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The Cryosphere
Discussions

# *Interactive comment on* "Simulating the climatic mass balance of Svalbard glaciers from 2003 to 2013 with a high-resolution coupled atmosphere-glacier model" *by* K. S. Aas et al.

**Anonymous Referee #2**

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This manuscript presents a thorough evaluation of a regional atmospheric model (WRF) coupled to a mass balance/snow model (CMB) using an extensive and divers data set. The manuscript is well written and well structured. It adds to available publications in using a smaller grid spacing, resulting in a better representation of the topography and topographic related processes, and the thoroughness of the evaluation.

I do have some (minor) comments, which are listed below.

General comments

Explain the use of the term 'Climatic Mass Balance'. This paper addresses the surface



mass balance and covers a period of 10 years. The term 'climatic mass balance' is not a generally used term and a bit confusing.

In the title you state that the atmospheric model is coupled to a glacier model. Without reading more, this might suggest coupling to a dynamical glacier flow model, while the coupling is in fact to a mass balance/snow model.

Specific comments

Abstract:
See comment above, add that you study the surface mass balance. You do not address the total mass balance since this setup does not provide any information about dynamics.

Introduction:
P5777 L17: I don't think MAR is a statistical model. Thus is the reference to Lang et al., 2015b correct?
P5778 L5: Rephrase this goal. I don't see the goal of this work as to reduce the spatial and temporal gap between observations an models. I think the goal is to thoroughly evaluate the surface mass balance product from a coupled atmosphere-snow model system and to investigate what spatial resolution is sufficient to describe the observations.

Methods:
P5779 L23: How is your glacier mask defined and how do you deal with grid boxes partially covered by ice and partially land?
P5779 L24: I don't understand why 2 transient runs of 5 years instead of 1 of 10 years will save computational time. I have the impression that they are run one after the other. Furthermore, this way the second one also needs to spin up.
P5780 L9: I guess that 'climatic mass balance model' is the name of this model but that it is basically a surface energy/mass balance model including a subsurface snow/ice model.

P5780 L16: I agree that it is not necessary to include all the details of the GMB model, nor the details of how it is coupled to MAR, but you do have to state how it is coupled in general, and what input parameters CMB needs. This coupling is what makes this research stand out compared to other efforts to determine the surface mass balance using WRF. How does this model compare to the standard WRF surface scheme? Furthermore, Collier et al., 2013 describe that there are 2 options how to couple: only one way, or two way, and that is a major difference. Which method do you use? What is calculated by WRF and what is calculated by CMB? What parameters from WRF does CMB use and what is feed back into WRF (in case of 2 way coupling).
P5781 L 3-11: I am not sure I understand the problem and its impact on the results. Furthermore, if you don't know what the problem is, how is the reader to judge the value of the results in general? L4 'low' mass balance values refers to negative values? L6 Why do you not exclude internal melting in all months? (I guess that internal melting results from readiation penetration?). L9 the values stated here are not very clear. What is compared here to give these numbers? ANd how can I judge whether this is big or small?

Model validation
P5785 L19: The temperature signal is dominated by the diurnal cycle, thus these high correlation coefficients are not surprising.
P5785 L23: Can you explain the biases in temperature and long wave fluxes?
P5787 L7: Since individual years correspond less well than the mean, there are compensating errors.
P5787 L13: My guess is that it is not the simple ELA estimate that results in wrong ELAs, but the model being not capable of representing the surface MB correctly, resulting in wrong ELA estimates.
P5787 L27: Do you have any information from observations about the role of snowdrift redistribution and evaporation on Svalbard?
P5788 L9: Do you have any idea on how large the contribution of dynamics is? Without any knowledge about that the statement that the comparison is good has no real value.



Sensitivity to model resolution:
P5789 L6: Why did you choose an extreme case instead of an average/representative case? P5789 L9: How is this difference related to the different estimated glaciated area on 9 an 3 km resolution.

Climatic mass balance:
P5790 L26: Consider adding a table presenting average and standard deviations of the information presented in figures 9 and 10 in order to quantify the interannual variability and the regional variability therein.

Discussion:
P5792 L4 and L21: I guess the better results are largely related to the resolution of your model run, 3 km vs 10 km for Lang et al, and 25 km for Day et al. Furthermore, Day et al do not actually calculate the surface mass balance since they do not have a snow model that calculates the melt. I am therefore not surprised by the better results. This should be stressed more.
P5794 L14: Explain how you apply this 30%? Or perhaps phrase differently: we had to limit the stability correction of turbulent fluxes to prevent too stable conditions to occur.

Conclusion:
P5795 L24: Thus the year to year variability is temperature driven? In combination with length of the melt season?

Tables:
T1: Is the depth scale in cm w.e. or cm snow?

Figures:
In general ALL your figures must be bigger.
F1: Increase figure size, especially axis labels of overlay figure bottom right.
F2: Increase figure size, especially the bars indicating precipitation.
F3: Increase figure size, I can't judge the differences, they are too small. Furthermore, consider adding uncertainty bars indicating interannual variability in terms of standard

deviation.
F4: Increase vertical axis in size to enhance the interannual variability.
F5: Increase figure size, especially the inset figures in b and d are much too small. Furthermore, check the caption, it refers to 2005 while above the figure it states 2006.
F7: Check spelling of Kongsvegen in the caption.
F9: Increase vertical axis in size to enhance the interannual variability.

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Interactive comment on The Cryosphere Discuss., 9, 5775, 2015.