Modelling the benthic pelagic coupling in the Gulf of Trieste (N. Adriatic)

Giulia Mussap, Marco Zavatarelli

Dipartimento di Fisica e Astronomia (DIFA), Alma Mater Studiorum, Universita' di Bologna, Italy

Introduction

Coastal waters are among the most delicate, productive and dynamic regions in the global ocean, and are greatly influenced by benthic biogeochemical processes.Sediment-water exchange processes play a critical role and can be regarded as an essential nutrient source for the water column. While the water column "feeds" benthic communities with the deposition of detritus, intense sediment microbial activity causes the interstitial waters to be enriched in nutrients.

Objectives

- Evaluate the role of benthic-pelagic coupling processes in defining the water column and benthic dynamics
- Investigate the role of suspension feeders in relation to the sinking velocity at the water sediment interface

Materials and methods

A coupled physical-biogeochemical one-dimensional numerical model, composed by the Biogeochemical Flux Model and the Princeton Ocean Model (BFM-POM 1D) is implemented in the Gulf of Trieste (N. Adriatic).

The pelagic and benthic systems are reciprocally interacting at the sediment-water interface.

The benthos Living Functional Groups (LFG's) are: epifaunal predators, deposit feeders, filter feeders, meiobenthos infaunal predators and aerobic and anaerobic bacteria.

Mechanistic experiments were performed on the detritus sinking velocity at the water sediment interface and the role of suspension feeders in shaping the water column was investigated.

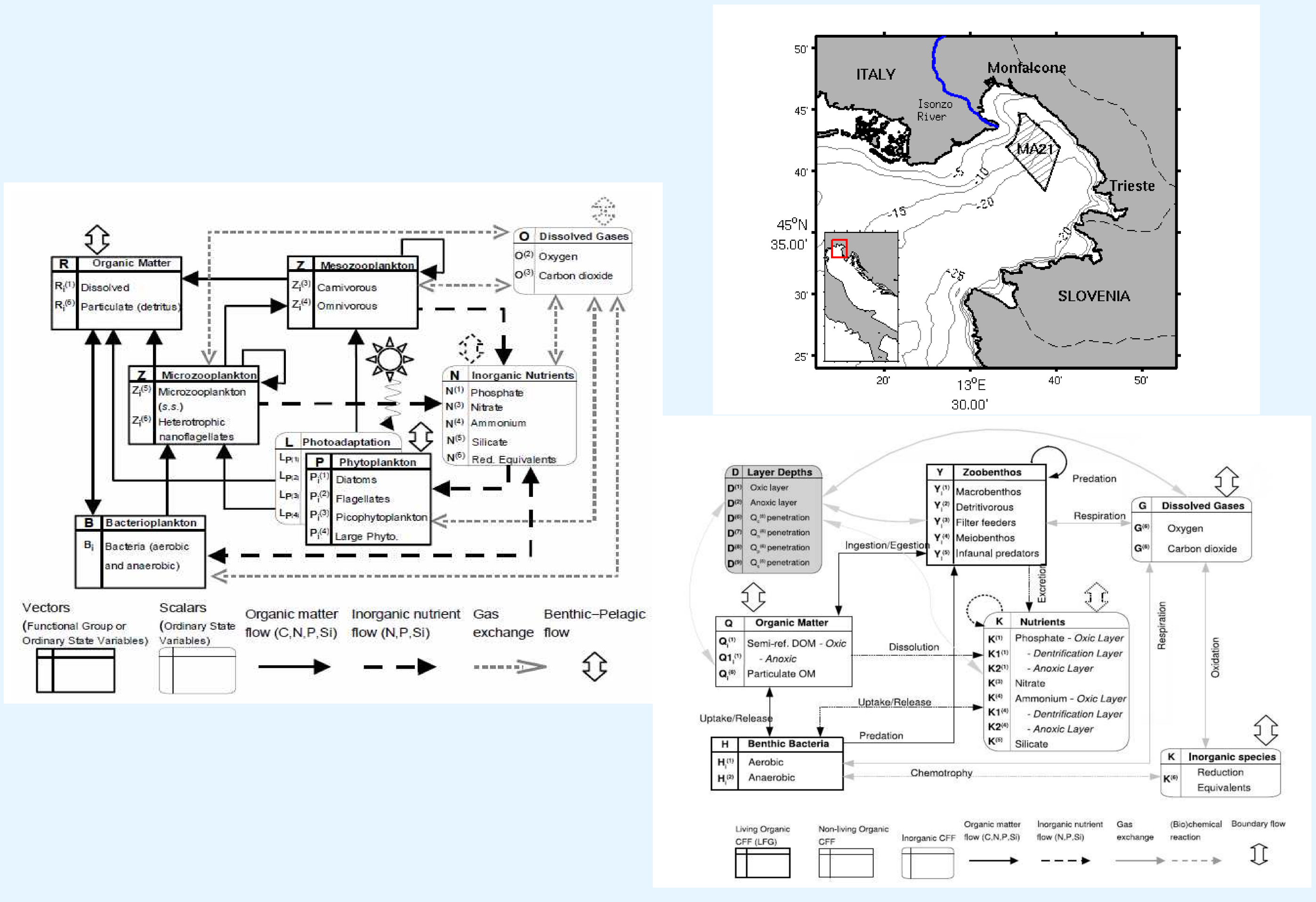

Figure 1. Map of the study area and schematic of the pelagic and benthic BFM state variables and their interactions.

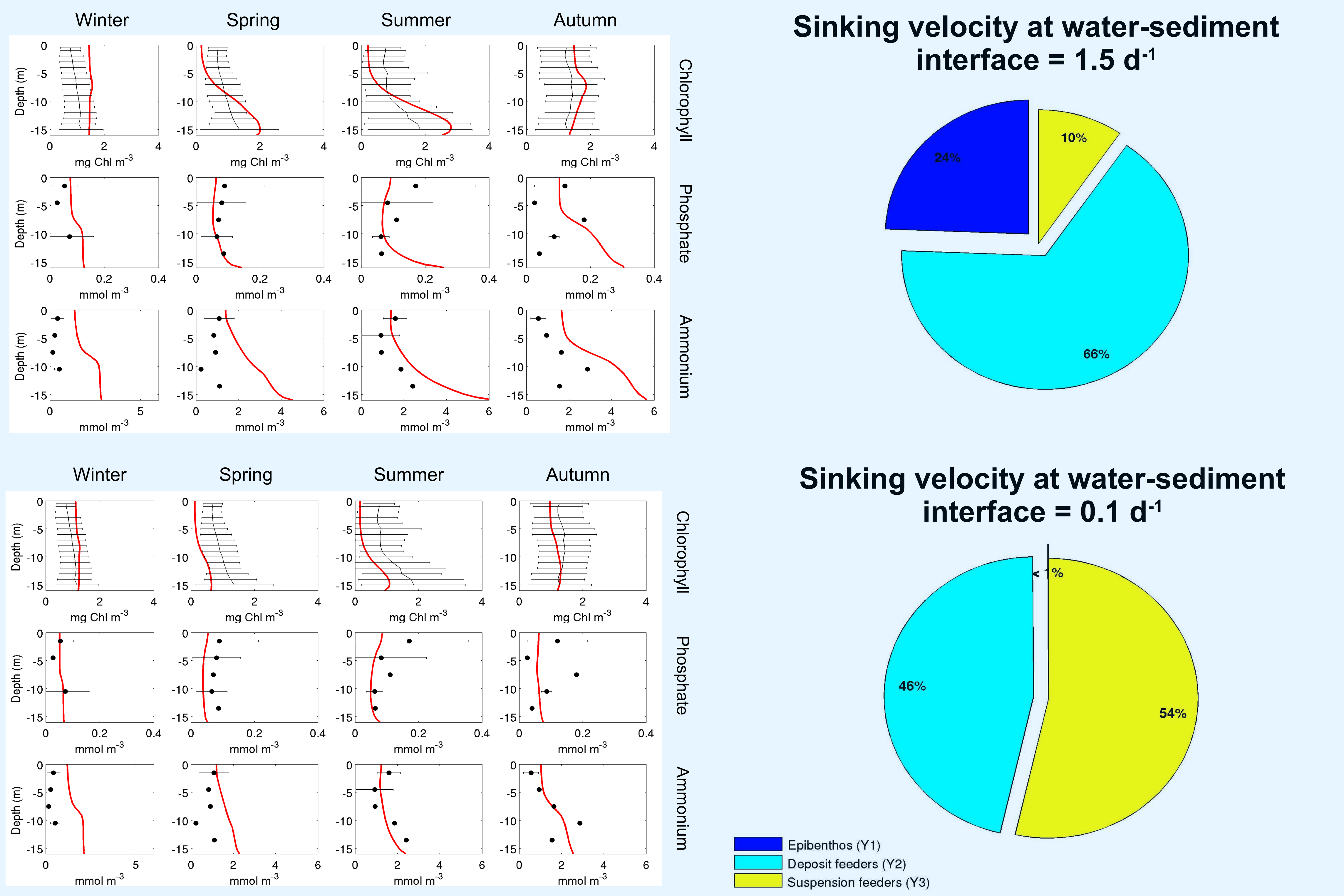

Figure 2. Results of the two mechanistic experiments with detritus sinking velocities of 0.1 and 1.5 d-1 at the water sediment interface. Model results (red line) are compared to seasonal observations (black line) for the water column. The corresponding benthic percentile distribution for epibenthos, deposit feeders and filter feeders is also shown in the corresponding pie chart.

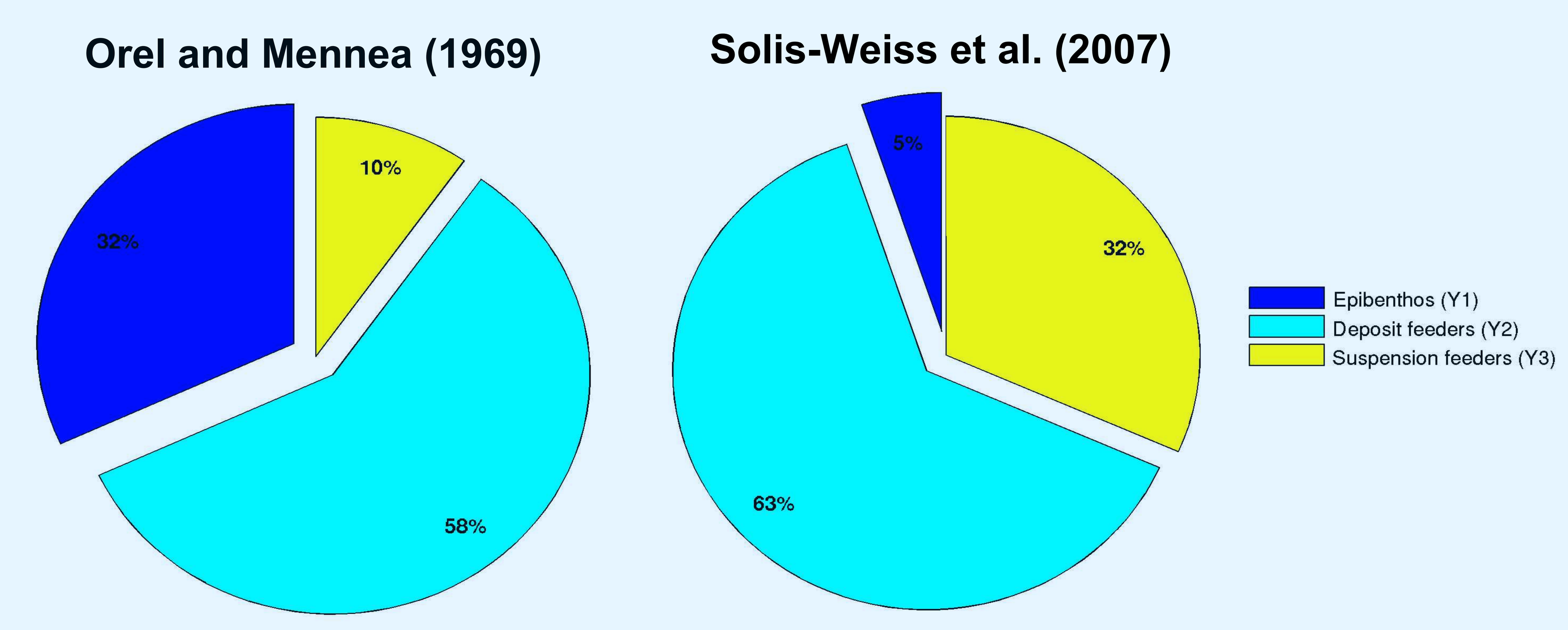

Figure 3. Pie charts of benthic distribution data for epibenthos, deposit feeders and filter feeders derived from Orel and Mennea (1969) and Solis-Weiss et al. (2007).

Results

Model results were compared to the available water column and the benthos data, as well as to the benthic-pelagic fluxes. Results show a good capability of the model to respond to small changes and adapt the whole system to different conditions.

Results highlight how different sinking velocities shape both the water column and the benthic biomass composition. In fact, a slower velocity favours the growth of suspension feeders, while the epibenthos nearly disappears. Simultaneously, vertical profile concentrations decrease, especially in the lower part of the water column. A slower sinking velocity means the filter feeders have more time to feed on the particles and remove them from the water column. Benthic-pelagic fluxes were also considered. With a decreasing sinking velocity, fluxes also decrease.

Conclusions

The benthic environments plays a critical role in shaping the water column and it is important to include it when modelling the coastal environment

Sinking velocity (d^{-1})	1.5	0.1	Faganeli and Ogrinc, 2009
PO4 ($mmol\ m^{-2}\ d^{-1}$)	0.073	0.014	0.03
NO3 ($mmol\ m^{-2}\ d^{-1}$)	0.38	0.09	-0.08
NH4 ($mmol\ m^{-2}\ d^{-1}$)	0.88	0.21	0.94
SiO4 ($mmol\ m^{-2}\ d^{-1}$)	0.59	0.178	-
O2 ($mmol\ m^{-2}\ d^{-1}$)	-5.67	-3.03	-12.1

Table1. Benthic-pelagic fluxes for the two mechanistic experiments and data from Faganeli and Ogrinc, 2009.

References: - Orel, G., Mennea, B., 1969. I popolamenti betonici di alcuni tipi di fondo mobile delGolfo di Trieste. Pubbl. Staz. Zool. Napoli 37, 261-276.
- Solis-Weiss, V. S., Ale, I. F., Bettoso, N., Rossin, P., Orel, G., 2007. The benthic macrofauna at hte outfalls of the underwater sewage discharges in the gulf of trieste (northern adriac sea, italy). ANNALES Ser .hist. Nat. 17.
- Faganeli, J., Ogrinc, N., 2009. Oxic{anoxic transition of benthic uxes from the coastal marine environment (gulf of trieste, northern adriatic sea). Marine and Freshwater Research 60, 700-711.