

ADRHYPOX

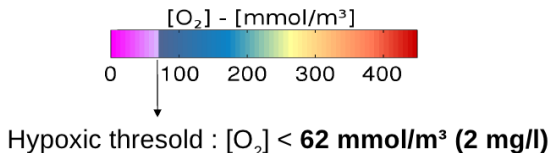
Hypoxia and Benthic-Pelagic Coupling in the Adriatic Sea

Arthur Capet

OGS, Trieste, Italy

November 2015

What is hypoxia ?



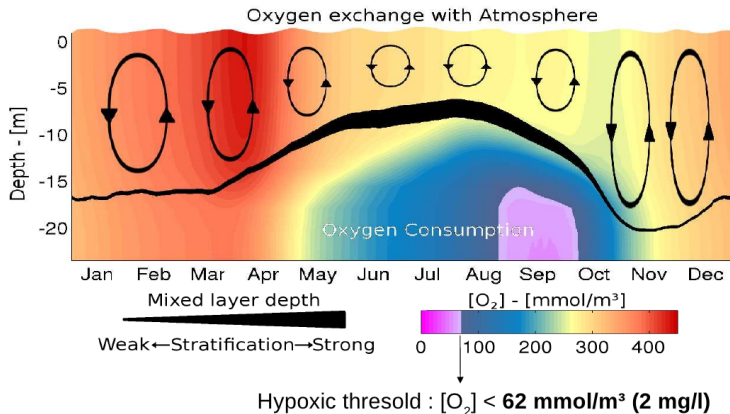
Affects :

- ▶ Biogeochemical processes
- ▶ Biology (Lethal and non-lethal effects)

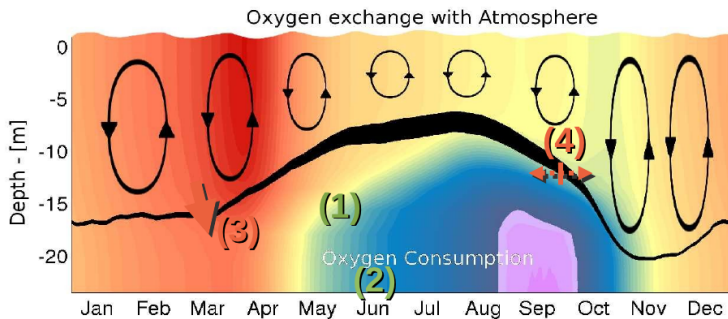
Hypoxic Events defined in terms of

- ▶ $[O_2]$ thresholds
- ▶ Temporal extent
- ▶ Spatial extent

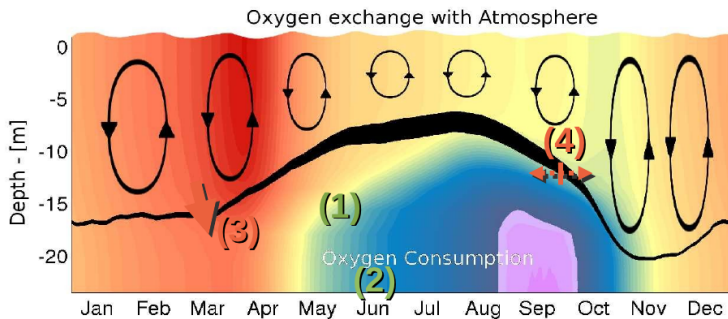
Why does hypoxia occurs?



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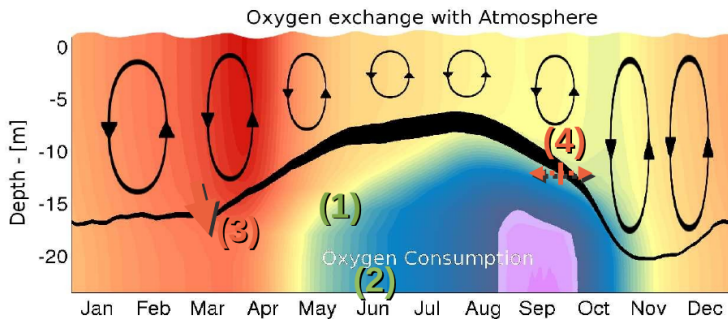


Why does hypoxia occurs?



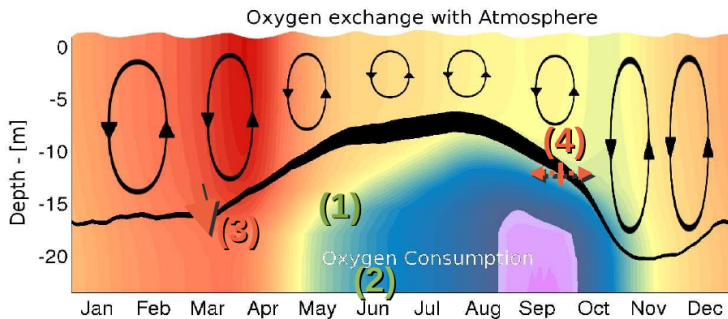
1. Primary production

Why does hypoxia occurs?



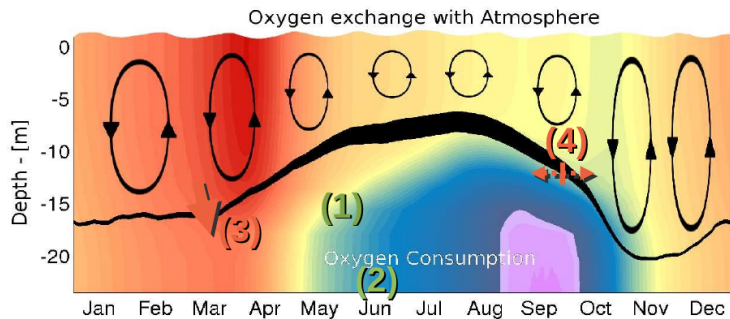
1. Primary production
2. Benthic fluxes

Why does hypoxia occurs?



1. Primary production
2. Benthic fluxes
3. Ventilation (before stratification)

Why does hypoxia occurs?



1. Primary production
2. Benthic fluxes
3. Ventilation (before stratification)
4. Stratification (extent)

Hypoxia in the Adriatic ?

We know that

1. It happens in the Emiliana-Romana Coastal zone

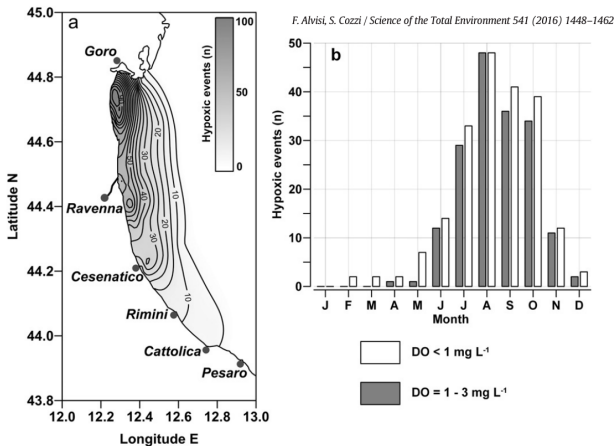
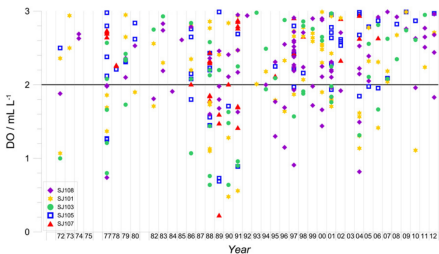


Fig. 2. Total number (n) of hypoxic events recorded in 1977–2008: (a) spatial distribution in the ERCZ, (b) monthly distribution of hypoxia and strong hypoxia.

Hypoxia in the Adriatic ?

We know that

1. It happens in the Emilagna-Romana Coastal zone
2. It happened in the Northern Adriatic shelf



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

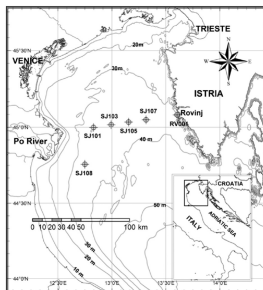


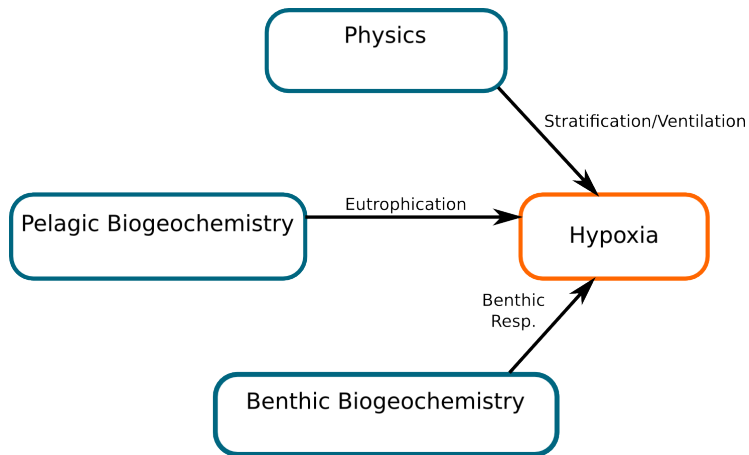
Fig. 1. The northern Adriatic Sea with sampling stations on the profile Rovinj–Po river delta.

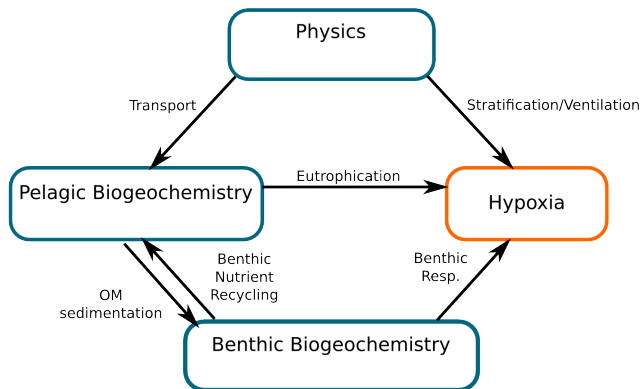
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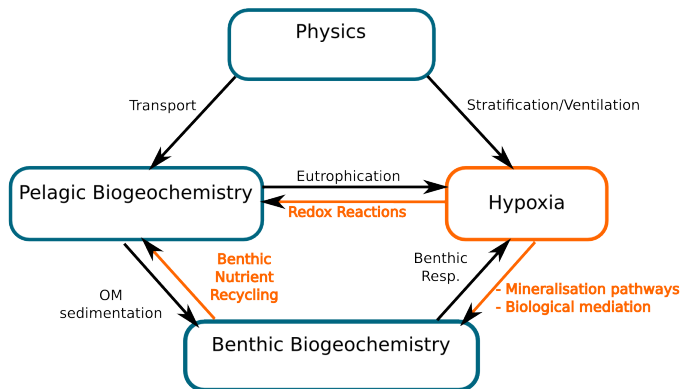
Needs a 3D model to :

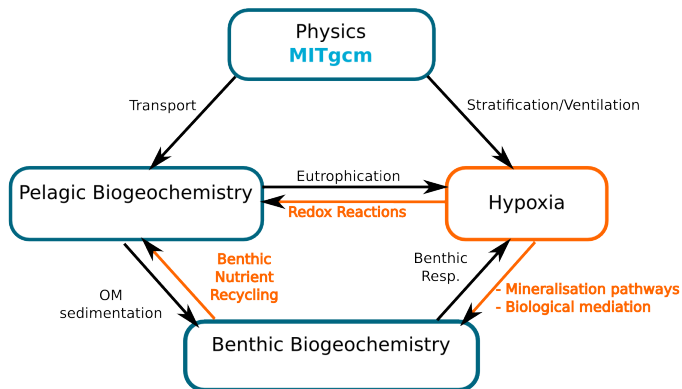
- ▶ Complete missing observations
- ▶ Advice monitoring strategy
- ▶ Test scenario (Environmental management policies, Warming)

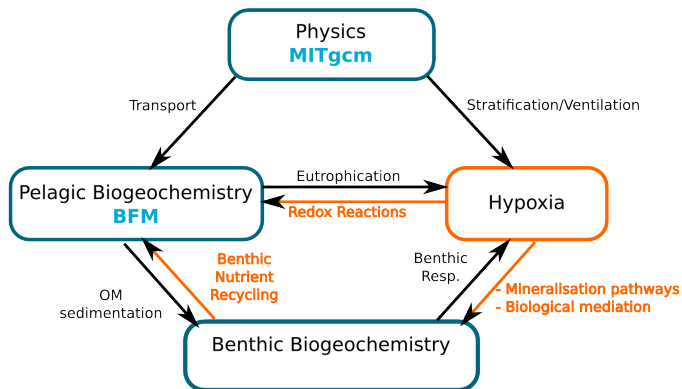
Adrhypox

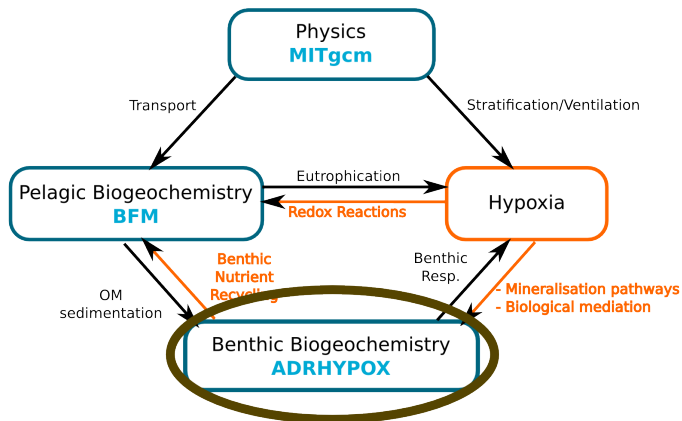




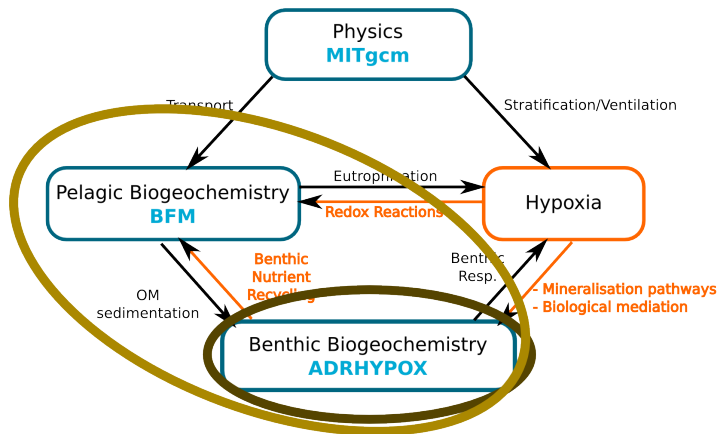






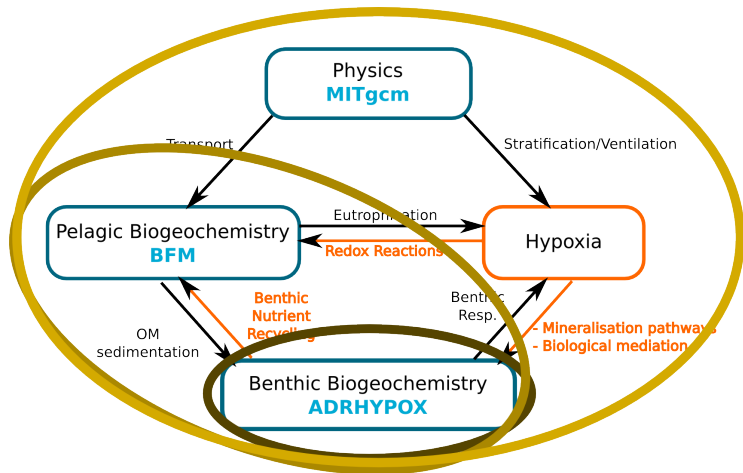


Task 1: Benthic Model



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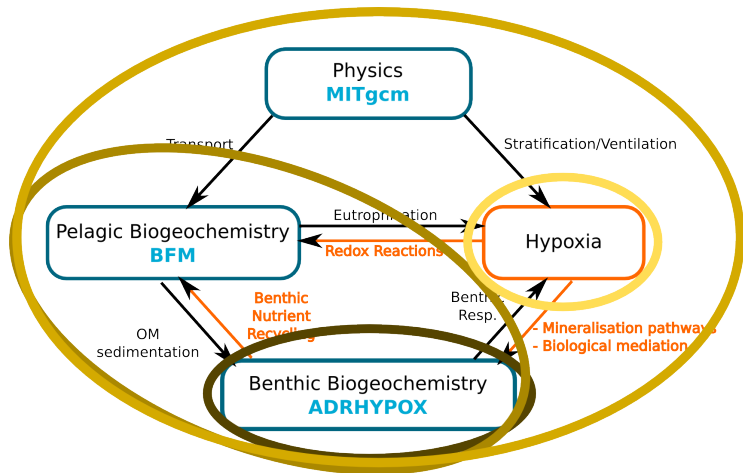
Task 2: Benthic-Pelagic Coupling



Task 1: Benthic Model

Task 2: Benthic-Pelagic Coupling

Task 3: 3D setup



Task 1: Benthic Model

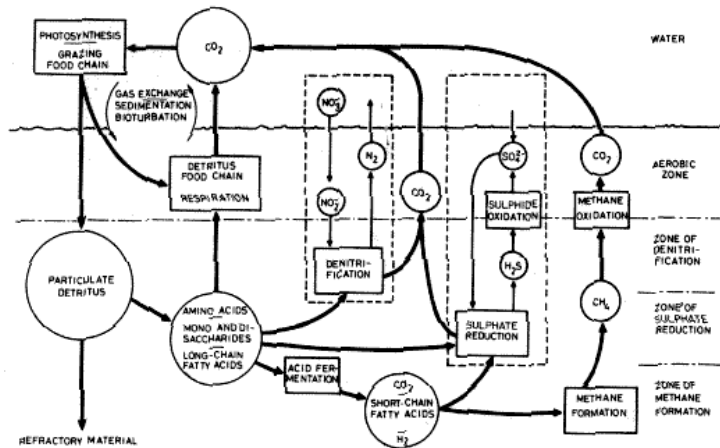
Task 2: Benthic-Pelagic Coupling

Task 3: 3D setup

Task 4: Hypoxia in the N. Adr.

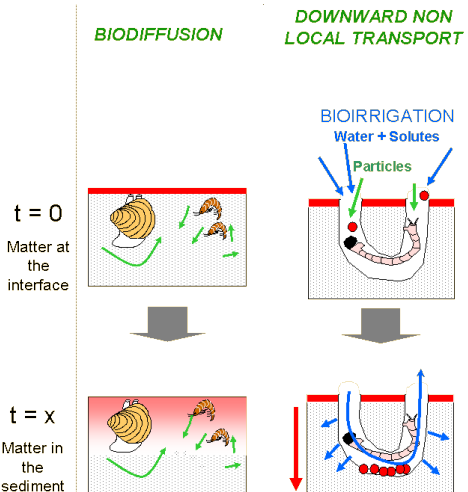
Task 1: Diagenetic modelling

General framework



Task 1: Diagenetic modelling

Biological Mediation



M. Tackx

Task 1: Diagenetic modelling

without bioirrigation

$$\frac{\partial \bar{C}}{\partial t} = D_s \frac{\partial^2 \bar{C}}{\partial z^2} + \sum \bar{R}$$

with bioirrigation

Enhanced Biodiffusion

$$\frac{\partial \bar{C}}{\partial t} = \beta D_s \frac{\partial^2 \bar{C}}{\partial z^2} + \sum \bar{R}$$

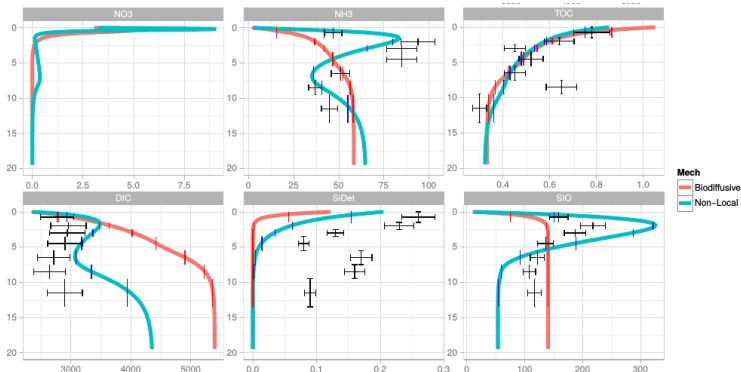
Non-local exchange

$$\frac{\partial \bar{C}}{\partial t} = D_s \frac{\partial^2 \bar{C}}{\partial z^2} - \alpha(\bar{C} - C_0) + \sum \bar{R}$$

Task 1: Diagenetic modelling

Non-local formalism

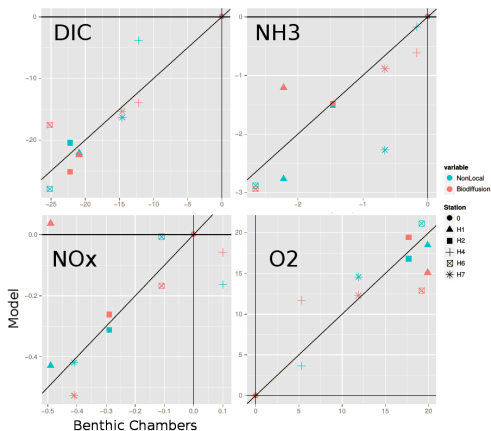
- ▶ Allows a better qualitative description of pore water profiles



Task 1: Diagenetic modelling

Non-local formalism

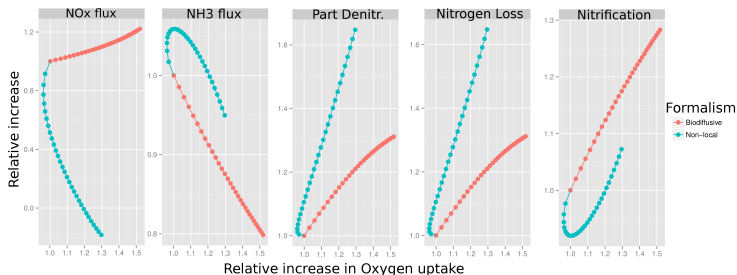
- ▶ Allows a better qualitative description of pore water profiles
- ▶ Allows a better quantitative description of multivariate dynamics



Task 1: Diagenetic modelling

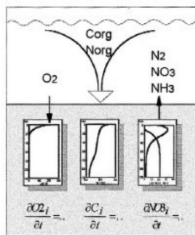
Non-local formalism

- ▶ Allows a better qualitative description of pore water profiles
- ▶ Allows a better quantitative description of multivariate dynamics
- ▶ Changes the way bioirrigation affects nutrient budgets



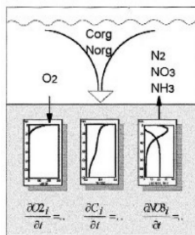
Task 2: Benthic-Pelagic coupling

Level (4): vertically resolved

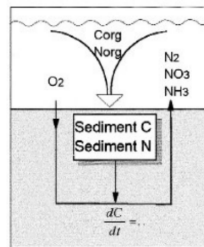


Task 2: Benthic-Pelagic coupling

Level (4): vertically resolved

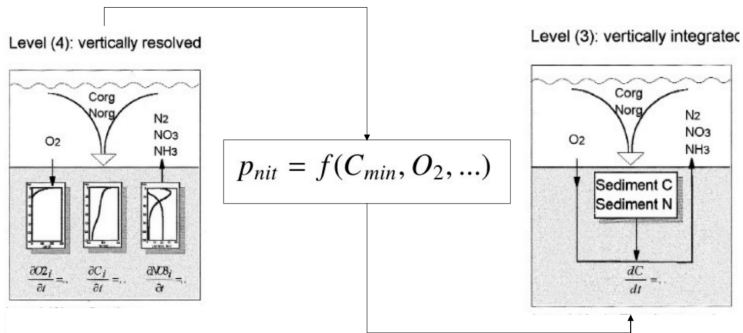


Level (3): vertically integrated

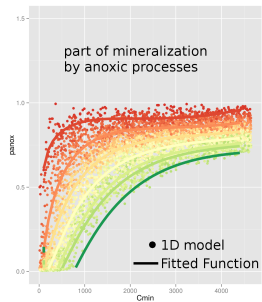


Task 2: Benthic-Pelagic coupling

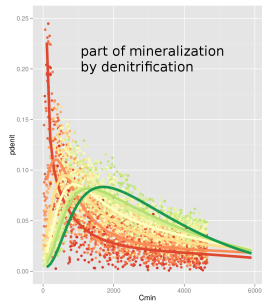
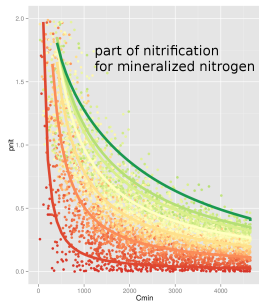
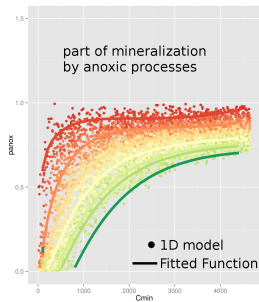
→ “Meta-Modelling”



Task 2: Benthic-Pelagic coupling

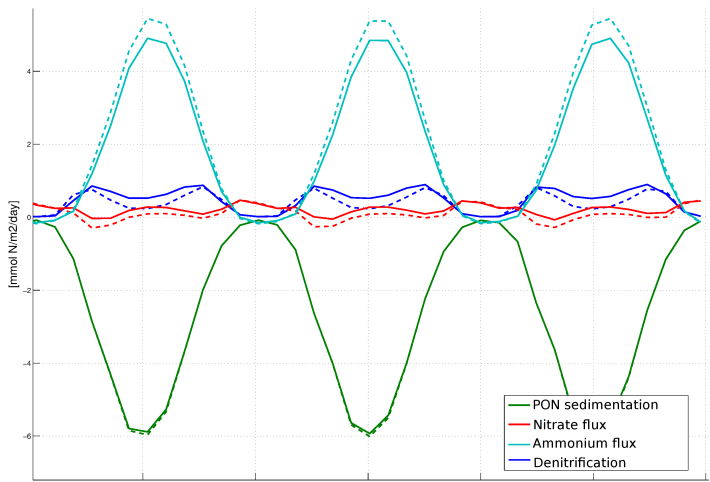


Task 2: Benthic-Pelagic coupling



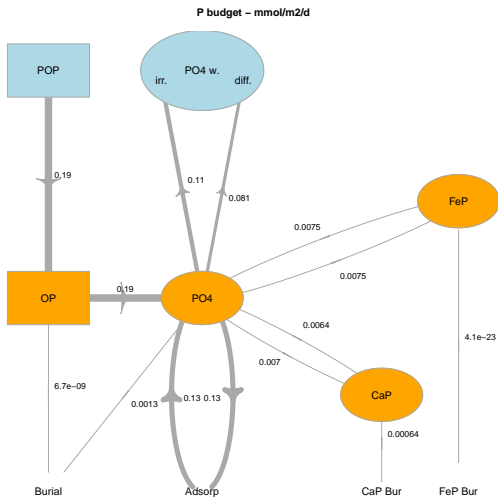
Coupled Model

- ▶ Seasonal dynamics
- ▶ Benthic denitrification $\sim 1/5$ of PON inputs



Next steps for this task

- ▶ More realistic setup
- ▶ Include phosphate dynamics in the Metamodelling framework
- ▶ Compare with 1D diagenetic model



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Dissemination I

Publication

- ▶ In Prep.: “Bioirrigation in multivariate diagenetic models”

Collaborations

- ▶ NIOZ: the Royal Netherlands Institute for Sea Research
 - ▶ May 2015 (one month)
 - ▶ December 2015 (short visit)
 - ▶ March-April 2015 (?)

Dissemination II

Meetings

- ▶ 8th European Conference on Ecological Modelling (October 2014, Marrakesh)
- ▶ The 2nd International Ocean Research Conference (IORC) (November 2014, Barcelona),
- ▶ TURBINTERMARS 2015: International conference on turbulence and interactions in marine systems (february, 2015, Trieste)
- ▶ AGU2016 (New Orleans, February 2016)
- ▶ **EGU2016 (Vienna, April 2016):**
Session on Benthic processes and Benthic-Pelagic coupling (OS3.3/BG3.9)
Conveners: A. Capet (OGS), G. Lessin (PML), A. Dale (Geomar) & K. Soetaert (NIOZ)

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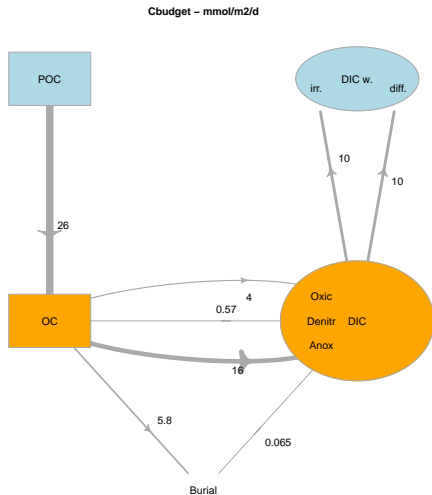
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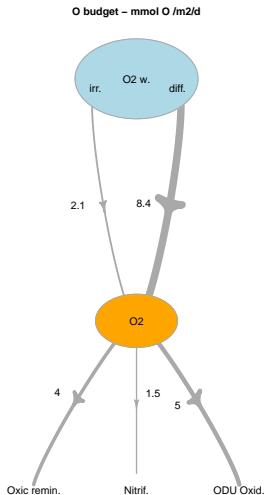
Task 1: Diagenetic modelling

Resulting Flows Dominance of Anoxic Mineralization



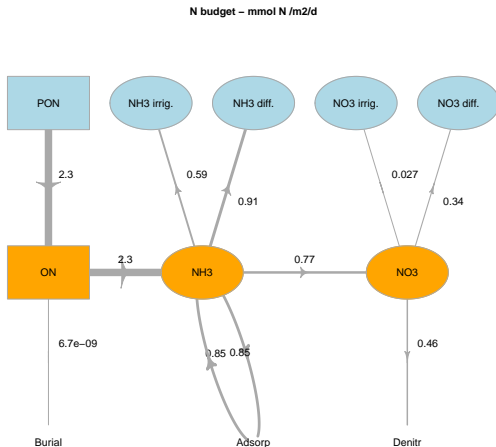
Task 1: Diagenetic modelling

Resulting Flows ..



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Resulting Flows ..

