

# ***Interactive comment on “Improved Multimodel Superensemble Forecast for Sea Ice Thickness using Global Climate Models” by Wang Yangjun et al.***

## **Anonymous Referee #1**

Received and published: 20 July 2020

The authors present the rationale for a technique for improving multimodel superensemble forecasts (for ice thickness) using ensembles from global climate models. The CMIP5 GCMs discussed by Wang and Overland (2015) represent the basis for this study where a total of 101 ensemble forecasts from ACCESS1.0, ACCESS1.3, CSSM4, CESM1, EC-EARTH, HadGEM2-ES, HadGEM2-CC, HadGEM2-AO, MIROC-ESM, MIROC-ESM-CHEM, MPI-ESM-LR, and MPI-ESM-MR are used. They effectively demonstrate that simply averaging the ensemble members does not provide meaningful insight. Next, they investigate a bias-removed ensemble mean method (MAVRIC) where observations from PIOMAS are utilized. A series of additional techniques are explored including artificial neural network (ANN), adaptive forecasting

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through experimental re-weighting (AFTER.L1 and .L2). After performing training simulations for the period of 2006-2017, the monthly average SIT RMSE for 2018 was lowest with AFTER.L2, followed closely by AFTER.L1, and ANN. MAVRIC RMSE was significantly higher in addition to the individual (101) ensemble forecasts. The temporally averaged SIT RMSE for these techniques shows that AFTER.L1 and AFTER.L2 performed best, with high values along the northern and northeast coast of Greenland. The spatially averaged SIT CC show similar results as the RMSE, with AFTER.L2 performing best (except for Jul-Oct) followed closely by AFTER.L1 and ANN. A structure similarity index measure (SSIM) is derived and it shows that AFTER.L2 and AFTER.L1 perform best with the superensemble lagging throughout the year versus all other techniques. An EOF analysis reveals that over 99% of the cumulative total variance is found in the first four patterns. The superensemble shows no agreement to observations for any of the first four components. ANN and AFTER.L2 show the best agreement with observations. Similar trends are found in the first two PC's, while ANN was the only method to match obs for PC3. An analysis of the sea ice volume revealed that the superensemble and MAVRIC showed the poorest comparison with observations. A ranking (Table 3) shows how each ensemble method compares amongst the others when evaluating skill in RMSE, CC, SSIM, EOFs, PCs and SIV. Overall, AFTER.L2 is ranked first with AFTER.L1 second, but with the superensemble finishing third ahead of Ann (fourth). I find this to be a well written paper with a thorough description of the techniques and analysis methods used. The graphics and tables are well laid out. I find that this research will be valuable to the community. I recommend publication with minor revisions noted below.

### Specific Comments

In lines 262-263, the authors state "Hence, the L1-norm AFTER superensemble method is adopted to predict future variations in September SIT". The rankings in Table 3 show that overall, AFTER.L2 has the top ranking, although overall similar to the second ranked AFTER.L1. Please comment on your selection. I assume it is because

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L1 was ranked first in RMSE (space and time), CC(space and time), and SSIM. Line 38: Please provide an example of “other forecasting”? Line 81: Briefly describe the four emission scenarios.

#### Technical Comments:

Line 49: Yang (2001a or 2001b)? Line 84: Replace “into” with “onto” Line 85: Should 2050 be 2049? Throughout the rest of the text, the years 2019-2049 are used. Table 1: RCP’s should be labeled as “2.6, 4.5, 6.0, 8.5” Line 91: Replace “they” with “the”? Is this what is meant? Line 99: Is there a reference for the Fifth Report? Line 107: Specify Melia et al. (2015a, 2015b or 2015c). Figure 1: Provide more details in caption. Table 3: Include in caption that colors of boxes represent rankings as well. Figure 7: I assume the results for AFTER.L1 lay underneath AFTER.L2 as I don’t see that data represented on the plot? Figure 12: Can you add boxes that show the 10 regions discussed?

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2020-86>, 2020.

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