The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC3
https://doi.org/10.5194/tc-2021-127-RC3, 2021

Comment on tc-2021-127

Anonymous Referee #3

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-RC3, 2021

Overview/summary

The authors present results of a study using the coupled ice-ocean FOAM modeling system (1/4 deg resolution used for this study) in which CryoSat-2 along-track ice freeboard data is assimilated into FOAM for a 3-year period from January 2015 - December 2017. The model assimilates CryoSat-2 alongtrack freeboard and uses snow depth from the model to convert freeboard to ice thickness. They show a reduction in RMSE and bias compared to a control run which did not assimilate ice freeboard data. The paper compares the control and assimilative experiments against NASA IceBridge (2015-2017), BGEP ULS moored ice draft (2015-2017), and Air-EM observations from 2015. A reduction in RMSE and standard deviation is shown against the NASA IceBridge data when comparing 5-day forecasts. Little improvement is shown when examining the BGEP data; the authors attribute this to the control experiment having similar ice thickness to what is found from CryoSat-2, thus showing similar results. The comparison between the Air-EM combined measurements of sea ice thickness plus snow depth showed poorer performance with the assimilative experiment versus the control run in 2015. They authors attribute this in part to uncertainties in the model snow depth, sampling error and possibly the in sity observations themselves. No data is assimilated in the May-Sept timeframe, but the assimilative model still demonstrated skill during the summer months.

This paper is well written with sufficient details on the FOAM modeling system and NEMOVAR data assimilation system used in the study. Tables and figures are clearly laid out. This paper presents the first known use of along-track CryoSat-2 data in a operational ice-ocean modeling system.

I recommend minor revisions to the manuscript based on my comments below.

Specific Comments:

Line 105: What is horizontal resolution of the atmospheric forcing? Please include this in the text.

Page 14 Fig 4: add 87.5 N gridline on Fig. 4a and 4b to make the area more discernable.

Line 357-358: "Improvement" in Atlantic sector is (5%) is small and difficult to see in plot. Can you make a difference plot between 10c and 10d to show this?

To augment the NASA IceBridge, BGEP ULS moorings and Air-EM observations, the paper would be more comprehensive if Dartmouth/CRREL IMB were included. Specifically 2015D and 2015F (http:// http://imb-crrel-dartmouth.org/archived-data/). These buoys are outside the Beaufort Sea region, where little improvement was found with the assimilation of CryoSat-2 along-track freeboard data. How do these observations compare with the FOAM ice and snow depths? I would like this analysis added to the paper.

The paper does not show any comparison to IABP ice drift data. Although not a fully coupled air-ocean-ice modeling system, have you examined ice drift and if you have, did you see any improvement in ice drift prediction between the Control and CryoSat-2 assimilative hindcast? If you have not , what is the level of effort to incorporate an ice drift analysis to the existing manuscript?