Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC1
https://doi.org/10.5194/gmd-2021-60-AC1, 2021

Reply on RC1

Joel Fiddes et al.

Author comment on "TopoCLIM: rapid topography-based downscaling of regional climate model output in complex terrain v1.1" by Joel Fiddes et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-60-AC1, 2021

REVIEWER #1: Richard Essery

We thank the reviewer for his thoughtful comments which have undoubtedly helped to improve this work. We also apologize for the somewhat delayed response. We provide here a point-by-point response where reviewer comments are in bold type and author responses in non-bold. Changed or inserted text is given in italics.

This is a useful and well-written paper. The text is rather compressed and benefits from being read alongside Fiddes and Gruber (2012 and 2014), but there would be a lot of repetition otherwise. I have minor comments.

5 GMD guidance is that citations should not be included in the abstract unless urgently Required.

We have removed the citation.

83 It is not clear at this point what a "subgrid scheme" is.

We have clarified this as:

"and additionally generalising this to a map product using the subgrid scheme, TopoSUB (Fiddes & Gruber 2012), which efficiently spatialises 1D model results to a map domain according to important dimensions of land surface heterogeneity."

84 It is not clear what "repeat (ability to be experimental)" means.

Clarified by changing the line:

"(ability to be experimental)" to

"(i.e. the ability to rapidly repeat numerical experiments that have a relatively low computational cost)"

100 31 September should always be missing.

Corrected to September 30th.

136 It is not observations that are temporally downscaled.

Changed section title 2.3 to *Spatial downscaling of reanalysis data*

Changed section title 2.5 to *Temporal downscaling of climate time series*

145 FSM is a multi-physics ensemble model, but Figure 6 suggests that a single configuration is run. Which one?

We always run configuration 31. We clarify this at first introduction on l.145 as:

"We use the Factorial Snow Model (FSM) model (Essery, 2015) to simulate the snow cover and TopoSUB (Fiddes and Gruber, 2012) to spatialise results to a 2D map. FSM is a multi-physics ensemble model, however, in this study, we always use configuration 31 which is the most complex version of the model where all five parameterisations are switched on. TopoSUB is.."

150 It would not take much space to state the predictors in TopoSUB here.

Added as suggested:

"Predictors used in the clustering algorithm are elevation, slope, aspect and sky view factor."

186 ERA5 resolution is stated as 30 km here and 25 km later. It is stored on a 0.25 degree grid (and 37 vertical levels, not 137).

Corrected to 0.25 degrees at all occurrences. It's a good catch as documents state **https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5** 137 model levels are computed, but as you say only 37 pressure levels are stored/ made available. We clarify as:

"vertical model levels to 137 (37 pressure levels are stored)"

225 "residual error"

We have corrected this typo.

273 It would be better to mention that avalanching is accounted for when stating that wind transport is not in 3.4.

Edited 3.4 as suggested:

"A higher resolution DEM may also be used but likely does not add value as processes such as wind transport that operate on these scales are not included in the model (Mott et al., 2018). However, it should be noted that avalanching off steep slopes is accounted for by removing snow linearly above a slope threshold (c.f. Fiddes et al., 2015). Importantly…"

And edited 5.3 for consistency

"An interesting observation in this figure is that in all time periods and scenarios snow depth is limited both at low elevation by temperature and at high elevation by terrain, which tends to be steeper and therefore permits lower accumulations due to avalanching (permitted by the model, as discussed in Section 3.4). A final point.."

276 "upper limit of seasonal snow limit" – lose a limit

Edited to *"upper limit of seasonal snow"*

334 With downscaled reanalyses used as the reference for bias correction, how can the scheme be used to bias correct historical reanalysis?

We see this as analogous to what we do with climate data - just going backward in time with a dataset that has a special set of uncertainties due to a reduction in the number of observational datasets that are used to constrain it. We clarify this point by changing the sentence starting on Line334 to:

"As a final point, TopoCLIM can be used to bias correct any dataset that partly overlaps with the reference period. Thus, in addition to the future projections considered in this study, it would also be possible to use TopoCLIM to correct coarser-scale reanalysis data that stretch far back in time. A prime example would be ECMWF's 20th Century reanalysis (ERA-20C) which spans 1900-2010 and thus partly overlaps with ERA5 (1950-today) that is used to drive TopoSCALE to generate the reference data T-MET."

Figure 1

Should there also be an arrow from the downscaled reanalysis to the hourly Disaggregation?

Yes good point, the hourly TopoSCALE data is used to temporally disaggregate the quantile mapped CORDEX. We have edited the figure to reflect this and other reviewers' comments.

Figure 3 Use superscripts in units.

We have corrected the unit superscript here.

Figure 6 The time axis is not day of calendar year. Is it day of water year?

Yes this is water year and has now been clarified on axis and caption as *"Day of water year (DOWY)"*

Why is there a downward spike in snow height around day 115?

This appears to be driven by a rise in temperatures in the TopoSCALE derived ERA5 data at this point. Day 115 corresponds to December 25th in case the reviewer was concerned there was a discontinuity in the forcing related to change of year. Interestingly, the authors' combined experience suggests that Christmas day is often bad skiing conditions in the Alps.

Figure 7 There is no need to extend the scale to negative snow depths.

This is an artifact of the plot routine (R package RasterVis/Levelplot) and has been corrected. We have confirmed that there are no erroneous negative values.

Table 1 "CF long name"

We have corrected this typo.