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Interactive comment on "Investigation on the trophic state of the North Sea for three years (1994–1996) simulated with the ecosystem model ERSEM – the role of a sharp NAOI decline" *by* H. J. Lenhart et al.

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Response on the interactive comment on " Investigation on the trophic state of the North Sea for three years (1994-1996) simulated with the ecosystemodel ERSEM - the role of a sharp NAOI decline" by Lenhart et al, by Anonymous Reviewer1.

The hint for a more detailed description of the ERSEM model will be followed. Generally we intend to keep the article short by referring to the model description already

published. But since this article does not address a typical "modeller community", we see that it is useful to describe the model in more detail. This is especially true for the processes discussed in the article, e.g. definition of the net primary production within the model. Following this line of a more detailed model description, this should be supported by an appropriate figure representing the state variables and processes involved, as Rev1 argues at the end.

We also see the need to clarify the terminology in order to avoid misinterpretation of the statements we want to make. In this context some of the references cited by Rev1 are of great help generalize our statements, e. g. (Mackenzie et al., 2000, 2004).

The statement "high nutrient load tends towards a net autotrophic state" has to be discussed in view of the total organic loads. Hence it is the ratio between organic and inorganic load which governs the resulting net autotrophic state. However it might be necessary to take into account the differences between the northern and the southern part of the North Sea, as supported by Jickells (1998).

The main comment of Rev1 on the paper was that a statement concerning the trophic state and the net ecosystem production must be based on the carbon budget. Until now this analysis was not included in the paper. ERSEM does not allow a full carbon budget because inorganic carbon and the related carbonate chemistry is missing in the model. Therefore we had decided to base the budget on nitrogen with the possibility to quantify also the cross-boundary transport of dissolved inorganic nitrogen.

We understand the objection of Rev1 and decided to include the budget of organic carbon. This allows to calculate the NEP as it was defined by Gatuso (2004). This step results in the following table (which we intend to include in the paper) for the

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North Sea (NS), the southern North Sea (SNS) and the northern North Sea (NNS):

NS (Gmol)	Sink	benRemi	pelRemi	netpp	NEP
1994	3740	3748	3776	7359	-165
1995	3775	3776	3864	7526	-114
1996	3731	3730	3617	7207	-140
SNS(Gmol)	Sink	benRemi	pelRemi	netpp	NEP
1994	2145	2149	1863	4081	69
1995	2168	2168	1925	4149	56
1996	2082	2082	1733	3864	49
NNS(Gmol)	Sink	benRemi	pelRemi	netpp	NEP
1994	1596	1600	1913	3278	-235
1995	1607	1608	1939	3377	-170
1996	1649	1648	1884	3343	-189

"netpp" is gross production minus autotrophic respiration (GPP-Ra).

The main conclusion that was drawn on the basis of nitrogen still holds: we find the ecosystem North Sea net heterotrophic for all years. The southern North Sea is net autotrophic and the northern part again has a negative net ecosystem production.

The variation between the years partly deviates from the nitrogen based net ecosystem production ("NNEP") where 1996 exhibits a vanishing NNEP (Fig. 5c). This is due to the decoupling of carbon- and nitrogen production within the ERSEM simulated phytoplankton: As shown there was a strong influx of nitrogen into the upper layer in summer 1996 (Fig 6d). This was not found in the other years as 1995. During nitrogen exhaustion in 1995 a high C:N ratio in phytoplankton cells was found. In 1996 this ratio was significantly smaller. This enhanced the dissolved inorganic nitrogen consumption

in 1996 and resulted in a relatively high NNEP (=0).

Concerning the comment on the necessity of combining pelagic and benthic budgets: Of course all budgets within the paper include the benthic processes. Without recognizing benthic remineralization the ecosystem would be strongly autotrophic. The benthic influence can be seen in Tab. 3: "pel-sedi". For example in 1994 the export of organic nitrogen into the sediment is 621 Gmol N while the benthic remineralization is 608 G mol N.

Page 733 Lines 23-24 Of course at several selected areas the nutrients phosphorus and nitrogen could not be substituted by each other. But for the major regions of the North Sea nitrogen as limiting nutrient is accepted (Jickells, 1998).

In Table 1 only the largest river inputs are listed. Of course all river inputs along the coastline are taken into account. River Scheldt, for example, is located downstream of box 148 in box 145.

Again Table 1: The annual loads of nitrate/phosphate are calculated using daily values of freshwater flow and interpolated values of weekly/biweekly concentrations.

OK, we will separate gross production, autotrophic and heterotrophic respiration terms.

Table 1
OK, area (km2) will be added.

Tab. 2
There are no areas to be defined in Tab. 2. Shown are transport values (Gmol/y).

Tab. 2
We will give numbers for TOC fluxes.

Tab. 3
We will rectify the legend. We will try to compare our flux of organic matter with literature values. The simulated North Sea area will be given.

It is clear to improve the figures where needed and to add further corrections.

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Interactive Comment