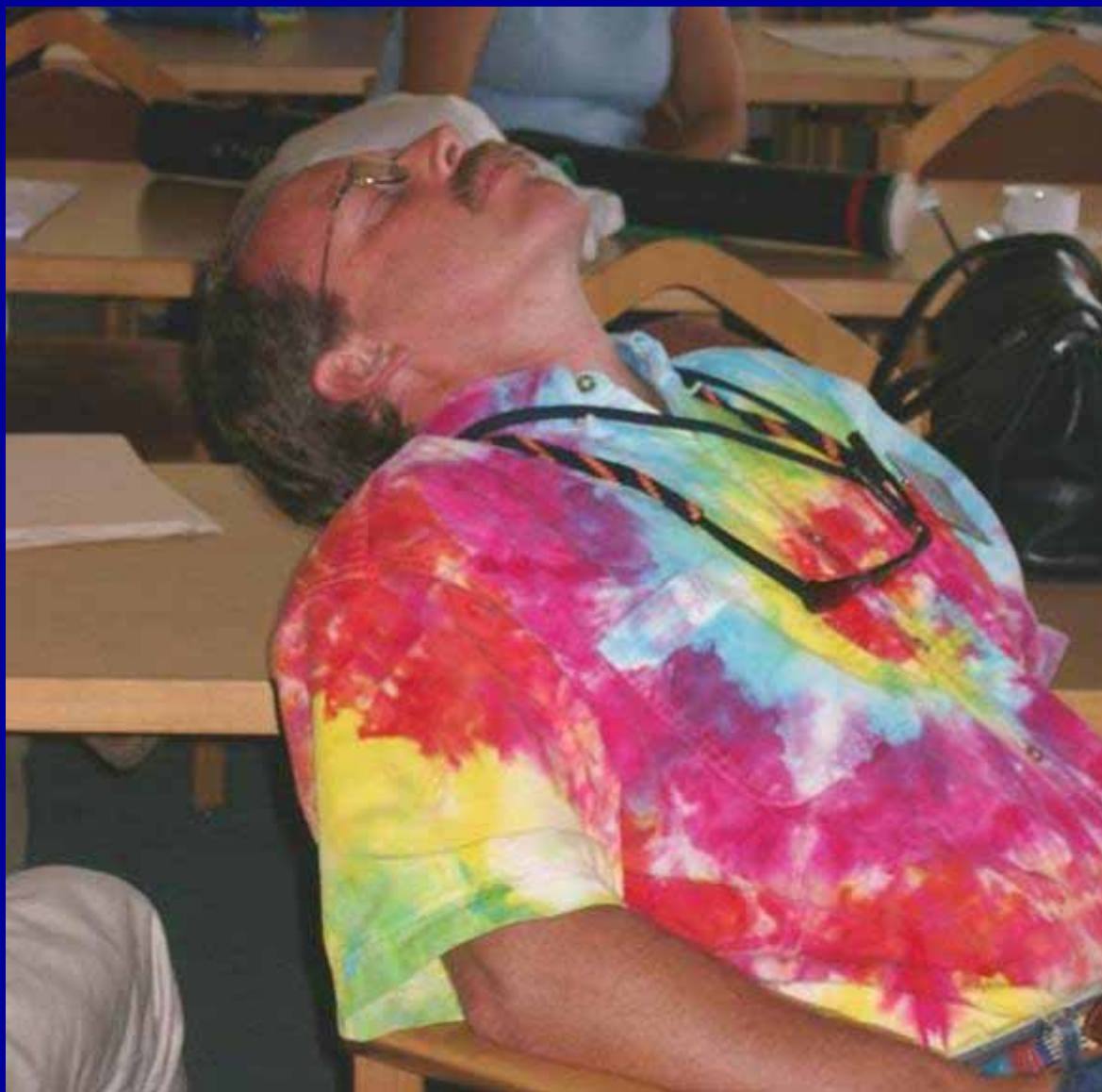

Nitrogen Isotopes and Particle Dynamics



Joseph P. Montoya, Georgia Institute of Technology
Maren Voss, Institut für Ostseeforschung, Warnemünde

Plan for Today

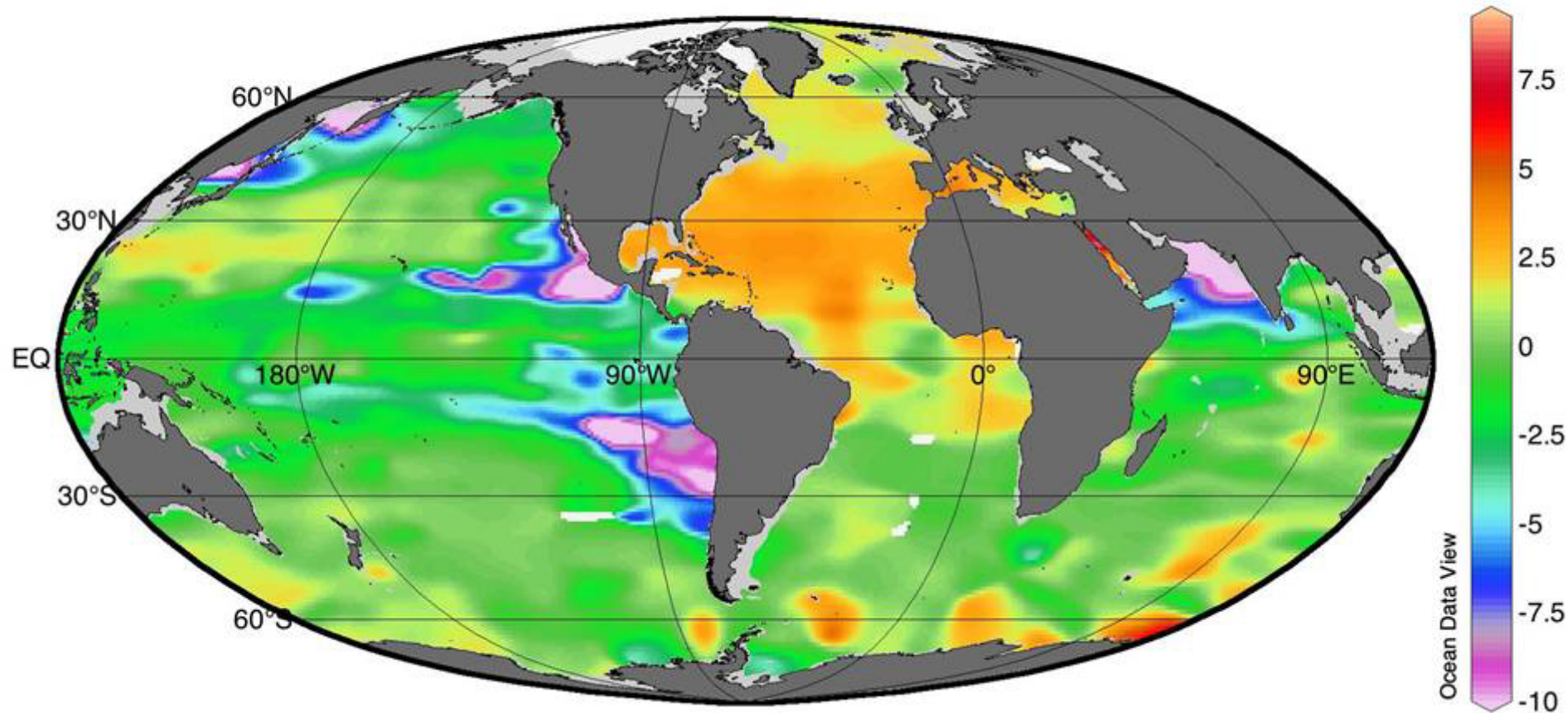
- General Isotope Stuff
 - N cycle & fractionation
 - “Normal” patterns
 - Unique factors in the Arabian Sea
- Arabian Sea data (German JGOFS)
 - PN profiles
 - Surface PN
 - Traps



Spotted at:
SPOT-ON Meeting
Warnemünde,
Germany
July 2005

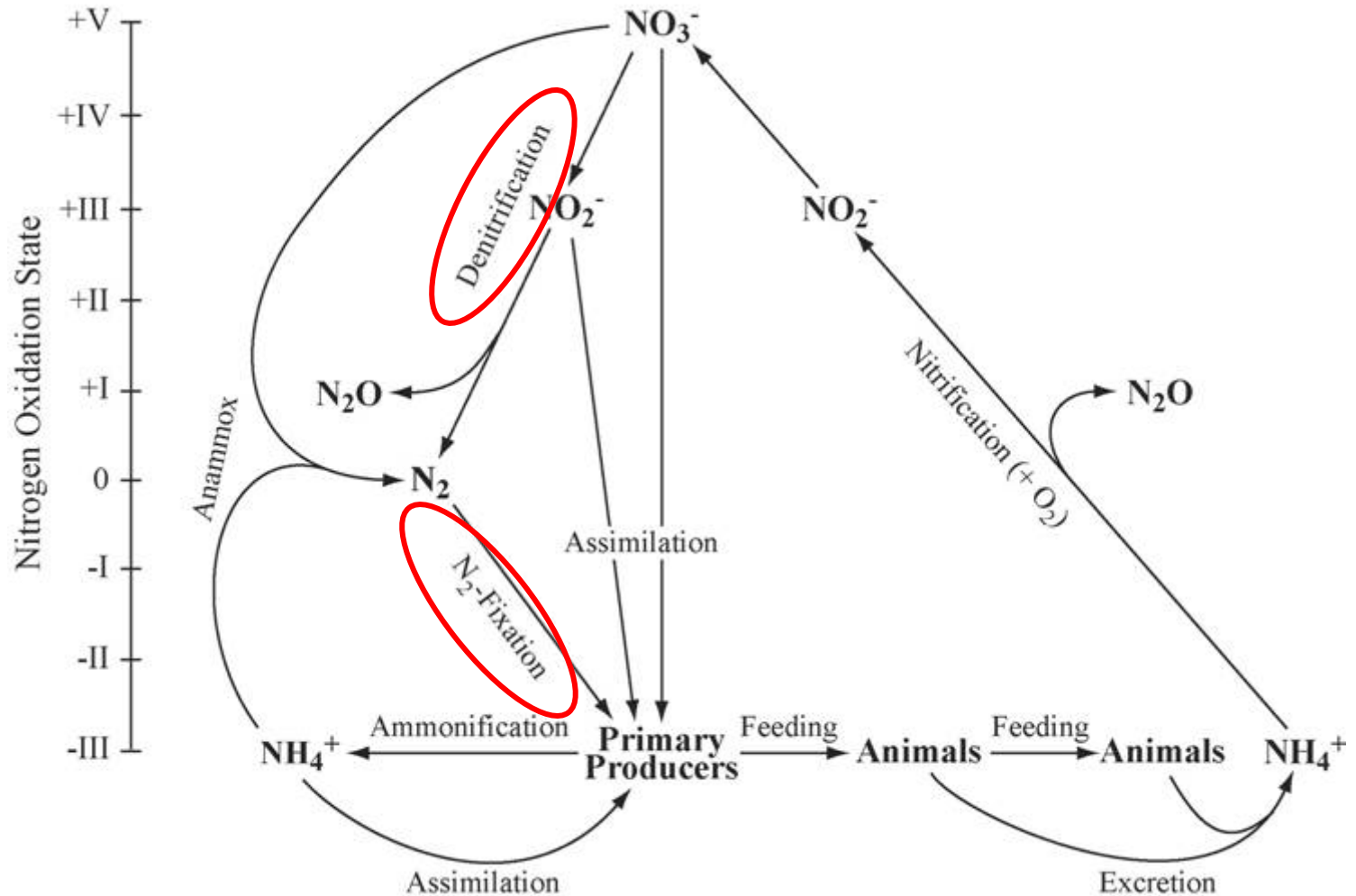
N* Distribution Shows Interplay Between N₂-Fixation and Denitrification

N* [$\mu\text{mol/kg}$] on Depth = 300 m



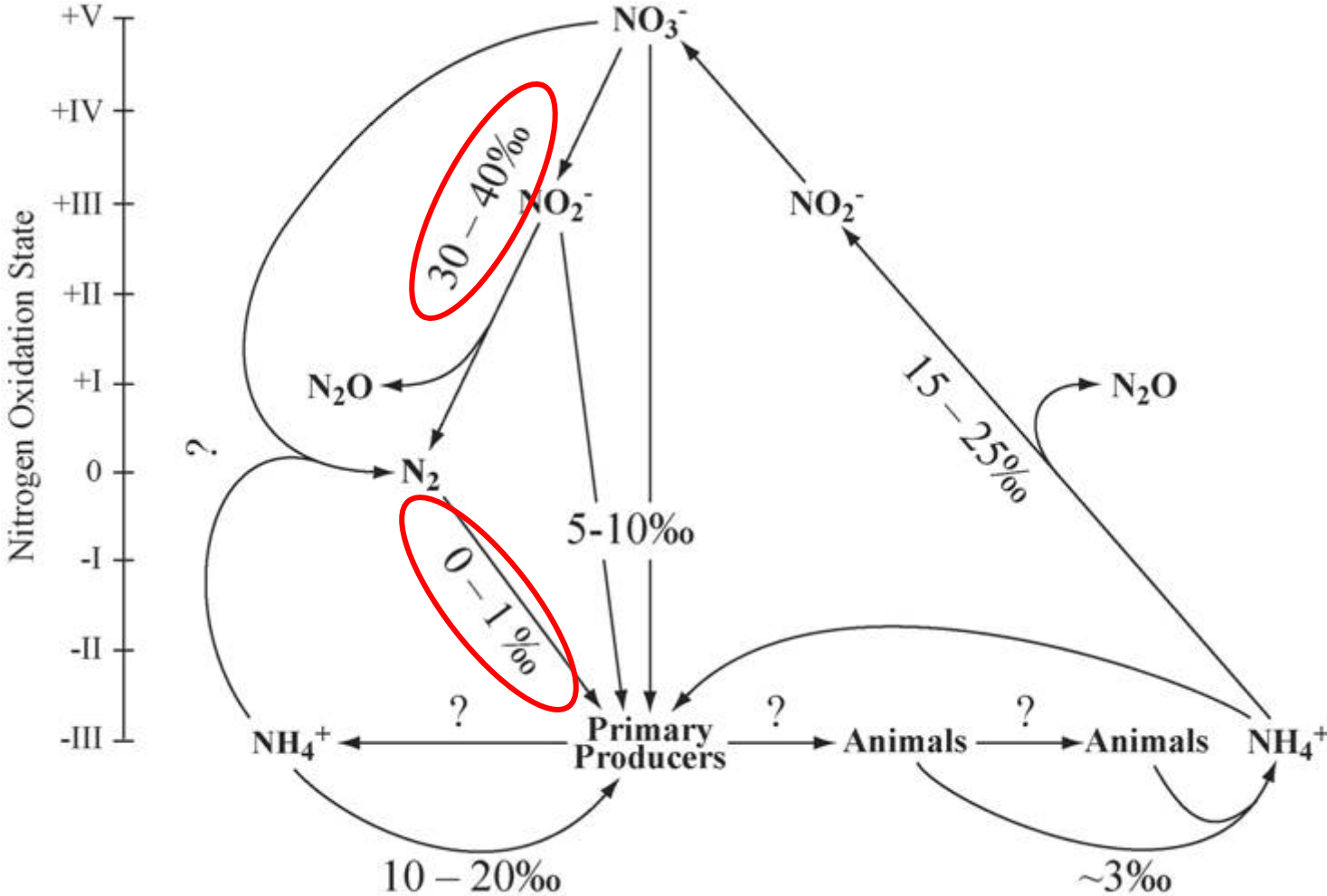
$$N^* = 0.87([\text{NO}_3^-] - 16[\text{PO}_4^{3-}] + 2.9) \quad (\text{Gruber \& Sarmiento 1997})$$

Major Biological Transformations of Nitrogen

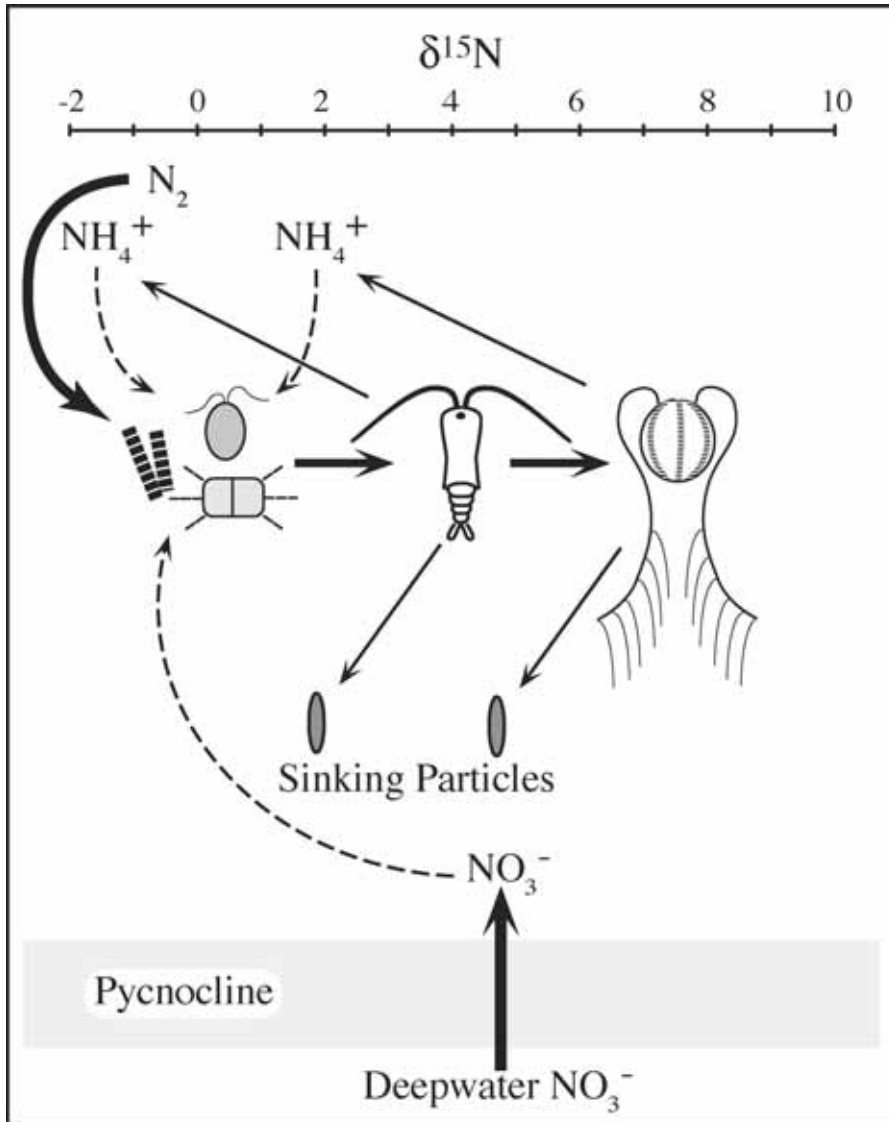


(Inspired by Codispoti 2001 and Liu 1979)

Biological Fractionation of Nitrogen Isotopes



(Inspired by Codispoti 2001 and Liu 1979)

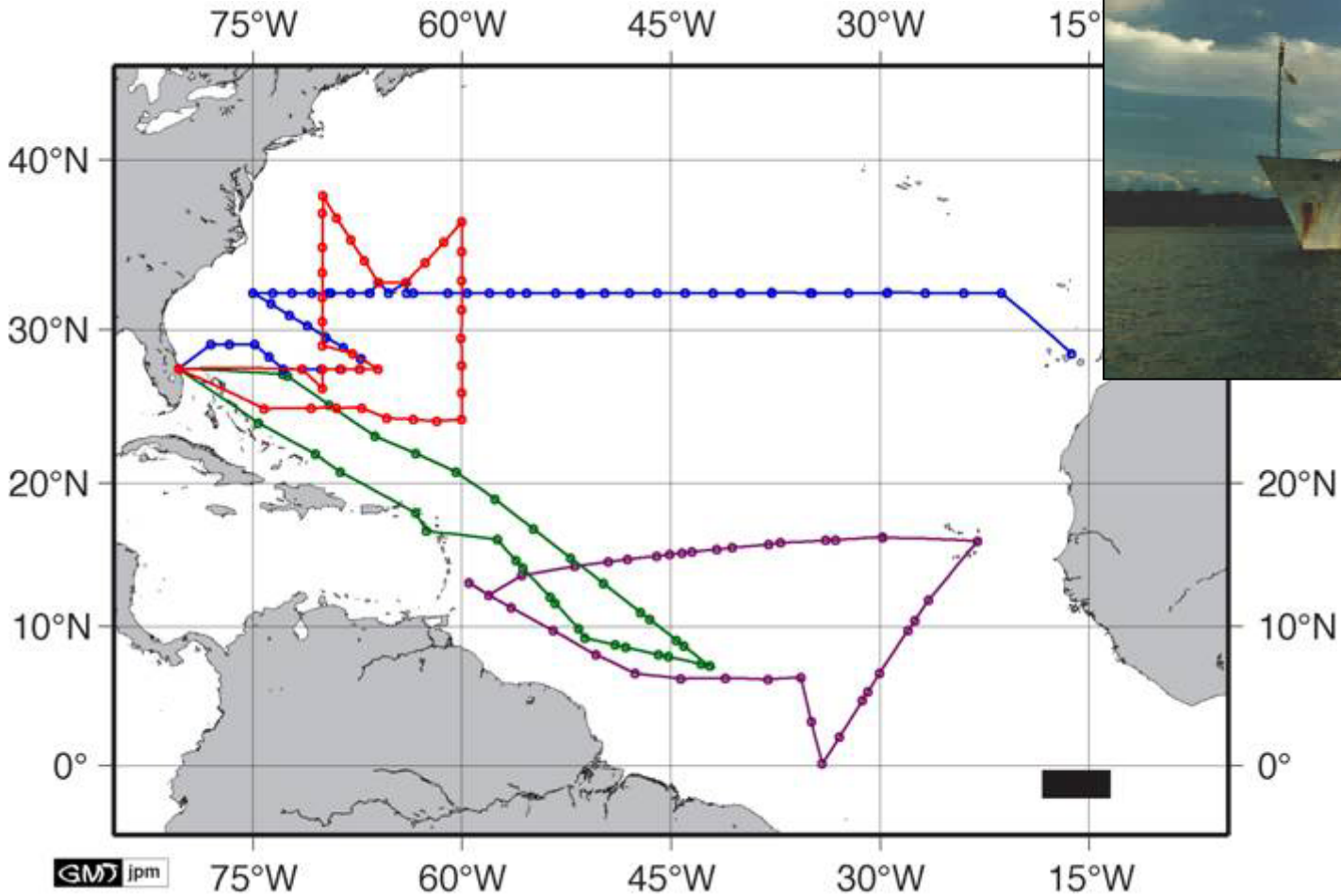


N Isotopes in the Upper Water Column

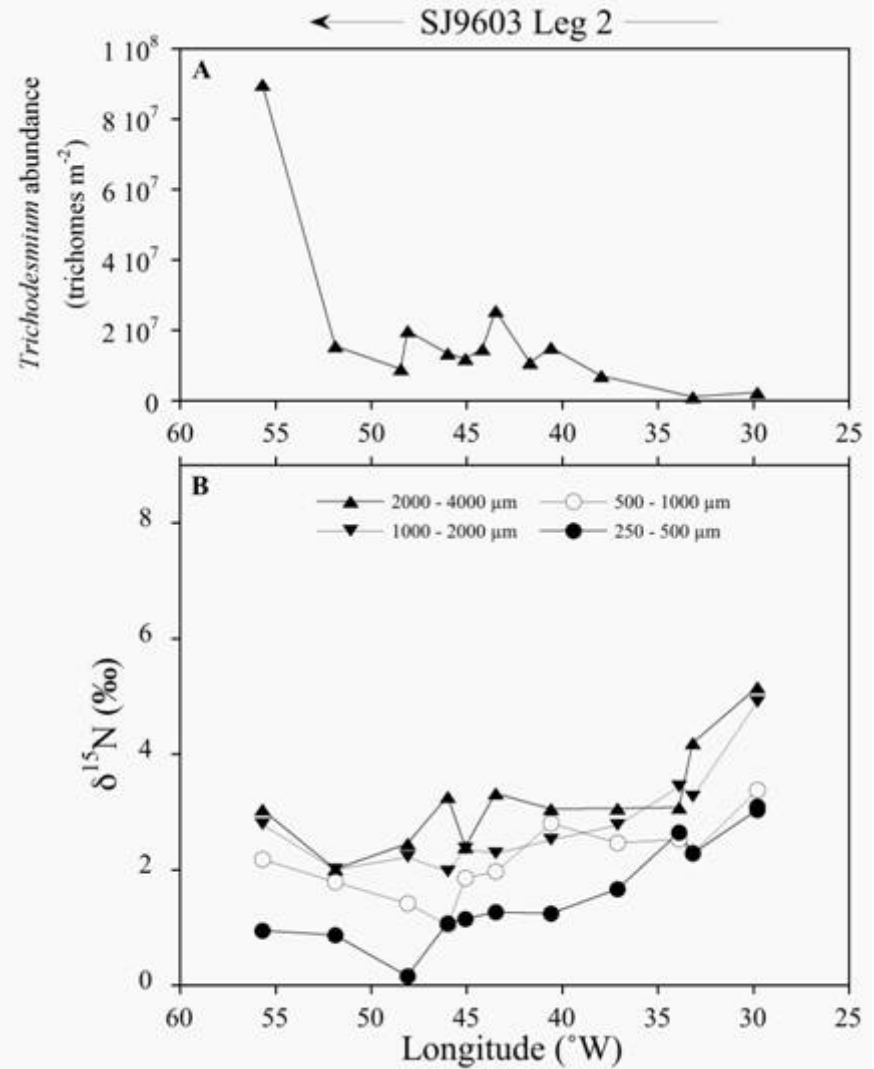
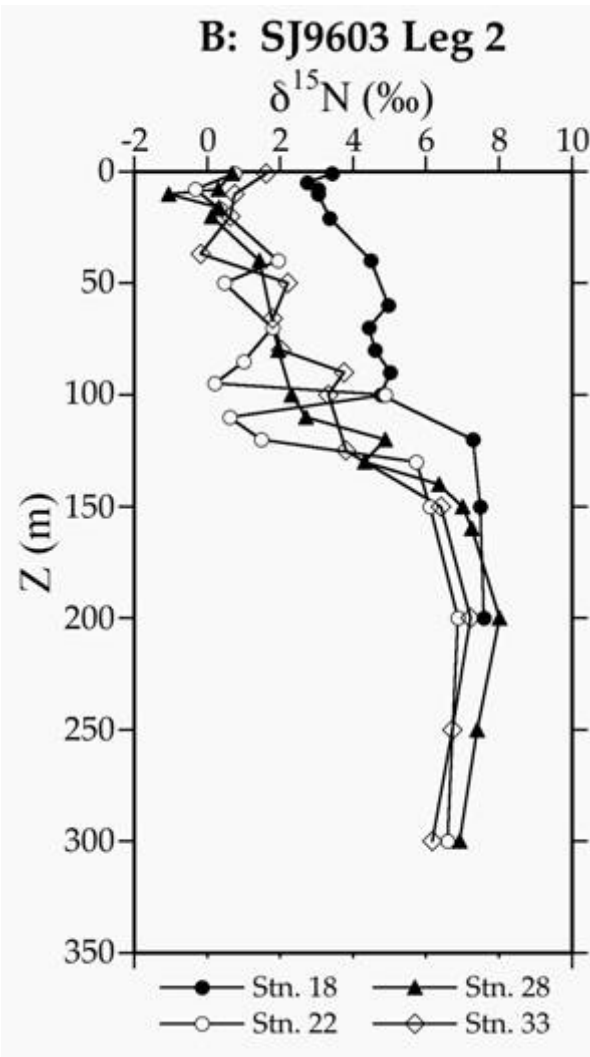
- In most places, subsurface NO_3^- has $\delta^{15}\text{N} \sim 4.5\text{‰}$
- N_2 -fixation produces organic matter with a low $\delta^{15}\text{N}$ ($\sim -2\text{‰}$)
- The $\delta^{15}\text{N}$ of organic matter in the upper water column is pulled in opposite directions by upwelled NO_3^- and in situ N_2 -fixation.

rev: 12/05

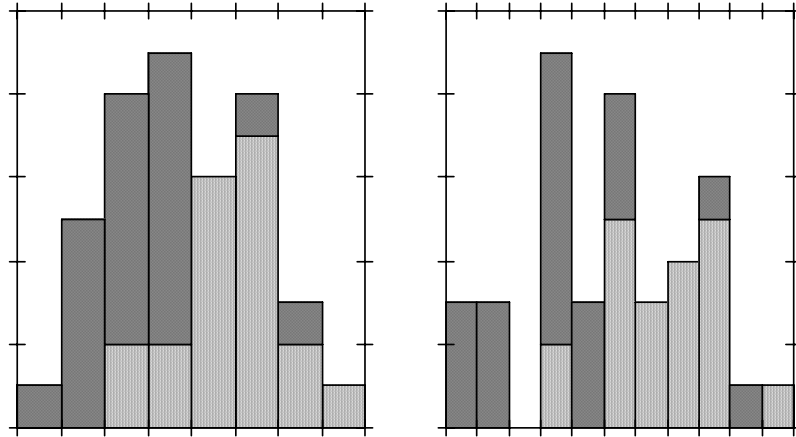
North Atlantic Cruise Tracks



SJ9603 Suspended Particles and Zooplankton



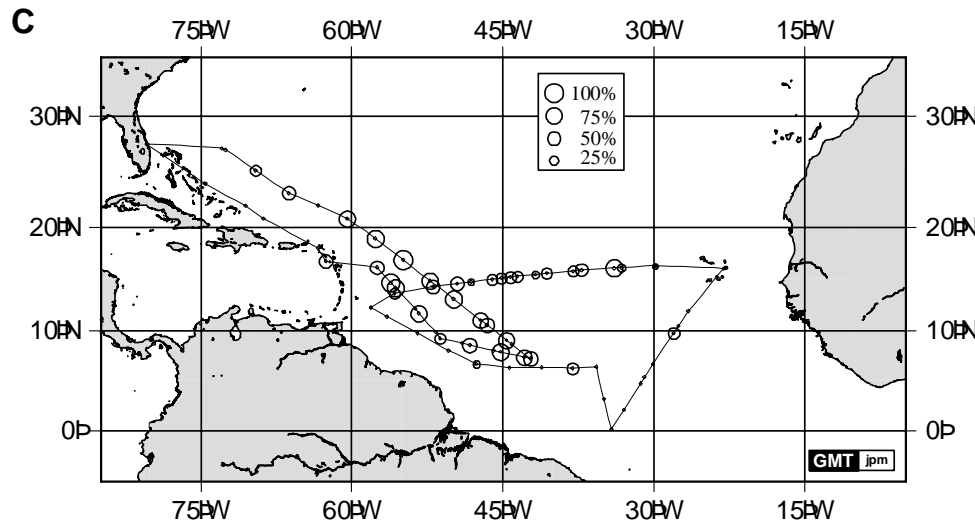
North Atlantic Isotope Budgets



A. Histogram of $\delta^{15}\text{N}$ of mixed layer PN (0-100m). Lower values reflect N_2 -fixation activity (Note reversed scale).

B. Estimated diazotroph contribution to mixed layer PN.

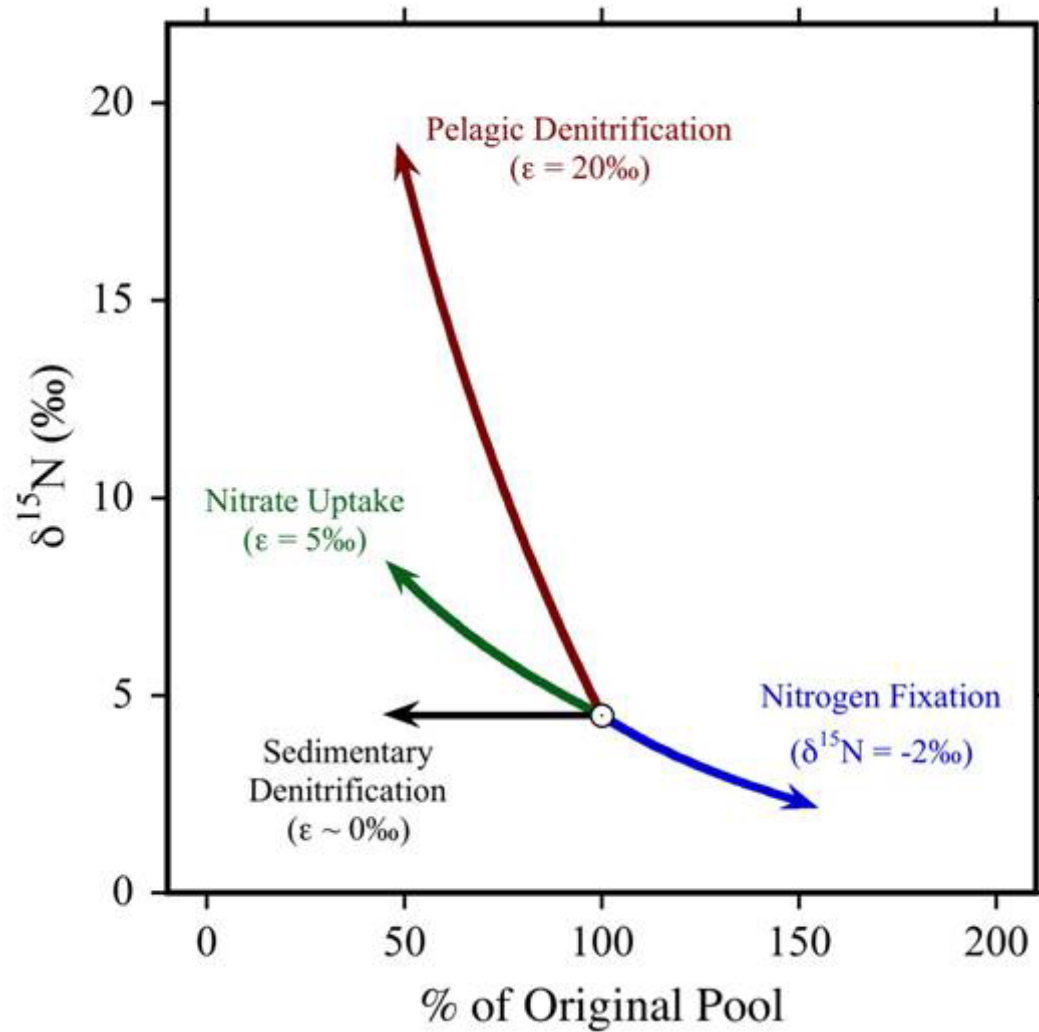
C. Spatial variation in diazotroph contribution to upper water column PN. Circle size is proportional to the diazotroph contribution to PN in the upper 100 m.

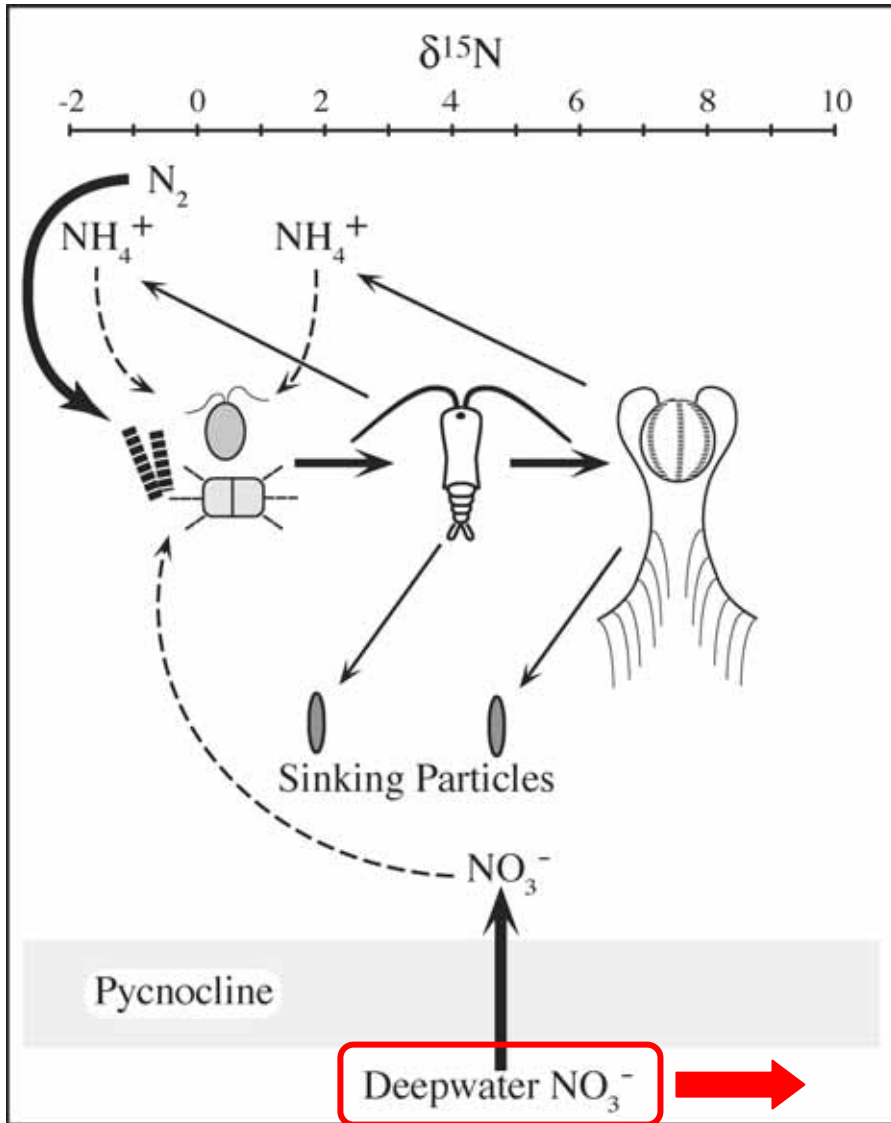


But who's doing

it??

Biological Processes and $\delta^{15}\text{N}$ of NO_3^-





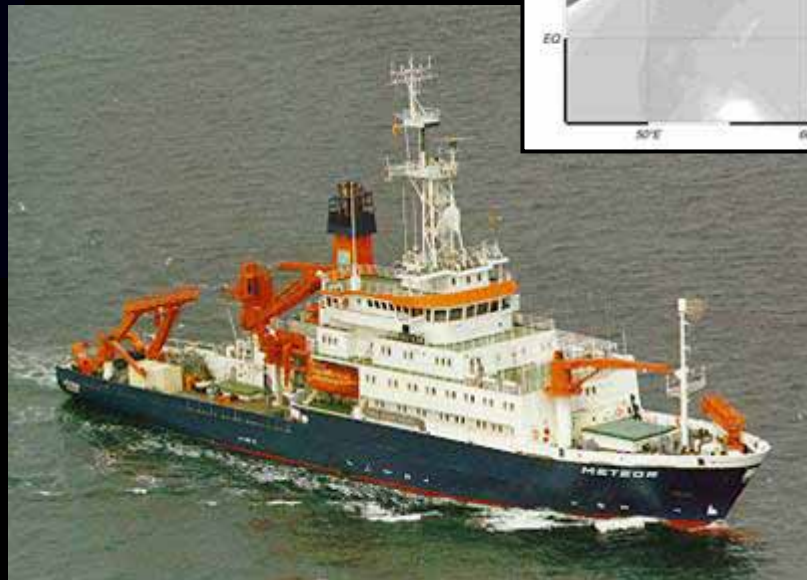
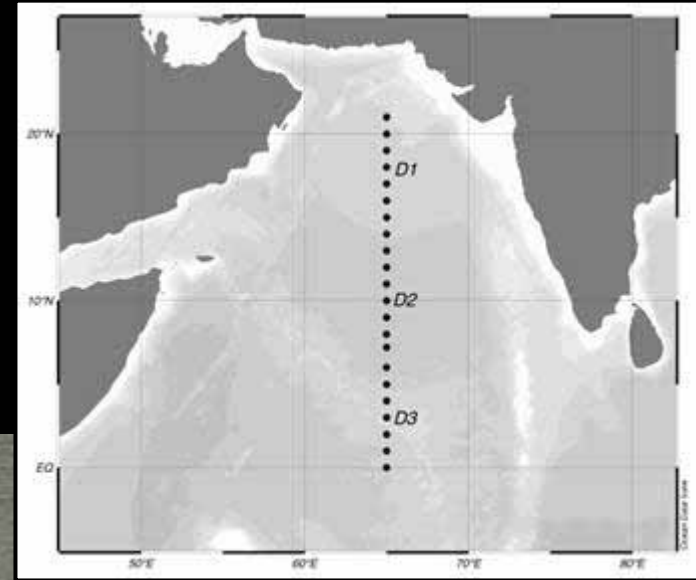
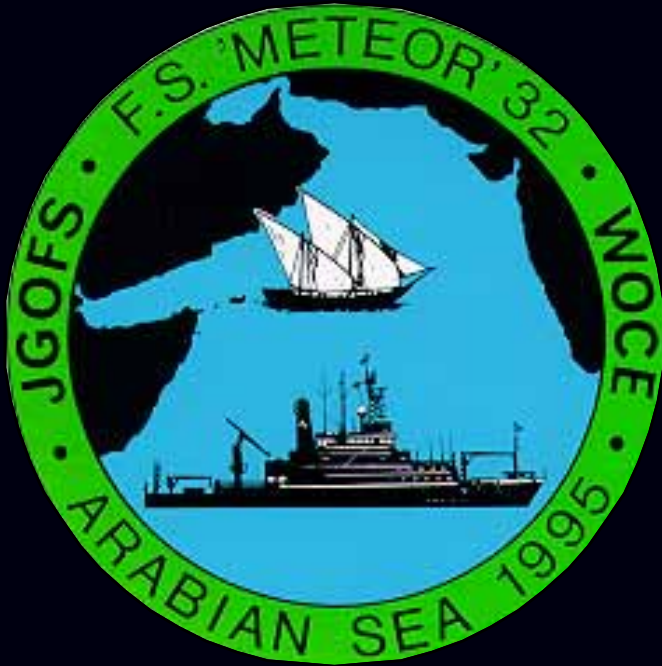
N Isotopes in the Upper Water Column

- In most places, subsurface NO_3^- has $\delta^{15}\text{N} \sim 4.5\text{‰}$
- N_2 -fixation produces organic matter with a low $\delta^{15}\text{N}$ ($\sim -2\text{‰}$)
- The $\delta^{15}\text{N}$ of organic matter in the upper water column is pulled in opposite directions by upwelled NO_3^- and in situ N_2 -fixation.
- In the Arabian Sea, denitrification accentuates this isotopic contrast by raising the $\delta^{15}\text{N}$ of NO_3^- .

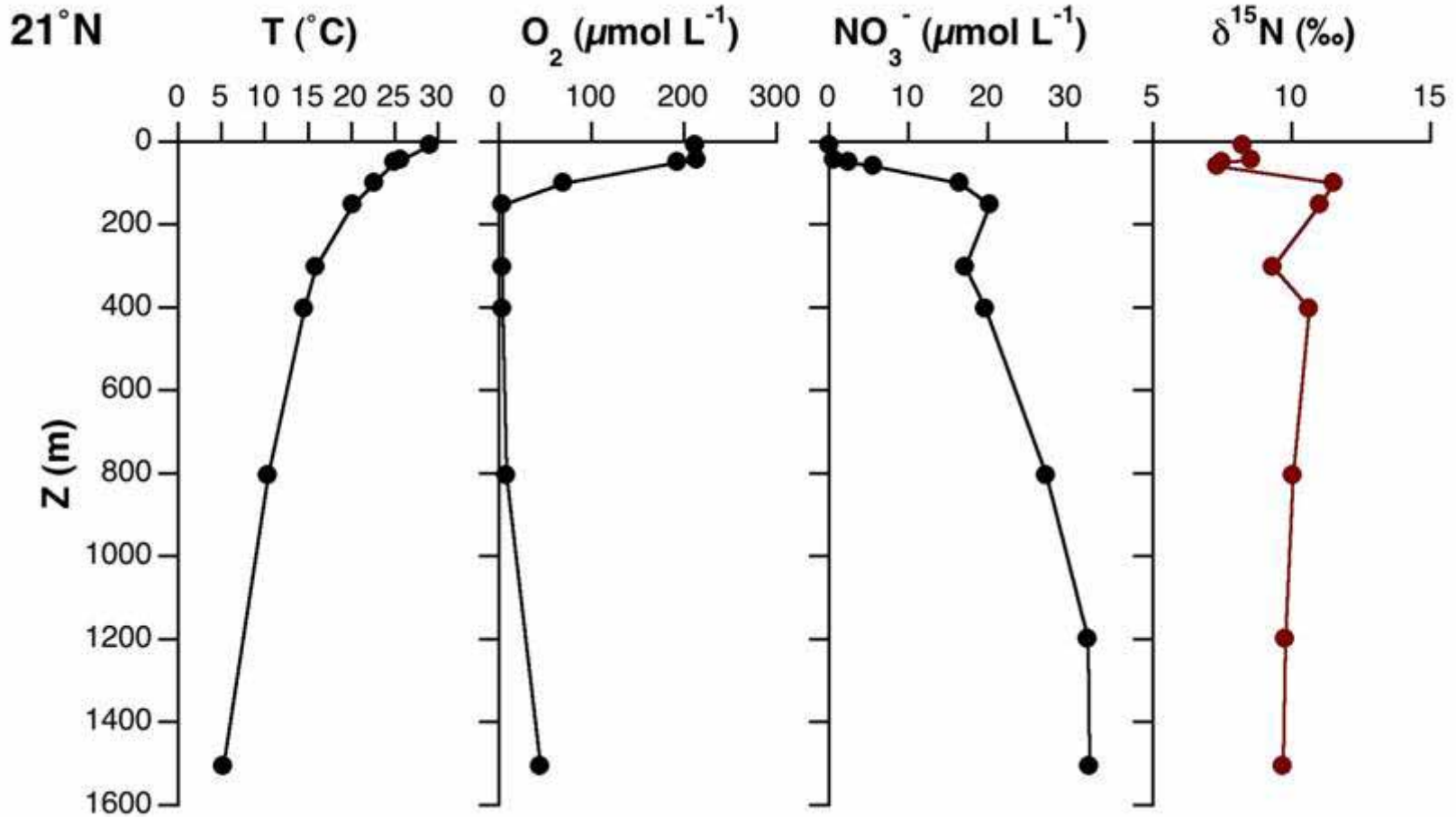
rev: 12/05

German JGOFS - Arabian Sea

ME32/3 May-June 1995

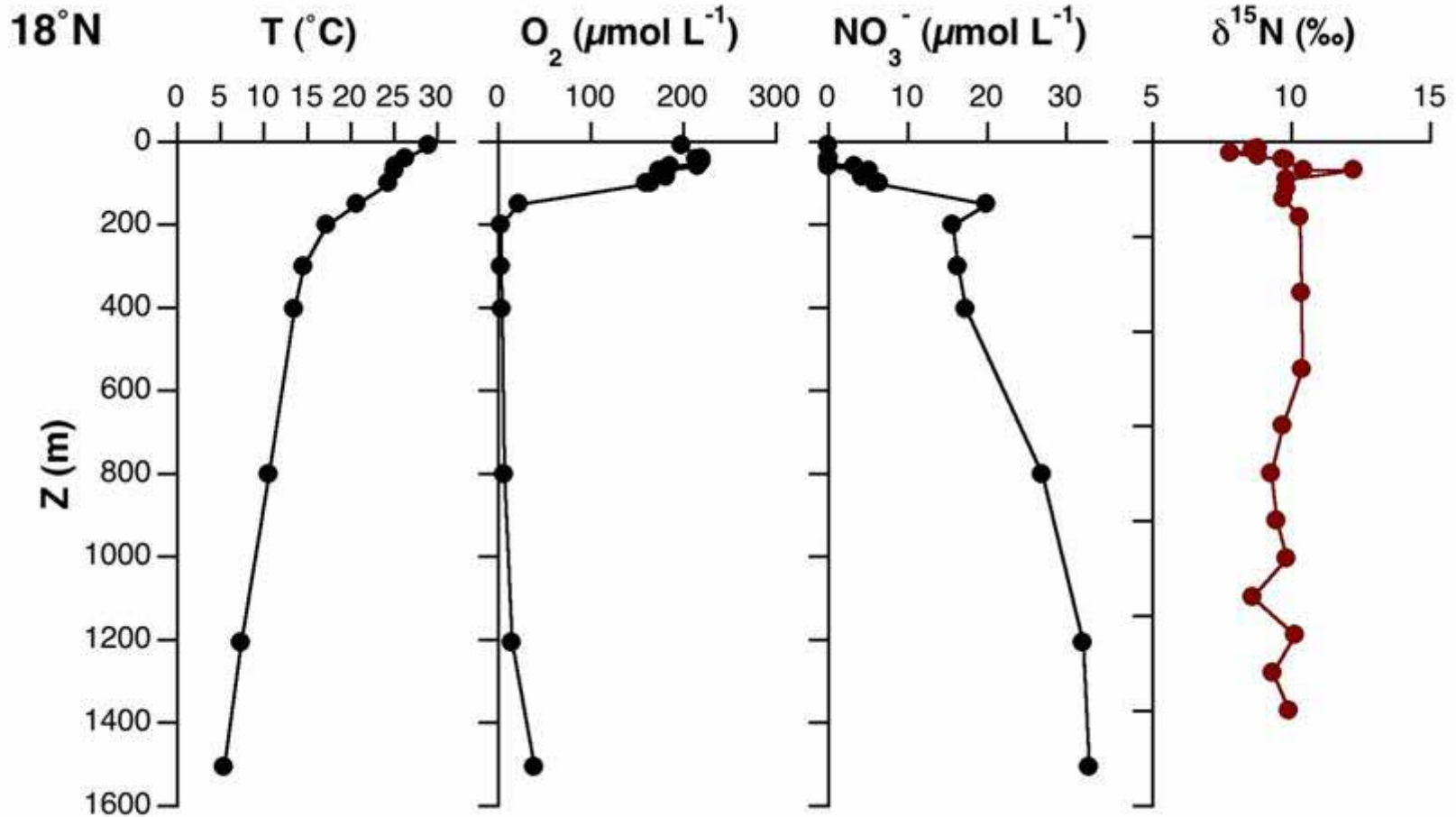


ME32/3 21°N Profiles



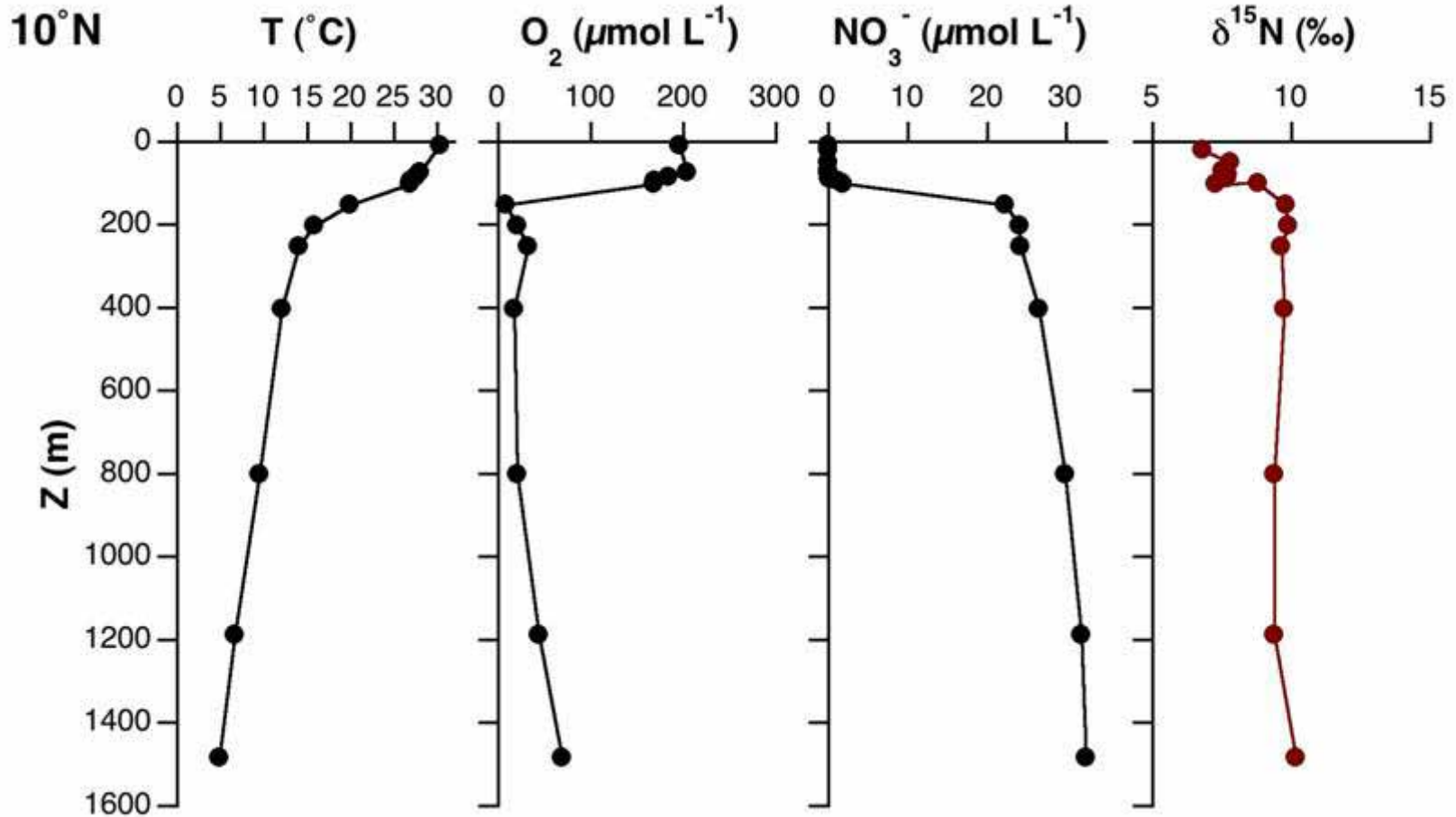
Georgia Tech Biological Oceanography

ME32/3 18°N Profiles



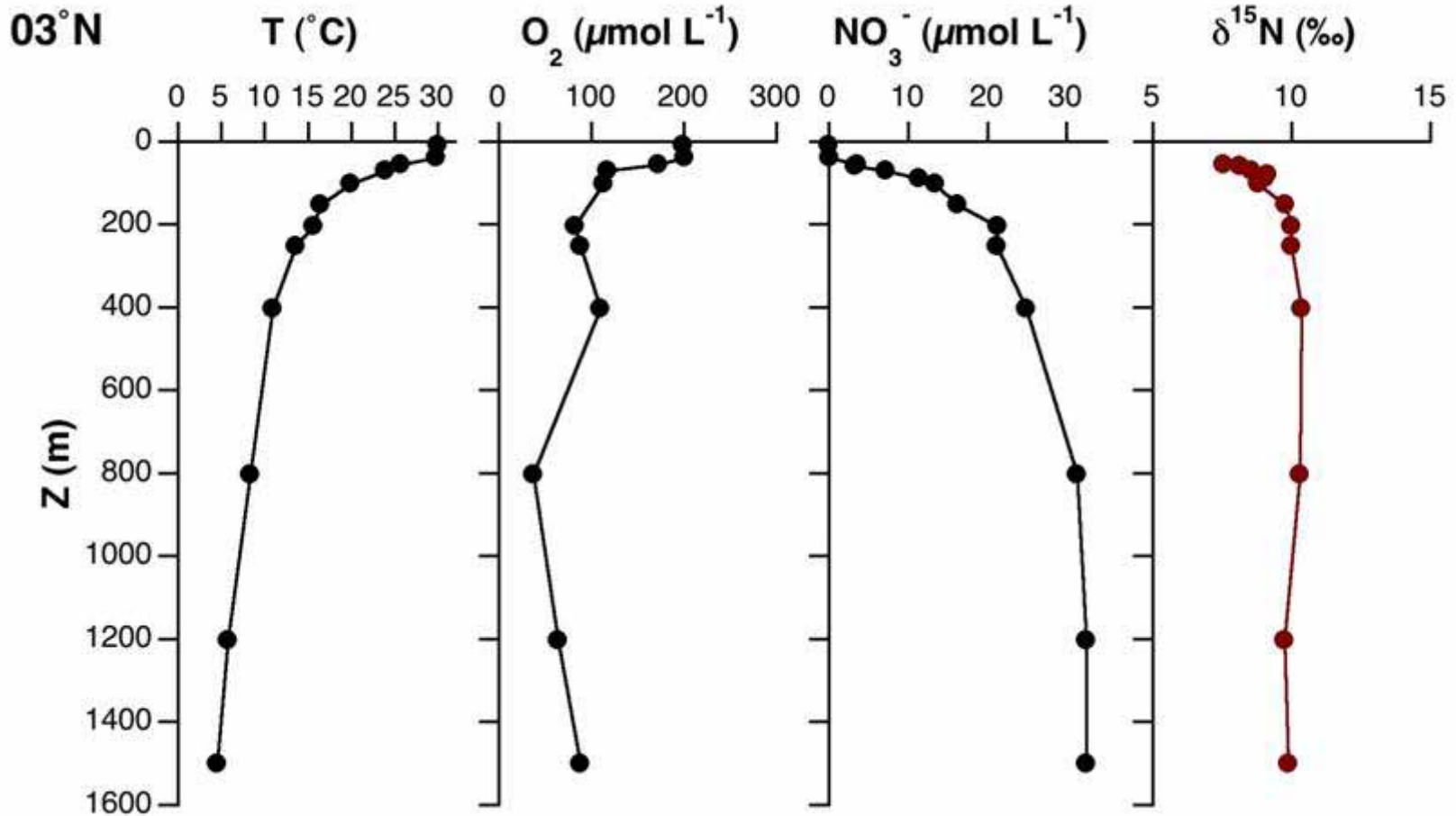
Georgia Tech Biological Oceanography

ME32/3 10°N Profiles



Georgia Tech Biological Oceanography

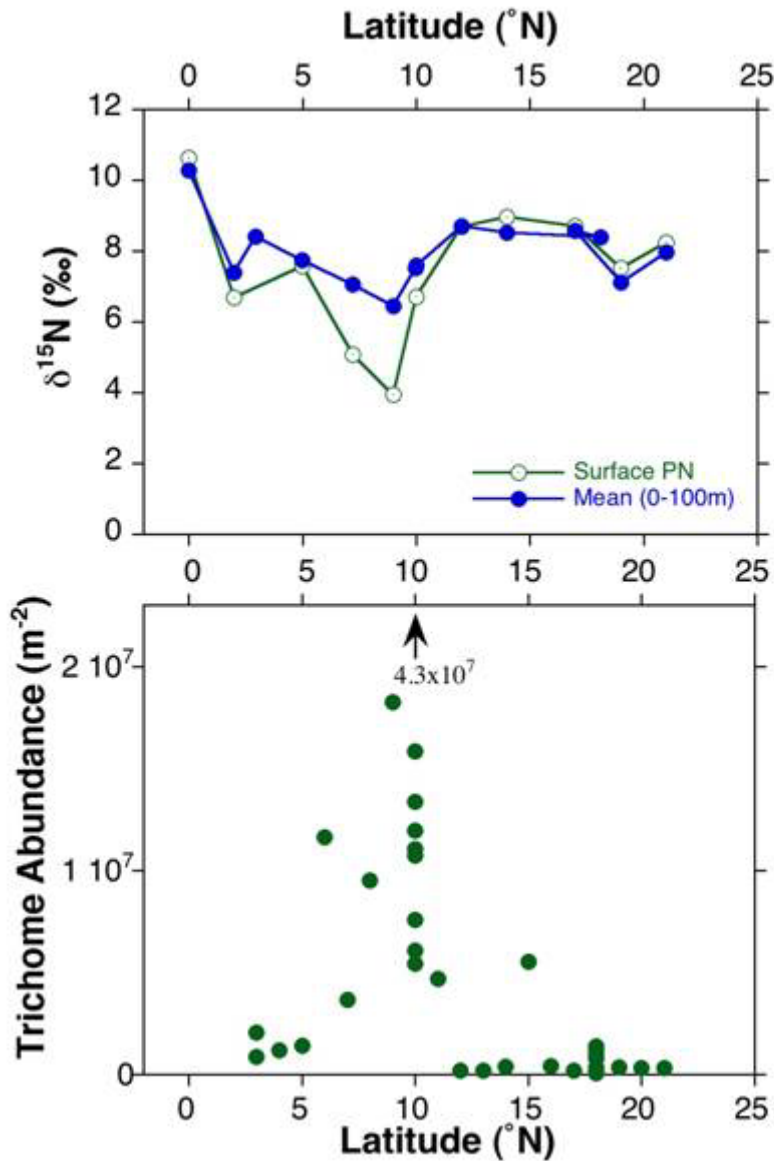
ME32/3 03°N Profiles



Georgia Tech Biological Oceanography

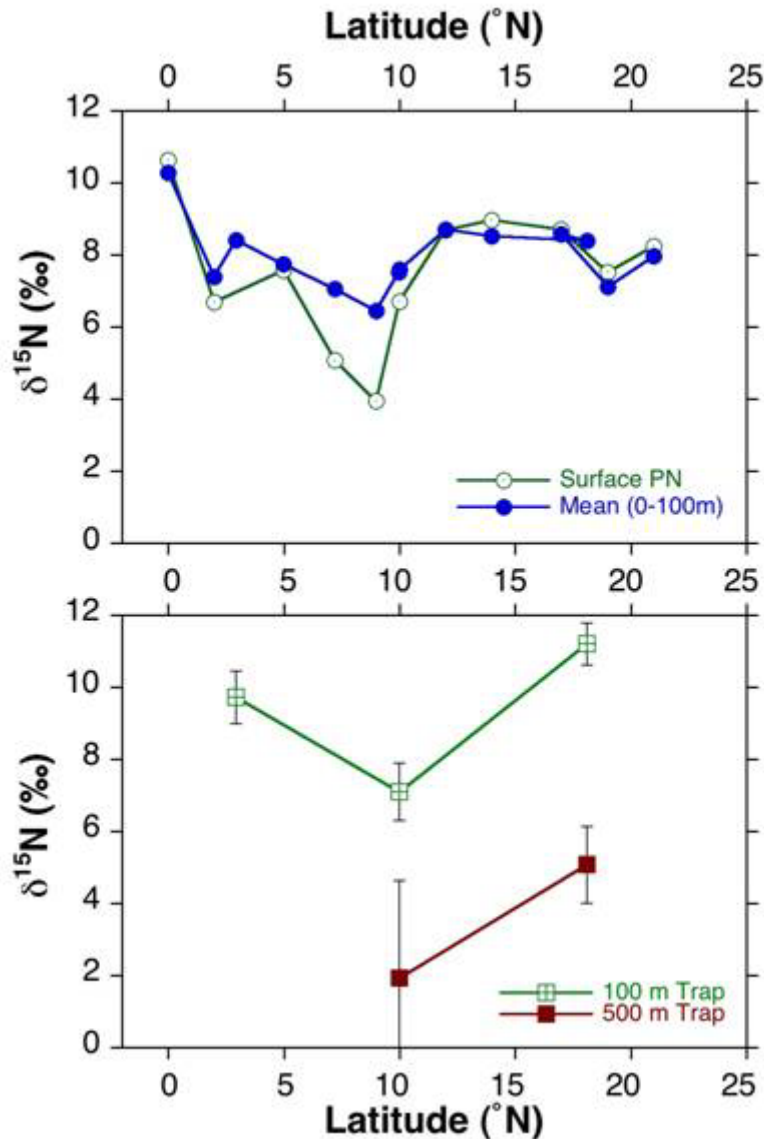
ME32/3 Transect Summary

PN & *Trichodesmium*



- $\delta^{15}\text{PN}$ is elevated relative to other waters.
- Minimum in $\delta^{15}\text{PN}$ occurred in a dense bloom of *Trichodesmium*.

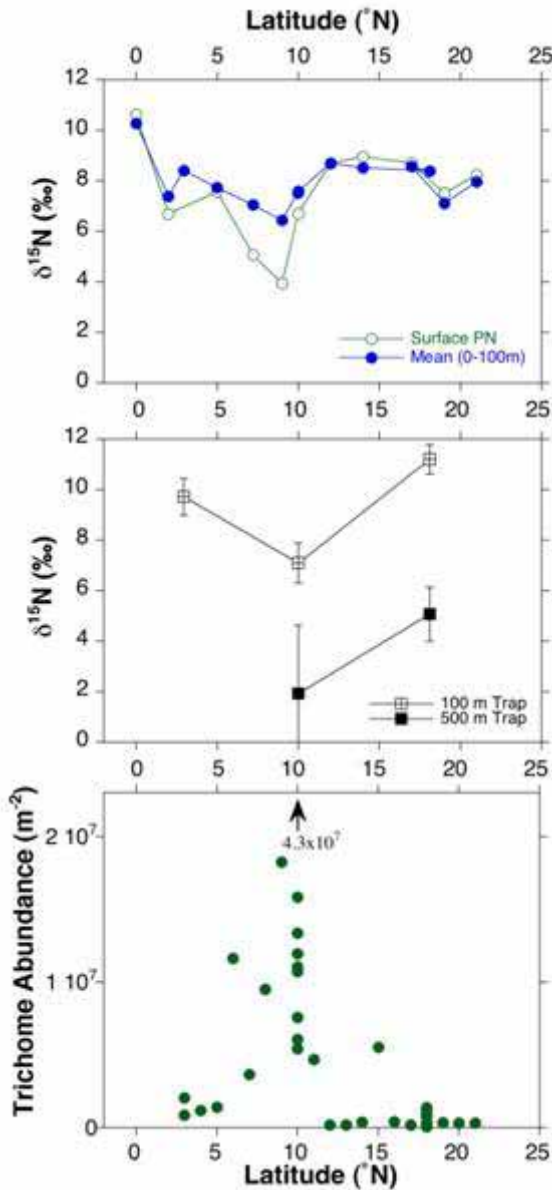
ME32/3 Transect Summary PN & Sinking OM



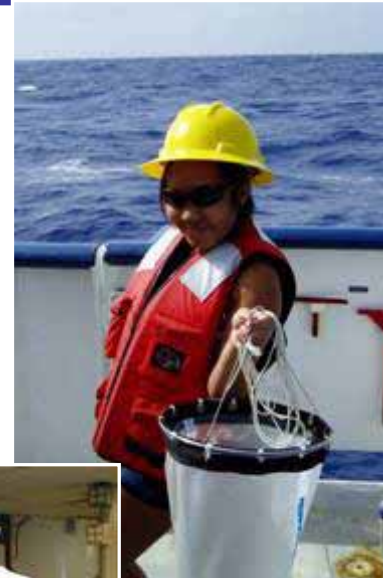
- Shallow trap $\delta^{15}\text{N}$ is comparable to or higher than the mean $\delta^{15}\text{PN}$ of the upper water column.
- The deeper trap collected material with a significantly lower $\delta^{15}\text{N}$.

Closing Thoughts

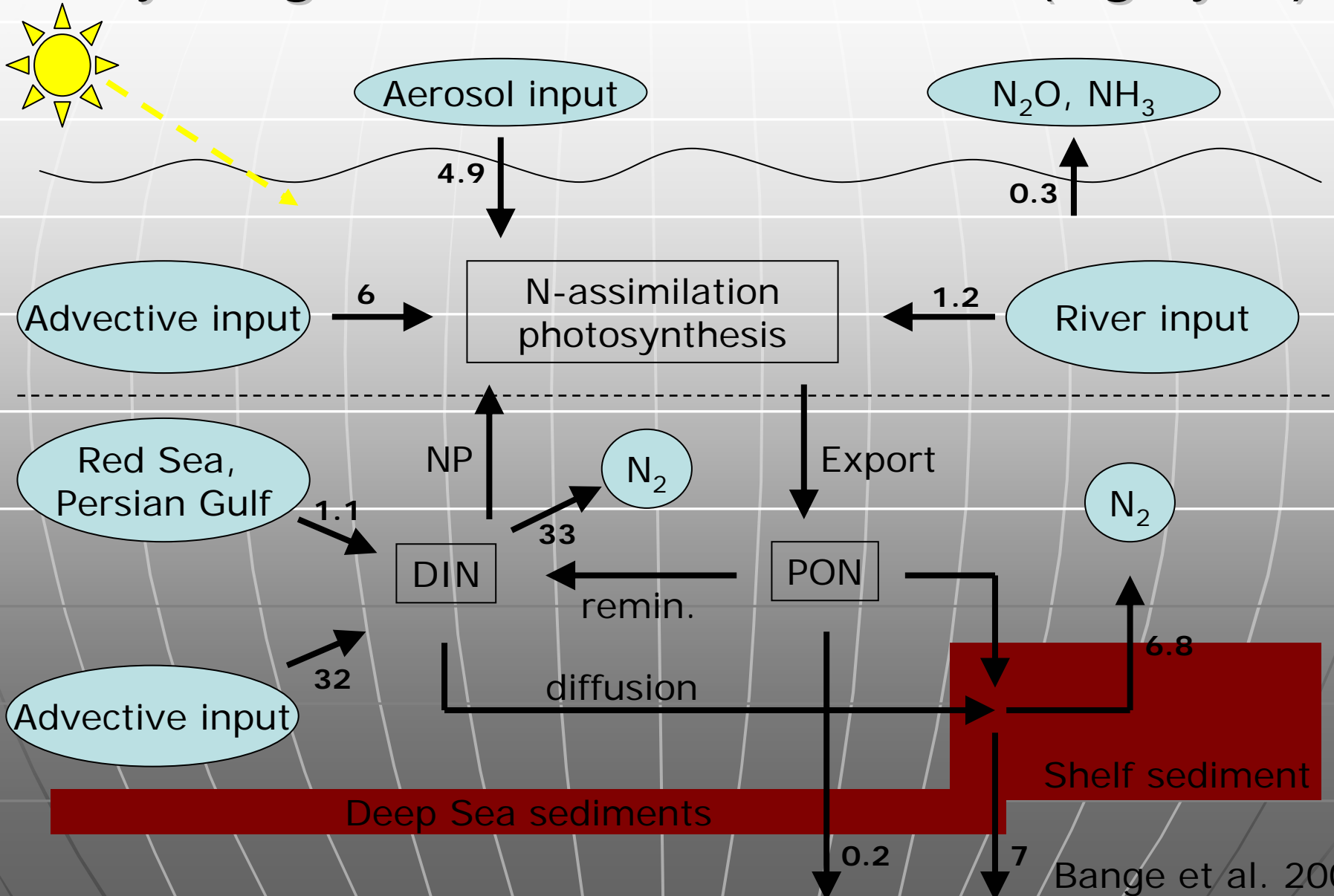
- $\delta^{15}\text{N}$ of PN shows a large range of variation, reflecting the impact of both denitrification and N_2 -fixation.
- The isotopic imprint of denitrification extended well beyond the region of active denitrification.
- Uniform $\delta^{15}\text{PN}$ at depth suggests that most of the reprocessing of particles occurs at the upper end of the ODZ.
- Trap data suggest that recently fixed N made a substantial contribution to the sinking flux of organic matter.

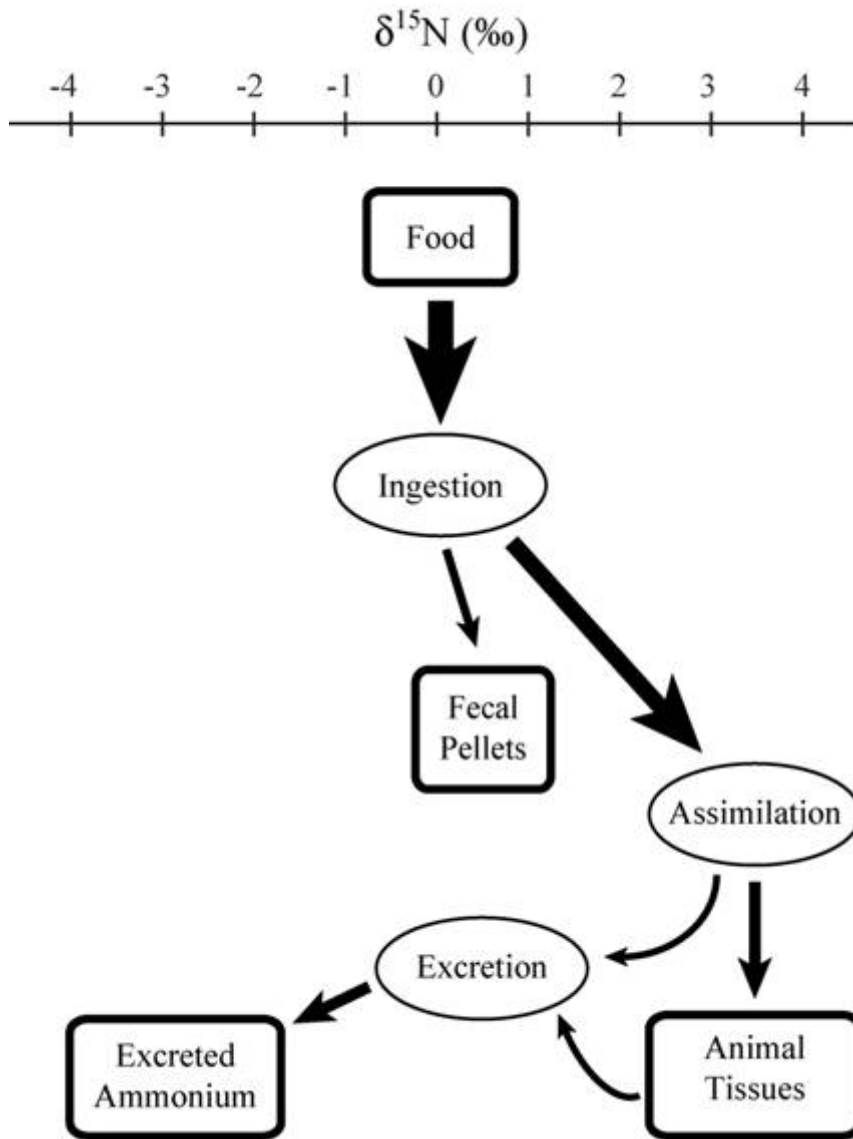


Thanks for Listening!



N-cycling Scheme Arabian Sea (TgNyr^{-1})





^{15}N and Trophic Processes

- Animal isotope budget.
- Quantification of isotopic fractionation in animals.
- Effect of diet and activity on $\delta^{15}\text{N}$.