The role of sediment resuspension in biogeochemical cycling across continental shelves

A modelling study of the Black Sea system

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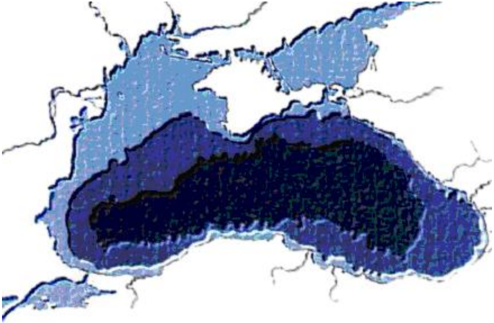
Northwestern shelf

- $<$ 120 m
- Large freshwater and nutrient inputs

Central basin

- 120 - 2000 m
- Strong stratification



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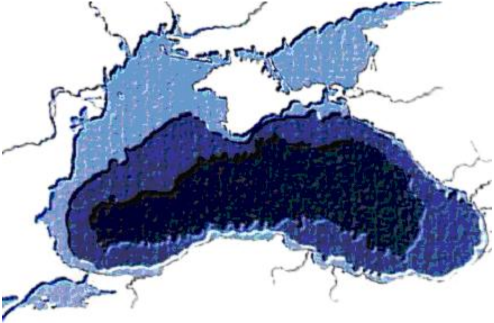
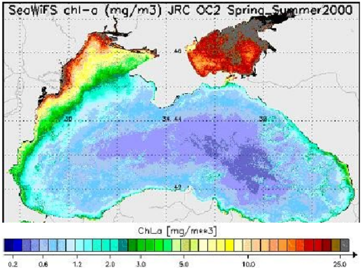
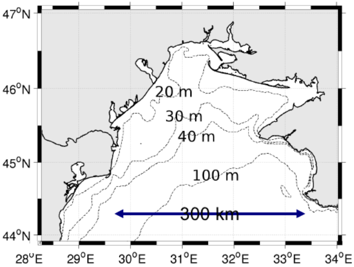


Objectives:
Resolve biogeochemical budgets across River-Shelf-Basin continuum.





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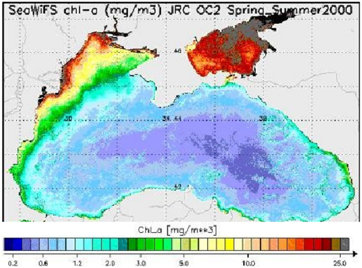

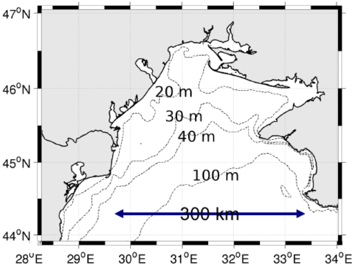

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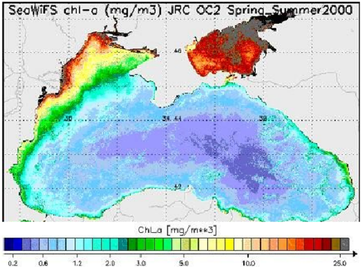

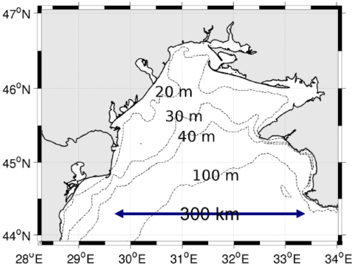

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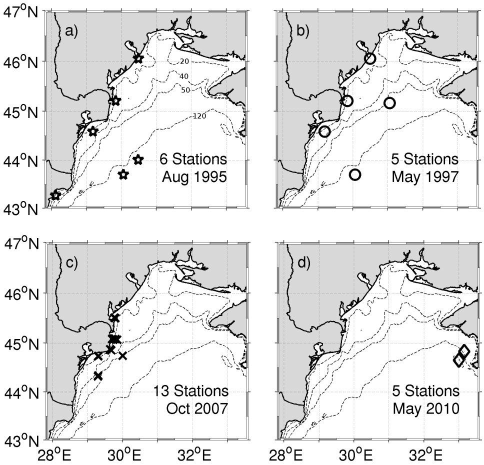
$\rightarrow$ Importance of benthic-pelagic coupling to represent the shelf biogeochemistry

- Benthic-dissolved fluxes are expensive measurements.
- Few available data



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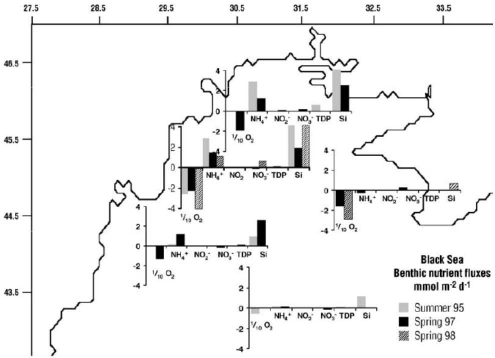

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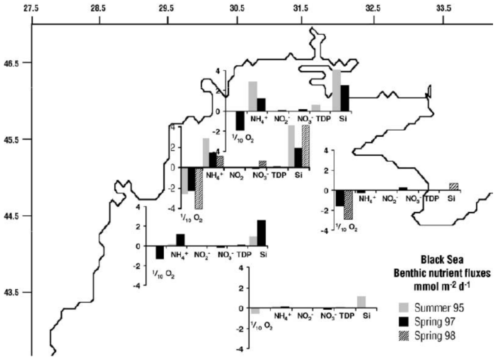
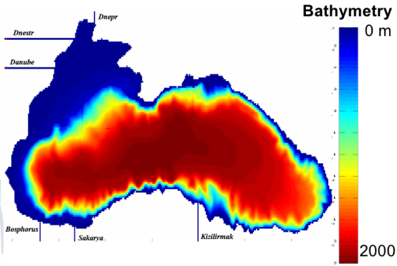
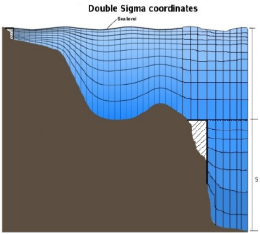


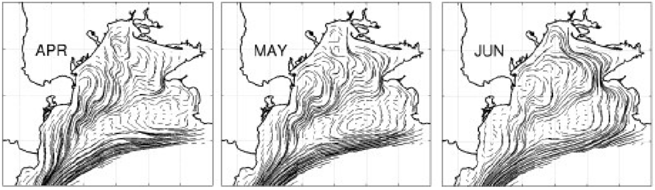
Technical requirement: set up a bentic-pelagic coupled model resolving the variability of benthic solutes fluxes

GHER 3D Hydrodynamic Model

Hydrostatic model, Double Sigma coordinates, Real time forcings (ECMWF)
Provides : T, S, TKE, U, V, η

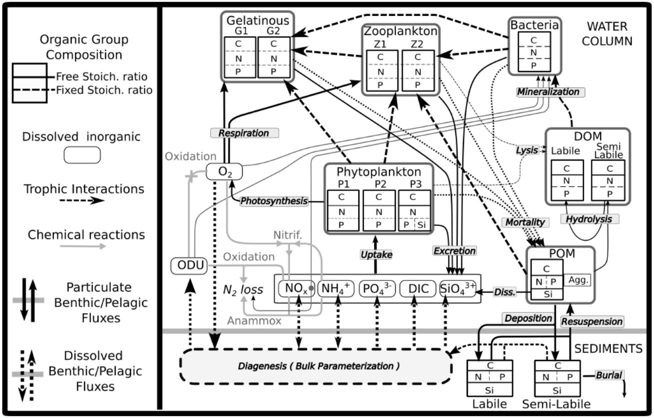






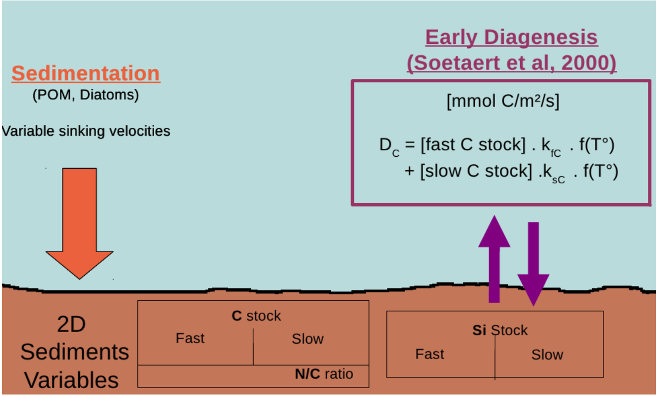
GHER 3D Biogeochemical Model

Provides : C, N, P, Si, O2 cycling through various forms.



Benthic-Pelagic coupling

Provides : Fluxes at the sediment water interface.



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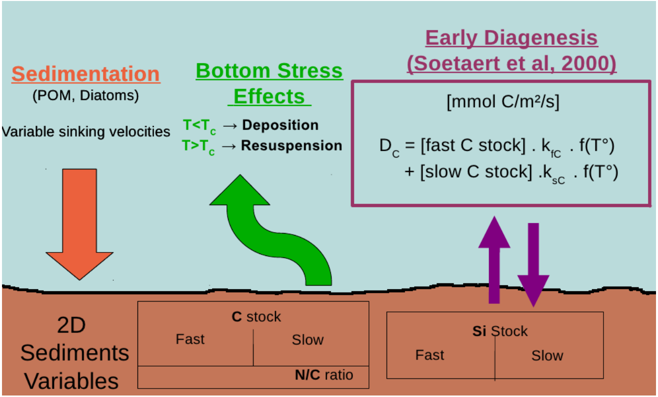


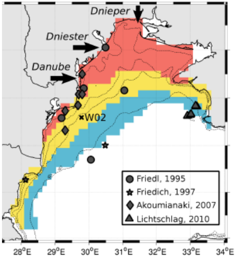
Benthic-Pelagic coupling

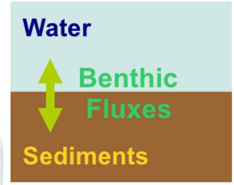
$\tau = \tau_{currents} + \tau_{waves}$
$\tau_{currents} \leftarrow$ (GHER model)
$\tau_{waves} \leftarrow$ (WAM model, offline)

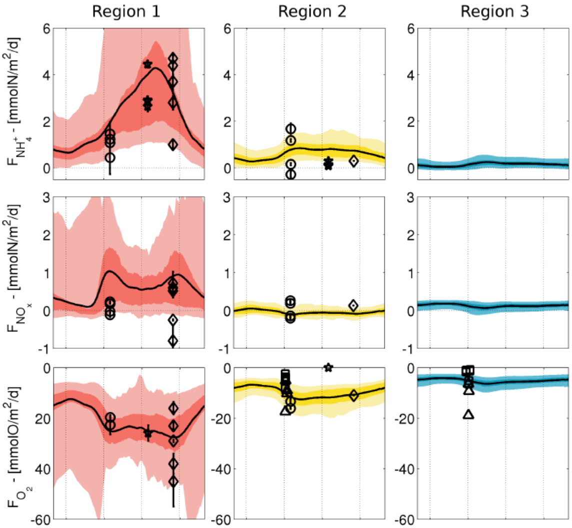
Kandilarov and Stanev, 2012
τ^f: Critical stress for deposition and erosion of S^f.
τ^s: Critical stress for erosion of S^s.

Deposition $\tau < \tau^f$	Resusp. S^f $\tau^f < \tau$	Resusp. S^s $\tau^s < \tau$
$P = (1 - \frac{\tau}{\tau^f}).w_{POM}.[POM]$	$P^f = (\frac{\tau}{\tau^f} - 1).Me^f$	$P^s = (\frac{\tau}{\tau^s} - 1).Me^s$

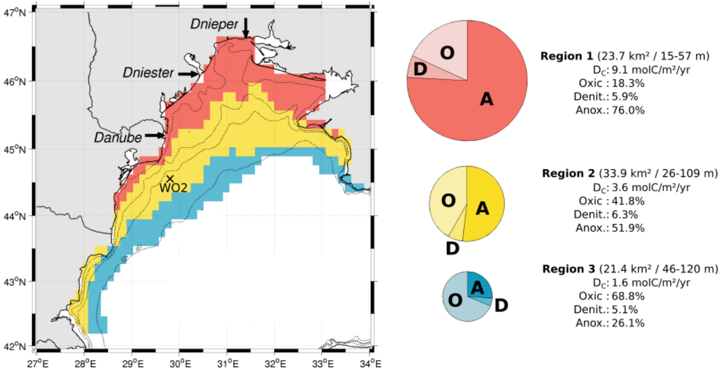
Fluxes Validation



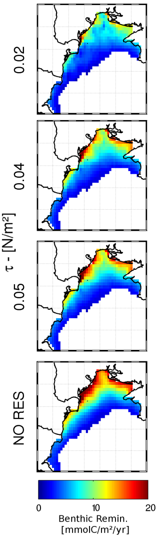




Diagenetic variability



Bottom stress effects impact on spatial variability



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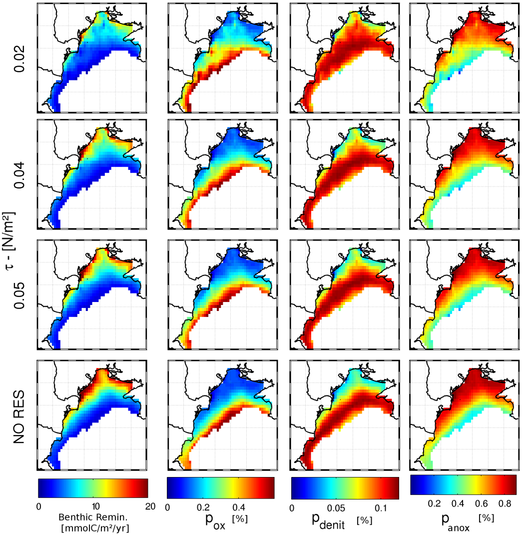
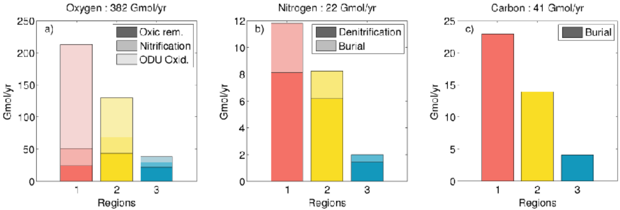


Bottom stress effects impact on shelf budgets



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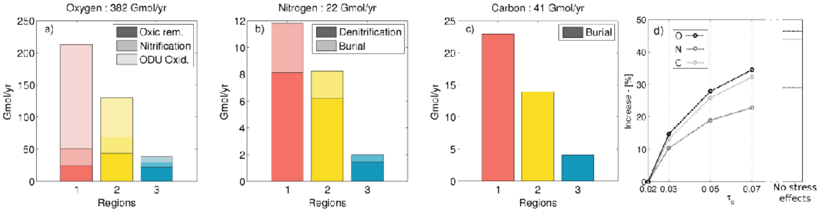
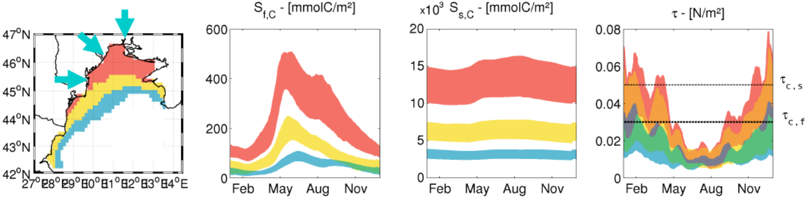


Bottom stress effects impact on seasonal variability



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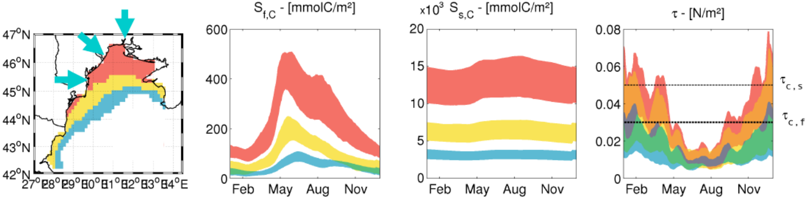
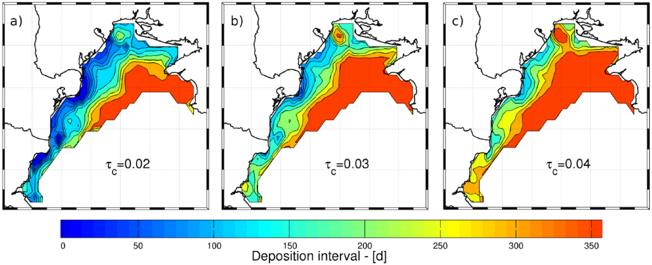
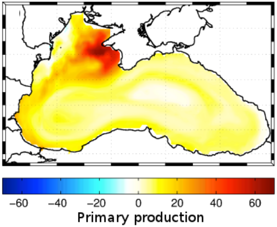




Bottom stress effects impact on basin budgets

Relative increase: $\tau_{dep} = 0.02$ compared to $\tau_{dep} = 0.05\ \mathrm{N/m^2}$



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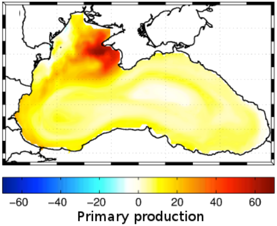

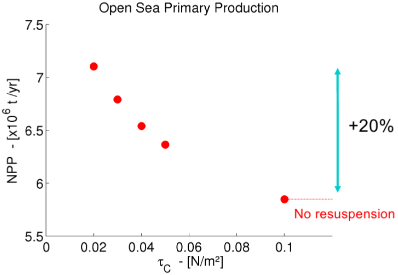

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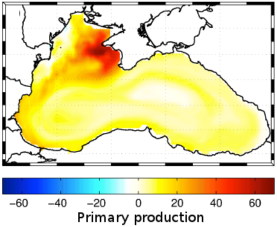

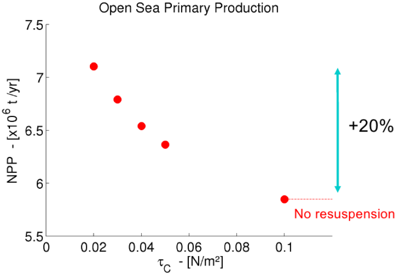

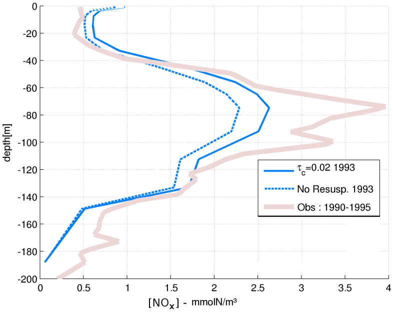

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  - .. is difficult AND bears large scale impacts,
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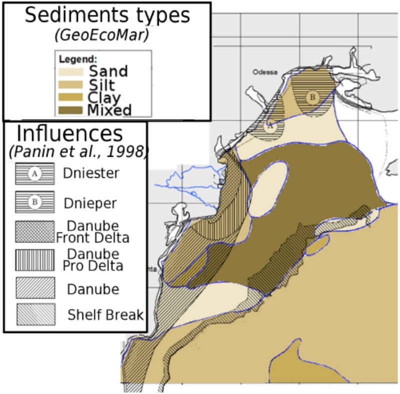
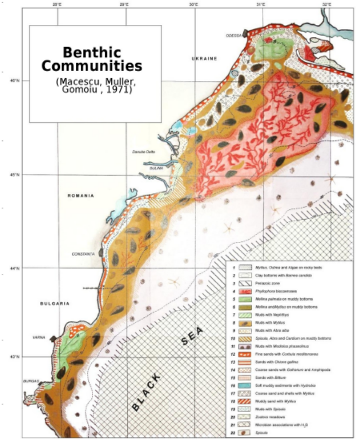
  - .. and, consequently, basin scale budgets.

What's next ?

Big gaps in this study :

- Fixed roughness length
- Fixed critical resuspension thresold and erodability constant





Thank you for your attention