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Biogeosciences Discussions

Interactive comment on "Isotope data improve the predictive capabilities of a marine biogeochemical model" *by* T. Van Engeland et al.

Anonymous Referee #1

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A modelling study is presented describing the advantages of additional measurements, in this case stable carbon isotope data, for model calibration for a mesocosm experiment. Parameters are estimated first by hand and then using automated methods. The automated methods also yield information about which parameters can be constrained by the observations. It is found that fewer measurements can constrain parameters less well than more measurements, and that additional measurements can ease the problem of over-parametrisation. The authors further conclude that modelling can help extracting information from experiments and assessing uncertainties in the experimental design and the quality of the observations.

The study was apparently done in a straight-forward manner, applying state-of-the-art techniques for parameter estimation, although the plankton model used is rather

simplistic. However, I found the main conclusions either rather uninteresting or not supported by the analysis (see below). The conclusion that additional observations can help constraining more parameters is really commonplace and the conclusions about using modelling to assess experimental uncertainties do not appear substantiated by the main text of the manuscript. For these reasons, I do not recommend publication.

Nevertheless, I still believe that a good and useful manuscript could be made out of these experiments, but it would require more than a major revision. I think the main problem here is the focus of the manuscript on parameter estimation and over-parametrisation. The authors stress the kind of additional data they use, which is 13C data, but then do not make much of this. The strength of the isotope data is that they contain information about the fluxes among different components of the plankton system, but this fact is only vaguely hinted at in the manuscript. I would recommend designing a plankton model specifically geared towards utilising the flux information contained in the 13C data and then analysing how this information could be used best in modelling.

Major problems:

1. The selection of candidate parameters (p. 9462, l. 10): whether a model is sensitive to a particular parameter often depends on values of other parameters, but apparently this was not considered when selecting the candidate parameters

2. The whole first paragraph of the conclusions does not appear substantiated by the manuscript. While this may all be true or not, the problem is that none of this material is covered in the preceding main text. For example, which assumptions involved in sampling, measurement and experimental design (p. 9470, l. 10) were made or explicitly in the model? What uncertainties in the experiment (l. 13) are the authors referring to? How could the model analysis aid quality control (l. 15)? Also, the statement that uncertainty analyses can help to define the condition under which such experimental findings and parameter values can be transferred to Earth System Models is prob-

lematic. Global models are not even mentioned once in the main text. Also, I do not believe this is possible unless several local studies from geographically distant places were combined.

3. Over-parametrisation is not the only cause for insufficiently constrained parameters. A mismatch between a process and the corresponding equation can also make parameter estimation difficult, e.g., by increasing multicollinearity. For example, as Aksnes and Egge (1991) have pointed out, maximum nutrient uptake rate and half-saturation constant are tightly correlated, whereas the affinity (ratio of maximum rate and half-saturation constant) is independent of maximum uptake rate. Thus, the choice of phytoplankton growth function will directly affect the multicollinearity index and hence the ability to constrain the model parameters.

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