The Importance of Ventilation to Ocean Biogeochemical Modeling

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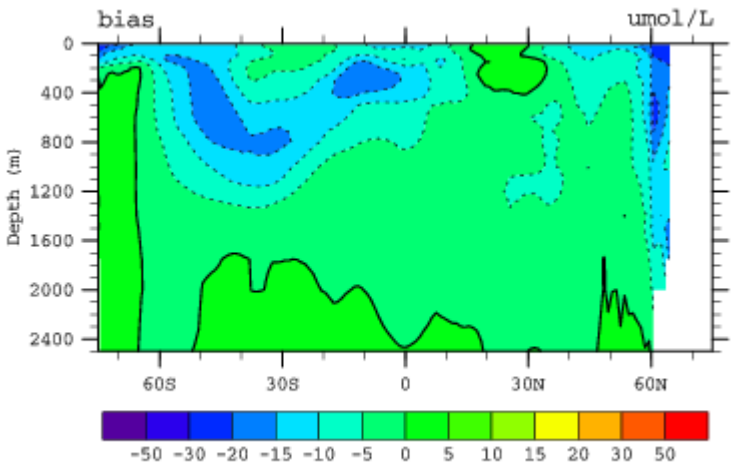
Outline of Presentation

- Anthropogenic CO_2 uptake in CCSM3.1
  - Southern Ocean Focus
  - Some Previous Sensitivity Experiments
  - Potential Paths Forward
- Oxygen Minimum Zones
  - Potential Paths Forward

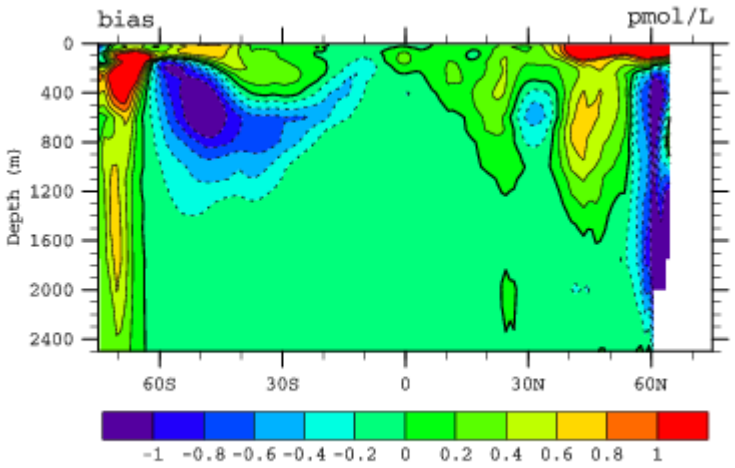
Zonal Mean CO_2 & CFC-11 Uptake in Coupled CCSM3.1, T31-gx3v5

CO_2 Bias from Obs



Uptake 42% below Obs

CFC-11 Bias from Obs



Uptake 11% below Obs

CFC-11 in 1994

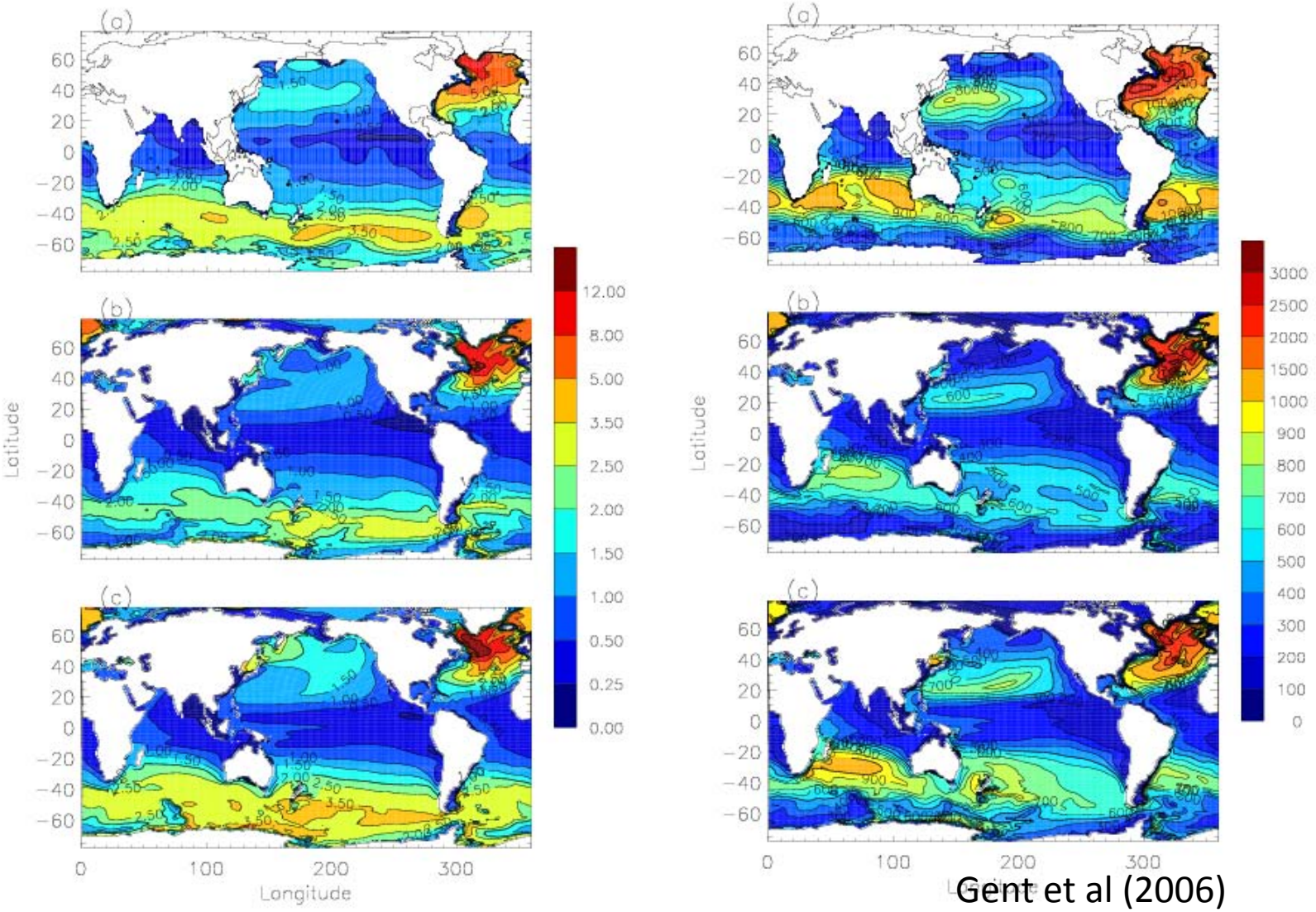
Column Inventory

Penetration Depth

Obs

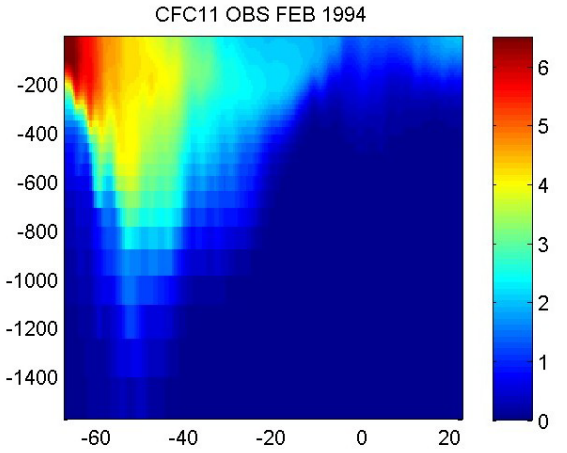
Ocean Model

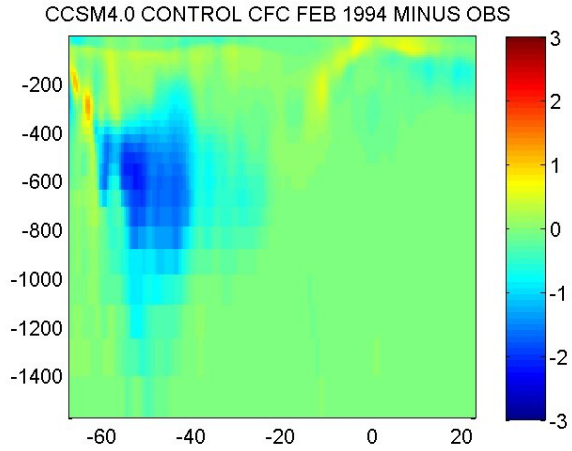
Coupled Model

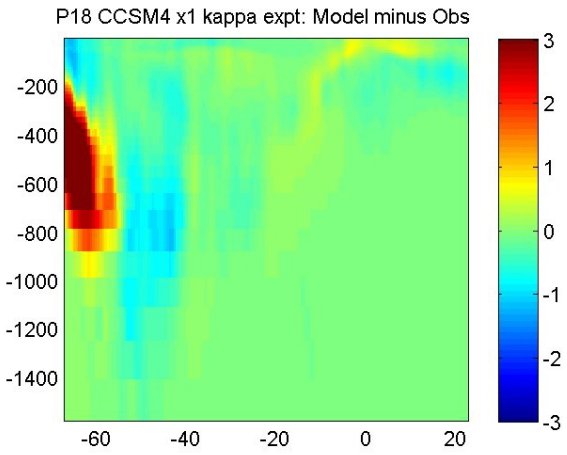


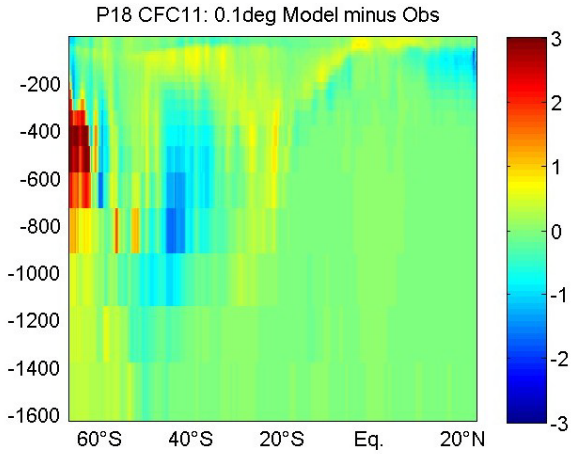
Gent et al (2006)

CFC-11 Along P18





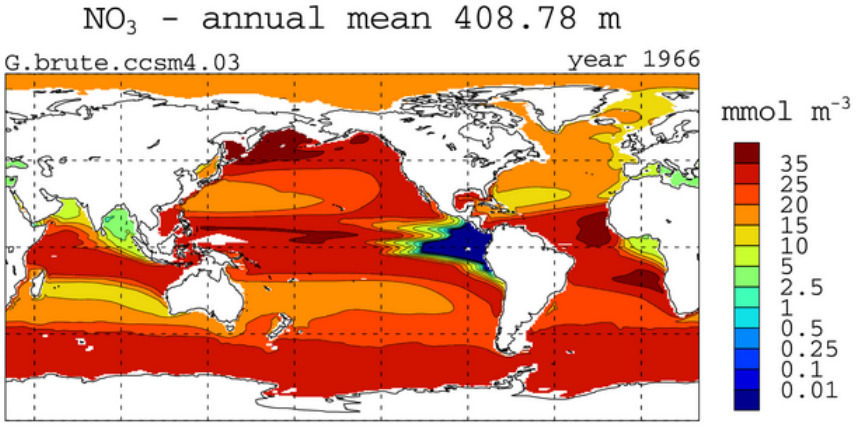


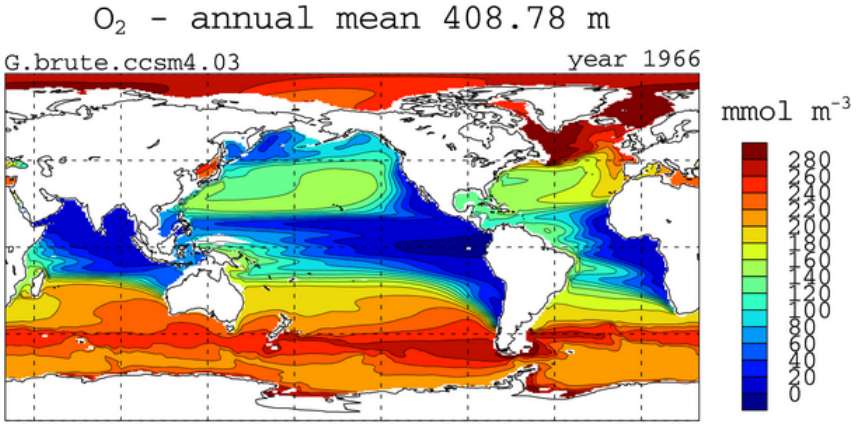


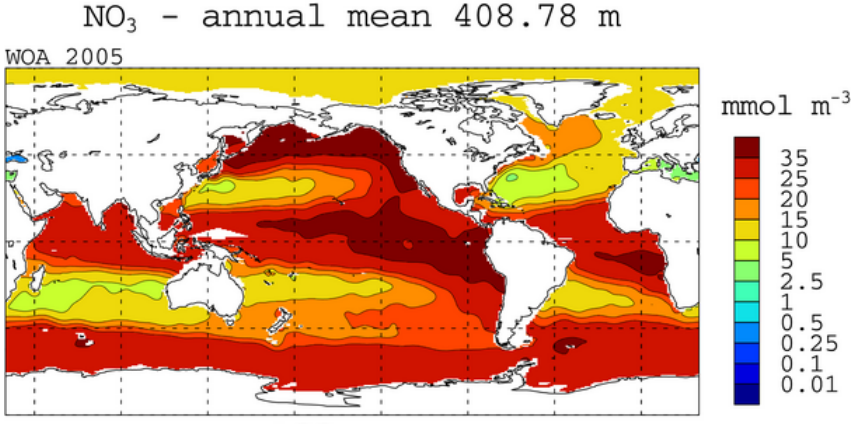
What next?

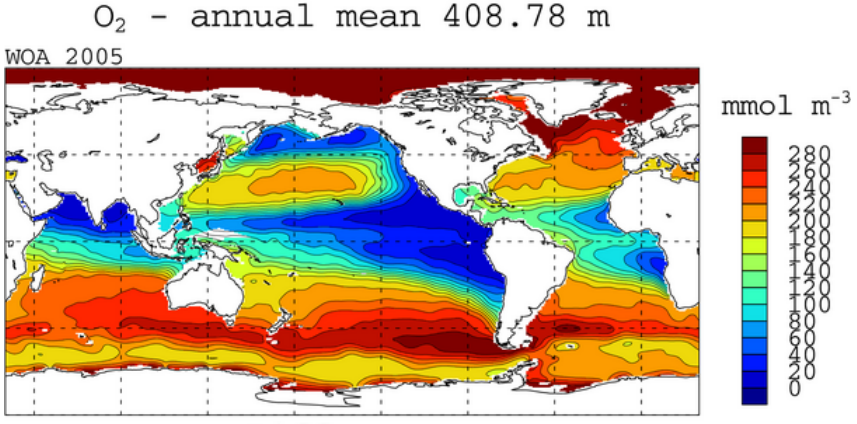
- Increased κ and resolving eddies appear to help. What should κ be?
- use 0.1° Watson runs for guidance
- Should know CO_2 uptake in x1 coupled CCSM4 in O(months)

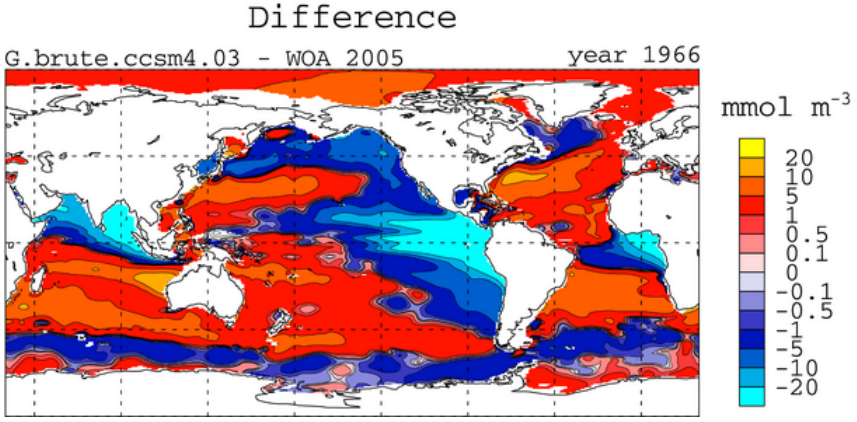
400m NO_3 & O_2 vs. Obs, yr 48-52

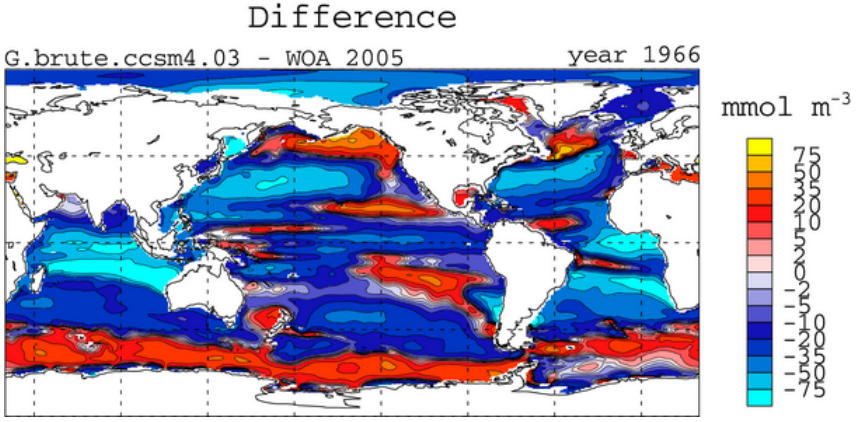




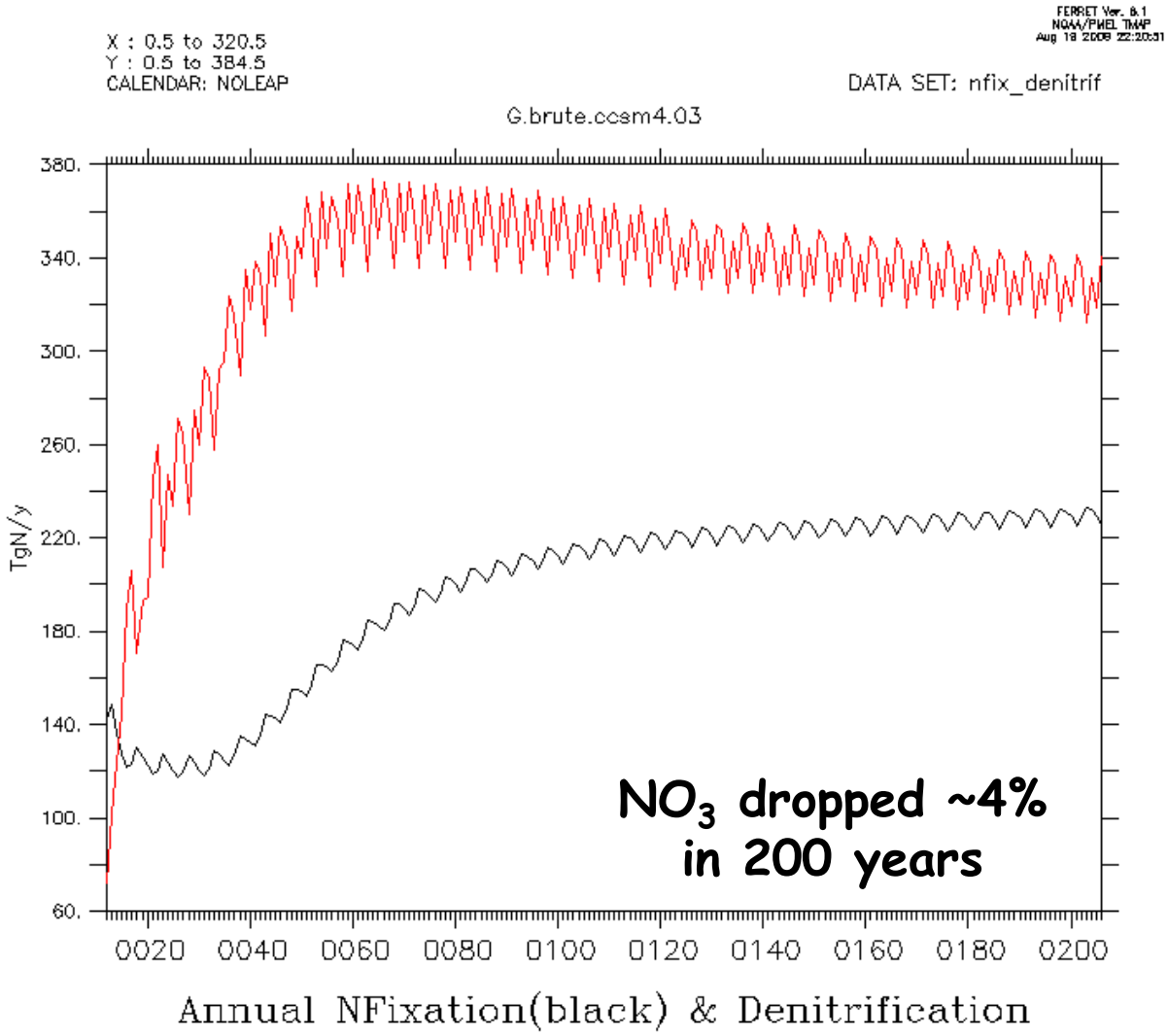




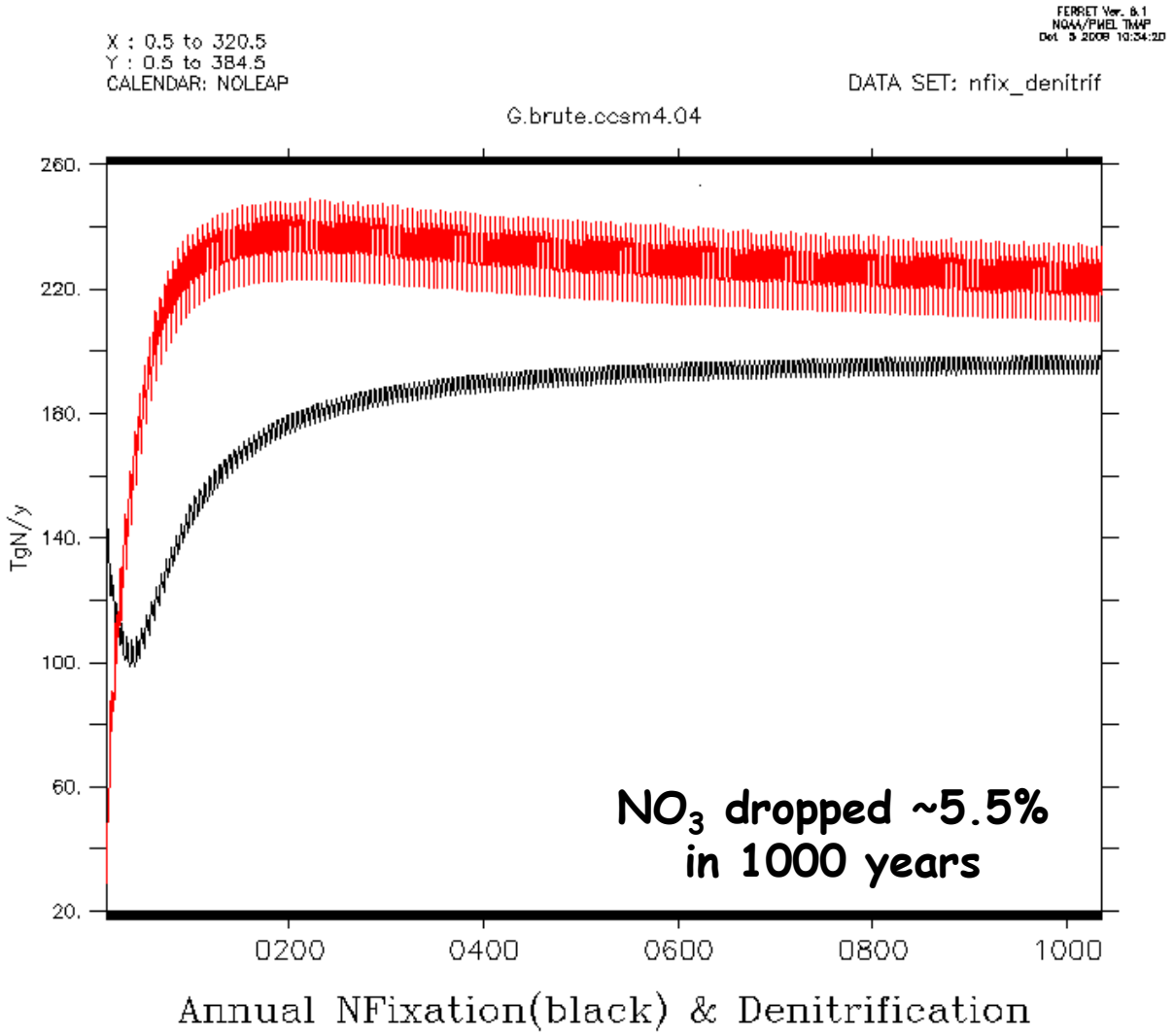




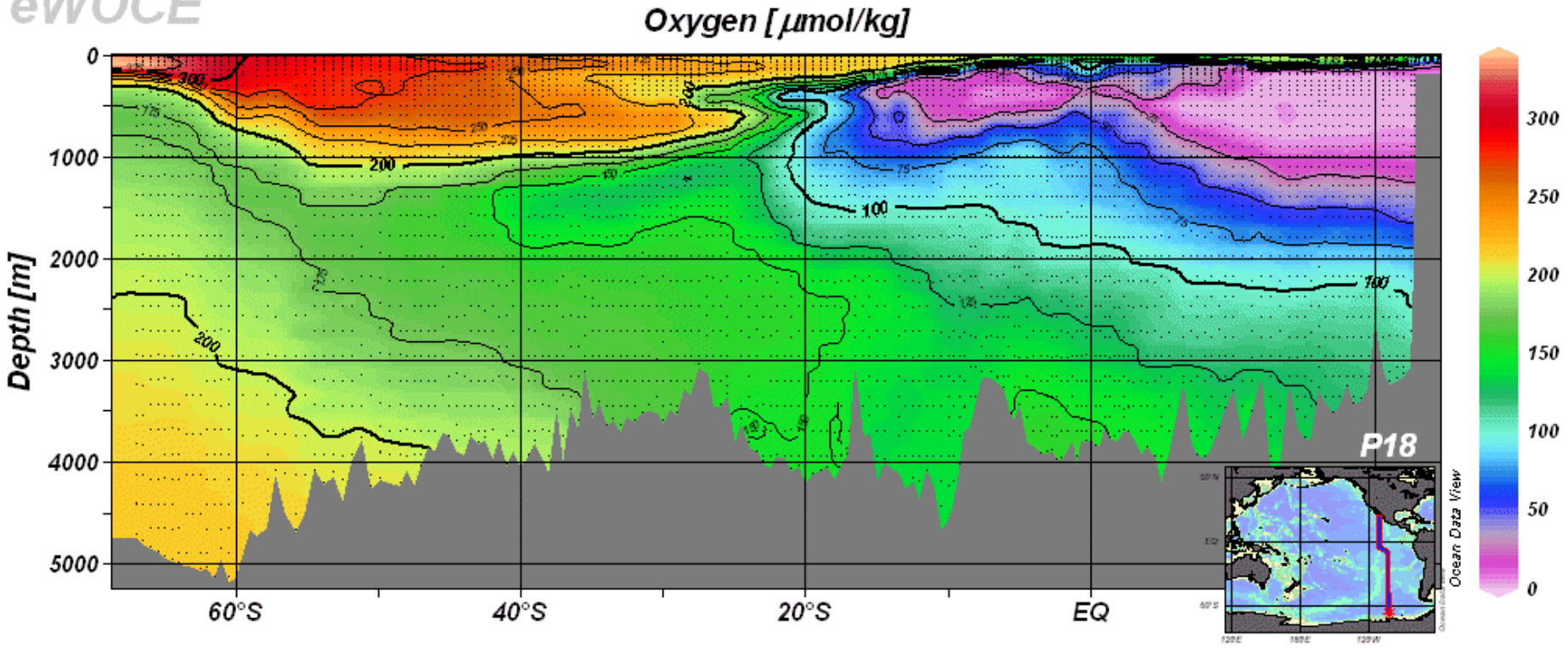
N cycle with coupled forcing

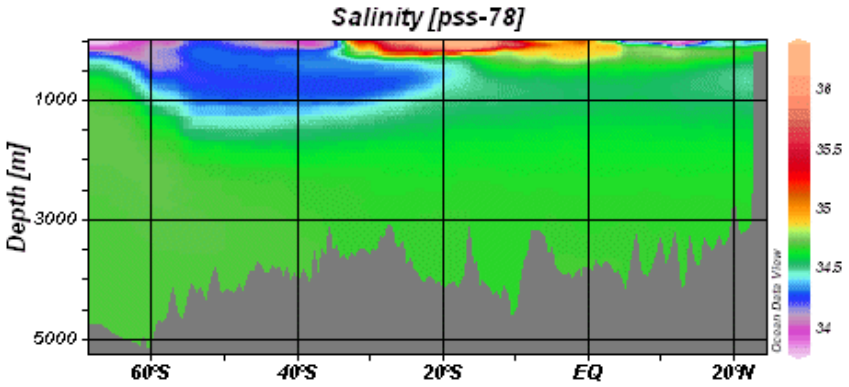


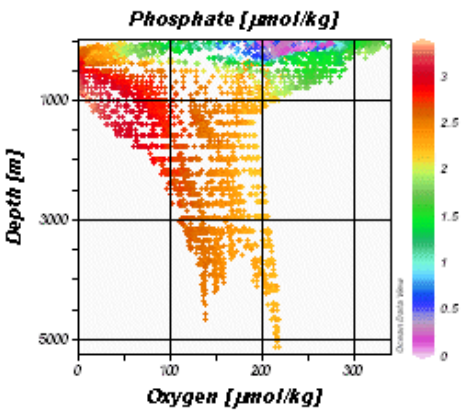
N cycle with coupled forcing fudged denitrification

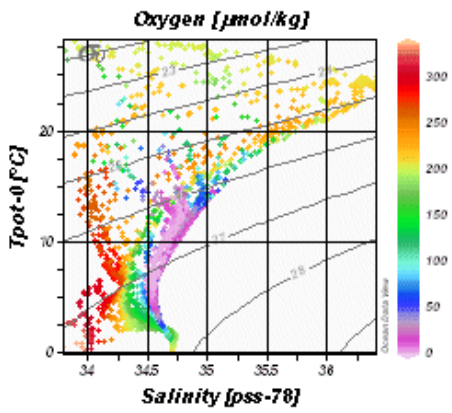


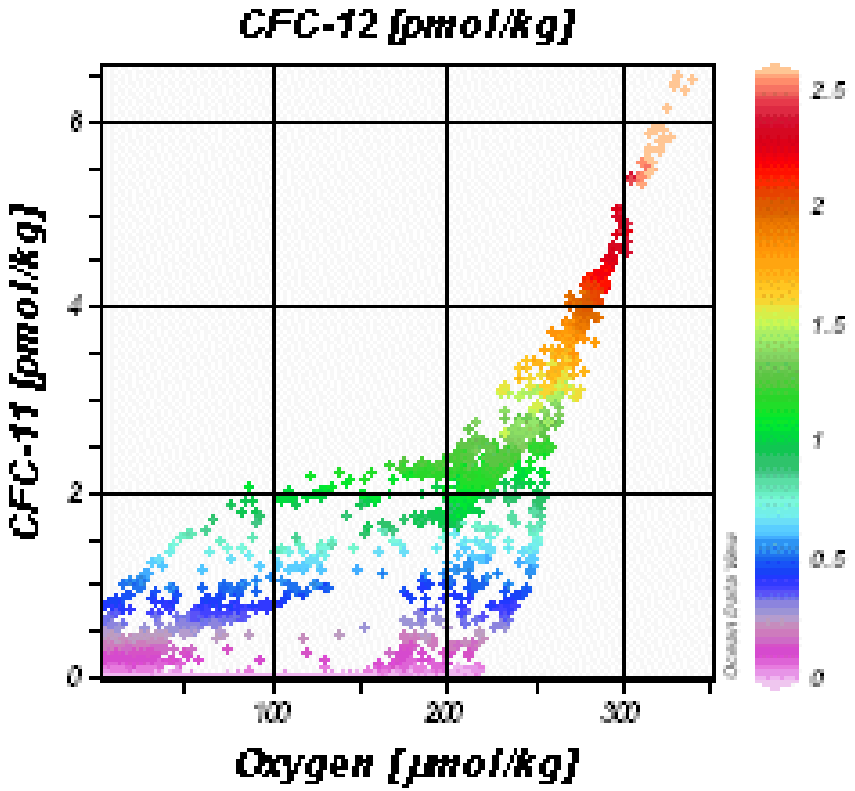
eWOCE

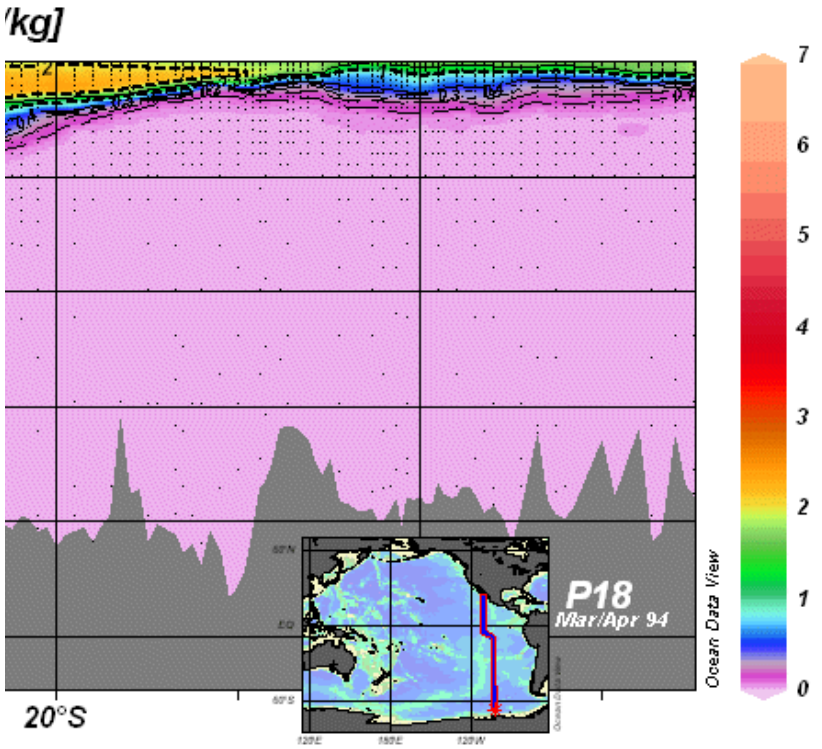

Oxygen [µmol/kg]
Depth [m]
0
1000
2000
3000
4000
5000
60°S
40°S
20°S
EQ
P18
Ocean Data View
300
250
200
150
100
50
0

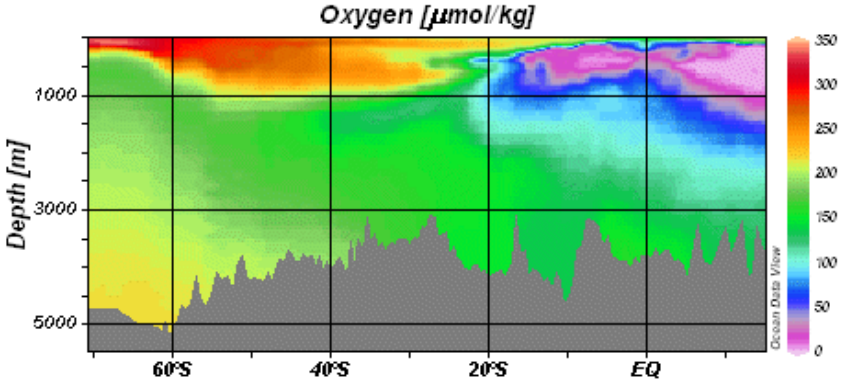

Salinity [pss-78]
Depth [m]
1000
3000
5000
60°S
40°S
20°S
EQ
20°N
Ocean Data View
38
35.5
35
34.5
34

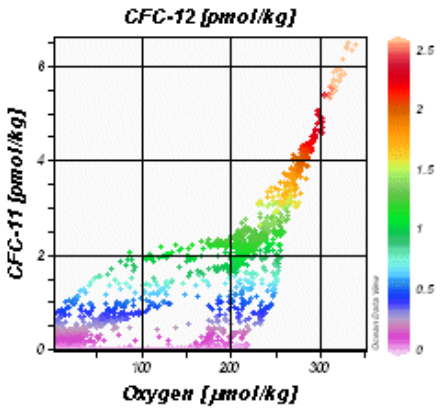

Phosphate [µmol/kg]
Depth [m]
1000
3000
5000
0
100
200
300
Oxygen [µmol/kg]
3
2.5
2
1.5
1
0.5
0

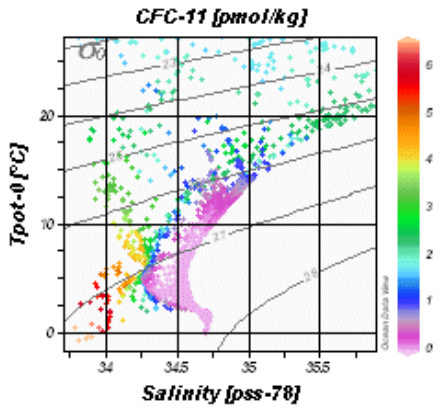

Oxygen [µmol/kg]
Tpot-0 [°C]
20
10
0
34
34.5
35
35.5
36
Salinity [pss-78]
300
250
200
150
100
50
0


CFC-12 [pmol/kg]
CFC-11 [pmol/kg]
Oxygen [µmol/kg]
0
2
4
6
100
200
300
2.5
2
1.5
1
0.5
0
Ocean Data View

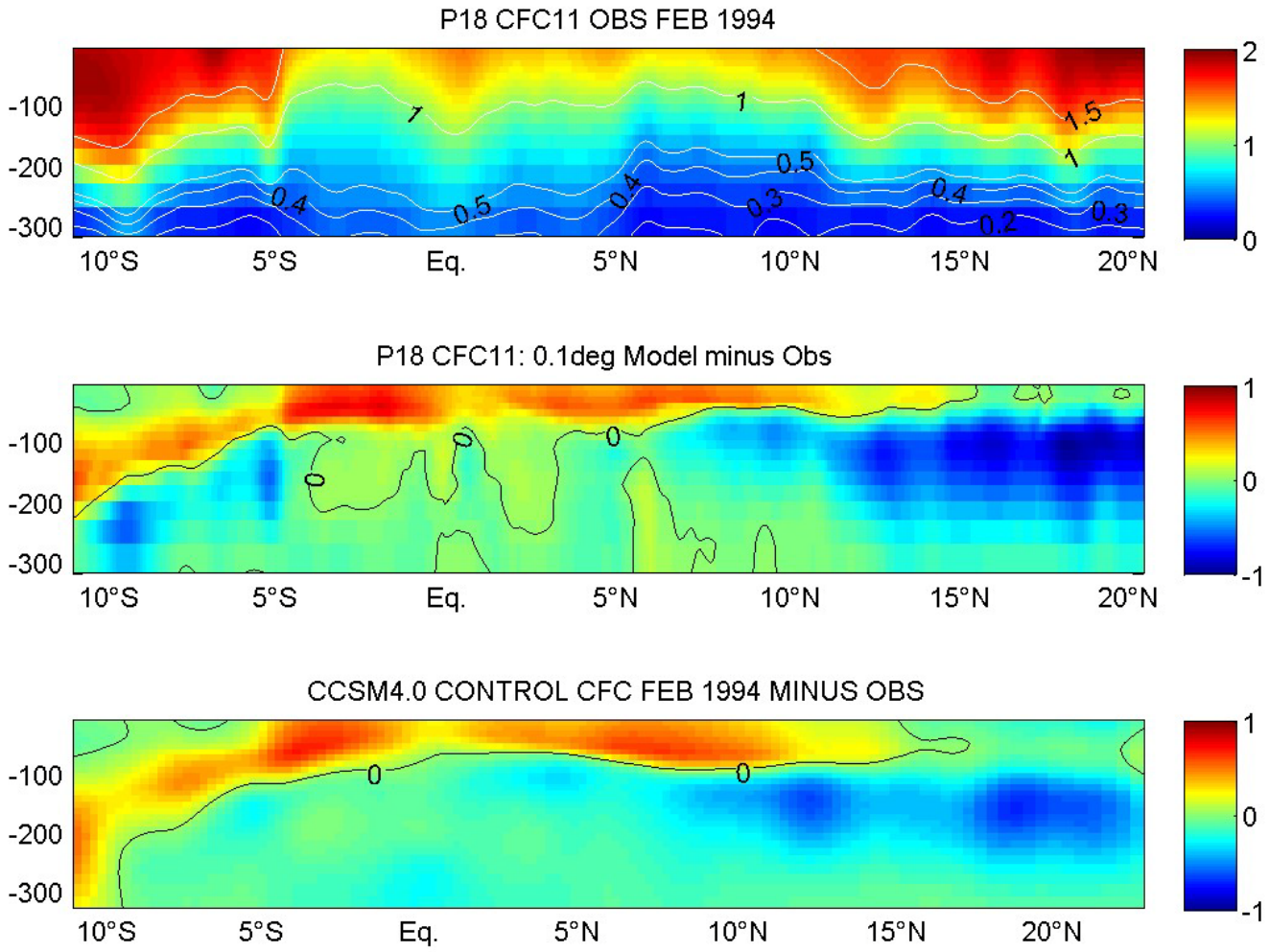

/kg]
20°S
P18
Mar/Apr 94
Ocean Data View
7
6
5
4
3
2
1
0


Oxygen [µmol/kg]
Depth [m]
1000
3000
5000
60°S
40°S
20°S
EQ
350
300
250
200
150
100
50
0
Ocean Data View


CFC-12 [pmol/kg]
CFC-11 [pmol/kg]
Oxygen [µmol/kg]
0
2
4
6
100
200
300
2.5
2
1.5
1
0.5
0
Ocean Data View


CFC-11 [pmol/kg]
Tpot-0[°C]
Salinity [pss-78]
0
10
20
34
345
35
355
6
5
4
3
2
1
0
Ocean Data View

CFC-11 Along P18



Discussion

- CFC-11 only penetrates the shallower depths of the OMZ. Cannot be only diagnostic tracer.
- Observed ^{14}C Age can be compared to model Ideal Age
  - get Newton-Krylov solver working for 1° model
- Sensitivity experiments show sensitivity to Southern Ocean vertical mixing.
- Where is the water in the OMZ coming from?
  - Examine regional TTDs