The Cryosphere Discussions

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Comment on tc-2021-127

Anonymous Referee #1

Referee comment on "Assimilation of sea ice thickness derived from CryoSat-2 along-track freeboard measurements into the Met Office's Forecast Ocean Assimilation Model (FOAM)" by Emma K. Fiedler et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-127-RC1, 2021

The paper describes the assimilation of along-track CryoSat-2 (CS2) sea ice freeboard observations into a sea ice-ocean coupled model. The along-track CS2 data are not commonly assimilated in the previous studies due to limited available tracks per day, but however are important for real-time forecasts that pursues smaller latency. The paper shows the conversion from freeboard to thickness and validates the 5-day forecasts against both the assimilated data and in-situ observations such as BGEP, IceBridge and EM sea ice thickness. I found that the paper is generally well organized and illustrative. The conclusions are convincing. Some paragraphs, I think, could be more compact. I would recommend a minor revision on the paper. However, the authors may check my comments below at first.

- Snow thickness is difficult to simulate in sea ice models. The unreliable precipitation and the lack of robust observations could be attributed to as possible reasons. However, since the conversion from the freeboard to thickness relies majorly on how well the snow thickness is simulated, I wonder if the authors could provide some sentences to discuss the sensitivity of the forecast results to the simulated snow thickness.
- L142: make -> makes
- Eq (3): The threshold for thickness is 0.7m when having an uncertainty of 8. I realize that the authors have explained how the shape of these functions are obtained, but I feel curious of why 0.7m is used. If it was arbitrarily selected, then this information is necessarily to be present in the context.
- Paragraph L370: About the unexpected improvement in the mean differences. The authors state that it is caused by the spatial noise introduced during data assimilation. That could be one of the reasons, but from my side, I tend to believe it is caused by the systematic errors of the model. In Figure 5b,c, the model shows negative thickness

bias, which indicates a slower growth during the freezing period. However, as suggested in Figure 9a, slightly thicker ice than observations are generally found. That is to say, the assimilation introduced thickness increment is faster than the ice growth by the model physics, i.e., ice grows faster in observations than in models. Could that be the case? I have no evidence about that.

- The discussion and conclusions could be made compact. I currently read it feeling too much redundant information. I would suggest one or two future plans are already enough for wrap-up.