Benthic contributions to Adriatic and Mediterranean biogeochemical cycles

Arthur Capet, Paolo Lazzari, Federico Spagnoli, Giorgio Bolzon, and Cosimo Solidoro

July 14, 2017

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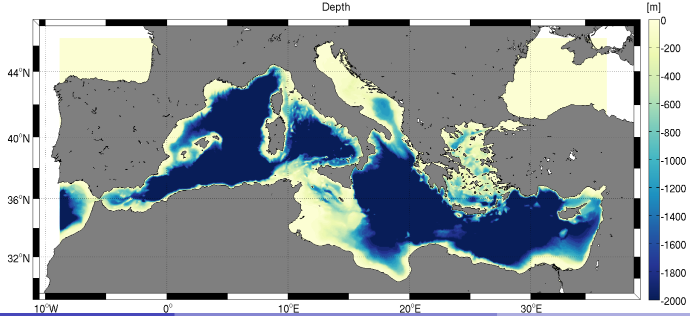
- Denitrification: Net N removal, eg. Black Sea *Capet et al. 2016*
- Phosphate sequestration: eg. Baltic Sea, North Sea *Slomp et al. 1998*
- Benthic biology services: Filtration, irrigation, turbation, consolidation, production, oxygenation,... *Norko et al. 2012*

Model Set-up

- Physics: CMEMS, 1/16°, 72 z-levels, NEMO
  - Climatology (1997-2007), offline (24h)



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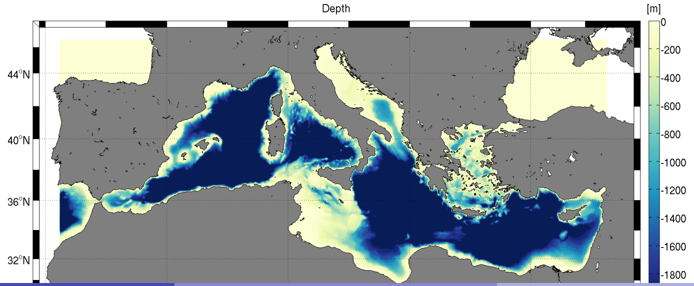
- Physics: CMEMS, 1/16°, 72 z-levels, NEMO
- Biogeochemistry: BFM *Vichi et al. 2007, Lazzari et al. 2010, 2012*
    - C, N, P, Si, O , reduced
    - 4 Phyto., 3 Zoo., 2 Bact.



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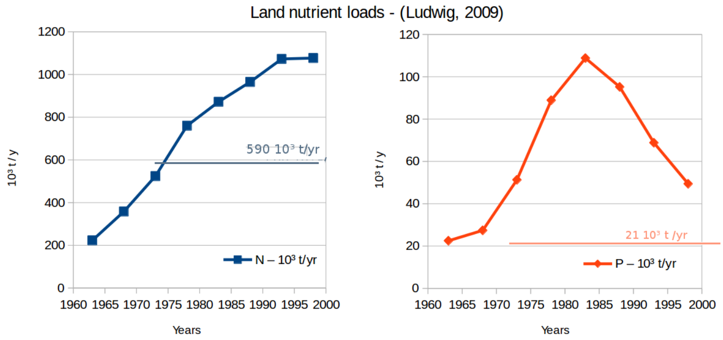
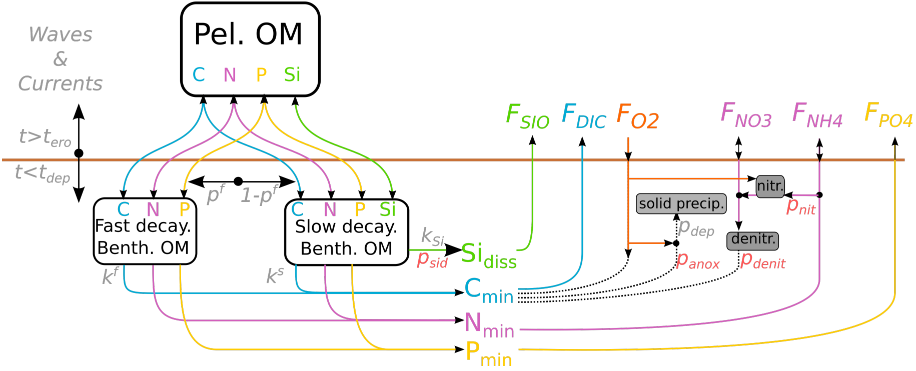
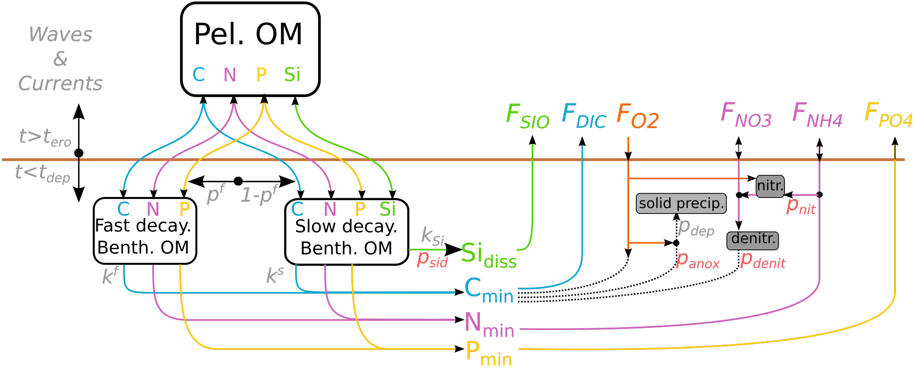
- Physics: CMEMS, 1/16°, 72 z-levels, NEMO
- Biogeochemistry: BFM *Vichi et al. 2007, Lazzari et al. 2010, 2012*
- Atmospheric deposits: Nitrate and phosphate deposit *Ribera d'Alcalà et al., 2003*
- Gibraltar: Newtonian dumping towards MEDAR-MEDATLAS
- Land inputs: *Ludwig et al., 2009*



The Benthic module



The Benthic module : transfer function



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

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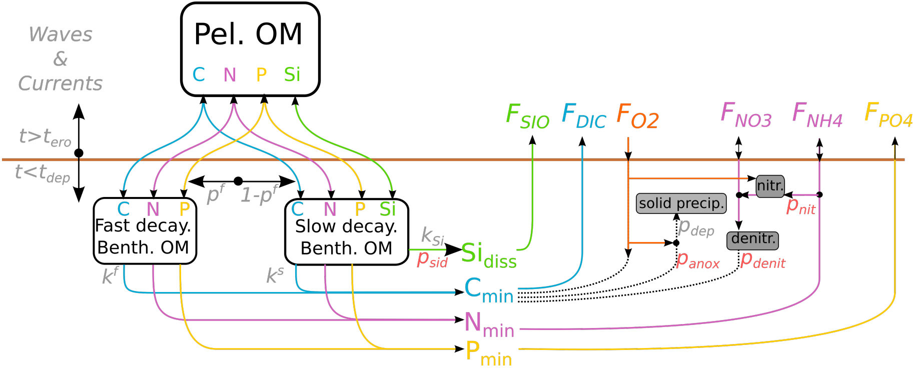

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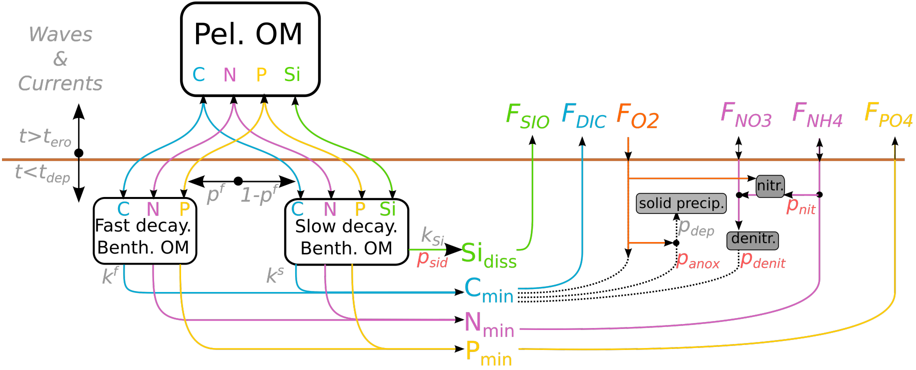

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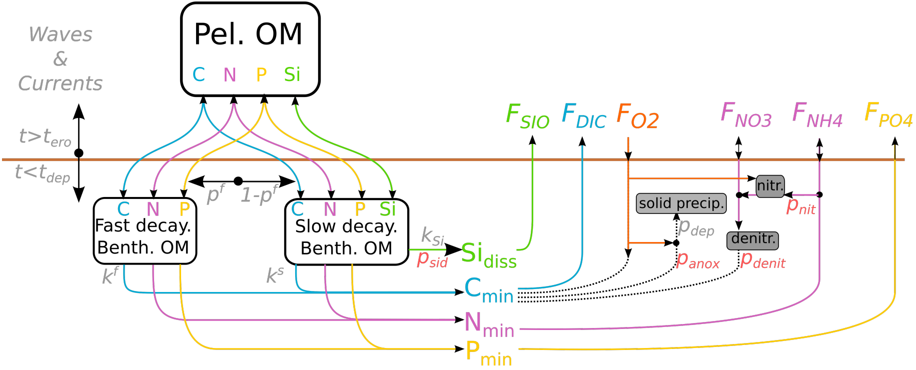

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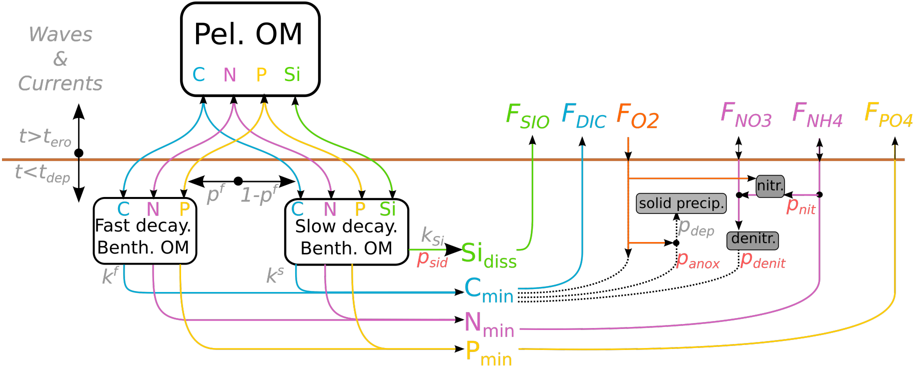

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$$p_{...} = f\left(\mathrm{O}_{2,\mathrm{bottom}}, \mathrm{NO}_{\mathrm{x},\mathrm{bottom}}, \mathrm{NH}_{3,\mathrm{bottom}}, \mathrm{SiO}_{2,\mathrm{bottom}}, \mathrm{C}_{\mathrm{min}}\right)$$

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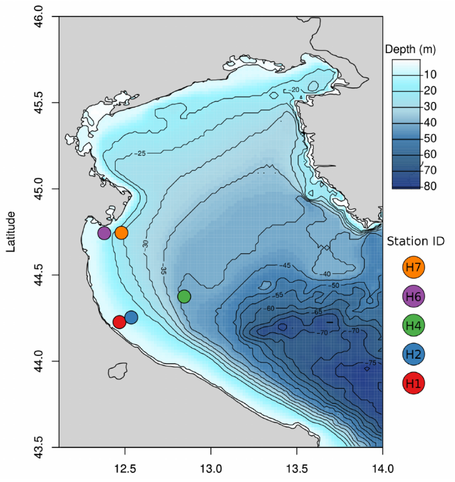

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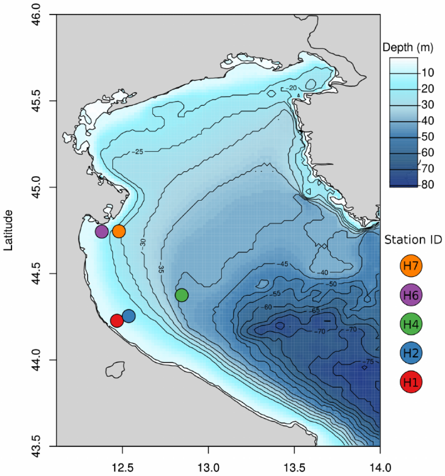
2. Perturbated Monte Carlo simulations



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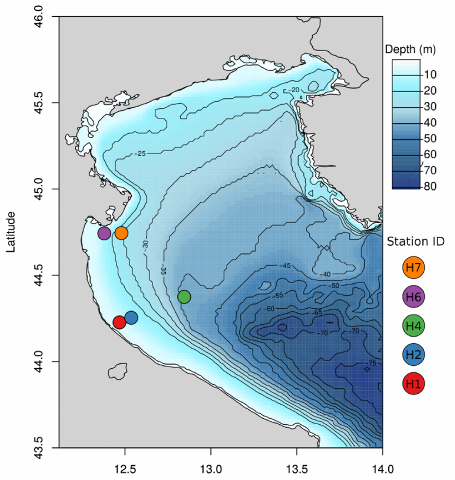
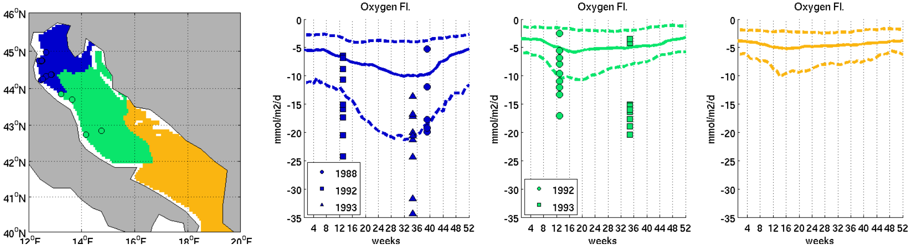
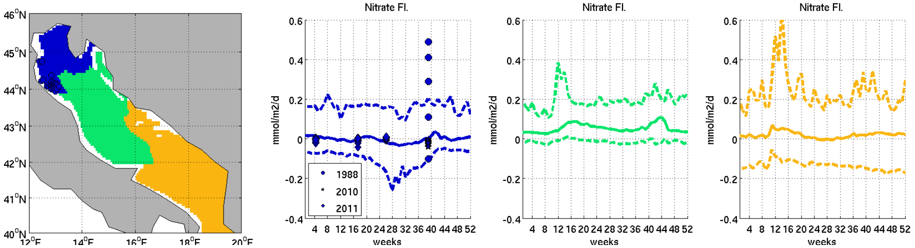


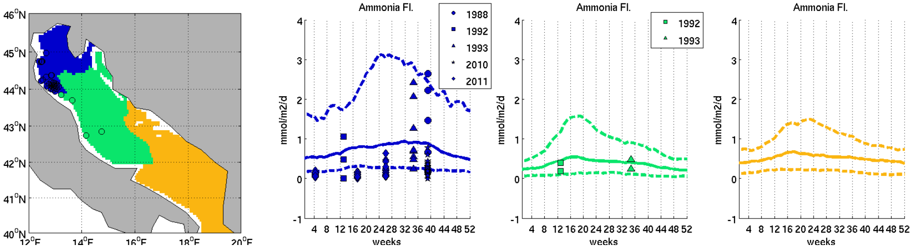
Benthic Fluxes : Oxygen



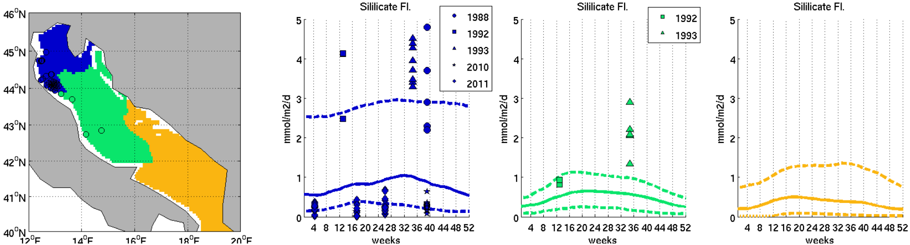
Benthic Fluxes : Nitrate + Nitrite



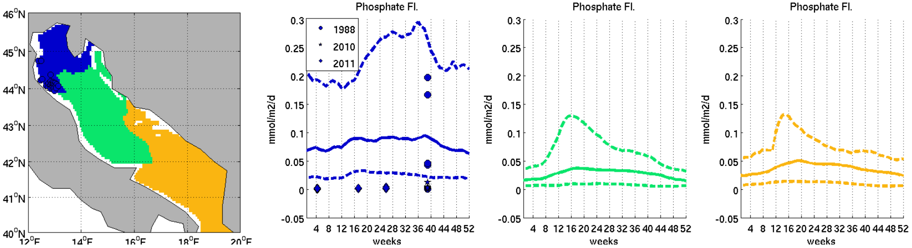
Benthic Fluxes : Ammonia



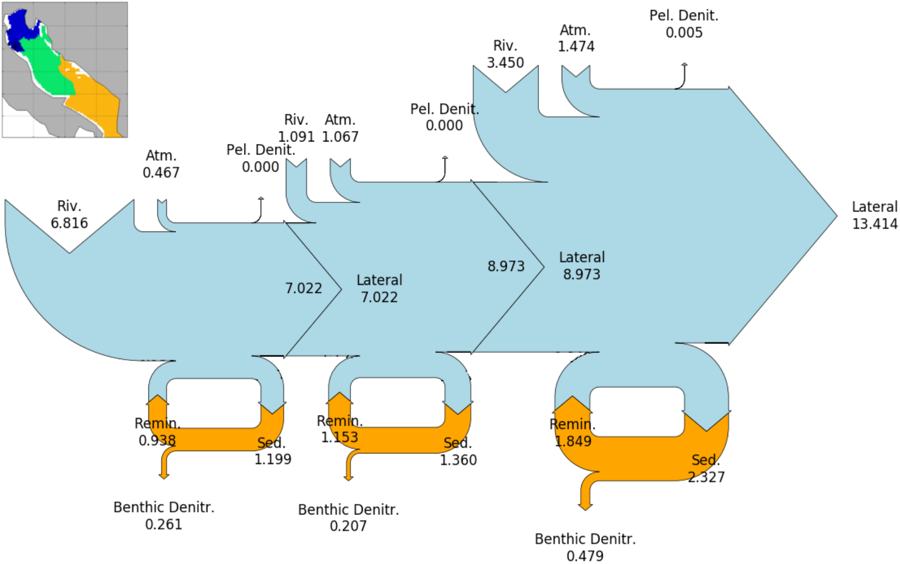
Benthic Fluxes : Silicate



Benthic Fluxes : Phosphate



Nitrogen Budgets



1. Intro

2. The 3D model Set-up

3. Comparison with observations

4. Contribution to budgets

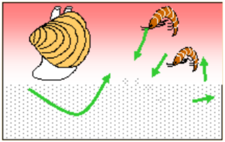
5. The role of biology

6. Nutrient retention and recycling

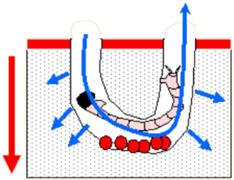
7. Conluding remarks

Biological control on Benthic-Pelagic coupling

Bioturbation



Bioirrigation



M. Tackx

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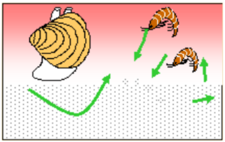
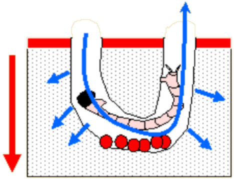


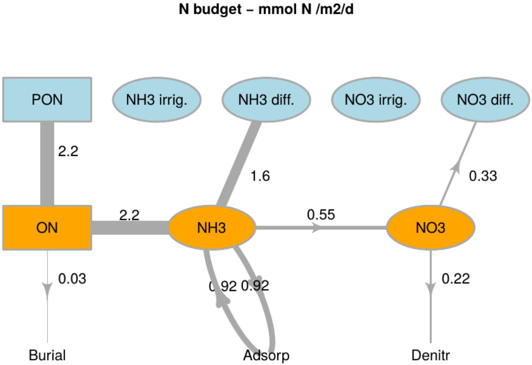


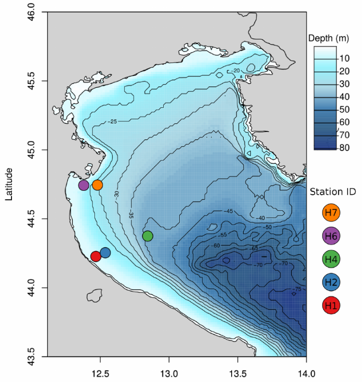
Sensitivity analysis of the (1D diagenetic) OMEXDIA model parameters :

1. Quantity of organic matter input
2. The mixed layer depth
3. Bio-irrigation intensity
4. Quality of organic matter input
5. Bio-turbation intensity

Biological control

Bio-irrigation impact on benthic denitrification





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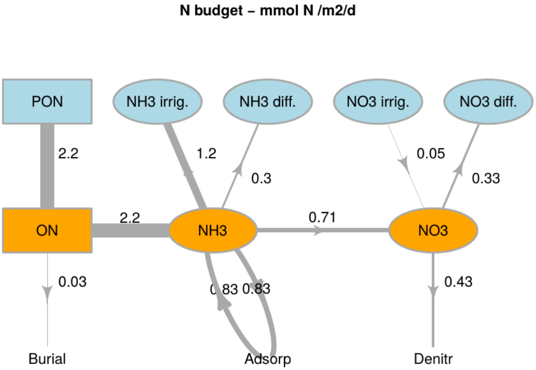
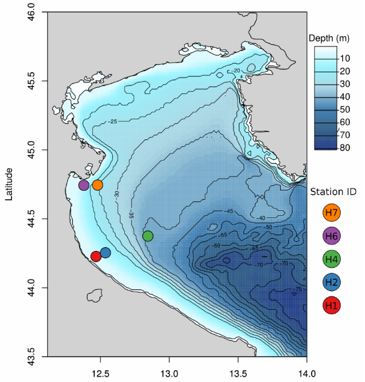
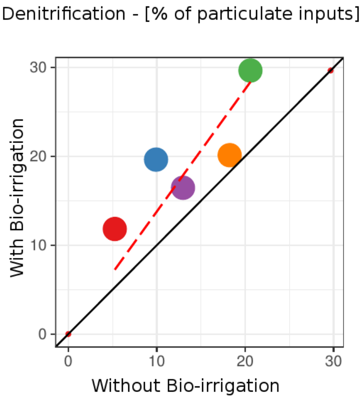
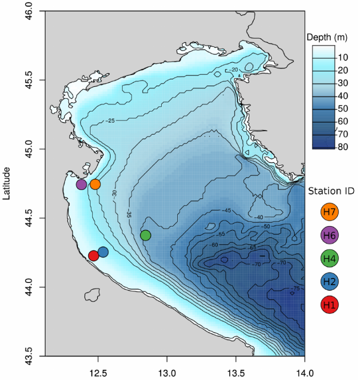




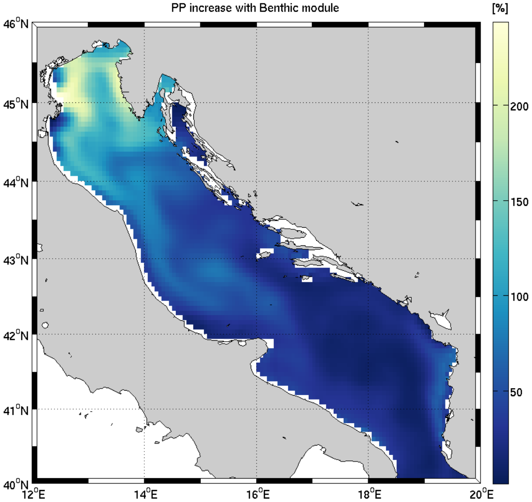
Biological control

Bio-irrigation impact on benthic denitrification : + [10 - 100] %





Primary production increase due to benthic retention



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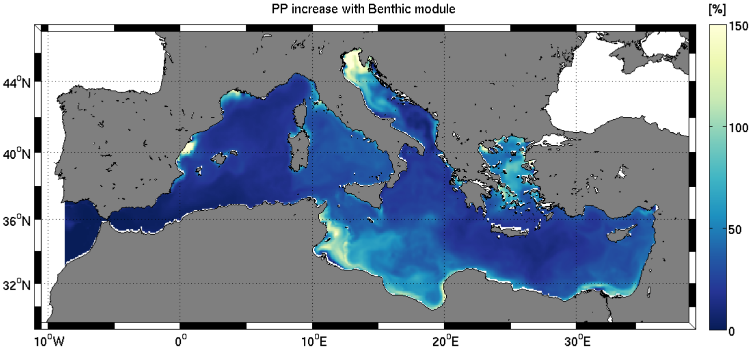

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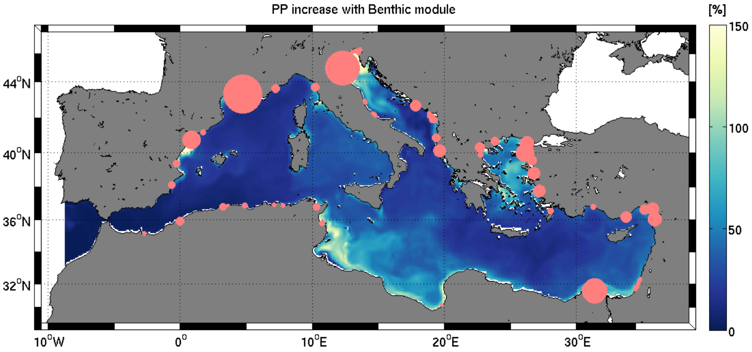

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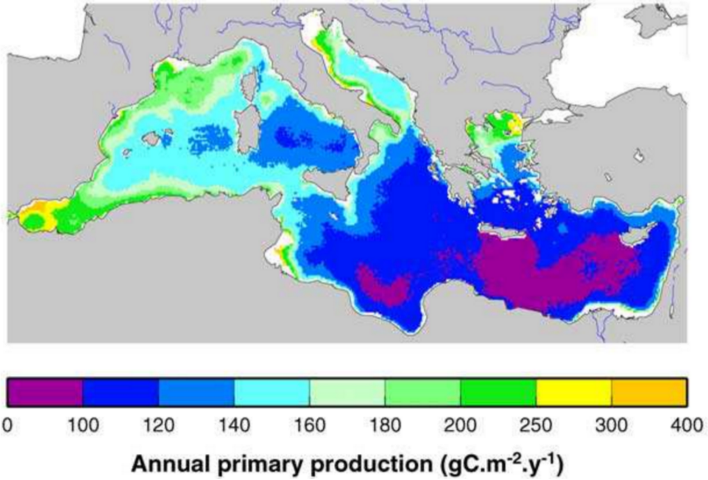

Bosc et al. 2004

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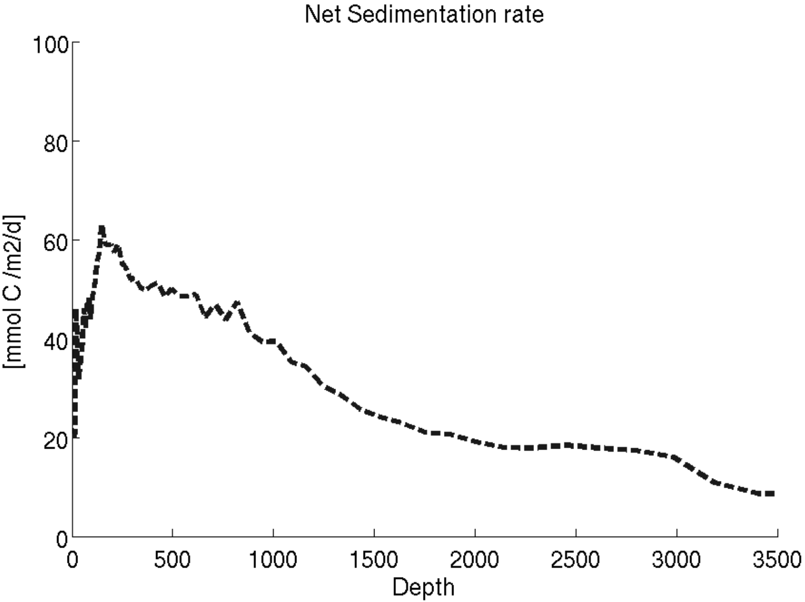

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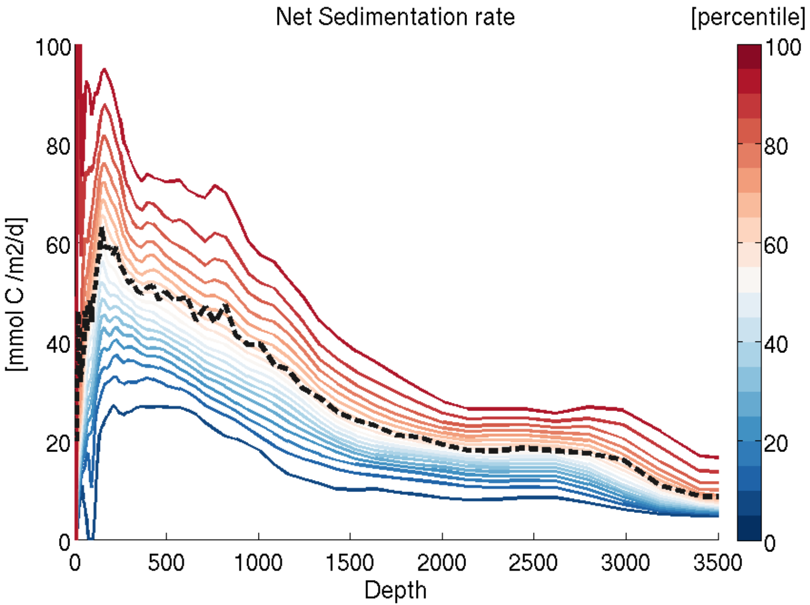

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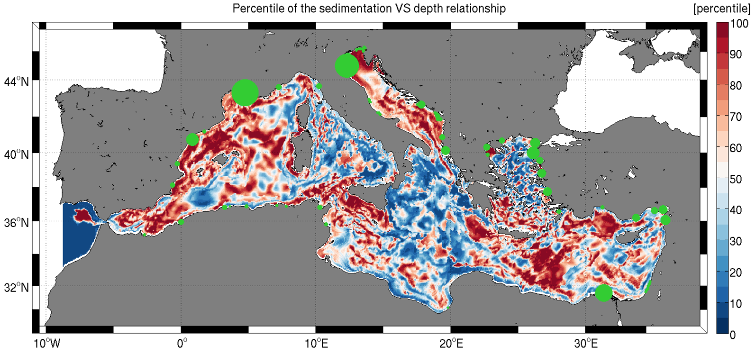

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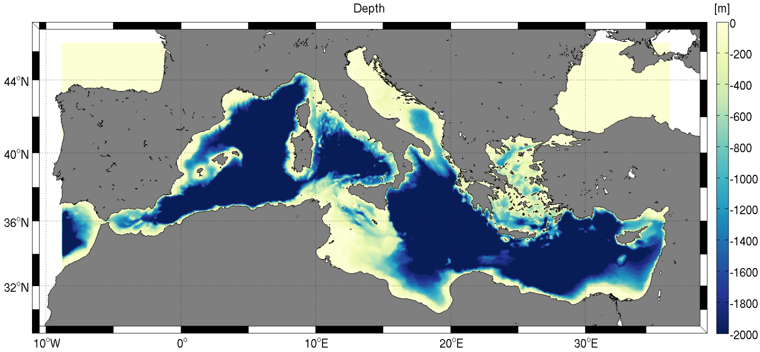

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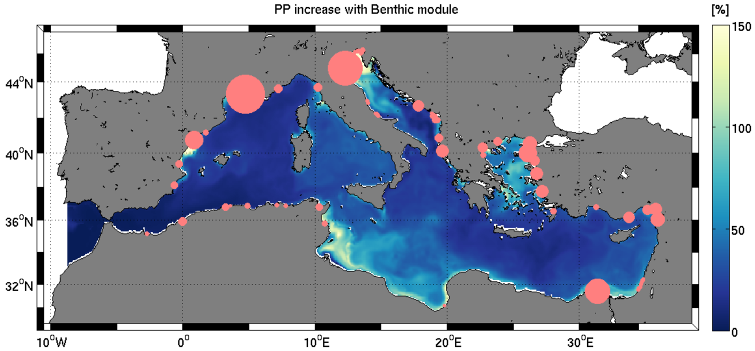

Conluding remarks

- Benthic-Pelagic coupling increases the retention and productivity in land-influenced areas and in regions of OM accumulation

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→ Benthic-pelagic coupling in spatially resolved frameworks

- Significant & spatially variable contribution of benthic fauna
- Need for benthic monitoring targetting spatial and seasonal variability

Thanks for your attention ...
... and questions

The Benthic module : transfer function

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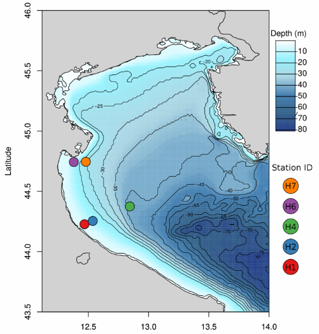

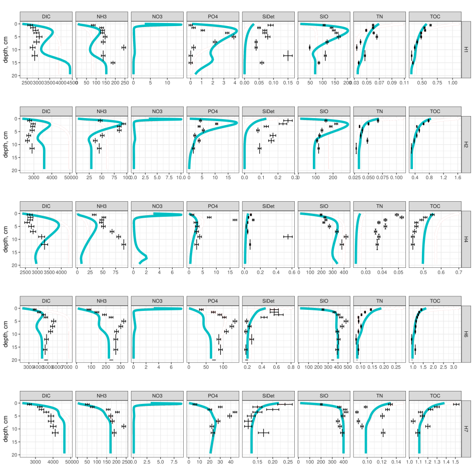

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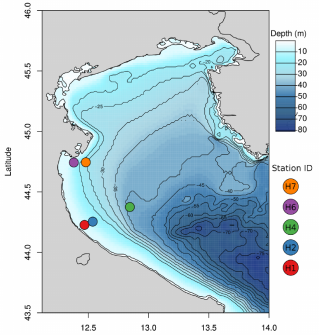

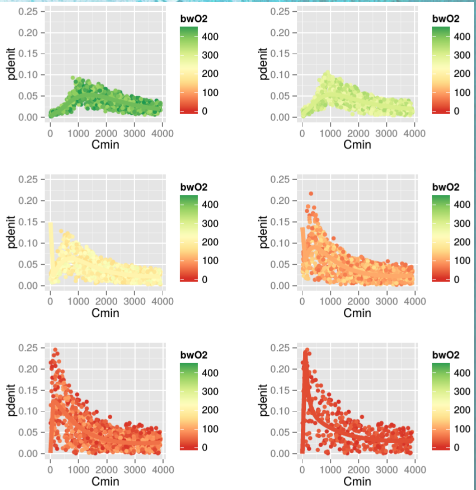

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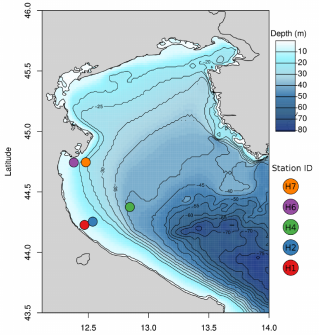
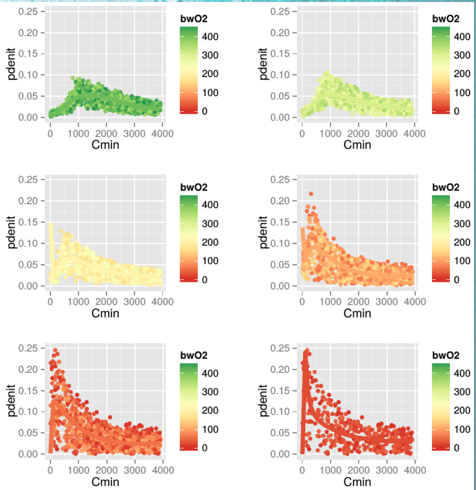


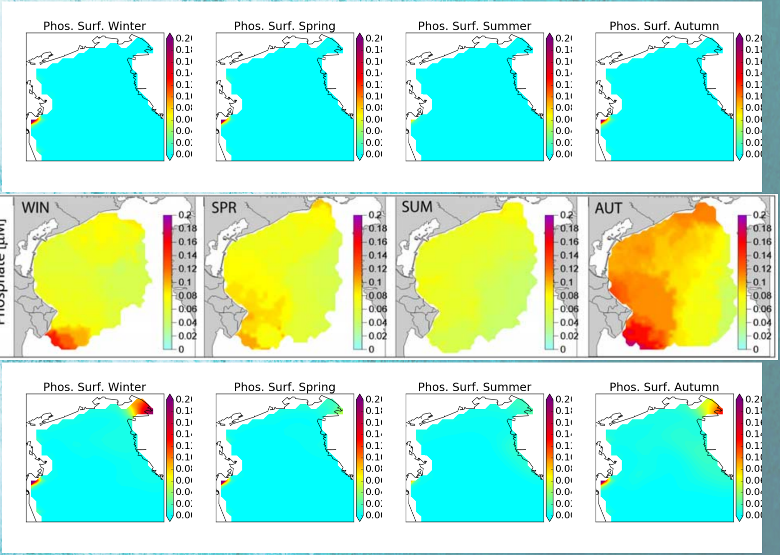


Phosphate, Surface [μM]

without Benthic Module

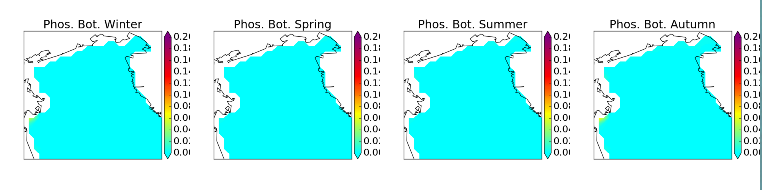
Solidoro et al, 2009

with Benthic Module



Phosphate, Bottom [μM]

without Benthic Module



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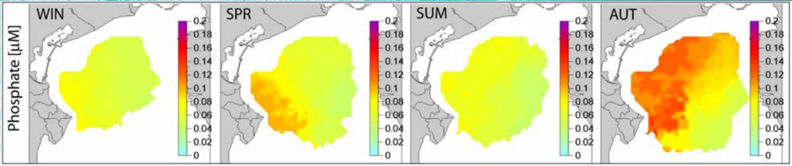
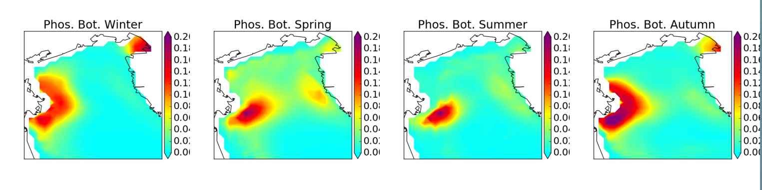
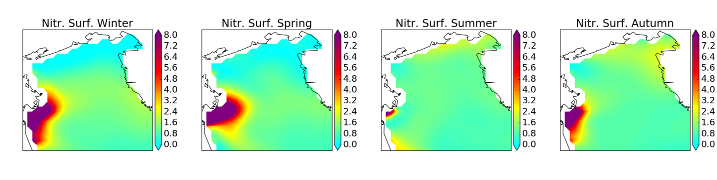


with Benthic Module

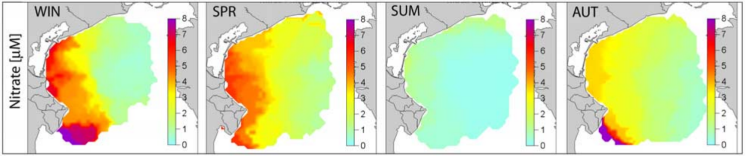


Nitrate + Nitrite, Surface [μM]

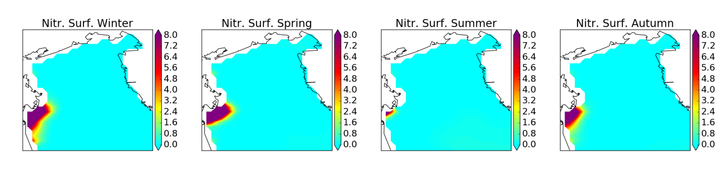
without Benthic Module



Climatology [1986–2006] Solidoro et al, 2009

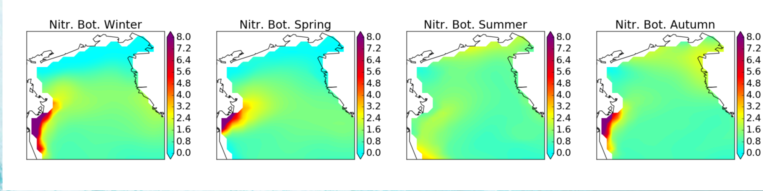


with Benthic Module

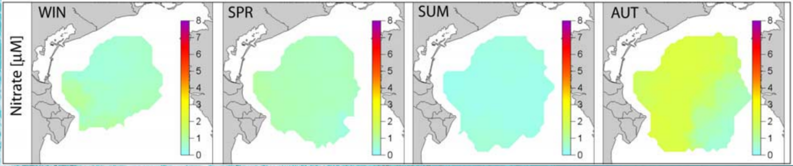


Nitrate + Nitrite, Bottom [μM]

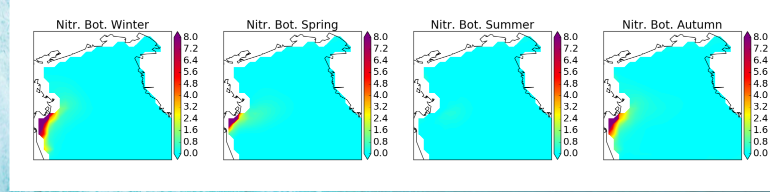
without Benthic Module



Solidoro et al, 2009

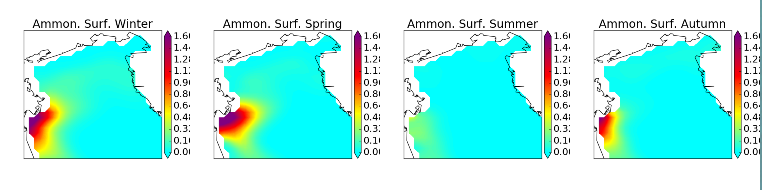


with Benthic Module

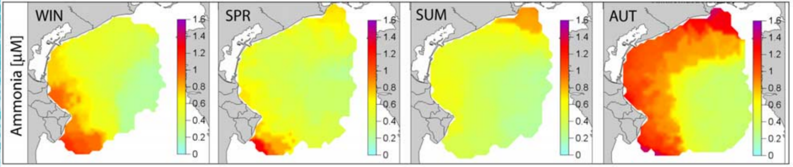


Ammonia, Surface [μM]

without Benthic Module



Solidoro et al, 2009



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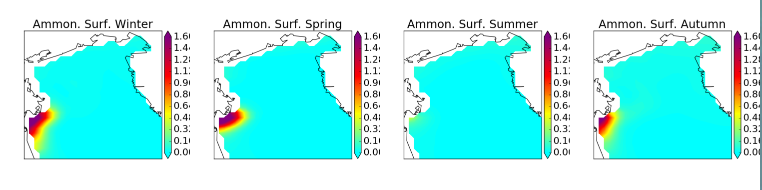
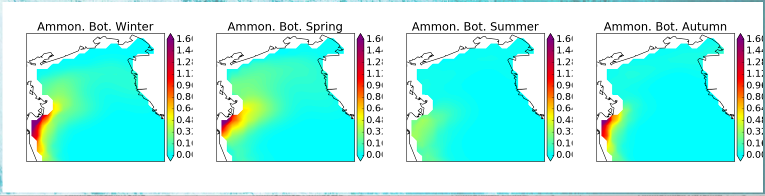
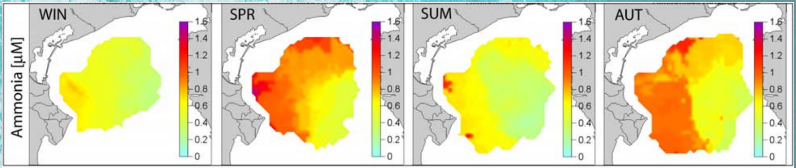


Ammonia, Bottom [μM]

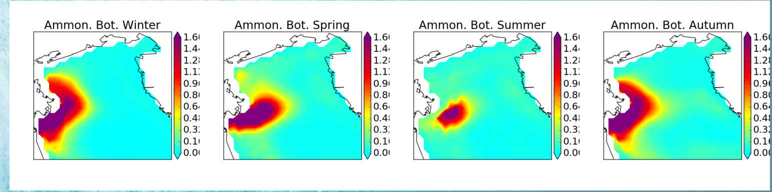
without Benthic Module



Solidoro et al, 2009

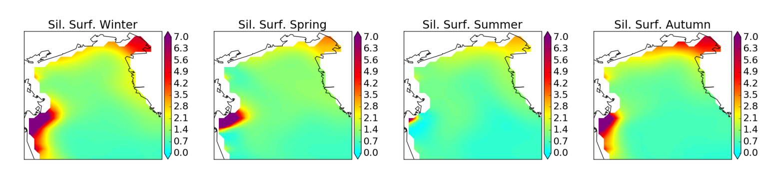


with Benthic Module

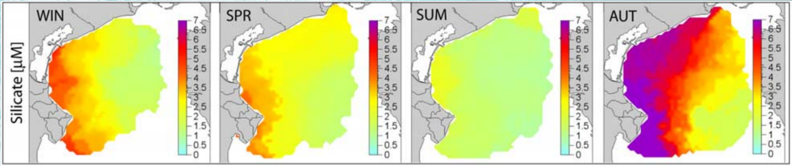


Silicate, Surface [μM]

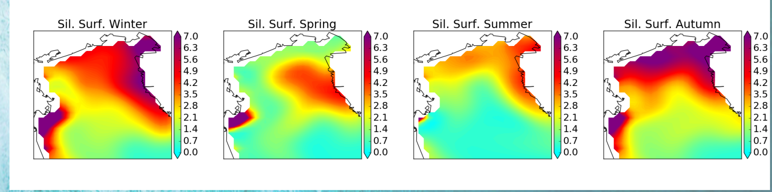
without Benthic Module



Solidoro et al, 2009



with Benthic Module



Silicate, Bottom [μM]

without Benthic Module

Solidoro et al, 2009

with Benthic Module