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***Interactive comment on* “Climate-mediated changes to mixed-layer properties in the Southern Ocean: assessing the phytoplankton response” by P. W. Boyd et al.**

Anonymous Referee #2

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In this study, the authors analyse, using a coupled carbon-ocean-atmosphere model, the changes in the physical and biogeochemical conditions of the Southern Ocean due to climate change. They compare these changes to the natural variability. Then, in a second step, they interpret the model results using the current understanding of the environmental control of phytoplankton growth. Their model results confirm previous findings in that the secular changes induced by climate change will be very subtle in the next few decades relative to the natural variability. As a consequence, the authors suggest that climate change will not produce the conditions necessary to induce the adaptation of the resident phytoplankton, at least for the next few decades.

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To be totally honest, I don't really know what to say about this study. In fact, this paper can be divided into two quite well distinct parts. In the first part, the authors present results from a coupled global model focusing on the Southern Ocean. This section is rather interesting, especially because this is, to my knowledge, the first study focusing on the comparison between the natural variability and the climate change in a biogeochemical perspective. Unfortunately, I find it too rapid. Many results are presented but not really analysed, neither used. For instance, figure 3 displays the spatial 2-D patterns of the natural variability and the response to the anthropogenic forcing. But this information is not used in the rest of the manuscript. Another example is table 3 which presents the co-variation between physical and biogeochemical property anomalies. The analysis of this table is extremely short and superficial (some variables correlate well, some others don't) and the information from this table is not used anywhere else in the study. Thus I would suggest either to shorten this first part to keep only the information really useful for the rest of the study or to extend the analysis. If the authors choose the second option, my advice would be to more clearly highlight the usefulness of the model results.

In the second part, the authors use some of the results analysed in the first part to try to infer what the consequences would be for resident phytoplankton in the Southern Ocean. Rather than being strictly speaking results, the authors use the current knowledge on phytoplankton growth/physiology to discuss on the potential response of phytoplankton to climate change in the Southern Ocean. This part is, like the first one, quite interesting because it reviews important aspects of the current knowledge in the perspective of a changing environment. However, to my opinion, this part is more a review than a discussion. Furthermore, the relationship with the first part is not always obvious. The only result that is used from the first part is the small anthropogenic change relative to the natural climate variability in the Southern Ocean. This second part is also sometimes quite hard to follow. For instance, section 4.2 is quite hard to relate to the rest of the discussion and is thus distracting.

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To conclude, I think that this paper presents some interesting results. However, the model results are to my opinion insufficiently exploited. Furthermore, the discussion section would need to refocus on some few ideas rather than exposing interesting but sometimes hard-to-follow general concepts.

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