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Ocean Science
Discussions

Interactive comment on "Model study on horizontal variability of nutrient N/P ratio in the Baltic Sea and its impacts on primary production, nitrogen fixation and nutrient limitation" *by* Z. Wan et al.

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First all, let's define two N/P ratios: 1. the N/P ratio of biological nutrient removal (net effect of nutrient uptake, respiration and reminerlization), denoted by the biological N/P ratio; and 2. the observed N/P ratio of DIN concentration change relative to DIP concentration change before and after spring blooms, denoted by the observed N/P ratio of seasonal nutrient changes.

This manuscript documents a finding that a horizontal distribution of the biological N/P

ratio (Figure 3b) is better than a fixed value in the Baltic Sea in terms of improving the model prediction for operative service. The horizontal distribution of the biological N/P ratio was indicated by (mathematically through interpolating) the observed N/P ratio of seasonal nutreint changes (Table 2). The observed N/P ratio of seasonal nutrient changes was identified as an important index to the biological N/P ratio, because the biological nutrient removal during spring bloom is larger than other nutrient changes, like the riverine and atmospheric inputs, and those caused by hydrodynamics (Wan et al., 2011). This index was found effective at offshore stations and most of coastal stations, but errorous at some coastal stations, that's why the distribution of Figure 3b was used in stead of Figure 3a.

Why do the observed N/P ratios of seasonal nutrient changes differ so much across basins, e.g. from 6.6:1 in the Gotland Deep (Station E) to 26.8:1 in the Bothnian Sea (Station H) (Table 2)? The observed N/P ratios of nutrient changes before and after spring blooms also represent a year round pattern, not just for a single season (spring bloom), because when DIP times up the observed N/P ratio (Table 2), DIP is close to DIN at all 9 stations in year 2000-2009 (Figure 2). Can we propose a horizontal distrution like those showed in Figure 2b as one explanation for the question? An 'alternative' explanation is that the nitrogen fixation can make the observed N/P ratio different from the biological N/P ratio. However, the nitrogen fixation occurs mostly during summer, seldom during spring blooms.

The referee's criticism is that the model tool (ERGOM) with only one detritus pool cannot be effective to test the hypothesis that the biological N/P ratio in the Baltic Sea has a horizontal variation pattern similar to the distribution of Figure 3b. We think this is a groundless judgement. Why a model with a single detritus pool cannot be used to test the model parameter 'biological N/P ratio' with/without horizontal variation? The referee seems confused the regional variability of biological N/P ratio with the variability of different biochemical processes. Yes, our model still assumes a single biological N/P ratio for different biochemical processes. As I pointed in response to

previous comments, it is a common practice to use a single biological N/P ratio for different biochemical processes. This is the current status of operational oceagraphy in providing service in the Baltic Sea. We noticed there are a few studies allowing for different N/P ratios for individual processes, however we have not seen such a complexity deployed in an operative system. All in all, even if a single biological N/P ratio for different biochemical processes is used, there is no reason impede such a model being used as a tool to test the hypothesis here.

In principal, the biological N/P ratios vary across processes biochemically, across seasons temporally and across basins regionally. Nevertheless, it is still rather common til now to use a single parameter with a fixed value for the biological N/P ratio in ecological modeling, e.g. ERSEM model. This study is specially siutable for Ocean Science Special Issue: The MyOcean project: scientific advances for operational ocean monitoring and forecasting, because the single N/P ratio parameter is the current status of operative prediction as the EU project MyOcean and the parameter with the horizontal variability can systematically improve the model prediction. The significance of this study to ecological modellers for developing operative service systems is that once the observed N/P ratios of seasonal nutrient changes show a long term pattern of obvious variations across subregions, the horizontal variation of biological N/P ratio should not be ignored.

Answers to additional comments: 1.The observed N/P ratio of seasonal nutrient changes was identified as an important index to the biological N/P ratio, because the biological nutrient removal during spring bloom is larger than other nutrient changes, like the riverine and atmospheric inputs, and those caused by hydrodynamics (Wan et al., 2011). This was documented by the model results and also an analysis of a static box model in the second and third paragraphs of Section 4.1 Evidence of the Observed Data in Wan et al. (2011). 2.What was pointed in page 388 line 7 is for the initial temperature and salnity. Both initial fields for physical and biochemical state variables were set up many years and run back and forth many times. The initial fields

for biochemistries were corrected with the data from ICES website recently. The simulation period 2007 $\sim$ 2008 was determined in the intercomparison experiment carried by all the member contries in the MyOcean project. We select this simulation period to convenience the comparison with the published results (Wan et al., 2011). 3.Why is it not relevant? 'phytoplankton flexibility to match nutrient supply' does not exclude nutrient limitation on phytoplankton. 'phytoplankton flexibility to match nutrient supply' is microscopic while 'nutrient limitation on phytoplankton' is macroscopic. No matter the biological N/P ratio of a system is fixed or variable, the nutrient limitation can likely take place. Section 2.5 defines efficiency of nutrient limitation, in order to investigate the effects of biological N/P ratio on nutrient limitation (Figure 10). This study shows that the biological N/P ratios can change the nutrient limitation both regionally and seasonally.

Interactive comment on Ocean Sci. Discuss., 9, 385, 2012.