

## ***Interactive comment on “Wind driven changes in the ocean carbon sink” by N. C. Swart et al.***

### **Anonymous Referee #1**

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This paper investigates the sensitivity of global ocean carbon uptake to variable and changing wind stress, with an emphasis on the Southern Ocean region. There has been quite a bit of debate in the literature about air-sea carbon fluxes in this region and their sensitivity to wind stress and eddy transport, and as such, this paper represents a nice contribution to the debate. The paper is generally well-written and the conclusions are sound. I recommend its publication in Biogeosciences, provided that the three major comments below are addressed during revision.

Major comments:

1) The paper is strongly focused on the Southern Ocean wind and CO<sub>2</sub> flux trends, but not exclusively so. For example, several figures show the global flux response to global wind changes, and yet, there is very little discussion about the wind-driven changes in CO<sub>2</sub> flux outside of the Southern Ocean. What might drive these changes? More

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discussion on this point is needed in the paper. Also, Figure 3 is confusing: the wind trend is for the Southern Ocean, but the CO<sub>2</sub> flux trend is for the global ocean (or is it?). Please clarify.

2) I have little doubt that introducing the variable GM coefficient into the model simulations caused the mean state of the model to drift from the simulation with constant GM, and yet the different mean states of the model are not discussed. Please quantify the difference in the mean ocean circulation with and without variable GM. How does this difference in mean state affect your interpretation of the overturning or CO<sub>2</sub> flux response to changes in wind?

3) A major finding in the paper is the connection between changes in MOC in constant/variable GM simulations and the changes in air-sea CO<sub>2</sub> flux. However the discussion is missing the link between a different MOC response to wind and a different air-sea CO<sub>2</sub> flux response to wind in the two sets of simulations. Exactly how does variable GM affect the transport of CO<sub>2</sub> by eddies in the Southern Ocean? Please demonstrate that it is the eddy transport of CO<sub>2</sub> that changes between these simulations, and not something else (e.g., a variable GM coefficient could cause differences in SST, which affect CO<sub>2</sub> solubility, or differences in the depth of the mixed layer, which affect CO<sub>2</sub> entrainment).

Minor comment:

-Section 3.2, line 4 should read “air to sea” instead of “sea to air”

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