The Darwin Project: Modeling Marine Microbial Communities

- How are marine microbial communities organized?
- Can we model them and their impact on biogeochemical cycles?
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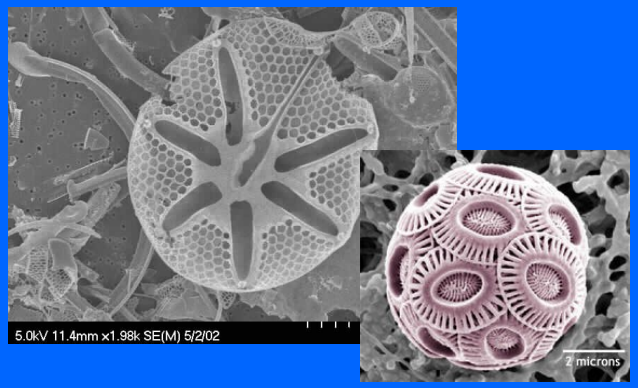
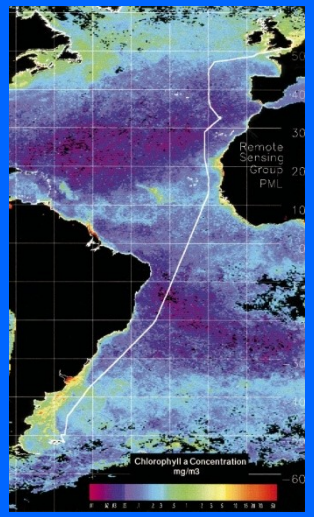
Gordon and Betty MOORE FOUNDATION

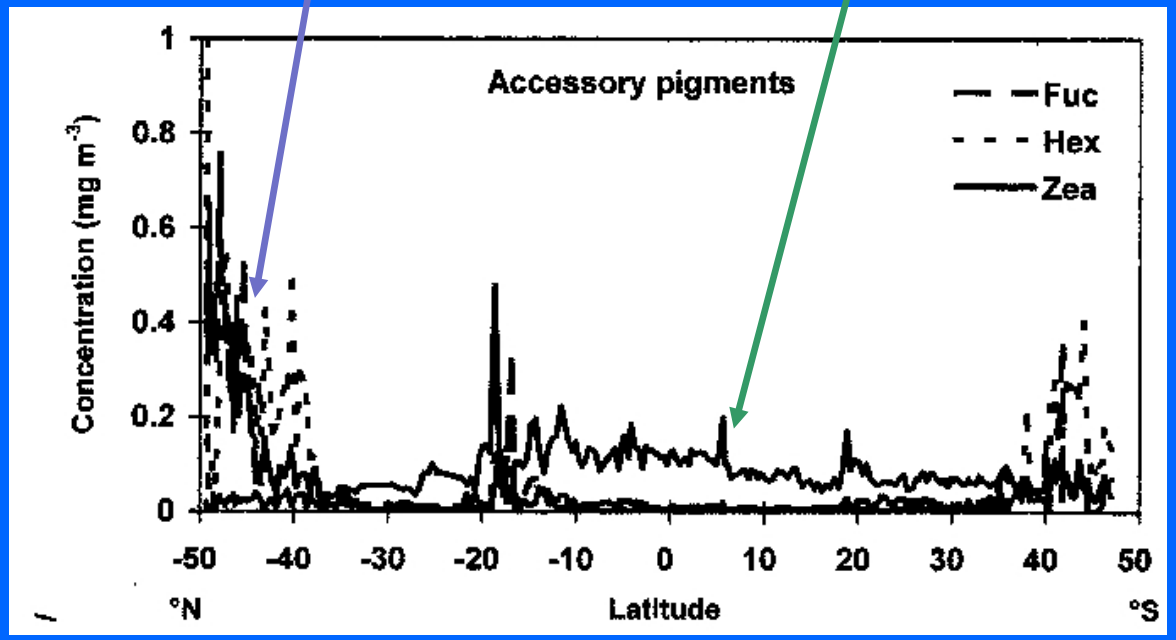
Community structure and function vary by region and season with implications for carbon cycle



Larger phytoplankton
- diatoms, cocco's
- EXPORTING

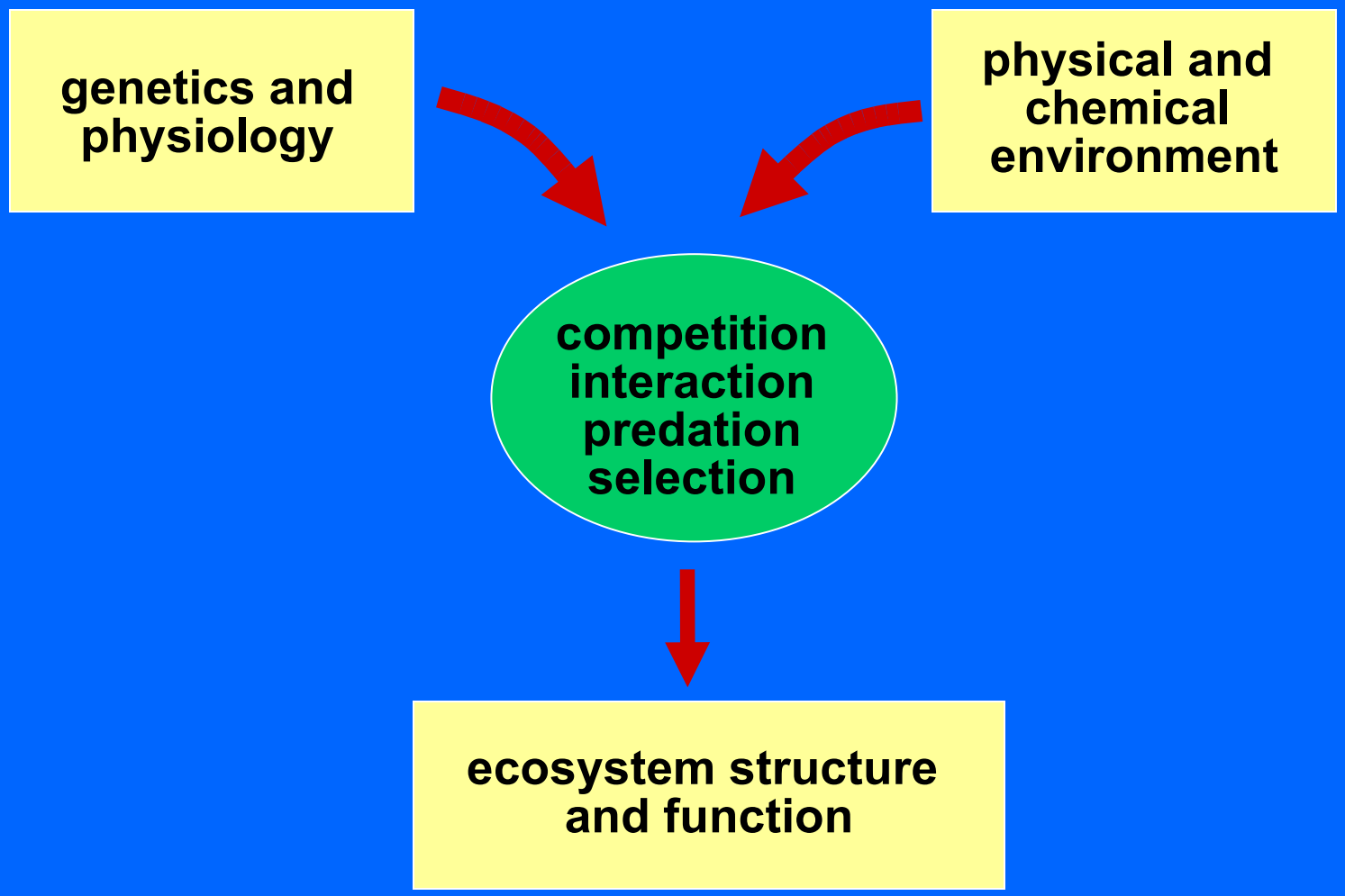
Small phytoplankton
– *Prochlorococcus, Synechococcus*
- RECYCLING





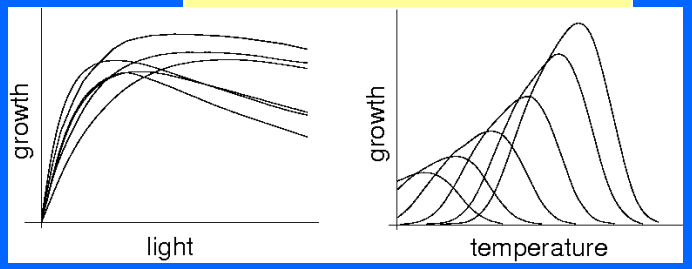
Atlantic Meridional Transect (AMT): Aiken et al. (2000)

Self-Assembling Ecosystem Model



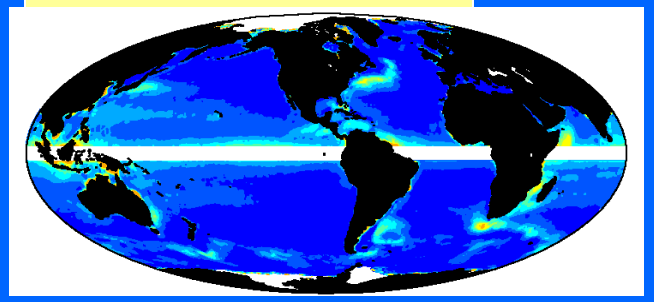
A Self-Assembling Ecosystem Model

genetics and physiology



Initialize many tens of plausible phytoplankton physiologies

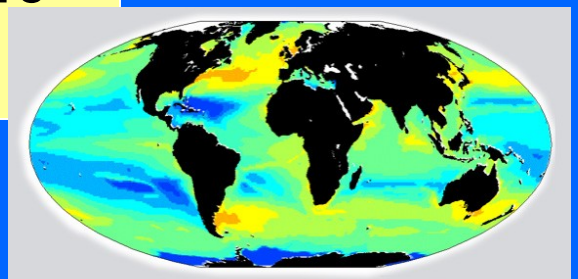
physical and chemical environment



Global ocean circulation model: ECCO GODAE

competition
interaction
predation
selection

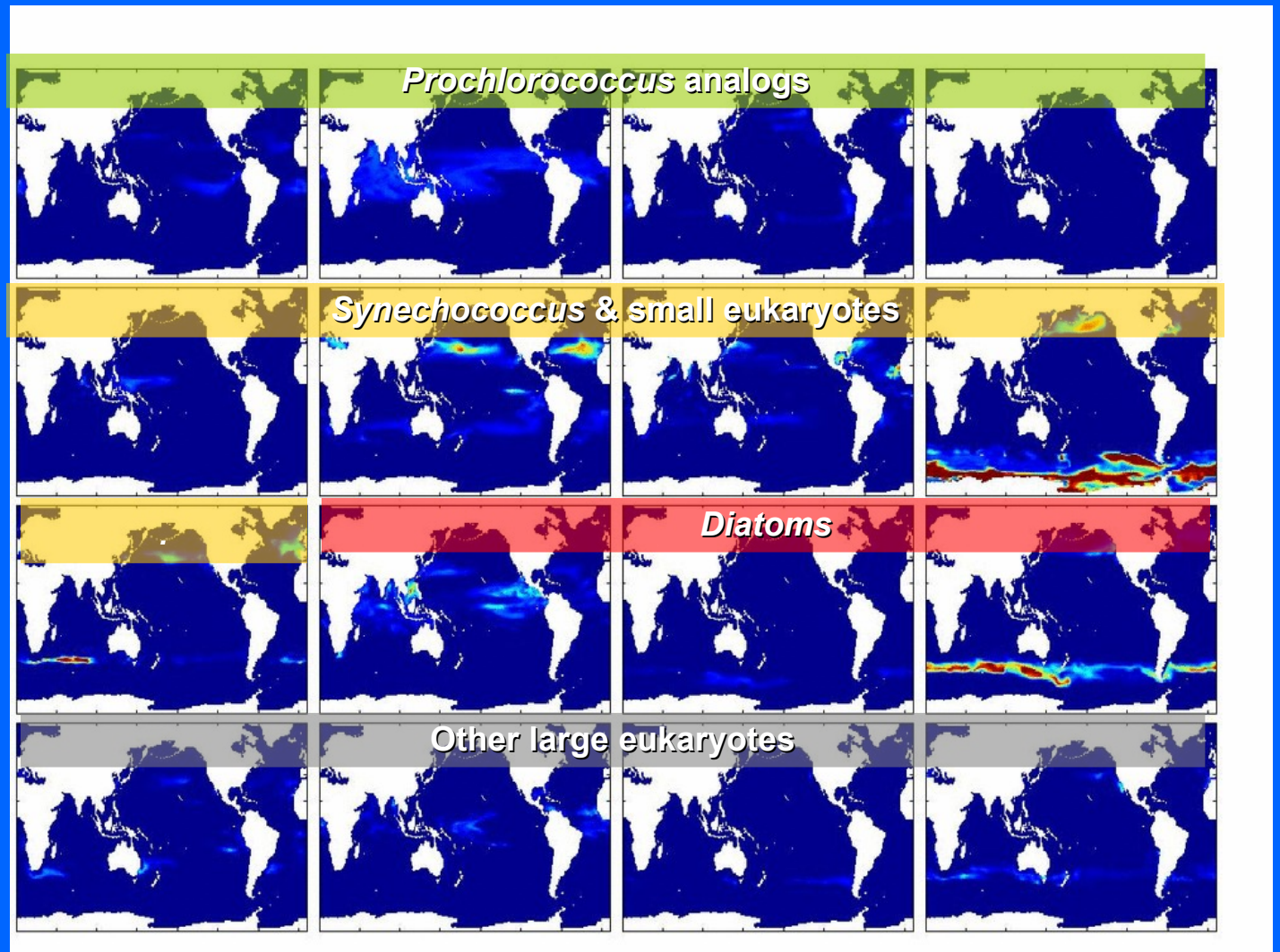
ecosystem structure and function



Fittest phyto types persist

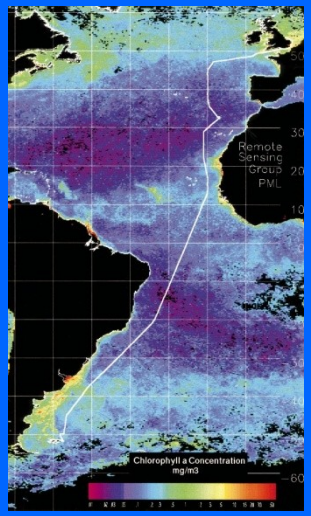
- 16 most abundant (of 78)
- Account for >99% biomass

(Follows et al., 2007)

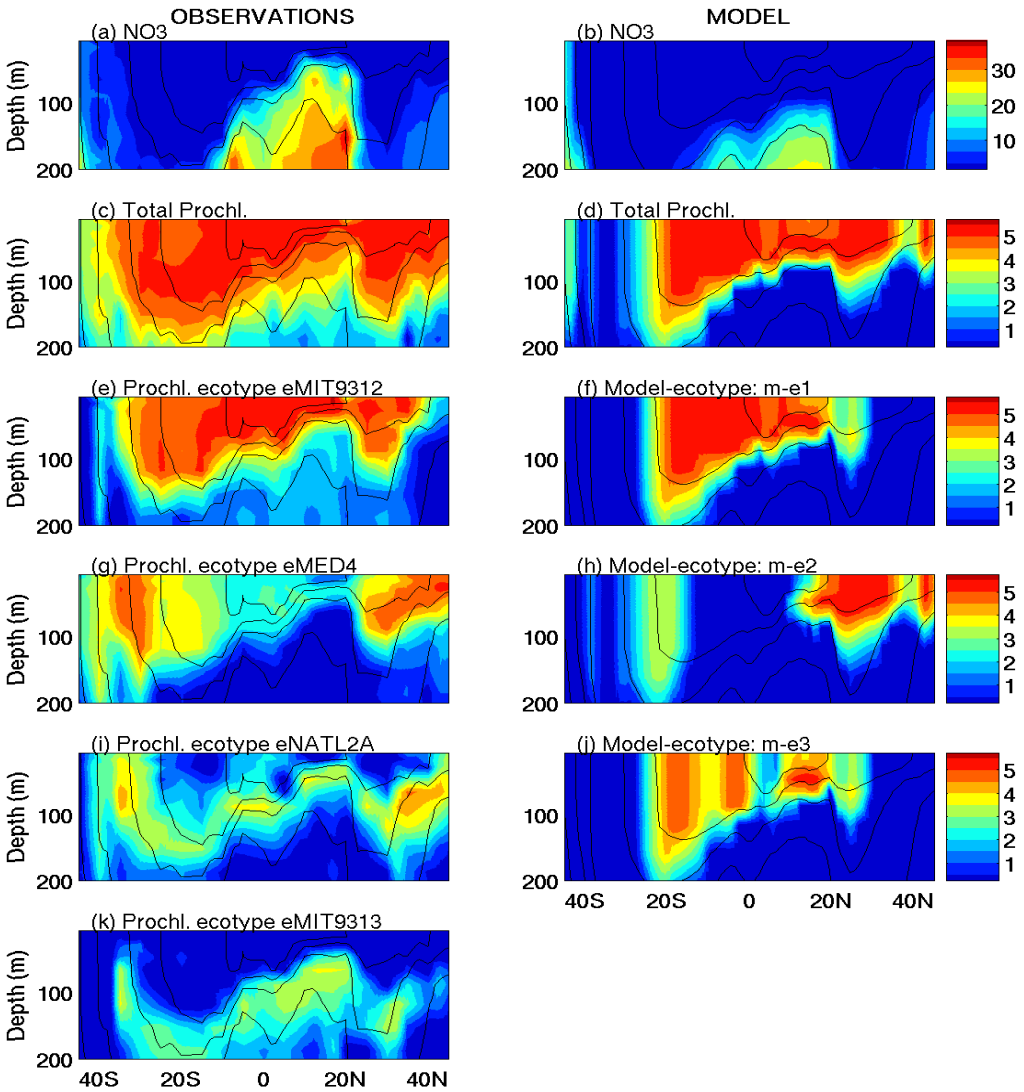


Self-Assembling Ecosystem Model

- Emergent analogs of *Prochlorococcus* ecotypes
- Habitat and physiological specialism corresponds to observed wild types

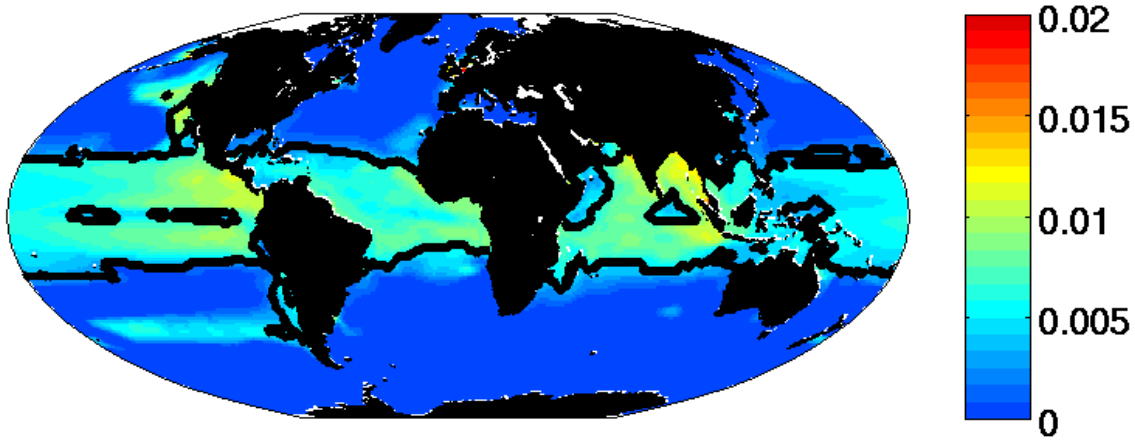


Follows et al (2007)

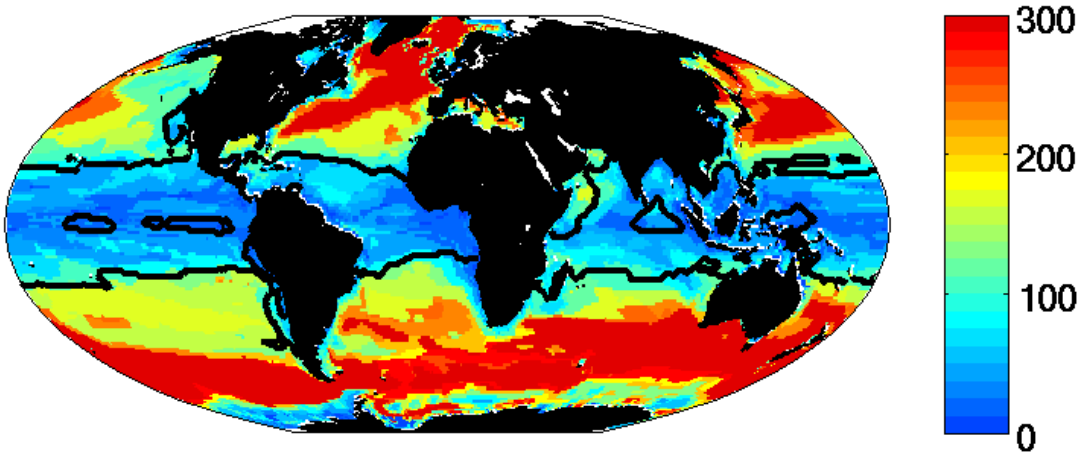


Johnson et al 2007 observations

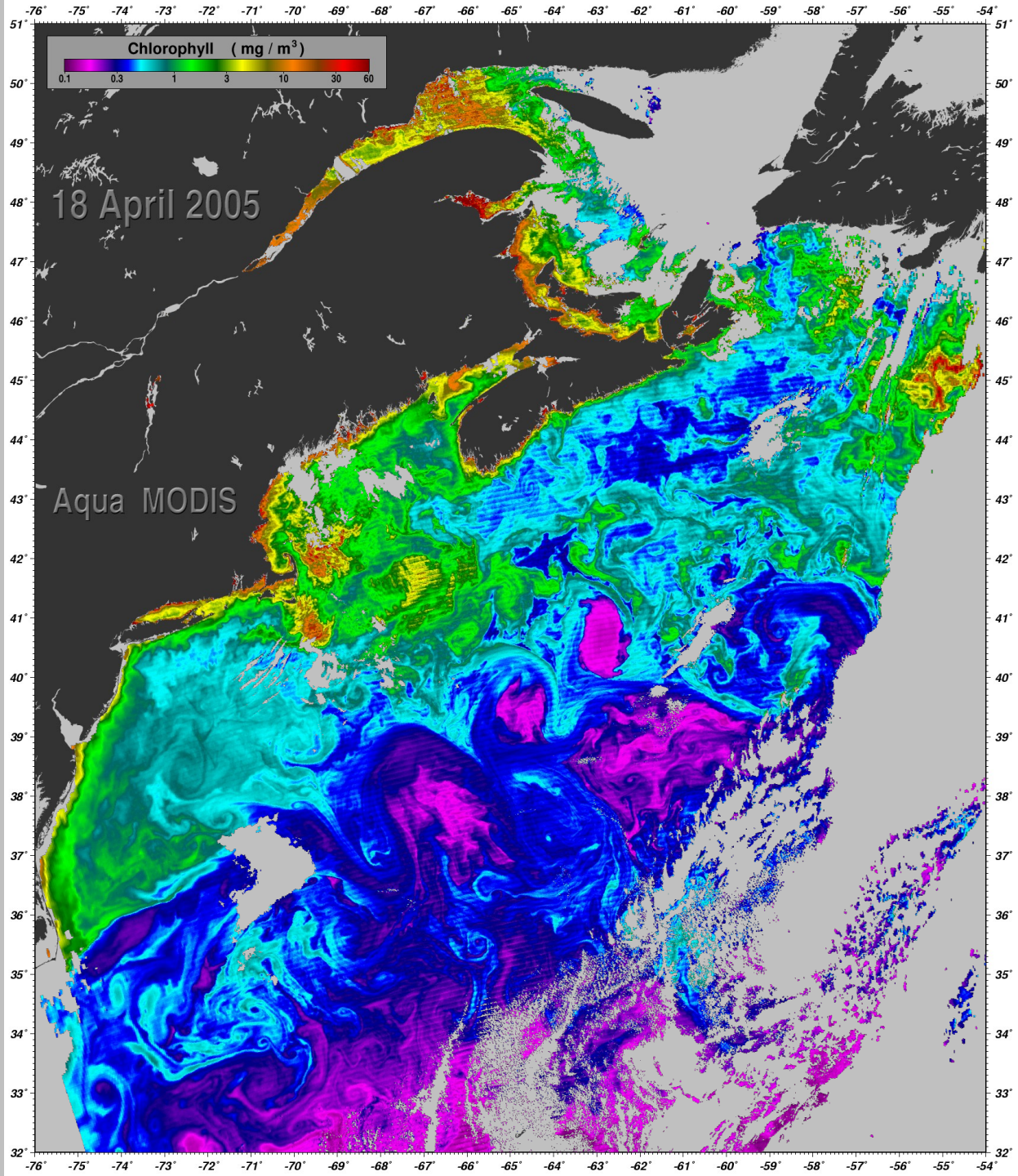
Seasonality strongly regulates ecosystem



Biomass of Prochlorococcus analogs (mol P m^{-3})



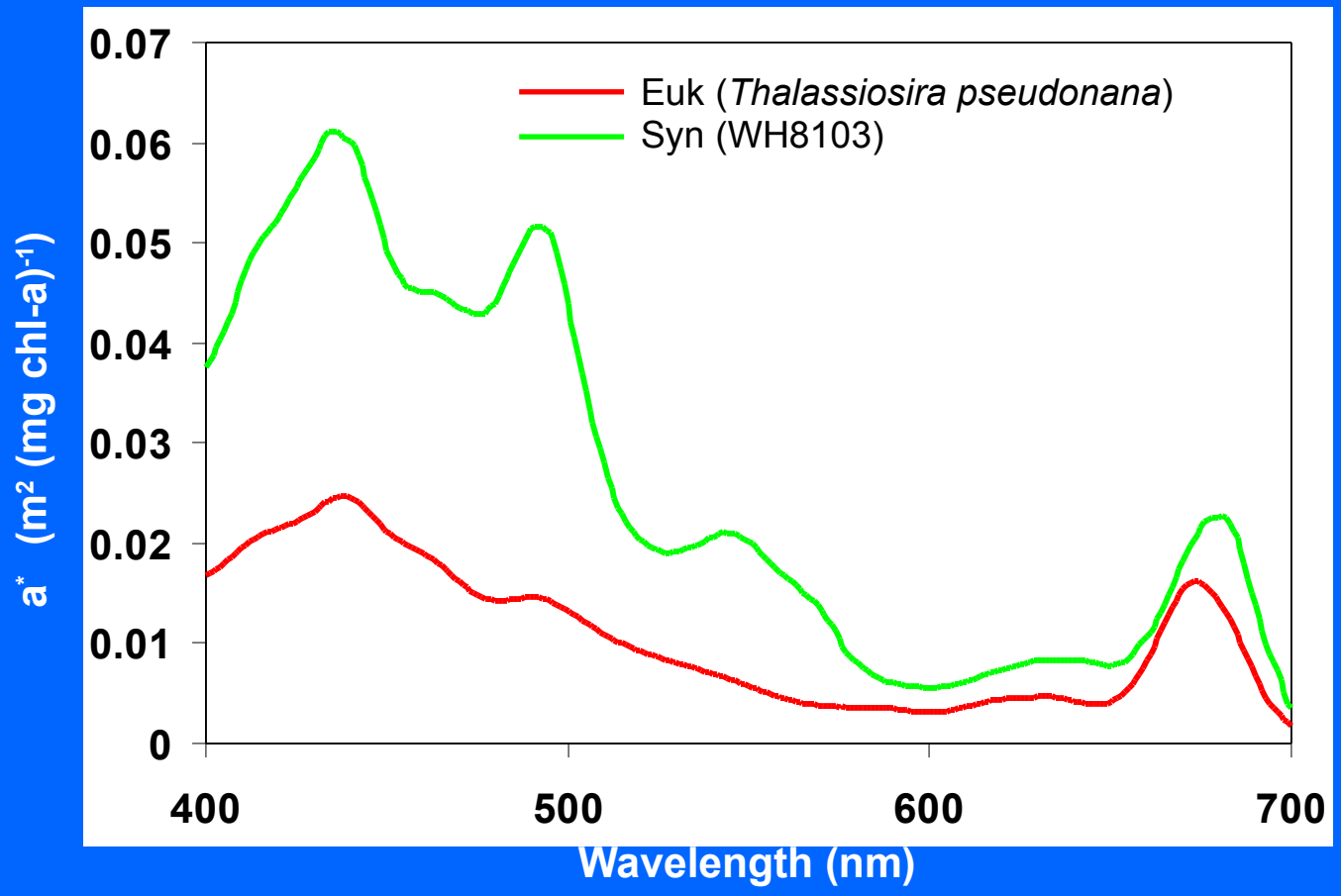
Annual range of Mixed Layer Depth (m)


Chlorophyll (mg / m3)
0.1
0.3
1
3
10
30
60
18 April 2005
Aqua MODIS
-76° -75° -74° -73° -72° -71° -70° -69° -68° -67° -66° -65° -64° -63° -62° -61° -60° -59° -58° -57° -56° -55° -54°
51° 50° 49° 48° 47° 46° 45° 44° 43° 42° 41° 40° 39° 38° 37° 36° 35° 34° 33° 32°

ECCO2

- How do ocean eddies shape the marine ecosystem?
  - eddy resolving, self-assembling ecosystem model (Oliver Jahn, Stephanie Dutkiewicz, Chris Hill)
- How does the light field influence/reflect phytoplankton community structure?
  - explicit, wavelength dependent radiative transfer model (Watson Gregg)
  - pigments as selective agent (Anna Hickman)

Light Absorption (Anna Hickman)

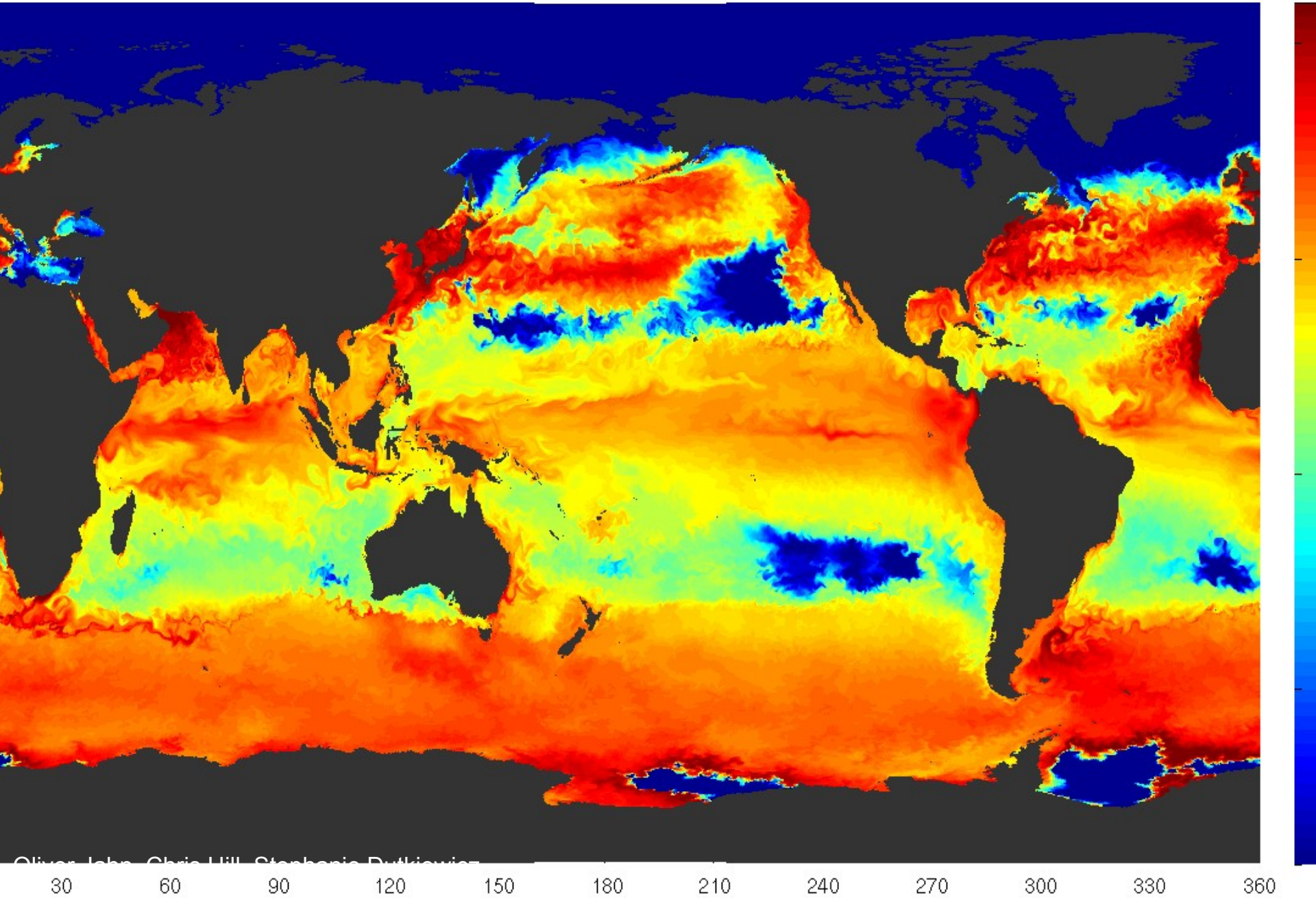


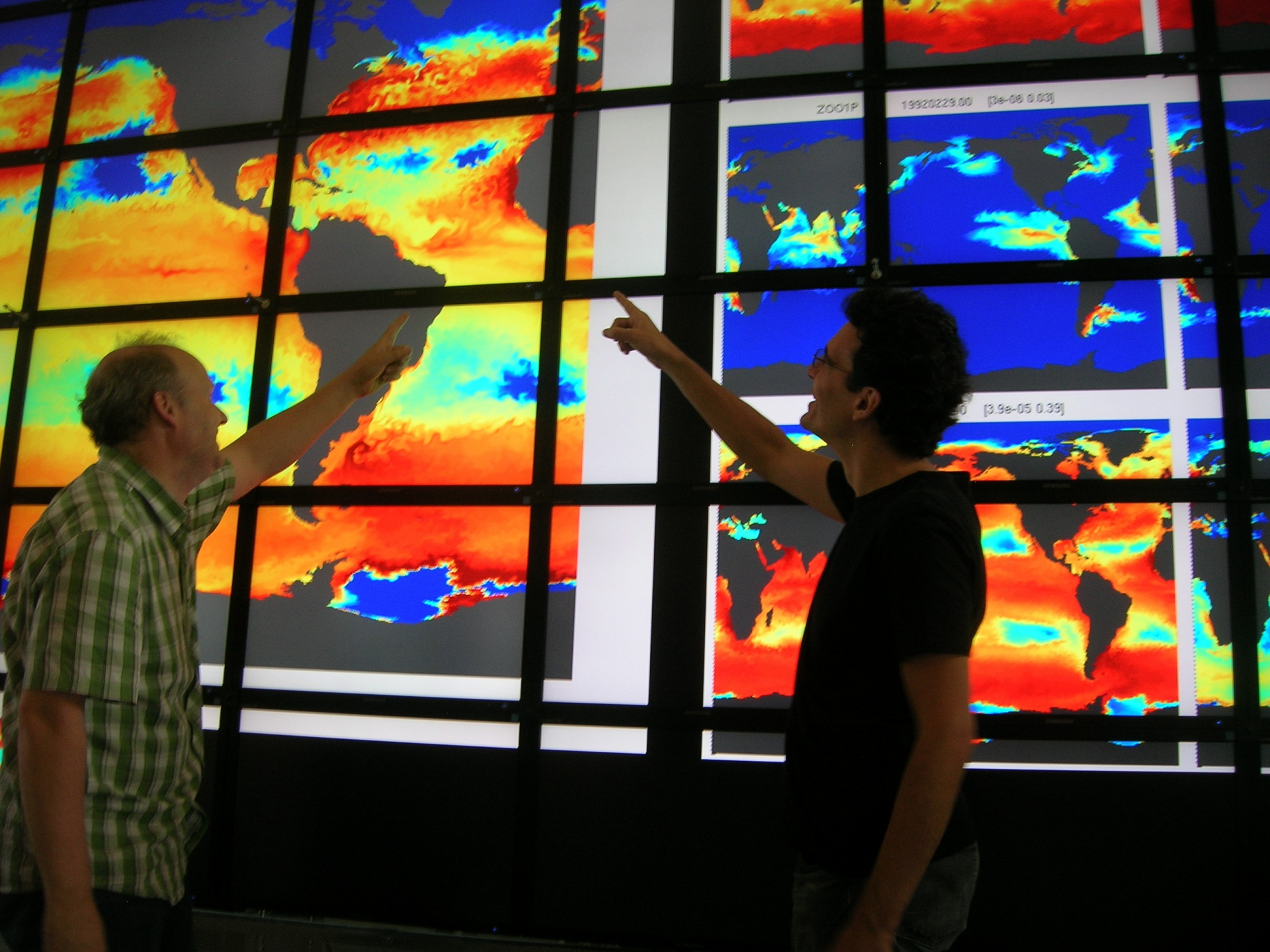
Synechococcus
Phycobillins
Zeaxanthin
β - carotene ?

Eukaryotes
19'-Hex
19'-But
Fucoxanthin
Peridinin
Alloxanthin

(Data courtesy: D. Suggett, L. Moore)

biomass 1992/02/29

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