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Interactive comment on "Using biogeochemical data assimilation to assess the relative skill of multiple ecosystem models: effects of increasing the complexity of the planktonic food web" *by* Y. Xiao and M. A. M. Friedrichs

Anonymous Referee #1

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General comments:

This study compares five lower trophic level ecosystem models with increasing numbers of P and Z state variables in terms of their ability to reproduce observed patters in remotely sensed surface chlorophyll and POC. The comparison is made by assessing changes in the cost function following data assimilation for a set of four test sites, and by computing the cost function for models with optimised parameters at four cross-validation sites. The approach is useful in that it isolates the effects of model complexity on fit to real data (without confounding with other aspects of model architecture), and

the results are consistent with previous findings that models of intermediate complexity tend to perform best in terms of their ability to reproduce observations.

The results are clearly presented and the discussion is succinct. For several components of the methods the reader is referred to Xiao and Friedrichs (2014), which is currently in review. While the submitted version of this manuscript appears to be available online, the relevant aspects of the methods referred to in this discussion paper have not yet undergone the full peer review process.

Specific comments:

1. Methods section 2.2 (satellite-derived data): at what scale (spatial and temporal) were these data extracted?

2. Page 487, lines 15-18: is there a reference for this statement?

3. Methods section 2.4: can the authors provide a brief justification for the selection of sites?

4. Discussion and Conclusions: while the authors do provide a useful evaluation of the tradeoffs associated with overtuning as the number of parameters being optimised increases, I am a little concerned that the assessment of a posteriori costs is confounded with (a) the level of fit to data with the initial parameter set (which may vary between models), (b) the efficiency of the optimisation for different models, and (c) the actual skill of the model after optimisation. If the authors could provide some commentary on this issue I think it would help with interpretation of their findings.

5. Page 550, line 10: but MZ (medium zooplankton) is not a state variable in any of the models specified (unless I've missed something).

6. Appendix A: It would be helpful to have a list of the symbols for parameters that were optimised (and are named in Table 1).

7. Figure 2b: the fit to data for a posteriori simulations is fairly poor from just visual

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examination, at least in comparison with examples of optimisation for NPZD models that I am more familiar with (Kidston et al. 2011, 2013, Melbourne-Thomas et al. 2013). Can the authors make a general comment on the ability of their models to capture seasonal cycles for this system?

Technical corrections:

1. Page 483, line 13: should read “lower trophic level model”.

2. Page 484, line 20: unclear to me what is meant by the term “community species”.

3. Page 484, line 22: suggest replacing the word “truth” with “observations”.

4. Page 487, line 3: the word “have” should be “has”.

5. Page 487, line 15: abbreviation “MAB” hasn’t been defined.

6. Page 488, line 2: the word “include” should be “includes”.

7. Page 488, line 13: the word “represent” should be “represents”.

8. Page 495, line 23: suggest replacing “a deterioration in the Total_cost” with “an increase in the Total_cost”.

9. Table 1: units for maximum Chl:C ratio – mg Chl mg C-1 – is this right? Not just Chl C-1 or mg Chl mg-1 C-1?

References:

Kidston, M., R. Matear, and M. E. Baird. 2011. Parameter optimisation of a marine ecosystem model at two contrasting stations in the Sub-Antarctic Zone. Deep Sea Research Part II: Topical Studies in Oceanography 58:2301–2315.

Kidston, M., R. Matear, and M. E. Baird. 2013. Phytoplankton growth in the Australian sector of the Southern Ocean, examined by optimising ecosystem model parameters. Journal of Marine Systems 128:123–137.

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Melbourne-Thomas, J., S. Wotherspoon, S. Corney, E. Molina-Balari, O. Marini, and A. Constable. 2013. Optimal control and system limitation in a Southern Ocean ecosystem model. Deep-Sea Research Part II. DOI: 10.1016/j.dsr2.2013.02.017.

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