

We thank Dr. Ridley for his useful comments and suggestions, these have helped improve this paper. An outline of the changes made and responses to these points is detailed here.

RC: This paper needs an author review of intent and structure paragraph by paragraph -the linguistic syntax is poor - which will sharpen the paper's focus (should have been done prior to sending it out to review). I have included a few examples and suggestions from the conclusion section at the end of this review.

AC: We have performed an author review of the work to improve the paper's focus and make the intent more explicit through the whole document.

RC: More generally the paper does not tell a targeted story and thus has neither a well defined science driver nor specific conclusion. I believe its intent is to assess the probable contribution of Svalbard to sea level rise, one that may be larger than expected through a retreat of the sea ice. If so then the Authors need to come back to this topic throughout and be explicit about such in the conclusions.

AC: The intent of this paper was not to assess the probable contribution of Svalbard's glaciers to sea level rise, rather to partition the projected changes in climate and surface mass balance into those which are due to changes in Arctic sea ice cover from other sources, such as global moisture transport. We have rewritten parts of the abstract and introduction to make this more explicit.

RC: The paper also needs to be written in a quantitative fashion with specifics (methodology and results) stated rather than a qualitative description.

AC: Throughout the paper an effort has been made to address this and make the study more quantitative. I have expanded the methods section to include the description and justification of the model validation approach and moved some of the details about how the research was conducted from the results section into the methodology section.

Specific points

RC: Abstract: This should indicate the rationale of the science behind the paper. Why are Svalbard glaciers important? Is it because of their contribution to sea level rise. If so what is the bottom line? Abstract should stand alone – avoid having abbreviations for terms only used once in the abstract. Use the main text to introduce other abbreviations!

AC: All abbreviations not subsequently used in the abstract have been removed and parts have been rewritten to make the rationale and main aim more explicit. Svalbard's potential contribution to sea level rise is now mentioned.

RC: Introduction: Include a paragraph on the role of ocean heat transport in the west Spitsbergen current on local climate. It is this which controls the local sea ice extent.

AC: A paragraph has been added to the introduction to describe the role of the Spitsbergen current on Svalbard's climate and present day sea ice variability in the region.

RC: 1888: 27. However, is it not the case that Svalbard glacier flow has a long response time to changes in surface mass balance (Raper & Braithwaite). Thus this study can justify ignoring ice dynamics and consider only the net surface mass balance.

AC: It is true that to assess the full glacial mass balance and sea level rise contribution, the dynamic response cannot be ignored. However, this is not a problem when assessing the sea ice-climate-SMB response, which is the central issue, discussed in this work.

RC: 1890:16. Might be worth mentioning that B2 is a low end GHG emissions scenario.

AC: This is now mentioned.

RC: 1991:16. HadGEM1?? Is this correct or do you mean only as the surface boundary conditions? You later state HadAM3 forcing which will conflict with HadGEM1 surface.

AC: Yes, only the surface boundary forcing was derived from HadGEM1. This paragraph has been changed to make this more explicit.

RC: 1891: 22. Scenarios – what is the component of A1B and A2 that is classified as 'severe'? Suggest changing this to something like 'high end emissions scenarios, selected to generate a large change in sea ice extent'

AC: This edit has been incorporated.

RC: 1892: 21. It is not the case the down scaling ratio should have a maximum of 10. This is only a very rough guideline and should not be taken literally. A slightly larger domain size rather than nesting is a perfectly adequate method to safeguard against it. Note that many HadRM3 studies have been conducted with no impact from the forcing (HadAM3) resolution.

AC: This was purely the recommendation of the particular Denis et al paper cited. This has been modified to reflect that this maximum was a recommendation rather than a general rule adhered to by the regional modeling community.

RC: 1895: 10-14. Has a lapse rate correction been applied to adjust from model to observation elevation? Is a bilinear interpolation use to match point observation within the model gridbox?

AC: A lapse rate correction was not used since, lapse rates are seasonally varying, probably spatially varying and not well constrained by observation on Svalbard. Bilinear interpolation is not used, rather the observation is compared with the grid box containing its location. The text has been modified to reflect this.

RC: 1895: 15-23. *Orographic effects due to a step change are rare because the model uses a terrain following atmospheric levels. The main problem with the HadAM3/HadRM3 physics is a readiness to form a stably stratified atmosphere over cold surfaces. A shallow boundary layer forms (Murphy et al JGR 2002)*

AC: Whilst we agree that there are issues with a overly stratified boundary layer in hydrostatic RCMs (also mentioned by Divine et al. 2011 in respect of the REMO RCM for Svalbard). I have modified the text to discuss this. However the Murphy et al 2002 paper does not appear to include such phenomena, rather the contrary: "These maximum values agree with those observed over the interior of Antarctica and thus appear realistic, with no suggestion that the surface boundary layer becomes too stable during winter" (Murphy et al. 2002).

RC: 1897: 17:23. *What time period from the ice cores record is the accumulation calculated. What time period from the RCM is it compared against? Is the RCM accumulation = solid precip – sublimation?. Note that HadRM3 does not allow any refreeze in the snow.*

AC: Since we are not calculating SMB at a point explicitly we use the ice core derived SMB as a lower bound which can be compared to modelled precipitation. In this sense we can determine which locations have insufficient precipitation. I have made the periods used in the analysis more explicit in the text, the periods covered by the ice cores are listed in Table 1.

RC: 1899: 2. *What is the definition of 'turbulent heat flux'? I am not aware that this is an available diagnostic from HadRM3!*

AC: we use turbulent heat flux= latent heat flux + specific heat flux and have modified the text to include this definition.

RC: 1899: 3. *Use of 'DJF' and 'JJA' undefined. Indeed, the paper would be more readable by reducing the abbreviations, so at no word cost it would be better to replace these with 'winter' and 'summer'.*

AC: These abbreviations have been removed from the document.

RC: 1999: 15. *Put these temperature changes in context against the equivalent global temperature rise.*

AC: The text has been modified to compare these regional values the global temperature change.

RC: 1899: 15-24. *What periods are the temperature changes averaged over and what is the reference period? Do these changes represent all land or glaciers only? Is there a linear relationship as A1B progresses or are there 'tipping points'?*

AC: As described in Section 2.1, all simulations were forced periodically with climatology surface boundary conditions. Section 2.1 also describes the period the climatologies were averaged over for both the 20C3M reference and future scenarios. As the simulations were forced with a climatology detection of tipping points is not possible.

RC: 1903: 6-12. *Suggest changes to this paragraph to something like: : : "The RCM performed well against observations [* how well?? *] in summer but in winter the climate was dominated by northerly flow leading to a ?? degree C cold bias. A comparison of HarRM3 climate diagnostics with coastal meteorological stations suggests that at 25km the orography was not adequately resolved to represent coastal atmospheric circulation [* this is not a new finding and could just be referenced to any of many regional model studies *]"*

AC: This edit has been incorporated as suggested.

RC: 1903: 13-17. *Suggest changing to ..
Verification of HadRM3 precipitation against the net accumulation derived from ice cores (Pinglot et al., 1999) was good at all 15 sites on Spitsbergen but is biased low over Nordaustlandet. The low model precipitation may be associated with smoothed topographic relief in HadRM3. [* is precip on Nordaustlandet seasonally different than on Spitsbergen? Can the low bias be due to excessive sublimation or northerlies?**

AC: This change has been made and some further discussion of the bias on Vestfonna has been added following the comment of Marco Möller.

RC: 1903: 25. *Is there a comparison that can be made with Førland et al. (2009) that would tie in with the introduction section?*

AC: I have moved a paragraph comparing the temperature response in our simulations to other studies (including from Førland et al. (2009)) from the results section to the conclusion.

RC: 1904: 17-21. *This paragraph contains repetition and make no sense – rewrite.*

AC: This paragraph has been rewritten.