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Interactive comment on "How robust and (un)certain are regional climate models over the Himalayas?" *by* A. P. Dimri

Anonymous Referee #1

GENERAL COMMENTS

The evaluation of Regional Climate Model (RCM) data over remote mountainous regions is a valid and useful research endeavour. A significant hindrance to such research, however, is the lack of observed data against which to compare the models. In this paper temperature and precipitation values in three RCMs are compared against gridded observed data and three (rare) station series at a remote albeit geophysically important glacier in the Western Himalaya and its surrounding area. The station-level analysis is useful, and the paper includes an interesting analysis of the vertical atmospheric temperature profile which is shown to be biased in the RCMs considered. The comparison against the gridded data is a weaker component of the paper and, as per my specific comments below, needs significant re-working to take into account the un-

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certainty in the observed gridded data, which I suspect is substantial over this region. I would also have liked to have seen more models/ensemble members being considered, including the latest CORDEX (S_ASIA) simulations. However, as a test of three RCMs the sample used is probably sufficient if the reasons for selecting these models are more adequately explained.

SPECIFIC COMMENTS

p. 6252, line. 8. I suggest stating here that three RCMs are tested in this paper (and maybe naming them)

p. 6252, line. 20. "primarily as they are data void...". Please make it clear that you are referring here to a lack of observed data. It would also be useful here to refer to the work of Wiltshire (2014), who used HadRM3 to downscale the ERA-interim data over the Western Himalaya, due to a lack of sufficient density of observed data in the region.

p. 6253, lines 1-8. It is worth including information in this paragraph about the wider field of bias-correction, which I consider this paper to fit into, although a correction procedure is not actually applied.

p. 6253, line. 16. There is no "Methodology" section in this paper. Change to "... details of these models is provided in Section 3" or similar.

p. 6253 lines. 18-19. More information is required here about the body of work conducted on the mass balance of the Siachen glacier.

p. 6253, line 22. Please include the reason for using these models, and state that you are using two RegCM3 models and one version of HadRCM3. This information is clearly stated in line 18 on page 6255, but should be included earlier.

p. 5256, line 5. Which version of the CRU data was used?

p. 6255, line 6. "...uncertainty in the downscaled outputs". This sentence needs to be

re-phrased as it suggests that you are actually downscaling data in this paper, when actually you are referring to the high-resolution of the RCM data.

p. 6255, section 3.3. Information should be included here about the reliability of the observed data. The use of the three station series is novel in this paper, and more information is required about the reliability of these series is required. Also information about the reliability of the APHRODITE and CRU data for this region should be included.

p.6256-6259. Throughout Section 4 more discussion is required about the potential reasons for the differences between the simulated data and the observations. These are listed in the paper's abstract but need to be worked into and expanded in the main body of the paper.

p. 6256, line. 3. "And hence observed precipitation bias..." This sentence is ambiguous. Are you referring to this bias arising from limitations in the reanalysis forcing?

p. 6256, lines 12-29. This paragraph needs complete re-writing. On first reading it appears that two conflicting statements are being made about the reliability of the RCM data compared to the APHRODITE observed data. On one hand it is stated that the RCM data very successfully capture the inter-annual and inter-monthly variability shown in the observations, and on the other hand reservations are expressed about the usefulness of the RCM data. I disagree that the results show similar variability at inter-annual/inter-monthly timescales in the RCM compared to the observed data. There is some weak correspondence evident at the inter-annual and inter-monthly timescales, but nothing that can be considered similar to the observations, and this is only a qualitative assessment. I consider the most important finding of this section, which is described towards the end of the paragraph, to be that while both the RCMs and observations show a wetter winter and drier summer, they have significantly different variability amplitudes - the annual amplitude in the RCMs is of the order of 5-6 mm/d, while the observations are <1 mm/d amplitude. This needs to be stated more

clearly, and probably also presented in a different manner than the contour plots. Also, monthly totals of precipitation may be considered for inclusion in this analysis. Furthermore, the results from the other RCMs tested need to be shown. Uncertainty in the observed data for this region also needs to be included. Consideration should also be given to inclusion of a comparison against the results of Ménégoz et al. (2013).

p. 6257. Figure 2c. The results from the HadRM3 simulation should also be included in this figure. Also, why do the series "flat-line" at ∼0.08% frequency - does that relate to the 1mm threshold used?

p. 6258, Figure 3a. I think it is important in this figure to include the average of the CRU data over the winter period (i.e. the absolute values from which the anomalies were calculated). This will provide information to the reader on the spatial variance and hence reliability of the CRU data. It is also important to include a plot showing the density of stations used in the CRU data, and the results from the HadRM3 data.

p. 6260, line. 2. Please provide more information on the slope lapse rate for readers not familiar with this work.

p.6265, Figure 1. Figure 1b is of poor quality. Please replace with a better quality image.

p. 6258, Figure 4. Please include the altitudes of the stations in the plot, to prevent the reader having to refer back to Figure 1.

REFERENCES

Ménégoz, M., Gallée, H., and Jacobi, H. W.: Precipitation and snow cover in the Himalaya: from reanalysis to regional climate simulations, Hydrol. Earth Syst. Sci., 17, 3921-3936, doi:10.5194/hess-17-3921-2013, 2013.

Wiltshire, A. J.: Climate change implications for the glaciers of the Hindu Kush, Karakoram and Himalayan region, The Cryosphere, 8, 941-958, doi:10.5194/tc-8-941-2014, 2014

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