

## ***Interactive comment on “Arctic Ocean CO<sub>2</sub> uptake: an improved multi-year estimate of the air–sea CO<sub>2</sub> flux incorporating chlorophyll-a concentrations” by Sayaka Yasunaka et al.***

### **Anonymous Referee #2**

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The authors present an improved version of the Yasunaka et al. (2016) estimate of the uptake of CO<sub>2</sub> by the Arctic Ocean. The paper is very clearly written and the detail in quantifying uncertainty is impressive. The principal limitation of the manuscript is that it is very technical, and will likely need to touch more closely and directly on broader scientific questions to be recommended for publication in Biogeosciences. In my opinion, this could be accomplished with minor revisions, consisting of adding to the Conclusions with a few paragraphs and emphasizing the broader implications and relevance for identifying key processes and/or optimization observing system design.

Main Points:

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Although the authors have done a very good job of quantifying uncertainty in pCO<sub>2</sub> and air-sea CO<sub>2</sub> fluxes, the paper would benefit from commentary on the implications for optimization of the observing network. The other missing component of the study is a mechanistic interpretation of the main results, perhaps as part of the Conclusions. In the Introduction, there is a broad overview of the mechanisms that might impact trends in carbon fluxes over the Arctic, but it was surprising that these points did not get addressed in the Conclusions.

Given the availability of forward ocean biogeochemistry models that include the Arctic, I believe that the burden on the authors to provide at the very least an account of why they do not consider an Observing System Simulation Experiment (OSSE) to assess the skill of their method. Presumably some of the models that participate in the Global Carbon Project are open-access, and could be sampled with the spatial/temporal coordinates of the SOCAT and other pertinent data products? If the authors have scientific reasons for not finding the process-representation of the current generation of models to be up to the task, what then are the critical scales and processes that would be critical to represent?

#### Minor Points:

It would be good if the authors could point out whether there are important methodological differences between their method and others in the literature that use neural-network-type approaches.

The Revelle factor was mentioned in the Introduction, and it would be very helpful to know if the authors believe that this will be an important factor over the Arctic when considering future climate change. It would be useful to discuss this as it pertains to the transient signal, and whether there is evidence that it is more important here than in other subpolar or circumpolar regions.

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