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Geoscientific Model Development Discussions

Interactive comment on "TopoSCALE: deriving surface fluxes from gridded climate data" *by* J. Fiddes and S. Gruber

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AUTHORS REPLY TO REFEREE #2

We would very much like to thank Anonymous Referee #2 for the effort in evaluating and commenting this manuscript. In the following text the referee's comments are marked "RC" and author comments "AC". We have subdivided comments alphabetically where appropriate. All RC references refer to original manuscript, whereas all AC references refer to the changes made in the manuscript to be possibly resubmitted.

SPECIFIC COMMENTS

RC1: The title is somewhat misleading. The manuscript is not about the computation or derivation of the surface fluxes, but about disaggregating gridded coarse-scale climate

data to the desired scale under consideration (which can be in turn used to obtain surface fluxes on the subgrid-scale) .

AC1: We had originally chosen to use 'derive' as this makes a conceptual separation from conventional methods (i.e. dynamic or statistical downscaling), as the method presented here is somewhat different from either. However, we now think you are right and have changed the title and terminology in the text to use the term 'downscaling', while ensuring that there is no confusion with conventional use of the term.

RC2: I would include the keywords "disaggregation" or/and "downscaling" (rather than "scaling", which is more general) in the text, that the article is found if people search for such methods.

AC2: Thanks for this comment, again use of 'scaling' was motivated by reason given in AC1. However, we agree with you and have changed terminology accordingly.

RC3: Topography is not the only source of horizontal heterogeneity. Others might be land cover / land use, subgrid-scale water pixels, soil characteristics... These are not considered in the manuscript, this however should at least be mentioned somewhere.

AC3: This is true, to a certain extent, although we think it is important to be clear in separating out heterogeneity that clearly effects atmospheric forcing (e.g. the effect of elevation on air temperature) and those characteristics that become important when performing a land surface simulation (e.g. soil properties effect on near surface air temperature). We have added this distinction to the Introduction, to clarify this point.

"We do not neglect the fact that other forms of heterogeneity may be important, such as surface cover, but it is important to distinguish between surface heterogeneity that clearly effects atmospheric forcing, e.g. the effect of elevation on air temperature, and those characteristics that become important when performing a land surface simulation, e.g. the effect of soil properties on near-surface air temperature."

RC4: Please give the period over which the evaluation has taken place.

AC4: Period has been included in Section 5.2 (Experiments/Setup).

RC5: In my point of view it is very important/interesting how the pressure-level values for levels below the ERA model topography are obtained. I checked the cited IFS-documentation for that, however it might be very helpful to list the methods for the different variables at least briefly, this helps a lot in understanding the concept.

AC5: We have added the following section to Section 2.2: “Geopotential is extrapolated below the model surface as a function of surface geopotential, surface temperature, temperature at mean sea level, surface pressure and pressure level value. Temperature is extrapolated below the model surface to a given pressure level as a quadratic function of surface temperature, surface pressure and pressure level value. Wind and relative humidity are both constant below model surface and equal to lowest model level values (ECMWF 2011).”

RC6: In principle the number and quality of references are appropriate. There are however also quite a few studies from the atmospheric sciences community, which also provide a more or less physical-based downscaling of near-surface variables which are used to obtain the surface fluxes at a higher resolution. For completeness it might be worthwhile to cite some of them too (e.g. Seth and Giorgi (J. Geophys. Res., 1994); Arola (J.Atmos. Sci.,1999), Dimri (Clim Dyn.,2009); Schomburg et al. (Tellus, 2010)).

AC6: We have now incorporated most of the suggested references into the Introduction.

RC7: Structure of manuscript: When reading the manuscript the first time, the structure of the article leads to some confusion, because limitations of the approach(section 2) are discussed before the data and methods are introduced. The manuscript should be re-structured such that 1) Introduction, 2) Data, 3) Methods 4) Experiments 5) Results and discussion 6) Conclusion. The section “Background” should be renamed and split up. The description of “pressure levels below model surface” should be placed in the data section, the limitations of the presented approach should be given in the

discussion section.

AC7: Our original logic was to provide background information on reanalysis/ climate datasets to provide context before the methods were introduced. However, we see how this could be confusing to the reader so have restructured the manuscript as advised.

RC8: You method for precipitation relies not on climate data and elevation alone, additionally a precipitation climatology is needed. You should state that early enough in the article.

AC8: This is true, and has been added to abstract. However, the precipitation can also operate in a spatially non-explicit mode (i.e. a lumped model) without the climatology. This is essentially the REF method. There is only marginal improvement by using the climatology so we would not say the method is, overall, significantly dependent on a climatology. This is not clear enough in the manuscript and so we have modified accordingly in ’Results’.

RC9: For me it is suspicious that TopoSCALE outperforms ERA for the GRID surface level (see Figure 12 and text p3402, line 10-15). This means the interpolation performs better than the explicit model? This is really strange.

AC9: we would explain this by (a) the fact that ’surface’ (red box) is a 400 m wide bin of stations compared to grid values whereas TopoSCALE is compared to stations at their exact elevation, therefore better performance should be expected, and (b) the model simulates a much more homogeneous surface than the real one. What we observe in reality however is a situation where at any given meteo station, the measurements represent a variable mixture of free atmosphere and surface effects.

RC10: The abstract should contain at least some information on the method that is used to obtain the fine-scale information.

AC10: We have added a more concrete description of the method in abstract.

TECHNICAL CORRECTIONS

Straightforward corrections are implemented directly in manuscript and not further commented.

RC7: p3385, line 19: What do you mean with “In general, assimilated observations are not scaled”? Scaled how/by what?

AC7: We have removed this sentence as now find it confusing.

RC8: P3386, line 20 and following: But are these effects not at least partly simulated by the model?

AC8: Rephrased to: “....and shallow convection which is parameterised by a bulk mass flux scheme (Tiedtke 1989) which cannot resolve the level of spatial differentiation that is present in the measurements.” The section on boundary layer effects stands as is, as boundary layer effects will be mainly present in the lowest model (as opposed pressure) level, where the land surface scheme interacts with the atmosphere.

RC10:P3388, line 1/2: refer to the section where this interpolation is described (currently it is section 3.3).

AC10: We have moved section (formerly) 3.3 to Appendix C so as to streamline text, and referred to it there.

RC18: P3392, line 18: You refer to the appendix for converting RH to Td, but actually the appendix does not contain any information on this.

AC18: We have removed this reference in order to maintain flow of paper as the conversion is not actually used in the paper.

RC26: P3402, line 17: you refer here to the point scale. But actually the scheme works very well for high resolution gridded data, I suppose, not only for single points/stations.

AC26: Thanks for this comment. Rephrased sentence: “This study has proposed a method that can efficiently provide meteorological variables to an LSM operating at high-resolution in complex terrain.”

RC30: Figure 4: This Figure is never referenced?

AC30: Reference added to Section 3.1.3, paragraph 1.

RC31: Figures 5,7, 11, 12: please enlarge them, it is hard to read the axes.

AC31: These were designed as full page figures but published in GMDD in a smaller format.

Interactive comment on Geosci. Model Dev. Discuss., 6, 3381, 2013.