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Interactive comment on "Modelling glacier change in the Everest region, Nepal Himalaya" *by* J. M. Shea et al.

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Shea and coauthors apply a glacier mass balance and ice flow model to glaciers in the Dudh Koshi catchment in the Nepalese Himalaya. The topic is important and relevant to the scope of The Cryosphere. The glacier model has previously been applied elsewhere in Nepal, but some major issues with the glacier model application concern the representation of glaciers where thick supraglacial debris modifies both mass balance and dynamics. The manuscript is generally well written, although difficult to follow in places due to the large number of terms and parameters discussed in each section and for both models.

General comments:

1. The model is applied with different degree day factors for clean ice, snow, and debris-covered ice (with a different value used for Khumbu Glacier) to represent different amounts of melt expected between clean ice and debris-covered ice across the study area. However, the dynamics of these glaciers are treated as whole, and include active ice, debris-covered ice that is likely to include large stagnant areas, and tributary glaciers that at present are dynamically detached from larger glaciers (e.g. Changri Nup and Shar). Calibrating the model to the area of these glaciers seems to be matching simulations with the Little Ice Age climate rather than representing 1961–2007.

2. Four sets of observations are used to calibrate the model by comparison of results from four large debris-covered glaciers; (1) terminus position, (2) glacier area, (3) mean flow velocity, and (4) mean basin-wide mass balance. Of these four values, both (1) and (2) are unlikely to change over the next century even with considerable mass loss as these glaciers are downwasting rather than receding. Mean flow velocity (3) is not a particularly helpful calibration value as velocities vary from 40 m per year to zero over relatively short flowline distances (Quincey et al. 2009). A better calibration/validation would be to see the variations in velocity across each glacier, and ideally similar ice flow rates, reproduced by the model.

3. The model outputs are validated against four independent datasets, although this validation is rather difficult to follow as written. The fit between calibrated model outputs and decadal glacier extents does not appear to be presented in Section 3.2 or elsewhere. Ice thickness validations are only presented for two glaciers and there is some mismatch in each case, the impact of which on the results should be quantified.

4. The validation also refers to ICIMOD glacier outlines from 1980–2010 (Bajracharya et al., 2014a) that are not presented in the current manuscript or visualised in the cited report. An image of or a link to these data should be included to allow the reader to compare these with the model outputs.

Specific comments:

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P5376 L17–19: This comment is unclear, why does the stated glacier elevation result in sensitivity to temperature and ELA change?

P5377 L15: Figure 2 referred to before Figure 1.

P5377 L22–26: Please also give absolute values for precipitation as well as temperature here. What fraction of annual precipitation is snowfall?

P5377 L26–P5378 L3: The range scale distribution of precipitation described by Bookhagen and Burbank is not relevant to scale and elevations described in the current study, please remove this text.

P5378 L15–17: Does the value for decrease in glacier extent refer to both clean-ice and debris-covered glaciers?

P5379 L3–4: Explain what is mean by “mass balance amplitude”

P5379 L24: What is the elevation of the rain–snow threshold for the study area?

P5382 L 10: The temperature bias values range between 3°C and 6°C. Please state this in this paragraph.

P5384 L10: The glaciological reasons for the use of a different DDF for Khumbu Glacier are unclear.

P5386 L20-27: When the calibrated model is run forward from the 1961 starting point, does it accurately reproduce the present-day glaciers when this year is reached?

P5391 L1–7: Do the measured precipitation values include snowfall as well as rainfall? If not, this may account for the overestimation of modelled precipitation at lower elevations, as higher stations would underestimate total precipitation to a greater degree.

P5393 L21–25: The authors refer to the comparison with their ice thickness estimates for Khumbu Glacier and those GPR data presented by Gades et al. (2000), but these results are not presented.

Interactive comment on The Cryosphere Discuss., 8, 5375, 2014.

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