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The Cryosphere Discussions

Interactive comment on "High-resolution interactive modelling of the mountain glacier–atmosphere interface: an application over the Karakoram" *by* E. Collier et al.

Anonymous Referee #1

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Review of

High-resolution interactive modelling of the mountain glacier–atmosphere interface: an application over the Karakoram

by E. Collier, T. Mölg, F. Maussion, D. Scherer, C. Mayer, and A. B. G. Bush

General

This paper describes the application of atmospheric dynamical downscaling (a three-nested regional atmosphere model coupled to a physical snow/ice model) to valley glaciers in the Karakoram. This technique currently represents the state of the art in

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glacier surface mass balance modelling and further testing/applications of this technique and appearance in literature must be favourably regarded. The technical quality of the paper is very good: it is very well written and the figures are of excellent technical quality. The scientific quality of the paper is also good: a proper effort is made to compare to observations and a sensitivity test is performed. In summary, the paper can be accepted if the issues raised below are addressed in a satisfactory way.

Specific comments

Consistent and proper use must be made of the terms 'mass balance' and 'surface mass balance'. To my knowledge, 'mass balance' includes surface and ice dynamical processes (calving), and the latter is not addressed here. So please use 'surface mass balance' throughout, also to indicate the numerical routine.

Futher to this: in the first paragraph on page 106, two things are merged in the discussion which acts confusing: reference is made to studies with interactive ice sheets in GCMs that can change their topography in response to climate forcing and therewith impact atmospheric circulation. This is 'fully interactive'. This paragraph is then followed by the description of the interactive ice/snow module for glaciated grid points used in this study. Although the latter is capable of influencing the atmosphere through fluxes of heat and moisture, it leaves the glacier topography unchanged and is therefore only 'partly interactive'. It should be clearly stated that in the study presented here, glacier geometry is kept constant, so full interaction (including ice dynamics and hence the temperature elevation feedback) is not aimed for. This is of course allowed for the timescales under consideration.

In the second paragraph on page 109, the authors state that increasing the diffusion (essentially lowering the model resolution) enhances the precipitation. This is somewhat unexpected. Are all prognostic variables subjected to this smoothing? How do you explain that smoothing enhances precipitation in mountainous areas?

In the second paragraph at page 112, it is stated that Baltoro Glacier is 2-3 km wide.

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With a model resolution of 2.2 km and filtering applied, the glacier is not resolved. Please discuss.

Page 115, section 3.2, first paragraph: if AWS and model gridpoint differ 300 m in elevation, then why is the temperature not at least 2 degrees different? Can you propose potential reasons for the underestimated humidity, which leads to underestimated precipitation and is therefore a serious issue for surface mass balance modelling?

Page 117, l. 12: Temperatures are higher/lower, not warmer/colder. Please check MS throughout.

Section 3.3: the differences between INT and OFF are really small when compared to the difference between INT and observations. The level of detail in this section, which stretches over almost five pages, is therefore not in balance with that of the previous section, which only covers two pages. I would therefore like to see more discussion on the deficiencies of the model results and possible reasons, and less detail about the impact of the interactive coupling so that both end up with a similar level of detail.

Interactive comment on The Cryosphere Discuss., 7, 103, 2013.