Reviewer #1 (Omta)

R: General comments
A key problem in predicting the rate of carbon uptake by the oceans is the uncertainty in the diapycnal diffusion. The authors show that this problem is not alleviated by optimizing an ocean model against the historical and current (biogeochemical) observations: the past and current state of the ocean can be described with very different parameter sets, which give dramatically different predictions for the future. Overall, this is a decent piece of work that I recommend for publication after minor revisions.

A: We thank A.W. Omta for his time and effort! We found his comments very helpful and will consider all of them in the revised version of our manuscript.

Specific comment
Although I think this is a decent piece of work, the Conclusions section leaves me rather dissatisfied. In particular, I find the conclusion "that an improved understanding of vertical diapycnal mixing in Earth System Models alleviates the risk of reciprocal bias compensation by (wrongly) tweaking biogeochemical modules to a deficient physics" weak. It is of course great to diagnose a problem, but it would be helpful to have some more specific pointers to how future research could work toward a possible solution. In other words: how can we get to an improved understanding of vertical diapycnal mixing?

A: Our ongoing work indicates that the saturation state of noble gases such as argon may be applied to constrain diapycnal mixing in ocean models. We will add this outlook to the Discussion part of the revised manuscript.

R: Technical comments

A: We thank A.W. Omta for the extensive list of corrections. We, gratefully, will consider all of them.