Biogeosciences Discussions, 1, S53–S57, 2004
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Biogeosciences Discussions

Interactive comment on "Modeling the nitrogen fluxes in the Black Sea using a 3D coupled hydrodynamical-biogeochemical model: transport versus biogeochemical processes, exchanges across the shelf break and comparison of the shelf and deep sea ecodynamics" *by* M. Grégoire and J. M. Beckers

Anonymous Referee #2

Received and published: 9 August 2004

The manuscript presented discusses the application of 3d hydrodynamical model for the Black Sea and the successive application of a biogeochemical model. The focus of the investigations lies on the quantification and comparison of the ecosystem fluxes on the shelf and in the central part of the Black Sea and the fluxes between these areas.

This subject is of great interest since there are hints that concentrating mainly on open ocean carbon fluxes as was the goal of JGOFS may neglect a big part of climate relevant mass exchanges that act on the shelves and between the shelves and the open ocean. In this context it is essential to quantify the ratio of organic vs inorganic

material exported from the shelf into the open sea. Because of this relevance the authors should discuss this point more intensively in their manuscript.

The authors discusses their modelling approach quite upright by estimating the errors of the simulations and the reasons for these discrepancies. In most cases I cannot agree with their arguments for accepting the discrepancies. The most important point is the cyclic ŞinstationarityŤ of the biogeochemical model. In Fig 3 the nitrogen input into the system is about 40% higher than the output. Due to the corresponding successive enrichment of the system the model simulates unrealistic fluxes which are interpreted as natural phenomena.

Detailed comments:

page 5 Have you tried also smaller values for the horizontal diffusion coefficient? Does this change the overall picture?

The relaxation to temperature and salinity in the upper layer should be mentioned in this chapter.

The authors argue that the establishment of the circulation reacts sensitively on fresh water input. This input is surely strongly related to short-term events of rainfall. Is the approach to use a hydrodynamical model which averages over several weeks appropriate for simulating the exchange between shelf and central basin? During the project OMEX it has been found that especially small scale processes govern the exchange between Northwest European Shelf and North Atlantic. Could you comment on this?

page 6 What is the reason for omitting O2? In other model versions the authors already used O2 as state variable.

Could it be demonstrated that nitrogen is the most limiting nutrient in the Black Sea?

Neglecting the microbial loop with the remark that it works particularly efficient in the Black Sea is misleading as variations of nutrient availability may result in nonlinear compensating effects (Lenhart, 2001).

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page 7 The use of a sigma-coordinate system cannot be justified by avoiding the rigid lid approach. Also z-coordinate models work with a free surface (Backhaus, 1985).

Gregoire (1998a) should be omitted for citation.

page 8 ŞThe implicit integration-approach causes mass defects. It cannot be avoided because explicit systems are not stable.Ť This is not true, you only need an automatic time-step adaptation.

page 9 It would be interesting to see local maxima of the artificial creation/destruction of matter due to the non perfect numerically conservativity.

page 10 The input of nitrogen lies not only in the lower range of river input but also atmospheric N-deposition and other rivers entering the Black Sea (is the latter true?) are neglected. The artificial accumulation of nitrogen would be even larger when these additional sources would be switched on.

page 11 The model does not represent denitrification processes on the shelf even though the authors argue that this process is relevant. Why is this process not integrated in the model; or at least: why is not any parametrisation used?

page 13 ŞBoth model results and observation ..Ť a reference to a corresponding figure would be helpful. Fig. 6: I cannot see the model results.

page 16 A figure of the horizontal annual primary production would be helpful.

page 18 The error concerning the water budget for the shelf: When the artificial water would be added to the shelf water it would lead to an annual sea level rise of 0.28m. Is this correct?

page 19 The structure of shelf Ű open sea transport seems to be export into the open sea in the upper layer and import into the shelf in the lower layer. Could this interesting feature supported by observational data?

page 20 Fig 12: the total export of 795,786 should be indicated by a dotted arrow, right?

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Fig 12: the difference of N inventory (last day Ű first day) does not fit with import/export; have I used the wrong numbers?

page 21 The authors give a reference for observational data concerning PON fluxes into the sediment and benthic remineralisation. These data should be discussed at this point.

page 23 A short comment on arguments for neglecting the microbial loop would be helpful at his place.

page 26 The export by sinking critically depends on the sinking velocity and the degradation rate. It would be very helpful to give arguments for the values chosen. A short study with different values and resulting export rates would give an impression of these dependencies.

page 29 One of the central statements of the manuscript is that river input of nitrogen more or less equals the nitrogen export across the shelf break. What does happen with this statement when a big part of nitrogen is converted into free N2 on the shelf?

page 30 The discussion of free N2 production in comparison with other sea areas should be strictly done with fluxes per square meter.

page 56 What is g(sigma)?

page 57 maximum detrital sing(k)ing velocity.

Fig 9 I would expect to see the topography in the cross sections.

Some general remarks: The big rivers surely deliver suspended matter which is flushed into the shelf water. Is this effect (especially the light limiting co-effect) included in the model?

The comparison with observational data is pure. For Fig. 6 the positions of observations should be indicated.

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References

Backhaus, J. (1985): A three-dimensional model for the simulation of shelf sea dynamics. Dt. Hydrogr. Z., 38, 165-187.

Lenhart, H.J. (2001): Effects of River Nutrient Load Reduction on the Eutrophication of the North sea, Simulated with the Ecosystem Model ERSEM. Senckenberginia maritima 31(2): 299-311.

Interactive comment on Biogeosciences Discussions, 1, 107, 2004.