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Ocean Science
Discussions

Interactive comment on "High resolution *in situ* measurements of phytoplankton photosynthesis and abundance in the Dutch North Sea" *by* Hedy M. Aardema et al.

Anonymous Referee #2

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This paper analyses spatial and temporal patterns in cruise data with 3 high-resolution monitoring methods: FRRF, Flow-cytometry and Ferrybox. Correlations between the observed variables are also analysed. The large dataset, including many phytoplankton and environmental variables observed together enables the authors to understand the patterns in the various phytoplankton variables. The results could guide the optimal application of such novel monitoring methods in operational monitoring for a.o. MSFD.

General comments

The paper lacks a clearly stated research question or hypothesis to be tested. Therefore, it is unclear what is the purpose of the various analyses performed and what we

can learn from the results. Based on the conclusion that this type of "high-resolution is a very useful supplement to current monitoring", I would expect a hypothesis such as "combined high-resolution monitoring of many phytoplankton variables along with environmental variables allows us to quantify seasonal and meso-scale patterns in phytoplankton biomass, species composition and primary production. The concurrent measurement of different phytoplankton variables allows us to understand the effect of phytoplankton species composition and physiological adaptation processes on the observed patterns in phytoplankton biomass and production". Then the analysis should show how the variables should be combined to provide the most reliable estimates of phytoplankton biomass and primary production.

There are many observed variables, which are not consistently named in the text, figures and tables. Therefore it is easy to get lost in the description of patterns for all individual variables. A clear definition of variables that is consistently used throughout the text would help the reader to understand the storyline. Some of the variables observed by the FRRF seem to be very similar. Which of the variables should be used as indicator and which are redundant to answer the research questions?

In the conclusions section a recommendation on next steps would be much appreciated: what would be required to use the high-resolution methods in scope to provide reliable estimates of phytoplankton biomass, production and species composition for long term monitoring? In the introduction and conclusion the species composition is defined in functional types such as nitrogen fixers, calcifiers or DMS-producers, but these do not correspond to the phytoplankton clusters used in this paper.

Specific comments

Sentences are often long: consider breaking up in multiple sentences to improve readability. Figure 1: please show only the stations (with names/ abbreviations) used in this study (see table S1) and the areas used in the text (such as Dogger Bank, Wadden, Den Helder, Rhine outflow) so the description of spatial patterns can also be under-

stood by people that are not Dutch. Section 2.2: please refer to international protocols/ methods rather than internal protocols. Table 1: it would help to have an additional column stating the interpretation / meaning of this variable, such as total biomass, nutrient stress, maximum growth rate, efficiency of light uptake etc. Then later in the text you can use these 'meaningful' names instead of codes, to facilitate understanding of observed patterns. Also a figure illustrating the meaning of the different variables (alfa, Ek, F', Fm' etc.) could prevent getting lost in all abbreviations. Equation 9: why did you use monthly averaged irradiance if you are looking at high-resolution patterns. Why did you not use irradiances measured during the cruise? Table 2: Since you use both Length_FWS and O/R ratio as criteria to distinguish the phytoplankton groups, it would be logical to include a column for O/R ratio with the applied criteria. It is not entirely clear whether pico-red includes pico-Synecho or not. On page 14, line 30 it says: "Both groups of picophytoplankton (Synechococcus and total)", whereas table 2 and figure 3 suggest the two groups are exclusive. Section 2.4: please state with every type of analysis what is the purpose / research questions for that analysis. For example: what are you trying to predict from what and why? Section 3.1: I don't see the value of comparing averages over whole transects (with large spatial variability, which is the subject of this paper), that are not even the same, between months. The only thing you see is seasonal patterns that are well-known from other studies and that can be summarized in section 2.1 in a description of the study area. Most of this section describes the data in table S1. I would replace table 3 with table S1 and remove table S2. N/P ratios address that same question as table S1, but with an indicator that is controversial. The text in this section (and subsequent sections) is sometimes hard to follow as it is not clearly structured in time and space and variable. We go back and forth in time. Section 3.2 describes first figure 2, then figure 3 and then again figure 2 and then figure 3. I suggest to make one section about phytoplankton biomass (figure 2) and then one section on species composition (figure 3). Page 16, line 14: the southern coastal stations are more strongly affected by the Rhine outflow than the Scheldt outflows (see for example: Lacroix, G., Ruddick, K., Ozer, J., & Lancelot, C. (2004). Modelling the

impact of the Scheldt and Rhine/Meuse plumes on the salinity distribution in Belgian waters (southern North Sea). Journal of Sea Research, 52(3), 149-163.). Figure 4: Please use consistent legends for the same variable between different months, with the same colour scheme and symbols (squares vs. circles) and with blue indicating low values and red indicating high values, so the high values stand out, more than the low values. Also captions in the table per line (red fluorescence, O/R ratio etc.) and per column (april, may etc.) would help to easier understand the figure. Section 3.5: I don't see the added value of this analysis. What does it tell us? Page 24: I suggest to mention in the table all the variables that were included in the analysis and note coefficients or 'ns' for not significant and the p values per explanatory variable. Then readers don't need to reconstruct the overview from the text. Actually, the significance test is likely not valid due to strong spatial autocorrelation in the data. Discussion: Here I would expect to get some advice: How to best estimate phytoplankton biomass from these data? Should we use total red fluorescence (best R2) or F0 (least affected by NPQ)? Is there a way to combine both (with other available variables) to get an even better estimate? Can we trust GPP from FRRF as a reliable estimate of primary production or is more work needed to achieve that goal? If so, what needs to be done? It is not really clear whether the diurnal variability in the FRRF variables is a problem that needs to be solved. Are the clusters in the FCM analysis the relevant ones to provide 'useful' information to science & society? Should we / Can we move on to other clusters that are mentioned in the conclusions? Do the FCM data help to better understand the FRRF data (and vice versa)? For example do we see diatoms under light limited conditions (high F'/Fm', high alfa, low Ek) and picoplankton under nutrient limited conditions (low F'/Fm')? Other ecological niches that we know from literature? Different conditions promoting Synechococcus compared to other picoplankton?

Technical comments

Collinear should be spelled with 2 ll's throughout the whole text. Page 9, line 4 & 5: I guess um means micrometers? Page 18, line 4: middle-right, please refer to the label

a-x. Figure 5: The figure would be easier to read if the colours per group are consistent between the cluster analysis on the right and the map on the left. Labels (A-D for April to August panels) would also help. Figure 9: Please add the hours of the day on the x-axis. Page 25, line 3: the word influenced is repeated too many times and therefor should get an e in the end. Page 28, line 11: estimates are. Line 13: parameter without s. Page 31, line 8: Jerico-next, without h.

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