Dissolved Organic Carbon in the Indian Ocean

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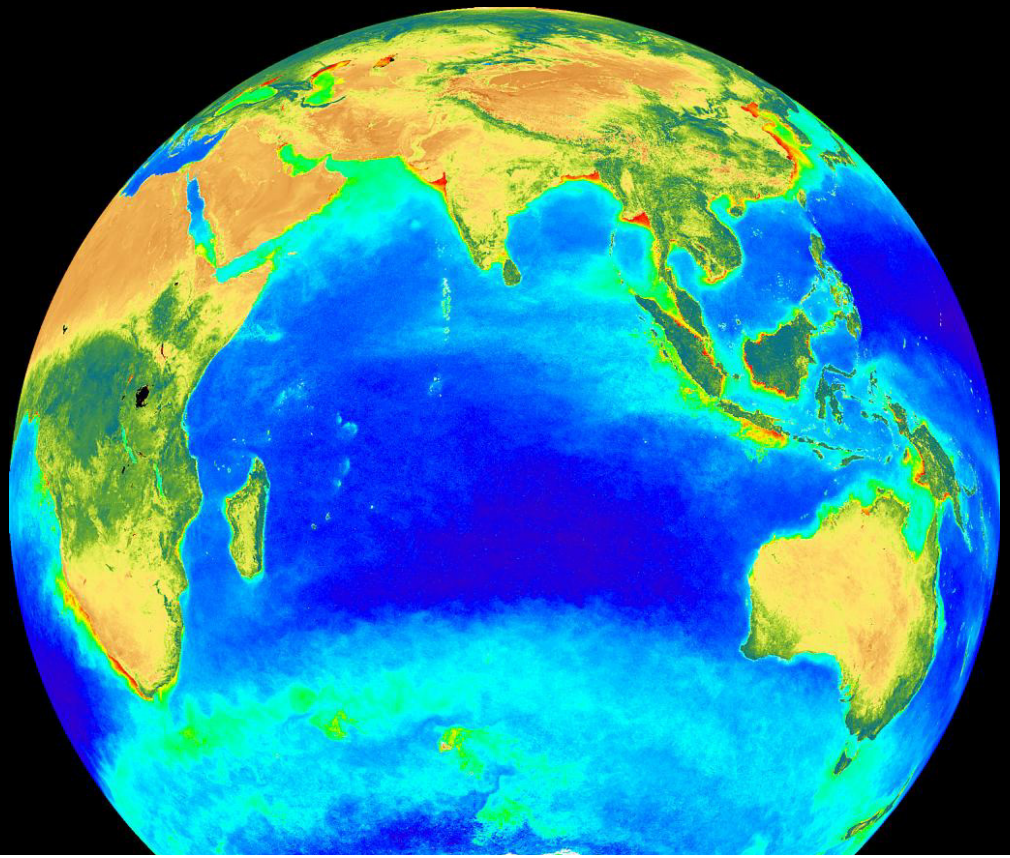
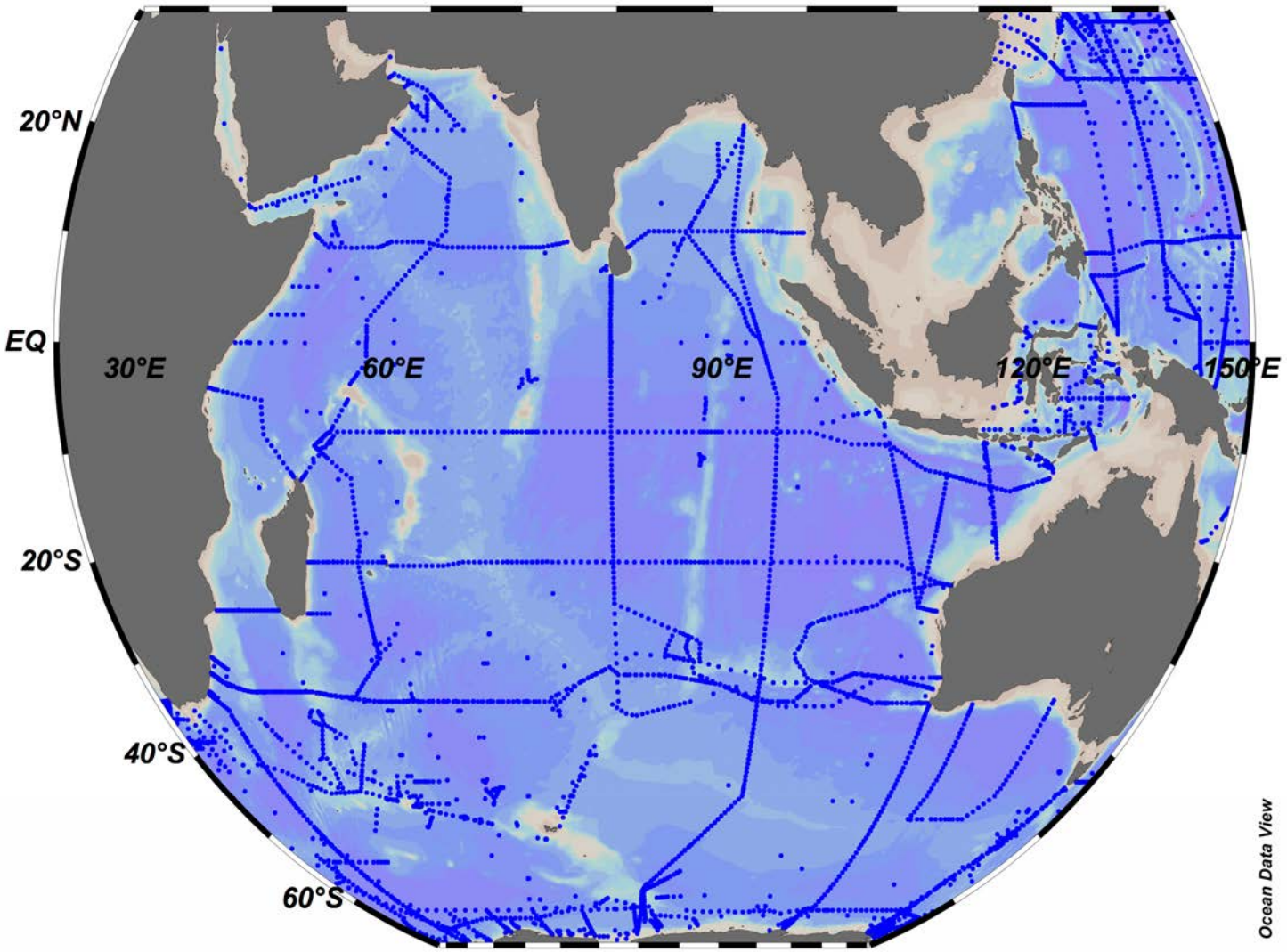


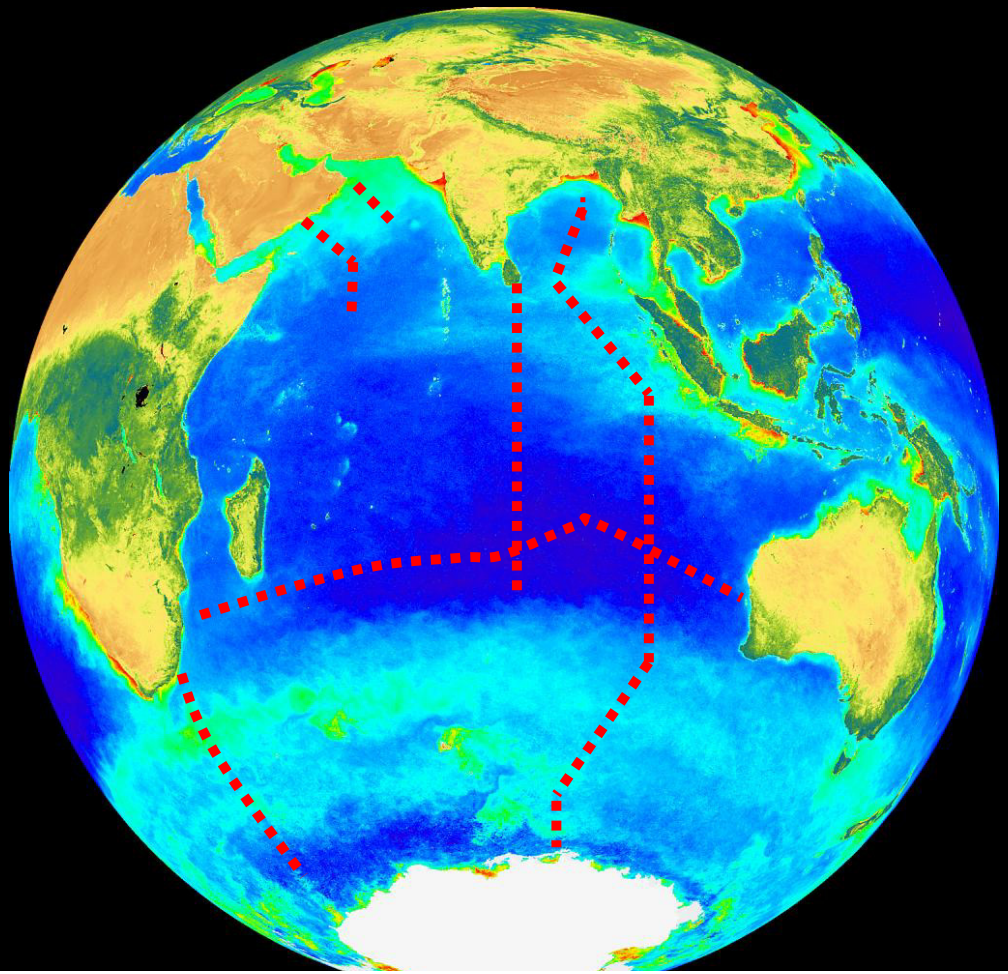
IIOE- 2 Theme 6:
Unique
Geological,
Physical,
Biogeochemical
and
Ecological
Features of the
Indian Ocean.

GLODAP v2
(Key et al. 2015)

T, S, O_2, CFCs, TCO_2, TA, pCO2, pH, nutrients



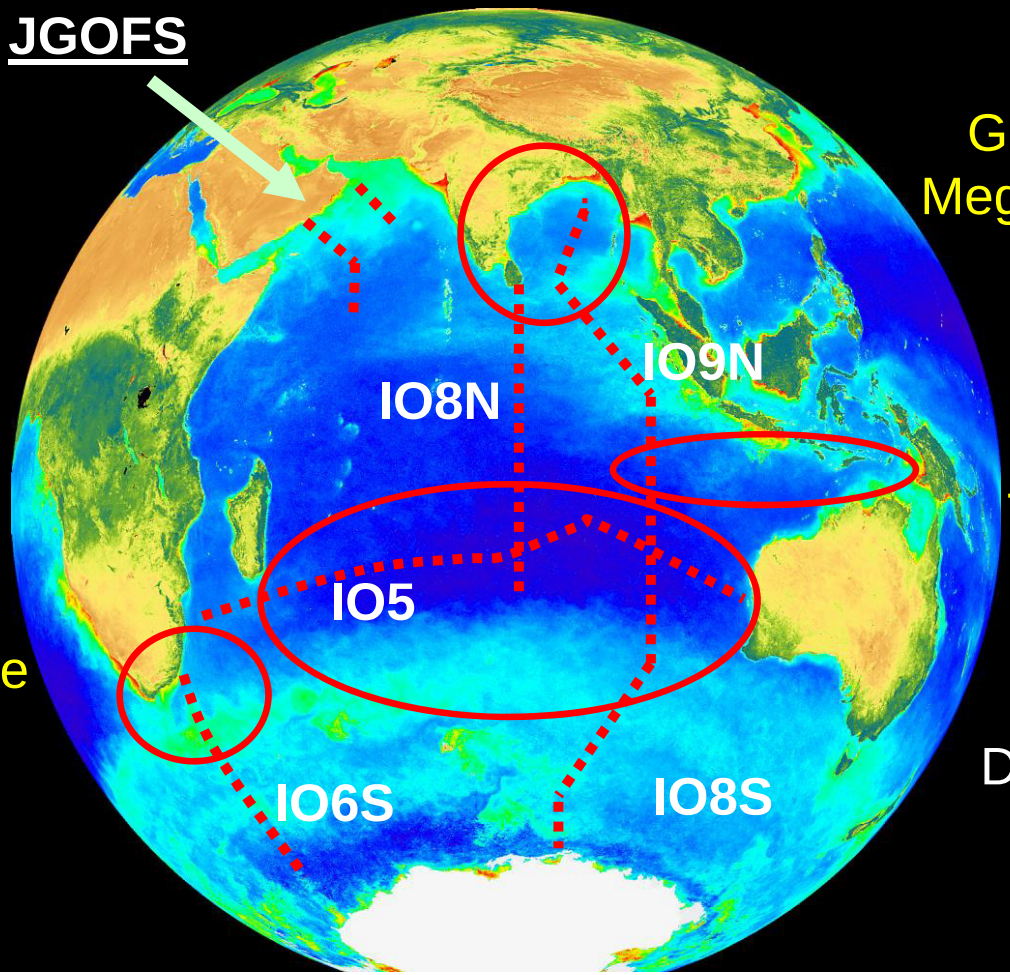
Survey and Process Studies with DOM Data



Monsoon dynamics; hypoxic basin

JGOFS

T, S, O_2, CFCs, TCO_2, TA, DOM, nutrients;
JGOFS includes many biological variables



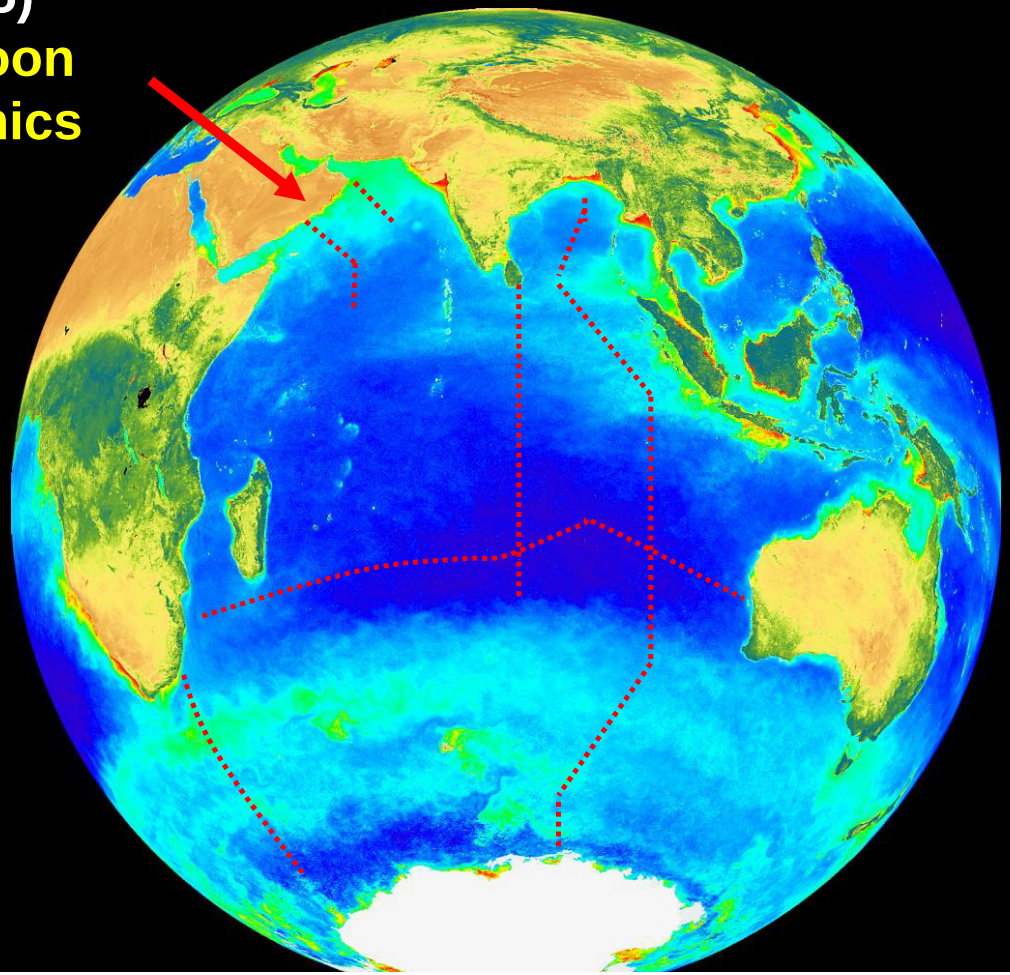
Ganges-Brahmaputra-Meghna-Irrawaddy Rivers; hypoxic basin

Indonesian Throughflow

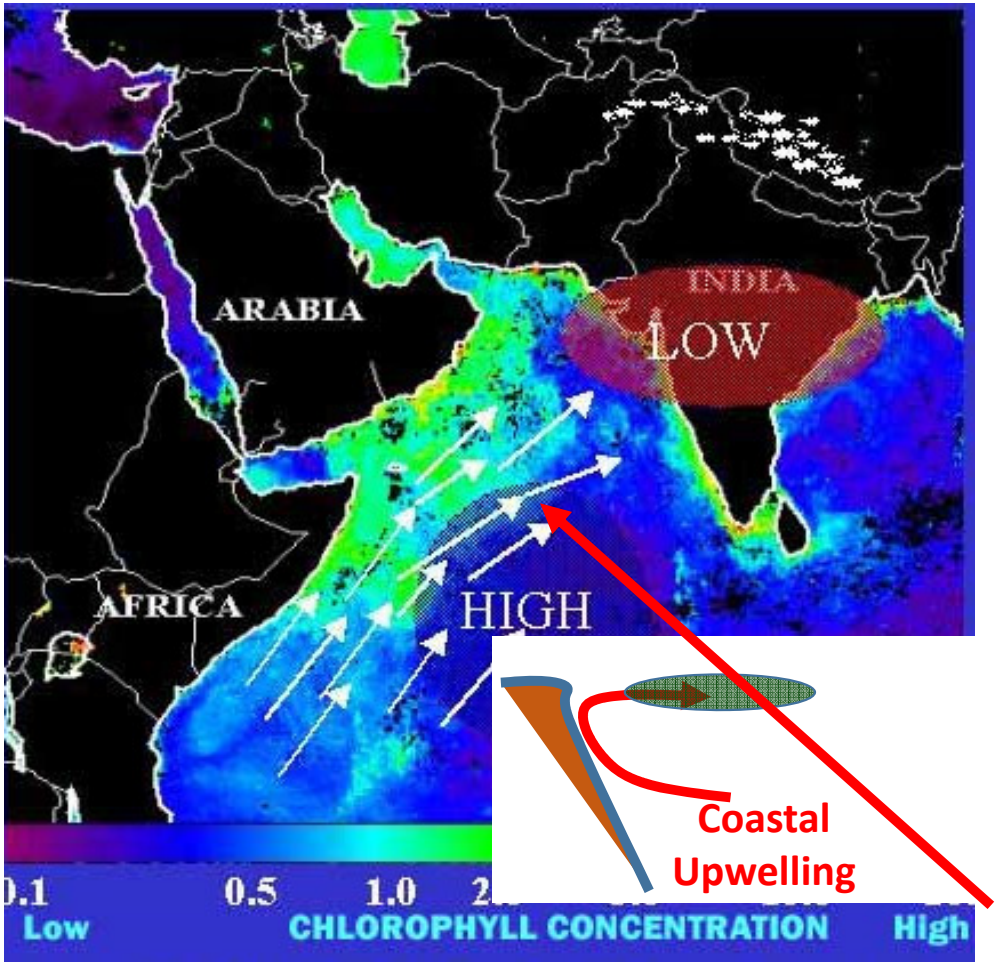
Agulhas leakage

Subtropical gyre;
DOC export with OTC

JGOFS
(1995)
Monsoon
Dynamics



Southwest Monsoon

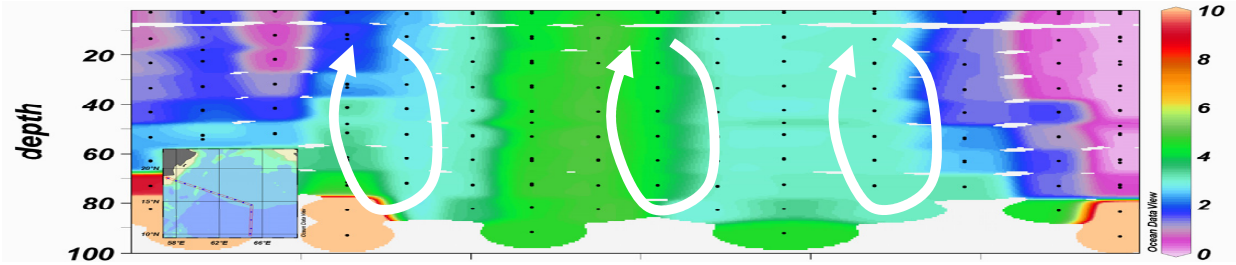


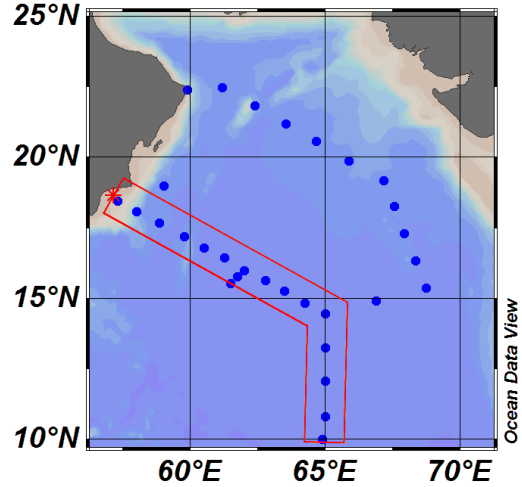
Diatoms & *Phaeocystis*

Synechococcus

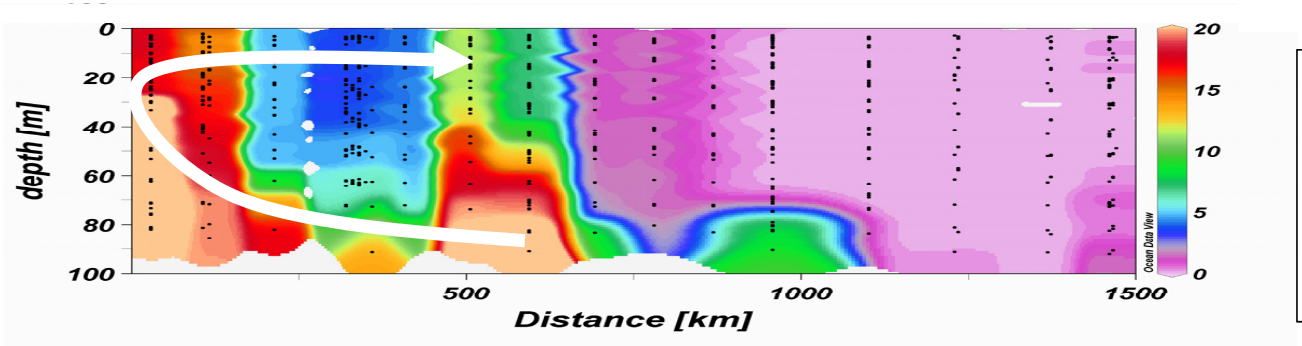
Nitrate (µmol/L)

NE Monsoon (Jan/Feb)

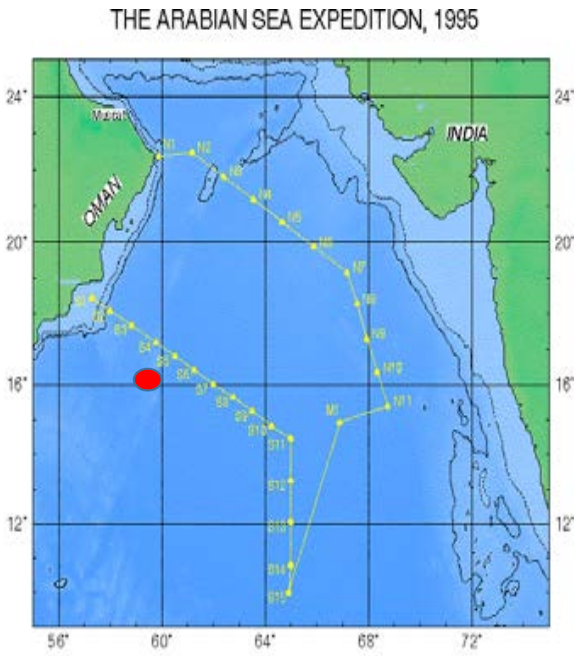




SW Monsoon (July/Aug)

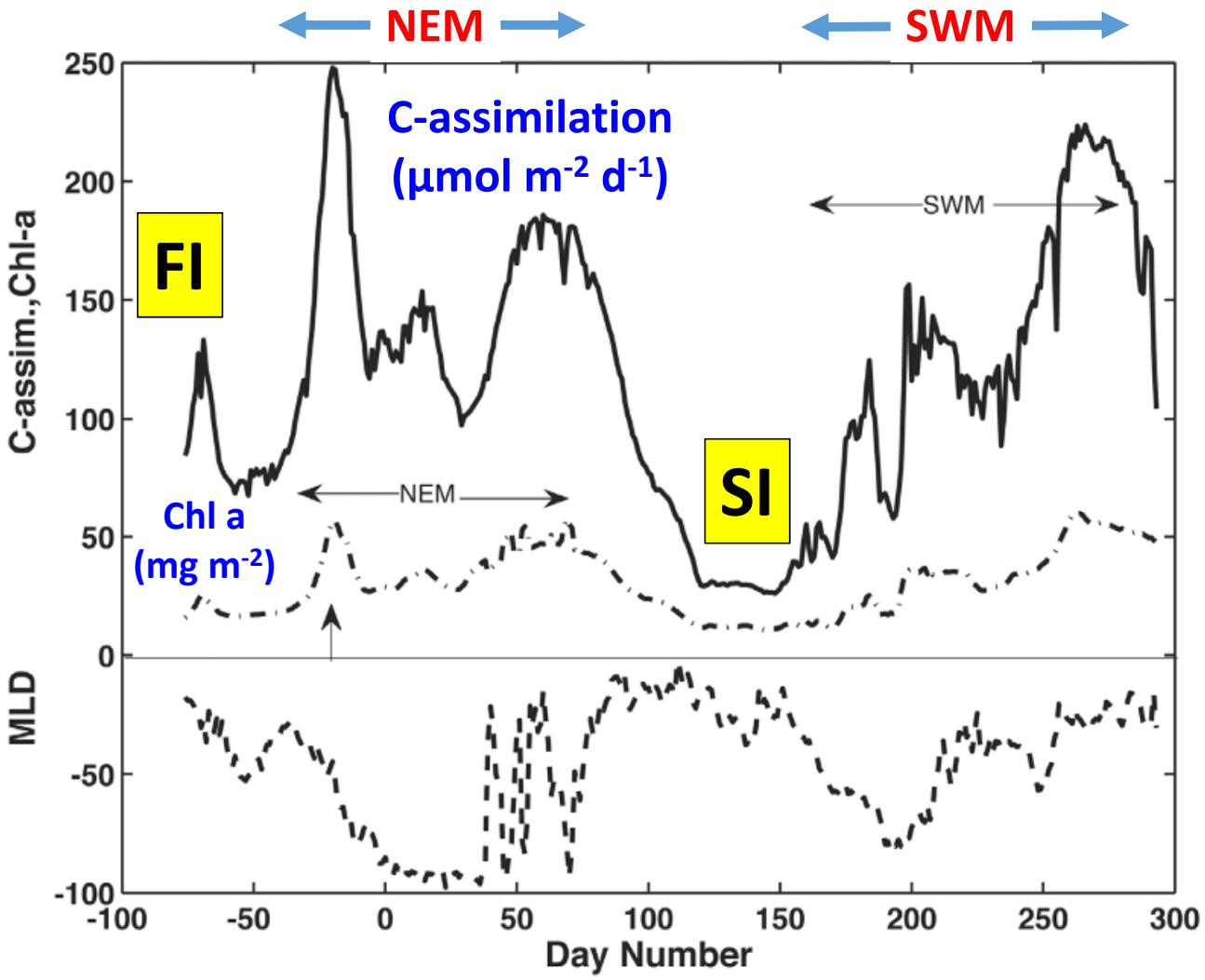


What is the response in the organic C field?

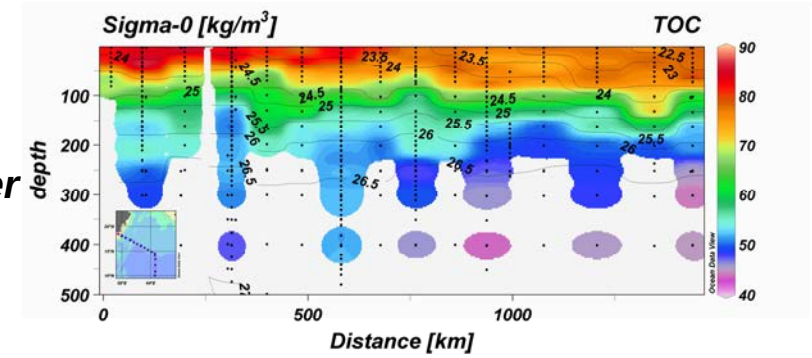


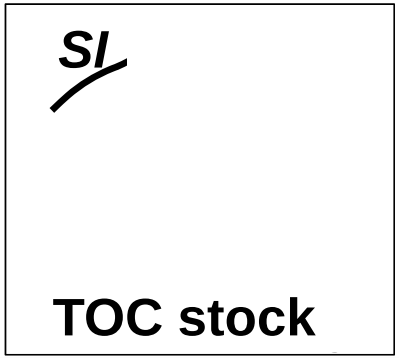
Observed at mooring (red symbol)

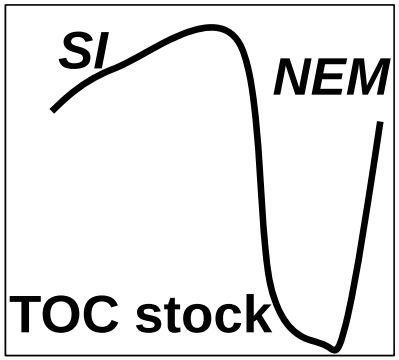
Marra and Moore (2009)



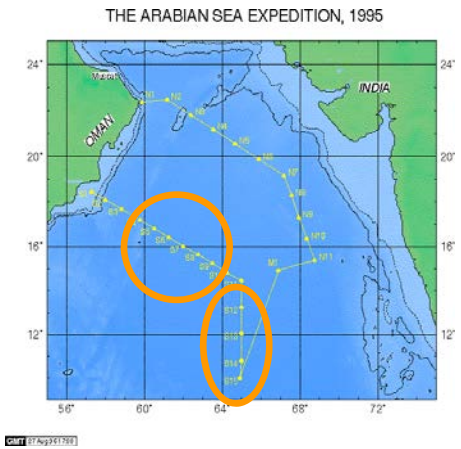
Spring Inter



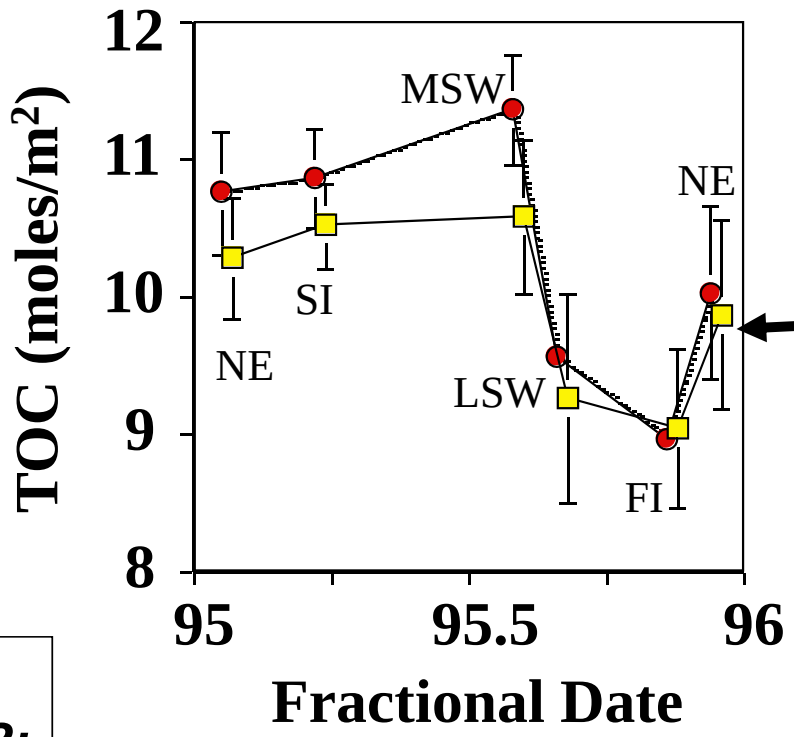




Mean TOC Stock
Upper 150 m along the South Line



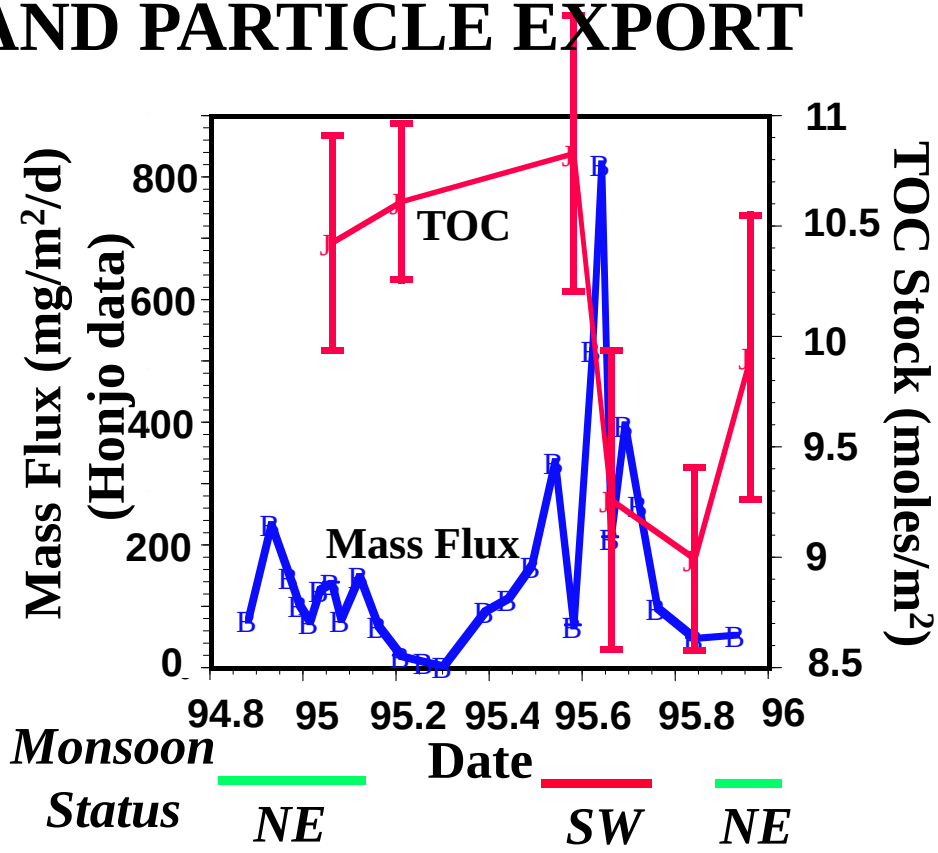
● *West*
□ *South*



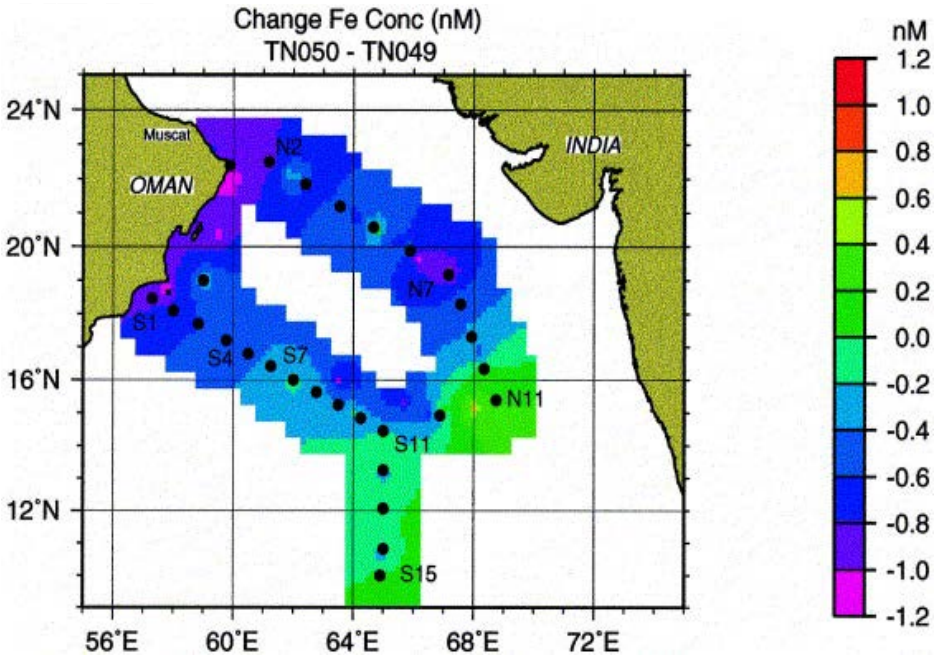
NPP >80% *Synechococcus*
(Liu et al., 1998)

TOC stock varied seasonally by ≈ 2 mol C/m2; POC by ≈ 0.3 mol/m2

TOC STOCKS AND PARTICLE EXPORT

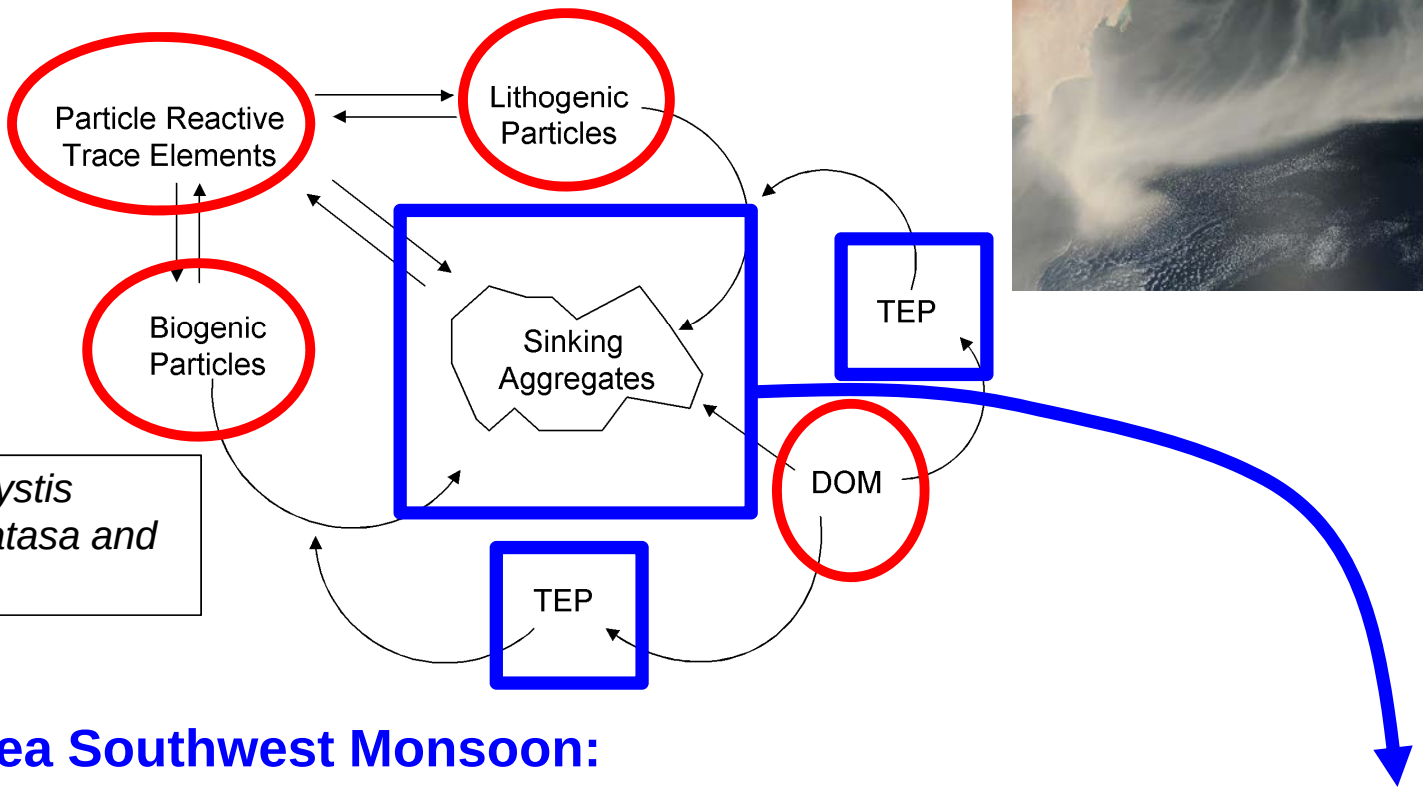


Large reduction in surface Fe concentration between mid and late SW Monsoon



Measures and Vink (1999)

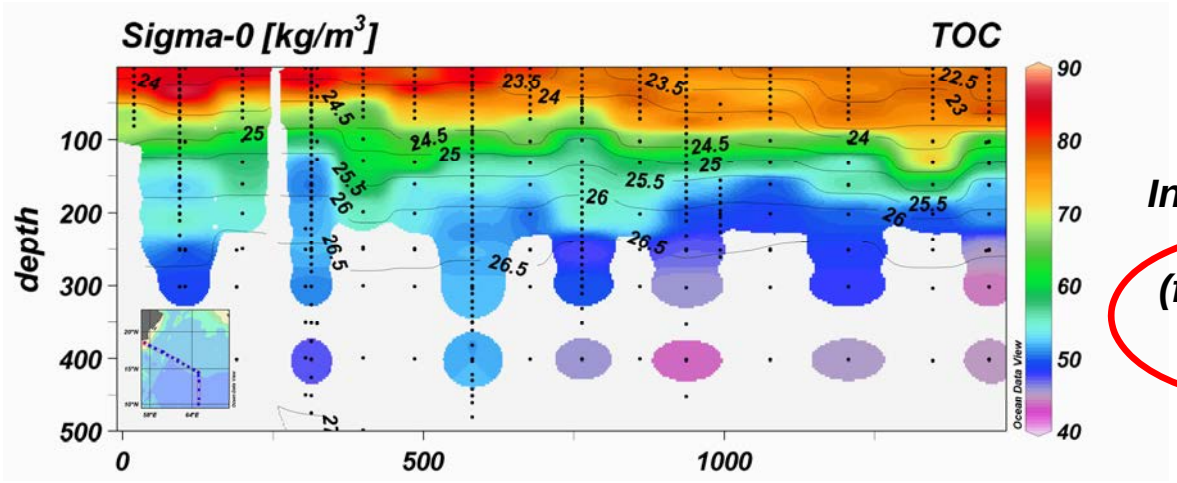
Export during the SW Monsoon



Diatoms → *Phaeocystis*
(Garrison et al., 1998; Latasa and Bidigare, 1998)

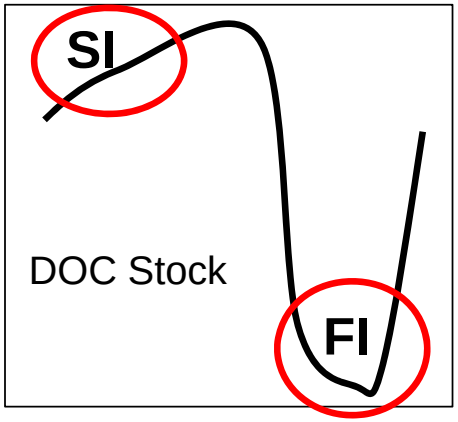
Arabian Sea Southwest Monsoon:

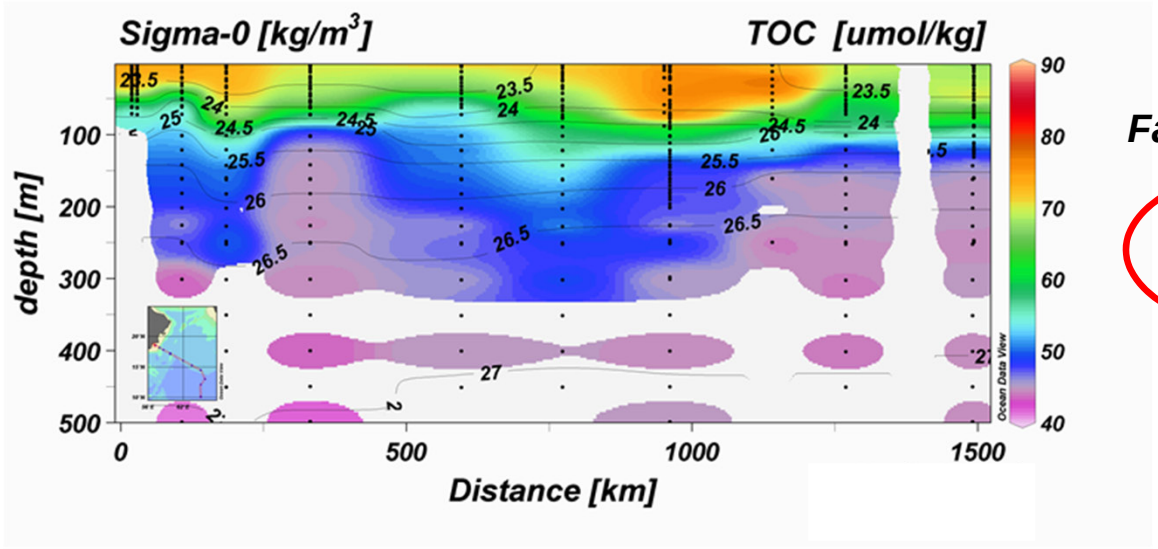
A good location/time for investigating processes controlling export



Spring Intermonsoon

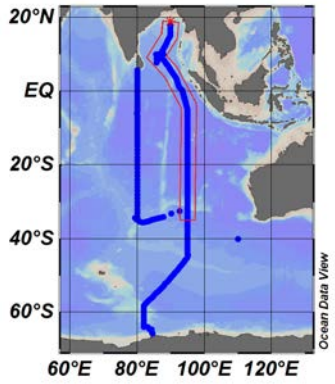
(following NE Monsoon)

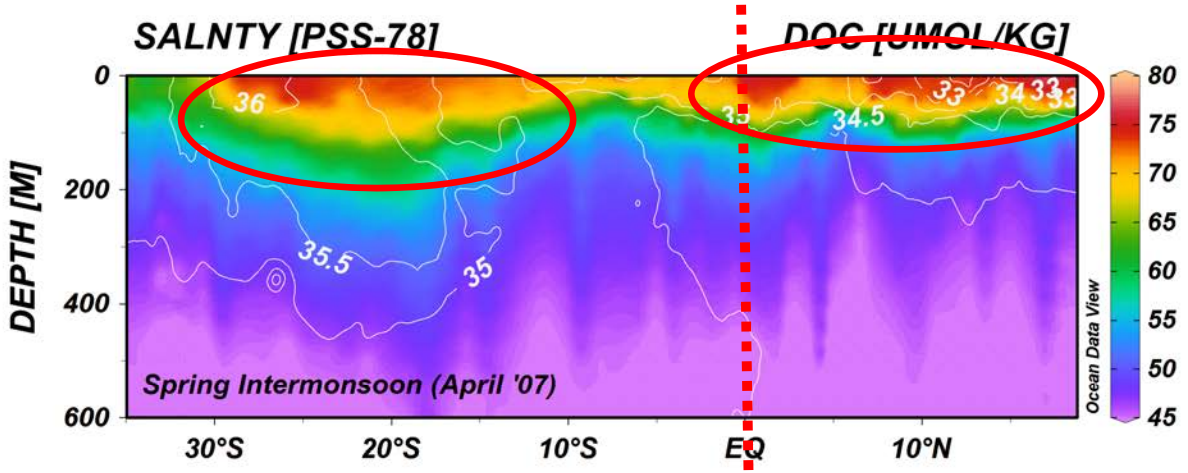




Fall Intermonsoon

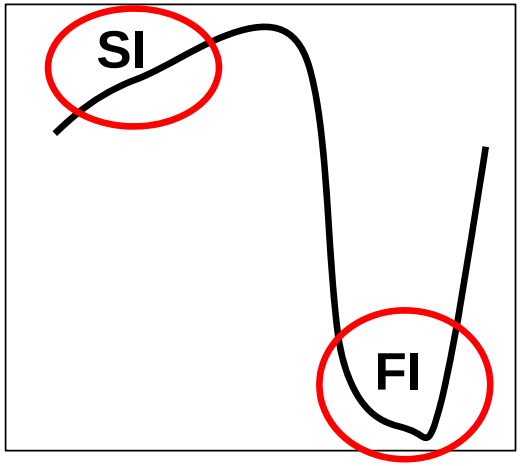
(following SW Monsoon)



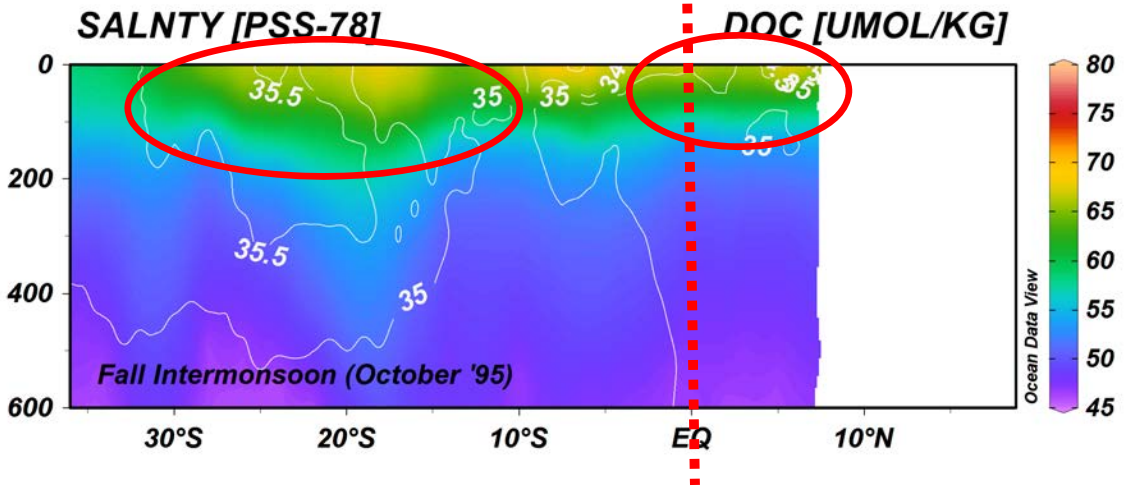


Northern Spring Intermonsoon

(April 2007)



Arabian Sea DOC Stock



Northern Fall Intermonsoon

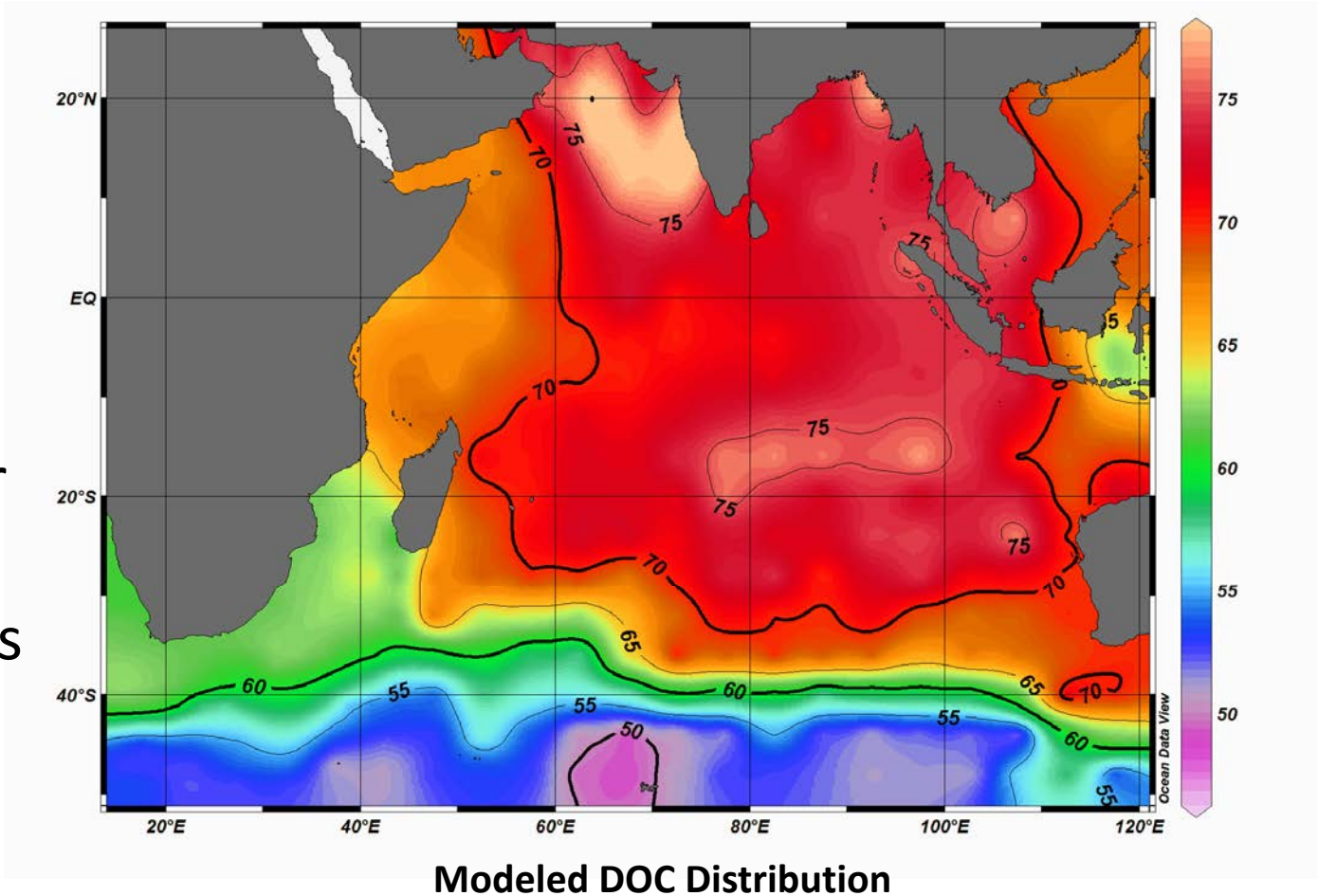
(October 1995)

Zonal synchrony, but also along the entire meridian, by coincidence?

DOC Export

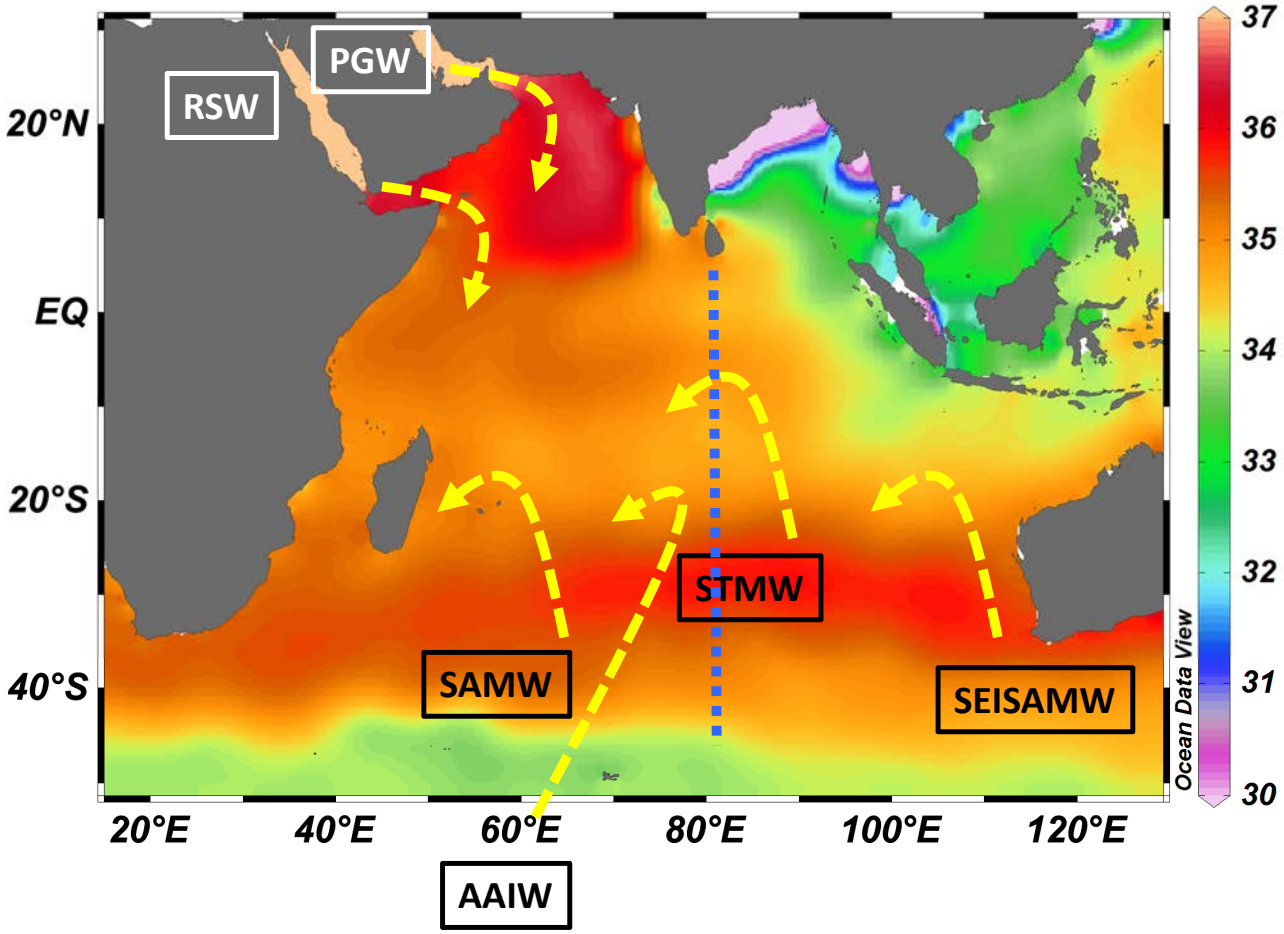
Need to move surface DOC to depth!

Low latitude water can export DOC; high latitude waters less so.

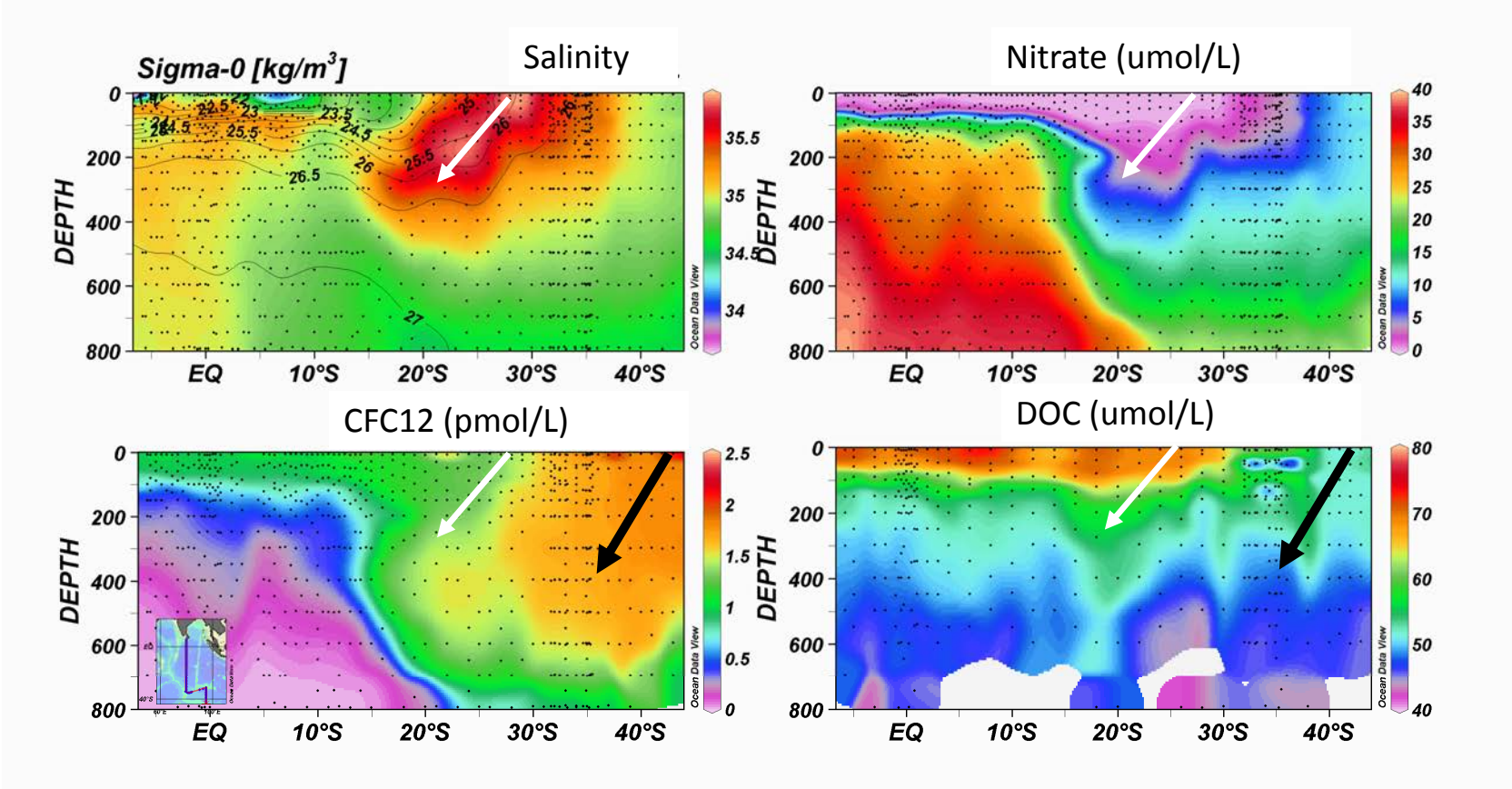


Modeled DOC Distribution

Surface Salinity (July – August; WOA)
Arrows indicate overturning circulation

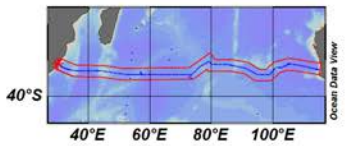


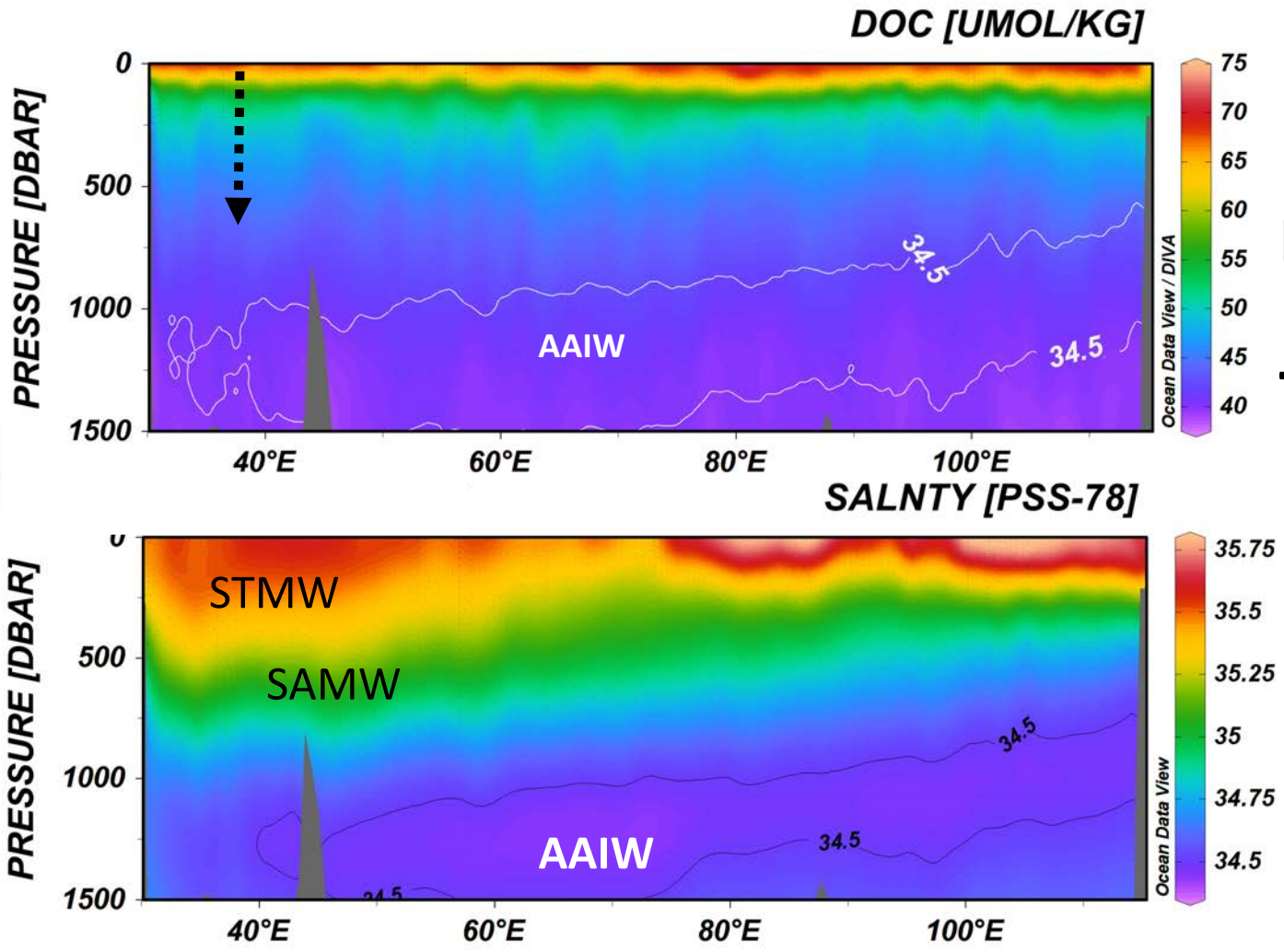
IO8 (80°E)



Ventilation with Subtropical Underwater exports DOC;
Ventilation with higher latitude (southern) waters does little to export DOC

IO5





DOC

↓

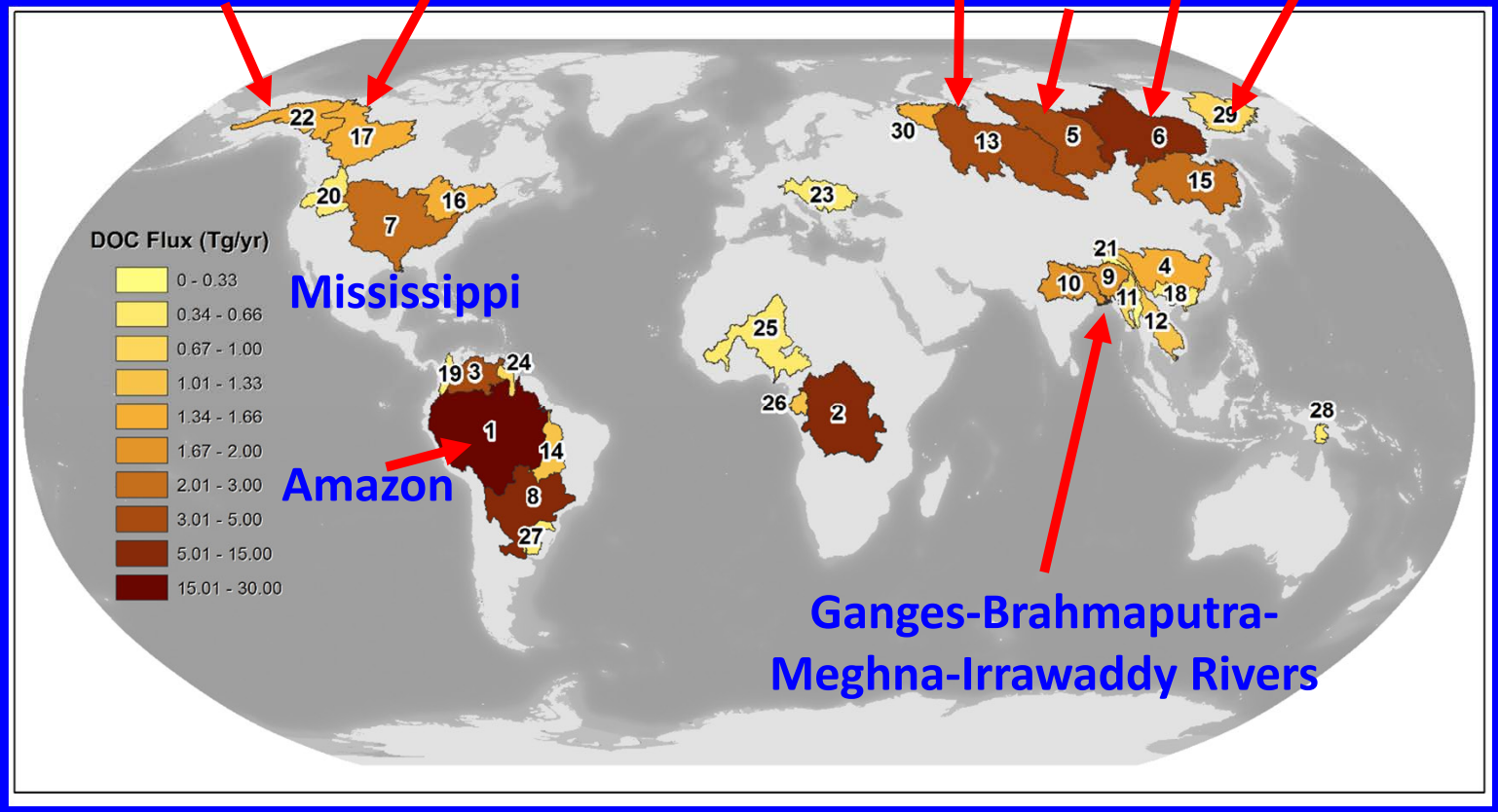
TCO2

Salinity

What conditions allow DOC to accumulate at the surface, then be consumed at depth?

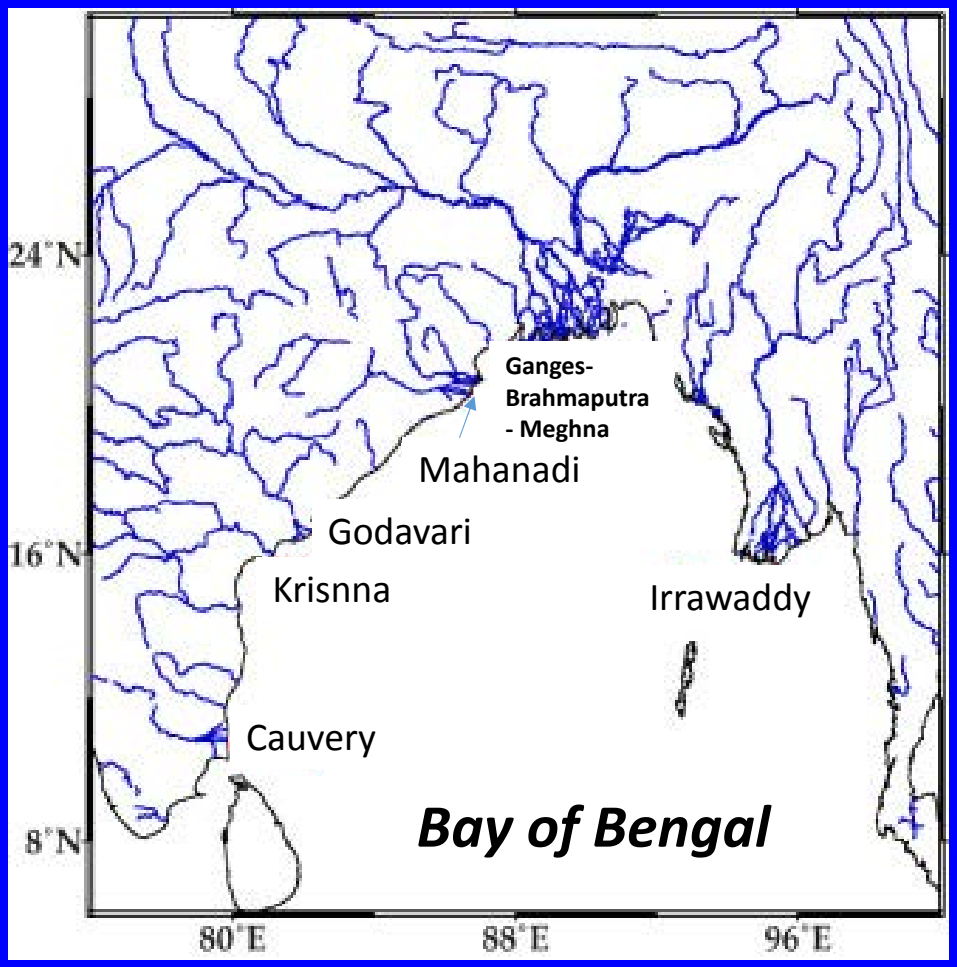
World's 30 Largest Rivers

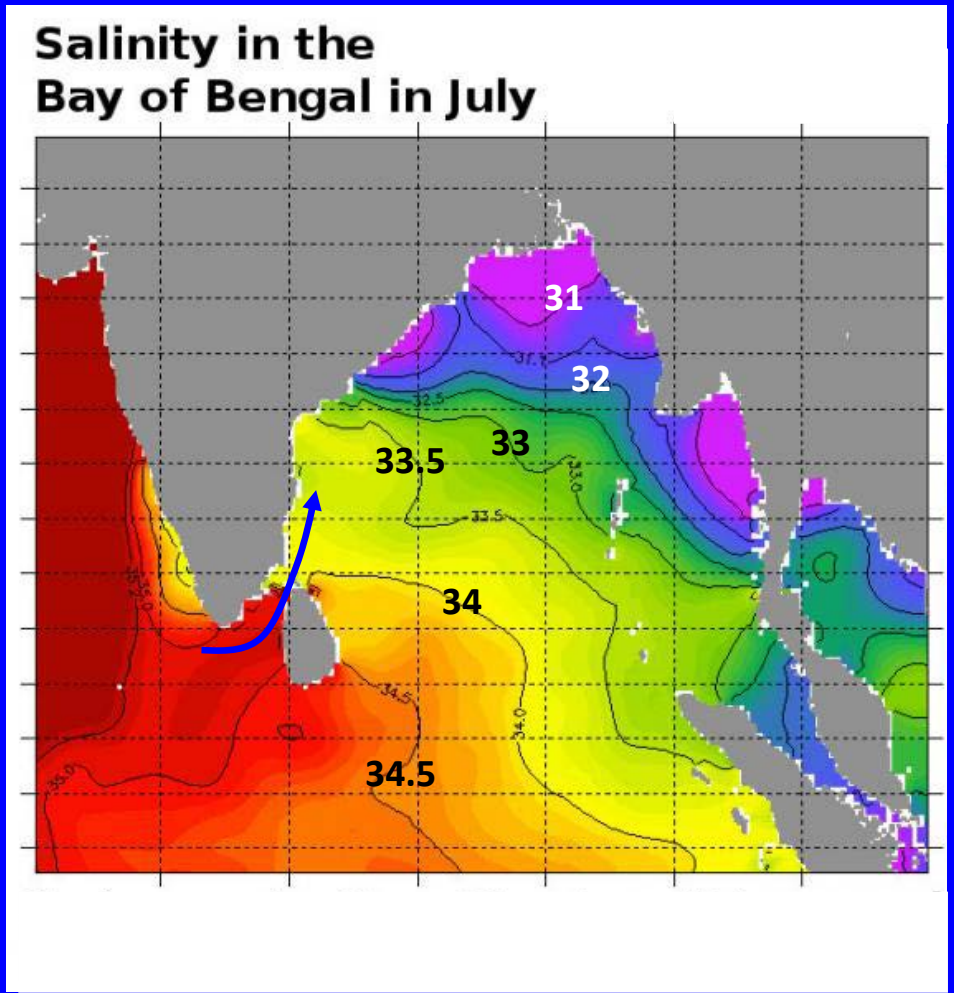
DOC Flux (TgC/yr)



Raymond and Spencer 2015

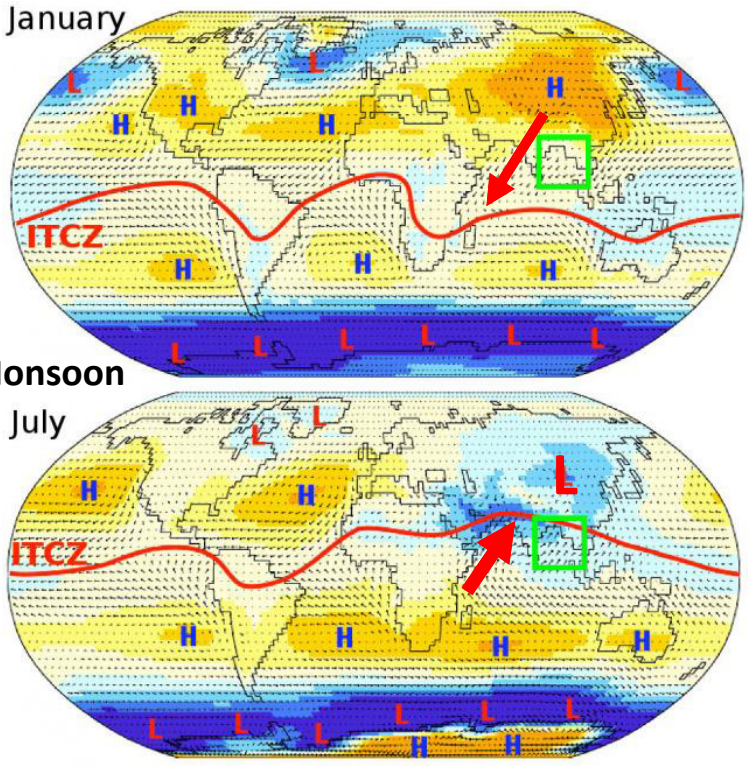
Major Rivers into the Bay of Bengal; Associated Salinity





ITCZ and Precipitation

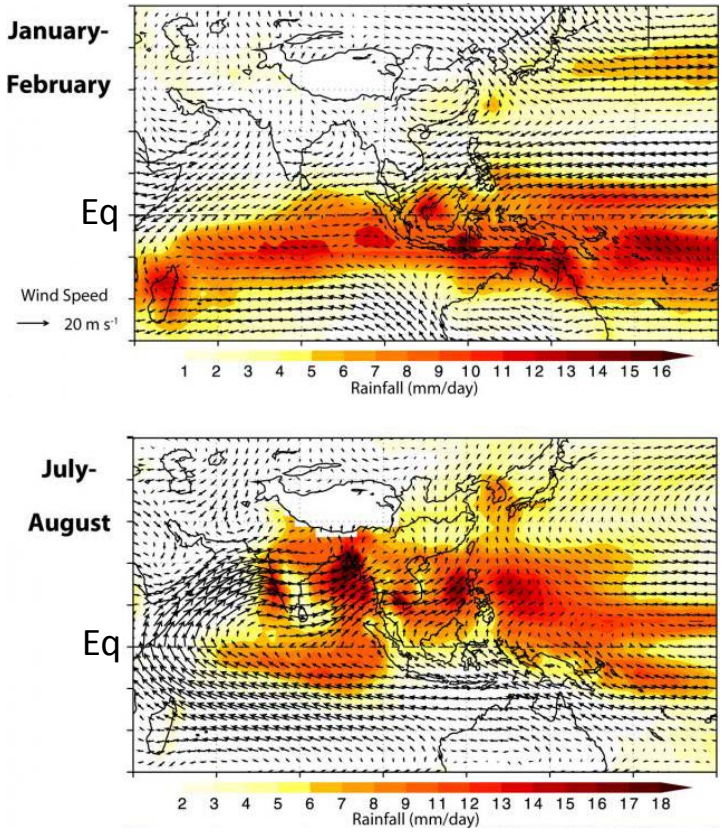
NE Monsoon



SW Monsoon

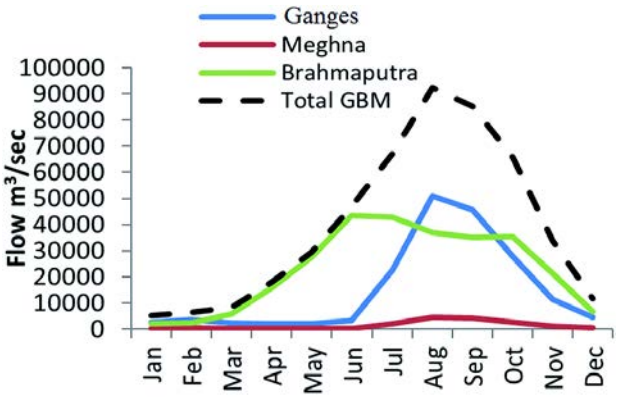
Changes of the ITCZ throughout the year: the biggest changes occur in the Bay of Bengal (green square). Main direction of the wind: towards the ITCZ.

http://joidesresolution.org/node/3844

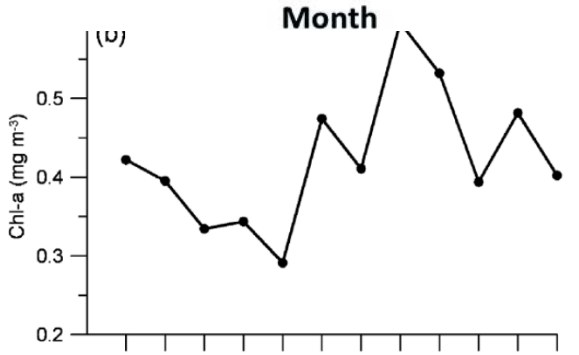


80% of the annual, continental rainfall occurs during the SW monsoon

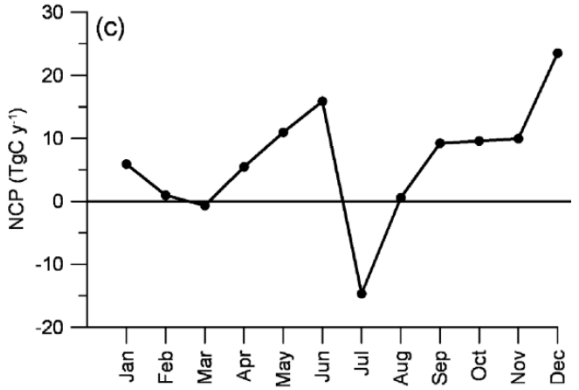
Bay of Bengal Dynamics



River Discharge ($m^3 s^{-1}$)



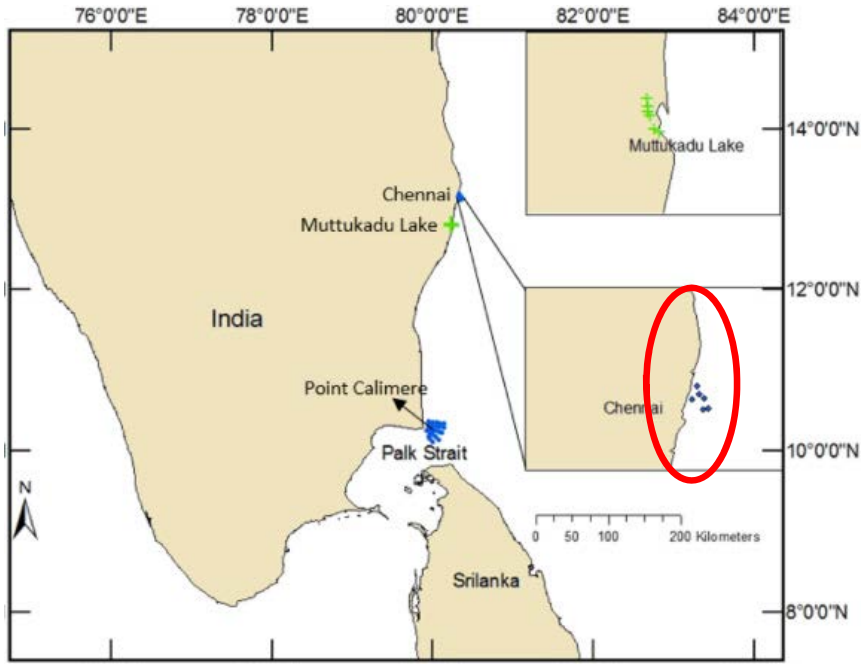
Chl a ($mg\ m^{-3}$)



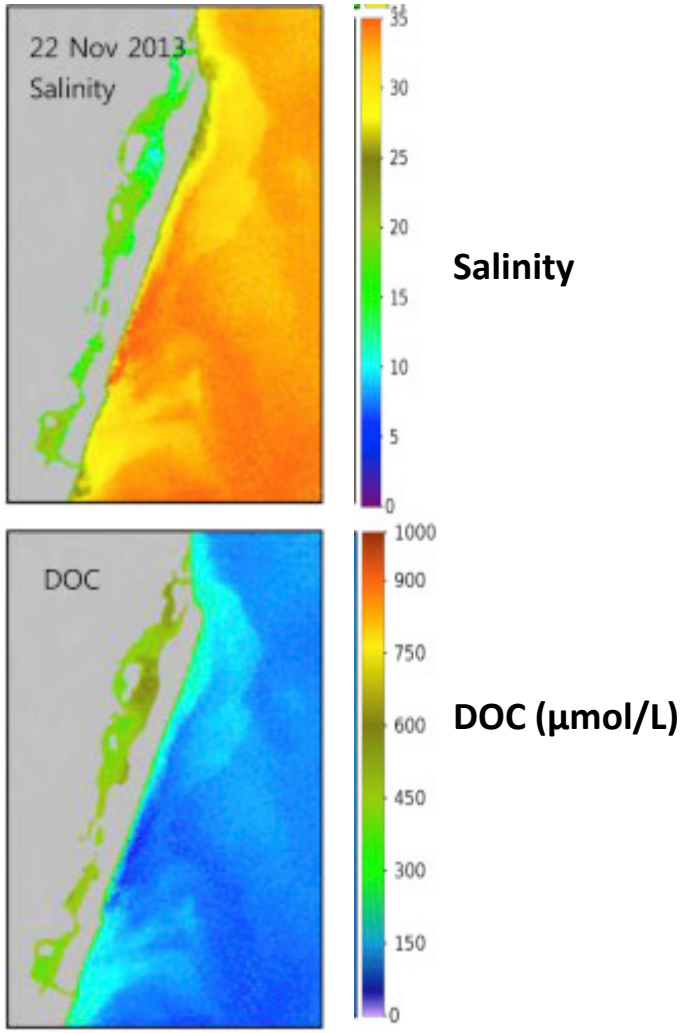
Net Community Production ($Tg\ C\ y^{-1}$)

Sarma 2009

Coastal, Fluvial DOC



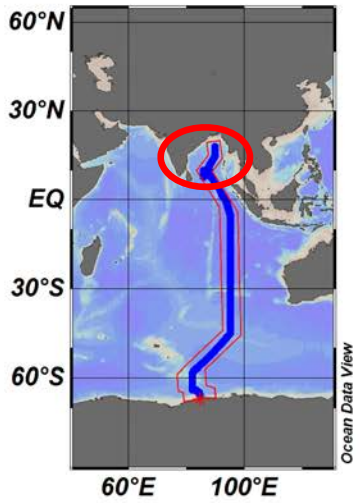
Shanumgam et al. 2016



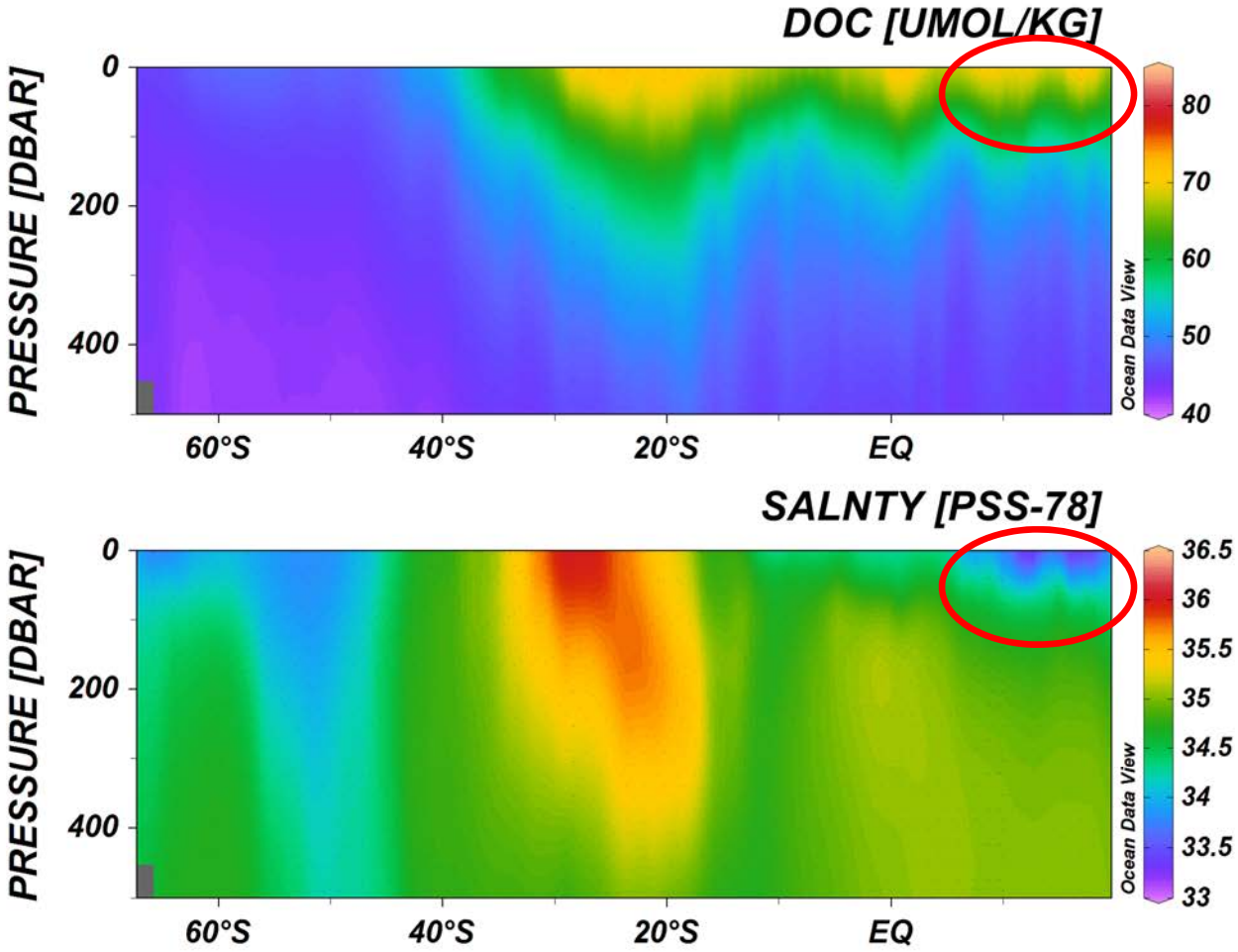
Salinity

DOC (µmol/L)

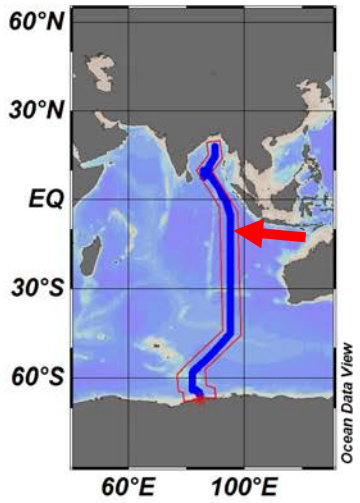
I9N/I8S



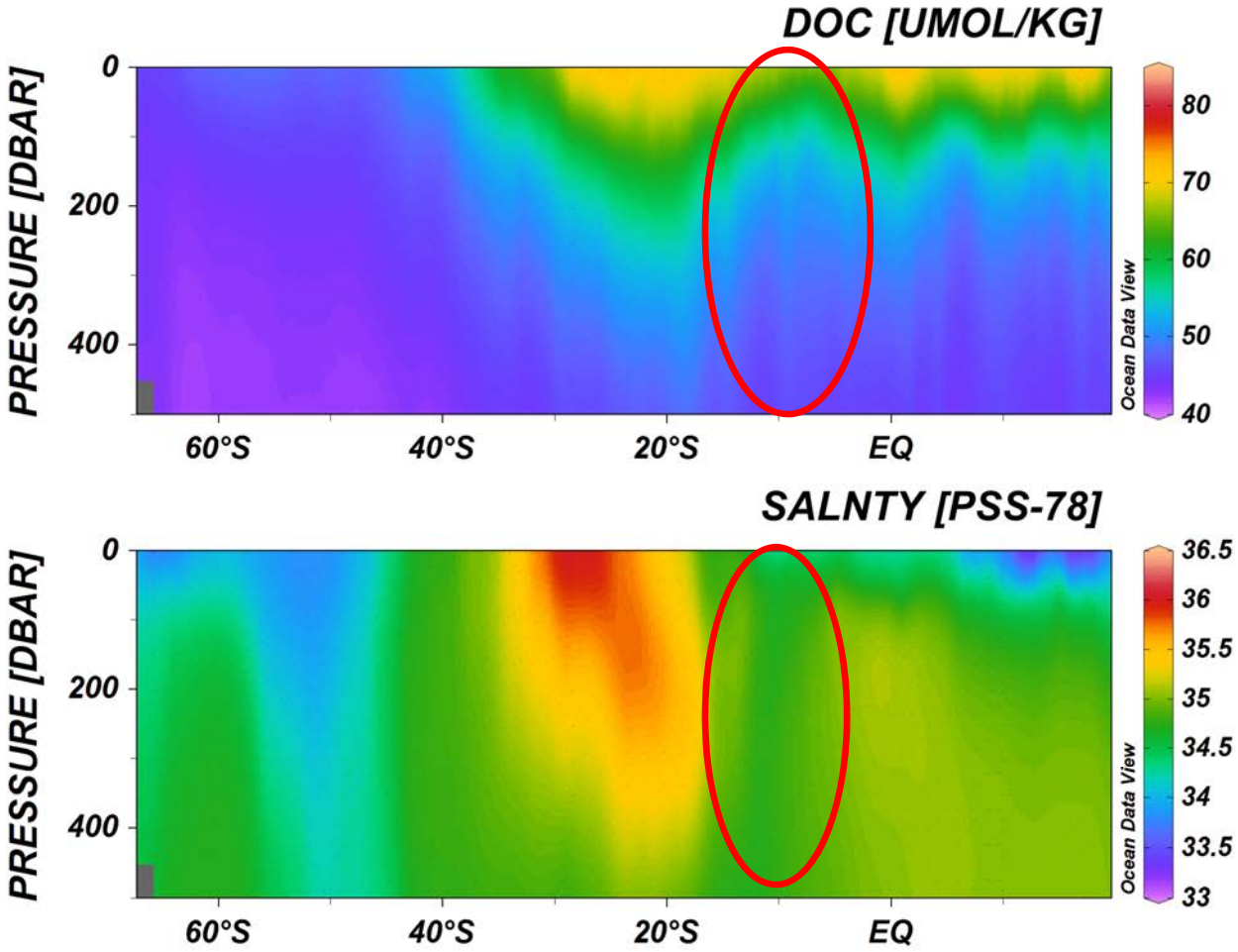
Occupation during Spring Intermonsoon (2007)

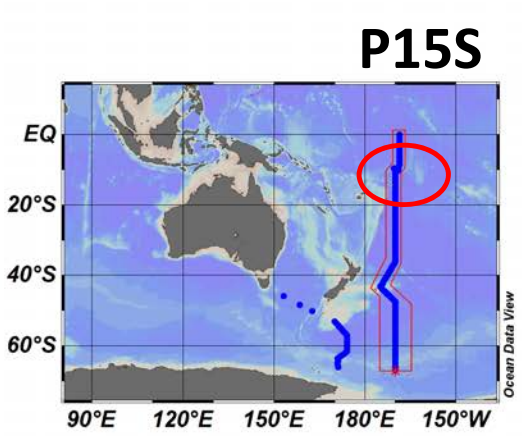


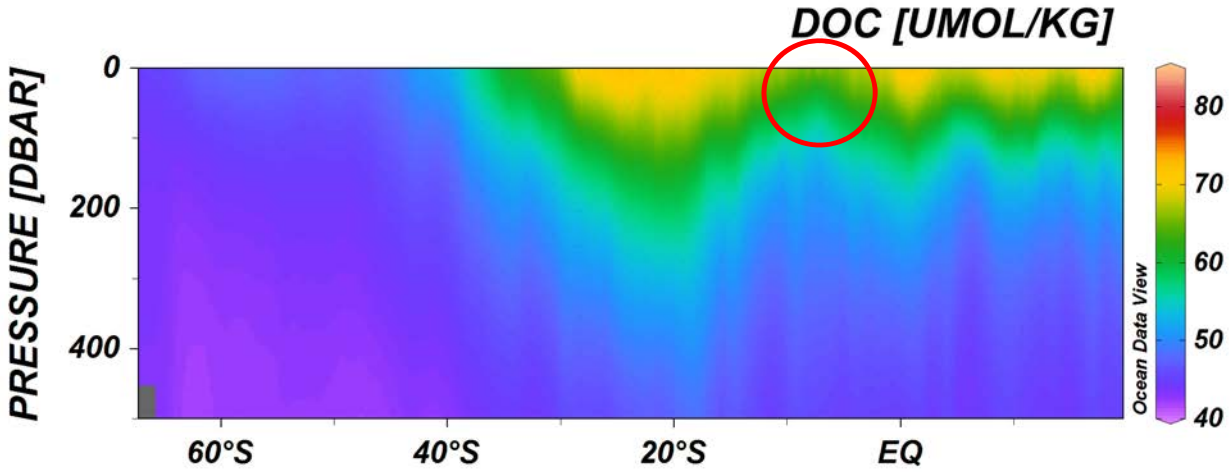
I9N/I8S



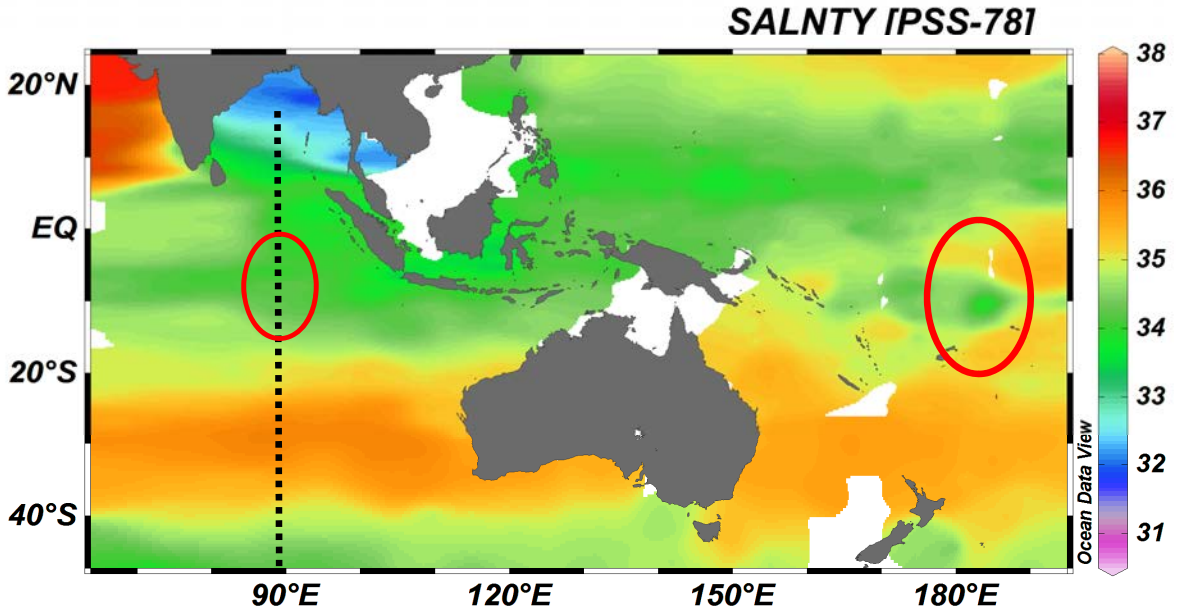
Occupation during Spring Intermonsoon

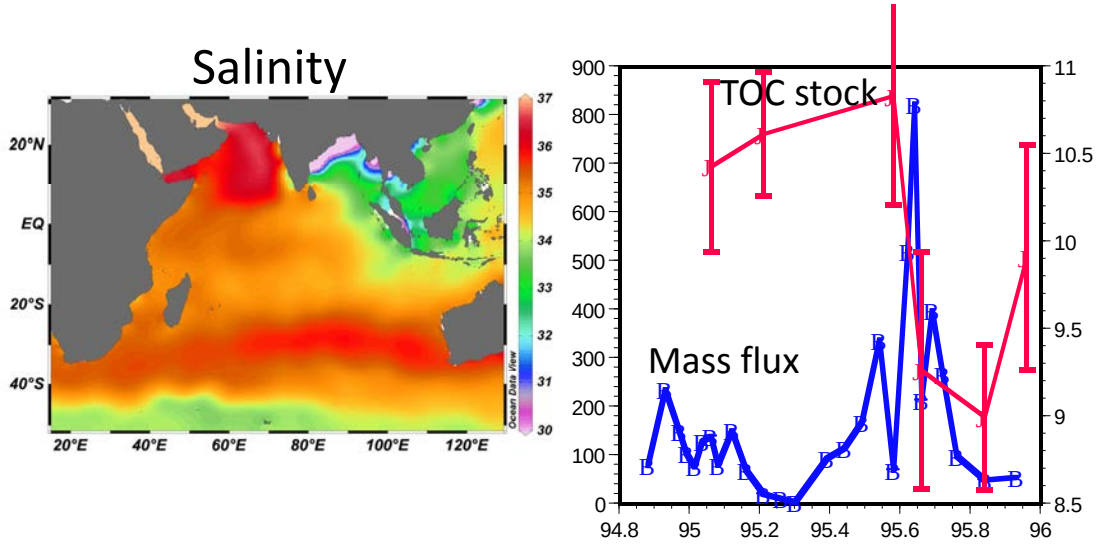


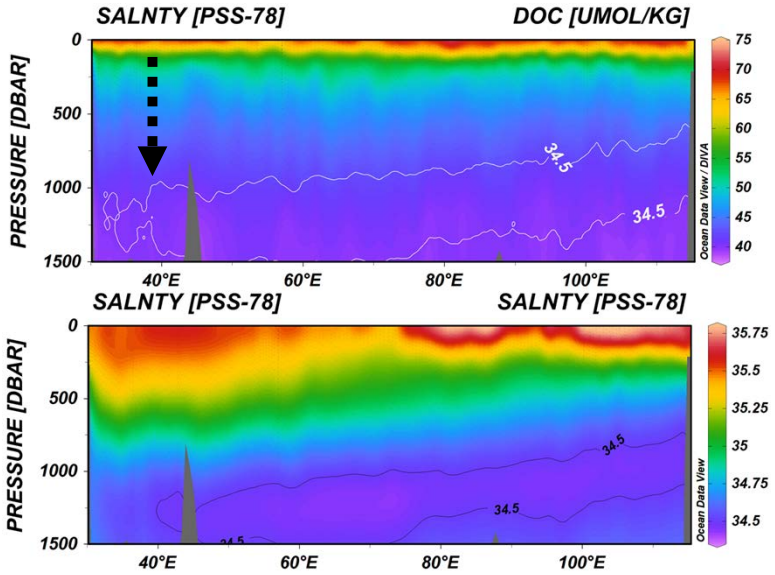




Need to distinguish relative and absolute roles of rivers vs precipitation as controls on surface ocean biogeochemistry in this region







Questions Posed

- In an upper ocean system freshened by both major rivers and rainfall, can we distinguish their individual impacts on the biogeochemistry of that system?
- What are the mechanisms controlling initiation of particle export (and associated scavenging), using the SW monsoon as the model system?
- What processes allow DOC accumulation at the surface, but then consumption at depth?
- Who produced that exported DOC? Is it largely of microphytoplankton of upwelling zone, or picophytoplankton elsewhere?