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Interactive comment on "A novel acclimative biogeochemical model and its implementation to the southern North Sea" *by* Onur Kerimoglu et al.

Anonymous Referee #2

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General comments

This paper addresses the challenging task to combine detailed modelling of intracellular processes in phytoplankton with detailed oceanographic modelling. The paper states that the detailed formulation intracellular processes in phytoplankton leads to improved modelling results for the southern North Sea. It would lead to more variability in vertical patterns and to amplification of the cross-shore chlorophyll gradient, due to the effect of light on chlorophyll to carbon ratios. But these conclusions are not well supported by the results:

- The time series comparison of chlorophyll results with in-situ data suggest that chlorophyll concentrations are systematically over-predicted in spring at many monitoring stations. The validation plots with in-situ data are only presented for other model variables

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and not for chlorophyll.

- The validation with satellite data shows also that chlorophyll is systematically over-predicted throughout the model domain during spring. The authors conclude that the satellite data are wrong. This is not supported by any comparison with in-situ data, but the above comparison with time series suggests that the model over-predicts chlorophyll in spring.

- It is unclear what trait effects are included in the model, which are not included in existing models. On page 4, line 20 a few traits are listed (very brief) but in the discussion at page 15 and 17 other effects are mentioned, such as effects on chlorophyll to carbon ratio and sinking rates.

- A critical discussion of the novel aspects of the phytoplankton model is lacking. For example: are the chlorophyll to carbon ratios in spring in a realistic range for spring conditions? How do sinking rates change over the year and how does that relate to observations?

- There is no validation of the light climate (as Kd) included in the manuscript. This would be helpful in explaining differences between the model and observed data. Hence, I recommend major revisions.

Specific comments:

-Page 4, line 20 and equation 1. This part needs to give a complete list of acclimation effects included in the model. It should also describe in words how it works. Like it is written on page 17: " sinking speed of algae in MAECS is inversely related to nutrient quota of cells.". So there are not only effects of nutrients on growth rate (as suggested by eq 1) but also on other aspects. And there are effects of light on chlorophyll to carbon ratio. And does a flexibility constant represent?

- Page 5, caption of Figure 2 mentions Fe-P:P adsorbed in iron-phosphorus complexes. I don't see this in the figure. Or you should refer to bAP in the caption.

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- Page 7: Could you please clarify in more detail the source of the ESA-CCI dataset. Is there a website where these data can be downloaded and where we can find validation reports of this dataset?

- Figure 4: the T and S are too small to read and overlap with the dots. - Page 9, line 10. I don't see that the classical seasonal pattern of phosphorus is entirely reversed in the data. This may be partly due to the small size of the figure. But also it may be that phosphorus concentrations in shallow muddy areas of the Wadden Sea are higher during the summer than during winter due to release of phosphorus from anoxic sediments. This does not reverse the seasonal pattern, because there is a classical drop in phosphorus concentrations during the spring bloom.

- Page 9: line 15: "potentially inadequate description of certain processes". Here a more thorough discussion of model functioning is needed. Now the validation data is more critically discussed than the model. I would expect that at location with a measurement frequency of several weeks to months, there is not much smoothing effect in monthly averages. Anyway such effect cannot explain structural differences between model and in-situ data, as shown in Figure 5a: DIN is consistently underpredicted and DIP overpredicted by the model.

- Page 10, Figure 5: the Pearson coefficients in the figures are too small to read. It would be clearer to present them in a table.

- Page 13, Figure 8: Please also include similar figures for chlorophyll. Chlorophyll is the only model variable that is relevant to judge the validity of the novel modeling approach.

- Page 15, lines 5 – 13. The reader has no information to judge whether the sinking speeds in MAECS are more realistic than in other models. I would expect that the variability in the physical model underlying the ecosystem model is the main driver of vertical variability in phytoplankton concentrations. I don't see any information to convince me that "intracellular regulation of nutrient storages and pigmentory material"

plays any role in this.

- Page 17, lines 3-5. This is not an entirely open question. There are some interesting papers about this effect, such as: Burson, Amanda, et al. "Unbalanced reduction of nutrient loads has created an offshore gradient from phosphorus to nitrogen limitation in the North Sea." Limnology and Oceanography (2016) and references therein.

- Page 17, line 10: If you use a data source for validation of the model you cannot conclude that the data are wrong instead of the model. Also the reason that some in-situ measurements in Figure 5 are above 50 is not valid. Figure 5 shows that the majority of the in-situ data is well below 50. So to make a fair comparison between in-situ data and satellite data, you should compare the seasonal averages, also at the offshore stations.

- Page 17: lines 13 – 18. Here you only compare patterns in chlorophyll-c ratios with literature, but not the actual ranges. The numbers in Figure 14 are too small to read so I cannot judge whether the overprediction in chlorophyll in spring (figure 13) is caused by too much phytoplankton biomass or too high chlorophyll to carbon ratios.

- Page 20: Lines 3 – 4. This is an interesting conclusion, but it is not well supported by the results presented in this paper.

Technical comments

The text is too small to read in most figures.

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