Past records of marine denitrification in the Arabian Sea, ETNP and ETSP: Implications for atmospheric N_2O variability

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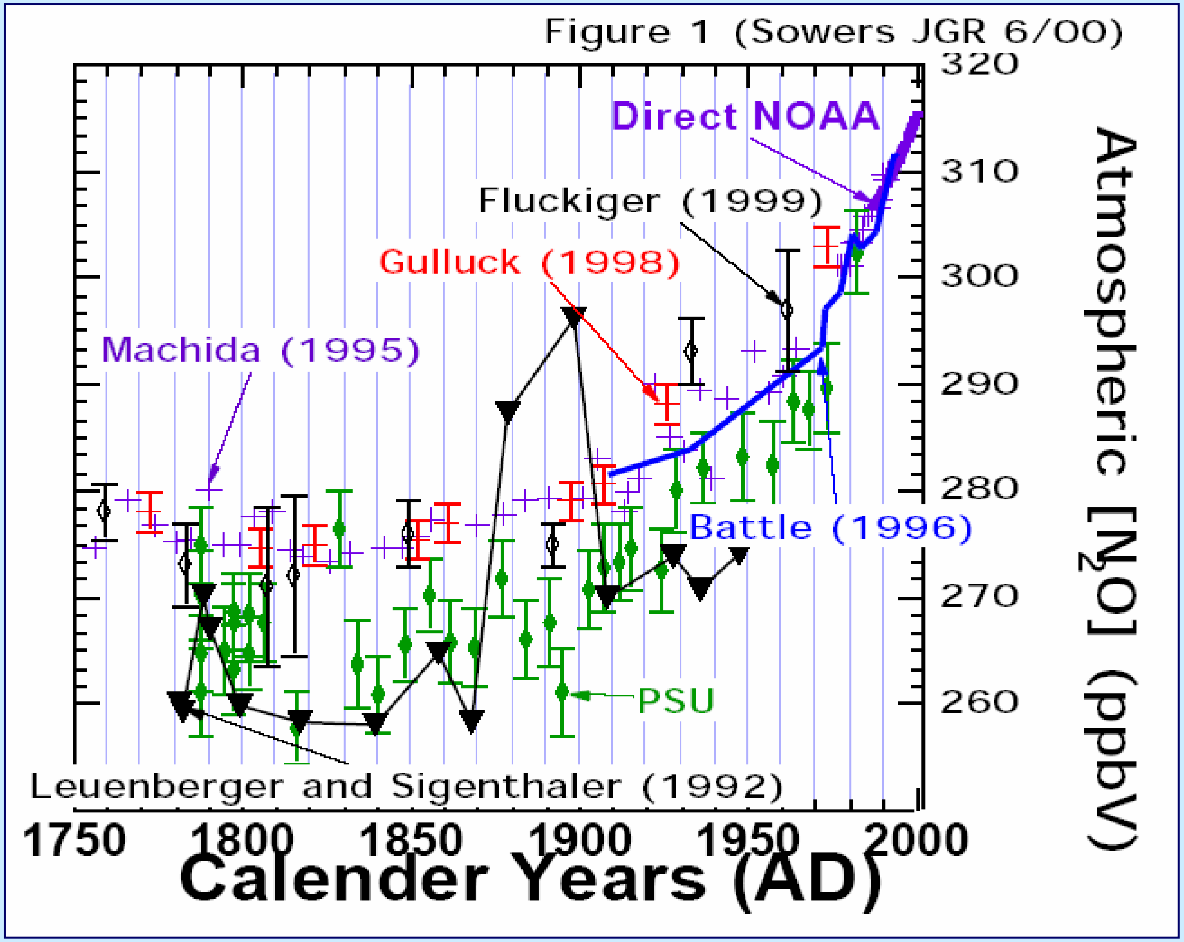
Plan-

- Significance of N_2O in the present climate [Sources and sinks]
- Influence of marine denitrification regulating global atmospheric N_2O inventory during the Holocene and late-Quaternary
- Summary

N_2O is the fourth most important greenhouse gas after water vapor, CO_2, CH_4.

Global mean [N_2O] ~314 ppbv; Atmospheric residence time ~120 years [IPCC, 2001].



Steep increase in [N_2O] coincides with beginning of industrialization

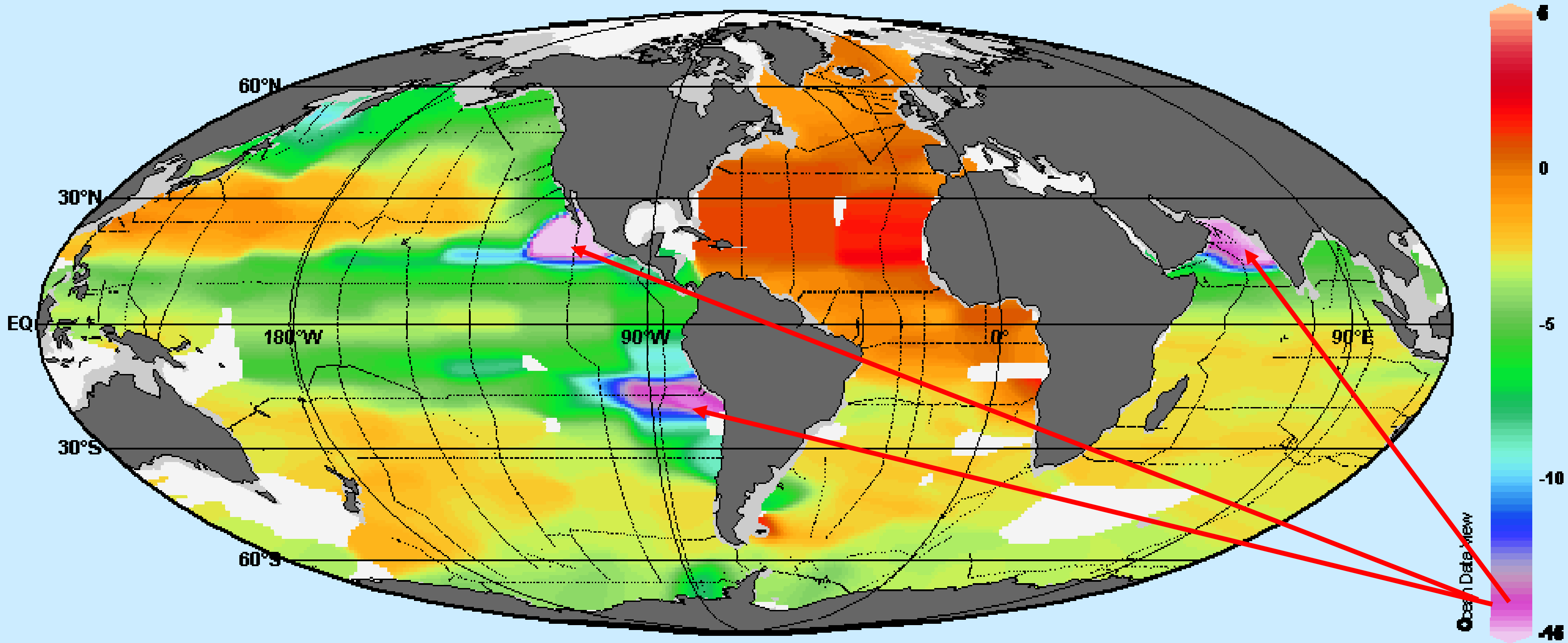
Sources: Nitrification and denitrification in soils (3-10 Tg N/yr) and in the ocean (3-6 Tg N/yr)

Sinks: decomposition in the stratosphere by photo-dissociation and reaction with excited Oxygen

***In addition to increased soil source on land (due to increased usage of fertilizers), increasing hypoxia in coastal areas like eastern Arabian Sea (due to receiving anthropogenically supplied NO_3^- and its subsequent denitrification) might be capable of increasing global atmopsherc N_2O inventory [Naqvi et al., 2000].**

It is important to assess its past natural variability during relatively stable climate eg. Holocene [Agnihotri et al., 2006, Geophysical Research Letters], as it is known that large climate changes such as YD, glacial interglacial changes have witnessed reduced inventory of N_2O [Suthhof et al., 2002, GBC].

N' on DEPTH [M]=300

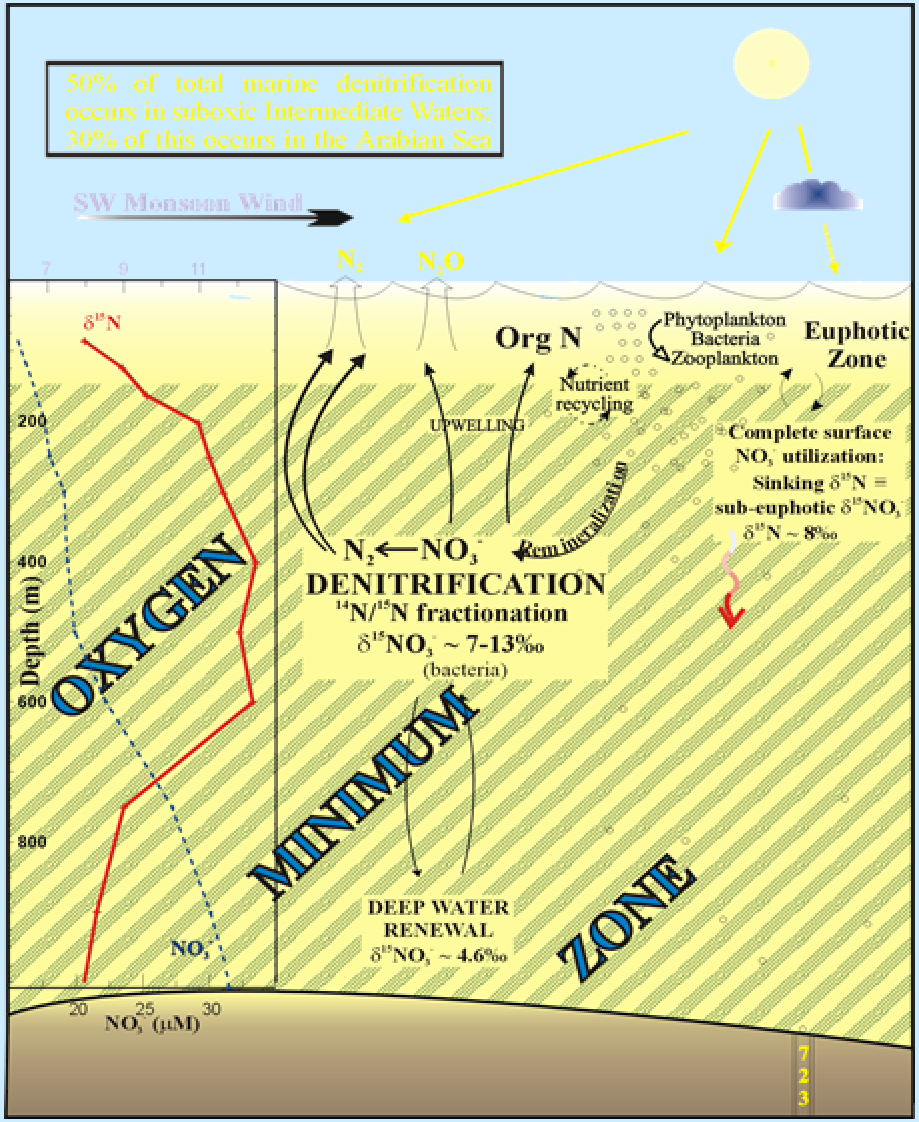


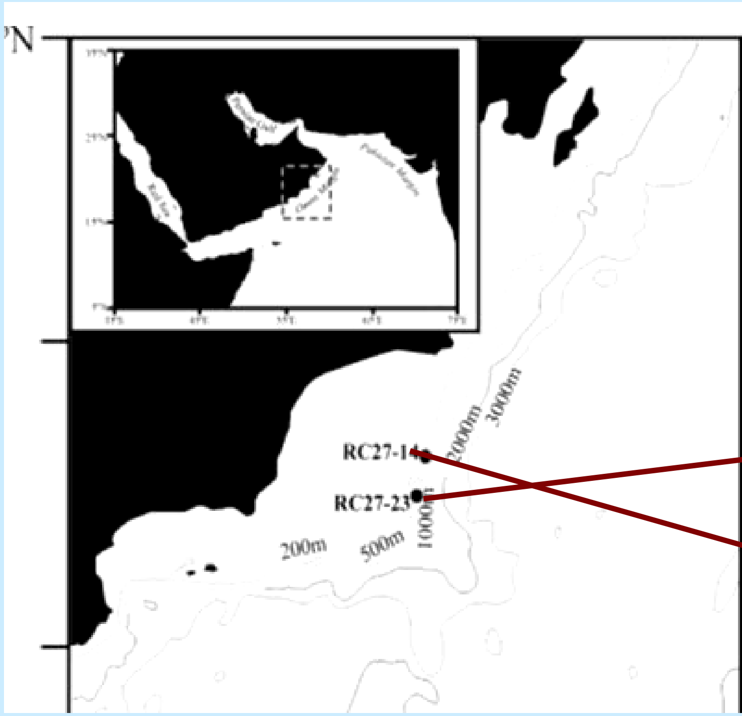
$$N' = NO_3^- + NO_2^- - 16 \times PO_4^{-3}$$

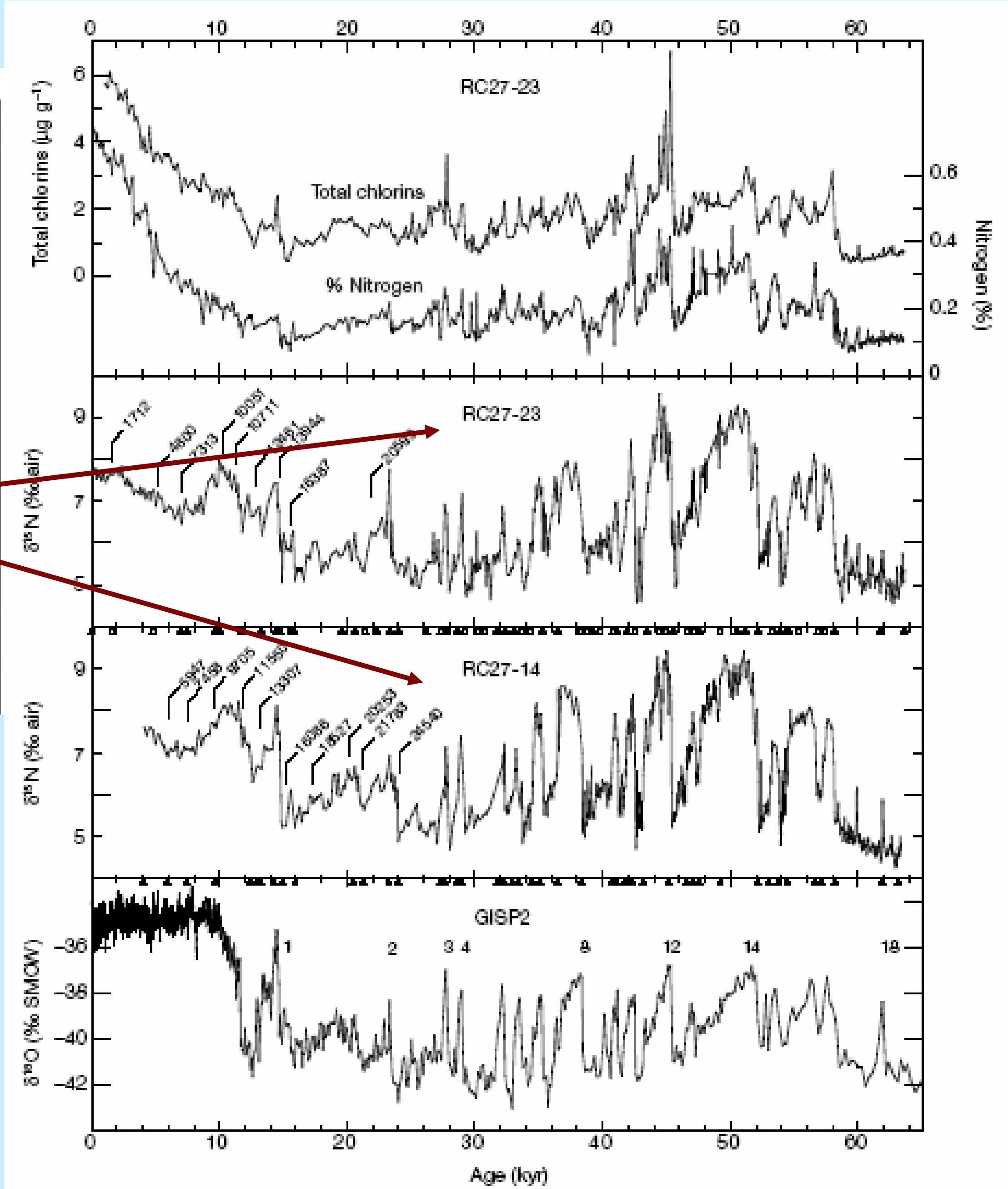
Nitrogen Isotopes

- Past variations in denitrification can be reconstructed using N isotopes-

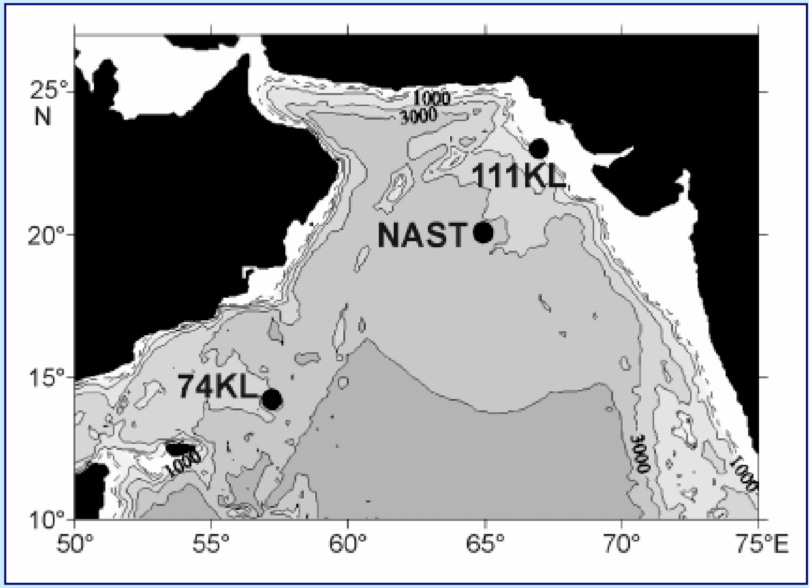
  $\delta^{15}N = [(^{15}N/^{14}N)_{sample} / (^{15}N/^{14}N)_{std} - 1] . 1000$



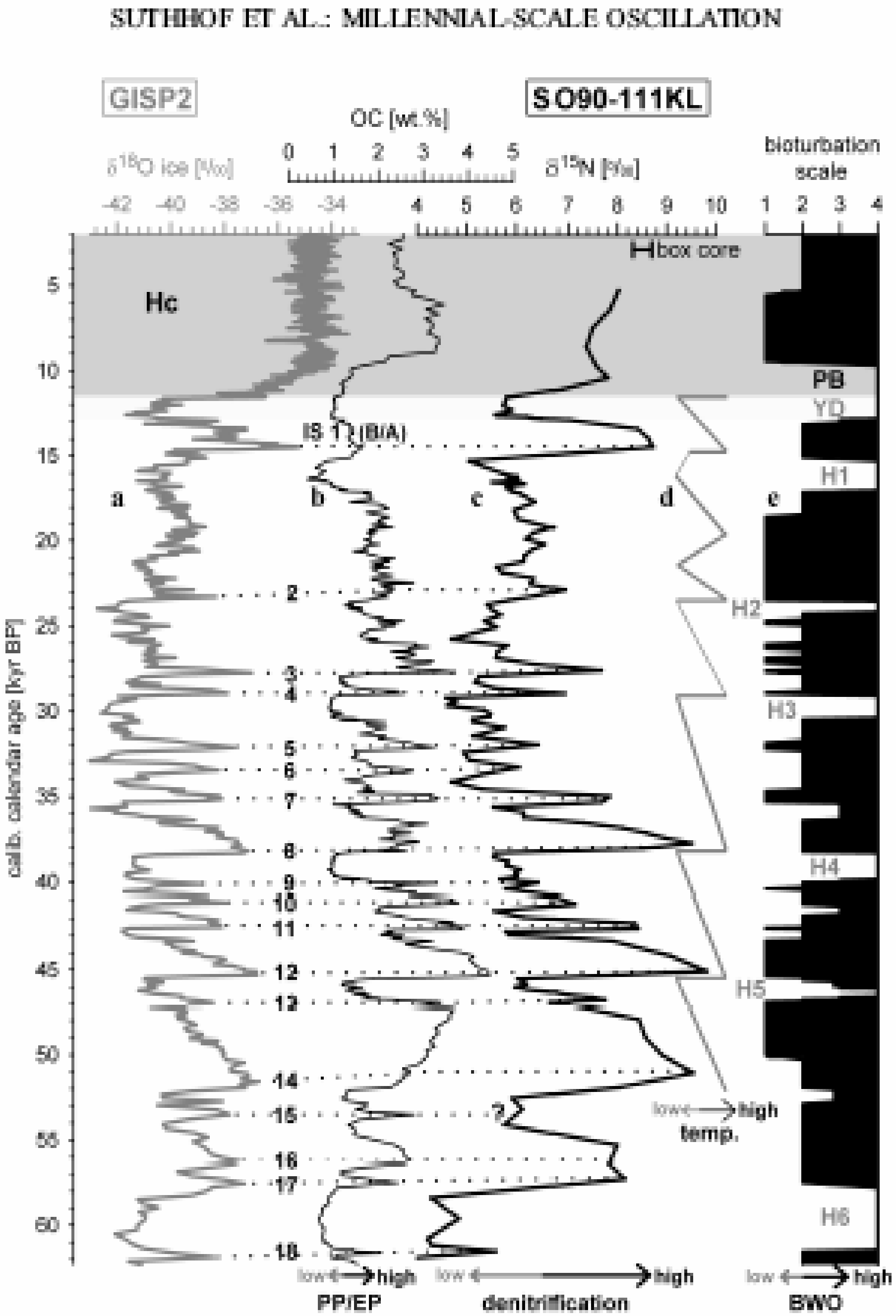


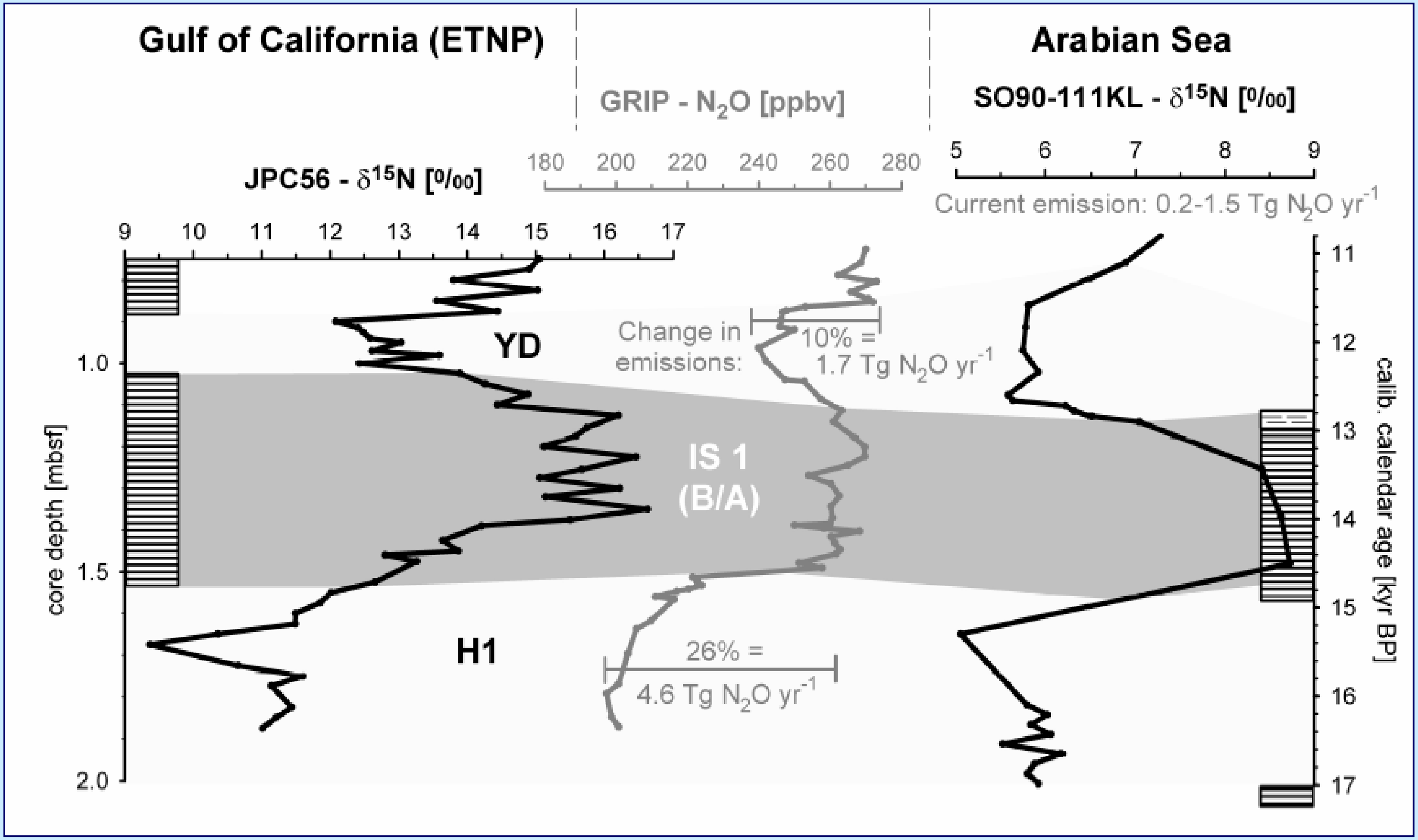


Altabet et al., 2002



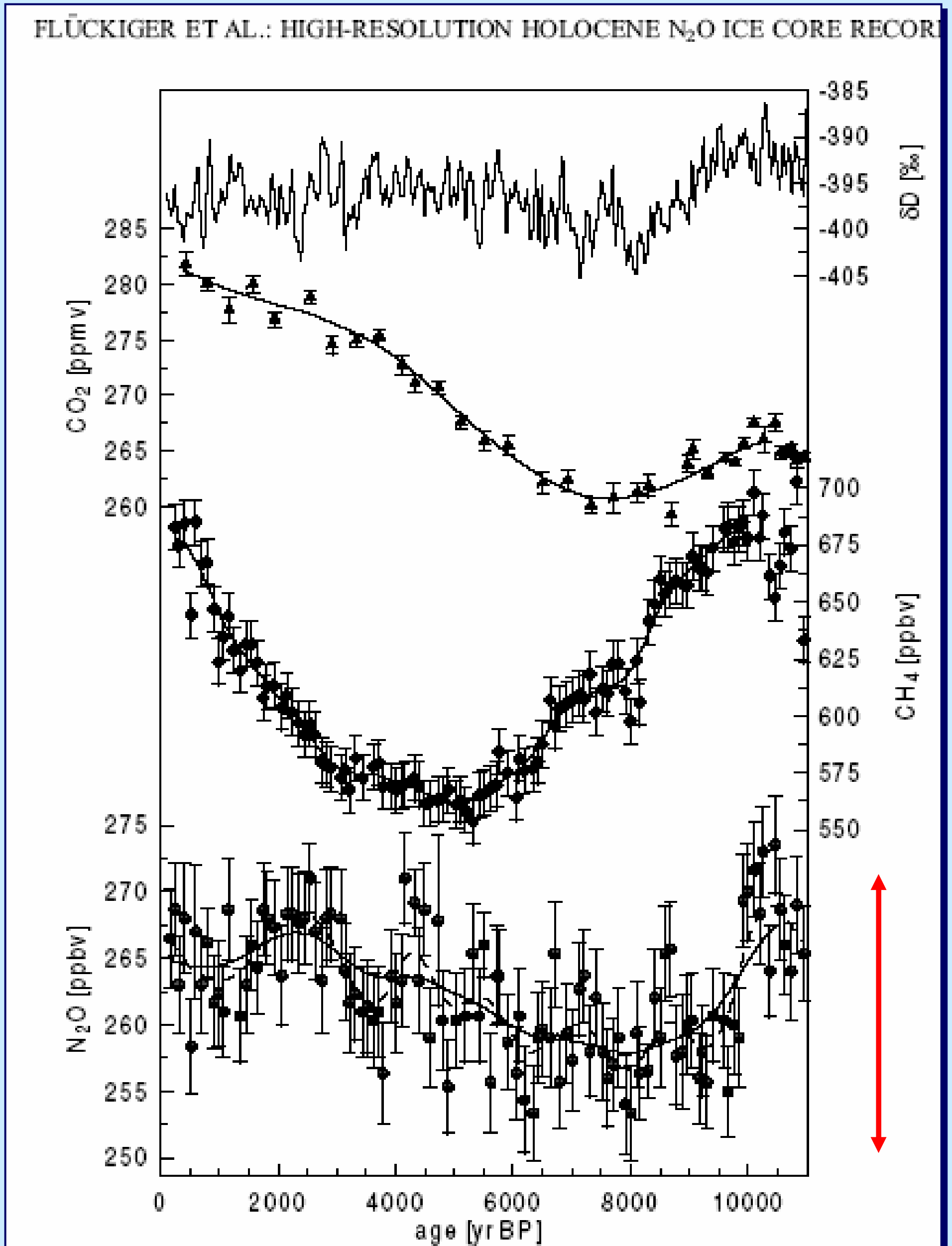
Suthhof et al., 2001





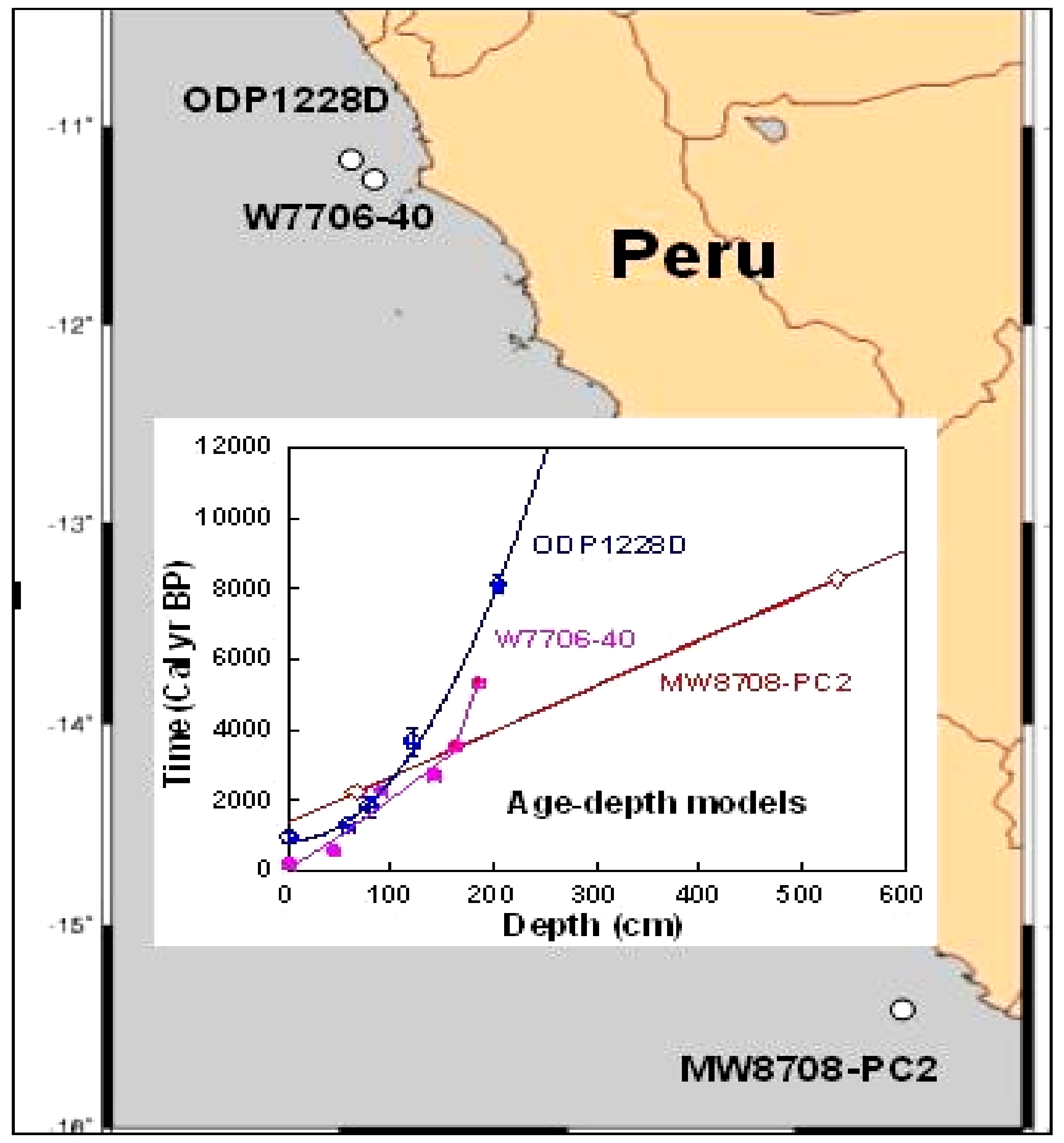
Gulf of California (ETNP)
Arabian Sea
GRIP - N_2O [ppbv]
SO90-111KL - $\delta^{15}N$ [‰]
JPC56 - $\delta^{15}N$ [‰]
Current emission: 0.2-1.5 Tg N_2O yr^{-1}
Change in emissions:
10% = 1.7 Tg N_2O yr^{-1}
YD
IS 1 (B/A)
H1
26% = 4.6 Tg N_2O yr^{-1}
core depth [mbsf]
calib. calendar age [kyr BP]

Natural variability of atm. $[N_2O]$ during the Holocene



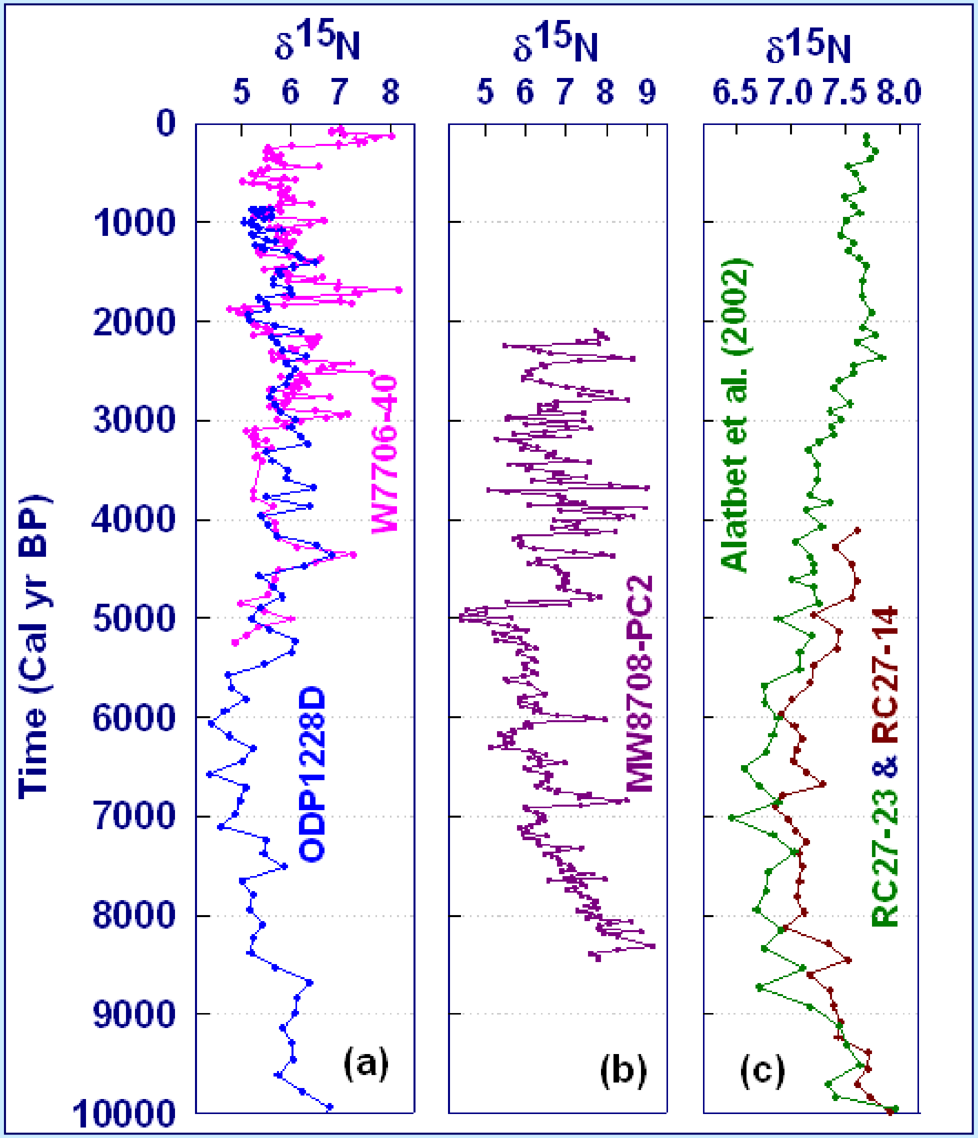
Major features :

- **Total change ~14% of glacial-interglacial change**
- **Variability of $[N_2O]$ does not follow $[CH_4]$ variability rather it shows closeness with $[CO_2]$ changes**
- **Observed change in $[N_2O]$ during Holocene have to be attributed to variations in the source strength (soils/ Oceans).**

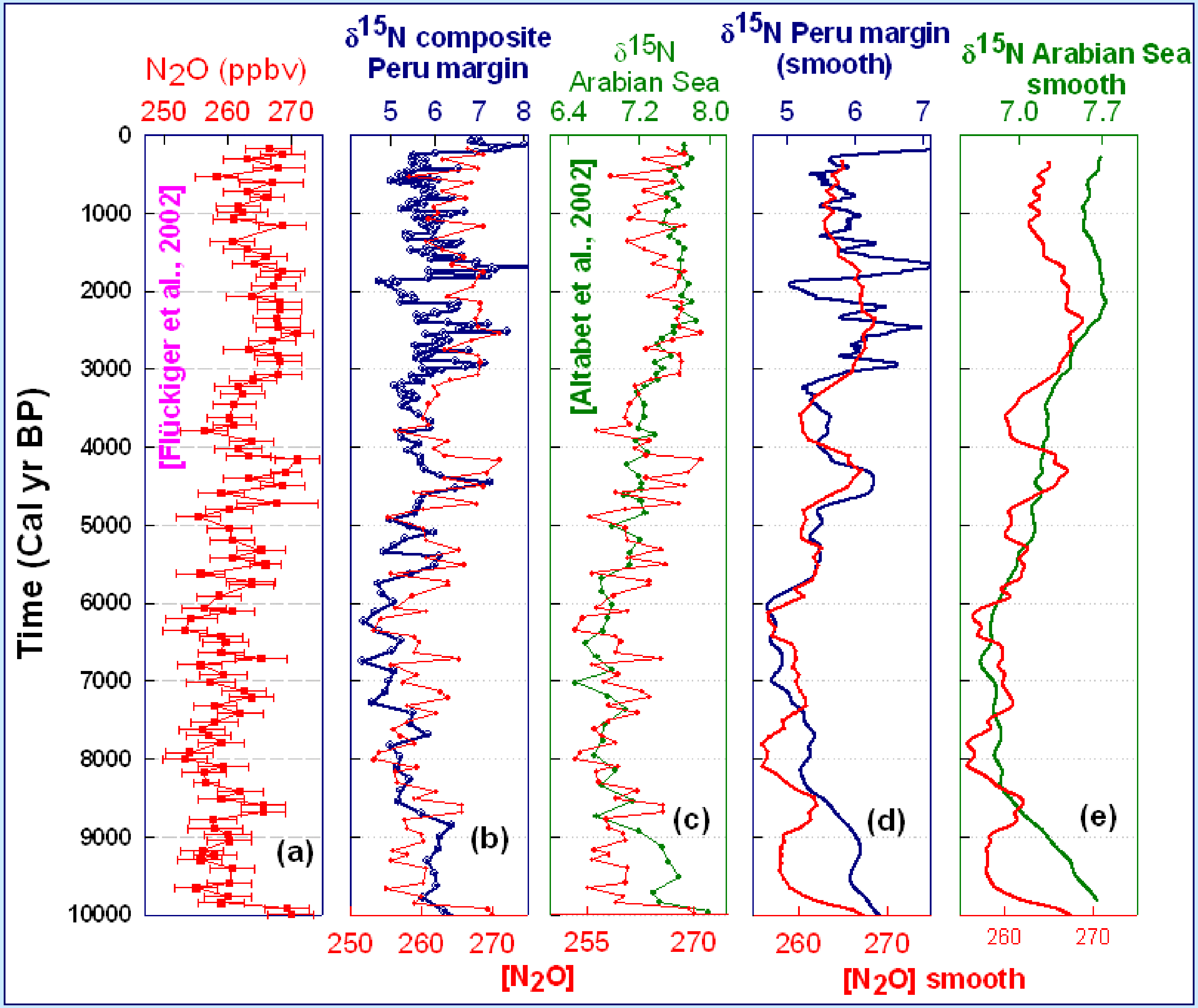


ODP1228D
W7706-40
Peru
MW8708-PC2
-11°
-12°
-13°
-14°
-15°
-16°
Time (Cal yr BP)
Depth (cm)
Age-depth models
ODP1228D
W7706-40
MW8708-PC2
0
2000
4000
6000
8000
10000
12000
0
100
200
300
400
500
600

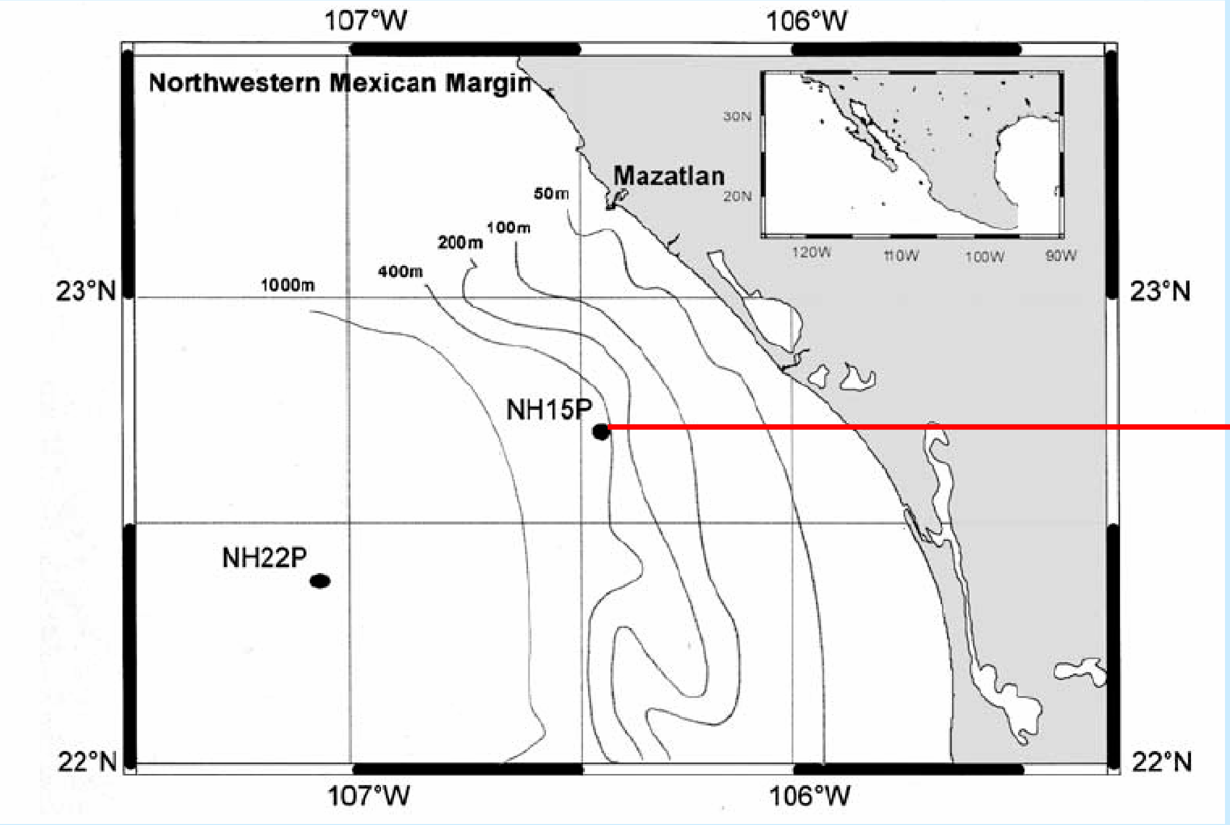
Paleo-denitrification off Peru and western Arabian Sea during the Holocene

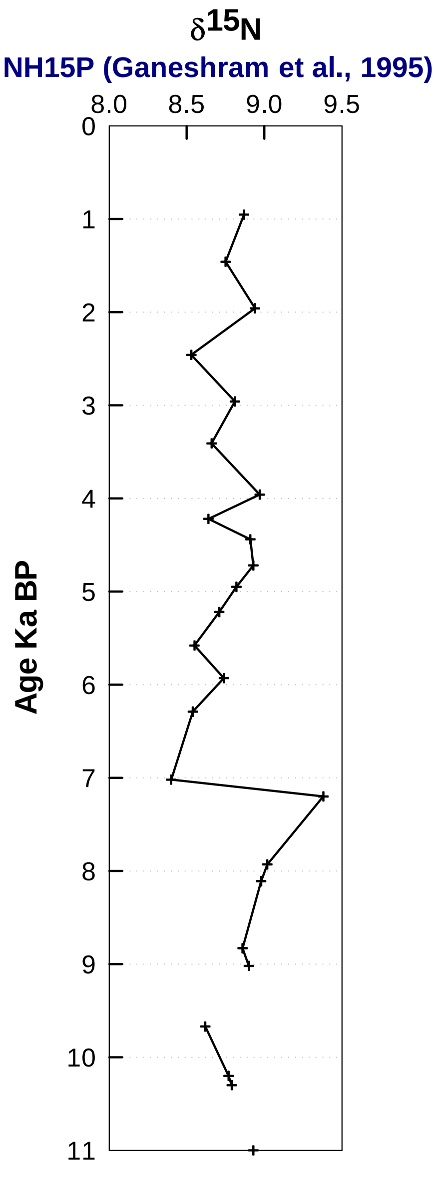


Synchronous changes in denitrification off Peru and atm. N_2O evolution during the Holocene



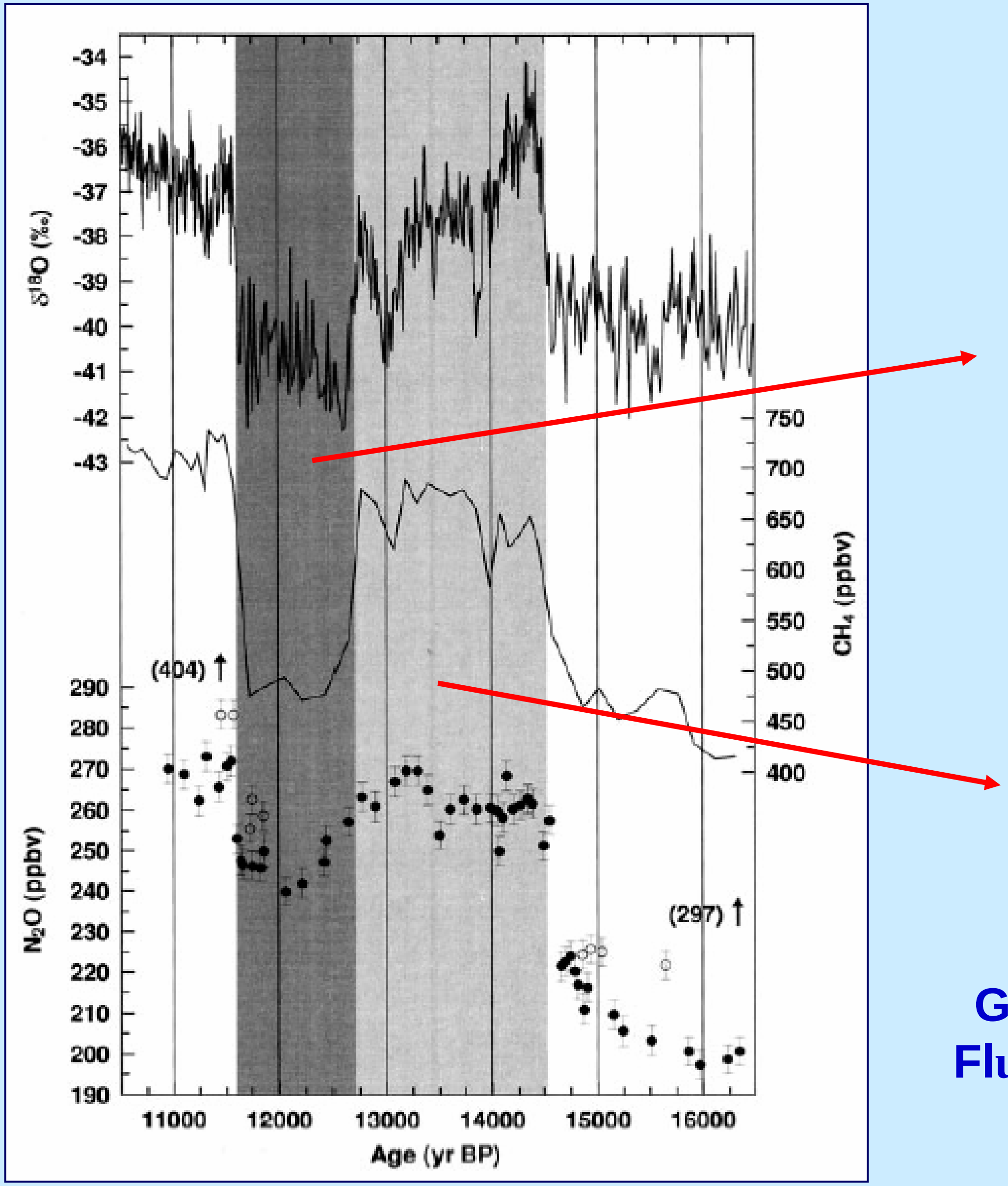
ETNP


107°W
106°W
Northwestern Mexican Margin
Mazatlan
30N
20N
120W
110W
100W
90W
50m
100m
200m
400m
1000m
23°N
NH15P
NH22P
22°N

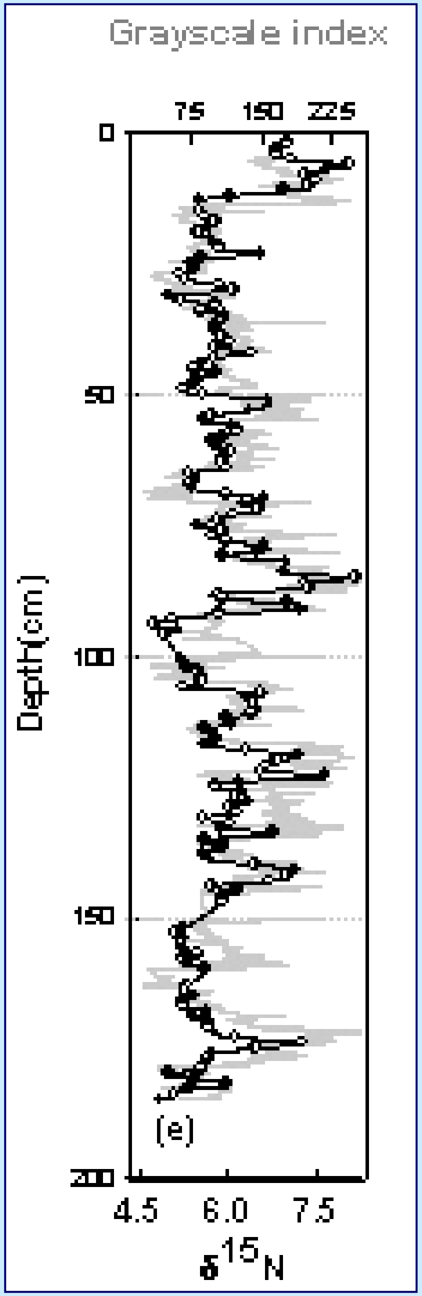

δ15N
NH15P (Ganeshram et al., 1995)
8.0
8.5
9.0
9.5
Age Ka BP
0
1
2
3
4
5
6
7
8
9
10
11

Summary

- Marine denitrification off Peru (ETSP) and Oman (western Arabian Sea) varied in tandem with atmospheric N_2O evolution during the Holocene on millennial time scale.
- Peru margin having high sensitivity to the ENSO cycles appears to have undergone centennial scale variations in sub-surface denitrification especially after the advent of the modern ENSO regime during mid-Holocene and thereby could have directly impacted the atmospheric N_2O inventory.
- These results provide a framework for further studies dealing with better models of the nitrogen cycle in the modern anthropogenic era.



GRIP ice core data
Fluckiger et al., 1999



Grayscale index
75
150
225
0
50
100
150
200
Depth(cm)
(e)
4.5
6.0
7.5
δ15N