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Interactive comment on "Seasonal cycling of phosphorus in the southern bight of the North Sea" *by* C. van der Zee and L. Chou

Anonymous Referee #2

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General comments.

The paper describes the seasonal cycle of phosphorus in the southern bight (Southern Bight?) of the North Sea. This paper is a valuable contribution to the nutrient studies in coastal waters in general and to BGS. At least for the North Sea, relatively little attention has been given to the role of organic nutrients in coastal eutrophication. The specific focus on Phosphorus is useful as the potential role P in limiting coastal productivity is frequently discussed as riverine TP loads decrease more rapidly than TN loads. The data are based on regular cruises in Belgian coastal waters. During these cruises surface samples are taken and the different P fractions have been analyzed with standard methods. The paper presents interesting data on the seasonal cycle of the different P fractions and differences with DON (Dissolved Organic Nitrogen) cycling are discussed. A clear seasonal pattern of DOP (Dissolved Organic Phosphorus) is ob-

served. Two characteristic phases are discerned: During the spring bloom, enhanced P cycling as indicated by enhanced DOP release may sustain the bloom. During autumn DOP is released form decaying algal material resulting in a small autumn peak. I would suggest the authors to further explore the seasonal cycle of the POP (Particulate Organic Matter) concentration (in μmol/l) in order to compare the different P fractions. In the present Figure 4 only data on the relative composition of SM (Susp. Matter) is given. The last conclusion (concerning the autumn decay of algae and release of DOP) could possibly be further substantiated by the data by showing that the increase of DOP is accompanied by a loss of POP. In the present Fig 4, the relative composition of particulate matter is given (POP/g SM), but not the absolute amount (POP/Liter). A problem might be that POP is increasing in the water column due to enhanced resuspension. In that case the authors might try to entangle the POP contribution from Resuspended sediment by correcting for the POP content per g suspended matter as observed in winter (e.g. based on the PIP concentration (PIP/l) and the POP/PIP ratio in SM during winter). The first conclusion (concerning the P limited spring bloom with enhanced P cycling) might be further supported by showing that the total amount of P is constant (i.e. only a phase shift has taken place from the inorganic to the organic form). This might shed light on the question whether other P sources like sediments may play an additional role in Belgian costal waters. For instance it is feasible that the sediment is a source of phosphate. This possibility might then be excluded. I would welcome a summarizing graph of PO4, DOP and POP (in μM/l) showing a generalized seasonal cycle of the different P components. If necessary, a differentiation between the various settings can be added (e.g coastal vs. off-shore; low vs. high salinity; high SM vs. low SM.

Specific comments. 682/14. Release instead of activity? The authors should consider to add a conclusion on the Polyphosphates.

682/23 Changes of Si loads have occurred in the Rhine: See Laane (1992), Admiraal & van der Vlugt (1990) or Conley et al (1993) for further information.

BGD

1, S381–S386, 2004

683/7 Missing Reference

683/15 This has been debated for the Wadden Sea. De Jonge (1990) suggested that P limited production in the Wadden Sea. But despite strong reductions in P loads Cadée & Hegeman (1993) could not observe a decrease in primary production. I suggest to be careful in suggesting that the southern North Sea is P limited, especially if it is only based on model calculations.

683/27 Missing Reference

684/5 When presenting TN loads, also TP loads should be given. TP loads are significantly higher than PO4 loads.

684/12 Please supply salinity information. Otherwise, concentrations are difficult to interpret.

Material and methods

685/6 Site description: I miss information on water depth. Is the water column completely mixed or seasonally stratified? Please indicate the annual primary production.

686/20 Could you provide information on the precision of the DON and DOP measurements? 687/7 Missing Reference

Results

687/16 Please note that with a frequency of 1/month, peaks are easily missed. The wording chosen should reflect this.

687/21. Whereas the POC content is a valuable indicator e.g. of suspended matter (SM) composition, if prefer to see data on the absolute amount of POC (/liter). Such values can be compared to the chlorophyll seasonal cycle.

688/4 I miss the presentation of DOC. At least values could be mentioned. How does the seasonal cycle relate to DOP?

BGD

1, S381–S386, 2004

Interactive Comment

688/7 I suggest incorporating a section on the dependence of Si, NH4 and NO3 with salinity in winter. Possibly, most of the patterns observed in winter can be directly linked to salinity (cf. Fig. 5), conservative behaviour of Si and NO3, but a non-conservative behaviour of NH4 emerges.

688/11 Do the Si maxima coincide with minimum Salinity values? Possible a correlation with Salinity indicates conservative mixing. I suggest to show (or at least discuss results from) Si salinity plots.

688/24 Again Nitrate/Salinity plots would be helpful.

688/25 What information do NH4/Salinity plots provide?

688/1 What information do DON/Salinity plots provide? I note the large fluctuations also in winter. Do you have any explanation?

689/22-24 Please rewrite this complex sentence.

690/4 This compares well with the relative contribution of POP and PIP in Wadden Sea and Elbe Estuary SM (van Beusekom & Brockmann, 1998). The relation could be used to discern between pelagic POP and POP from resuspended sediments.

Discussion

690/7 Mixing of Atlantic and coastal water is a fundamental point and stresses the necessity to be underlined by plotting nutrients etc. against salinity, or at least provide the information (as you nicely did for P).

690/12 Along most of the Dutch coast (North of the mouth of the Rhine) the residual current is towards the North. The clockwise circulation in the southernmost part of the Dutch coast should be specified more clearly in this sentence. See also van Bennekom & Wetsteyn (1990).

690/18 The authors could make a stronger point if they discuss the possible role of riverine DON and DOP. One major problem I have with the DON patterns, is that the

BGD

1, S381–S386, 2004

Interactive Comment

highest concentrations are found during winter. How does this relate to the role of biological processes? What about riverine sources?

690/23 I suggest to present Figure 5 as part of the results section. Does extrapolation of the property plot yield reasonable river values. Are local (shelf) sources relevant (conservative mixing)? What does this imply for the discussion on the role of DOP in P cycling?

691/2 Sampling is only once a month. The possibility of missing the spring peak and implications for the observed patterns should be discussed.

691/7 The authors should try to unravel the different sources of particulate organic matter in order to clarify the contribution of locally produced organic P (and organic C) to the total standing stock.

691/20 Is the decrease of PO4 in line with the increase in POP and DOP (both as μM/liter) during the blooms?

692/4 The TN/TP ratios and NO3/PO4 ratios (e.g. from the monitoring data) in the Scheldt and Rhine could be mentioned here as well.

692/18 Might loss of NO3 on the one hand and buffering of PO4 on e.g. particulate iron hydroxides in the sediment and in suspended part. matter also play a role?

692/20 If light levels are mentioned and comparisons with river plumes and Wadden Sea are made, the SM levels as observed during this study should be mentioned and compared with the Thames and Wadden Sea. I suspect that the light levels in the study area were quit good as compared to e.g. the Wadden Sea.

682/28 Missing Reference

693/2 Missing Reference

693 The conclusion of 4.3 is that P limits the phytoplankton. (Si only limits diatoms). But later you state that P is recycled much faster. So the approach based on ratios is

BGD

1, S381–S386, 2004

overestimating the potential P limitation. This should be discussed. I suggest first to discuss DOP and P cycling and than discuss ramifications for nutrient limitation.

693/13 I suggest reorganizing Table 2 by first sorting on months and than sorting on distance from the Scheldt River.

694/14 Missing Reference

694 In the DOP discussion I miss the work by Butler et al. (1979).

695/11 You cant compare PO4 and DOP concentrations in water with POP concentrations in suspended matter. The total amount depends on the SM content and SM amount in water.

695/20-22 Does this imply that between these two phases, P cycling is less intense? Or is a steady state being reached?

Interactive comment on Biogeosciences Discussions, 1, 681, 2004.