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

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

31 double-sigma layer

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

The Model

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 explicitly includes anoxic chemistry through 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 due 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]
Main conclusion about shelf sediments:

- 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.

~21 Gmol/yr
~ 1/3 of riverine inputs
Fluxes values : Spatial variability

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


~ 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

-20 Gmol/yr

Shelf's budget

~40 Gmol/yr

N. W. SHELF
Transport to open sea

~40 Gmol/yr
N. W. SHELF

Shelf's budget
Transport to open sea

**Southern shelf break**

**Northern shelf break**
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 detailed this afternoon by G. Shapiro.
Nitrogen destruction in the suboxic layers

- ~ 40 Gmol/yr for oxidation by Sulfide and manganese
- ~ 30 Gmol/yr for ANAMOX

- ~ 52 Gmol/yr for ANAMOX

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

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 twice higher than McCarthy.

Vertical integration of excess N2 from denitrification following Bosporus plume.
June circulation and CIL interannual anomaly

Strong CIL year

weak CIL year

jun1985

jun1986

jun1987

jun1988

jun1989

jun1990

jun1991

jun1992

jun1993

jun1994

jun1995

jun1996
June circulation and Cil interannual anomaly

More marked June gyres in intense CIL years, could be the link with important 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 bactérie oxique et anoxique malheureusement pas 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 régions sur le séduiment du shelf ..
des régions (celle-ci) basée sur le tout .. puis evoutions des régioesn 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
bottomstrss pour pas que ça pet e.. le probleme est que à parti des ICS clims ça donne le
temps d'équilibration que tu connais ..