BFM Benthic

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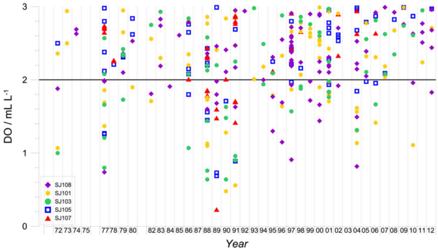
- Biology Filtration, irrigation, turbation, consolidation, production, oxygenation, etc ...

Hypoxia in the Adriatic

We knows that

1. It happened in the Northern Adriatic shelf



T. Djakovac et al. / Journal of Marine Systems 141 (2015) 179–189

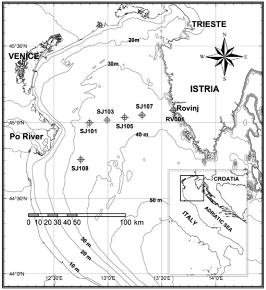


Fig. 1. The northern Adriatic Sea with sampling stations on the profile Rovinj–Po River delta.

Hypoxia in the Adriatic

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2. It happens in the Emilagna-Romana Coastal zone

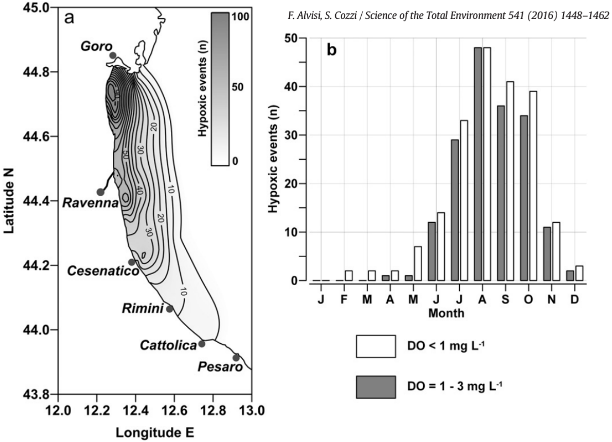


Fig. 2. Total number (n) of hypoxic events recorded in 1977–2008: (a) spatial distribution in the ERCZ, (b) monthly distribution of hypoxia and strong hypoxia.

BFM benthic module

Previously in BFM, 4 levels of complexity :

0. No benthic-pelagic coupling
1. Simple return
2. Benthic Organisms + intermediate diagenetic model
3. Benthic Organisms + diagenetic model

0. No benthic-pelagic coupling

$\equiv$ Bath Tub

- No sediment layer
- Sinking OM accumulates in the lower layer
- All mineralisation process are driven by pelagic formulations

$\rightarrow$ Delocalisation of OM remineralization, and pelagic rates instead of benthic rates.

1. Simple Benthic return

Benthic stocks for Organic Matter

- Sinking OM accumulates in the sediments
- Fixed mineralisation rates provide Oxygen and nutrient fluxes
- No burial (except from the standing equilibrium benthic stock when mineralisation = sedimentation)
- No benthic losses (e.g. denitrification, P sequestration) : All mineralised fluxes are sent back to the water column

2. Benthic Organisms + Simple Benthic return

Benthic food web includes (all heterotrophs)

H1 : **Aerobic bacteria**

H2 : **Anaerobic bacteria**

Y1 : **Epibenthic predators** ∼ Megabenthos, acts on surface

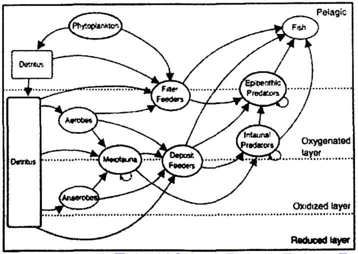
Y2 : **Deposit feeders**, feeds on Benth. Detritus + small Benth. Organisms

Y3 : **Filter feeders**, feeds on Pelagic OM and Phy.

Y4 : **Meiobenthos**: Large aggregation. Small → No effect on sed. mix.

Y5 : **Infaunal predators** "hunt" in the sediments for prey of their size

- Vertical distribution of OM and organism activity.
- No diagenetic modelling (fixed rates, no losses)



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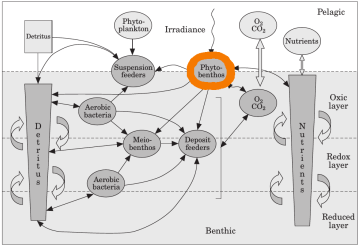
- Later version of ERSEM (Blackford, 2002) includes Microphytobenthos (diatoms)



3. Benthic Organisms + Diagenetic model

- Now includes pore water dissolved state variables : $\mathrm{O_2}$, $\mathrm{NO_3}$, $\mathrm{NH_4}$, $\mathrm{PO_4}$, SiO + Reduction Equivalent
- No vertical resolution, but analytical resolution for three (variables) layer : Oxic, Suboxic, Anoxic.

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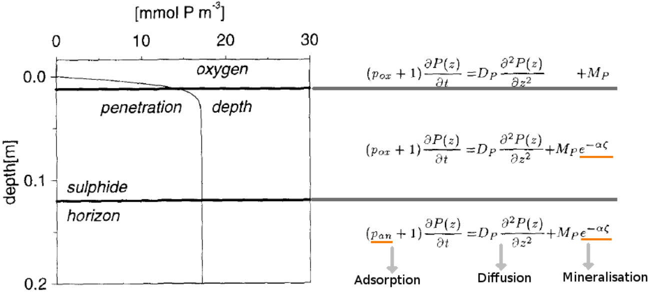

Figure: Example for phosphate dynamics.

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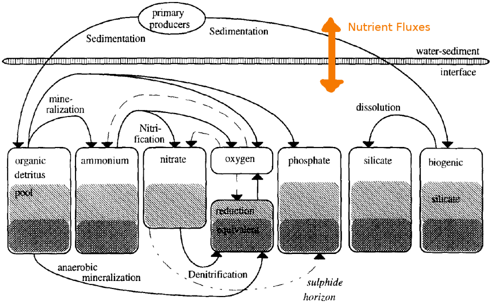
- No vertical resolution, but analytical resolution for three (variables) layer : Oxic, Suboxic, Anoxic.
- Bioturbation and bioirrigation derive from benthic organisms
- Benthic losses and burial finally enabled

3. Benthic Organisms + Diagenetic model



- Oxygen consumption (miner., nitrif. and oxid. of reduction equivalents) determines oxygen penetration depth.
- Oxygen penetration modifies the nutrient dynamics.
- The sulphide horizon depth derives from the nitrate module and controls the adsorption properties of Phopshate

Table

CalcBenthicFlag	Retention	Seasonal inertia	Interannual inertia	Denitrification	P retention	Variability of P,N diagenesis	Biology
0	X	X	X	X	X	X	X
1	V	V	X	X	X	X	X
2	V	V	X	X	X	X	V
3	V	V	X	V	V	V	V

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1b	V	V	V	V	X	V	X
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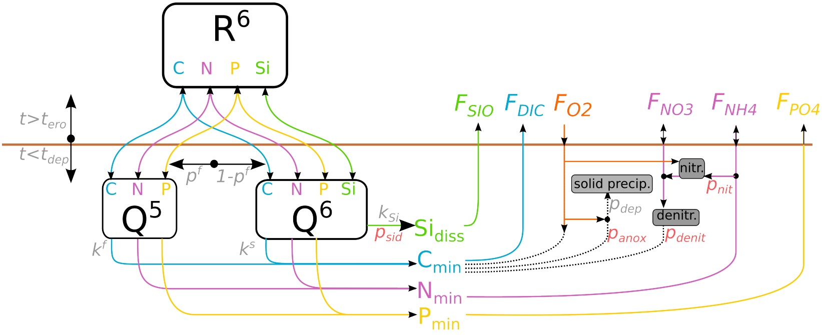
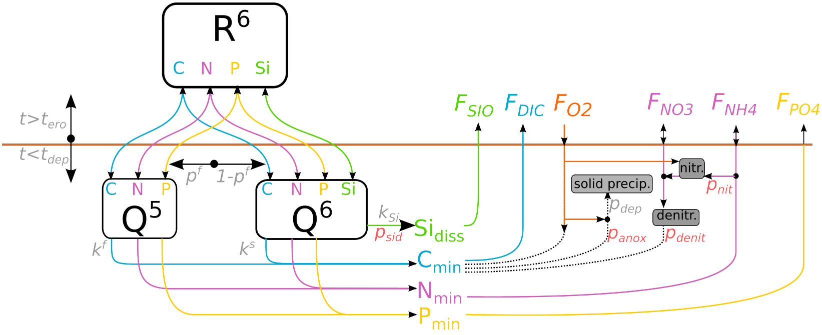
3	V	V	X	V	V	V	V
OMEXDIA	V	V	V	V	V	VV	X

B1B



p_{anox} part of anoxic mineralization (ie. producing ODU)

B1B



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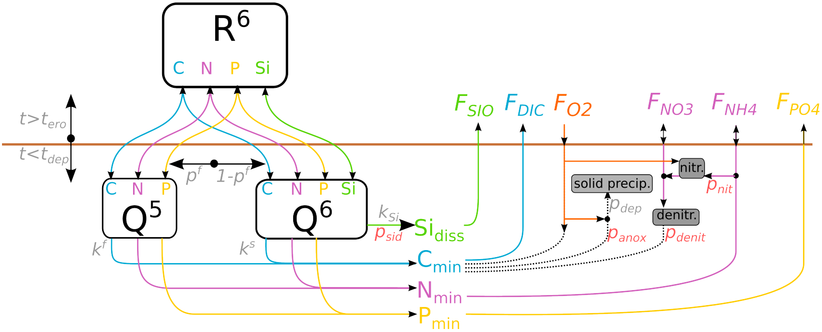

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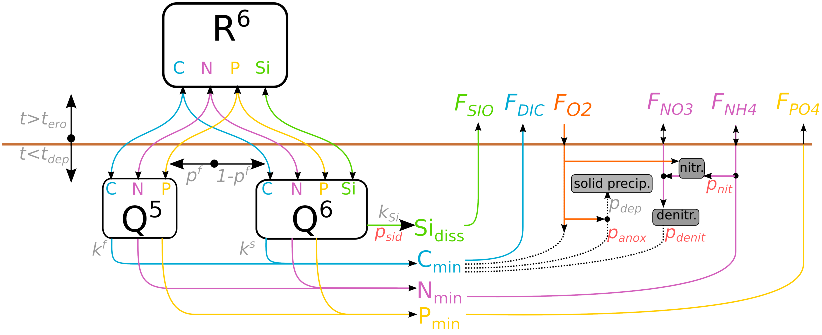

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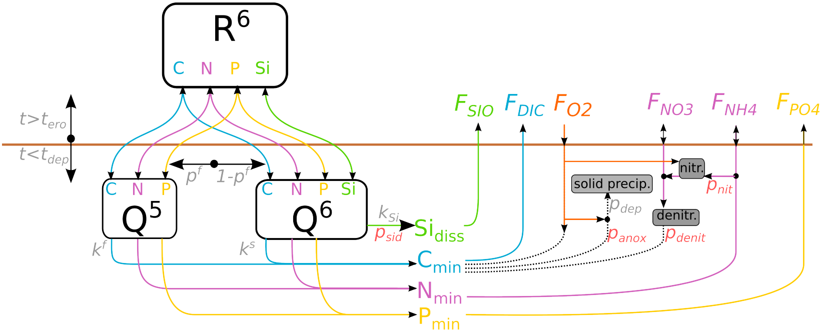

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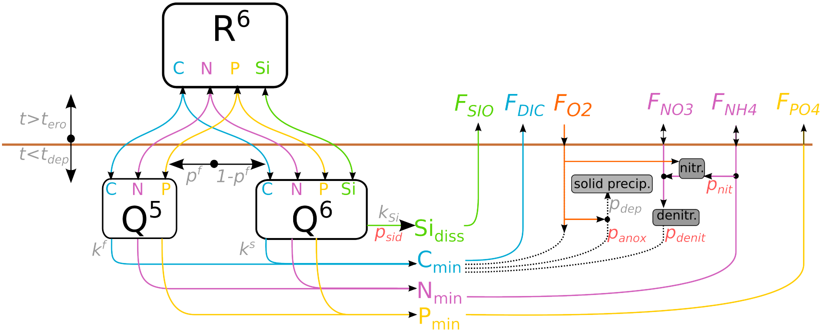

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$$p_{\ldots} = f\left(\mathrm{O}_{2,\mathrm{bottom}}, \mathrm{NO}_{\mathrm{x},\mathrm{bottom}}, \mathrm{NH}_{3,\mathrm{bottom}}, \mathrm{SiO}_{2,\mathrm{bottom}}, \mathrm{C}_{\mathrm{min}}\right)$$

Meta-modelling

1. Calibrate (extend) OMEXDIA model from observations

OMEXDIA

- C,N,O,ODU,**P,Si**
- 100 lev. for 50 cm
- non-local irr.
- 2 lability (fixed)
- in-situ
  - Bottom Water
  - Porosity
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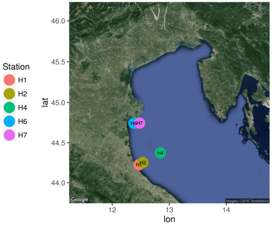

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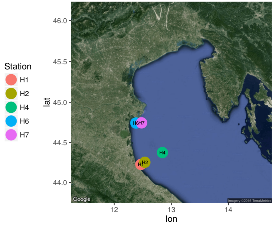

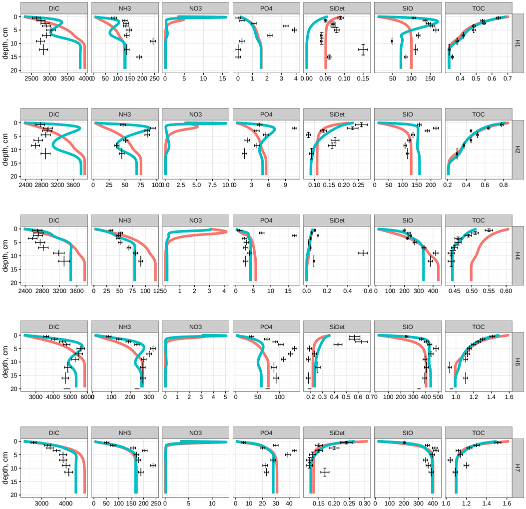

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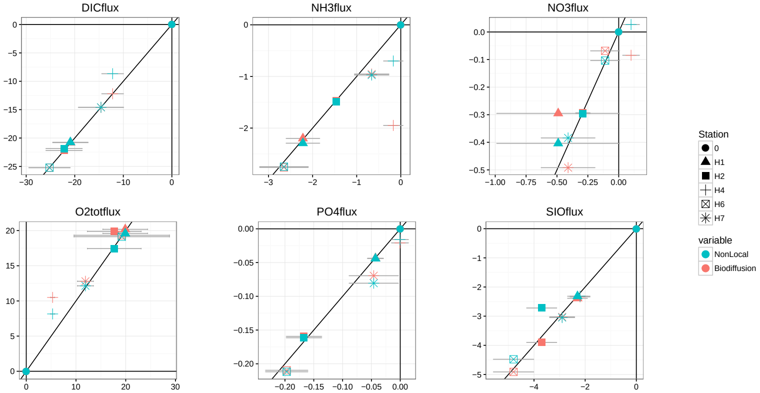

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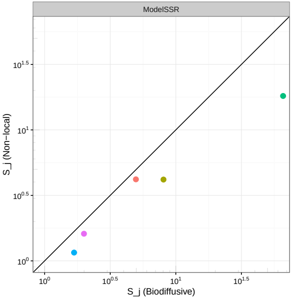

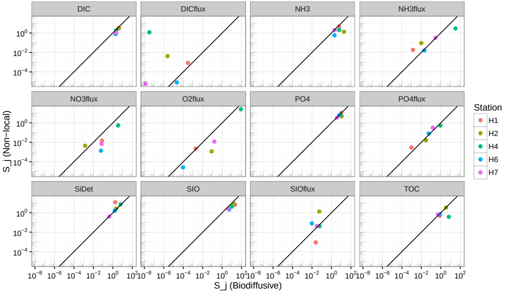

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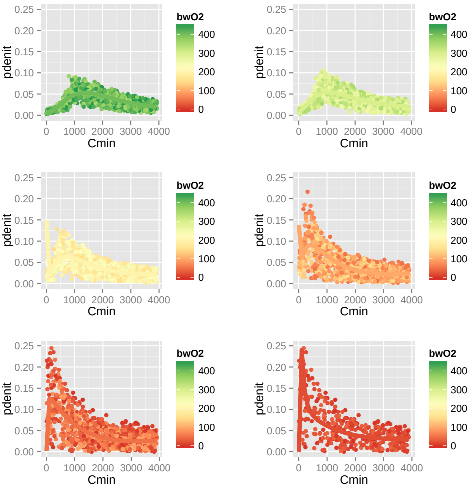

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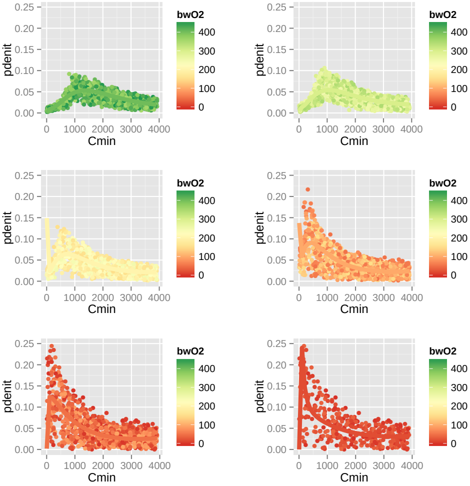
3. Derive functions for B1B



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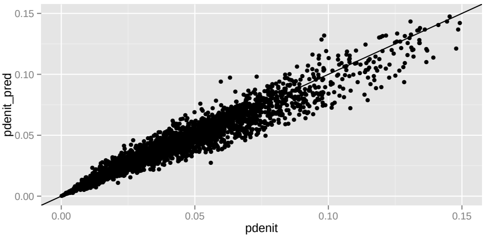
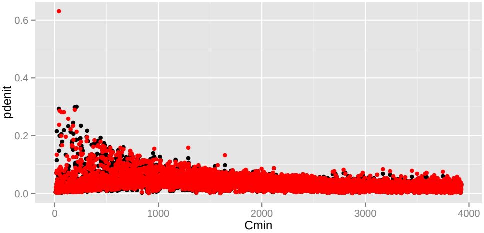
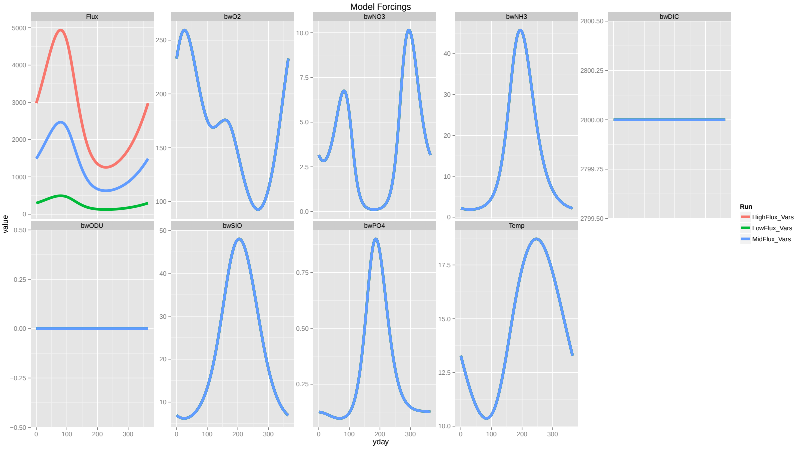




Steady State VS Dynamic



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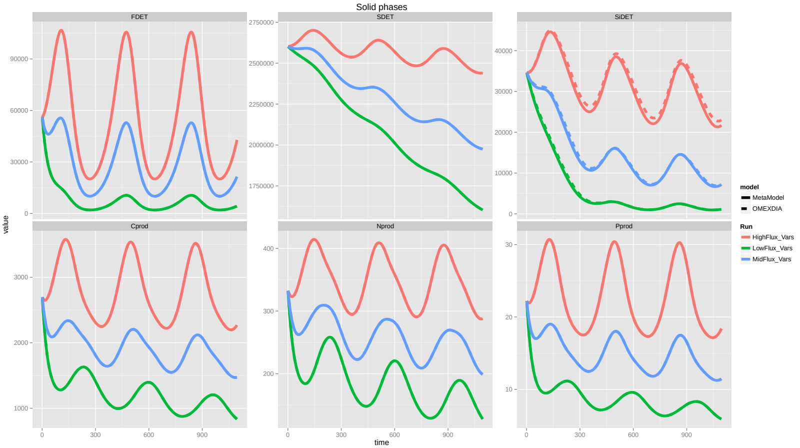

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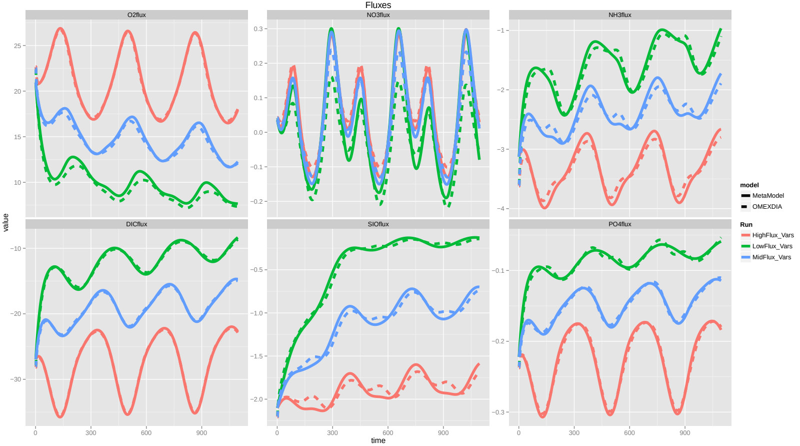

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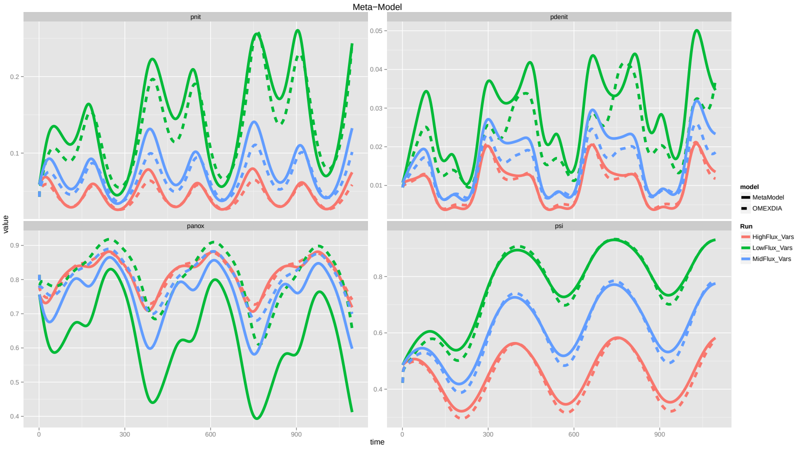

B1B in the Med

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- Mask for CalcBenthicFlag
- Real case resuspension
  - Waves (CMEMS)
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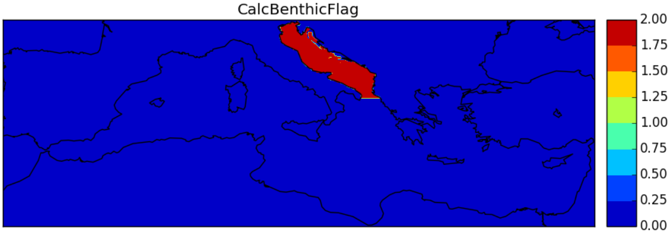

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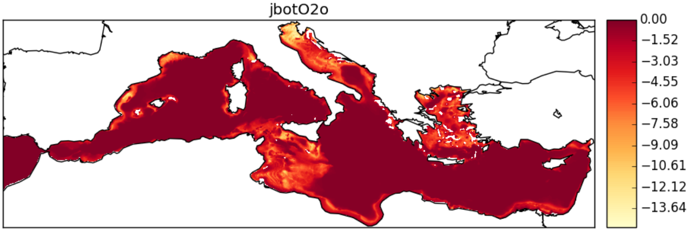

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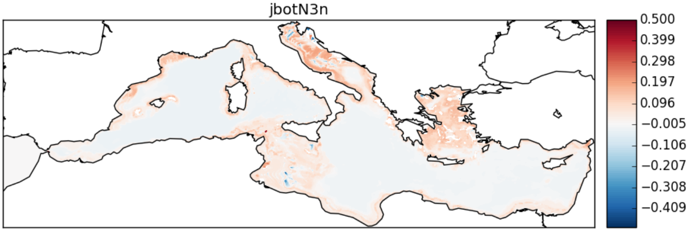

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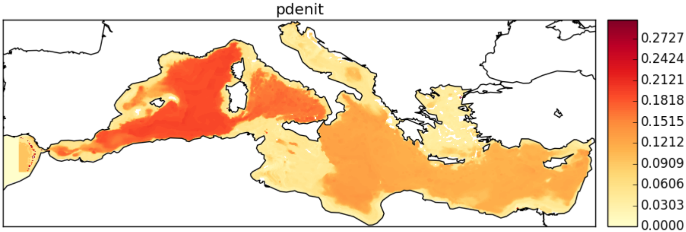

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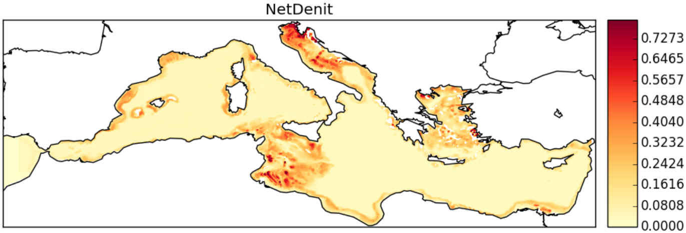

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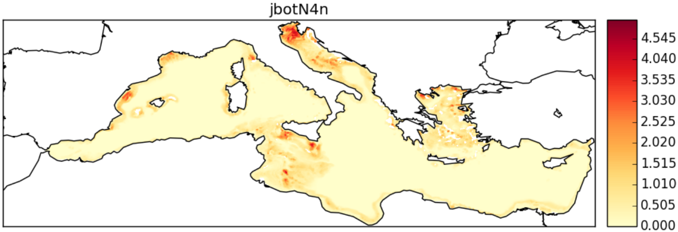

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Side Steps :

- B1B - CO_2
- B1B - Biology

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Börstenwürmer des Meeres.

1. *Heteronereis vagans* Quat. 2. Röhren der *Sabella* im Kalkstein. 3. *Terebella Emmalina* Quat. 4. *Serpula fascicularis* Lam. und *Serpula triangularis* Quat. 5. *Hetione Schmardae* Quat. 6. *Eunice magnifica* Quat. 7. *Sabellaria alveolata* Sav. 8. *Vermilia socialis* Quat.