The Cryosphere
Discussions

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Interactive comment on "Estimation of sea ice parameters from sea ice model with assimilated ice concentration and SST" *by* Siva Prasad et al.

Anonymous Referee #2

Received and published: 30 July 2018

General Comments

In this paper, the authors assimilate ice concentration and AVHRR-derived SST into a 10 km CICE model for Baffin Bay and the Labrador Sea for the period spanning from 2010-2015. A series of 3 experiments are performed to assess the model's performance against ice thickness from SMOS, ice draft and keel depth from a ULS, and freeboard estimates versus CryoSat-2. A control run does not have any data assimilation, while the other two assimilate SST and SST and ice concentration. A nudging and optimal interpolation technique based on Lindsay and Zhang (2006) is used. Model mean ice thickness is compared against the SMOS ice thickness for the periods of Oct – March for the years 2010-2015. Overall, the "M2" test case which assimilates SST and ice concentration performs best, and is generally within the uncertainty bounds of

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the SMOS data; however there is a significant positive bias shown for all years. An impressive comparison of the model's (M2) keel depth versus a ULS for 2005, 2007 and 2009 show very good agreement with data. However, model freeboard differences with CryoSat-2 data for Jan, Feb, and Mar 2011 show very little difference amongst the three test cases. Overall, while not "state-of-the-art", this paper shows some improvement with the assimilation of SST and ice concentration in a regional ice modeling system. I recommend publication with minor revisions.

Specific Comments

How are ice boundary conditions addressed in the model? Same technique as discussed in Prasad et al. 2015 paper? If yes, state this in the paper.

You use a 35-50 km SMOS ice thickness product for your thickness comparisons. You state that the SMOS data should not be used for thickness greater than 1 m; Figure 8 (middle column) shows a significant area of ice thicker than 1 m by March 15, 2011. Why didn't you consider using a merged CryoSat-2/SMOS ice thickness product such as is available from AWI? Do you have plans to assimilate ice thickness or freeboard into your model?

Page 1 line 19: why limit discussion to "climate forecast researchers"? This is important for operational sea ice modeling as well.

Page 3 lines 7-8: Why does the assimilation begin in January 2005? If the model is started from a no-ice state in September 2004, why doesn't assimilation begin in October 2004, when you should have data?

Page 3 line 11: Explain how you use AMSRE for validation of the model if you are assimilating that same data?

Page 4 line 1: What do you mean by "erroneous data"?

Page 7 lines 1-2: Why does M2 only assimilate SST when there are gaps in AMSR-E (and I assume AMSR2)? Why not assimilate all the time?

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Page 8: Why is there no discussion on error reduction for the period from Nov 2012 – Dec 2015? A table of error stats would be helpful here.

Page 9: Have you tested different values of α?

Page 15: How is snow measured or estimated in the ULS data? I assume the model results shown in Fig. 13 are for M2? If yes, state in figure caption. How do M0 and M1 compare here?

Page 17: I see little difference in Fig. 15 between column 2 and 3 in the plots. The paper states "M2 freeboard measurements are close to observed freeboard". I disagree. Perhaps the Jan 2011 looks best, but overall, the differences seem small for all 3 test cases.

Technical Corrections

Page 1 line 18: add "it" after "makes" and before "practically"

Page 2 line 7: rephrase to "into CDOM using a 3D"

Page 2 line 9: replace with "Lindsay and Zhang (2016)"

Page 2 line 16: "extent were overestimated"

Page 2 line 19: "of the CICE model"; which version of CICE is used? Specify in text

Page 2 line 20: ", and the combination"

Page 2 line 21: "(Lindsay and Zhang, 2006; Wang et al., 2013)"

Page 2 line 22: replace "cheap" with "inexpensive"

Page 2 line 24: "Baffin Bay and the Labrador Sea". "This work uses a high-resolution..."

Page 2 line 33: replace with "Density-based criteria (Prasad et al., 2015) to compute..."

Page 2 line 34: replace "fo" with "of"

Page 3 line 3: give reference for and spell out NARR

Page 3 lines 7-8: reword last sentence as it is confusing. Page 3 line 10: "remote sensing data sets"

Page 3 Table 1: add a column with dates for AMSR2

Page 3 last line: "The OSI SAF product"

Page 4 line 2-3: reword sentence to "Measurements derived from AVHRR (Reynolds et al., 2007; Smith, 2016) were used for SST assimilation."

Page 4 line 18: "ice thickness (observations) shown in Table 2 include..."

Page 4 line 19: "knowledge of the"

Page 4 line 22: "cover and the onset"

Page 4 line 25: "from an ULS"

Page 6: Reword first 2 sentences as they are poorly written

Page 5 line 12: here and in numerous places in the text, use "Lindsay and Zhang (2006)" as the reference, not the way it is written in the paper.

Page 7 lines 1-2: add parentheses to "AMSR-E (e.g., from 24 March 2005 to 31 March 2005), AMSR-E..."

Page 7 line 7: reword to "little improvement between M1 and M2 is shown for May 2010.

Figure 2: Makes dates Jan 2010, Mar 2010 and May 2010 BOLD black so they are easier to see. Caption is labeled wrong as it should be for Jan 2010, March 2010, and May 2010.

Page 3 Figure 3 legend: reword to "The absolute error for models M0, M1, and M2 from a) January 2010 to September 2011, and b) August 2012 to December 2015.

Figures 5-7: Make the uncertainty shading a lighter gray as it is difficult to see the other lines. What is the bias and RMSE for these comparisons?

Figure 8: same comment about making dates on plots readable. Can you add another column showing the difference between M2 and SMOS-MIRAS?

Figures 9-11: Make grey uncertainty lighter for readability. Captions not correct as M0 and M1 are shown (not just M2) as stated in Figure captions.

Page 14: Explain the difference in uncertainty shown in Fig 11 from Dec 31 to Jan 1.

Page 14 line 7: reword to "blow-ups" or something similar

Page 19: Make dates legible on all 9 plots.

Page 20 line 13: sentence with "November end but lies" does not make sense.

Page 22: provide a more complete reference for Deutch 1965

Page 23 line 21: Provide a date for first Tietsche reference

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