The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-134

Anonymous Referee #2

Referee comment on "The sensitivity of landfast sea ice to atmospheric forcing in single-column model simulations: a case study at Zhongshan Station, Antarctica" by Fengguan Gu et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-134-RC2, 2021

General comments

This paper used the single-column sea ice model ICEPACK forced by the ERA5 atmospheric reanalysis and by atmospheric in situ observations to simulate snow depth and sea ice thickness at Zhongshan Station, Antarctic. Through some sensitivity experiments, the authors tried to find which variables from atmospheric forcing affected the simulations largely. Overall, the manuscript has a potential value for publishing. However there are some major issues need to be clarify firstly.

- When assessing the importance of the forcing variables, it is not fair to compare their absolute values. Relative values should be considered.
- Some results may be close related to the threshold values in the model parameterization, for example, 1 mm/day in the figure 7. If yes, please discuss the possible results to use another threshold value. If no, explain the reason why it is 1 mm/day.
- The discussion is not sufficient. The biases caused by precipitation may come from flooding ice (direct thickness contribution) and thermodynamic insulate effect (indirect). The quantitative contributions from those two aspects should be fully studied and clearly presented. Some oceanic heat flux experiments on OML depth should be considered.
- The writing have a lot of typo errors. For example, the citing of the subplots are wrong for many figures.

Specific comments

Lines 163: how about the water depth of the sea ice observation site? Should the real water depth was considered when you set the MLD to 20 m?

Lines 206-208: what is the role of wind on precipitation comparisons? The strong wind caused snow blowing events and the precipitation observation bin could not collect all the snow fall. Do the larger biases occurred during the strong wind events? This should be assessed here.

Lines 232: a space missed between the number and the unit, and the same errors should be checked through the paper.

Lines 251-253: As figure 3b shown, both blue lines and red lines were different compared to black lines. However, in figure 3a, no obvious ice thickness differences occurred for red lines, but the large difference occurred for blue lines. Does this indicated that the ice thickness simulation became more sensitive when the snow biases exceeded some values? What kind of parameterizations in the model caused this phenomena?

Lines 290: the influences of Qa on ice was 1.009, not comparable to the other two variables, therefore its contribution was not that strong.

Lines 292-293: this sentence is not clear. As Table 3 shown, P should be the largest factor for snow and ice simulations.

Lines 292: "Ua … the largest …" you cannot compare the absolute value here, you should use the relative percentage. Also the column value "Forcing" in the table.

Lines 295-297: it is not reasonable to say P caused the major overestimation, based on the current experiment design. Only one sensitivity experiment was run for every single variable, this is not enough. You should design multi-sensitivity experiments for every single variable. If we say the variable P, the additional experiments like 0.5*P, 2.0*P, 3.0*P … should be considered.

Line 299: not figure 4b, snow is in figure 4d. It is not usual to place (a) (b) (c) vertically in the figure.

Figure 4c: the accumulated ice growth decreased since middle July. Why? Does that mean ice started to melt in the bottom?

Lines 318-319: check the subplot label (a) (b) (c) (d), and make sure they were cited correctly.

Lines 320-325: The flooding ice was parameterized to total ice thickness in the model? When water flooded into ice surface layer, snow-ice will formed if snow existed, however we didn't see snow thickness change a lot when accumulated flooding ice rapidly increased in July, why?

Lines 325-326: Accumulated snow fall was about 400 mm (40 cm) in July, similar to snow thickness (40 cm), I didn't see "much lower" you mentioned here. How the model deal with the relationship between snow fall, snow thickness, flooding ice, snow-ice thickness and total ice thickness should be explained clear in this section.

Line 321: You proposed a guess here. This could be confirmed by calculating the conductive heat flux and bottom heat flux balance.

Lines 340-341: If wind-blowing was not considered by the model, therefore snow thickness was the accumulation of total snow fall? Or any other processes were included? What caused the differences of snow thickness simulations? Why the surface heat fluxes can affect the snow thickness?

Line 369: it should be the bias of sea ice thickness and snow depth

Lines 370: why to calculate from 27 July, not the initial day of experiments in April?

Lines 375-377: what control the threshold value to be 1 mm/day. Was it related to the value in the model parameterization?

Lines 380: I notice snow had a rapid melt in November (Figure 6). How about the superimposed ice formation in summer, which is caused by snow melt and refreeze? Is it considered in this model?

Lines 408-409: what will happen if we used a different oceanic mixed layer, for example 10 m? Are the results sensitive to this value?

Please also note the supplement to this comment:
https://tc.copernicus.org/preprints/tc-2021-134/tc-2021-134-RC2-supplement.pdf