

The Cryosphere Discuss., referee comment RC5  
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## Comment on tc-2021-127

Anonymous Referee #5

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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.,  
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The article of "Assimilation of sea ice thickness derived from CryoSat-2 along-track freeboard measurements into the Met Office's Forecast Ocean Assimilation Model (FOAM)" presents the 3-year assimilation experiment run in FOAM in which the along-track Arctic freeboard measurements of sea ice have been assimilated into, and further the corresponding SIT/SIC has been validated by assimilation statics and other independent observations. Clearly, this topic is very interesting for other operational ocean-sea ice modelling and forecasting systems, and the present results will be a good reference to compare with the assimilation of traditional gridded SIT products. Undoubtedly, it is a nice work to show how to use this challenge observation of SIT. However, there are still some issues affecting the full understanding of their results.

1) In the assimilation experiment, the converting from the freeboard  $F_i$  to sea ice thickness is a key part to affect the SIT forecast performance in FOAM. Compared with the common converting tool like Round Robin Data Package (ESA, 2013), the authors use the model snow depth to replace the climatology. If possible, showing these two types of along-track SIT could be interesting and meaningful to understand the large contrast between the different SIT observation products in Fig. 12c and Fig. 13c.

2) As Line 286 of "an estimate of 50 km for theminimum SIT correlation length scale." It can infer the spatial scale for assimilation of SIT used 50 km. If that is true, it may be one of reasons

why the increments shown in Fig. 14 (a) and (b) are still noise. So there are two related comments: 1) How about to compare the used horizontal scale for the SIC assimilation in this system? 2) Have you tried to increase this scale from 50 to 100 km which is a practical order of the spatial scale for averaging RA data.

3) To convert the sea ice draft from BGEF by dividing observations by 0.89 is not good for the validations in the ice brake-up and freeze-up months, due to it omits the snow existing. The big issue is that it will mix with the system bias of SIT and return to be detrimental of the analysis in Fig. 15. So I suggest to investigate the best fit lines in the scatterplot are divided into the three interesting periods by the months like MA, ON, MJJAS. It will be helpful to shed light on the MA evaluation to contrast with the validation in Fig. 13 in Beaufort Sea.

4) In the section 2.4, the assimilation of SIT uses IAU as well, and the SIT increments how to feedback on the 5 categories ice in sub-grid, although there are some words about "in proportion to the initial volume distribution". It should be paid more words or show one example for the reader to well understand how they can work together.

Other general comments:

1) Line 97 at P4: "No SIT observations are currently assimilated operationally". It is better to

use "No SIT observations are currently assimilated operationally in the system."

2) Line 193 at P7: "...for the SIT assimilation experiment period at the time of assessment."

Replaced by "... for assessment of the SIT assimilation in the experimental period."

3) Line 246 at P10: the representation uncertainty is set to 0.05 m. Does it mean the minimal observation error is about 0.1 m as the minimal value around the 3m SIT shown by the curve in Fig. 3a? If right, it could be better to be presented on this panel. And this setting could be too small, compared with previous studies and other observation platforms.

4) Line 353 at P18: "The largest regional improvements are in March-April, where the mean difference is above 1.30 m and 1.22 m for the RMSD." Is it possible to specify where the regions are involved.

5) Line 396 at P 23, the 30-day periods were chose to cover the observation days. As shown in Table 1 of Section 2.3.1, the observations are located only in one or two days in the April so the 30-day window could be too wide and far away from the reality condition.

6) Fig.13: The observations from Air-EM are clearly located into two regions: Beaufort Sea and north of Canadian. The related scatterplot separated into these two regions may be more helpful on physic to find something and compared with the result in Fig. 15.