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The Cryosphere Discussions

Interactive comment on "The impact of a seasonally ice free Arctic Ocean on the climate and surface mass balance of Svalbard" *by* J. J. Day et al.

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General comments

We thank Marco Möller for his encouraging and insightful comments and for informing us of the mass balance work he and his colleagues have undertaken on the Vestfonna ice cap, Nordaustlandet. His comments are related to the overall scientific motivation for this study and interpretation of model precipitation on Nordaustlandet.

In the following, Short Comment (SC) precedes a quote from the Short Comment this is a response to and AC precedes is the Author Comment response.

Specific comments

SC: *A spatiotemporal analysis of various snow-pit data from all over Vestfonna from the period 2007-2010 is presented by Möller et al. (2011b). Among other results, we find that accumulation on the ice cap is almost exclusively controlled by altitude. No significant correlations with other spatial parameters are obtained. This indicates that surface elevation has to be regarded as a crucial factor for accumulation modelling. The low resolution of the Day et al. (2011) RCM surface topography (Fig. 5c) might thus represent a serious drawback for the accuracy of precipitation modelling and thus for mass-balance estimation. Surface elevations are frequently underestimated over large parts of the glacierized areas in eastern Svalbard (Fig. 5c).*

For Vestfonna, a modelled 9-year climatic mass balance time series (2000-2009) is presented by Möller et al. (2011a). The mass balance model employs an accumulation scheme that was calibrated from a relation between ERA-Interim data and in situ snow water equivalent measurements on the ice cap. Calibration results show that winter accumulation on Vestfonna increases by a factor of more than nine from the lowermost parts of the ice cap to its summit ridges. This strong increase with terrain elevation could by now means be reproduced by a 25 km resolution RCM. It could thus be regarded as an explanation for the extremely high deviation of modelled and measured accumulation on Vestfonna (Fig. 5b).

AC: We accept these points above and will extend 1903: 16-17 to read: Accumulation rates on Vestfonna are almost exclusively controlled by altitude, with a factor 9 increase between the lowest and highest points on the ice cap (Möller et al., 2011a, 2011b). The insufficient levels of precipitation on Vestfonna simulated by the RCM can thus be attributed to the low model orography on Nordaustlandet, which is over 300m below the actual height of the Vest 95 ice core site (Table 2.).

SC: *In the same study (Möller et al., 2011a) the dependency of Vestfonna's mass balance on the North Atlantic Oscillation (NAO) is analysed. We find that winter balances,*

i.e. accumulation, are significantly correlated with the mean winter NAO. Positive NAO conditions usually coincide with reduced sea ice cover on the Barents Sea (Yamamoto et al., 2006) and a resulting increase of precipitation over Svalbard (Rogers et al., 2001).

AC: In response to the above comment we have inserted the following at 1889: 17: Further, Vestfonna's SMB is significantly correlated with the mean winter North Atlantic Oscilation (NAO). Positive NAO years often correspond with low levels of sea ice in the Barents Sea and associated anomalously high precipitation over Svalbard (Möller et al., 2011b; Rogers et al., 2001; Yamamoto et al., 2006).

SC: *Day et al. (2011) state that future changes in DJF precipitation are modelled to more than 400% over Nordaustlandet compared to present conditions (page 1899, lines 24-25). When taking together this statement with the considerable underestimation of accumulation on Vestfonna (Fig. 5b), it can be argued that the future accumulation over Nordaustlandet might be even higher. Therefore, the statement that increased accumulation might compensate only parts of the melt driven future mass loss (page 1902, lines 5-8) should be reconsidered. At least for the coming decades, where temperature increase is still moderate, it should be discussed that a distinctly higher net accumulation might temporarily balance the effects of increased surface melt on Nordaustlandet.*

AC: Whilst we accept that the underestimation of precipitation in the present day simulation implies that the future absolute precipitation anomaly is not particularly reliable on Vestfonna, this should not greatly effect the percentage change due to the climatic changes in sea ice and global moisture transport, which is the focus of this study.

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