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Hydrology and Earth System Sciences Discussions

Interactive comment on "Downscaling ERA-Interim temperature data in complex terrain" *by* L. Gao et al.

Anonymous Referee #1

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GENERAL COMMENTS

The authors present a method for correcting / downscaling ERA Interim re-analysis data over a region in the Bavarian Alps. ERA Interim model output is corrected taking into account the elevation difference between the model grid cell and the elevation of three measurement sites located within that grid cell. Different methods are applied to derive the vertical temperature lapse rate used for correction. It is shown that the application of lapse rates directly derived from ERA Interim yields better results compared to the application of fixed monthly mean lapse rates given by previous studies.

The paper is well-structured, the methods are well-described for most parts. The results are presented in a clear and concise way, the figures are adequate for most parts.

The significance of the results obtained and their applicability, however, are very limited in my opinion. The authors introduce their work as a downscaling methodology of ERA Interim data for complex terrain, but the core of the work is not more than a simple elevation correction of re-analysis output. One could argue that even such a simple correction can be considered as a "downscaling", but further processes (mesoscale circulations, topographic effects other than mean elevation, etc.) are not considered but are typically associated with the terminology of "downscaling". I'd therefore rather speak of an "elevation correction" method rather than of a "downscaling". As such, the study certainly has some relevance for the scientific community as a temperature elevation correction is necessary for many application requiring meteorological input data. However, the usefulness of the current study is still limited by the fact that only one individual region with good observational data coverage is considered, and a more widespread usage is questionable. The authors claim that their method is, in principle, independent of observational data, but they provide no information whether temperature data of the three reference stations was actually assimilated into ERA Interim, which might well be the case for the DWD stations Garmisch and Zugspitze. In that case, the ERA Interim model results themselves (and therefore the ERA Interim derived lapse rates) are conditioned on local observations and are not independent. The same might be true for nearby radio soundings (e.g. Hohenpeissenberg) which are probably assimilated and favor an application of ERA Interim and ERA Interim derived lapse rates over that specific region. Given the clear dependency of mean air temperature on elevation, almost any correction method taking into account some vertical lapse rate can be assumed to yield better results than uncorrected model output for elevation differences of several hundred meters. Some of the results are therefore not very astonishing and could be expected beforehand. The fact that the application of ERA Interim derived lapse rates (methods III and IV) and lapse rates derived directly from local observations (method II) yield better results than fixed mean lapse rates extracted from the literature can also be expected given the known temporal variabilities of temperature lapse rates and the advantage of methods II, III and IV regarding their conditioning

on observational data measured at that specific time and place (see above). A further limitation of the presented study is that the overall (larger scale) temperature bias of ERA Interim is not assessed at all (even though ERA-Interim assimilates observational data, it is still a model). This would be important and to put the results obtained (remaining RMSE and MAE after elevation correction) into perspective.

Given this overall assessment and the mentioned limitations of the study, I would not recommend a publication of the manuscript at the current stage. Please see further details below. In case the paper is returned for revisions, I'd strongly recommend to request improvements on the mentioned issues. With kind regards.

SPECIFIC COMMENTS

- Title: As outlined above, I'd rather use the term "Elevation correction of" instead of "Downscaling".

- Intermediate downscaling step (page 5935, line 12): ERA Interim provides atmospheric parameters on a T255 grid (79km), but the authors use a refined 25 km version. No details on their interpolation method are provided, but are important for interpretation of the results. Which interpolation method has been used, and was the elevation dependency of 2m temperature accounted for during the interpolation of this parameter? Has the ERA-Interim model orography been interpolated with the same method? These issues should be clarified.

- Section 2.2: It is important to know whether data of the three observational stations (or a subset thereof) has been assimilated into ERA-Interim. If yes, the model data would not be independent of the observations, as claimed by the authors. Could the authors provide such information? It might also be useful to know which radiosonding sites in the vicinity were assimilated (see above).

- Naming of lapse rates and explanation of methods (section 2.3): The naming scheme for the different lapse rate approaches is rather confusing and non-intuitive (E2s, E2fa,

. . .). The reader has to frequently consult section 2.3 and/or Figure 2 to recall which lapse rate approach has been chosen in which method. I'd suggest to rethink the naming scheme and maybe also to include a table indicating which lapse rate approach has been used in which method and using which reference temperature. Concerning Method III: Why is T_ERA2m used for Garmisch, but T_ERApl for Zugspitze and Zugspitzplatt? Please explain the reasoning behind this choice.

- NSE (page 5937, line 21): I think the readership of the journal cannot be generally expected to be familiar with the NSE. A brief explanation (two or three sentences) might be helpful.

- Section 3.2 and Figure 4: It should be clearly mentioned that the model-derived lapse rates as well as those derived from the literature systematically underestimate the measured lapse rate over the entire year. The implications of this systematic bias for the validation results should be discussed.

- Page 5939, lines 1-2: Is the reason the strong underestimation of lapse rates by the literature values during summer? (see Figure 4)

- General temperature bias of ERA-Interim: Previous studies have shown that reanalysis products, though assimilating various kinds of observations, can be subject to important biases in 2m temperature and further parameters. Even if realistic lapse rates were applied, a general bias of ERA-Interim would still result in biased downscaled/elevation-corrected temperatures (Figures 5 and 6). A discussion of this important issue is missing in the manuscript. The larger scale bias of ERA-Interim (i.e. for larger regions without explicitly accounting for elevation effects) could for instance be assessed by comparison against gridded temperature products based on surface observations (CRU, E-OBS, ALPIMP, etc.).

- Page 5941, lines 1-5: Given the systematic underestimation of observed lapse rates by ERA-Interim (Figure 4) I'd strongly doubt this statement.

TECHNICAL CORRECTIONS

- page 5932, line 7: “downscale” instead of “scale”.

- page 5932, line 17: “near-surface air temperature” instead of “surface air temperature”.

- page 5934, line 10: “0.25° ERA-Interim results” instead of “0.25° results”.

- page 5936, line 10: “four” instead of “three”.

- page 5936, line 10: “Method I applied specific . . .”.

- page 5936, line 13: “Methods III and IV” instead of “Method III”.

- page 5938, line 12: “. . . lapse rates were generally smaller ..”.

- page 5941, lines 16-17: This sentence seems to be incomplete.

- Figure 1: The upper panel seems to be a 3D representation of the topography with an inclined view angle. Please correct me if I’m wrong. If it is a 3D representation the length scale is definitely not correct for the entire picture. I’d suggest to replace the panel by a simple 2D horizontal plot.

- Figure 2: Do the elevations of the light-blue lines represent the mean geopotential height of the respective pressure level over the period 1979-2010? Please indicate for completeness.

- Figures 3, 5 and 6: The panels in these figures are too small, and the axis labels and error metrics are hardly readable. Please enlarge the panels.

- figure 4: Gamma_S (literature lapse rate) is only represented by a single horizontal bar in the plot. This bar should also be used in the legend (instead of a white box).

- Figures 5 and 6: The columns (Garmisch, Zugspitze, Zugspitzplatt) and rows (Method I, II, III and IV) should be labeled with a larger font, this would enhance the readability.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 5931, 2012.