

The Cryosphere Discuss., referee comment RC4
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Comment on tc-2022-84

Anonymous Referee #4

Referee comment on "Arctic sea ice and snow from different ice models: A CICE-SI3 intercomparison study" by Imke Sievers et al., The Cryosphere Discuss.,
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The authors present two forced ocean sea ice simulations which only differ regarding the sea ice component (SI3 and CICE), but which consist of the same ocean model (NEMO), identical forcing and similar boundary conditions. Their aim is to investigate the impact of internal parameters on sea ice conditions and to identify and discuss the causes for differences.

They find that differences between the two simulations are generally small, but state that some regional differences can be linked to different model processes. They claim that drag formulation, albedo parametrisation, and treatment of snow have the largest impact.

The concept of the study to investigate the impact of internal parameters (model physics) on sea ice results by applying the same external parameters (forcing data and boundary conditions) is excellent and the choice of sea ice model comprehensible. The sea ice models CICE and LIM (main predecessor of SI3) have been the most widely used sea ice models among all CMIP6 contributions. The study is nicely motivated in the Introduction with demonstrative examples. However, the description of the commonalities and differences between the two sea ice models is insufficient, the albedo tuning questionable in different ways, and your main conclusions that albedo, form drag and snow treatment have the largest impact are largely not supported by your results.

Albedo: Why do you tune the albedo parameters for both models to fit PIOMAS sea ice

volume? After tuning to PIOMAS, you would expect both models to be closer to CS2SMOS, but what can you conclude from this about the impact of model physics? Potential differences from some model parameterisation can be compensated by this tuning. Furthermore, your results do not allow to conclude anything about the impact of albedo if you do not show and include the original simulations before tuning. In addition, how did you actually tune sea ice albedo parameters within CICE? According to your namelist file, you applied the Delta-Eddington radiation scheme. The key concept of this scheme is not to prescribe any albedo values, but resulting albedo values are calculated based on optical properties for which you can derive uncertainties. Your namelist file shows that you did not alter R_{ice} , R_{pnd} and R_{snw} and changes to the visible and infrared snow and ice albedo parameters are ignored when using the Delta-Eddington scheme. Your approach is puzzling to me.

Form drag: Maps of ice-ocean and ice-atmosphere drags are shown for CICE applying the form drag formulation from Tsamados et al. (2015) and some differences in resulting sea ice drift in your Appendix. However, how do you know this has a big impact on sea ice volume and improves sea ice thickness in some region? Sea ice changes due to advection are not shown or neither impact of form drag on turbulent heat transport.

Snow: Your resulting differences in snow depth in spite of same amount of snowfall (same forcing) is interesting. You demonstrate impact on sea ice volume. However, a more detailed analysis is missing: Differences caused by snow drift or thermal processes?