The Cryosphere Discuss., 8, C322–C325, 2014
www.the-cryosphere-discuss.net/8/C322/2014/

The Cryosphere
Discussions
Open Access

Interactive comment on "Small impact of surrounding oceanic conditions on 2007–2012 Greenland Ice Sheet surface mass balance" *by* B. Noël et al.

J. Day

j.j.day@reading.ac.uk

Received and published: 26 March 2014

Noël et al. present results of a sensitivity study using the MAR Regional Climate Model (RCM) to try to determine the importance of Greenland ice sheet (GrIS)surface mass balance (SMB) to local sea surface temperature (SST) and sea ice concentration (SIC) anomalies during the 2007-2012 period. Note that, I believe this distinction between the impact of local and global ocean boundary condition anomalies should be made much clearer throughout the manuscript as it is hugely important for the interpretation of the studies outcomes and is only really mentioned in the title. The manuscript certainly aims to tackle an interesting and important research questions, but I have some

concerns about the methodology and the study's outcomes.

I have two comments relating to the suitability of the experiment to answer the proposed research question. My understanding is that the authors would like to assess the impact of the anomalous SIC and SIC conditions to the GrIS SMB during the period 2007-2012.

1. The question implies the hypothesis: 'there was something different about the 2007-2012 years' (i.e. low ice and high SST). Therefore I was expecting to see comparison to a reference run (pre 2007) and perturbations to this (i.e. 2007-2012 SSTs & pre-2007 SIC, 2007-2012 SIC & pre-2007 SSTs etc.). I suppose the SIC+6/SST-4 is the "pre-2007" simulation in this context. But it is not clear to me what this represents. What observed years are the SIC+6 sea ice cover like? More ice than the 2000s? 1990s? It would be useful to make this analogy to reality so the reader can put the perturbations into context.

2. Both the perturbed SST and SIC simulations with MAR use the same lateral boundary conditions (LBCs). I am concerned that, even with the relatively large (900km) domain, the impact of the local surface conditions on large scale variables such as 500hpa geopotential height will be suppressed by the imposed large scale synoptic situation imposed by the LBCs. Is there some justification for why this would not be the case? Is the distance from the lateral boundary to the ice sheet longer than the horizontal correlation length scale of geopotential height or SLP? Could this explain the lack of any significant circulation change over the upper levels of the ice sheet in Fig. 3a? Is any nudging imposed on the RCM interior?

In my opinion this second point is absolutely crucial and is somewhat skipped over in the manuscript.

Other comments:

I think it is important to stress that two rather distinct types of RCM sensitivity experiment are compared in the manuscript:

1) Impact of local forcing: experiments that aim to determine the roll of changes in local surface condition by modifying the surface boundary conditions and leaving the boundary condition unchanged (Hanna et al., 2009, 2014).

2) Impact of global forcing: experiments that aim to determine the roll of changes in global or regional surface conditions by modifying both the surface and lateral boundary conditions (the latter coming from a GCM) (e.g. Day et al., 2013).

An important caveat of 1 is that the impact of any local changes on the general circulation will not have an effect in the RCM. Thus, the impacts of any changes in surface boundary forcing are likely to be underestimated. I think it is important to synthesise the results from both types of experiments, as is done here, but one must keep in mind these non-trivial differences.

In the conclusions:

P1464L26: I have an alternative explanation for the apparent discrepancy between Noël et al. and Day et al. (2013). Due to the differences between experiment type 1 & 2 above, the perturbation in Day et al. (2013) is much larger, so I expect that JJA temperature anomalies to be higher, hence more summer melt. Note that the runoff in Day et al. (2013) is calculated from an ITM SMB model, so Vernon et al. is only relevant for precipitation, but not runoff.

Day, J. J., Bamber, J. L. and Valdes, P. J.: The Greenland Ice Sheet's surface mass balance in a seasonally sea ice-free Arctic, Journal of Geophysical Research: Earth Surface, 118(3), 1533–1544, doi:10.1002/jgrf.20112, 2013.

Hanna, E., Cappelen, J., Fettweis, X., Huybrechts, P., Luckman, A. and Ribergaard, M. H.: Hydrologic response of the Greenland ice sheet: the role of oceanographic warming, Hydrological Processes, 23(1), 7–30, doi:10.1002/hyp.7090, 2009.

Hanna, E., Fettweis, X., Mernild, S. H., Cappelen, J., Ribergaard, M. H., Shuman, C.

A., Steffen, K., Wood, L. and Mote, T. L.: Atmospheric and oceanic climate forcing of the exceptional Greenland ice sheet surface melt in summer 2012, Int. J. Climatol., 34(4), 1022–1037, doi:10.1002/joc.3743, 2014.

Interactive comment on The Cryosphere Discuss., 8, 1453, 2014.