

Interactive comment on “Climate change impacts on sea-air fluxes of CO₂ in three Arctic seas: a sensitivity study using earth observation” by P. E. Land et al.

Anonymous Referee #1

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Since the Arctic is undergoing such rapid changes, as exemplified by the precipitous decline in summer sea ice coverage, a study of how these changes will affect air-sea CO₂ fluxes, such as the one by Land et al., is timely. However, in conducting this study, the authors ignored many of the processes that make the Arctic unique with respect to gas exchange and gas fluxes (e.g., interaction between sea ice and surface water; stratification created by sea ice melt and freshwater discharge), thereby rendering the study less realistic and relevant.

Main problems:

The manuscript suffers from oversimplifying the processes that control gas exchange

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and ignoring important factors that affect gas fluxes in the Arctic. In many biogeochemical studies in polar regions, it has been assumed that gas transfer velocities (and therefore gas fluxes) scales with fractional sea ice cover. However, because there are factors that modulate subsurface turbulence in the presence of sea ice, gas transfer velocities might not scale linearly with sea ice cover (or sea ice duration) and this is supported by some field and laboratory evidence (e.g., Fanning and Torres, 1991; Loose et al., 2009).

For instance, because wind drag is higher for sea ice than for water, the presence of sea ice could enhance subsurface turbulence significantly. In the presence of sea ice, the factors that affect turbulence include: wind waves and their interactions with ice floes; shear in the ice-ocean boundary layer; buoyant convection/stratification due to ice formation/melt; surfactants derived from biological activities in the ice. All of these factors need to be considered if the authors are interested in how climate change will alter gas exchange in an ice-covered region.

The authors use climatological values of pCO₂ from Takahashi et al. (2009), and re-gridded them to 1x1° “using linear interpolation”, to calculate their CO₂ fluxes. However, the reason that the Takahashi et al. (2009) climatology is gridded at 4 x 5° is because there are not enough original data to create a climatology at a finer scale. It is not reasonable to interpolate these data to 1x1°, especially in the Arctic. Perhaps the authors should consider looking at what is available in the SOCAT database, the beta version which has a lot more data in the Arctic. Otherwise, using the original Takahashi et al. (2009) values from the 4x5° boxes is probably a more reasonable approach.

References

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