3D modelling of a planktonic ecosystem integrating the HABs species *Phaeocystis globosa*. Validation by satellital imagery / Tracking nitrogen's origin

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1 Objectives

The eastern English Channel and the southern bight of the North Sea are eutrophicated areas. The Prymnesiophyceae ***Phaeocystis sp.***, dominant since 1970's along the Belgian and Dutch coasts **extends southwards to French coasts since many years.** Large quantities of mucus can be discharged into the water column and be at the origin of accumulation of **foam on beaches** (photo) during spring.

The aim of this work is to introduce this species in an **ecosystem model** of the Channel. An original use of the model, the **tracking of nitrogen in the compartments of the ecosystem**, is exposed too.

2 The model

The grid is regular with meshes of 4 km x 4 km. The water column is divided into 12 layers (σ-coordinates). The hydrodynamic model is **MARS3D** (Lazure & Jégou, 1998). The water column is coupled to a **sedimental bed**. The inputs of nutrients and mineral SPM of the **21 major rivers** are introduced at the terrestrial limits.

The equations of ***Phaeocystis globosa*** are added to the **general model of primary production of NPZD type** (fig. 1). Many processes are from the MIRO model (Lancelot et al., 2005). But the model does not describe the carbon cycle and is not based on physiological principles as MIRO is. **Two life forms** of *Phaeocystis* are taken into account : free living and colonial cells. The growth of the intracolonial **mucuous matrix** (only carbon) is parametrized in order to control the disruption of the colonies.

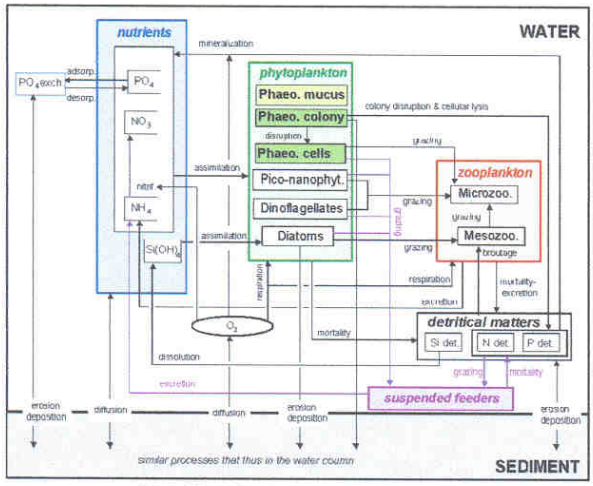

Fig. 1 - Biogeochemical processes of the model.

In regions of fresh water influence, the turbidity is controlled by the hydrosedimental model. Offshore, monthly composits of mineral suspended SPM from SeaWiFS are used.

3 Validation (year 2003)

Comparison with satellital imagery :

The sea surface chl-*a* concentration (SS-Chl*a*) computed is compared to monthly composits derived from SeaWiFS (Gohin et al., 2002, 2005).

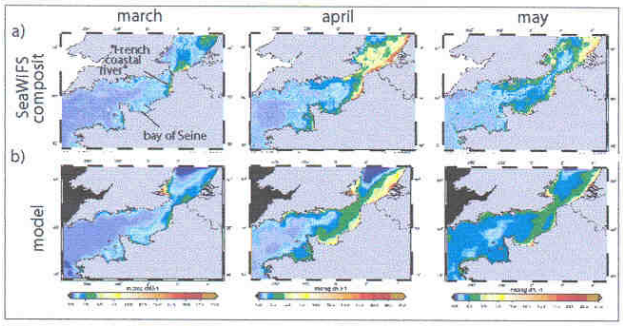

Fig. 2 - Monthly means of the sea surface chlorophyll a (SS-Chl*a*) derived from (a) the satellite SeaWiFS and (b) computed.

For the spring months presented, the SS-Chl*a* computed is closed to the satellite observation. The biomass is higher in the regions of fresh water influence : the bay of Seine and the frontal area called the "French coastal river".

Coastal observations : nutrients, chl*a* and *Phaeocysis globosa*

The modelling results are compared to data of coastal networks (IFREMER).

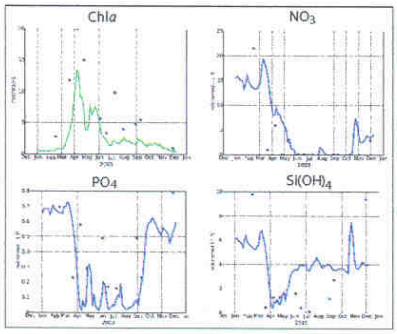

Fig. 3 - Comparison of model runs and data at station DUN1 (station 1 of the radial off Dunkerque, SRN Network).

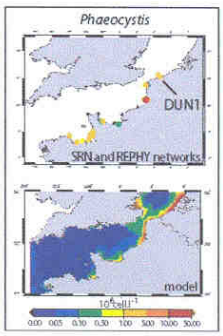

Fig. 4 - Comparison of the yearly maximum cell concentration.

The geographical distribution and the intensity of the maximum of *Phaeocystis* cell density are well computed along the French coasts. The biggest bloom appeared in the bay of Somme (many tens of millions of cells per liter).

4 N-tracking in the ecosystem

The technique applied is from Ménesguen et al. (2005). The biogeochemical equations of the nitrogen cycle are doubled. Here is illustrated the **fate of nitrogen of French rivers** origin. One year of spin-up is done in order to constitute the river plumes.

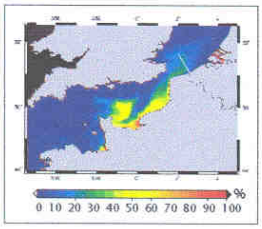

Fig. 5 - Part of French nitrogen inputs in the diatom biomass computed the 25/04/2003.

The figure 5 shows the percentage of nitrogen from French rivers in the biomass of diatoms during spring. This uptake of tracked-N is above 50 % of the total available nitrogen along the French coasts of the eastern English Channel. The **hydrobiological continuum** from the Bay of Seine to the Dover Strait is put in front. The percentage reaches 20-25 % at the boundary between French and Belgian coastal waters (white line). Norhwards, the primary production is mainly due to local inputs (Sheldt, Rhine, Meuse).

5 Conclusion

The model computes quite well the global primary production over the domain. The **SS-Chl*a* satellite-derived product is a powerfull tool of validation** of the model. It is completed along the coasts by regular samplings. For ***Phaeocystis***, the **maximum cell densities simulated are in very good adequation with cell counts** all along the French coasts and in particularly in the eastern English Channel.

The ***N-tracking technique*** allows to assess the importance of local sources of nutrients in the primary production. Although the part of French rivers nitrogen in the phytoplankton booms along the Belgian coasts is not negligeable (0-20%) during spring, it is not dominating. This technique is a really interesting tool for the study of the fate of nutrients in eutrophicated ecosystems.

References

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