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Discussions

Interactive comment on "Precipitation and snow cover in the Himalaya: from reanalysis to regional climate simulations" *by* M. Ménégoz et al.

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We would like to thank the Editor to follow the peer-review process of our manuscript. We also would like to thank the referee #1 for its useful and thorough reviews. Our replies to its comments follow below. In addition with this response, we submitted a revised version for our manuscript, including most of the suggestions of the two referees (see the supplement material).

1. As recommended, we improved the English grammar and style of the entire paper, using corrections by a native speaker. In particular, we included all the corrections mentioned by the first referee. 2. p. 7655, line 11: To avoid misunderstanding, we modified in the revised version of our manuscript the sentence containing "even event":

"Theses two last studies showed that the dynamical downscaling with RCMs can be used to simulate regional climate at the mountain scale, but also to reproduce local meteorological events." 3. The Referee #1 pointed out our insistence to speak about the high computational cost of our simulations. However, we chose to keep this point in our manuscript, as the reader, even if he is a specialist, has to keep in mind that multiannual applications are currently not possible with our model, which limits both the method used to validate our model and the climatic analysis. However, we added in the outlook of the last Section the applications suggested by the reviewer: "Improving the physical schemes of our RCM, we hope in further studies to decrease the biases highlighted in this study, and to perform simulations over longer period to analyse in more detail the snowfall inter-annual variability over the Himalaya. Multiannual applications of this model could be also used to study the poorly known interactions of the East Asian and the Indian Summer Monsoons with the snow cover extent over the Himalaya and the Tibetan Plateau." 4. As suggested by Referee #1, we added a section (Section 4) after the model description to present the observations and reanalysis data sets that are used in our paper. In particular, the new version of the manuscript includes a table synthesizing all the characteristics of these data. 5. Assessing the scientific papers dealing with the Asiatic monsoons, one can find numerous studies dedicated to the evaluation of the convective schemes used in both global and regional models when simulating these monsoons (e.g., Hourdin et al., 2006, Kang et al., 2008, Chen et al., 2010, Dimri et al., 2013). One rigorous way to evaluate the performance of a convective scheme is to perform sensitivities experiments with different model configurations, as done in these papers. This point is not the main goal of our work. Therefore, we do not want to include such heavy task in our study. However, the reader can find in our model description the references to the works describing the convective scheme used for our simulations (Bechtold, 2001) and an analysis of the application of our model to simulate tropical convection (Gallée et al., 2004, Messager et al., 2004, Vanvyve et al., 2008). The convective adjustment scheme used for our simulation adapted from the Kain-Fritsch scheme (Bechtold et al., 2001) is widely used both in global and regional models. This scheme is expected to be the most reliable at the spatial resolution that we used for our simulation (20 km). However, as most of convective schemes, it generally simulates the triggering of the diurnal convection with a delay of some hours, in particular during periods of monsoon (Gallée et al., 2004). Overall, as clearly demonstrated by Kang et al. (2008), each convective scheme has is strong and weak points, in particular when used for monsoons simulations. In this last study, the Kain-Fritsch scheme has been found to simulate the East Asian monsoon with a wet bias over land and a dry bias over the oceans. However, it has been more efficient than the other schemes tested in this study to capture the intraseasonal variations of precipitation. Finally, it is quite difficult to highlight the links between the biases of our simulation and the efficiency of the convective scheme used for our simulation without having performing sensitivities experiments. This could be done in further works, and would allow to determine the role of the convection scheme when examining the biases of our simulation, isolating it from the roles of the dynamic, the cloud microphysics scheme, and the boundaries applied at the border of the domain of simulation. 6. As explained in our manuscript and as reminded by referee #1, the period of simulation is too short to calculate the statistical significance for the differences between models and observations. Before an analysis of the annual cycle of snowfall and snow cover in the Himalaya, we show in our paper comparisons between precipitation estimated from ERA-INTERIM, APHRODITE, TRMM and our regional simulation. The main goal of this comparison is to see how our model reproduces the seasonal accumulated amount of precipitation. We assume that the differences between these products shown in Figures 3 and 4 give a good idea of the main seasonal biases of our model over the period 2001-2002. It would not be interesting to compute RMSE for seasonal values, as we have only two years of simulation. In further study, it would be interesting to compute RMSE for a daily analysis of simulated precipitation, but it would be out of the framework of our study, more dedicated to the analysis of the seasonal accumulated amount of precipitation. Overall, no product is able to describe accurately the precipitation in Himalaya. Therefore, it is quite difficult to choose one reference among the different products

when computing statistical parameters. 7. We modified in our manuscript the sentence which concerns the observational data in the Himalaya (p7660, l.9) to explain more in detail its weakness, adding also one reference, as recommended by referee #1: "It is quite difficult to verify the correct precipitation rate due to the difficulty to monitor hydrometeorology by in situ stations in these mountainous regions. As explained by Archer and Fowler (2006), such networks are often biased in altitude, as stations are generally located in valley floors, lower in altitude than the zones of maximum precipitation, located on mountains slopes and top." 8. The temporal definition of the climatic seasons in the Himalaya differs according to the position along this large mountainous area, but also according to the authors of the studies dealing with this topic. Overall, the summer monsoon season is commonly defined as the period extended from June to September (e.g. Krishnamurthy et al., 2007), even if it can last till October in some parts of the Himalaya as explained by Jain et al. (2012). According to this last study, fall is also described as the post-monsoon period, extended from November to December. Winter is extended from January to February. Spring is often denominated as the preÂň-monsoon period, extended from March to May. In our paper, we analyse the precipitation rates separately for the monsoon period and the extra-monsoon period, to check the ability of our model to capture precipitation during these two fundamentally distinct weather regimes. Concerning snow cover, we show an analysis month by month (see Figure 8) to study its monthly evolutions, at an intra-seasonal timescale. However, in the new version of our manuscript, we denominate the seasons more appropriately and more homogeneously, as Jain et al. (2012). Our seasons definitions differ from Jain et al. (2012) only for the monsoon period which we considered to be extended from June to September, as commonly defined in the literature dedicated to the Indian monsoon over large domains (e.g. Krishnamurthy et al., 2007). 9. Figures were modified in the new version of the paper, according to the suggestions of referee #1. 10. We applied all the suggested technical corrections in the new version of our manuscript.

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Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C4597/2013/hessd-10-C4597-2013-supplement.zip

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