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Discussions

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Interactive comment on "Improving Met Office seasonal forecasts of Arctic sea ice using assimilation of CryoSat-2 thickness" by Edward W. Blockley and K. Andrew Peterson

Anonymous Referee #2

Received and published: 17 May 2018

General Comments

In this paper, the authors use a version of the "Met Office" fully coupled atmosphere-ocean-sea ice modeling system to examine the impact of the seasonal skill (improvement) of the September sea ice by assimilating "winter" CryoSat-2 ice thickness data from CPOM. A control run without this data is compared to a simulation for the period of 2010-2015 in which CS2 data was assimilated via a nudging method for three specific sets of dates: April 25, May 1, and May 9 with 8 ensemble members each. This study represents the first known fully coupled atmosphere-ocean-ice forecast system to utilize CryoSat-2 ice thickness data for seasonal forecasts. The underestimation of

the basin-wide extent was reduced for this period from 3.78X106 versus the control run (2.79x106) versus the observation average of 4.62x106. Another study is performed to examine ice edge error by using an Integrated Ice Edge Error (IIEE) metric in which a 37% reduction was observed with the CS2 initialization experiment. A volume comparison between the Control and CS2 runs shows an increased volume with the CS2 initialization; the PIOMAS volume is consistently lower except for the summer months. Some improvement was found in the 2-m air temperature in September, where the error was determined as the difference between the model and the ERA-I reanalysis. Differences were also noted for the 500hPa thickness and sea level pressure; but with the limited time period examined (5 years), the authors could not make a direct connection to the AO and NAO.

Overall, this study shows promising results. I recommend publication with minor revisions. See comments below.

Specific Comments

Page 3 Line 1: Add Cummings and Smedstad (2014) for another coupled ocean-ice modeling system with data assimilation, here is a full reference: Cummings, J. A. and O. M. Smedstad, 2014: Ocean Data Impacts in Global HYCOM, Journal of Atmospheric and Oceanic Technology, 31, doi:10.1175/JTECH-D-14-00011.1

Page 7 line 31: why couldn't a longer period, say from 2010-2017 or at least 2010-2016 be used?

Page 8 line 14: which version of CICE (v4.0, 4.1) is used. Are melt ponds used in this study?

Page 14 line 17-18: can you quantify bias reduction with some range or percentages?

Figure 4: Please add an inset for both plots showing a blow-up for the period 2010-2015? It's a bit difficult to see with the longer data record shown.

There is no mention of ice drift in the paper. Could you analyze IABP ice drift data

(Pan-Arctic domain) to determine the impact of assimilating CS2 data into the seasonal forecasts? This would complement your existing study. SIDFex is presently examining modeling center's skill in making long-term ice drift trajectory forecasts.

I would like to see the ice edge error metric used to examine the regional differences seen from use of the CS2 data. Can it be divided into the following (or similar) basins (Beaufort/Chukchi/Bering Sea, Canadian Archipelago, Greenland Sea, Laptev Sea, Barents Sea, East Siberian Sea)?

No comparisons are made against ice thickness observations from either ice mass balance buoys and/or moored ULS data. I recommend inclusion of some time series plots of the modeled ice thickness beginning with the Apr/May initializations through September for 2010-2015, with the control run included. The ensemble spread can be shown as well. This should clearly show the impact of the inclusion of the CS2 data.

Lots of acronyms are used without spelling them out. A partial list is shown below. Perhaps a list or table of acronyms would be useful.

Technical Corrections Page 2 line 6: replace "Better knowledge" with "Improved knowledge"

Page 2 line 34: define SLA here

Page 3 line 22: define CFSv2

Page 3 line 25: replace "find" with "found"

Page 3 Line 34: Yang et al. reference not listed in References

Page 4 line 3: spell out NRL (Naval Research Laboratory)

Page 5 line 3: spell out FGAT

Page 5 lines 12-14: "used" appears in sentence 3 times. Perhaps change second mention of this word to "utilized"

Page 5 line 26: reword statement "have been around for some years"

Page 5 line 27: replace "main" with "primary"

Page 5 line 32: spell out SIRAL

Page 6 line 22: replace "was" to "is"

Page 7 line 16: spell out SSMI/S

Page 7 line 28: Ridley reference says (2017, in review); reference section states 2018

Page 9 line 24: reword to "although IT has".

Page 10 line 4: delete "the fact"

Page 10 line 7: reword "amongst other things" what things?

Page 10 line17: Williams reference in references section says 2018

Page 10 line 25: MacLachlan reference says 2014 in references section

Page 12 line 2: delete "down"

Page 13 line 26: reword "doing things this way"

Page 14 line 28: spell out SEDNA

Page 15 line 4: Neither Tsamodos reference is listed in References section

Page 15 line 17: replace "down" with "due"

Page 21: Peterson reference should be 2015 not 2014