

Interactive comment on “Thermodynamic and Dynamic Ice Thickness Changes in the Canadian Arctic Archipelago in NEMO-LIM2 Numerical Simulations” by Xianmin Hu et al.

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**Thermodynamic and Dynamic Ice Thickness Changes
in the Canadian Arctic Archipelago in NEMO-LIM2
Numerical Simulations**

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January 17, 2018

Reply to Reviewer 1:

We thank reviewer 1 for pointing out the misleading title, as well as their other comments. We have updated the draft. Details are given as follows.

Answer to general comments: “Hu and others developed and presented a high resolution model to look at simulated sea ice thickness in the CAA from 2002-2016. They compared their model output to ice thickness from the Canadian Ice Service. From the title, I was expecting the authors to look at thermodynamic and dynamic processes contributing to variability and change but they only scratched the surface. Overall, I

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feel the authors did not really use the model to its full potential. I think some additional analysis and interpretation is required and I offer the following suggestions:

1. I was very surprised the authors chose not to look at the entire CAA ice thickness time series separating out dynamic and thermodynamic from 2002-2016 similar to their Figure 4 site specific plots. Doing this would probably illustrate when (and then where) changes in these processes are occurring over the longer term record and this certainly would allow for more discussion. Also, related to thickness distribution changes they could investigate if the model can identify the regions of very thin ice (i.e. invisible polynya's) similar to Melling et al. 2015 and look at longer term variability."

We apologize for the old misleading title. We were not focusing on the inter-annual variability but wanted to present the spatial distribution and seasonal cycle in the original draft. "Change" was used in the title to avoid "negative seaice growth" (melting period). However, it turned out be more misleading. We changed the title to "Thermodynamic and dynamic ice thickness contributions in the Canadian Arctic Archipelago in NEMO-LIM2 numerical simulations" to make it clear. In addition, we added a new chapter on ice volume budget in the northern CAA, Parry Channel and Baffin Bay to better describe the ice changes in our study area. We do see some polynya features, e.g., relatively thinner thickness, in the ice thickness field or the dynamic component of the ice thickness contribution, but the simulations does not produce thin enough or a good enough concentration field to investigate the polynya processes in detail. We keep that in mind for future investigation.

"2. Section 3.2.1 provides useful information by separating the dynamic and thermodynamic component of ice thickness but it would also be better use the model to identify locally grown MYI from MYI advected from the Arctic Ocean. It would be also be useful to spatially illustrate changes in the source of MYI. Furthermore, why not construct an ice mass budget for the CAA and look at how it changes from 2002-2016? These

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additions would give more substance to the manuscript."

A section about ice volume budget is added to provide some related information. Note that with LIM2, we can not identify the MYI directly.

"3. Why did the author's chose to start the study in 2002? I would think looking at longer term changes would provide more useful information to the readers and provide more opportunity to compare to Sou and Flato (2009)."

This is due to the availability of the atmospheric forcing. The high resolution CGRF data set goes back to 2002 only. Even with other forcing data, the computation cost, limits our ability to carry out long runs of 1/12 degree resolution.

Answer to specific comments:

- "Page 1, Line 1: Sea ice thickness evolution within the Canadian Arctic Archipelago (CAA) is of great interest." Why?"
Changed to "Sea ice thickness evolution within the Canadian Arctic Archipelago (CAA) is of great interest to science, as well as local communities and their economy"
- "Page 2, Line 5 National security issues?"
Changed "secucrity" to "safety"
- "Page 2, Line 5 Replace "opening" with "using""
Done as suggested.
- "Page 2, Line 13 The dates of that study are from 1979-2008. Does this statement still hold true? Looking at recent work posted on The Cryosphere Discussion appears to indicate large changes have occurred in the last 10-years which could

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negate that statement. Rephrase. See Mudryk et al. (2017) in The Cryosphere Discussions.”

Updated based on the recommended reference. The revised version is “Reduction in the September MYI cover is also found to be -6.4% per decade until 2008 (Howell et al., 2009). But this trend was not “yet statistically significant” due to the inflow of MYI from the Arctic Ocean mainly via the Queen Elizabeth Islands (QEI) gates in August to September (Howell et al., 2009). With extended data in recent years (until 2016), Mudryk et al. (2017) showed that the summer MYI decline rate has almost doubled”

- “Page 2, Line 23 Replace “export” with “transport” and replace “in the past” with “known to occur.””

Changed as suggested.

- “Page 6, Lines 9 to 18 I think it is important to state that the sites are all on landfast sea ice.”

Added text to make is clear the observations are landfast ice. To evaluate the performance of the model in terms of ice thickness, simulated ice thickness is compared to the observed landfast ice data from Environment and Climate Change Canada (ECCC) New Icethickness Program (hereafter ECCC thickness).

- “Page 6, Table 2 I think the reader could better identify with actual place names and not an acronym.”

Agree. We use full names in both table 2 and texts now in the revised version. Acronyms are now used only in figure 1 to keep it concise.

- “Page 8, Line 10 It would be useful to include some correlation coefficient values for comparison.”

We think the correlation in our case could be biased by the seasonal cycle. In the revised version, we added the seasonal cycle plot. It provides more

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information to our current comparison. Our time series might be too short to provide a robust interannual correlation.

- “Page 24 Could you confirm this by looking at a long time series? I’m puzzled by the 2002 start date.”

It is due to the availability of our high resolution atmospheric forcing data.

- “Page 11, Line 5 It is been shown MYI flows down into these regions. How much is convergence compared to thick MYI?”

In LIM2, we can not identify the MYI. Thus, we can not accurately do this task. We hope the reviewer is happy with our new ice budget section.

- “Page 12, Section 3.3 A lot of methodology and techniques are being introduced the results section. Suggest moving to methods.”

Moved the the methodology and techniques texts to method section, “2.3 Wavelet analysis” as suggested.

- “Figure 2. There are no y and x-axis labels.”

Added as suggested.

- “Figures 4-6 No y-axis labels. Also, why not produce this figure for the entire CAA? That would be more useful and also show changes in ice thickness (dynamic versus thermodynamic) over a 15-year period. I don’t feel the work reflections the title. See major suggestion 1.”

Added the y-axis labels. We were focusing on the spatial distribution over the CAA rather than how it behaves over the entire region. It does show significant spatial variability. It is better to average over a region with fields that do not vary a lot in space. Anyway, we think the new ice budget section provides interesting information.

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