

Title: Challenges and Opportunities to reduce uncertainty in projections of future atmospheric CO₂: a combined marine and terrestrial biosphere perspective.

Author(s): D. Dalmonech et al.

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[Reply to RC1:](#)

Key-comments of the reviewer are here reported in bold. The reply follows.

Much of what is said in the later part of the review about metrics and benchmarking goes over ground already covered in the recent Foley et al. paper in Biogeosciences.

Some overlap of these two manuscripts is expected as the procedure of model evaluation and model constrain share same data and methodology. However, in our manuscript, we deliberately set another focus, and discuss the utility of these metrics for constraining a model, i.e. reducing/constrain the spread in the projections of atmospheric CO₂, which is not the same as (simply) evaluating a model's performance. Most sections of our manuscript are framed in the context of model constrain and are hence focused on reducing the uncertainties of the projections of a specific variable of interest. This involves metrics and benchmarking, but also issues as e.g. model independence, correlation of model-data error and a variable of interest in the future, weighting models in multi-model ensemble etc. In this context it is still important to discuss the relevant aspects of metrics, and omitting this part would have reduced the value of the review as a stand-alone piece.

The authors should have demonstrated progress beyond the state of the art as represented in AR5, but this was not at all clear.

We regret that the organization of the manuscript meant that the reviewer did not see that we were aiming at pointing to ways for progress beyond the "AR5" state of the art (which by the

time we wrote the manuscript was not yet finalized, and we could therefore not refer to it), and that we were trying to look at alternative approaches used in the climate community which might be applied to the evaluation of biogeochemical feedbacks. We felt that given the current efforts in understanding and quantifying feedbacks, it was important to reflect on I) challenges and limitations to our understanding, II) limitation of the applications of methodologies in order to reduce e.g. atmospheric CO₂ projections due to uncertainties of different nature.

Due to the focus on aspects related to both marine and terrestrial ecosystems, even with the removal of specific aspects such as the uncertainties related to e.g. the population dynamics, the manuscript would still remain very long. In order to achieve a more fluent and articulate manuscript, a very deep restructuring of the text with the inclusion of new content would be required, which is beyond the scope of revising this manuscript. We therefore do not intend to submit a revised version.