# Interannual variability in the chlorophyll concentrations on the Mid-Atlantic Bight along northeast United States

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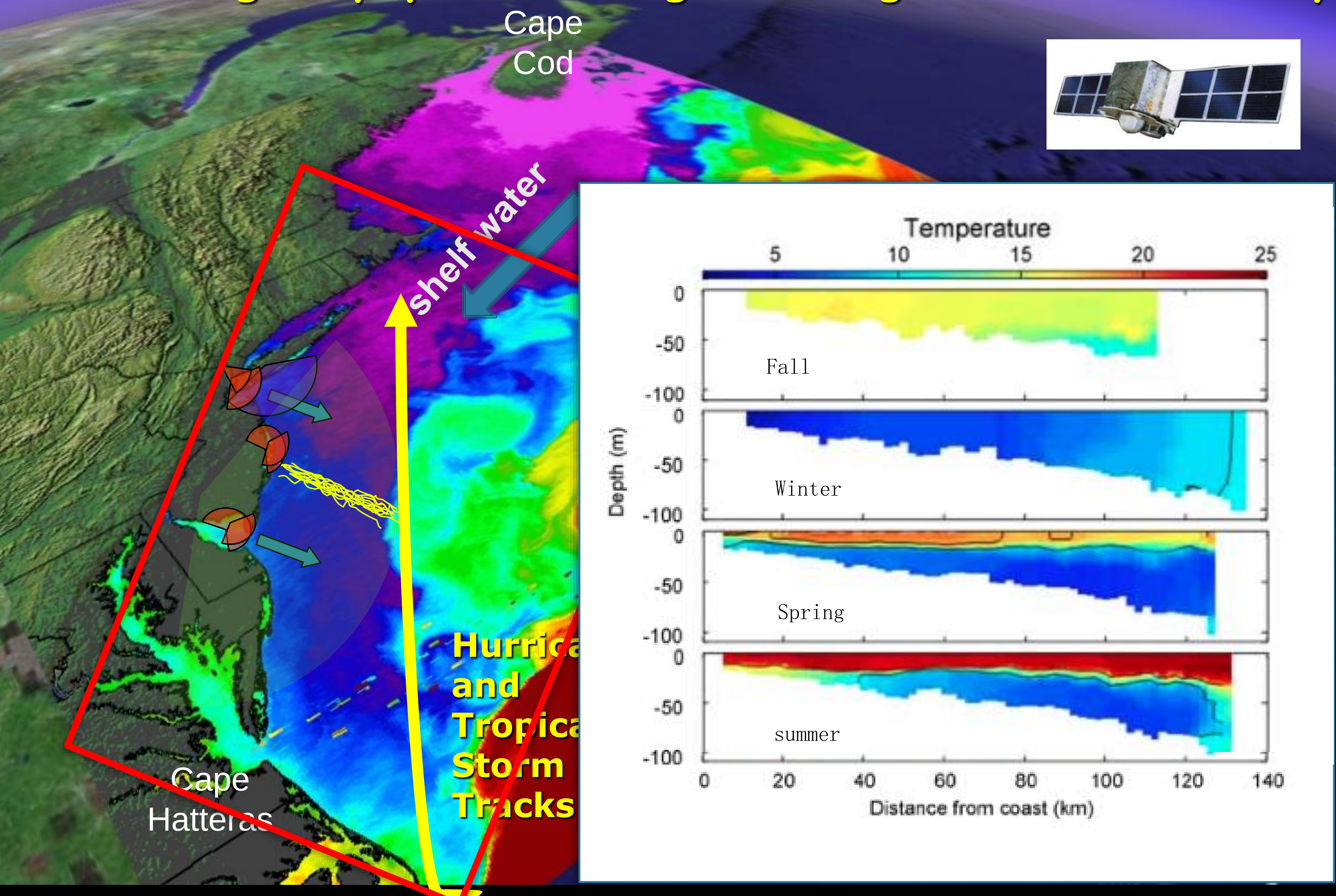
# MAB: Productive Shelf, influenced by oceanographic and meteorological physical forcings. strong seasonal variability



# *MAB* is warmer, fresher

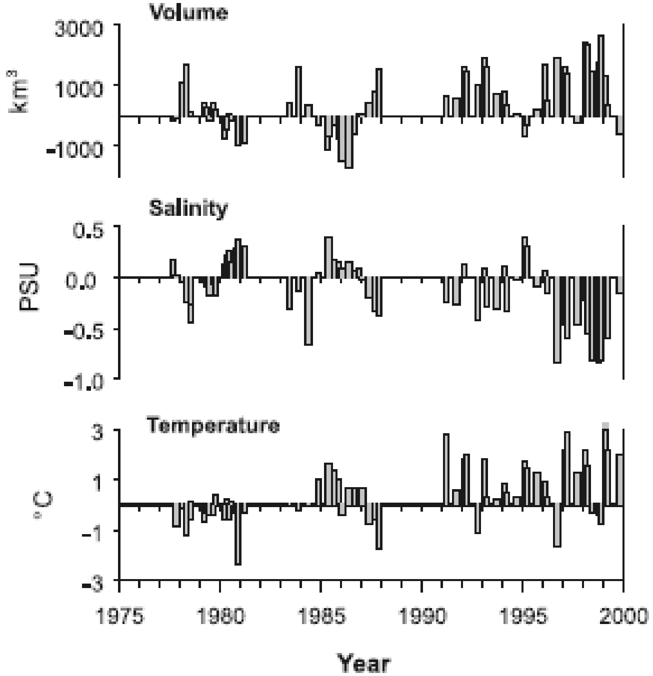



Figure 6. MAB-wide anomalies in SHW volume, salinity, and temperature.

(Mountain, 2003)

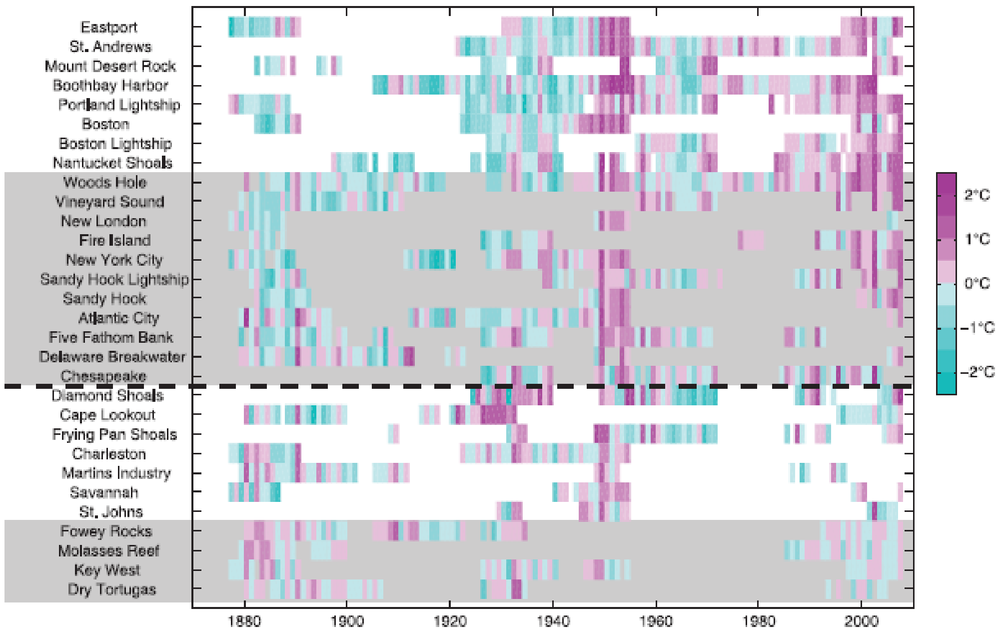


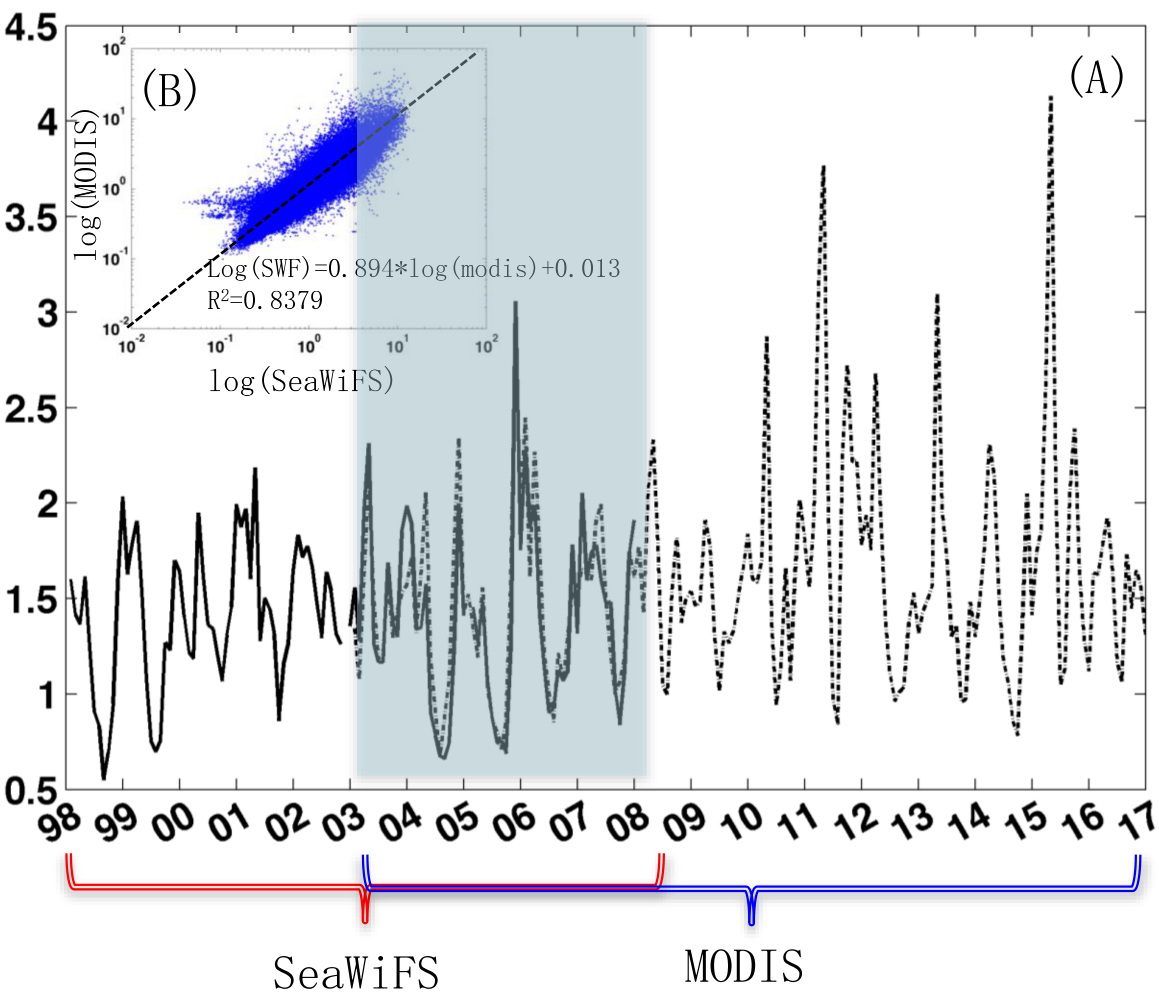

FIG. 5. Annual average SST anomalies (section 3a) along the U.S. East Coast. Along-shelf regions are shaded, and the dashed line indicates the approximate position of Cape Hatteras (36°N).

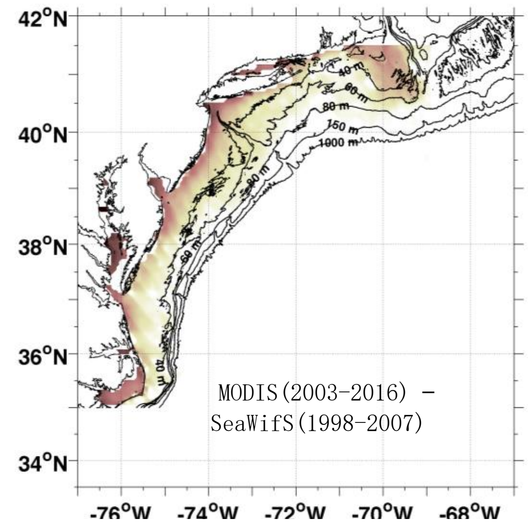
(Shearman and Lenta, 2010)

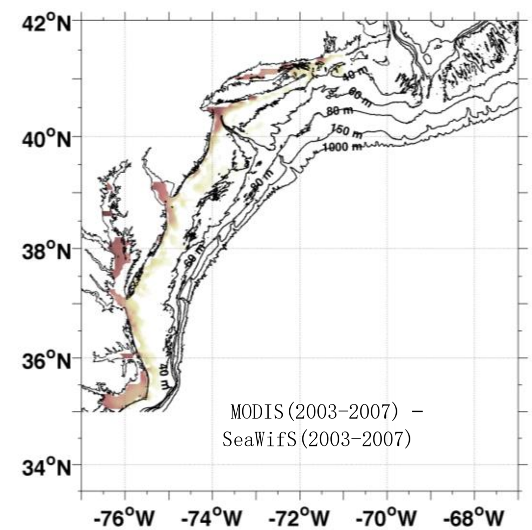
How these **regional environmental changes** in combination with a **changing climate system** might influence regional **primary production**?

# The SeaWiFS and MODIS Chla comparison

(sensor performance and retrieval algorithms)

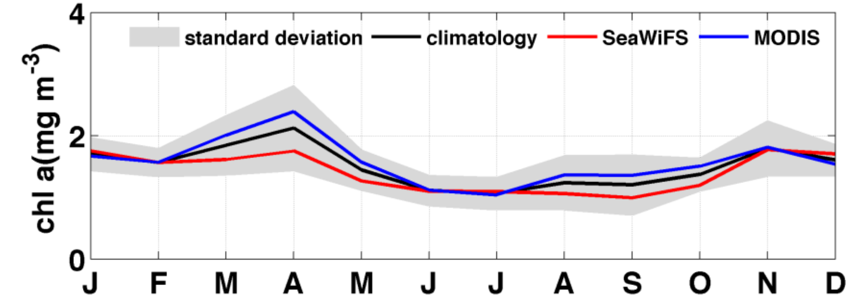


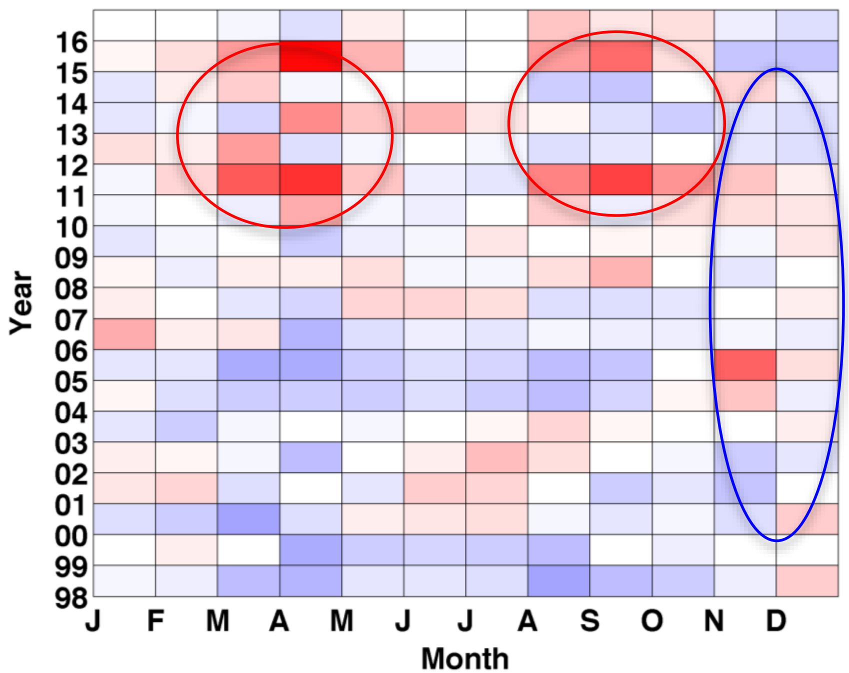



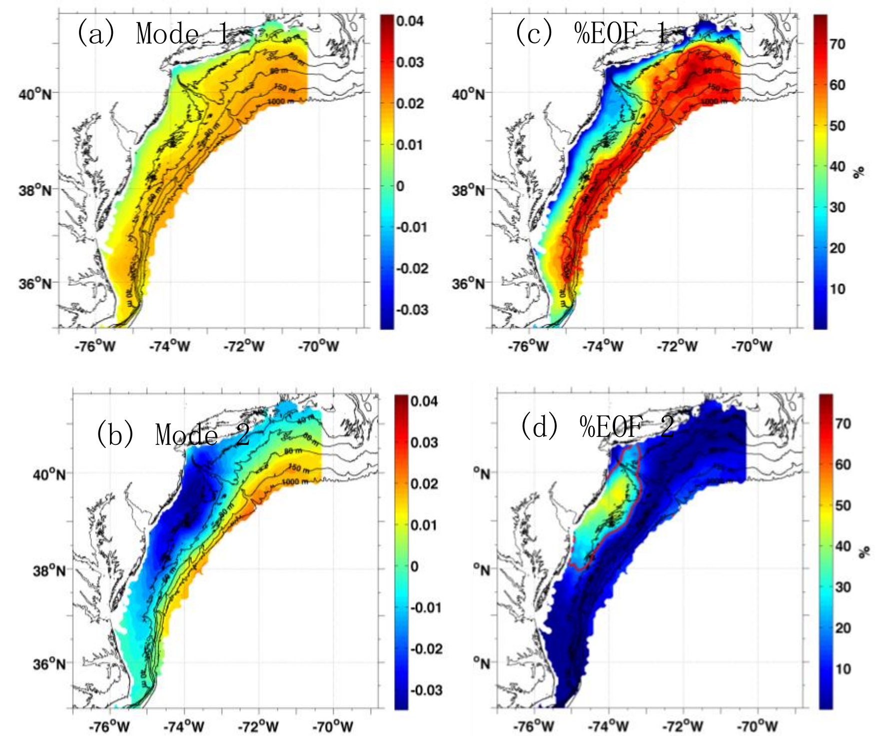



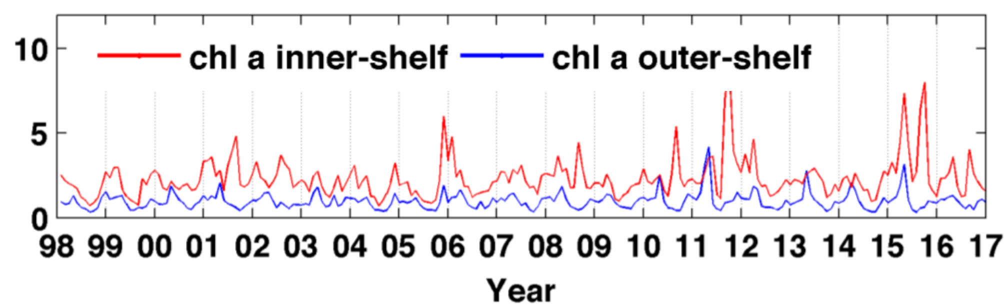

The combined 19-year SeaWiFS-MODIS datasets were compiled for the analysis of interannual variability

# Chl a climatology and anomalies



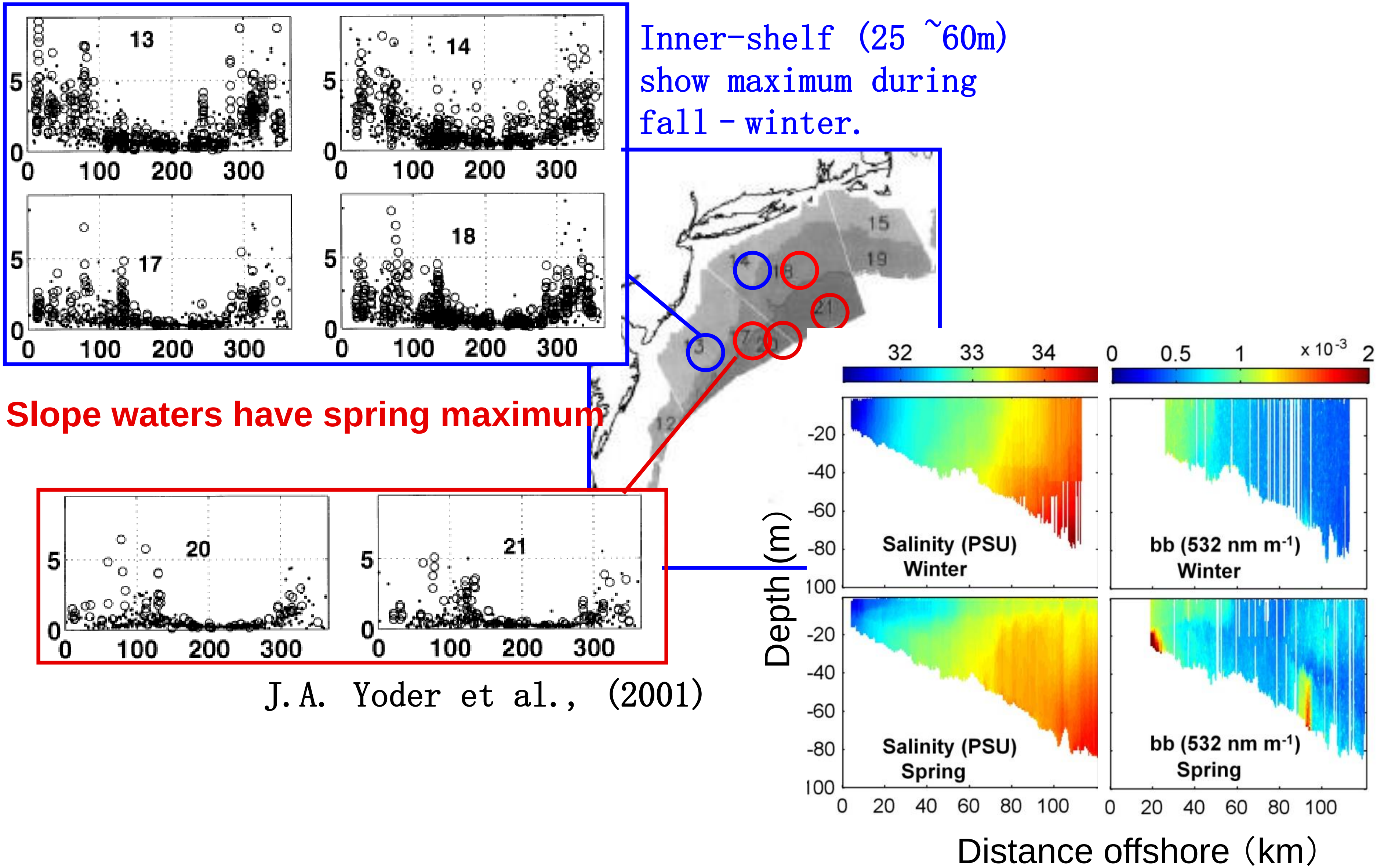




Chl a have been increasing driven by larger spring and fall blooms that offset declines in winter.

# Observations of fall-winter bloom and spring bloom

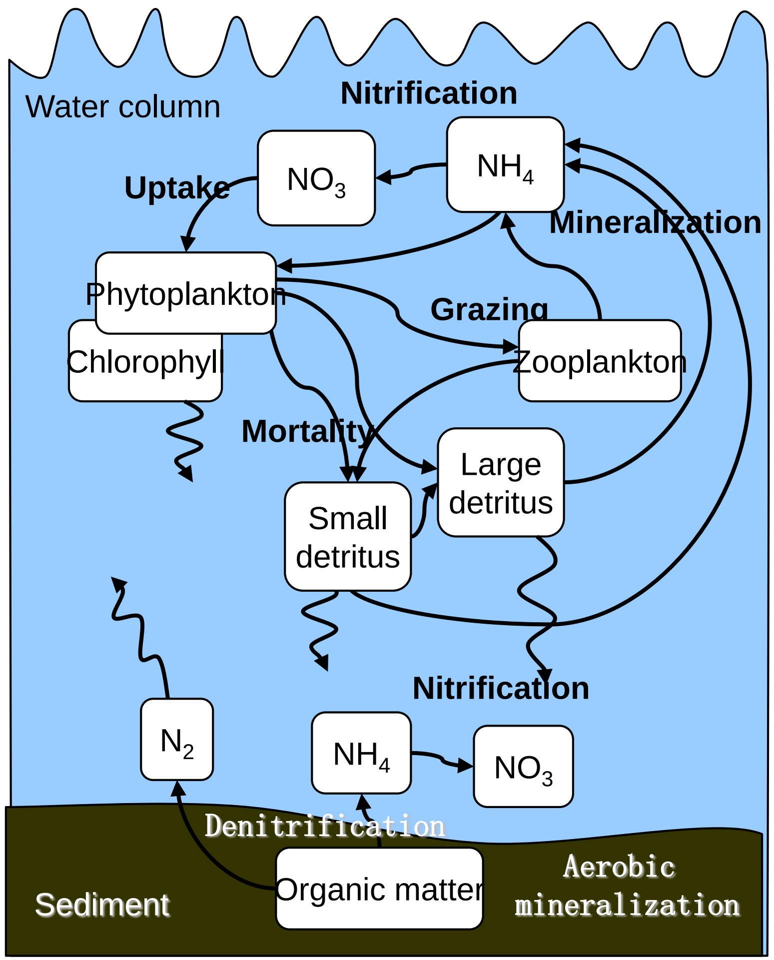



Inner-shelf (25 ~60m) show maximum during fall－winter.

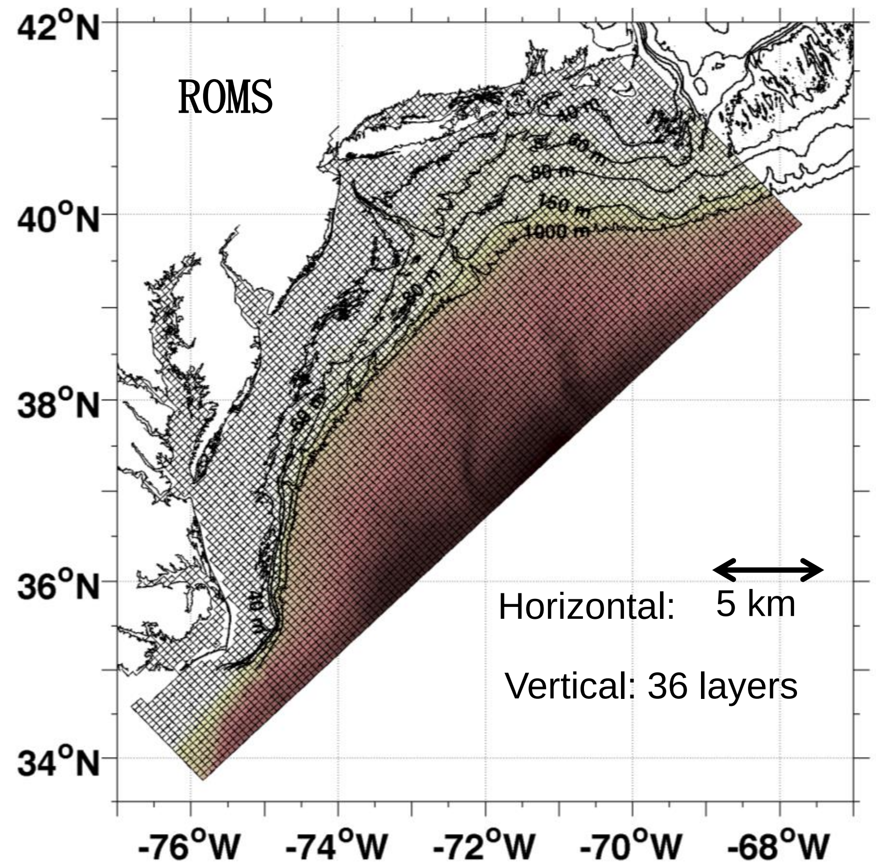
**Slope waters have spring maximum**

J.A. Yoder et al., (2001)

# Circulation and biogeochemical modeling

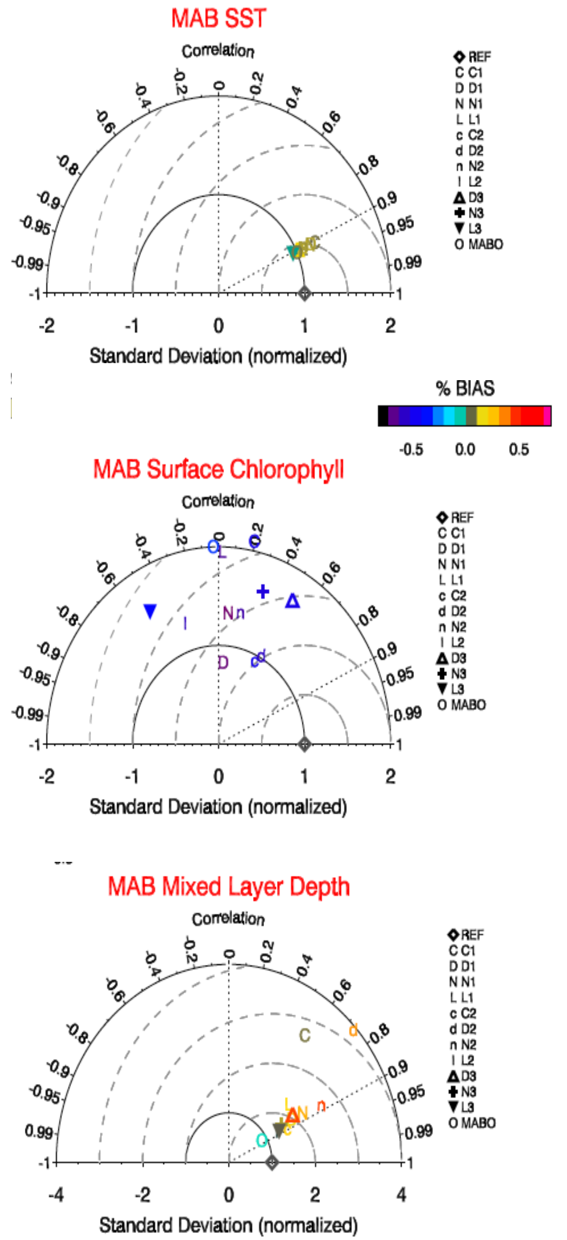


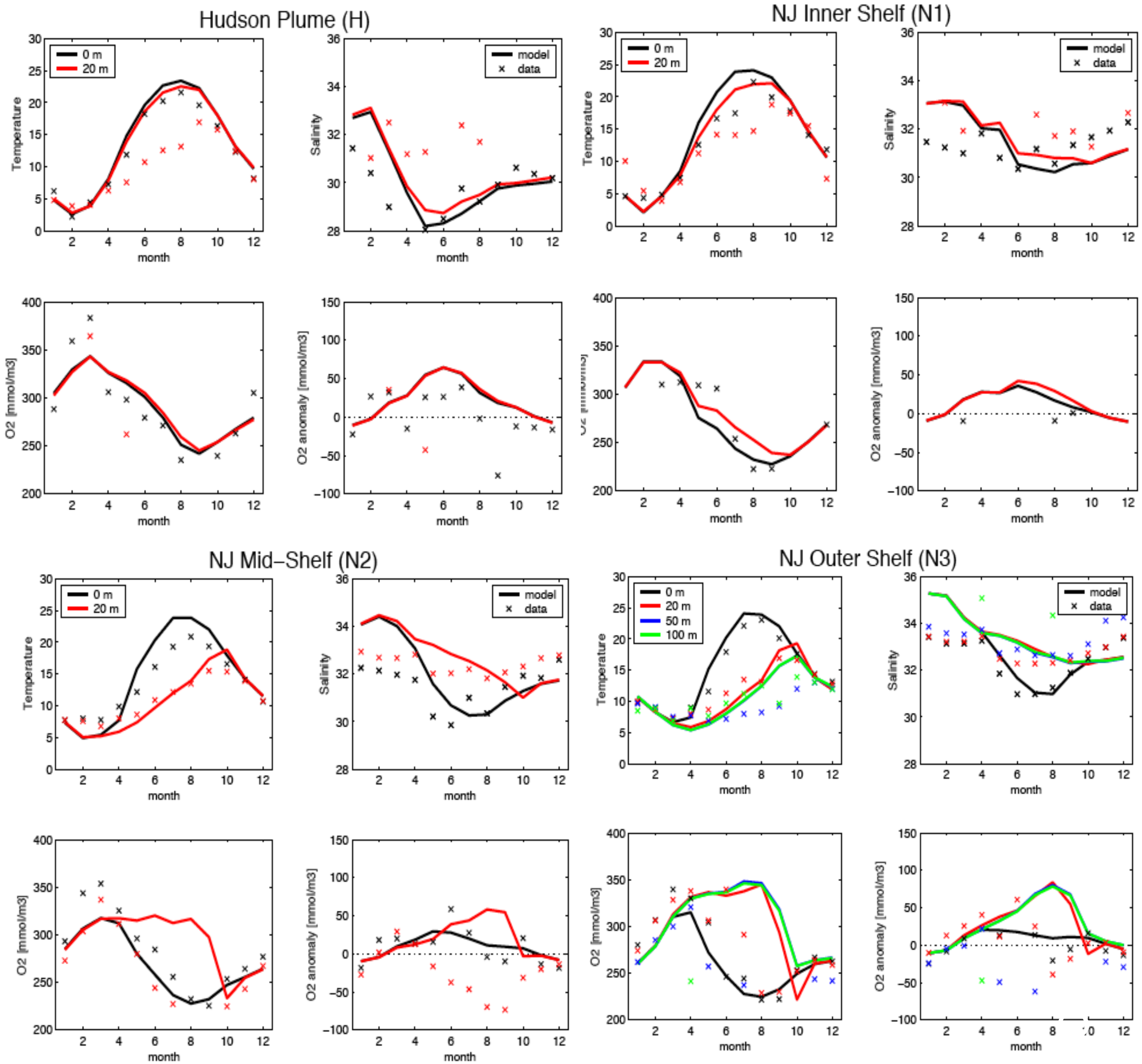

*Fennel, K., et al 2006. Glob. Biogeochem. Cyc., 20, doi:10.1029/2005GB002456.*



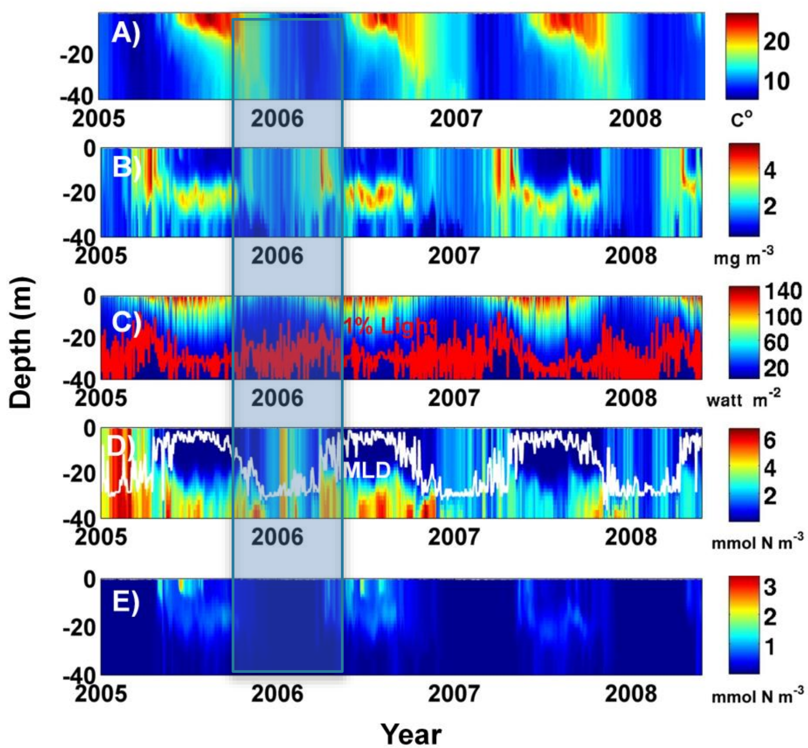

- **Wind**
- **Long&short wave radiation**
- **Precipitation**
- **Rain**
- **Humidity**
- **Air temperature**
- **Rivers**
- **Tides**

# Model Validations

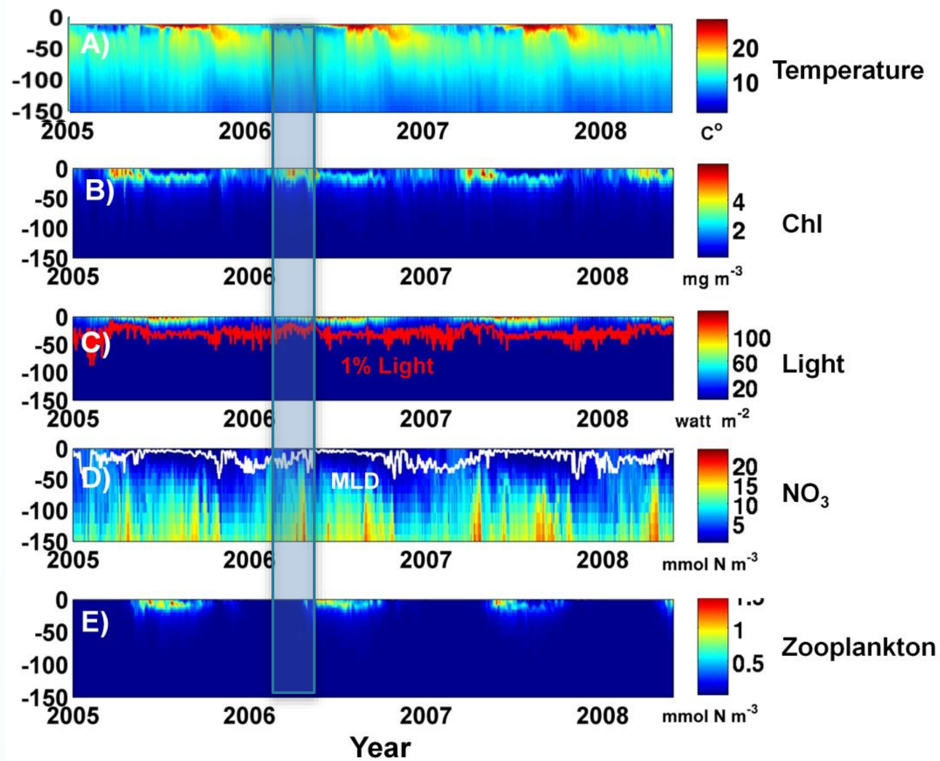


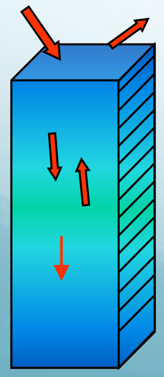
## Inner-shelf




## Outer-shelf




**Hydrolight radiative transfer :**



| Parameter | Shelf valley | Offshore Hudson River | Inner-shelf | Outer-shelf |
|---|---|---|---|---|
| Mean Chl a | | | 1.7 | 0.7 |
| Maximum Chl a | | | 4.9 | 2.1 |
| Minimum Chl a | | | 0.6 | 0.2 |
| Mean 1% Light depth | 20 | 10 | 20 | 33 |
| Mean Water Depth | | | 41 | 200-681[1] |
| Percent of water column above the 1% light | 50% | 25% | 49% | 5-17% |

- 25 – 50% of the inner-shelf water column above the 1% light level.
- 5 – 17% of water column of outershelf are above the 1% light level.

# POTENTIAL ENERGY ANOMALY(PEA)

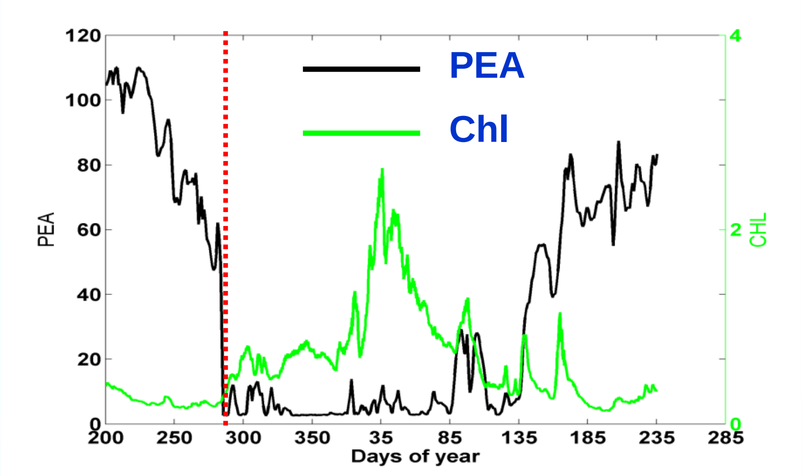
(amount of energy per volume that is necessary to vertically homogenize the entire whole water column)

$$\phi = \frac{1}{D}\int_{-H}^{\eta} gz(\bar{\rho} - \rho)dz$$

PEA > 0 (stable stratification)

PEA = 0 (fully mixed )

PEA < 0 (unstable stratification)

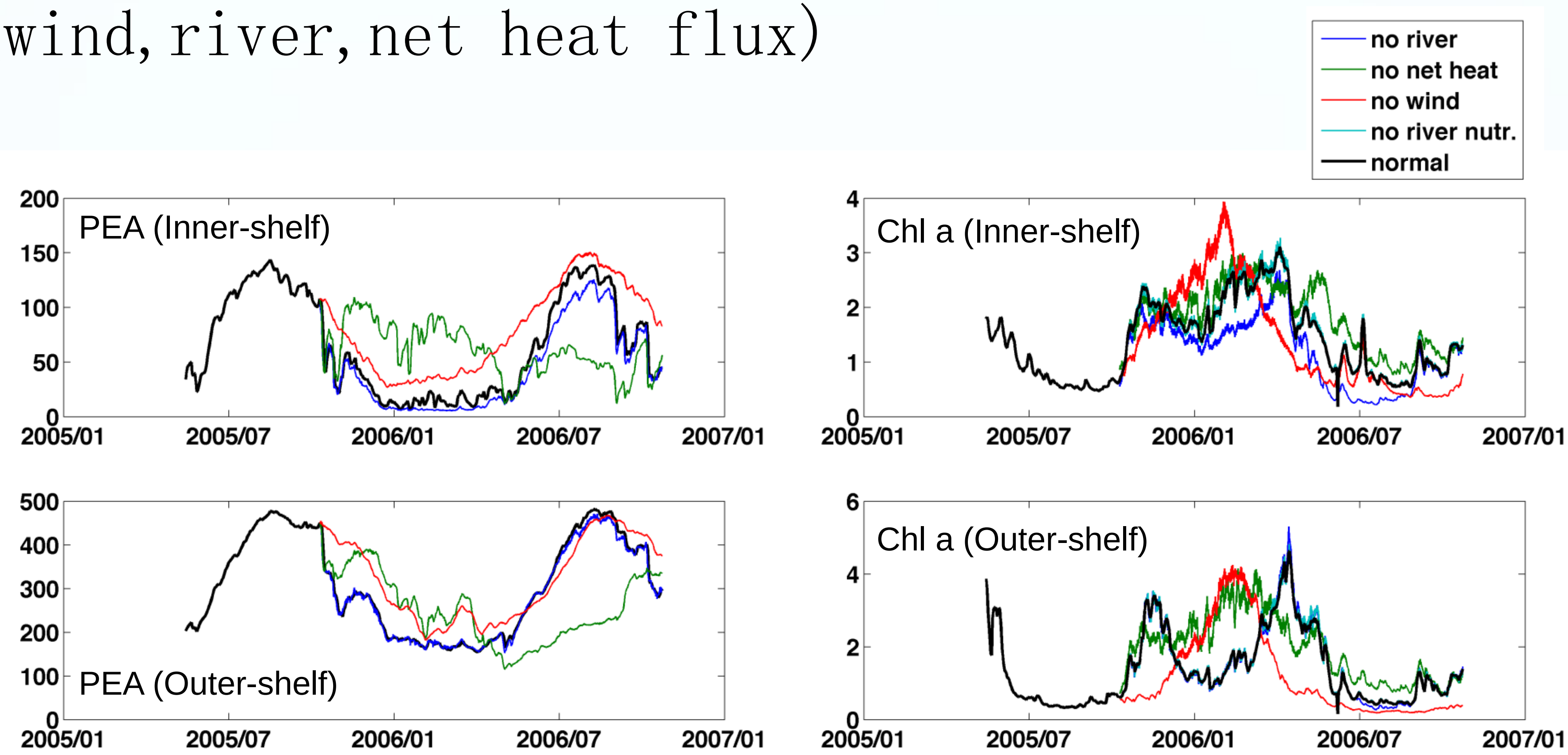



**PEA are largely influenced by wind, river, and NHF**

$$\frac{d\phi}{dt} = \frac{\alpha g Q}{2c} + \frac{g(E-P)\Delta\rho}{2} - \varepsilon k_b \rho \overline{|u_b|^3} - \delta k_s \rho_s \frac{\overline{W^3}}{h} + \frac{g}{h}\frac{\partial \rho}{\partial y}\int_{-h}^{0}(v - \hat{v})zdz$$

Surface net heat | Salt flux | Tide mixing | Wind mixing | River runoff

# Model sensitivity study for stability (wind, river, net heat flux)



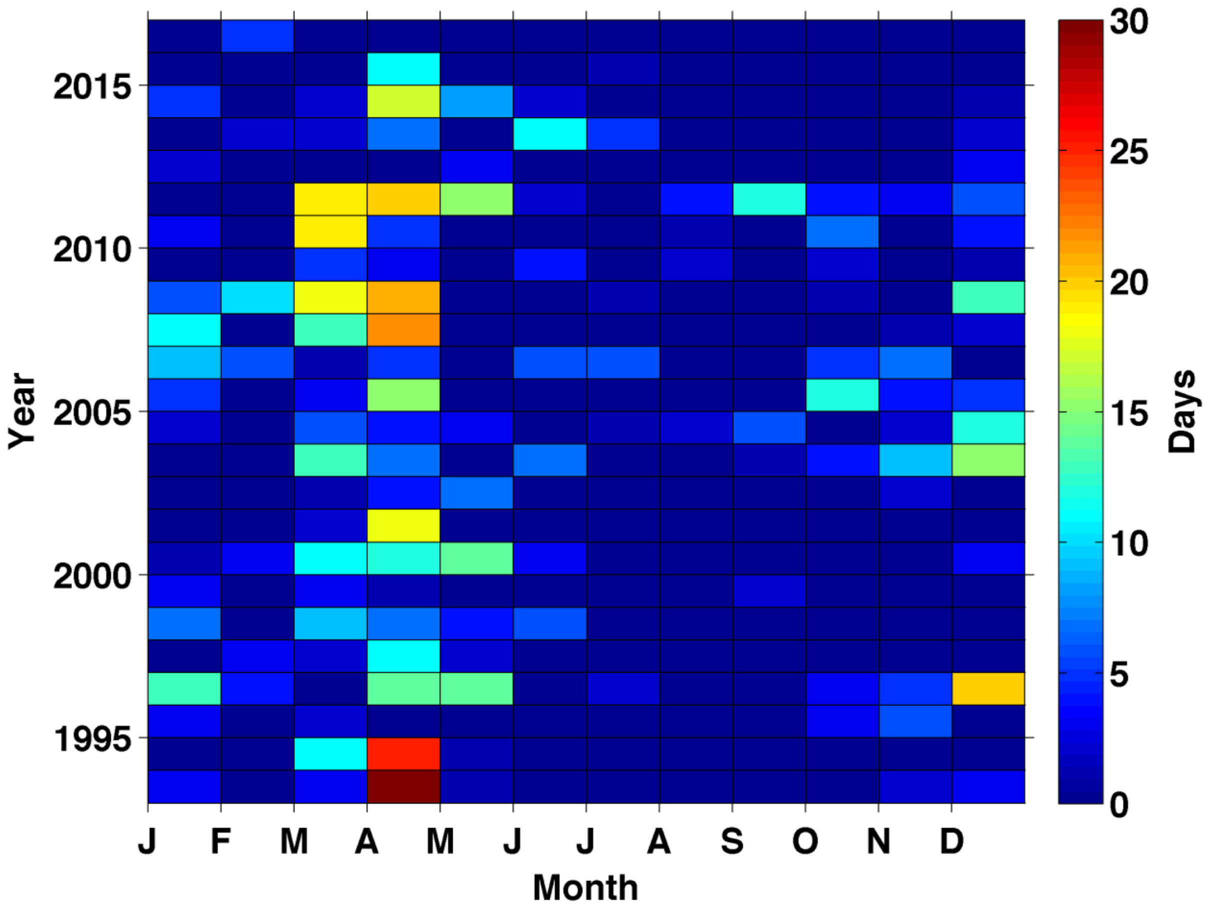

Inner-shelf:

- Initial of fall bloom (wind)
- Magnitude of fall-winter bloom (wind, net heat flux, and river buoyancy)

Outer-shelf:

- Initial of spring bloom (wind)
- Magnitude of spring bloom (wind, net heat flux)

# Decadal variability of **river**

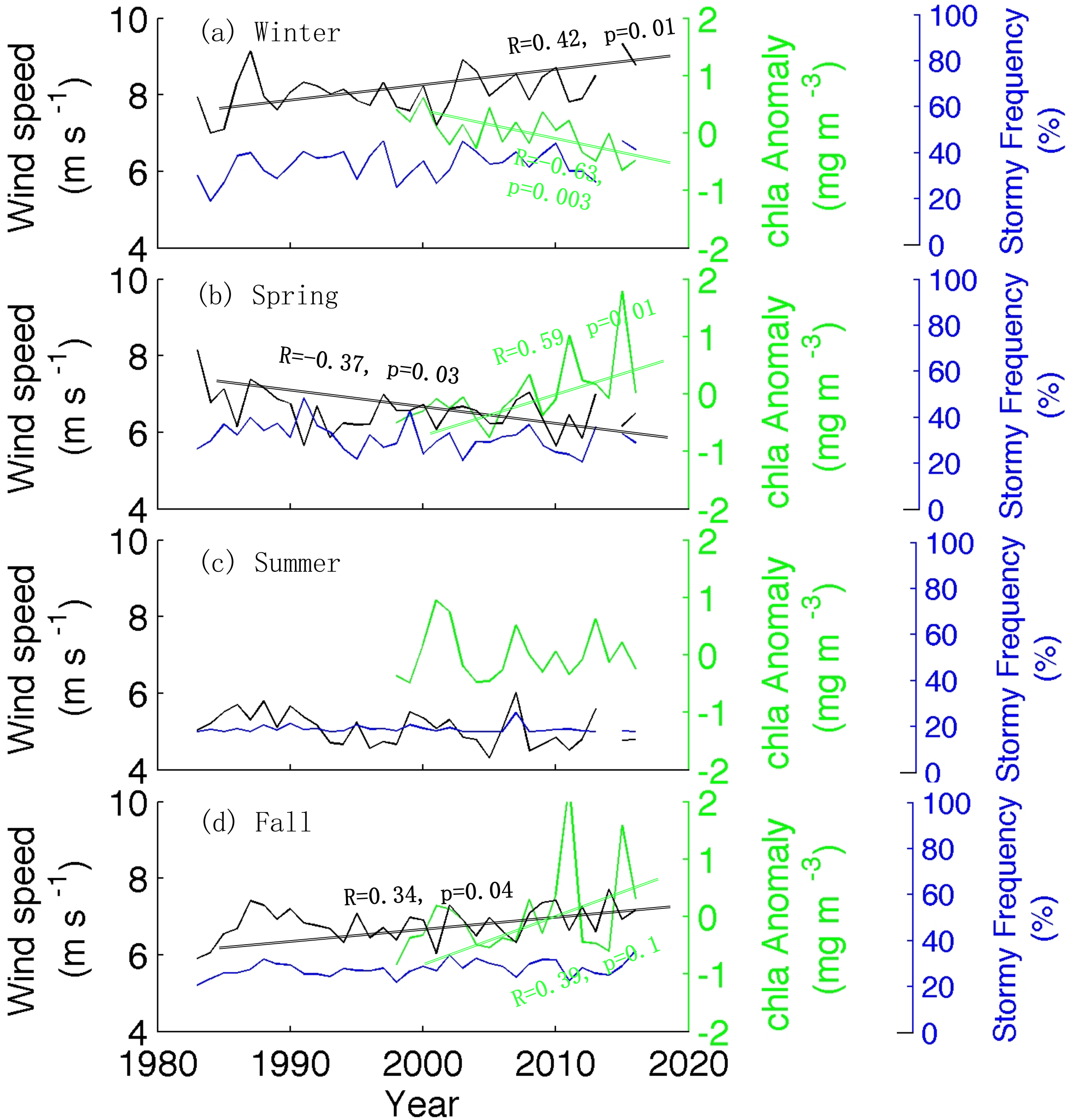



High and persistent river discharge events

Highest freshwater river discharge occurred during the spring.

There is a decreasing trend of winter river discharge since 2005 (with R=-0.81, p<0.01).

# Decadal variability of **wind**




There was an increasing trend of wind speed in the **winter and fall**, and decreasing trend during the **spring** over the 34-year time series

# In conclusion

- Surface chlorophyll concentrations of the MAB have been increasing driven by larger spring and fall blooms that offset declines in winter.
- Opposite tendency of winds and chl a are found in winter and spring, similar tendency of winds and chl a are found in fall.
- Combined satellite data and regional models are used to study the underlying mechanisms controlling phytoplankton distributions.

**Thank You !**