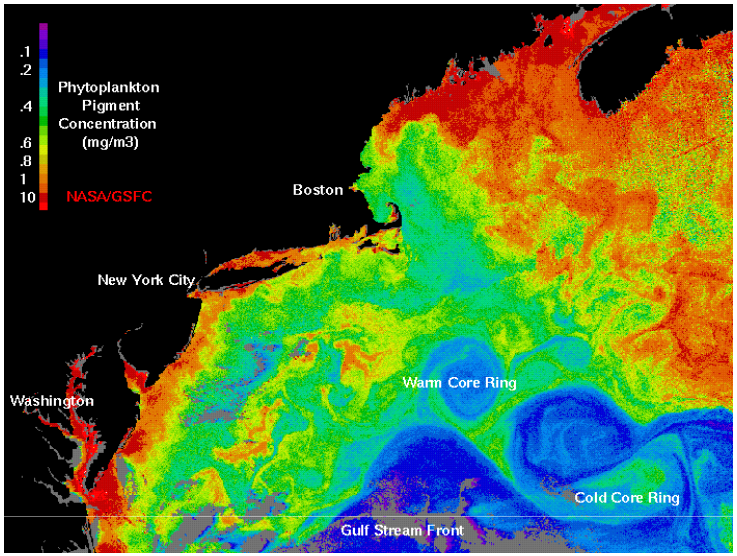
r_0(SSH, CHL')

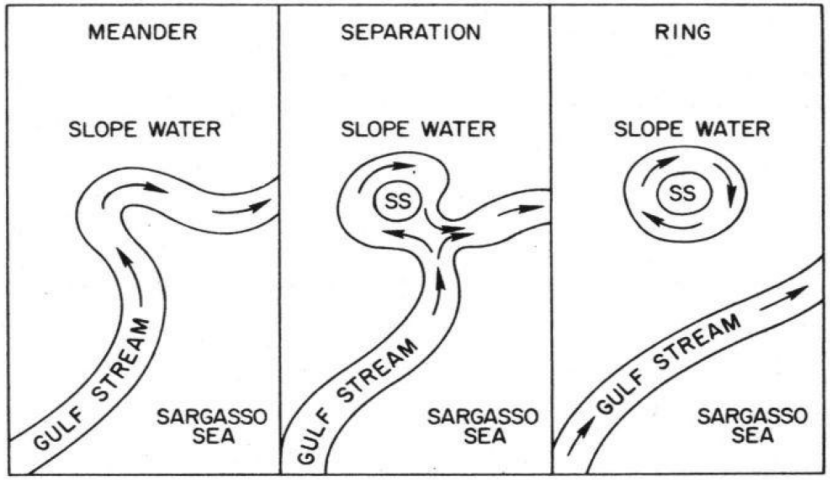


Gaube et al., 2014

Two mechanisms produce negative r_0(SSH', CHL')

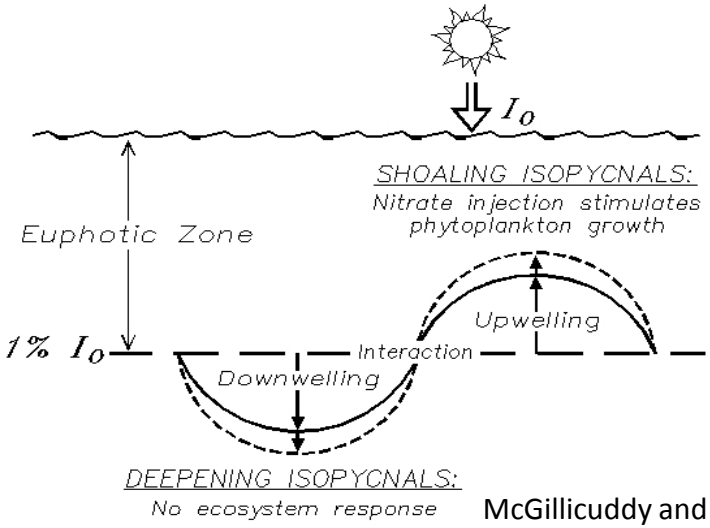
1. Trapped ecosystems



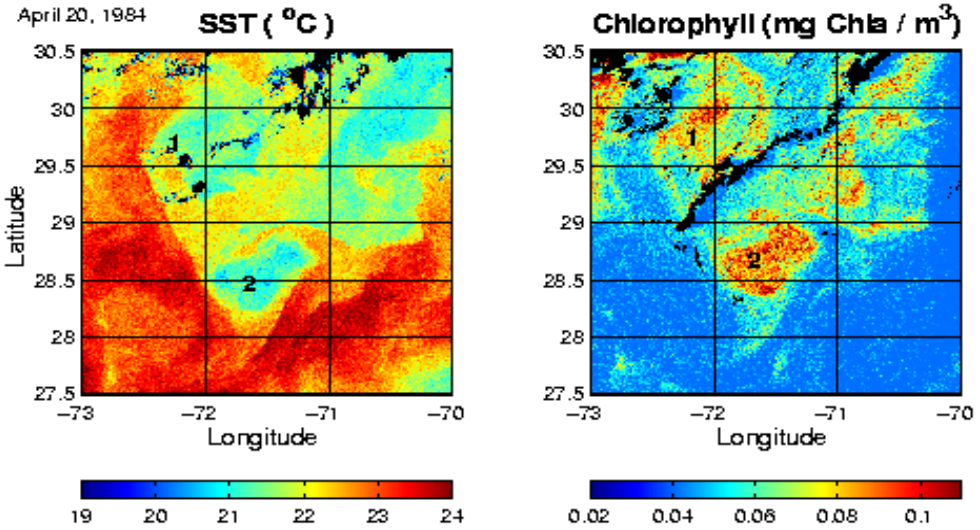


Warm Core Ring Executive Committee, 1982

2. Eddy formation / intensification

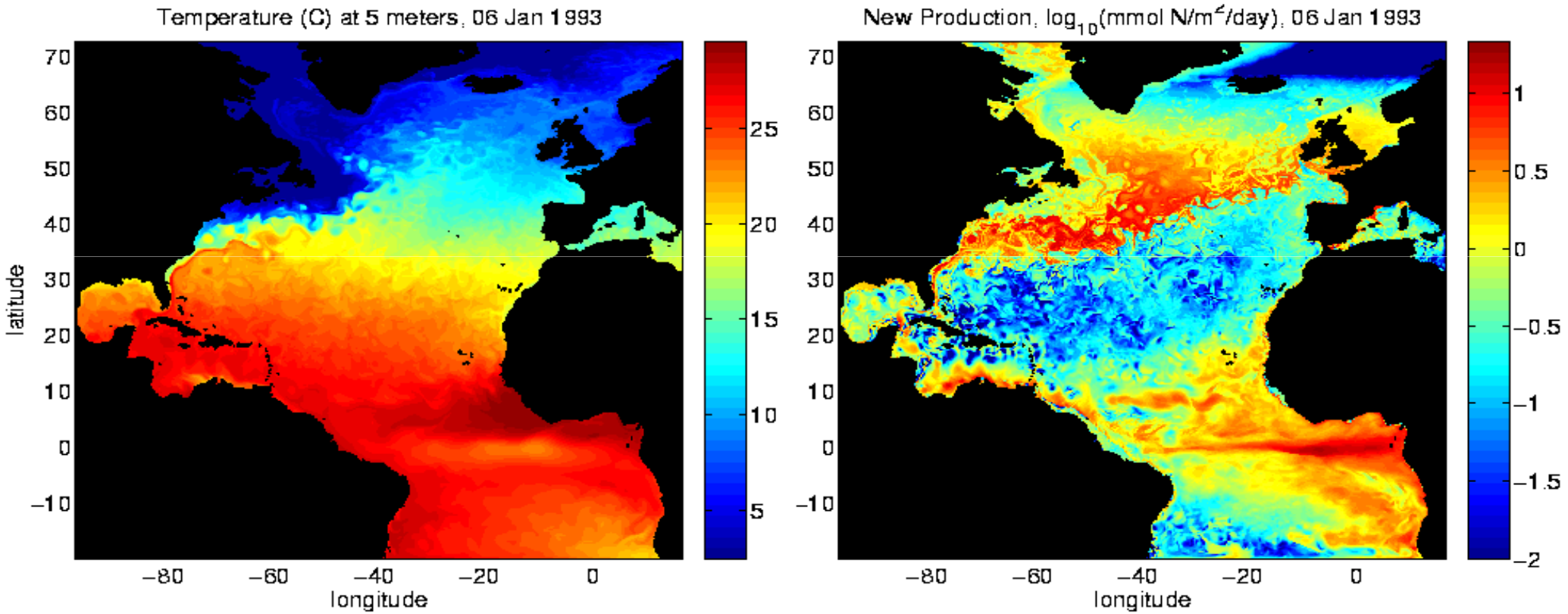


McGillicuddy and Robinson, 1997



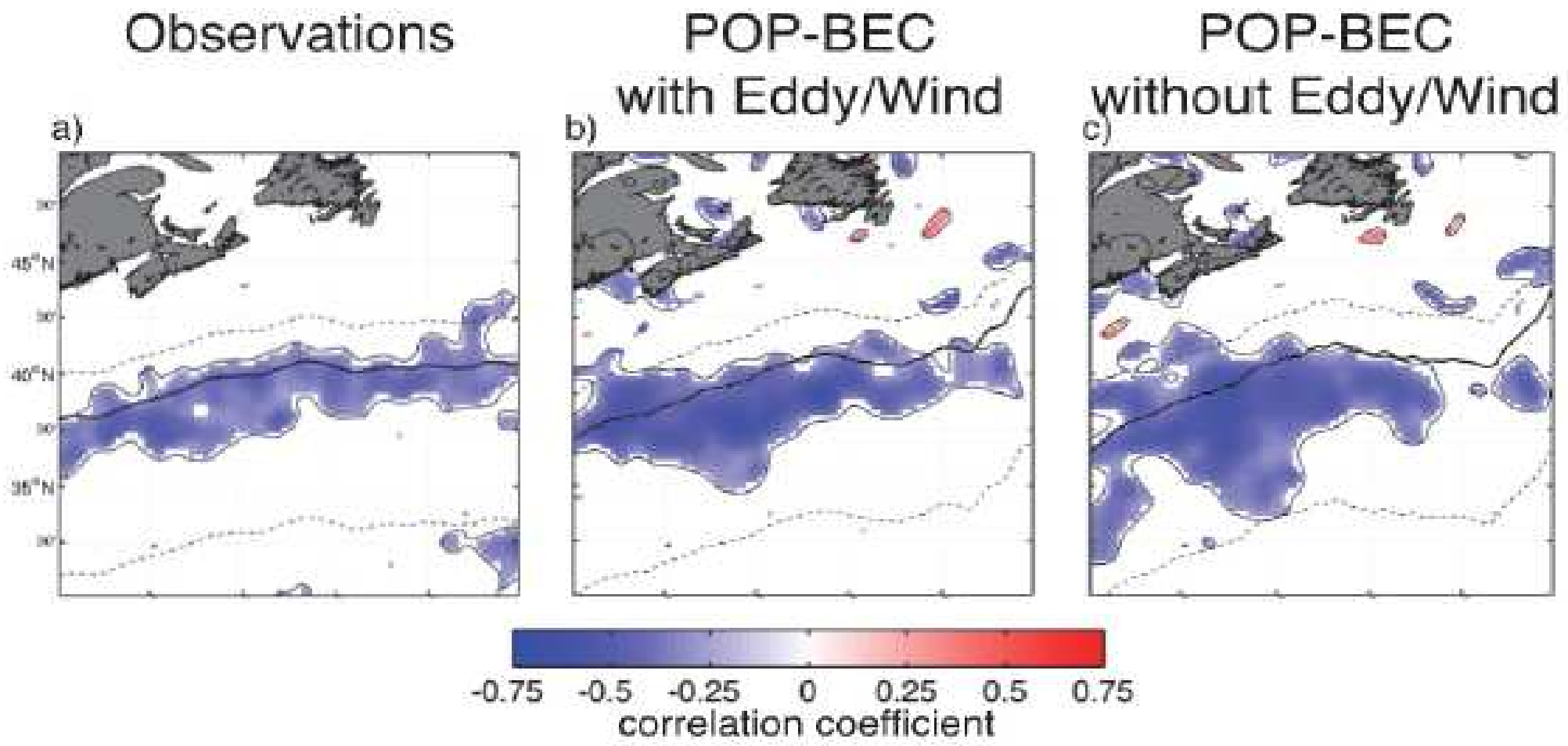
McGillicuddy et al., 2001

A 0.1° Resolution Model of the North Atlantic



BEC: Biogeochemical Elemental Cycling model (Moore et al., 2006)
Eddy-resolving North Atlantic simulations: Anderson et al. 2011; McGillicuddy, 2014

SLA & CHL' correlation



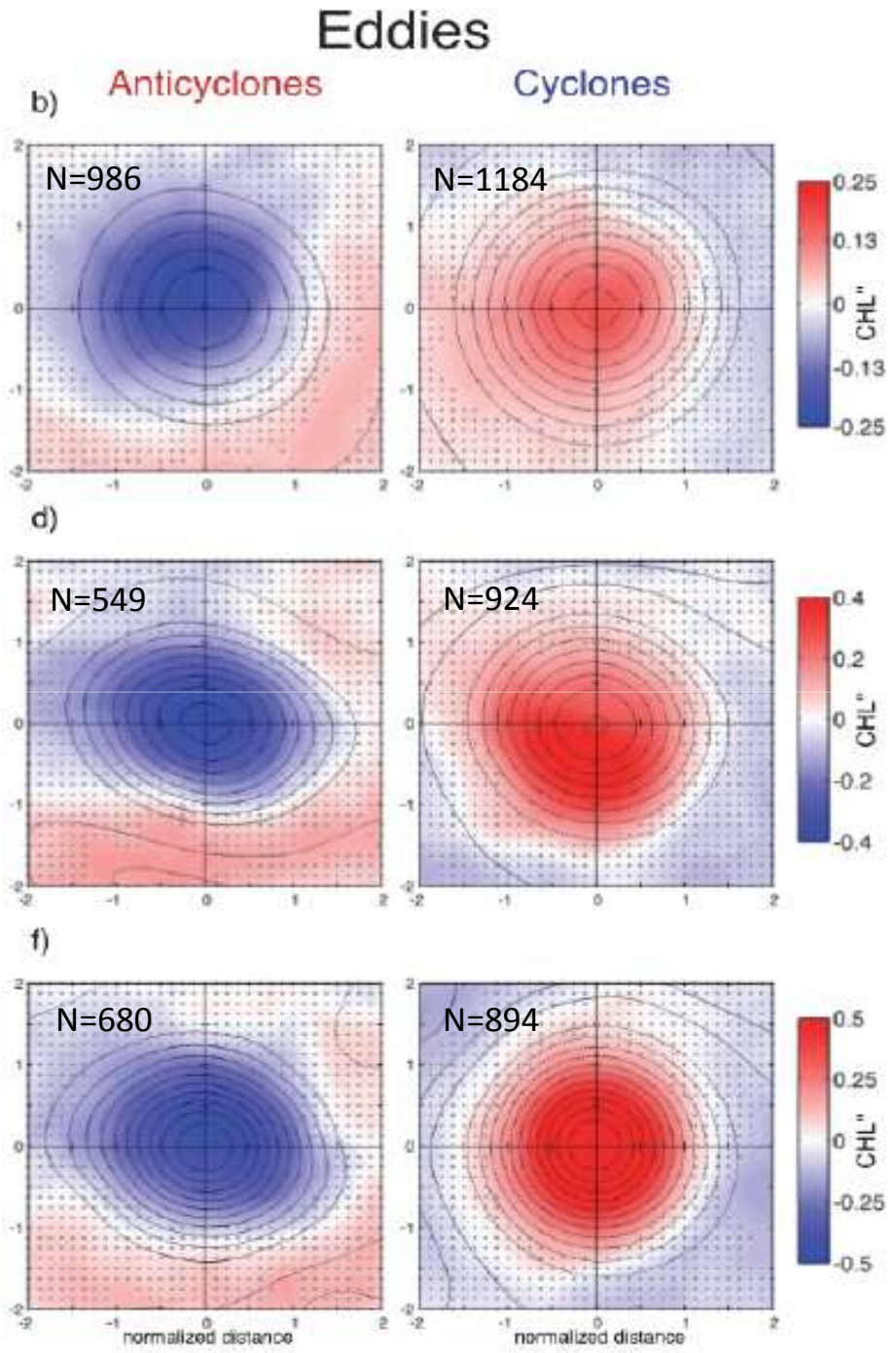
$CHL' = CHL - \langle CHL \rangle$ Removal of a 6°x 6° spatial average

SLA & CHL'' in eddies

Observations

POP-BEC with eddy/wind

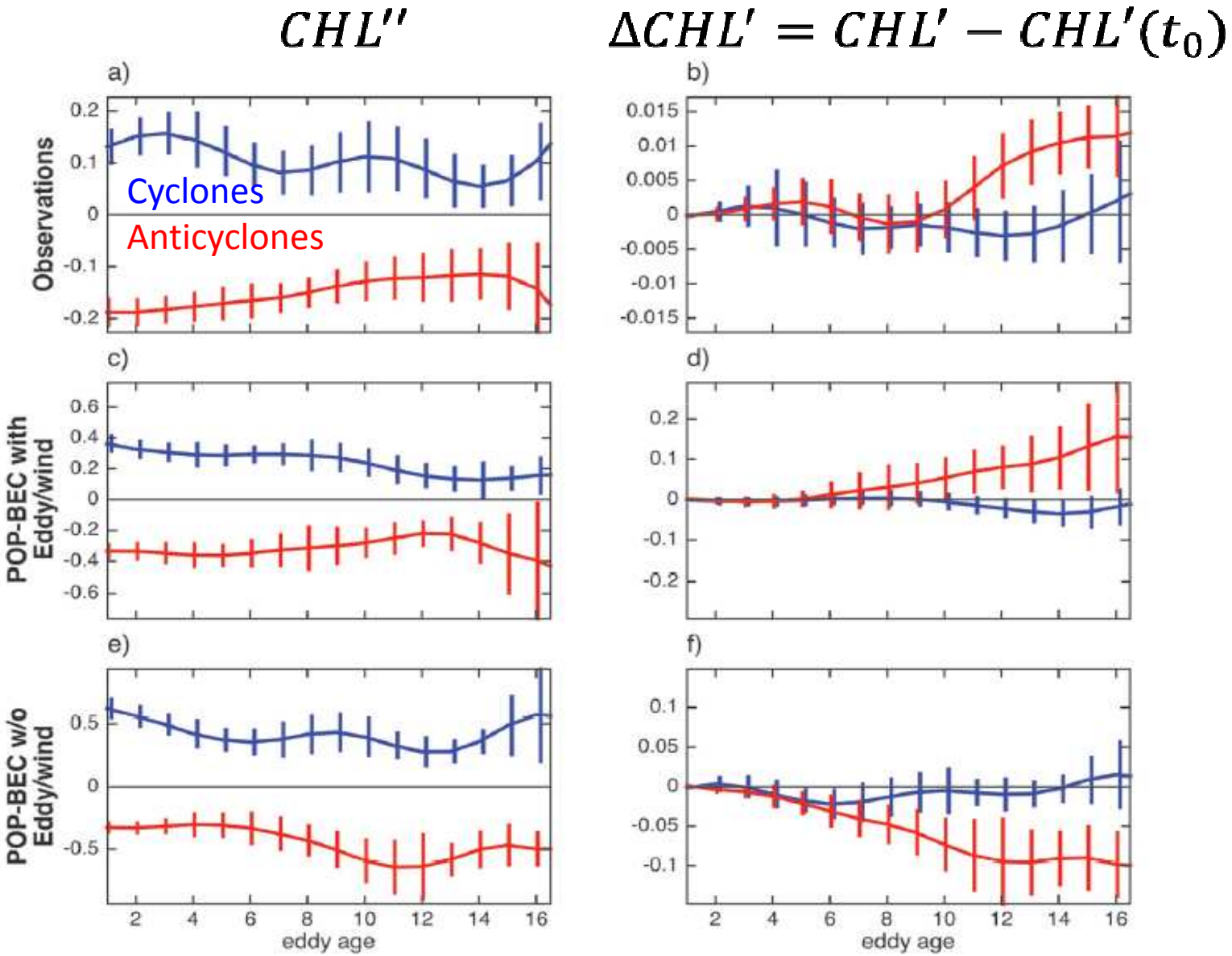
POP-BEC without eddy/wind



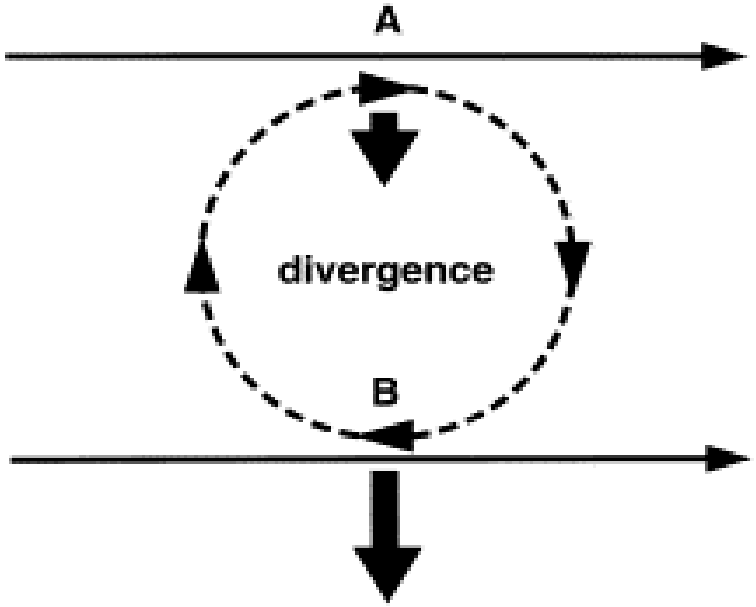
$$CHL'' = \frac{CHL'(x,y)}{\overline{CHL(x,y)}}$$

Normalized CHL anomaly

Time-series of composite averages: eddies



Mechanisms of mesoscale physical-biological interaction: Eddy-induced Ekman pumping



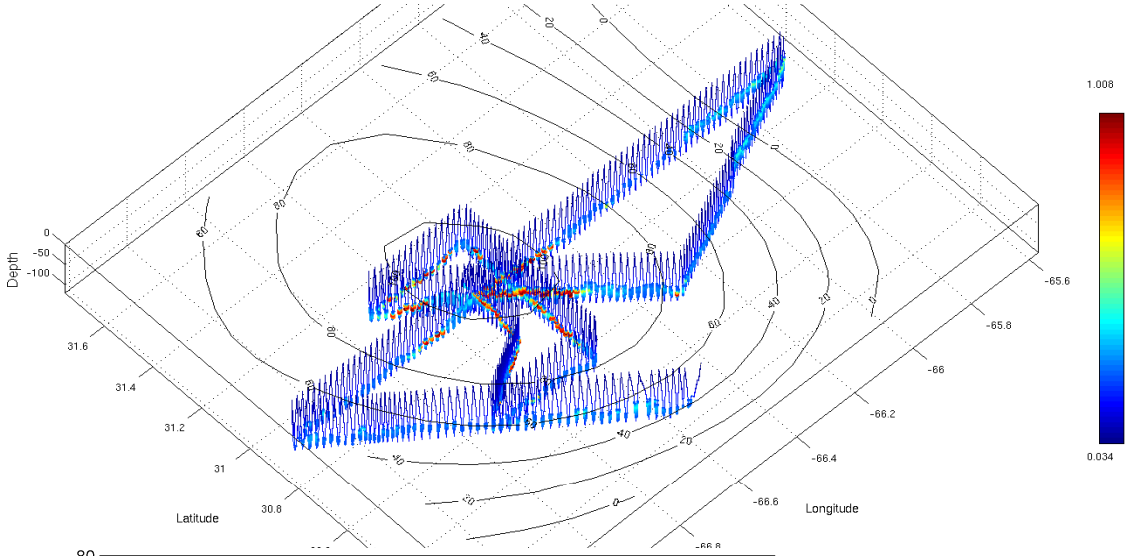
Key:

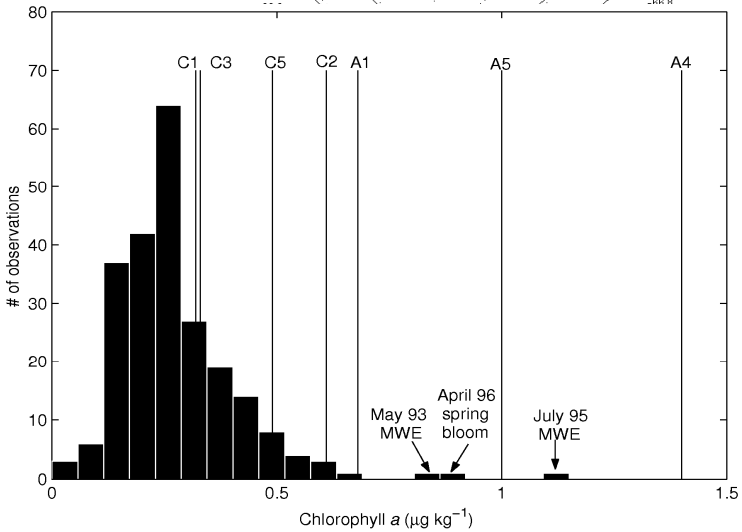
wind

eddy current

Ekman transport

Dewar and Flierl, 1987
Martin and Richards, 2001



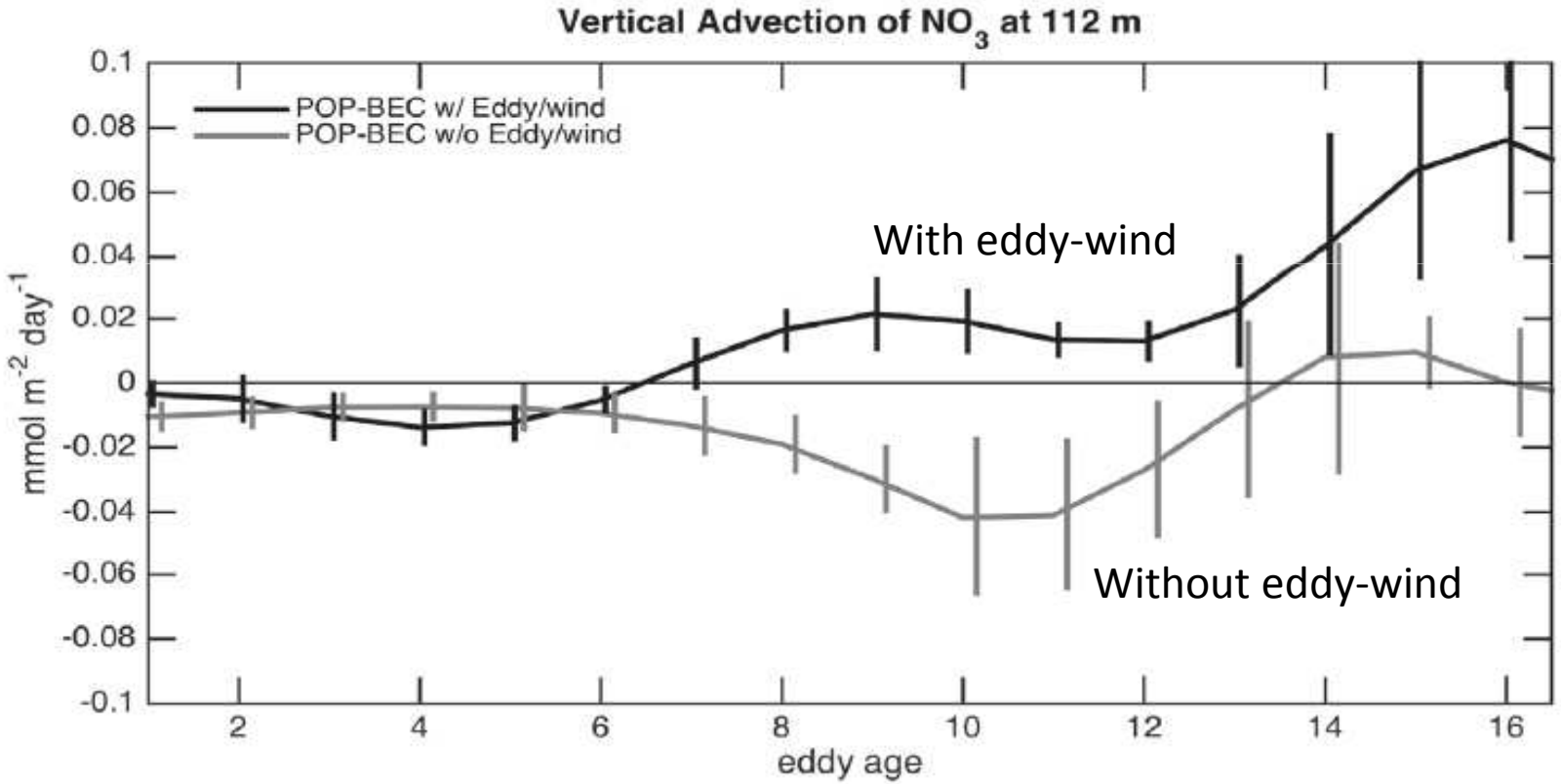


Fluorescence µg Chl *a* L^{-1}

BATS Chl a 1988-2003

McGillicuddy et al., 2007

Vertical advection of nitrate in anticyclones: with and without eddy-wind interaction



Cf. Franks et al., 1986; Nelson et al. 1989

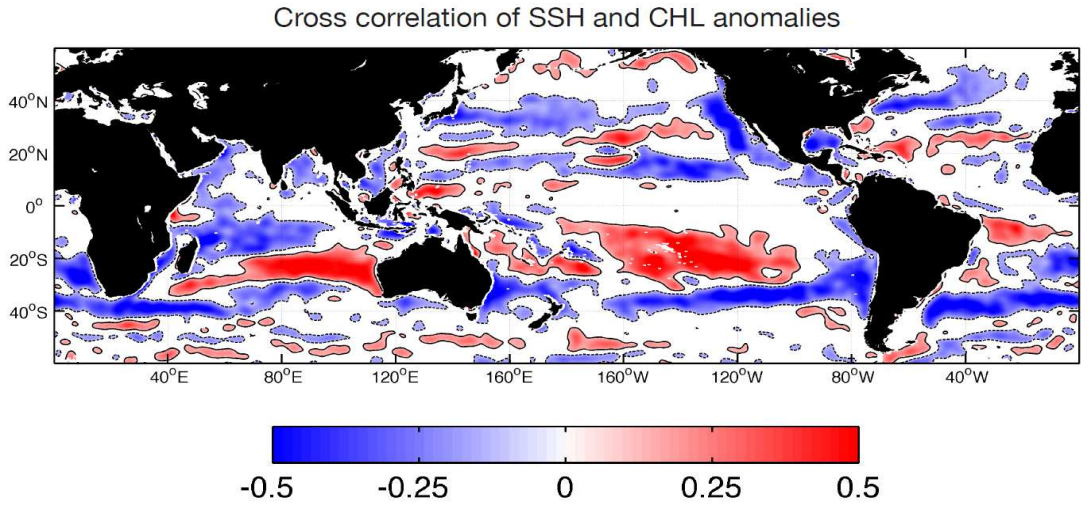
Conclusions: The Gulf Stream Region

Trapping signal is clear

Did not detect the eddy-induced upwelling signal

Evidence for eddy-induced Ekman pumping increasing CHL in anticyclones

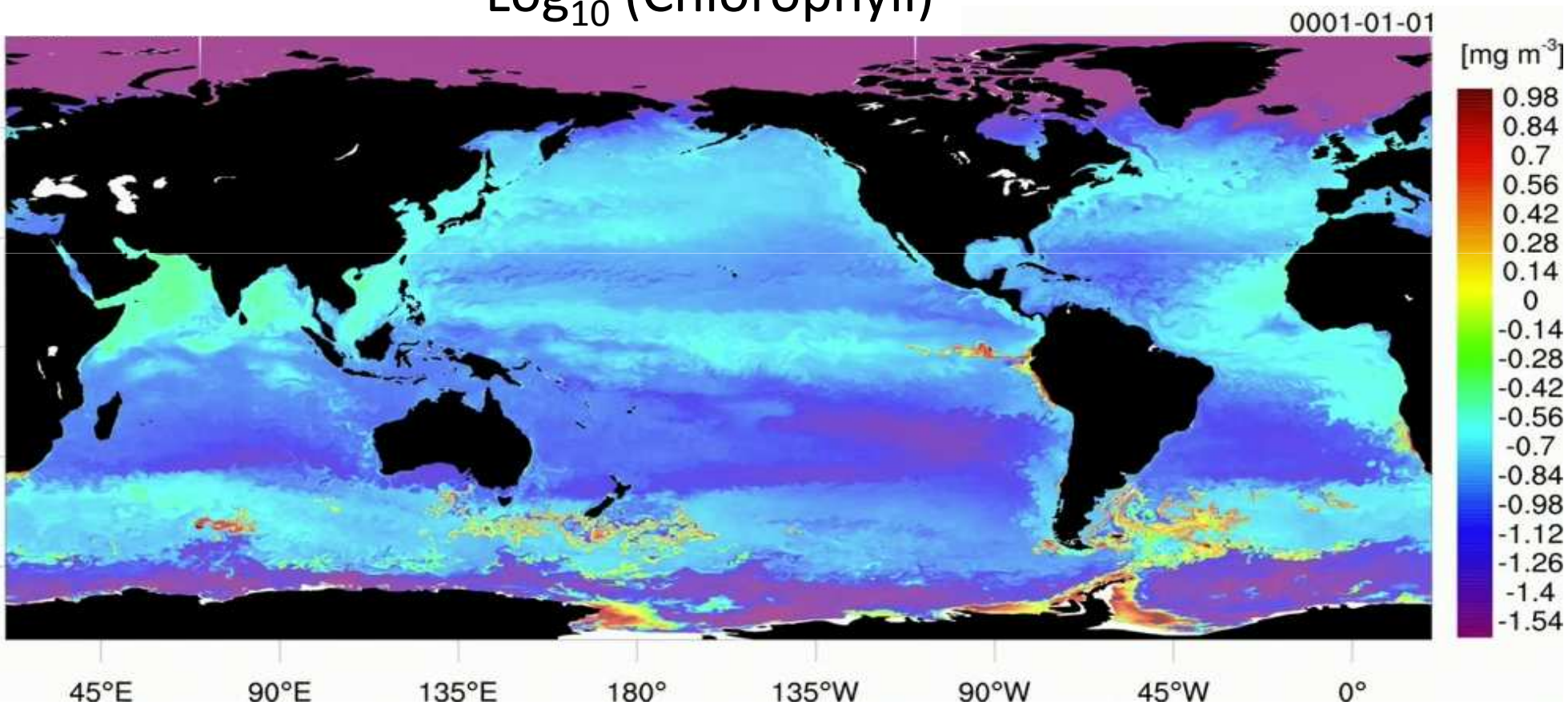
Trapping thus overshadows eddy-induced Ekman pumping in the correlation of SLA and CHL



A 0.1^{o} Resolution Global Simulation

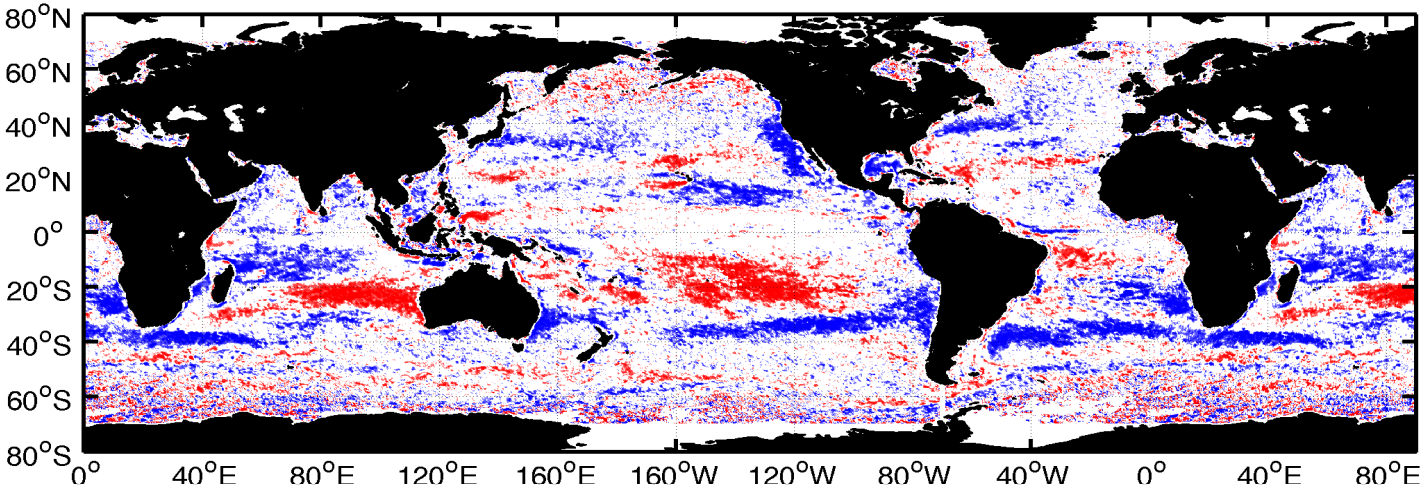
Long et al., in preparation (NSF MOBY project)

Log_{10} (Chlorophyll)

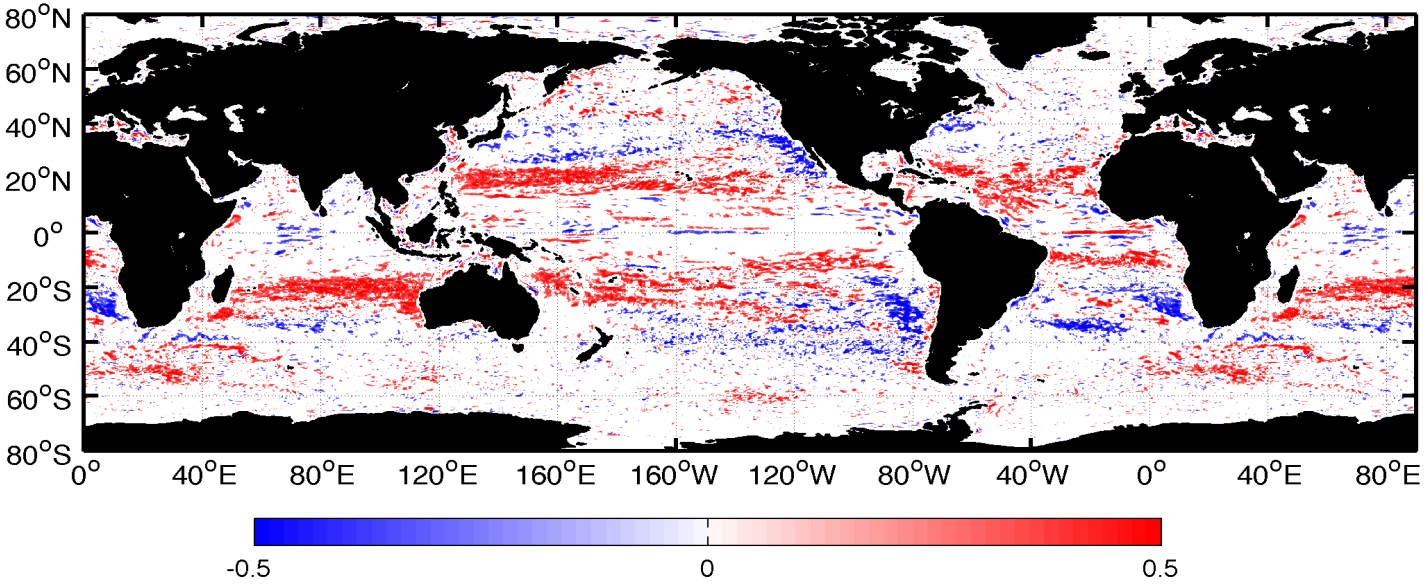


Cross-correlation of SSH and CHL anomalies

Gaube et al., in preparation



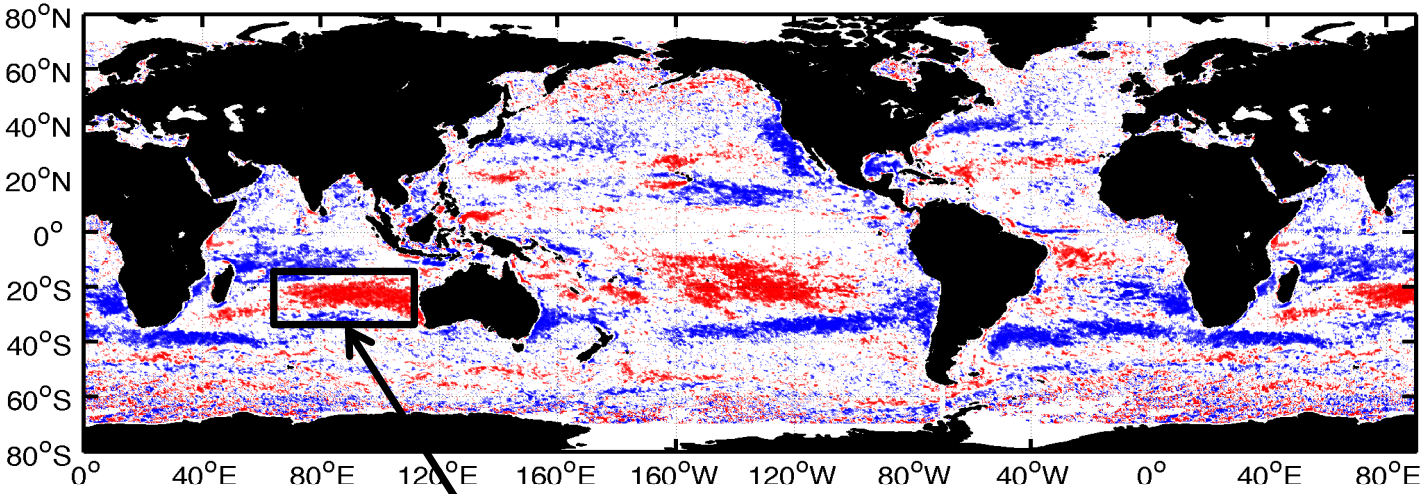
Observations



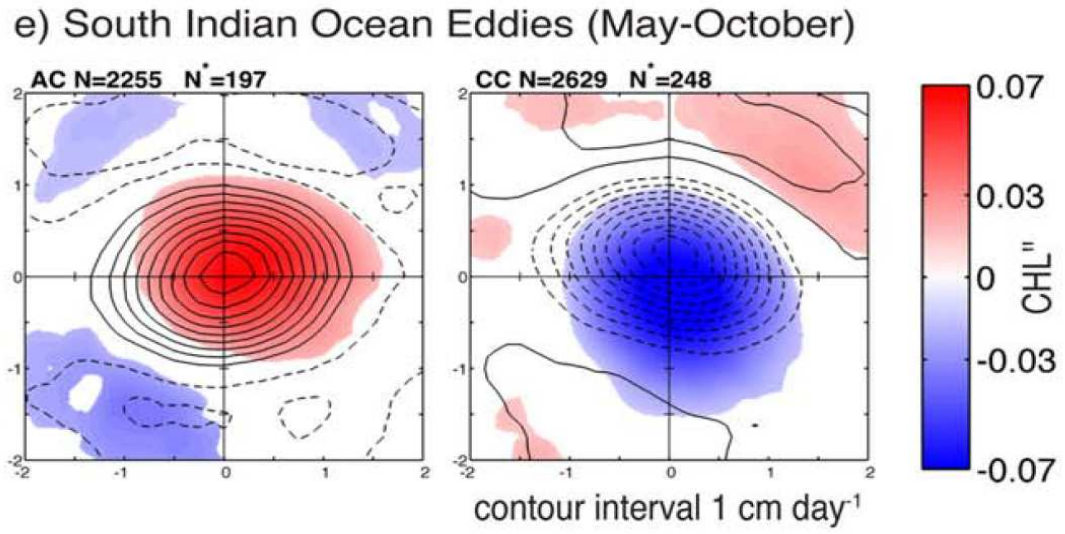
Model

Cross-correlation of SSH and CHL anomalies

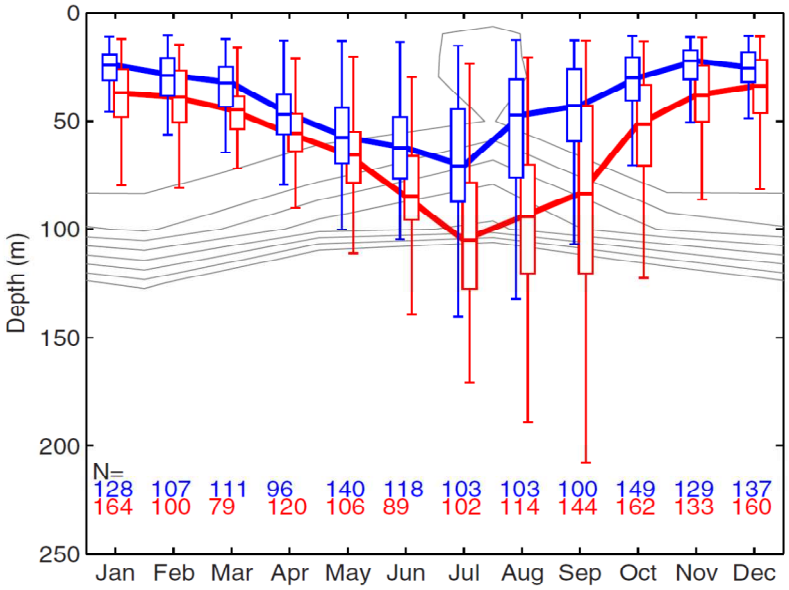
Gaube et al., in preparation



Observations



Gaube et al. 2014



Dufois et al. 2014

End