**Biogeosciences Discussions**

# *Interactive comment on* "Control of phytoplankton production by physical forcing in a strongly tidal, well-mixed estuary" *by* X. Desmit et al.

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This manuscript adds new insights into the complex physical forcing functions that control primary production in the upper reaches of macrotidal estuaries, ecosystems that have long been considered to be too turbid to allow for positive phytoplankton growth rates. The authors studied controls on primary production in turbid estuaries by means of a modelling approach and applied their model to two stations in the Schelde estuary. In contrast to many previous primary production models, their model added a new level of complexity to previous models by taking into account variations in water depth and SPM concentrations during a tidal cycle. Two main conclusions were drawn from their modelling study: (1) that net primary production is possible in extremely turbid waters if mixing depth to photic depth ratio is sufficiently low and (2) that resolving variations in water depth and SPM concentrations at < hourly timescales is important for estimating primary production in this type of ecosystems.

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While the model presented in this paper takes into account the effect of tidal variations in water column depth on primary production, it is not clear to me how the resulting changes in water surface have been taken into account in the primary production estimates. If the water level of a given water volume declines, its surface will change. The effect of tidal water level fluctuations on the surface of a given volume of water will depend on the morphology of the system that is studied. If the system consists of a channel with vertical banks (as is suggested by Fig. 1) surface will increase during low tide. This effect would be particularly strong at the shallow site at Dendermonde, where the water surface during low tide would be two to three times (!) higher during ebb tide than during high tide, resulting no doubt in a strong influence on daily integrated primary production of the volume of water that has been studied. On the other hand, when the morphology consists of a deep central channel with extensive intertidal shallows, theoretically, an inverse pattern could occur and surface might decrease during low tide. If this extra level of complexity has not been or will not be included in the present model, I think it should at least be discussed in the paper. It might also be interesting to evaluate how differences in morphology between the 2 Schelde sites that were compared would influence differences in primary production.

The strength of this complex model lies in the fact that it has incorporated complex short-term changes in water depth and turbidity. The importance of this complex short-term variability is nicely illustrated in Figs 11 and 12 (which might be combined into a single figure). It is fascinating to see how the interaction between daily variations in turbidity and solar irradiance sometimes leads to a single productivity maximum around noon and sometimes to two maxima, one around sunset and one around sunrise. Apparently, incorporating this complexity into a model affects primary production estimates. Although the text mentions that integrated primary production over one month is about 30% lower when this complexity is taken into account in contrast to a model that ignores this complexity, these data are not presented in a graph or table.

It would be interesting to see how differences in the position of the production maximum

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(noon versus sunset/sunrise) affect daily integrated primary production. As the modelled increase in phytoplankton biomass over time(shown in Fig. 13) appears nicely exponential, the large day-to-day differences in the position of the production maxima apparently do not lead to large differences in daily integrated production. Plotting daily integrated growth rates over time would probably yield a nicer visualisation of day-to-day variability in growth conditions than the evolution of biomass over time.

The model ignores transport processes, which of course play an important role in a real estuary. Not taking into account water retention time may give the false impression that phytoplankton growth is possible in the estuary, while in fact growth rates may be lower than the rate at which phytoplankton is being washed out of the system, even at the Dendermonde site where net primary production is positive. If average daily integrated growth rates would be presented, this would allow evaluating the minimum water retention time in the estuary required to allow for positive phytoplankton growth.

The authors conclude that differences in diel variations in photosynthetic parameters did not influence their conclusion regarding differences between the two stations in the Schelde estuary, being that net growth was possible at site 2 but not at site 1. This gives the reader the feeling that it is not important to integrate such diel variations in photosynthetic parameters into primary production models. However, differences in diel variations in photosynthetic parameters clearly lead to considerable changes in phytoplankton growth rates at site 2. These may be important enough to make the difference between positive and negative population growth if water retention time would be taken into account.

The description of the model in several places wordy and can in my opinion be reduced in length. For example the explanation why photinhibition was not included in the model can be stated in one sentence (p. 43 l. 7-15).

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