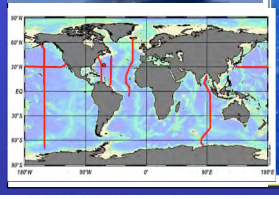
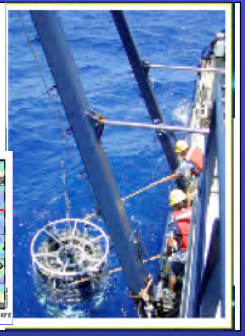
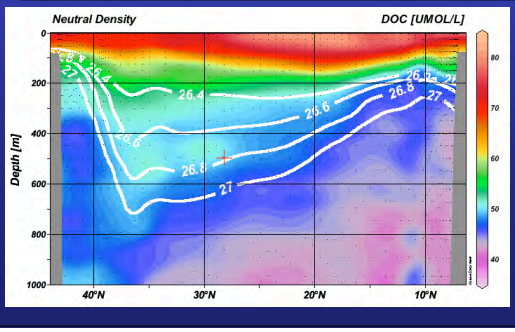
An Intro to Oceanic Dissolved Organic Carbon





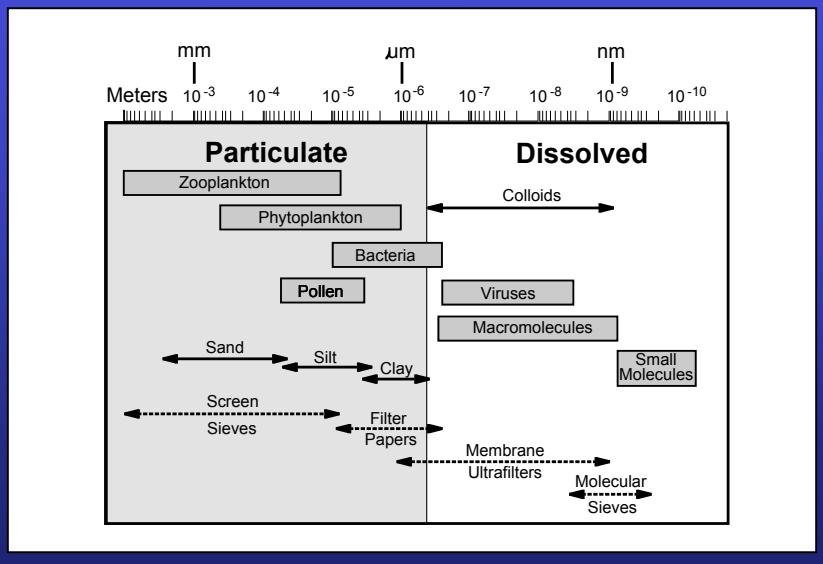


Outline:

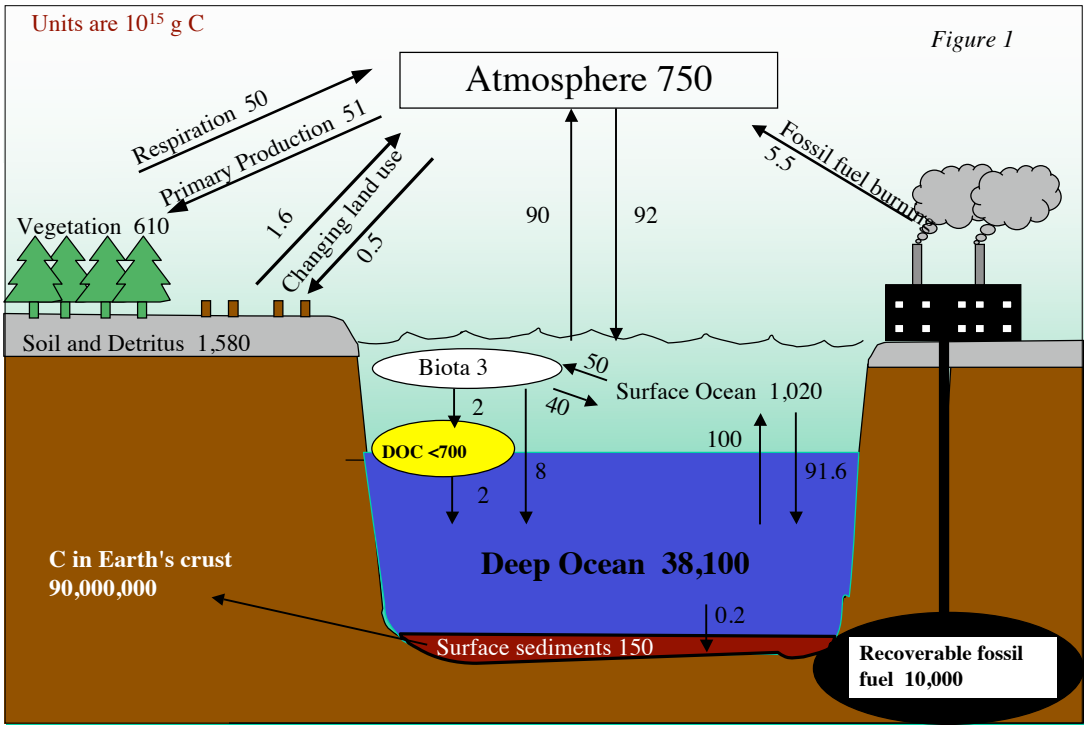
- DOC how we define it and its relevance in the C-cycle
- A brief history of the measurement and the controversy
- Partitioning the bulk pool into broad pools of lability and look at ways to assess their turnover

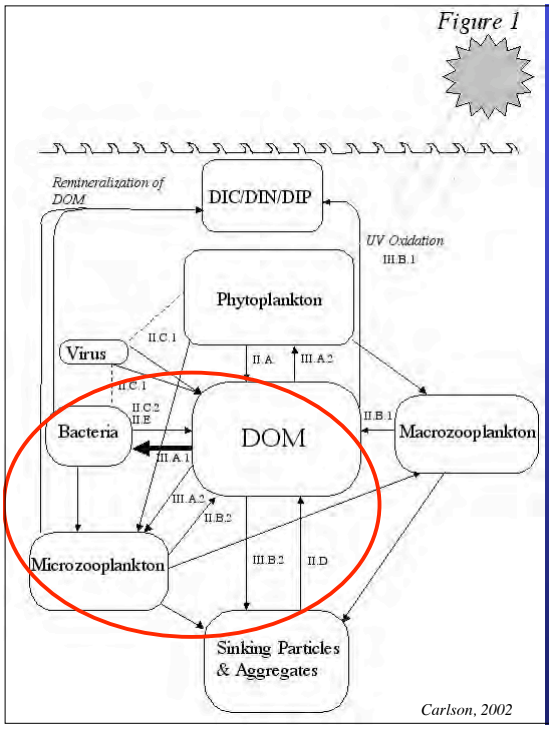
Size spectrum of organic matter

Fig. 1



Hedges 2002





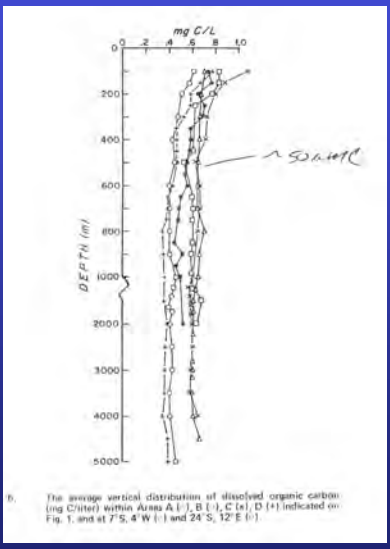
DOM production and removal mechanisms

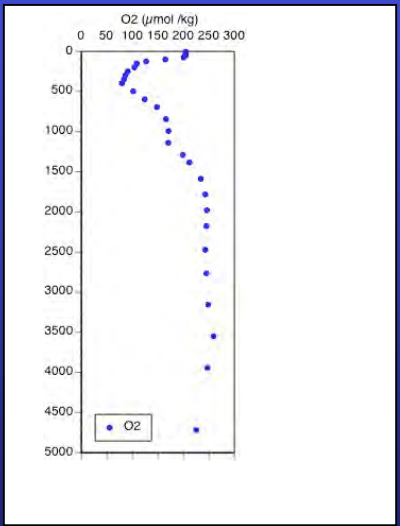
In the open ocean…..DOM production is ultimately constrained by the level of Primary production w/in a system.

Brief History and the Controversy of DOC measurements

- 1909 Pütter - developed first wet chemical combustion technique with chromic acid …problems with chlorine interference
- 1934 Krogh and Keys- removed chlorine …first reliable estimates of DOC
- 1950s- Soviets started trying high temperature combustion
- 1961- Duursma - wet oxidation and coulometric titration
- 1964- Menzel and Vaccaro - wet persulfate oxidation
- 1966 - Armstrong - UV oxidation
- 1970's - Sharp revisited the HTC method

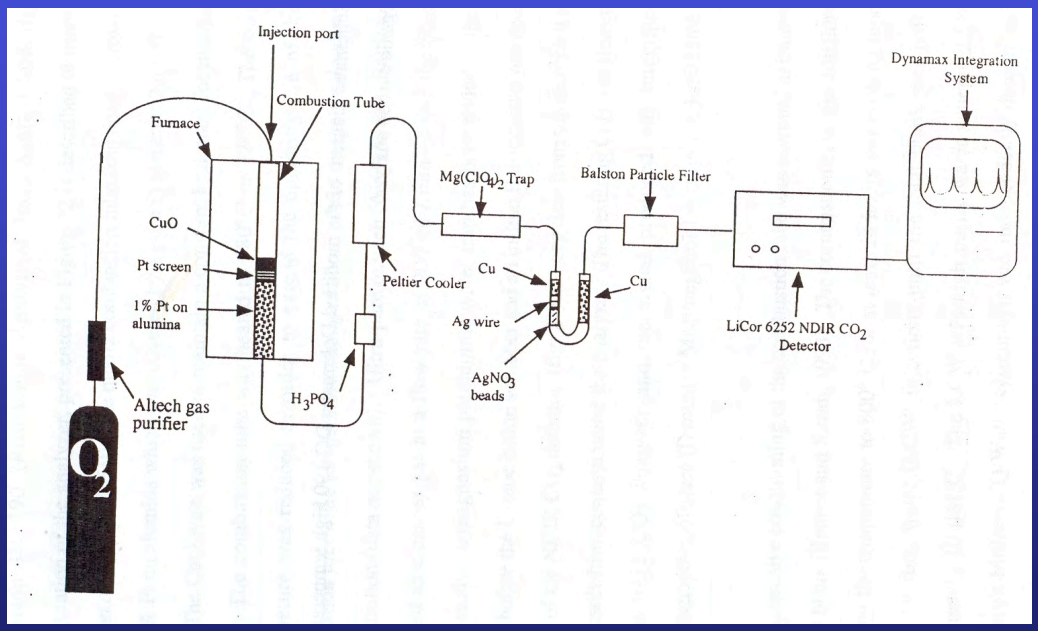
Historical view of oceanic DOC - relatively unvarying pool of recalcitrant organic matter





Menzel and Ryther 1970

The Basics of the High Temperature Combustion System



DOC: The controversy… new high concentrations

Sugimura and Suzuki 1988…used new Pt/ alumina catalyst
50- 400% higher than previous estimates

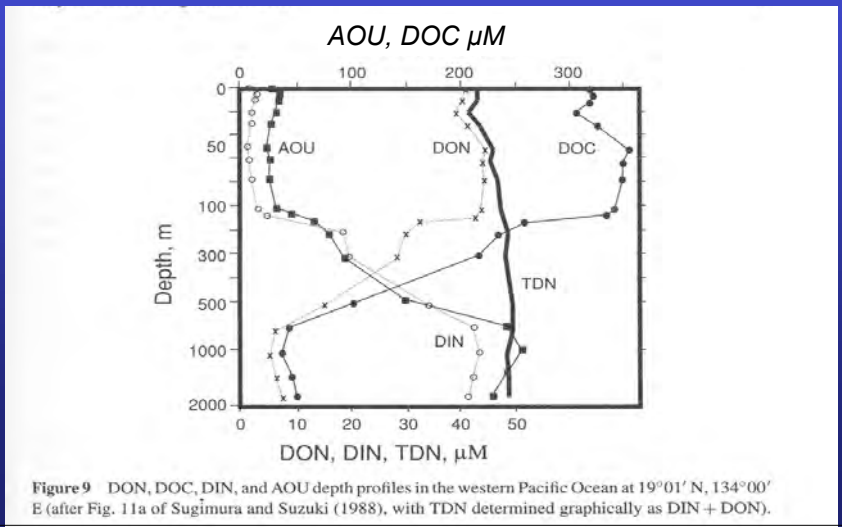
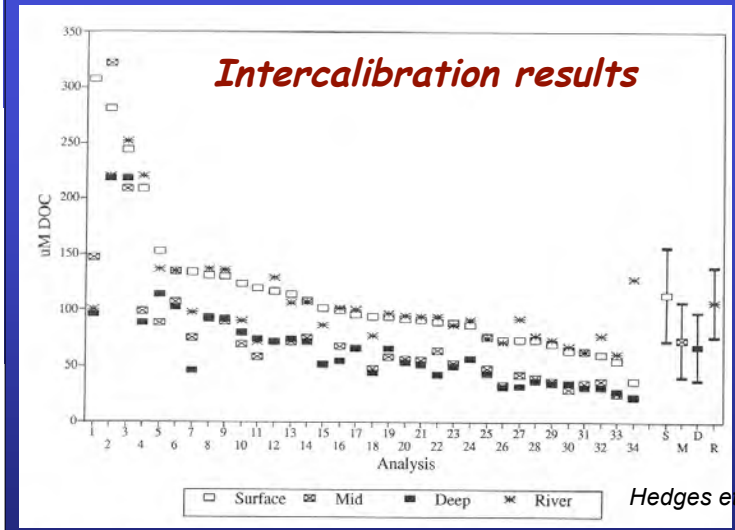


Figure 9 DON, DOC, DIN, and AOU depth profiles in the western Pacific Ocean at 19°01′ N, 134°00′ E (after Fig. 11a of Sugimura and Suzuki (1988), with TDN determined graphically as DIN + DON).

Seattle DOM Workshop 1991



- *34 separate analyses of the same sample*
- *order of magnitude range in values from same sample!!!*
- *Blanks were not properly accounted for*

Hedges et al. 1992

"We have initiated over a decade long program in ocean carbon and we have no reliable estimate for DOM….you guys have to figure this out!!!" ***-Neil Anderson NSF Chem OCE***

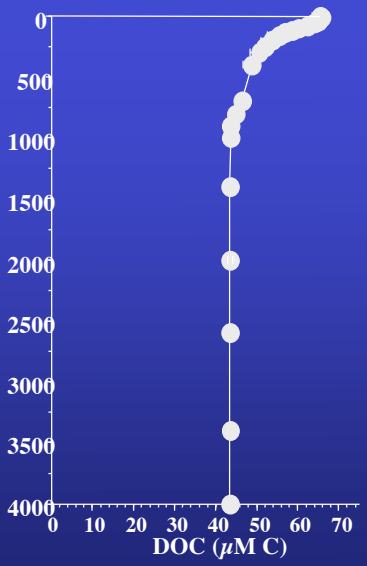
Fine tuning the instrument, column conditioning, proper blank correction, implementation of reference materials and community intercalibrations …helped get to the bottom of it.

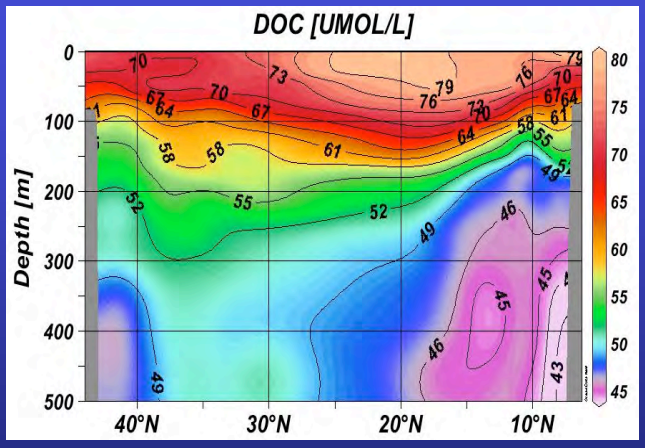
Home Made

High Temperature Combustion Systems (HTC)

Modified Shimadzu - High throughput!!

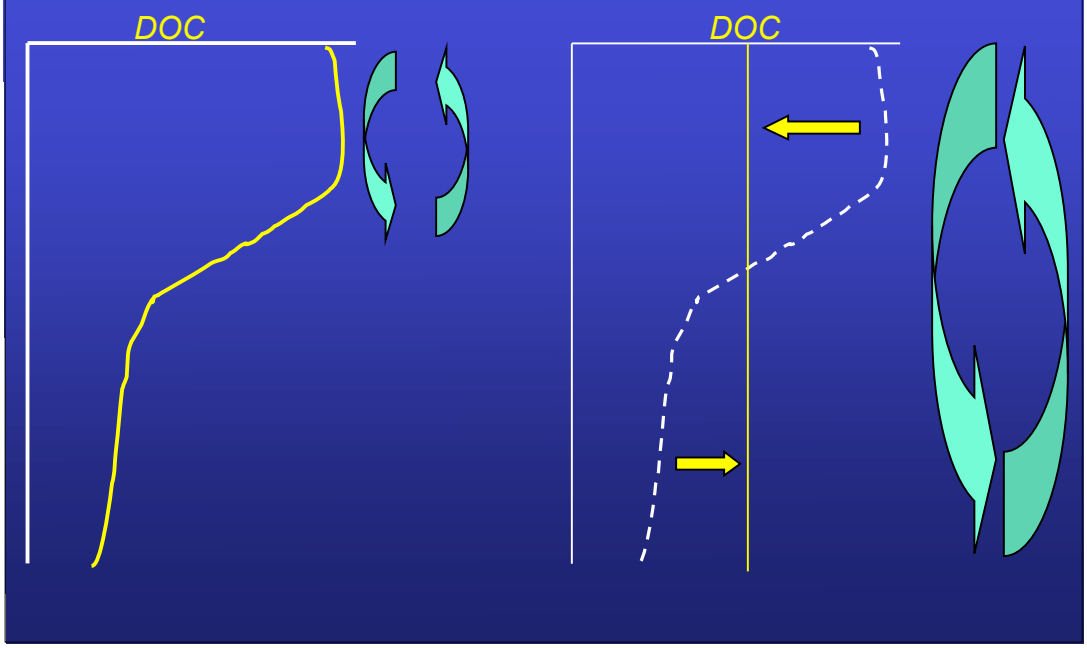
DOC and the Oceanic Carbon Cycle



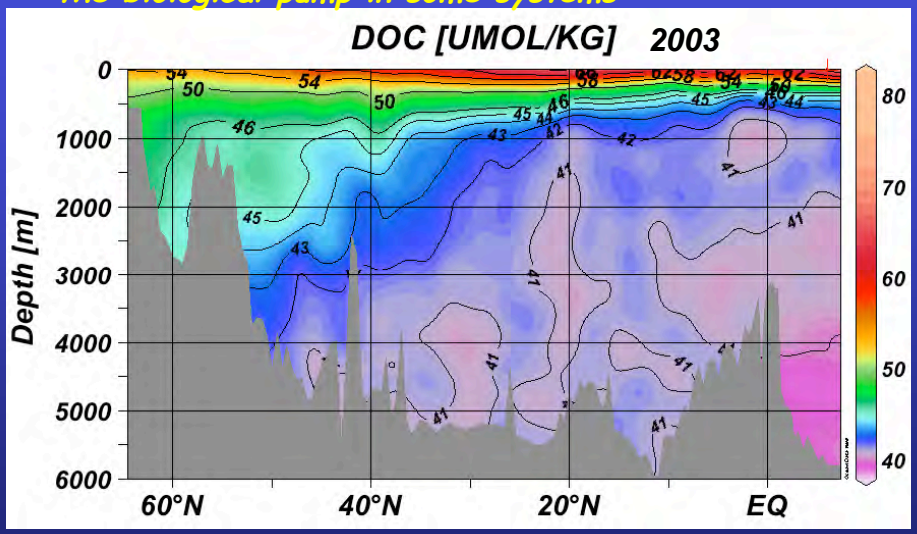


Who Cares??? Why is DOC/ DOM important?

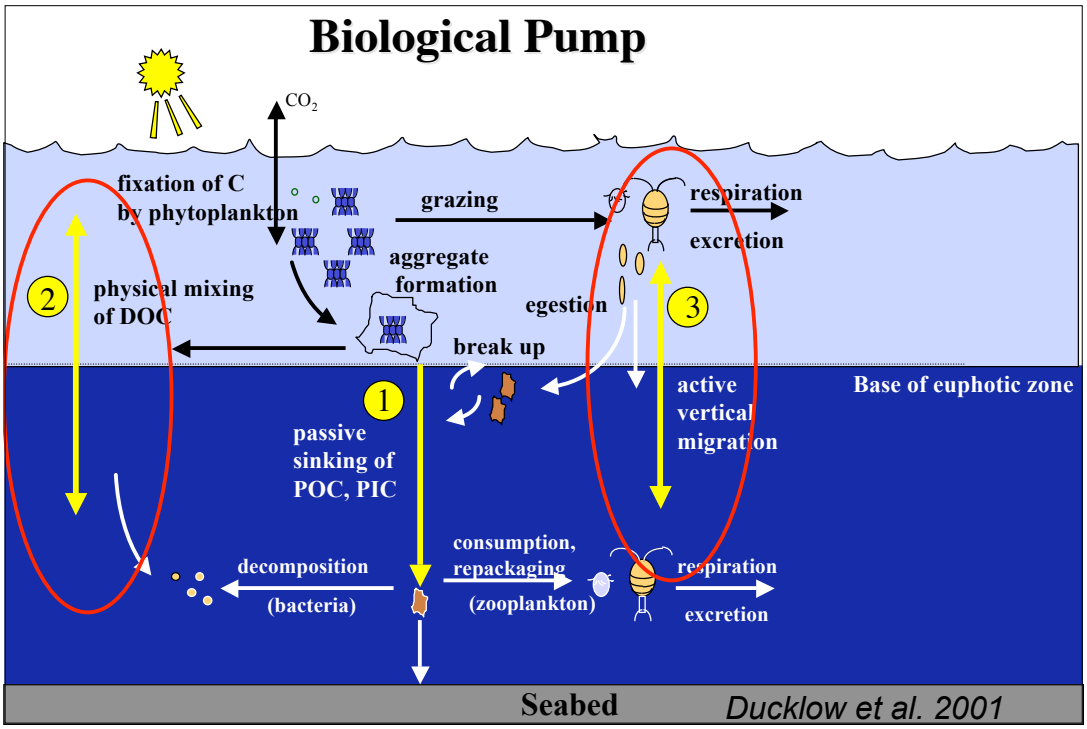
Role of mixing and DOC export

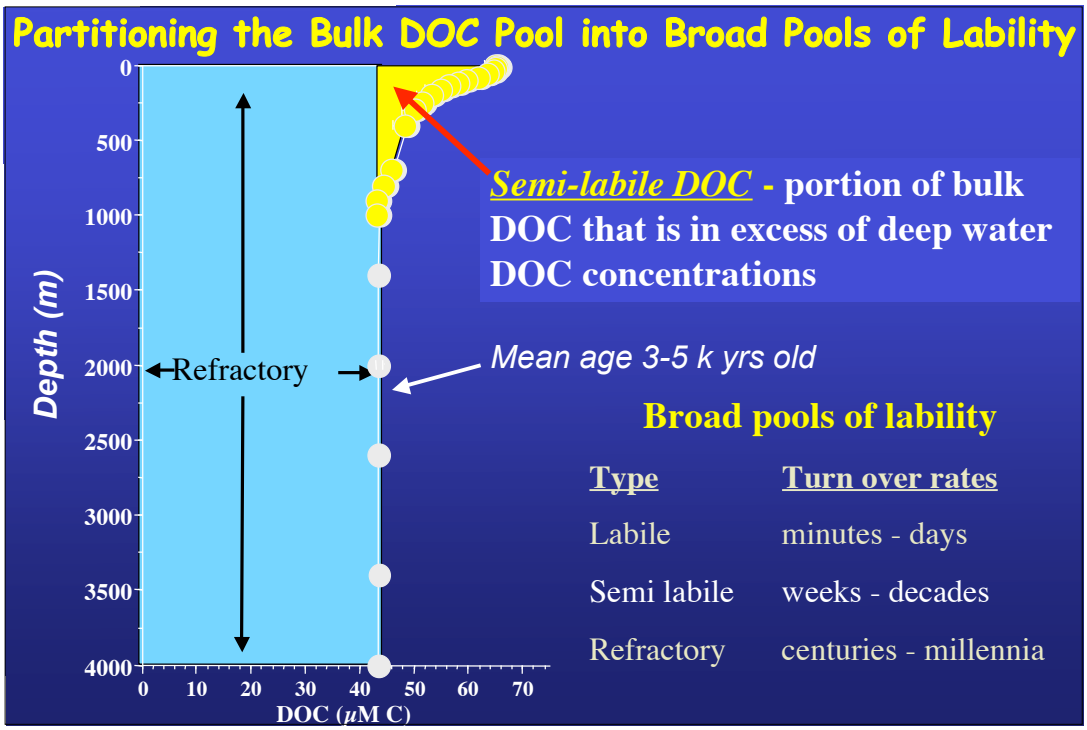


Biogeochemical significance in C-cycle ….an additional component of the biological pump in some systems

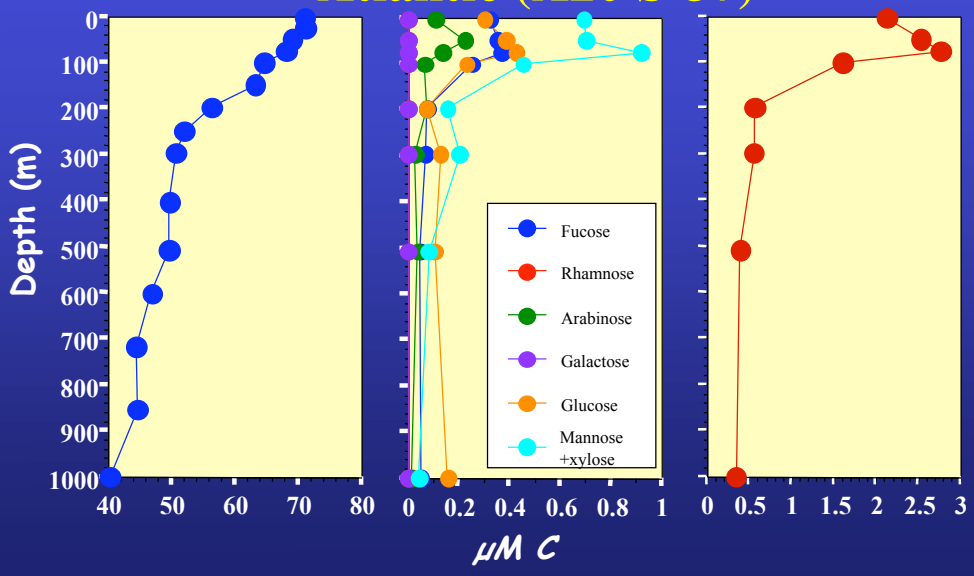


Current estimates are that DOC export is approximately 20% of NCP and 20% of export production - Hansell 2002


Biological Pump
CO_2
fixation of C by phytoplankton
grazing
respiration
excretion
aggregate formation
egestion
2
physical mixing of DOC
3
break up
1
Base of euphotic zone
active vertical migration
passive sinking of POC, PIC
decomposition
(bacteria)
consumption, repackaging
(zooplankton)
respiration
excretion
Seabed
Ducklow et al. 2001

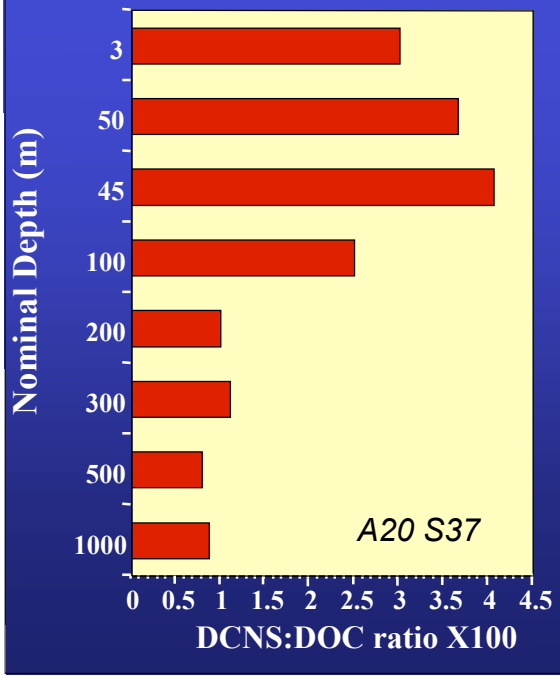

Partitioning the Bulk DOC Pool into Broad Pools of Lability
Depth (m)
0
500
1000
1500
2000
2500
3000
3500
4000
Refractory
0
10
20
30
40
50
60
70
DOC (μM C)
Semi-labile DOC - portion of bulk DOC that is in excess of deep water DOC concentrations
Mean age 3-5 k yrs old
Broad pools of lability
Type
Turn over rates
Labile
minutes - days
Semi labile
weeks - decades
Refractory
centuries - millennia

Characterization of DOC pool in North Atlantic (A20 S-37)



Goldberg et al. in revision

DCNS : DOC ratio in the Subtropical Atlantic

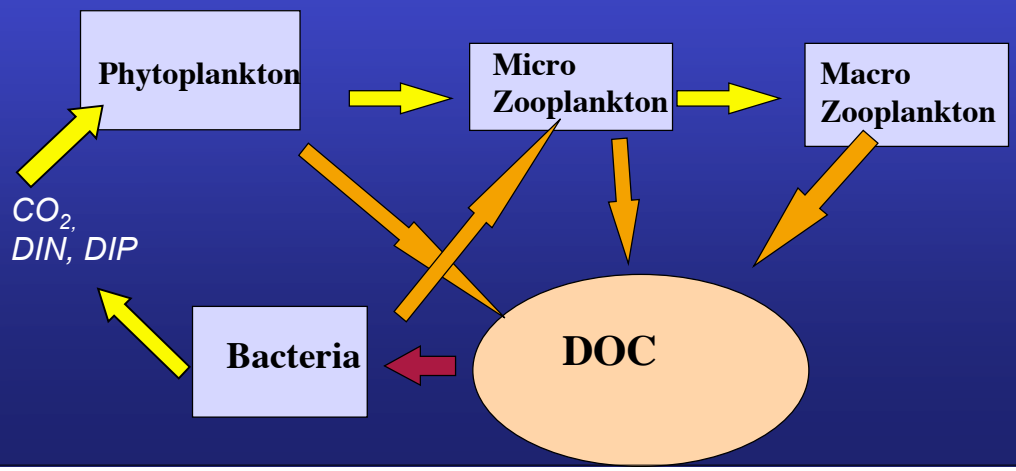


- **Contribution of specific compounds like DCNS to bulk DOC can be used as and index of diagenetic state (Cowie and Hedges, 1994 & Skoog and Benner, 1997)**

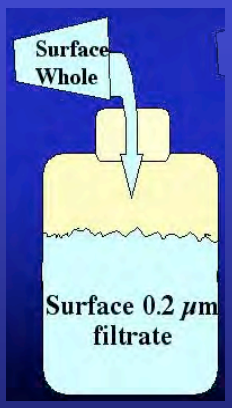
- **The lower the yield the more highly degraded the organic matter is**

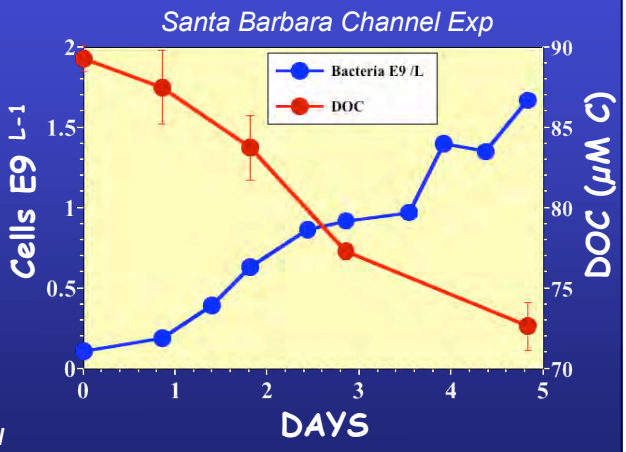
The Microbial Loop (Pomeroy 1974, Azam et al. 1983)

Classical Food Chain with the Microbial Loop



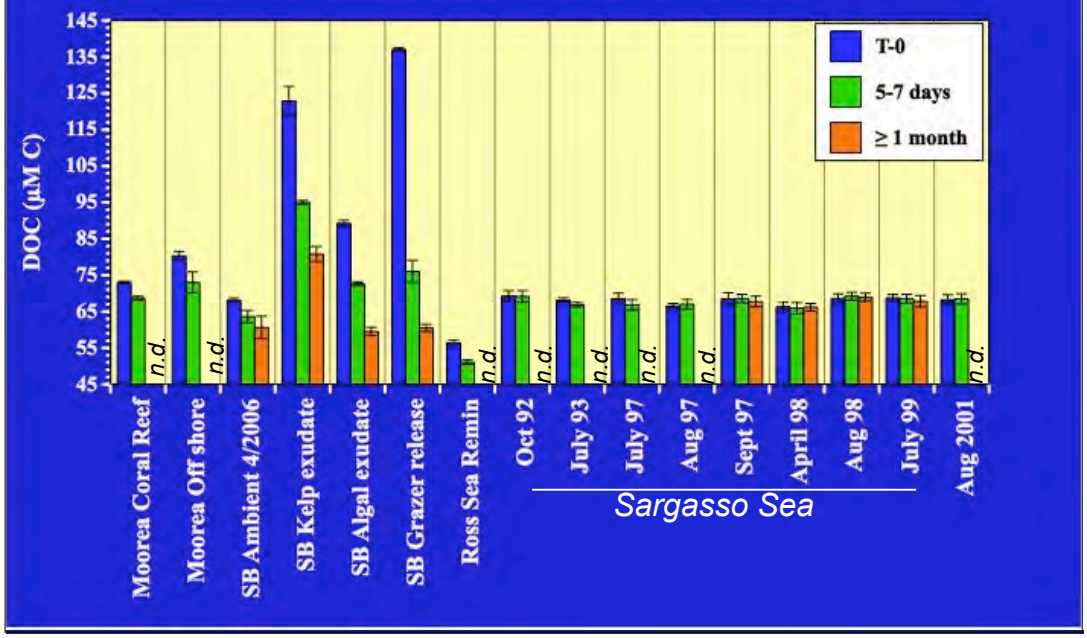
Example of a Remineralization Experiment used to examine the magnitude of the "labile" DOC pool



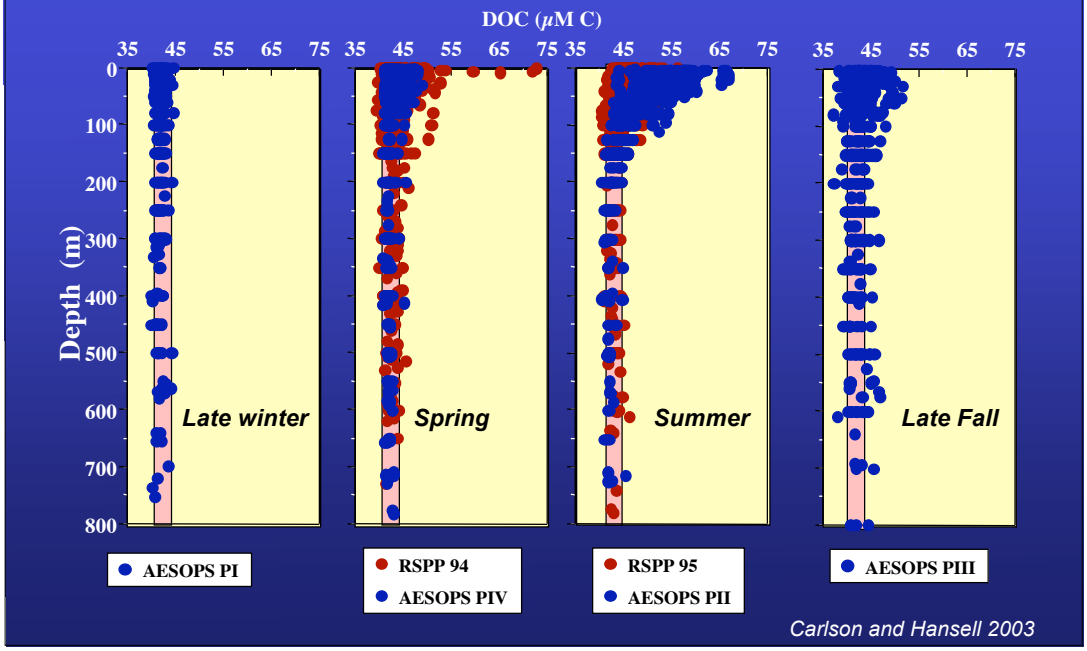


- *incubate in the dark at in situ temperature*

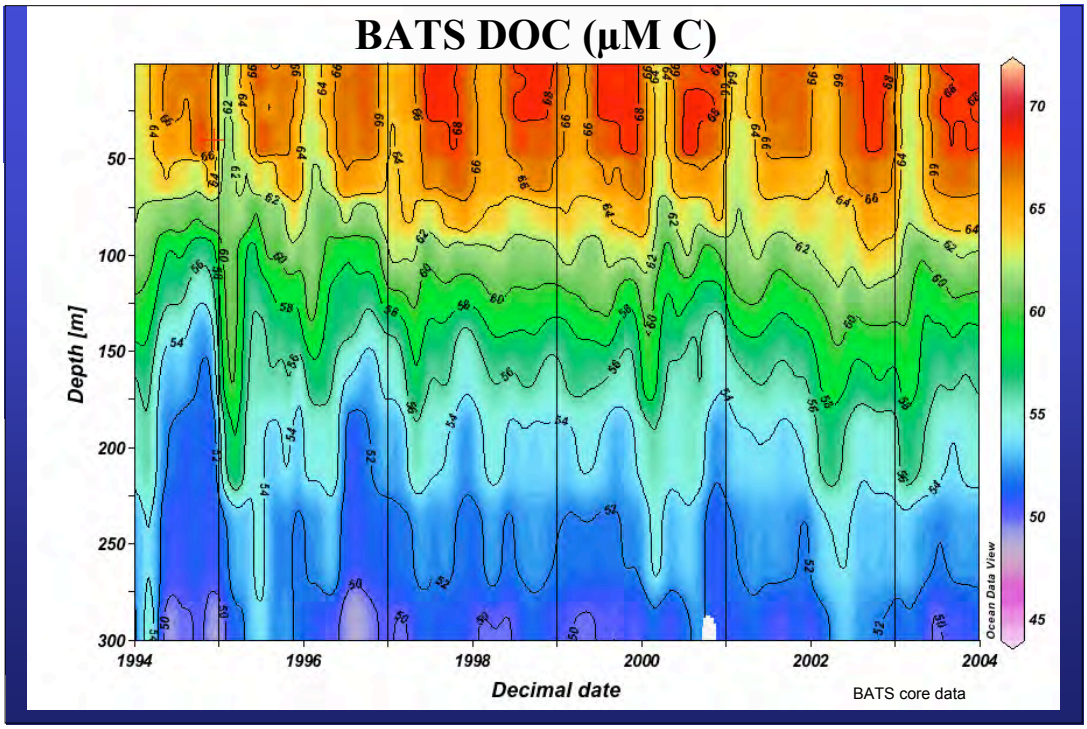
Examples Bacterial Remineralization Experiments

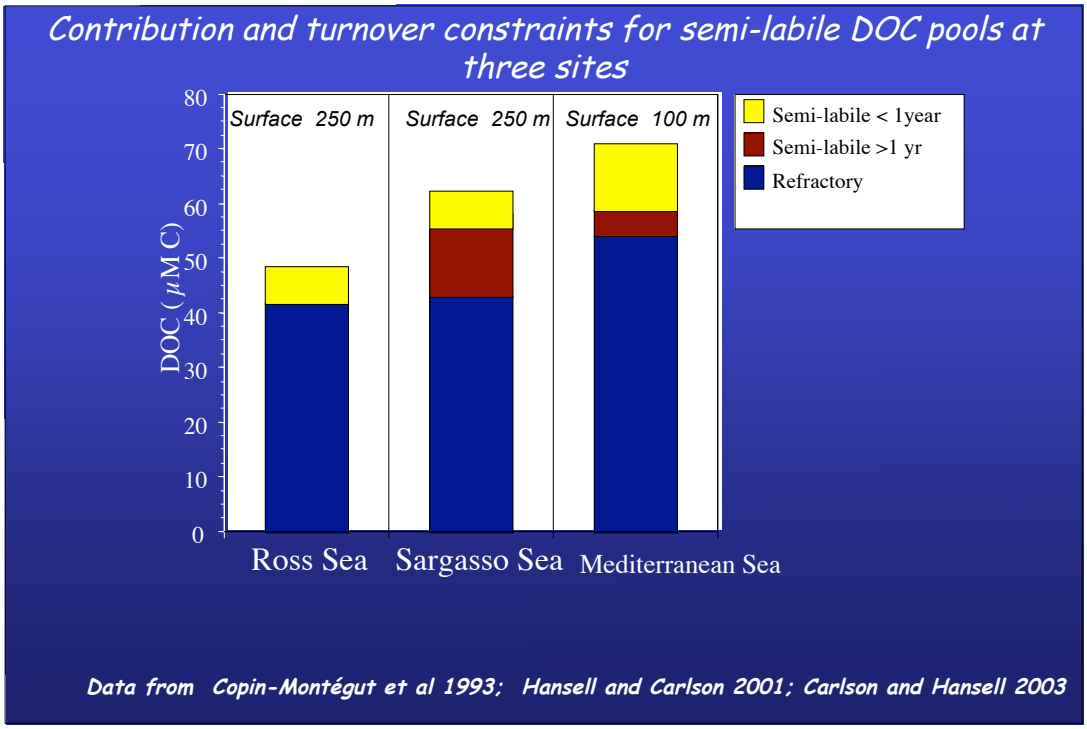


Seasonal Variability of DOC distribution in the Ross Sea

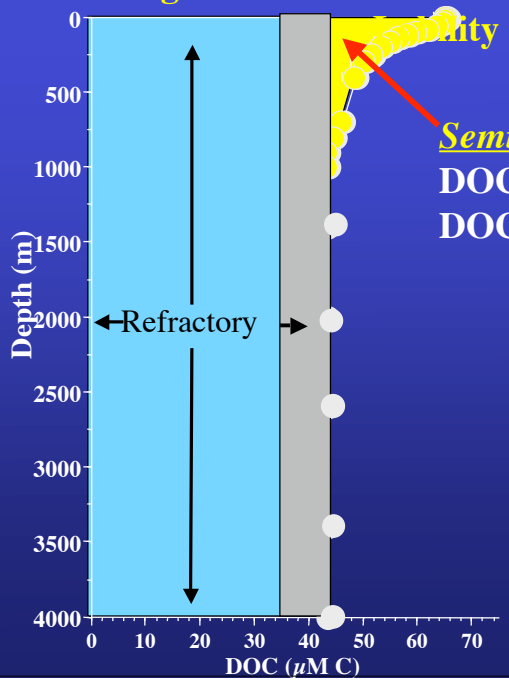


Carlson and Hansell 2003


BATS DOC (µM C)
Depth [m]
50
100
150
200
250
300
1994
1996
1998
2000
2002
2004
Decimal date
70
65
60
55
50
45
Ocean Data View
BATS core data


Contribution and turnover constraints for semi-labile DOC pools at three sites
DOC (µM C)
80
70
60
50
40
30
20
10
0
Surface 250 m
Surface 250 m
Surface 100 m
Semi-labile < 1year
Semi-labile >1 yr
Refractory
Ross Sea
Sargasso Sea
Mediterranean Sea
Data from Copin-Montégut et al 1993; Hansell and Carlson 2001; Carlson and Hansell 2003

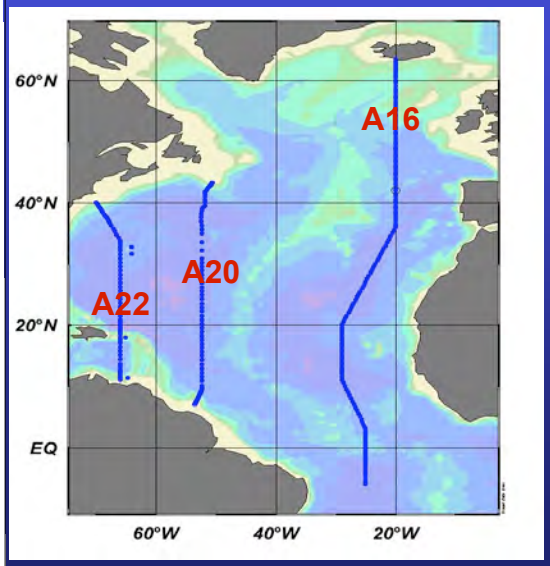
Partitioning the Bulk DOC Pool into Broad Pools of ity



Semi-labile DOC - portion of bulk DOC that is in excess of deep water DOC concentrations

Decay rate?

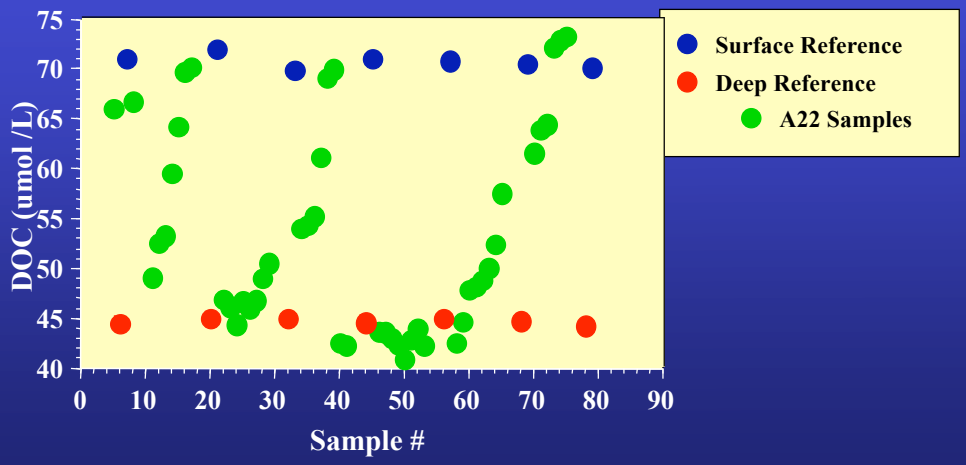
Distribution and Decay of DOC in the Interior of the North Atlantic Basin



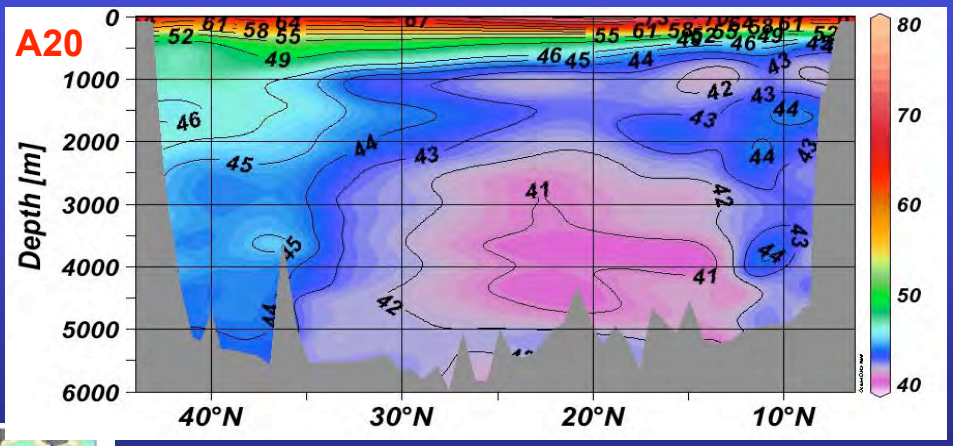
US Repeat Hydrography

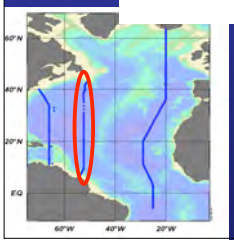
- *ocean transport*
- *decadal variability of climatically important parameters*

Use of referencing to resolve small variability



DOC (μM C) in the N. Atlantic

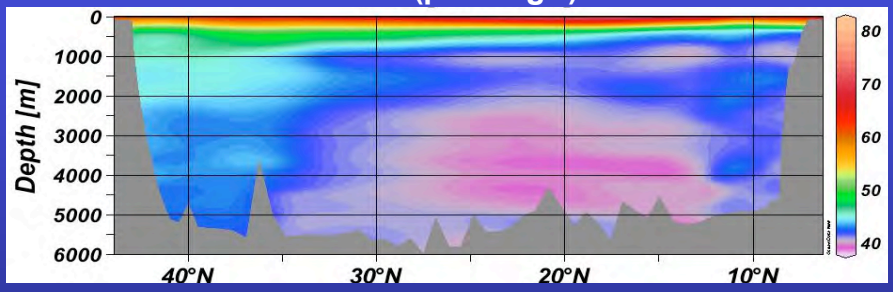




- greater DOC variability within the ocean's interior than previously thought to exits….
- how does it correlate with other tracers??

Variability of DOC and AOU along A20

DOC (µmol kg^{-1})



AOU (µmol kg^{-1})