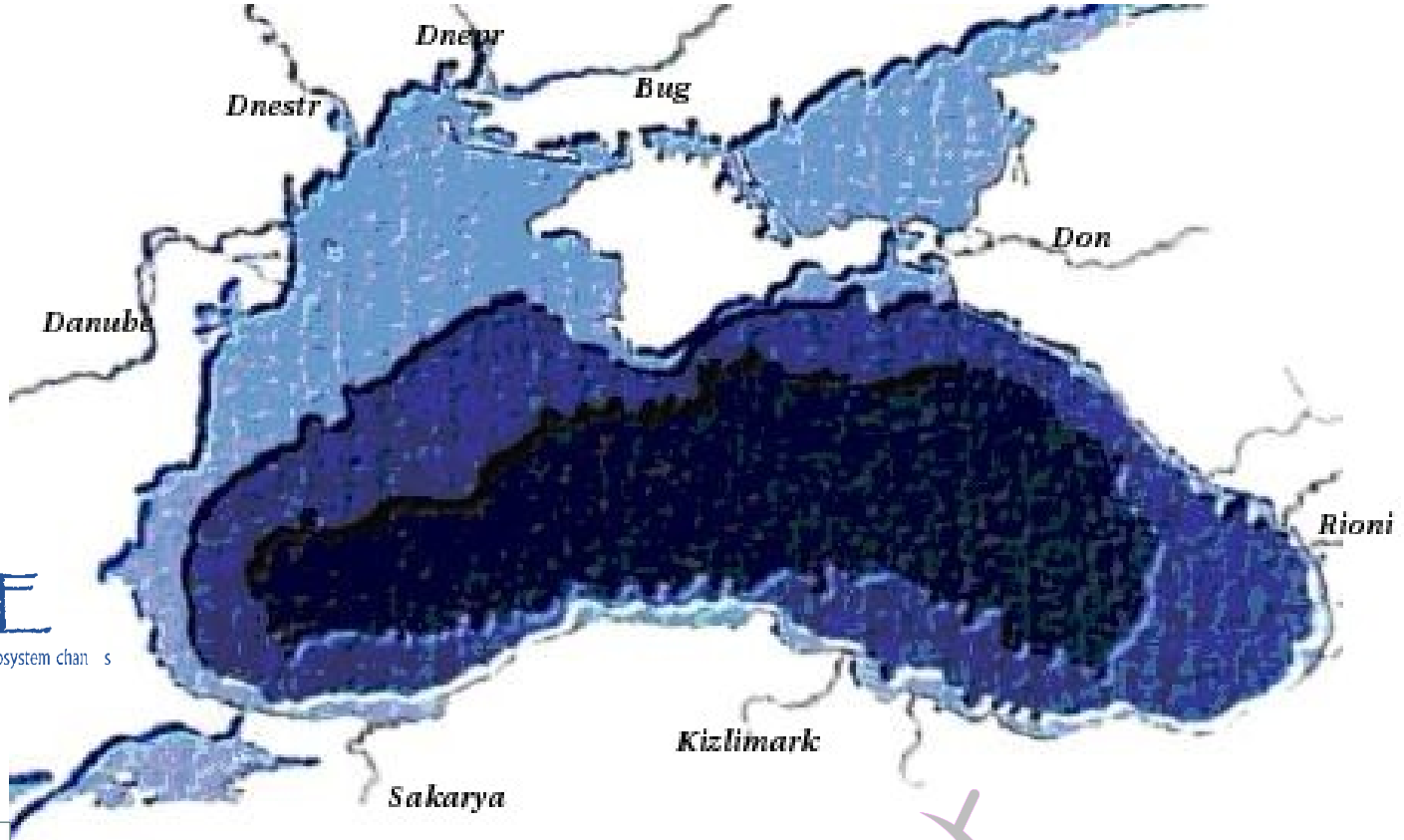
3D MODELLING OF THE BLACK SEA NORTH WESTERN SHELF ECOSYSTEM :



SESAME
Southern European Seas: Assessing and Modelling Ecosystem chan s

WP 4 - 6

Université de Liège

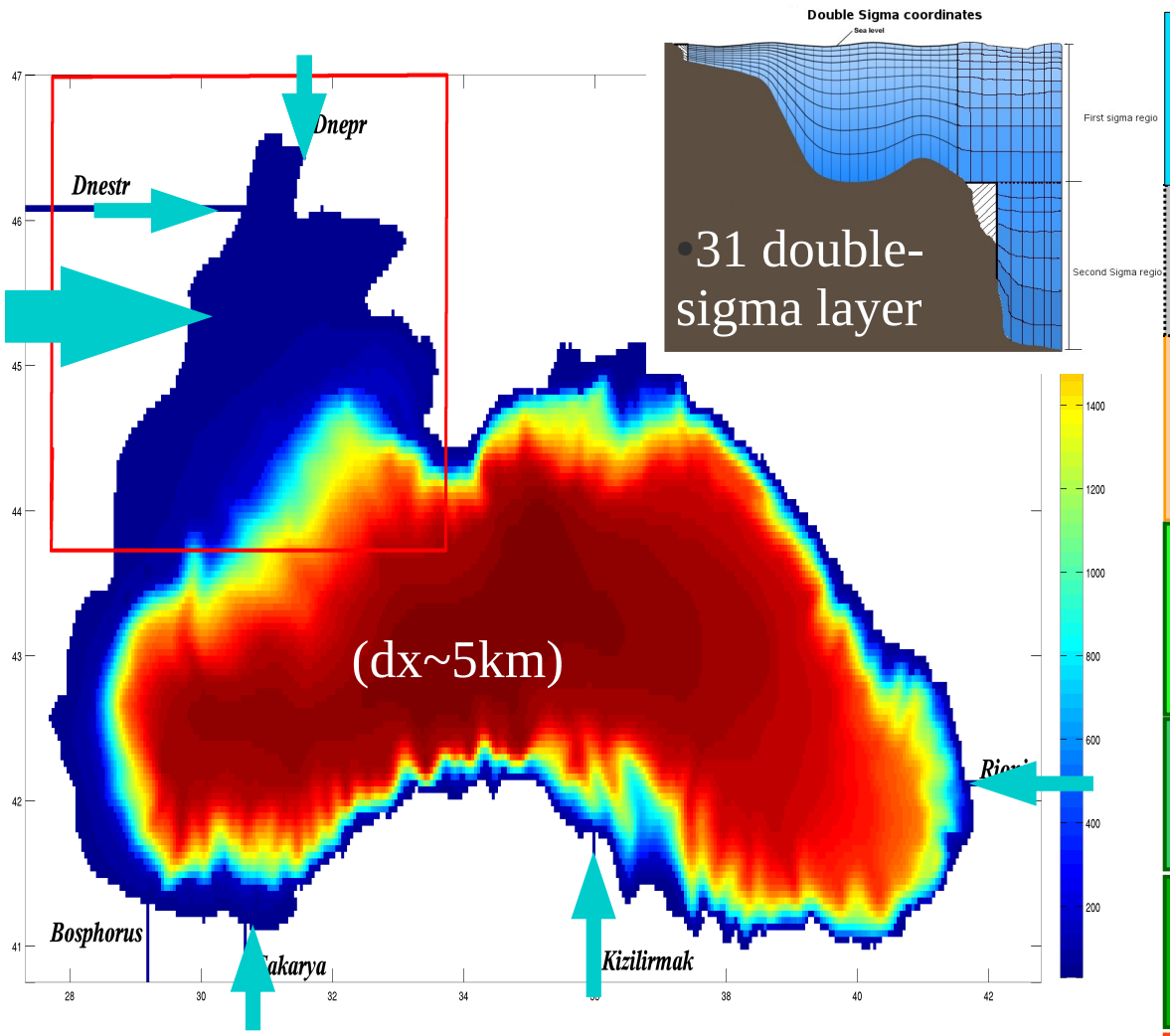
MARE
INTERFACULTARY CENTER FOR MARINE RESEARCH - LIEGE UNIVERSITY

GHER
GeoHydrodynamics and Environment Research

FNRS

Capet Arthur, Grégoire M, Beckers, JM.,Joassin P., Naithani J., Borges A.V., Soetaert K., Meysman F.

The Model



Monthly RIVERS fluxes and nutrients flows (from SESAME & A. Cociasu)

6h-atmospheric forcings from ECMWF (1.125°). (from ERA40)

36 States variables

Physics (5)
Currents, T°, Salinity,
Surface elevation, Turbulence

Oxygen and Dissolved Inorganic Carbon (2)

Inorganic nutrients (5)
SiO,NO3,NH4,PO4,"Reducers"

3 Phytoplankton (6) (free C/N)
Diatoms,Flagellates, Small Flagellates

Zooplankton (2)
Micro-, Meso-.

Gelatinous zooplankton(2)
Omnivorous , Carnivorous

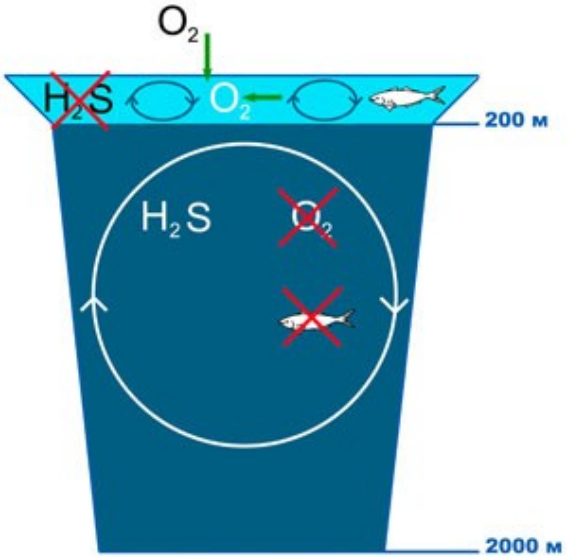
Detrital matter (8)
Particulate, Semi-labile and Labile forms
Silicious Detritus, Aggregates

Bacteria(1)

Model's Specificity

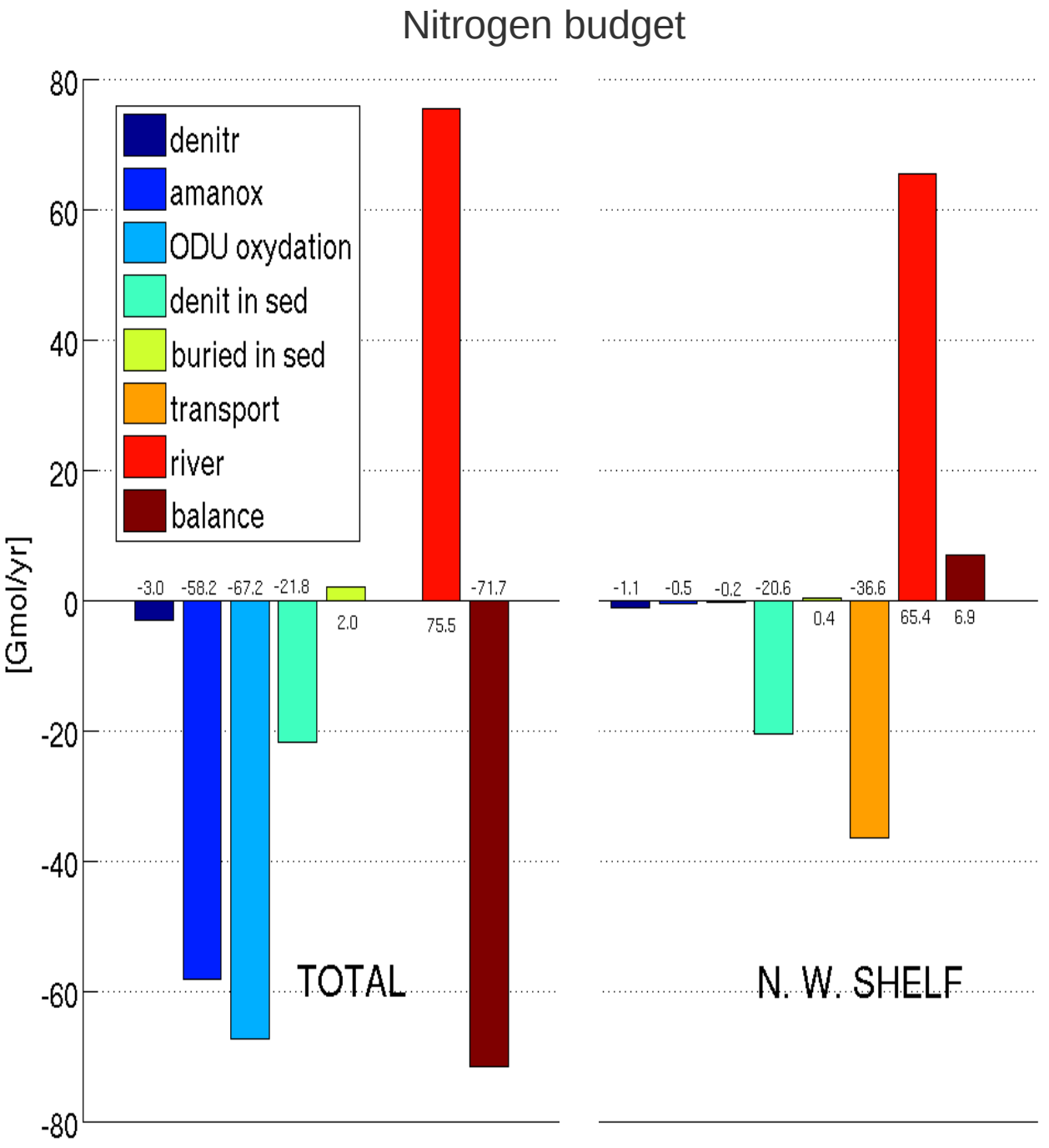
- No data assimilation : Necessity to construct specific Bosphorus representation to ensure conservation of volume and total salt content.

- Anoxic waters : The biological model explicitely includes anoxic chemistry trough the use of a variable 'Oxygen demanding Units', as a proxy for reducers acting in the anoxic zone.

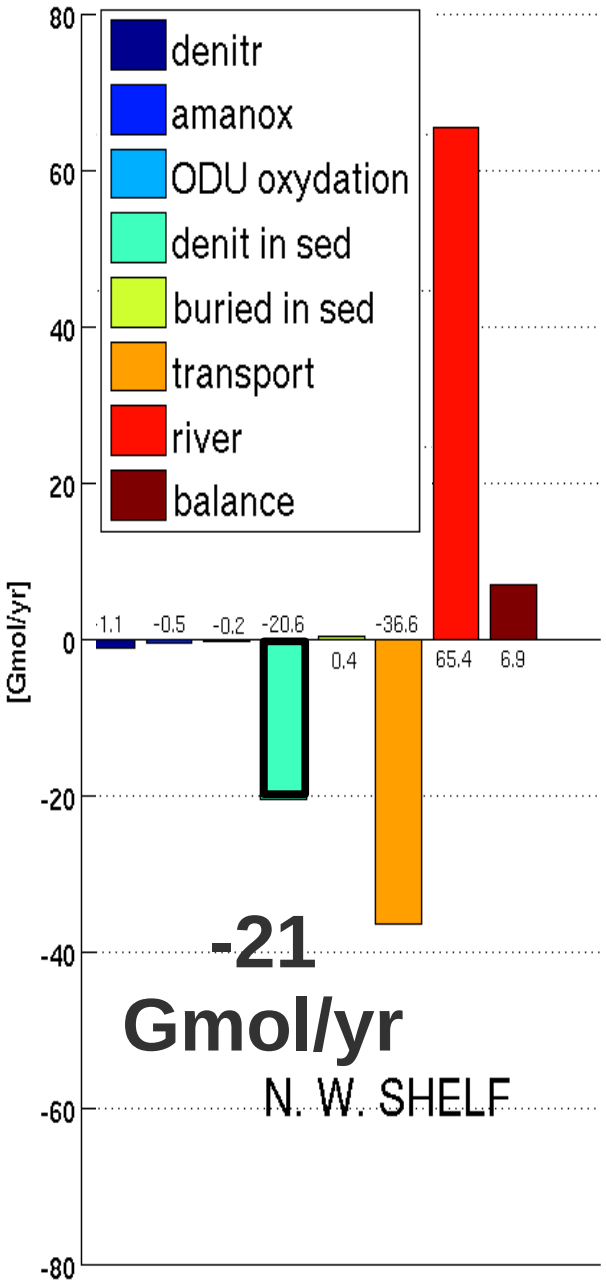


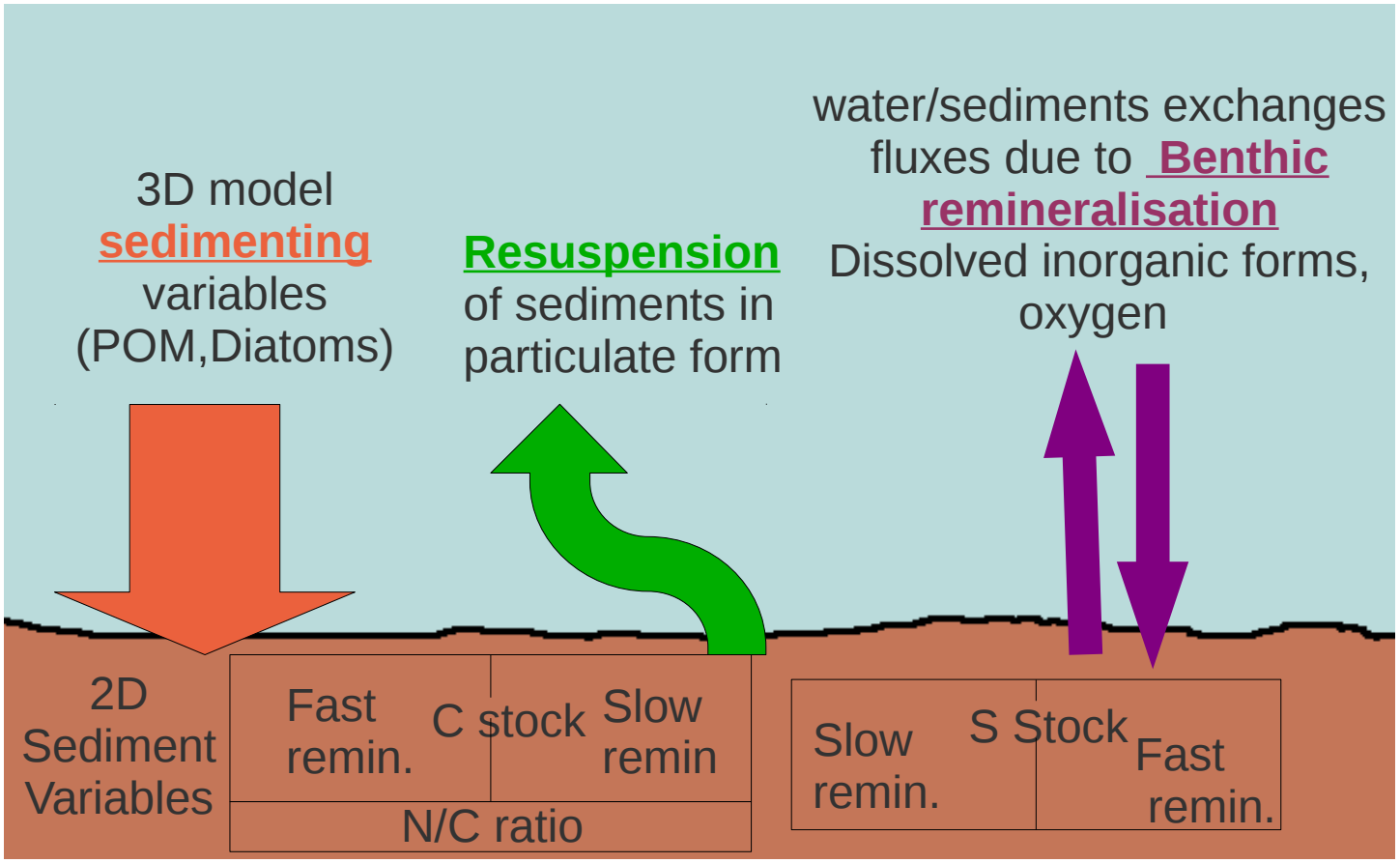
* Main process description

* Interannual variations of those process



Shelf's sediments chemistry





• Sedimentation is driven by an aggregation models (typically ~2/3 m/d).

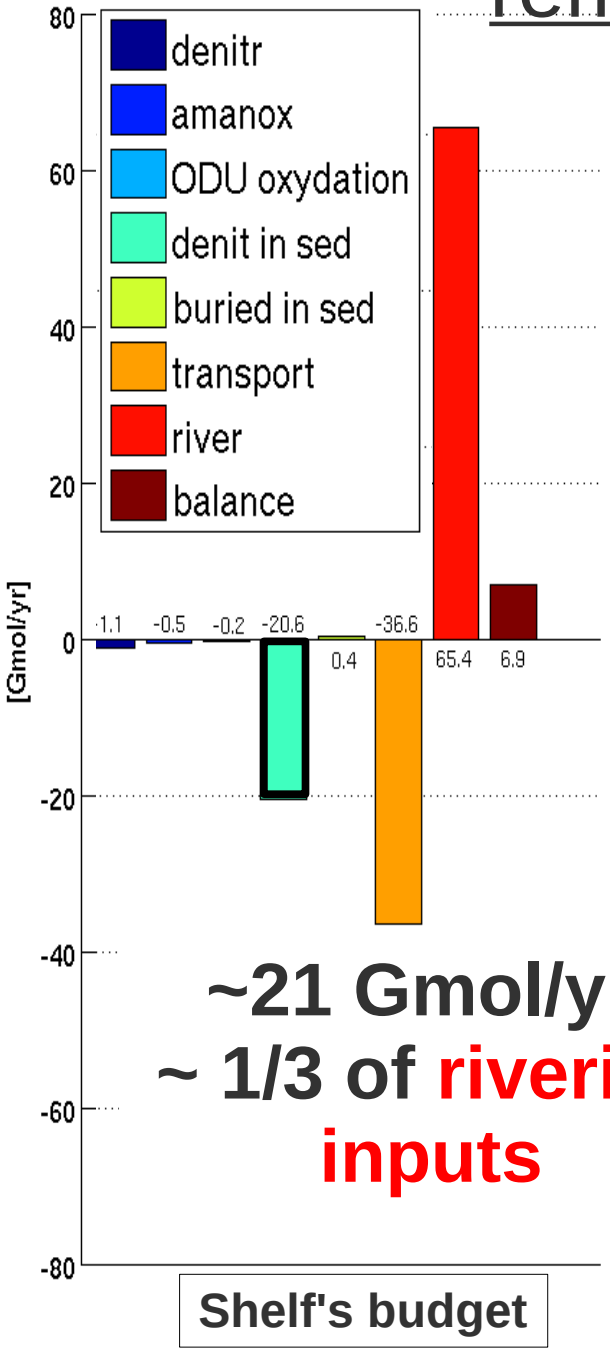
• Resuspension is the effect of bottom stresses du to bottom currents and (mainly) waves. [*cf. pres. of R. Kandilarov*]

•Remineralization is computed according to stocked quantity of sediments, and bottom concentrations [Soetart, Meysman]

Benthic remineralization

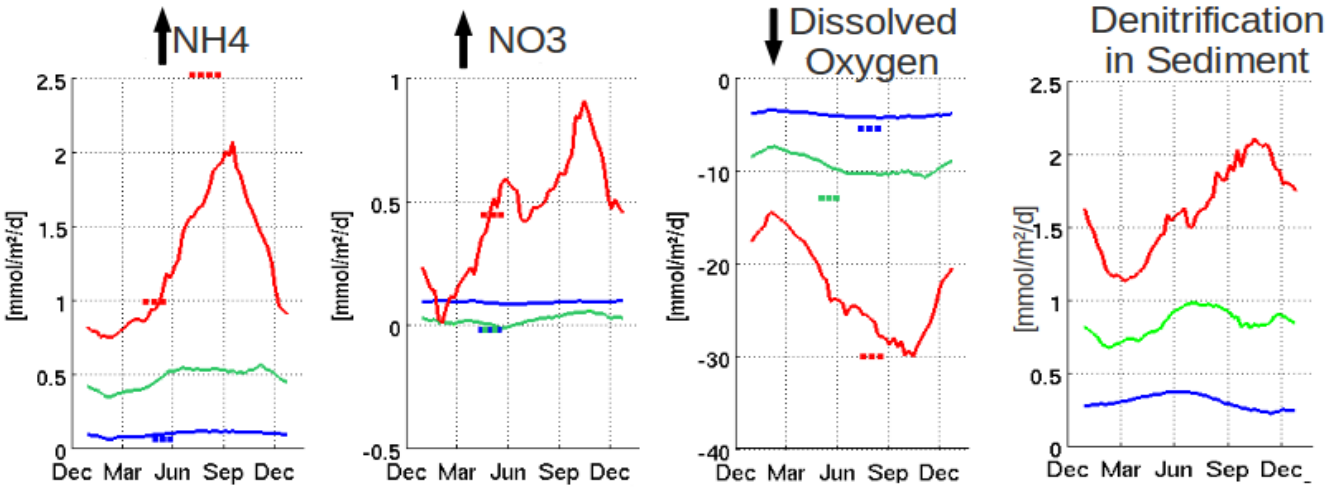
Climatological run. 1996 → 2000

The dotted bars indicates value from EROS21 [Wijsman, *Spatial distribution in sediment characteristics and benthic activity on the north-western Black Sea shelf.* , Mar Ecol Prog Ser **39**



~21 Gmol/yr
~ 1/3 of riverine inputs

Shelf's budget



- Detailed Remineralisation parameterization is essential in terms of budgets.

- If Resuspension is not taken into account up to 80-90% of riverine N is denitrified on the Shelf

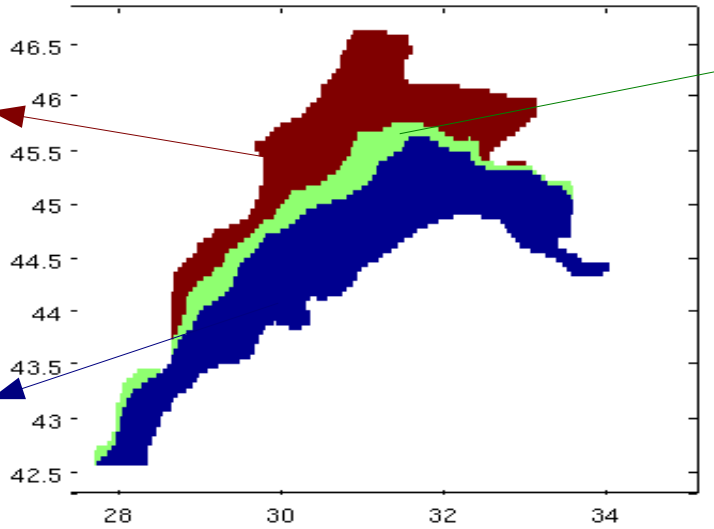
- As benthic fluxes are function of stocked sediments and not of bottom fluxes, the slow remineralisation time of refractory component introduce strong hysteresis in the system.

Fluxes values : Spatial variabilty

With respect with sedimenting fluxes of PON

Northern Part (river side)
20 % emitted in nitrate.
30 % emitted in ammonium
48.5 % denitrified

Southern Part (basin side)
4 % emitted in nitrate.
29 % emitted in ammonium
62 % denitrified



Mid Part
12 % emitted in nitrate.
33 % emitted in ammonium
53 % denitrified

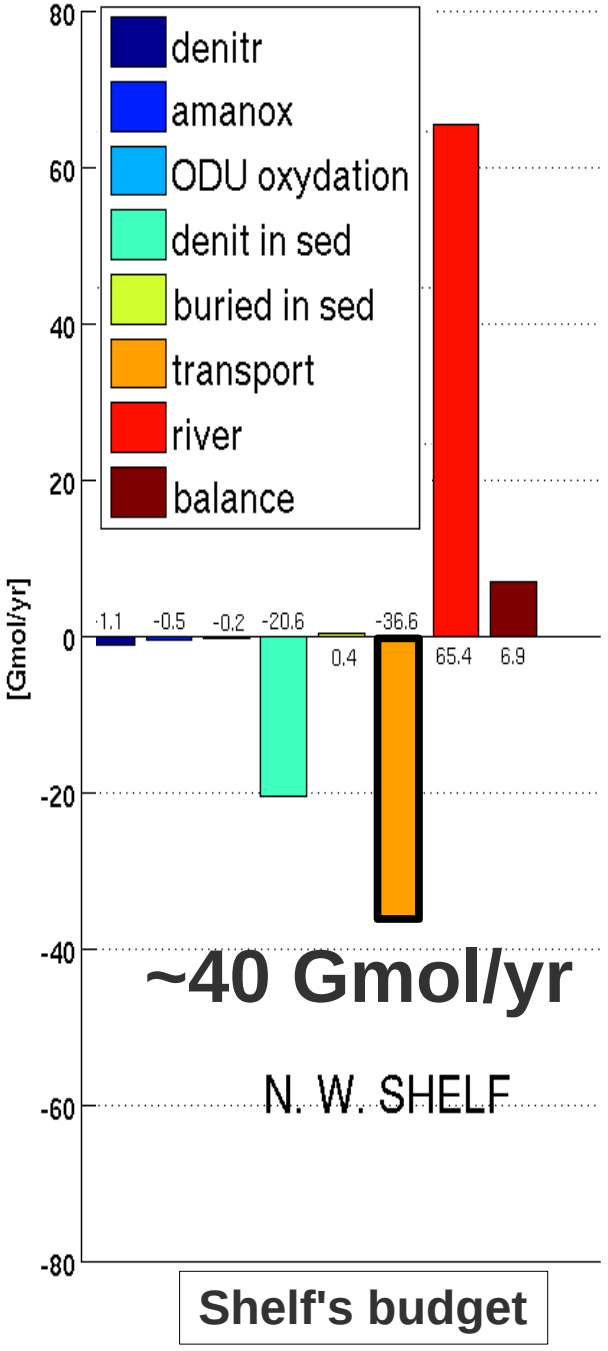
Whole Shelf
18 % emitted in nitrate.
28 % emitted in ammonium
51 % denitrified

Gregoire & Friedrich, 2004, *Nitrogen budget of the northwestern Black Sea shelf inferred from modeling studies and in situbenthic measurements*, Mar Ecol Prog Ser, **270** :

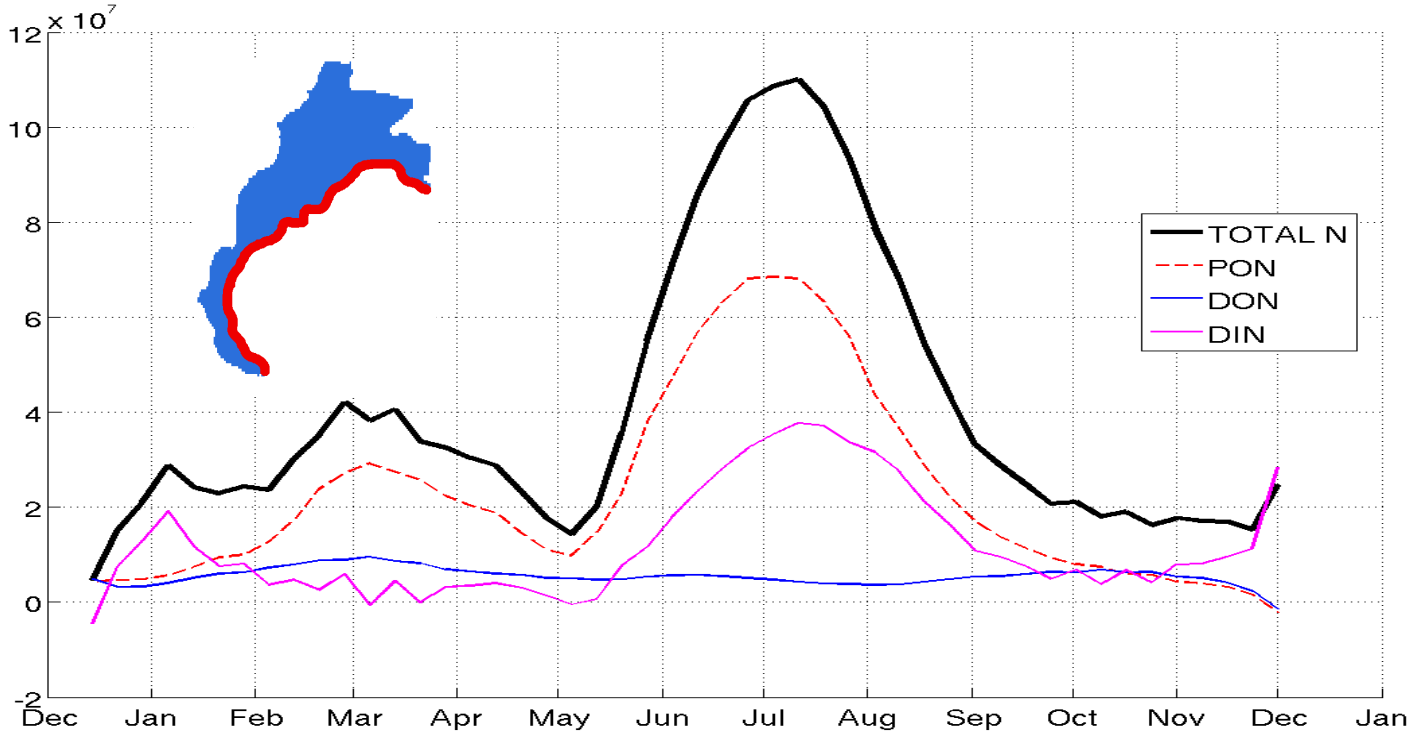
~ 5 % in nitrate
~37 % in ammonium
~51 % is lost by denitrification

" *In our estimate, 60% of the PON deposited on the sediment of the Black Sea's north-western shelf is lost through denitrification (51 and 65% for respectively the high and low flux areas)* "

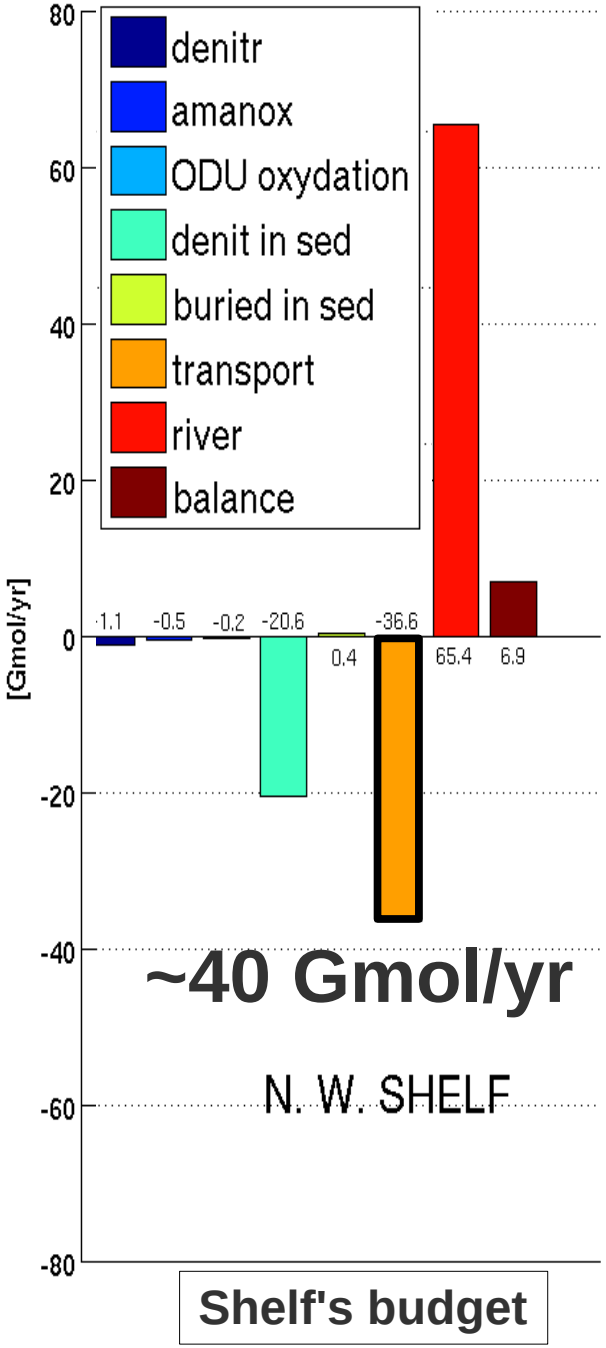
Transport to open sea



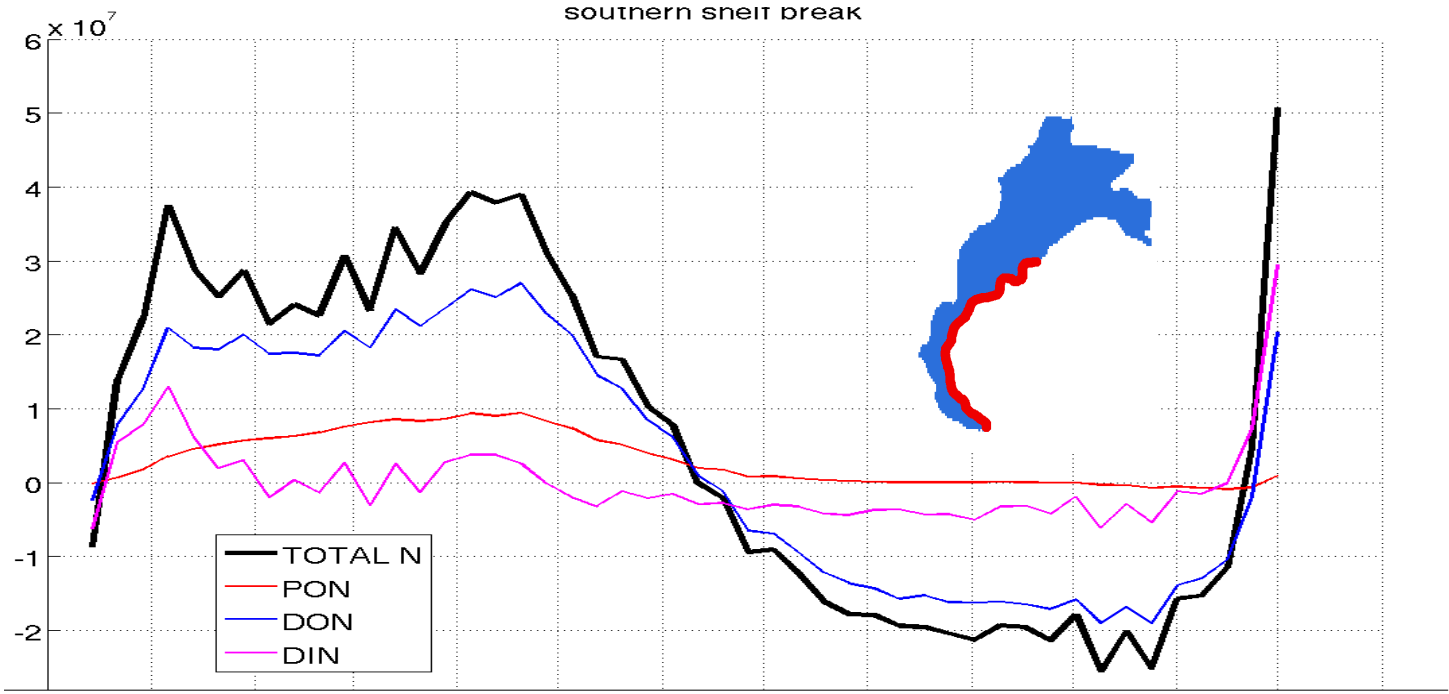
Shelf's budget

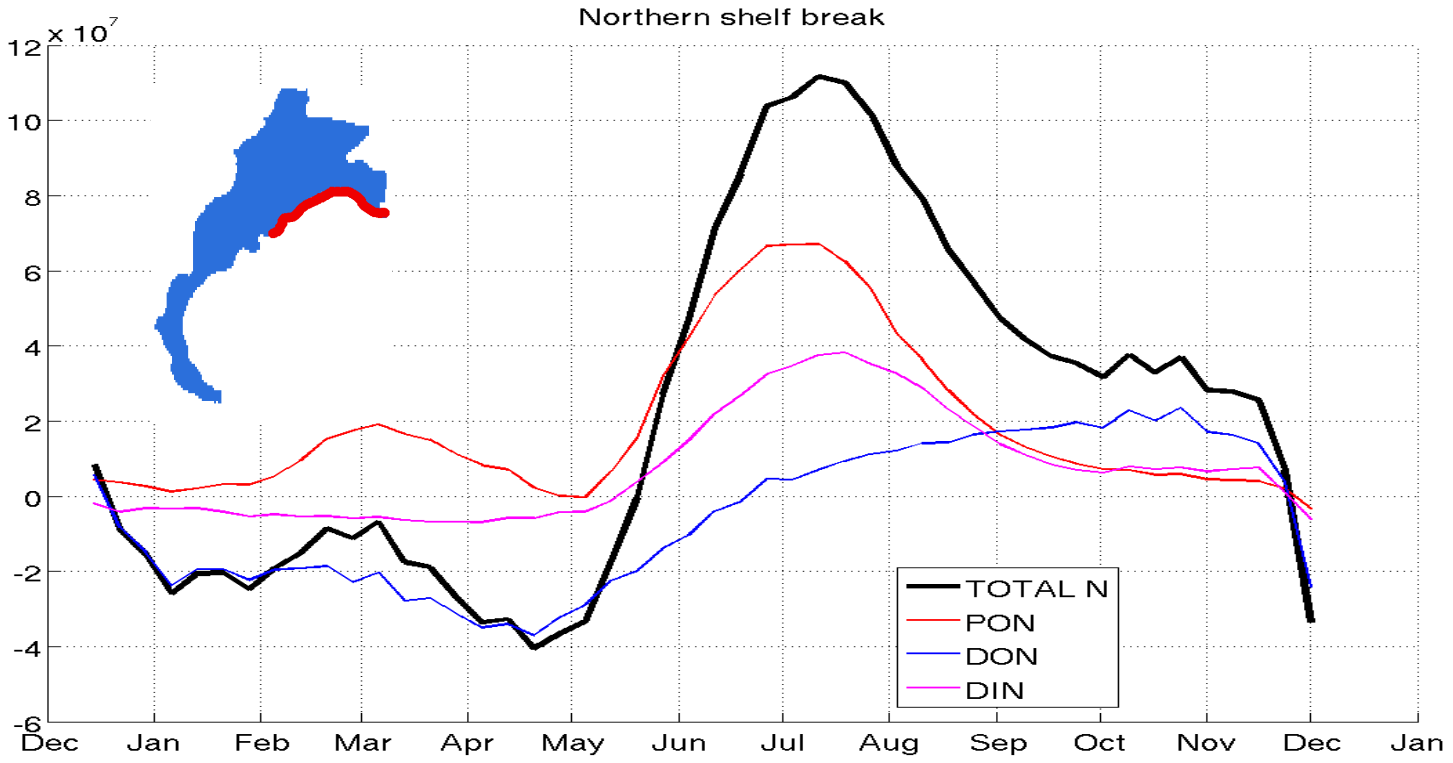


Transport to open sea

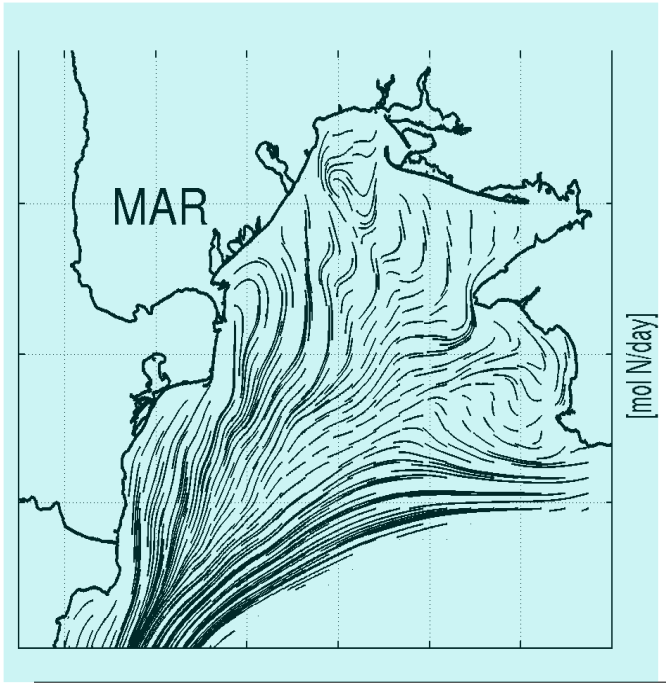


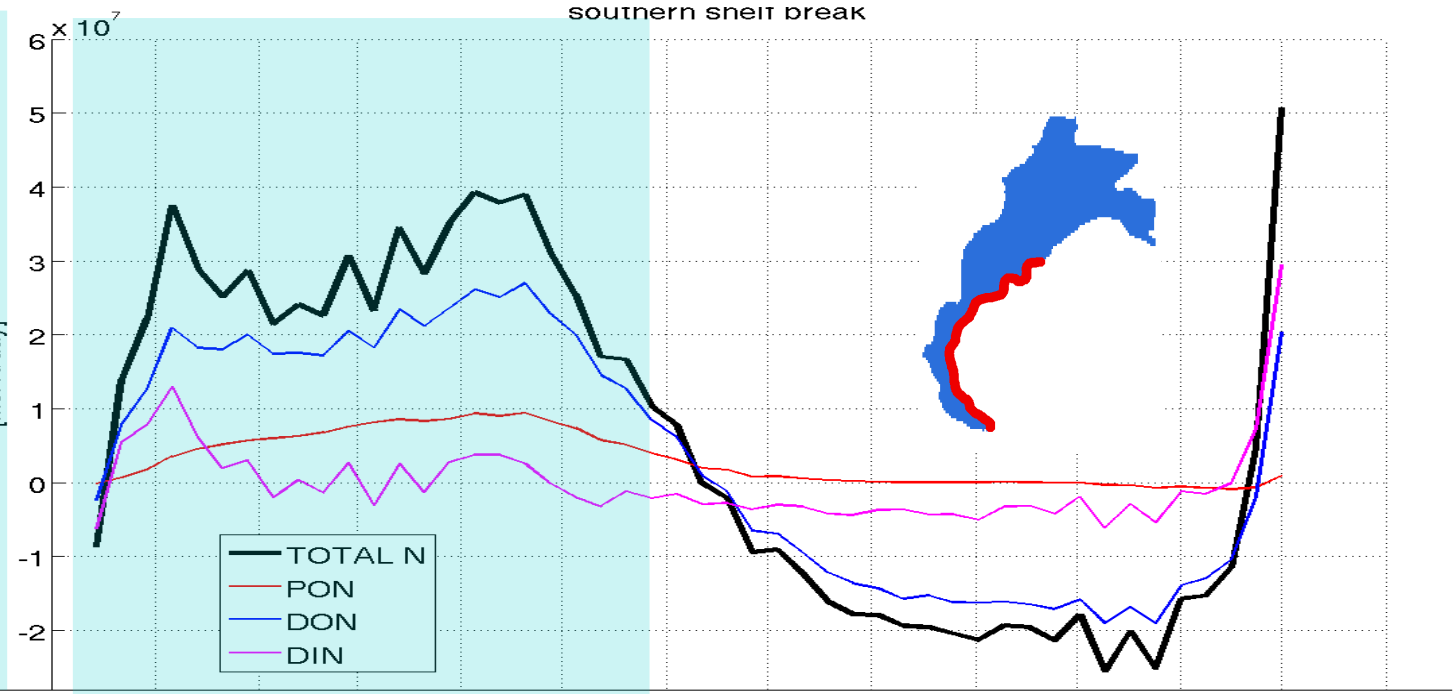
Shelf's budget

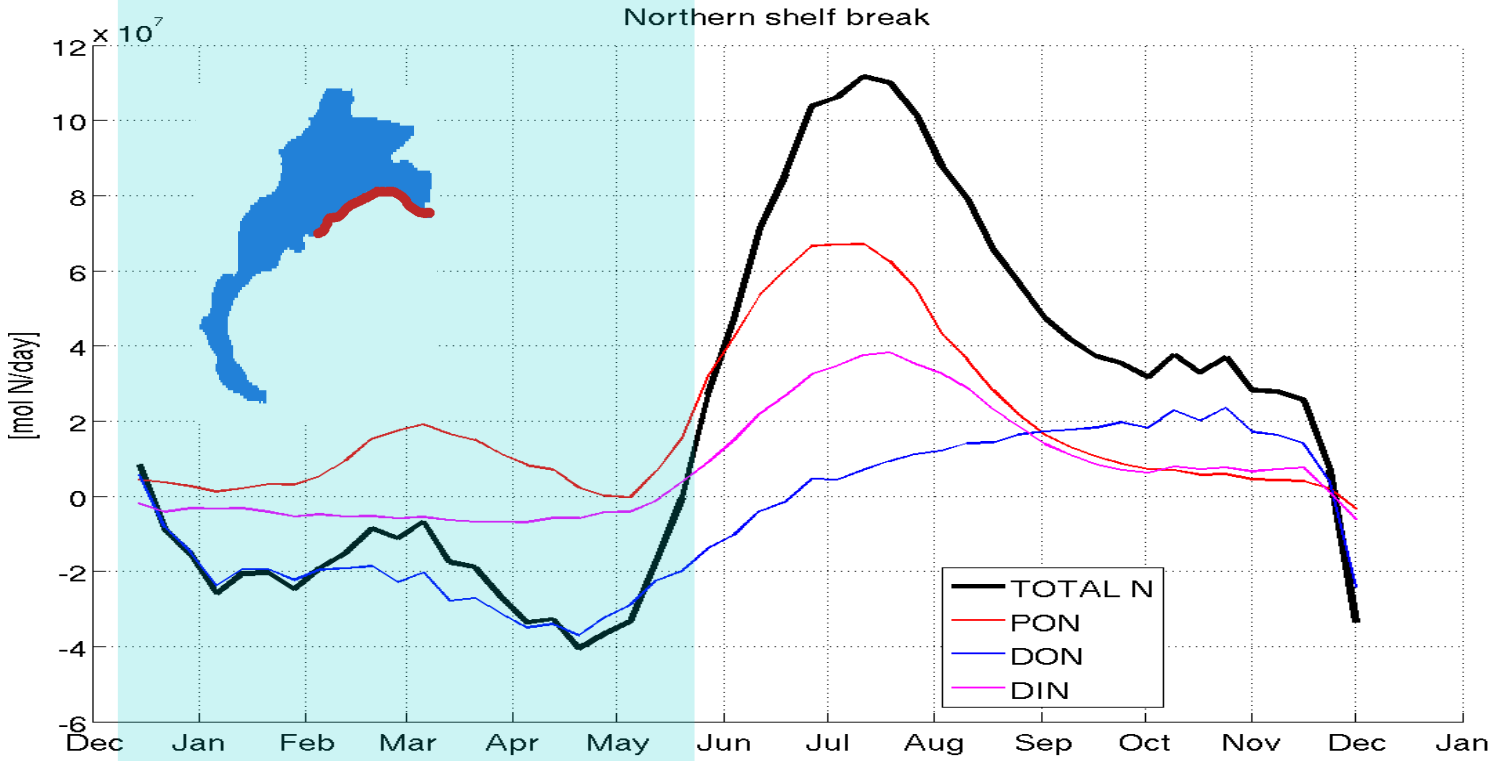




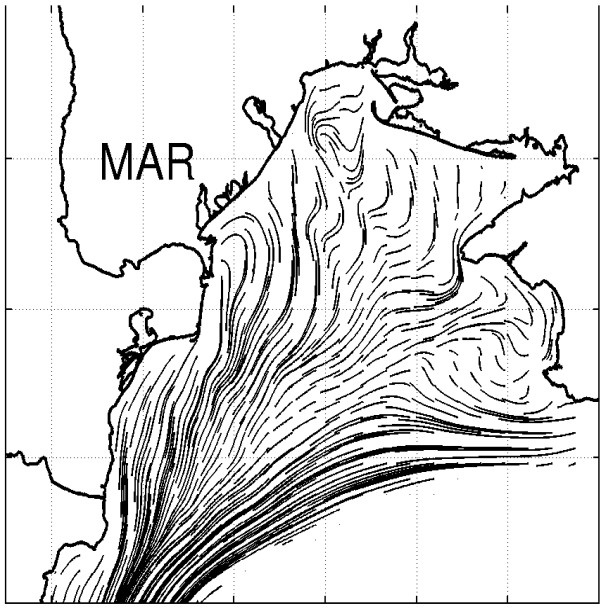
Transport to open sea

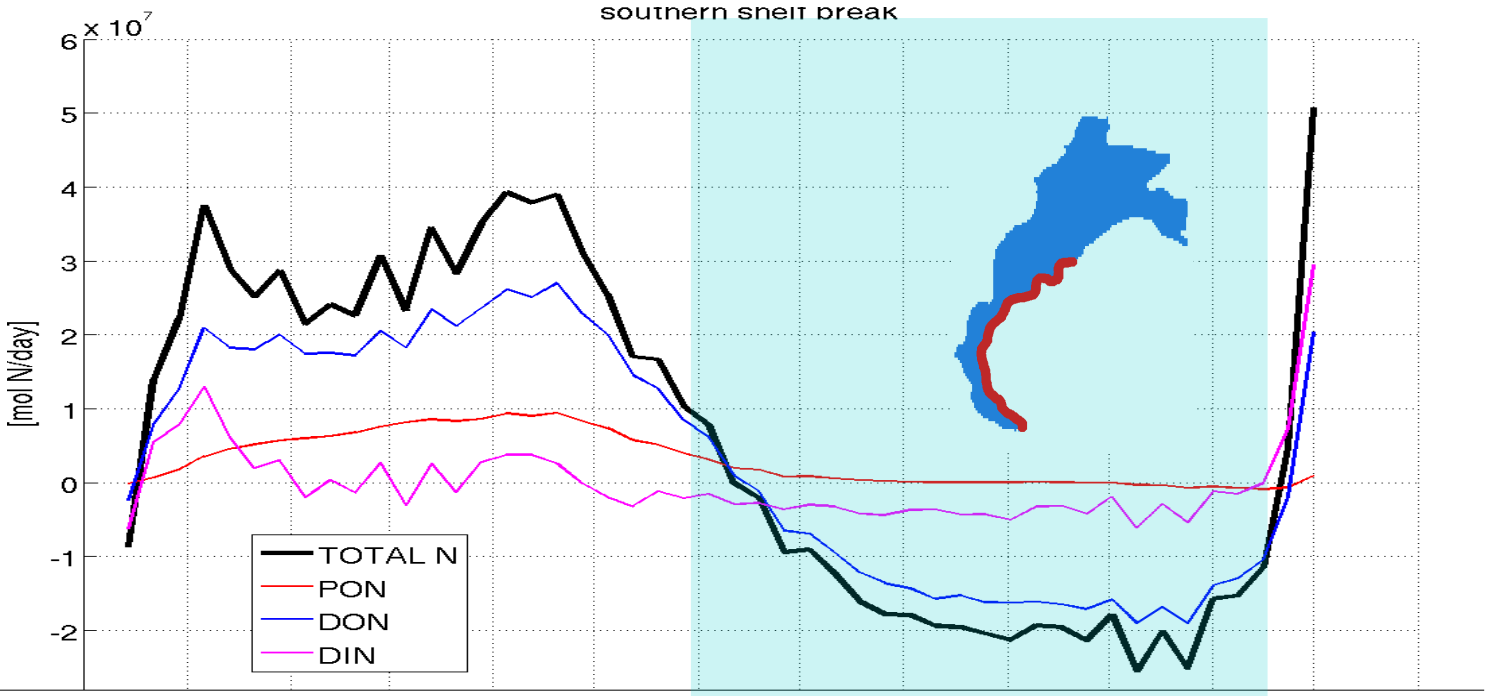


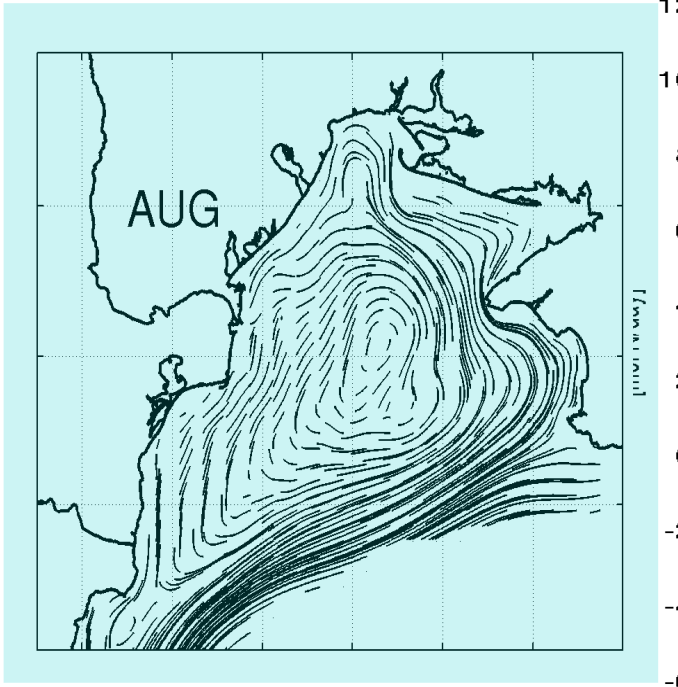


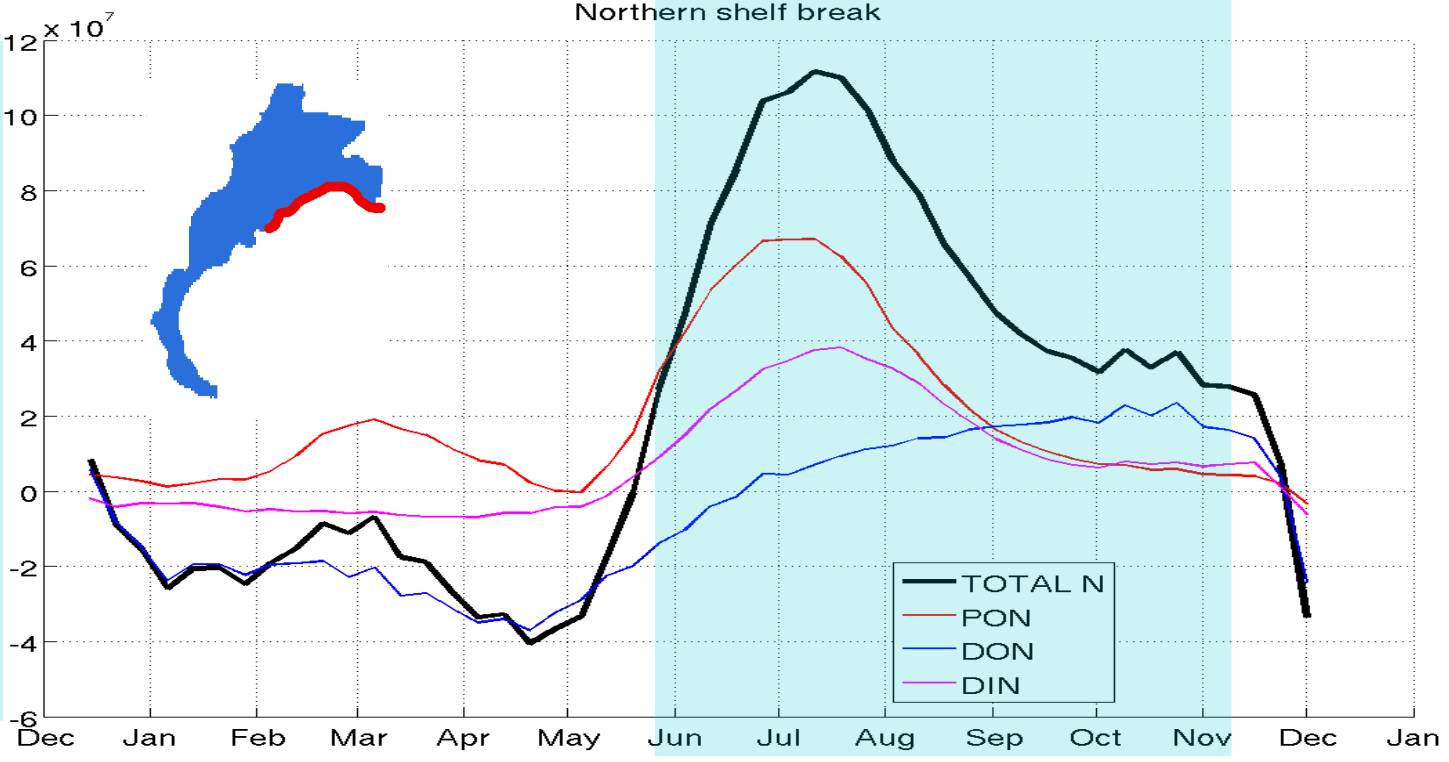


Transport to open sea



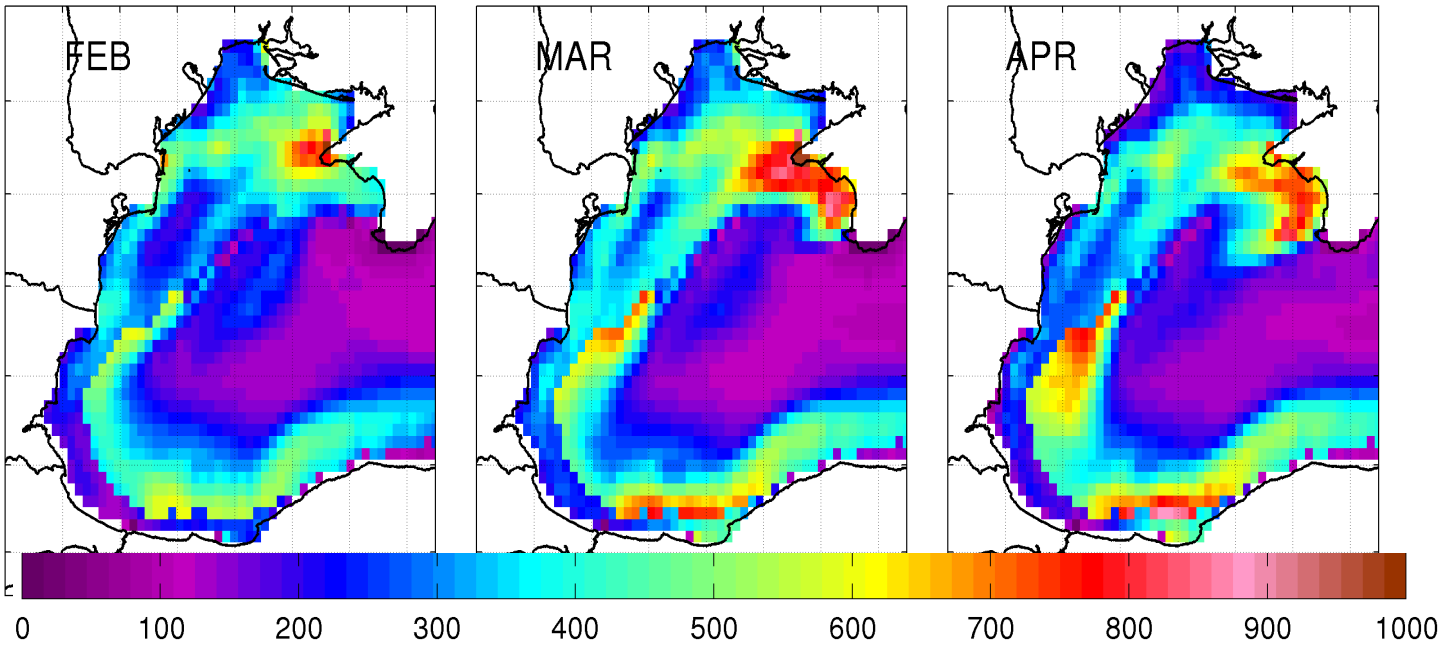


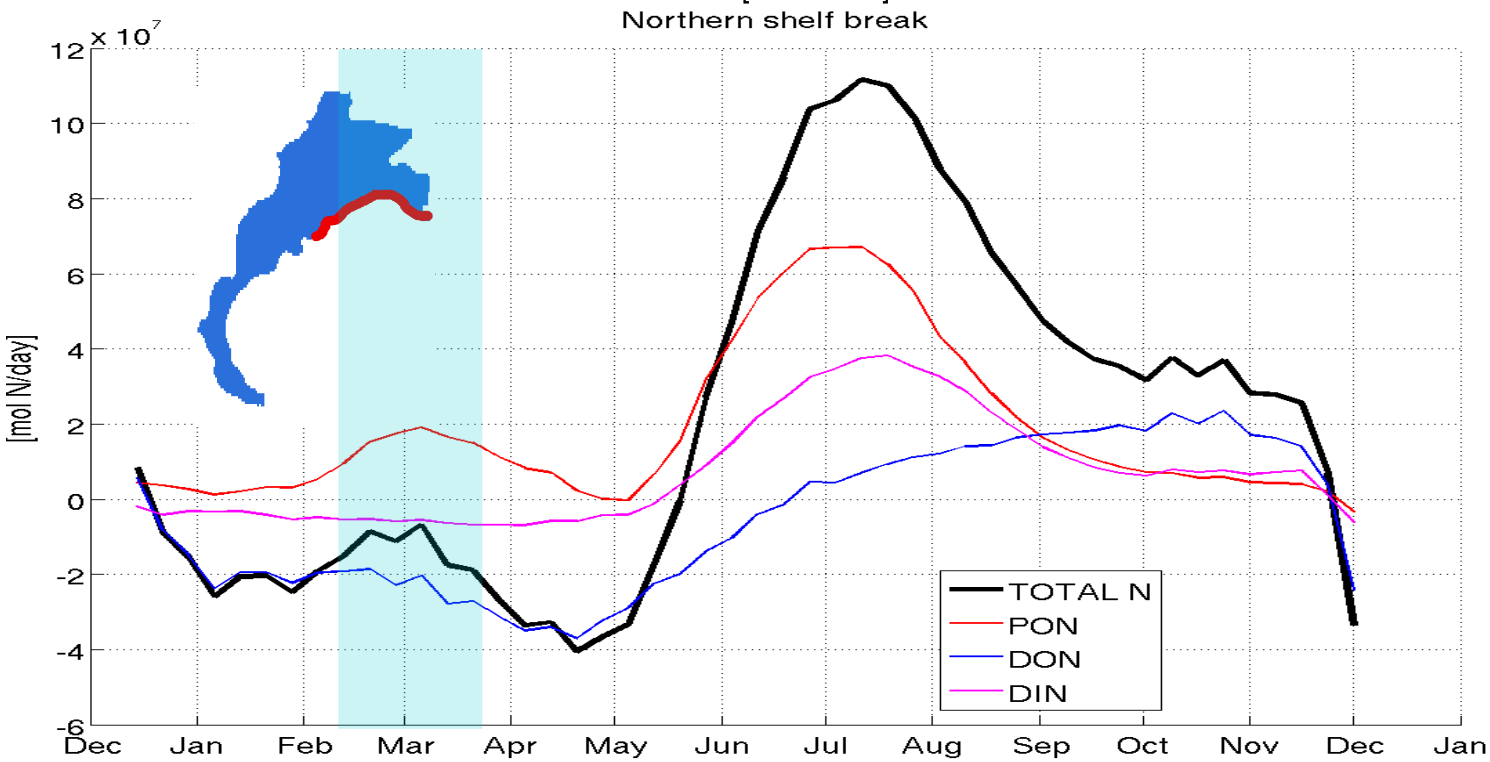




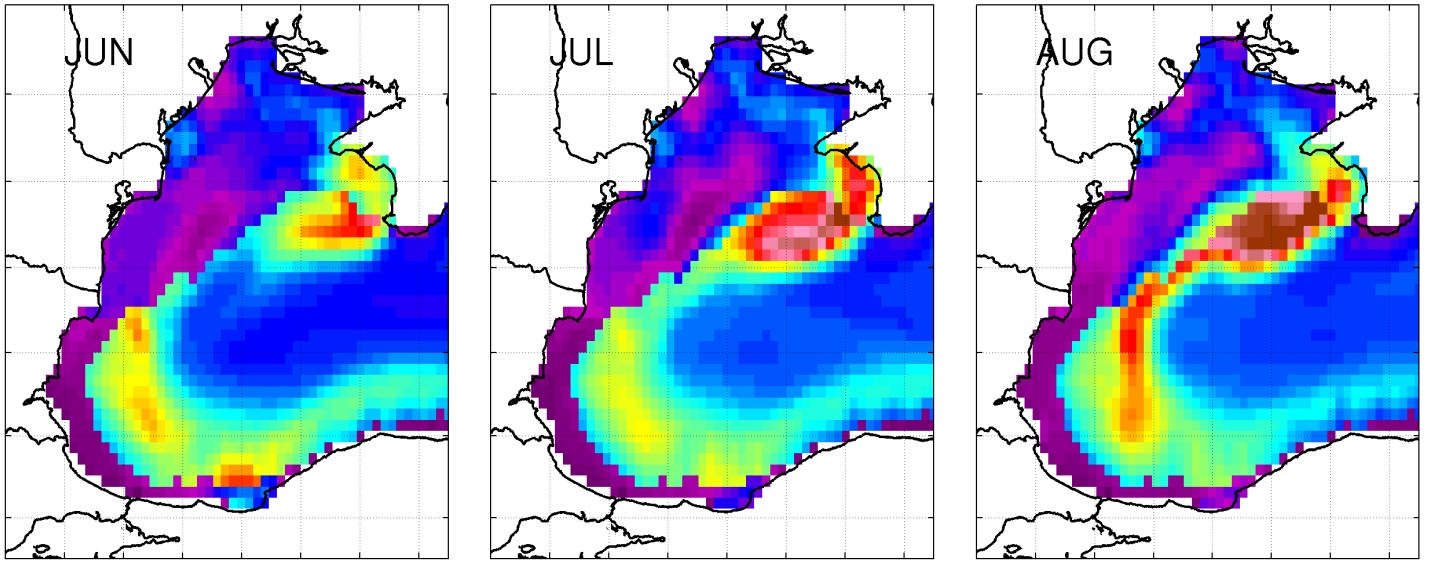
CIL dynamics impact on Shelf – open sea export :

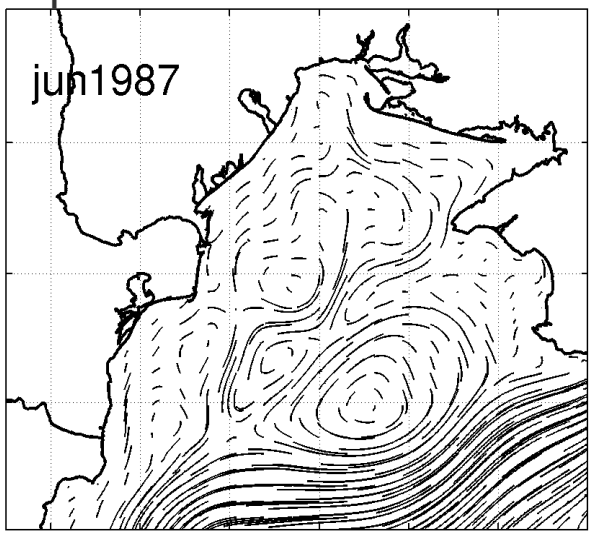
• Entrainment of resuspended material during formation phase.

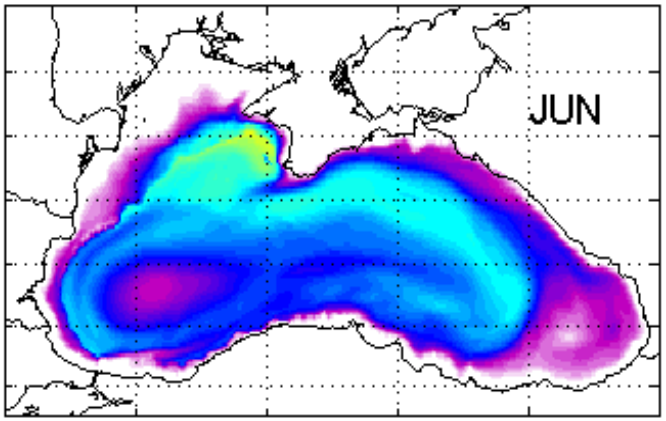


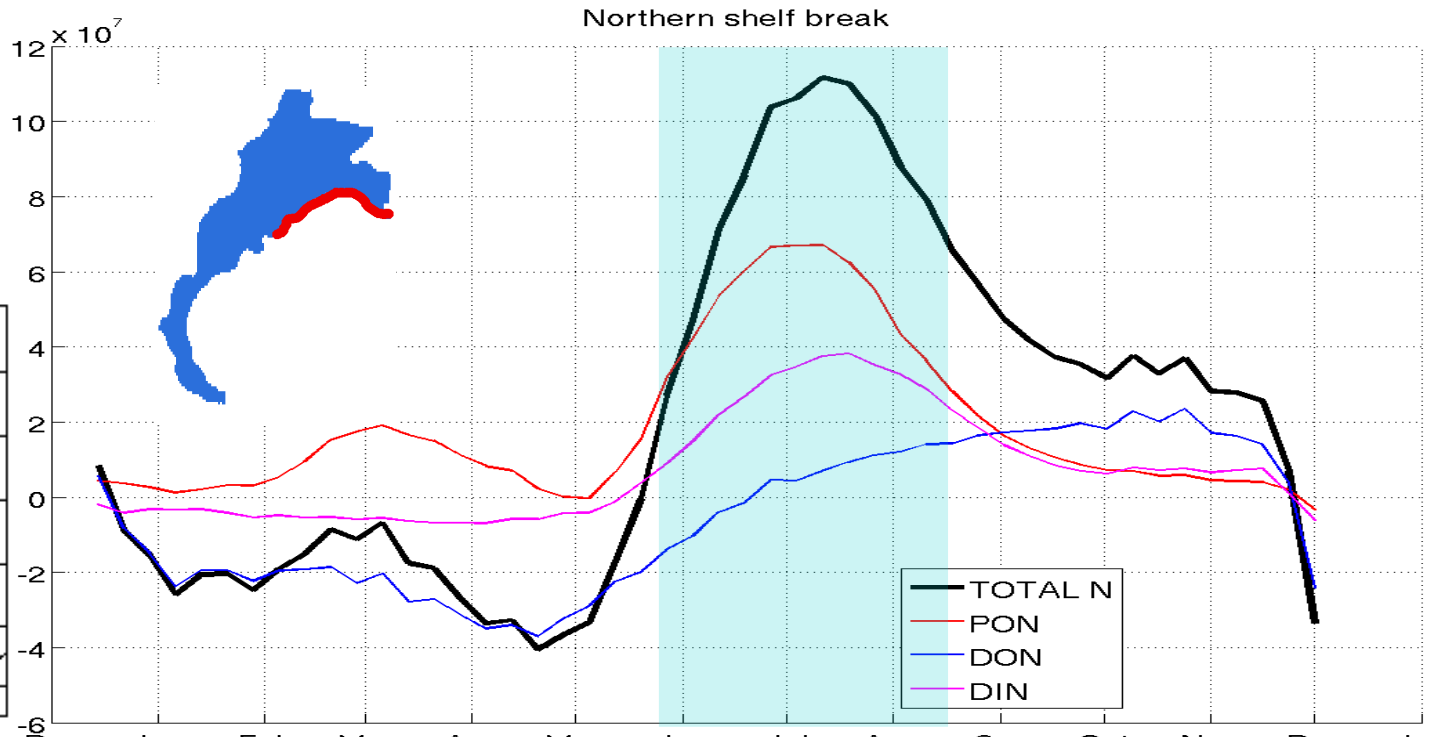


Summer export is mainly achieved by the medium of an anticyclonic recurent gyre forming South West of Crimean Coast, which anatomy will be detailled this afternoon by G. Shapiro .

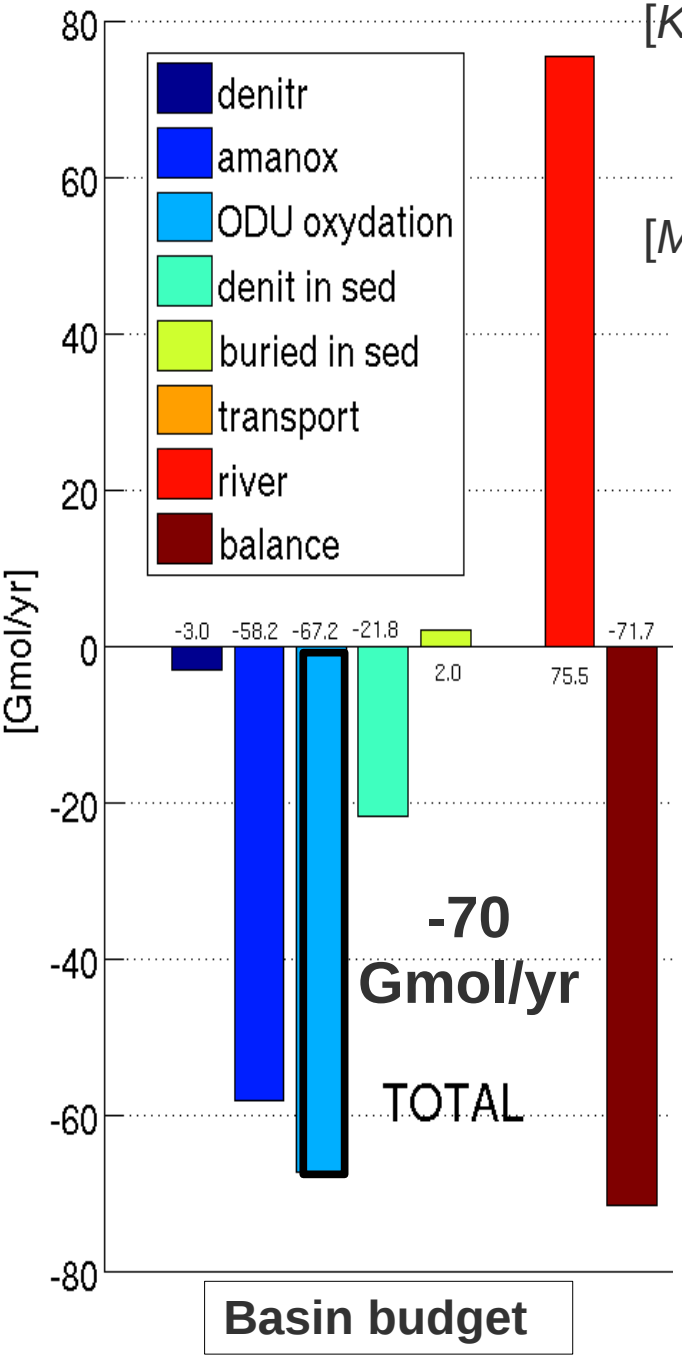








Nitrogen destruction in the suboxic layers



Basin budget

[*Konovalov, 2006, Deep-Sea Reseach II*]

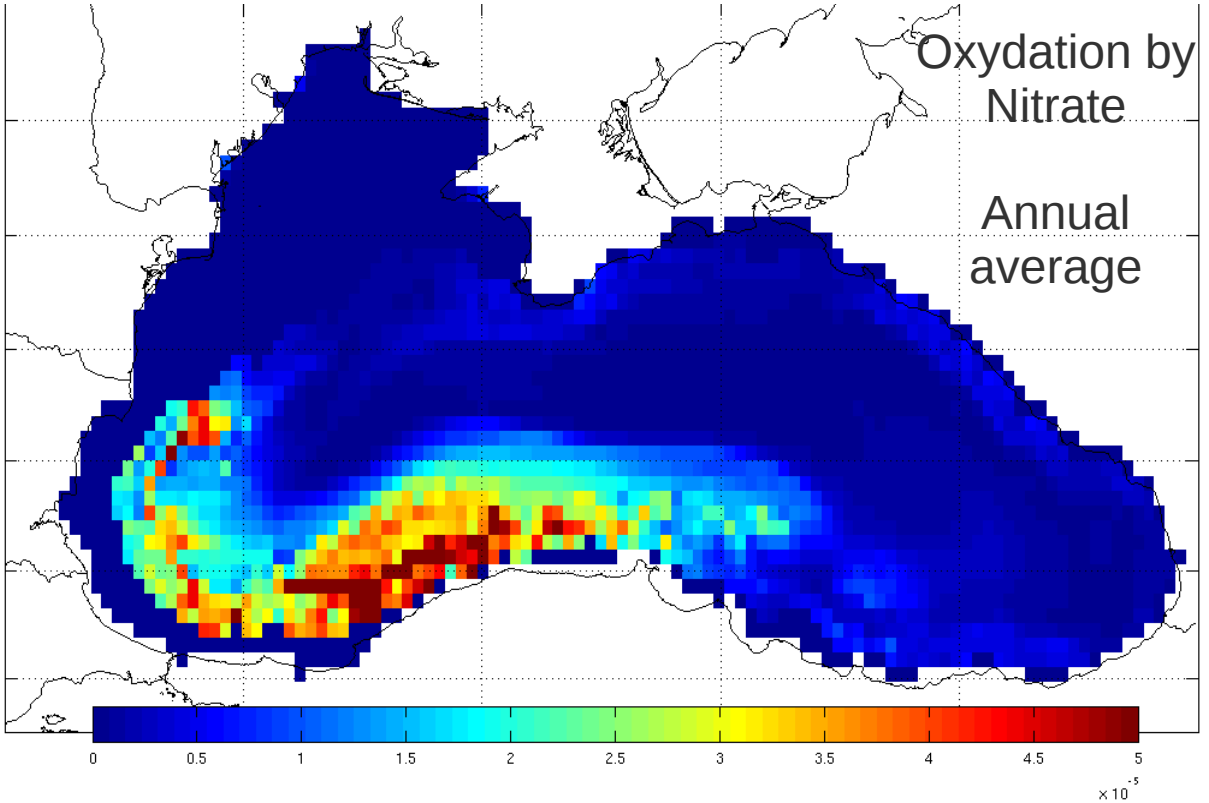
~ 40 Gmol/yr for oxydation by Sulfide and manganese

~ 30 Gmol/yr for ANAMOX

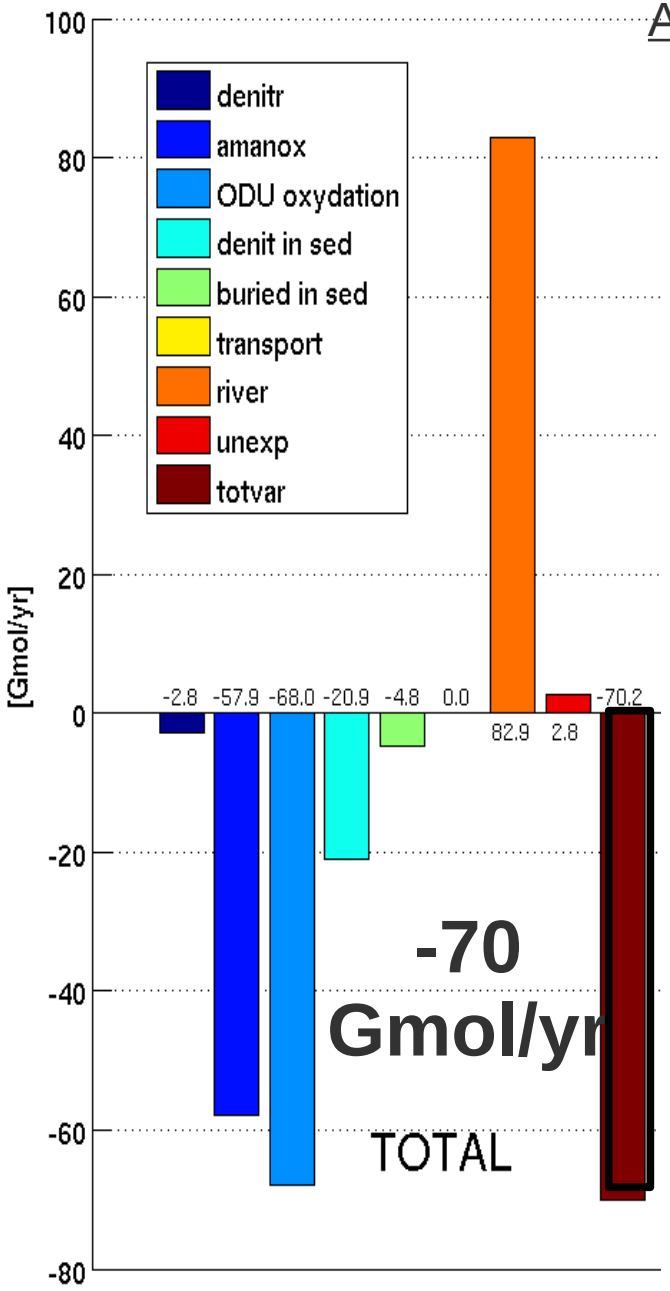
[*McCarthy,2007, Estuarine, Coastal and Shelf science*]

~ 52 Gmol/yr for ANAMOX

Mainly resulting from Shelf's export entrained by the Bosporus plume



Missing Part

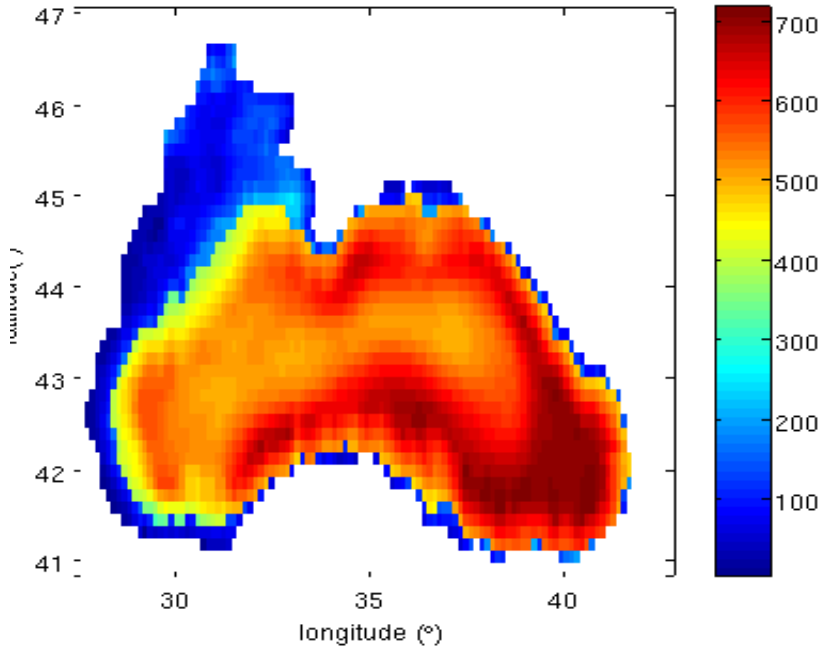


Atmospheric Wet/Dry deposit. (not taken into account in SESAME).

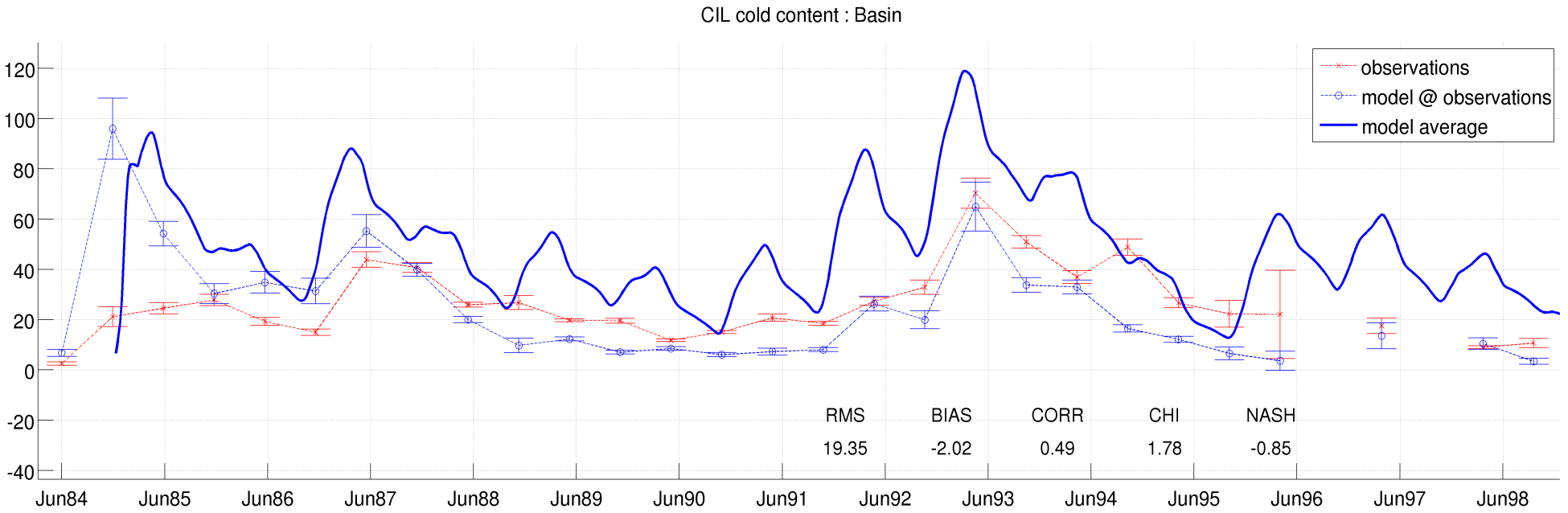
- Bear strong anthropogenic signal and consequent spatio-temporal variability
- Estimation reviewed in [*McCarthy,2007, Estuarine, Coastal and Shelf science*] gives 13+-4 GmolN/yr, with 60% of NH4

Nitrogen Fixation. (not taken into account in this model).

- Estimation reviewed in [*McCarthy,2007, Estuarine, Coastal and Shelf science*] gives 33 GmolN/yr.
- [*Fuchsman,2008,Marine Chemistry*] measures rates twices higher than McCarthy.



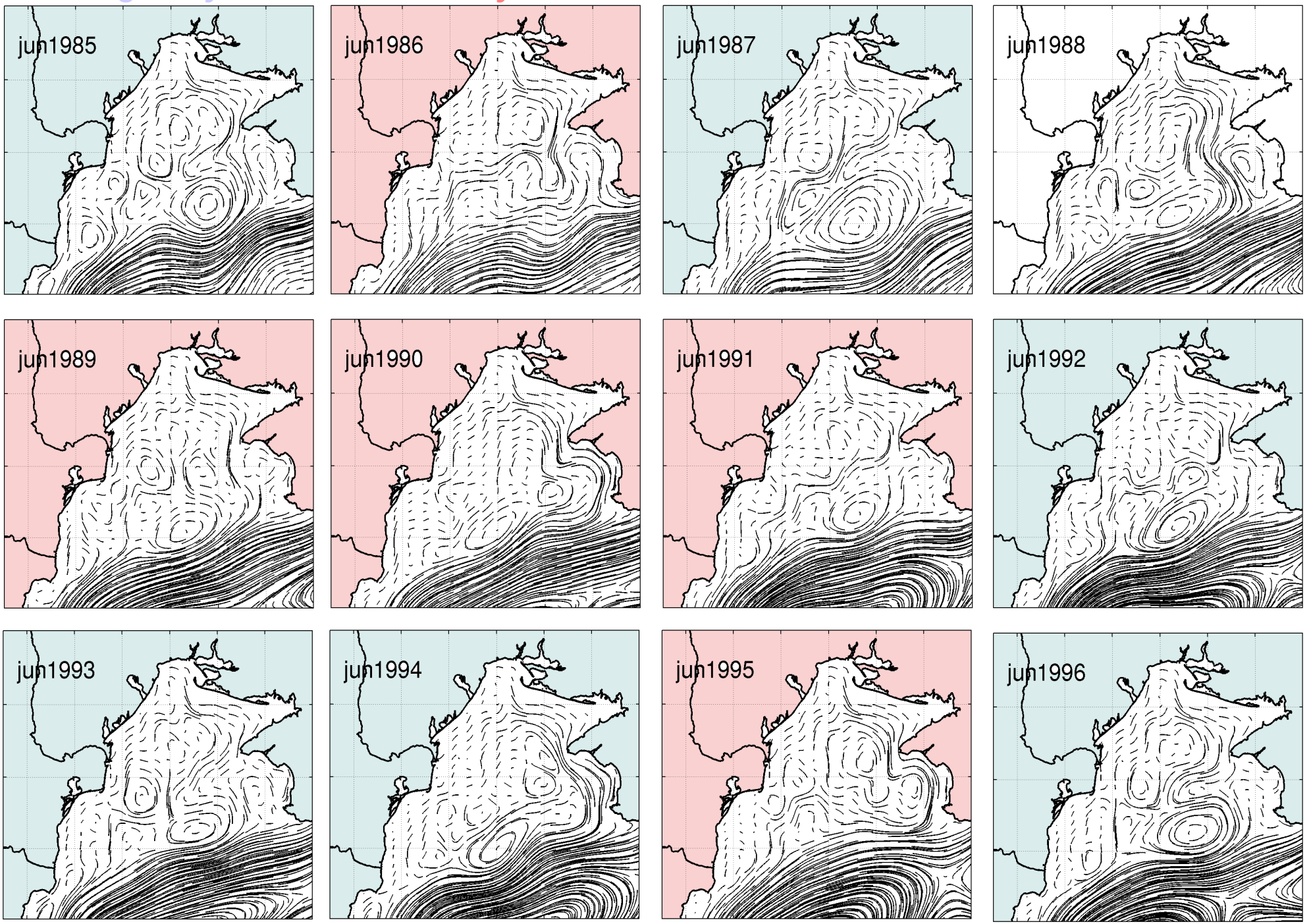
Vertical integration of excess N2 from denitrification following Bosporus plume


CIL cold content : Basin
observations
model @ observations
model average
120
100
80
60
40
20
0
-20
-40
Jun84
Jun85
Jun86
Jun87
Jun88
Jun89
Jun90
Jun91
Jun92
Jun93
Jun94
Jun95
Jun96
Jun97
Jun98
RMS
19.35
BIAS
-2.02
CORR
0.49
CHI
1.78
NASH
-0.85

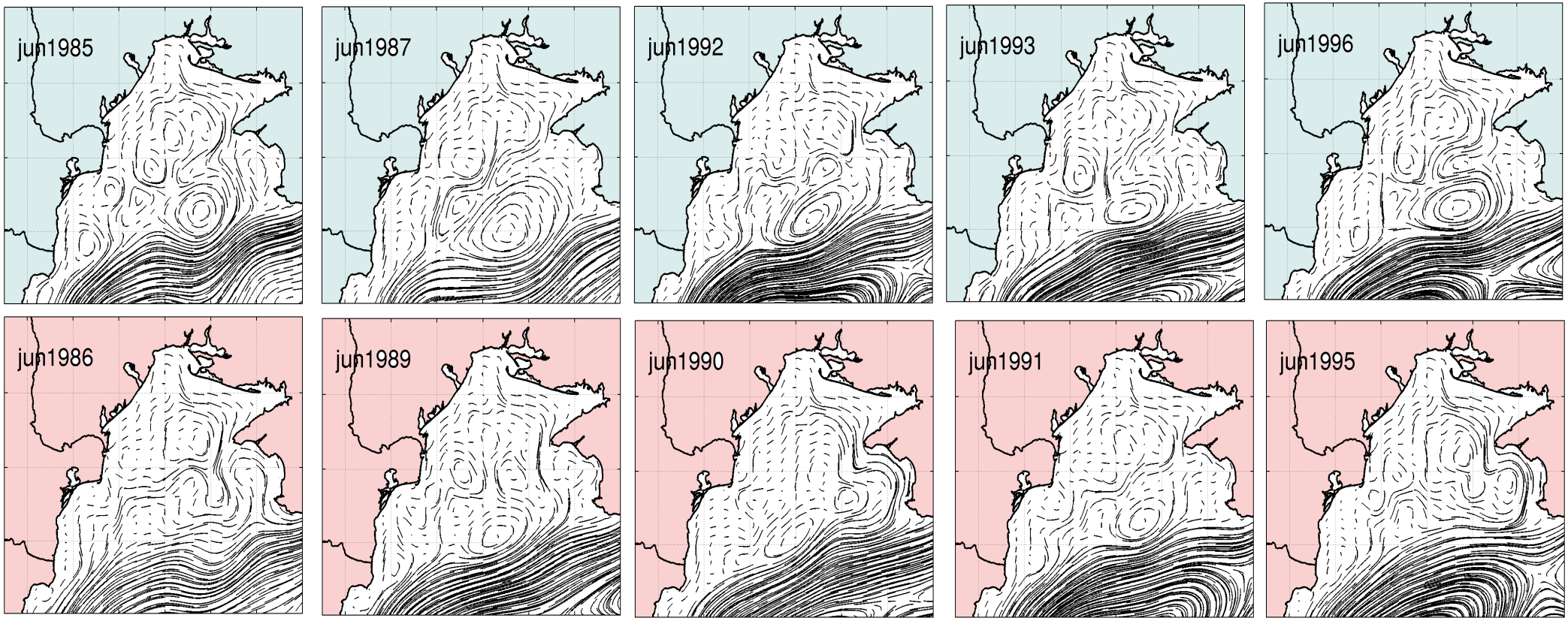
June circulation and Cil interannual anomaly

Strong CIL year

weak CIL year



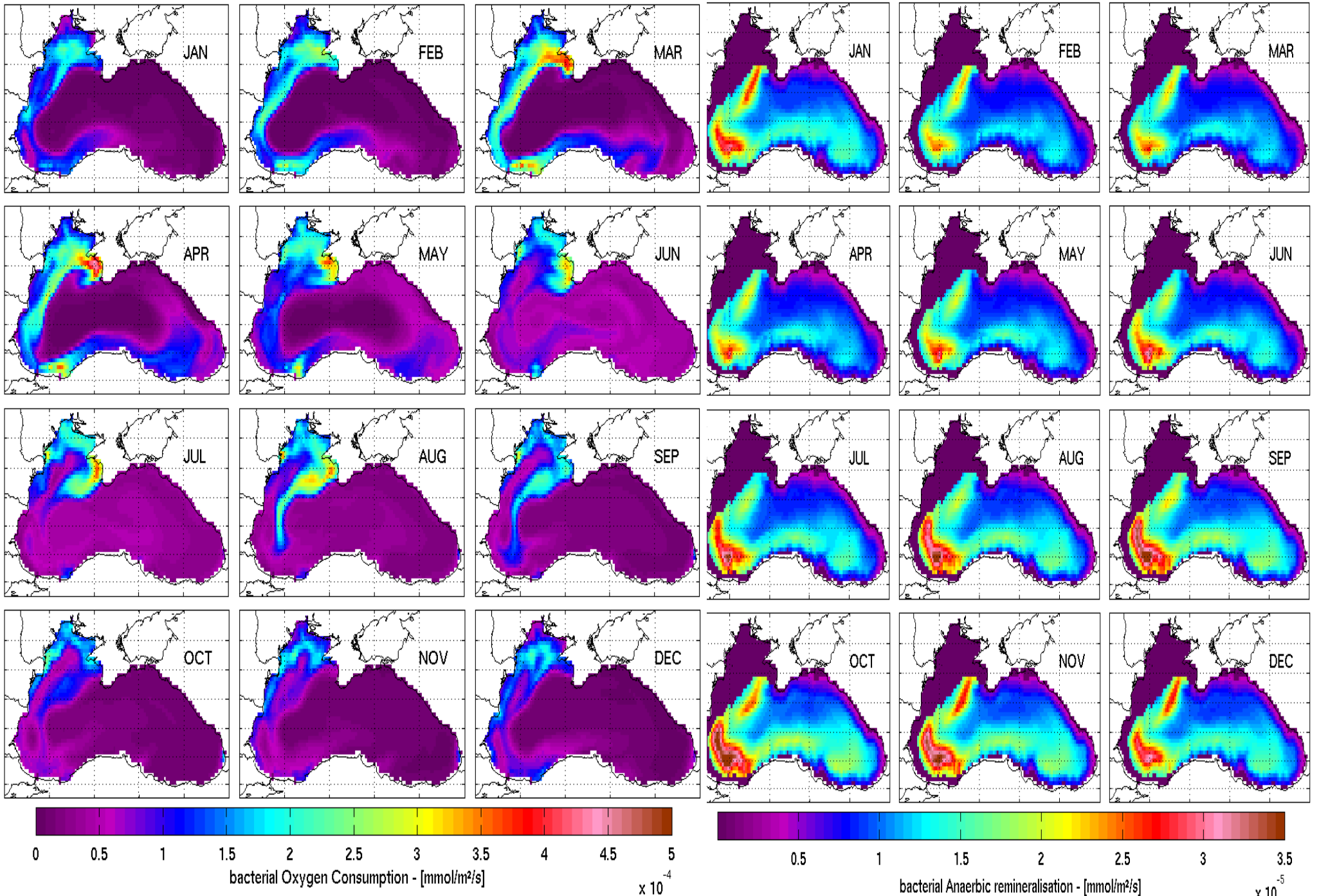
June circulation and Cil interannual anomaly

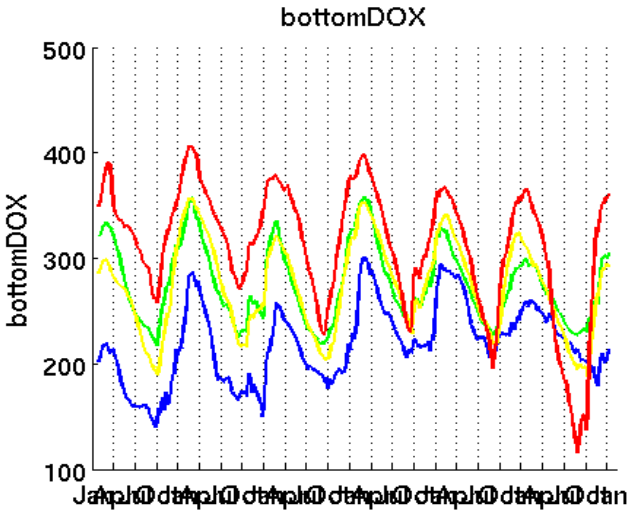


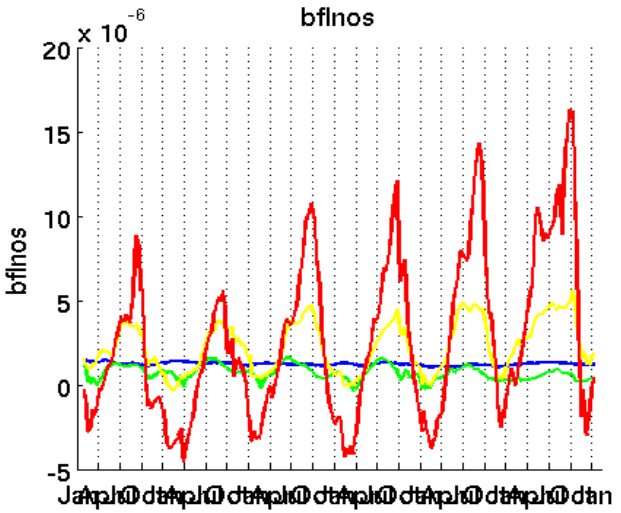
More marked june gyres in intense CIL years, could be the link with imoprtant export. Furthermore, the vertical stratification at the basis of the CIL will impact on material subduction, and the share between lateral and vertical export of shelf's material and nutrients

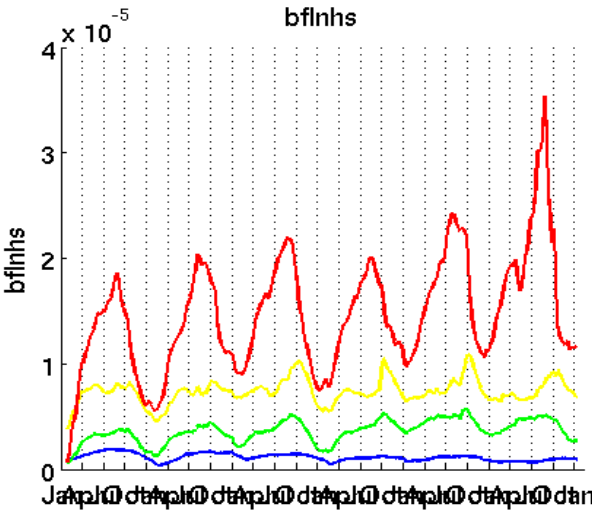
(je peux montrer de la rem anoxique intense par les bactéries en sept qd la CIL s'en va .. à cet endroit où ça coule ... mais pas pour ces années là ...et pas en interannuel .. .. ou es profils avec coexistence de POC et de CIL

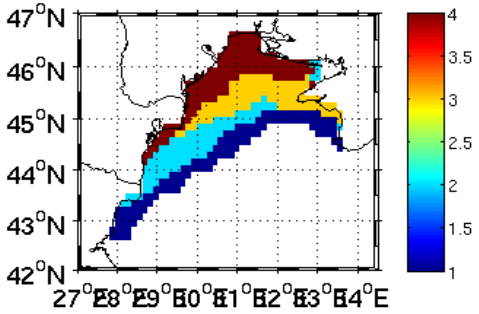
Activité bact .. oxique et anoxique .. malheureusement ps de diag en interannuel ....
Et influence sur les profils verticaux de DOX ou quoi .. pas évident à souligner ...

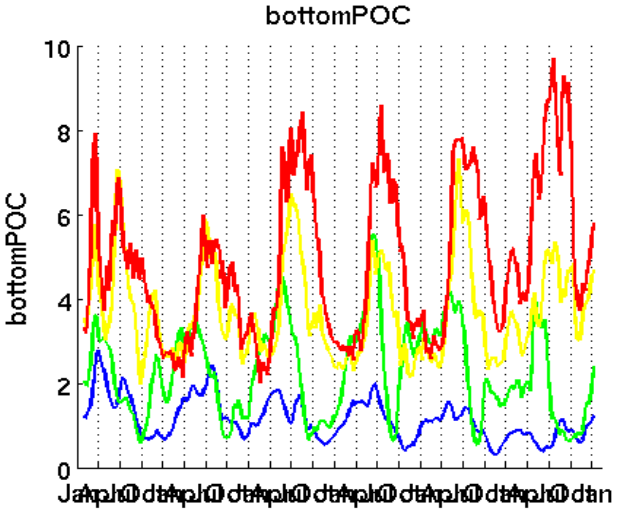


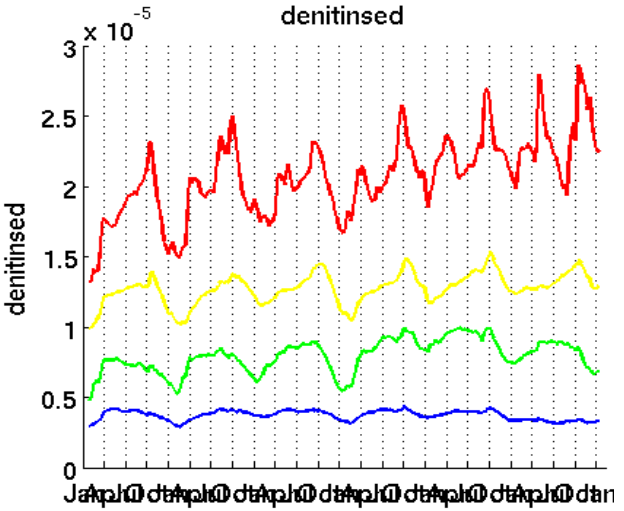




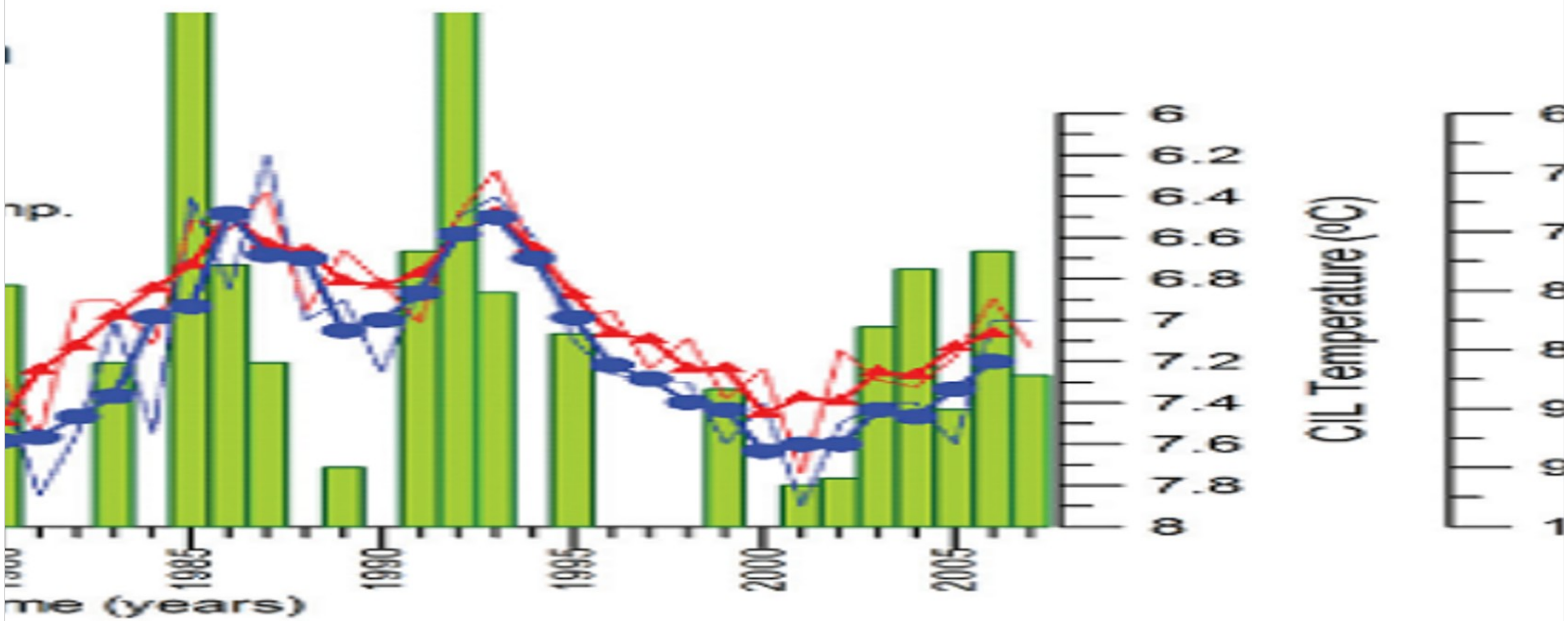


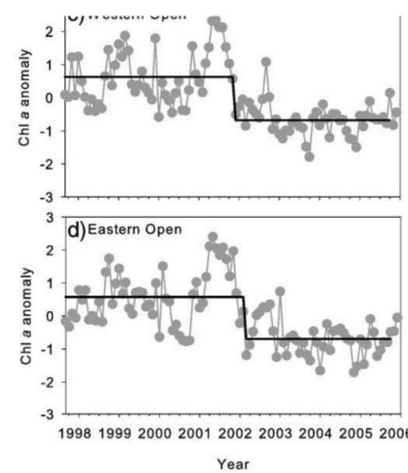






Je compte encore faire comme on avait it pour les regions sur le séduiment du shelf .. des régions (celle-ci) basée sur le tout .. puis evoutions des régiosn interannuel ..
HIC : comme les années réelles sont plus fortes que les clims pour les vagues (extremas quasi doubles) on a une resuspension bcp plus intense .. j'ai du borner le bottmstrss pour pas que ça pet e.. le probleme est que à parti des ICS clims ça donne le temps d'équilibration que tu connais ..


np.
CIL Temperature (°C)
6
6.2
6.4
6.6
6.8
7
7.2
7.4
7.6
7.8
8
1985
1990
1995
2000
2005
me (years)


Chl a anomaly
d) Eastern Open
Chl a anomaly
1998
1999
2000
2001
2002
2003
2004
2005
2006
Year