

The Cryosphere Discuss., referee comment RC1
<https://doi.org/10.5194/tc-2022-92-RC1>, 2022
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Comment on tc-2022-92

Anonymous Referee #1

Referee comment on "Reconstruction of Arctic sea ice thickness and its impact on sea ice forecasting in the melting season" by Lu Yang et al., The Cryosphere Discuss.,
<https://doi.org/10.5194/tc-2022-92-RC1>, 2022

Introduction:

The current study presents a statistical method that uses SIC and SIT from a reanalysis dataset to construct a historical SIT dataset. The idea behind this is that the SIT of the source reanalysis dataset is not accurate in the melt season as no SIT measurements in the melt season are available to feed into that reanalysis dataset, and that incorporating statistical relationships between SIC and SIT leads to an improved SIT dataset. Detailed comparisons with in situ observations and other often-used SIT datasets show that the newly developed SIT performs well. In addition, assimilation runs are performed in which only SIC or both SIC and the newly constructed SIT dataset are assimilated, which are then used to initialize 7-day forecasts. The skill of forecasts initialized from the assimilation runs in which both SIC and the new SIT dataset are assimilated is shown to be higher than forecasts initialized from assimilation runs in which only SIC was assimilated. The analysis shown is detailed and interesting, but there are several major issues that the authors have to address before I can recommend publication.

Major comments:

- Although I understand that the authors are not native English speakers, the English is poor, which makes it difficult to follow the text. I suggest the authors improve the language by consulting with an English native speaker.
- Perhaps it is due to my lack of expertise in the area, or the poor English (or a combination of these factors), but I do not fully understand the statistical model that is used to construct the SIT as described in section 3.1 and in figure 2. Other readers may have similar problems and therefore this should be improved. In particular, I do not understand the 'linear regression for each grid point'. What is particularly confusing is that the authors write that (l. 145) 'the linear regression process is carried out at each grid point ... *for each year.*' And (l. 147) 'the corresponding SIC-SIT regression ... can be obtained for each year'. This description suggest that the linear regression is done

spatially for each year (i.e. regression of SIT at a location with SIC at all other locations in a fixed year), but other text later in the paper suggests the linear regression is done at a specific grid point over the time dimension (i.e. regression of SIT at a location with SIC at that same location over time). Figure 2 also suggests that the regression is done spatially for each year, but I don't think that is what the authors mean. Please clarify.

- The abstract should be improved, as I initially did not understand the method that the authors are introducing. I understood that the aim of the authors is to construct a historical SIT dataset, but they aim to do that based on gridded SIC *and* It should be explained more clearly how the SIT that is the input of the BRMT method differs from the SIT output. Also, the abstract contains several statements about improved performance, without specifying the baseline:
- 17: 'BRMT-constructed SIT is more accurate': more accurate than what?
- 19: 'closer to observations': closer than what?
- 21: 'significantly improved': compared to what?

The baseline should be specified. Finally, some more details on the forecasting experiments should be included in the abstract. In particular, it would be helpful to note that these pertain to 7-day forecasts (to contrast with seasonal forecasts that run for up to a year and in the context of which SIT initialization is often discussed).

Minor comments (note: there are many more grammatical errors that I don't list below, see main comment #1):

- Some key references are omitted and should be included: Dirksen et al 2015 (<https://doi.org/10.1002/2015GL063930.1>) develops 3 statistical methods to generate a SIT datasets, and Dirksen et al 2017 (<https://doi.org/10.1175/JCLI-D-16-0437.1>) shows that one of the 3 statistical methods leads to improved seasonal forecasts of SIC. The authors should include these references.
- The authors try to highlight the importance of the newly SIT dataset by comparing forecasts initialized from assimilation run in which it is used with forecasts initialized from assimilation runs in which it is not used. While this is interesting and worth reporting, it only highlights the importance of initializing SIT versus not initializing SIT. To investigate whether or not the newly developed SIT dataset provides additional value compared to other SIT datasets (e.g. that from the reanalysis dataset that it was derived from) in the context of forecasts, an additional set of forecasts would have to be presented in which an alternative SIT dataset is used for creating the initial conditions.
- 63,66: is à was
- 255: will not à does not?
- Figure 5 (bottom map): what do the colors represent?
- Figure 8: I suggest to use a non-linear scale for the Normalized standard deviation as

a) the most interesting data is where normalized standard deviation is close to 1, and because most points are located there

- 365: 'In part with small deviation evaluation criteria value': not clear. In the following lines (including the quoted numbers for correlation coefficient), do you only use data points with 'small' standard deviation, and if yes, what is the cut-off value for 'small'?
- 477 'significantly smaller': this is a bit hard to see from Fig. 13 as it is hard to compare panel a with panel b. Perhaps it would make sense to add a 3rd panel showing the difference between panel a and b? Also: it is not clear what the authors mean with 'a long-term stable effect' in l. 479
- Figure 14: it is hard to see what the authors refer to, as all the figures are so similar. Perhaps adding a contour line would help, but as it stands the current figure 14 does not add much to the paper. Figure 15 is much more informative
- 530 'are largest': except for Exp_Ctrl
- 533: 'Variation law': not sure what is meant with that