Reply to Anonymous Referee #1

This work provides a 1km-resolution climate dataset from January 1991 to December 2022 for the Sierra Nevada mountain range in Spain. This high-resolution dataset will help to study the impacts of climate change on the botany, ecology and other aspects of mountainous regions.

The dataset was generated using the Weather Research and Forecasting (WRF) model with lateral boundary conditions given by the ERA5 reanalysis. The configuration of the WRF model is clearly described. The quality of the dataset is carefully evaluated. The climate variables of the dataset are well introduced.

Reply: Authors thank the reviewer for reading the manuscript and taking the time to review it, asking critical questions, which will help us to improve the quality of the manuscript. This comment will be therefore included in the acknowledgements section. We have responded to the referee's request point by point indicating the actions to be taken in the final revision of the manuscript. All our replies are included in blue.

General comments:

(1) Do the authors think that assimilating station data into WRF simulations will improve data quality? There could be some discussion at the end of the paper.

Reply: We think that the use of data assimilation would be of interest. However, for such assimilation, observational information for the region is required, and in this respect, note that Sierra Nevada is a region of complex topography where observational data are very scarce, already in the case of temperature and precipitation, and even more so for other variables, and if they exist, they are of short temporal length and low quality. For this reason, we believe that at present we cannot generate quality climate information using assimilation techniques. Everything indicated here will be included as a discussion at the end of the article as suggested by the reviewer.

(2) The authors clearly described how the WRF model is configured and listed relevant references. However, as a non-expert in this model, I would have appreciated a bit more information on the justification of the configuration chosen by the authors and how well the WRF model simulates mountain climates in general.

Reply: An important part of the configuration was based on the balance between obtaining good quality results and the computational cost, since CPM simulations require a large amount of resources, especially when using a model such as WRF. For example, the configuration of the domains was based on the experience of the research group. Configurations based on a single domain require simulating a much larger domain as the change in resolution from ERA5 to 1 km is very pronounced. However, the use of two domains with a 1:5 grid ratio seems to be adequate and has already been employed by other researchers such as Messmer et al. (2021). Moreover, we used a one-way nesting approach to complete CMP simulations because it has a lower computational cost than two-way nesting and the improvement of the latter is not very appreciable according to several studies such as Prein et al. (2015) or Messmer et al. (2021). Concerning vertical levels, we selected 46 vertical levels since our experience indicates that a greater number of levels does not generate large differences in the results, but they do involve a great computational effort. On the other hand, we use

hybrid coordinates because they reduce numerical errors associated with the influence of topography. The model was fed with initial and boundary conditions every six hours as it has proven to be a suitable frequency, also for CPM simulations. In this respect there are authors who indicate that higher frequencies could be more suitable but when we talk about climate simulations the cost/benefit seems to be unclear. All these details will be added in the new version of the manuscript considering the reviewer's suggestion.

Similarly, and taking into account the suggestions of referee 2, we will include additional information from the study used as a reference to selecting the physics schemes in order to make clearer the aspects related to the configuration of the model.

Moreover, we will add more information about the ability of a regional climate model (RCM) such as WRF for simulating mountain climates in general.

References

Messmer, M., González-Rojí, S. J., Raible, C. C., and Stocker, T. F.: Sensitivity of precipitation and temperature over the Mount Kenya area to physics parameterization options in a high-resolution model simulation performed with WRFV3.8.1, Geosci. Model Dev., 14, 2691–2711, https://doi.org/10.5194/gmd-14-2691-2021, 2021.

Prein, A. F., Langhans, W., Fosser, G., Ferrone, A., Ban, N., Goergen, K., Keller, M., Tölle, M., Gutjahr, O., Feser, F., Brisson, E., Kollet, S., Schmidli, J., Van Lipzig, N. P. M., and Leung, R.: A review on regional convection-permitting climate modeling: Demonstrations, prospects, and challenges, Reviews of Geophysics, 53, 323–361, https://doi.org/10.1002/2014RG000475, 2015.

(3) There seems to be some data (daily primary climate variables) missing at

- Longitude: -3.296478271484375, Latitude: 37.09039306640625
- Longitude: -3.352783203125, Latitude: 37.099708557128906
- Longitude: -3.465118408203125, Latitude: 37.16318893432617
- Longitude: -3.476409912109375, Latitude: 37.16325378417969

HighResClimNevada.GFAT-UGR.ECMWF-ERA5.Evaluation.WRF433.day.tasmax.1991010100-2022123100.nc (day 1)

Reply: Thank you for your appreciation. There are some points with missing data because this database was created using the land-sea mask from WRF. In those points where WRF detect “sea” (a lake in this case), the temporal series was masked. In this regard, we will add an additional comment in the data description to clarify that this data is only for land.

Specific comments:

- Line 23-24: “For precipitation, variable, more uncertain and difficult to characterize, HighResClimNevada exhibits a higher amount of precipitation when compared to station-based, coarse satellite-based, and reanalysis-based products.” This relates to the second general comment. How sensitive are the results to the model configuration? Is the chosen configuration optimal?

  Reply: WRF is sensitive to the model configuration and the simulation was completed using a configuration particularly designed in convection-permitting mode, considering aspects related to the domain, the number of vertical levels and the parameterization settings, among others. The latter plays a very relevant role in the results, so it is one of the most tested aspects in our study. For this reason, a sensitivity study was obtained

from these tests, which was recently published in Atmospheric Research (Please see Solano-Farías et al., 2024), from which the best set of parameterizations for the region was selected. As indicated in the general comments, more details will be included in the new version of the manuscript.

Reference:

Solano-Farias, F., García-Valdecasas Ojeda, M., Donaire-Montaño, D., Rosa-Cánovas, J. J., Castro-Díez, Y., Esteban-Parra, M. J., and Gámiz-Fortis, S. R.: Assessment of physical schemes for WRF model in convection-permitting mode over southern Iberian Peninsula, Atmospheric Research, 299, 107175, https://doi.org/10.1016/j.atmosres.2023.107175, 2024.

- Line 176-177: Why were temperature observations from only two stations used?

  Reply: The stations with temperature data available are scarcer than for precipitation. At the same time, when we did the quality check, we only obtained two stations with 19 years of data with at least 85% of records (Line 175-176). In this regard, additional details will be included in Table 2.

- Table 2: Is there information on the number of stations in the second column?

  Reply: Yes, the second column in the case of punctual in-situ stations between parentheses indicates the maximum number of stations used as indicated in its header. This was done considering the number of stations in general, since those stations providing temperature are contained in precipitation. In this sense, the value for SAIH-S will be changed to also indicate the stations contemplated only for temperature.

- Line 314-315: In addition to the citation, is it possible to describe briefly how to obtain the pseudo-PDFs?

  Reply: To obtain the pseudo-PDFs**,** the precipitation was grouped by events with bin of 1 mm, all the precipitation accumulated in the grid points within the National and Natural parks was computed, dividing it by the number of points and the number of days. In this regard, we will describe briefly how the pseudo-PFDs were obtained in the new version of the manuscript.

- Line 480: Is it possible to provide a link to the data download page?

  Reply: We are not quite sure which link the reviewer is referring to. The only link that seems to be missing could be in reference to the stations which will be included in the new version of the manuscript.

- Figure 6: Black is used to define two things.

  Reply: Thank you for pointing this out. Actually, black color is only used to indicate the HighResClimNevada position in each square, but there is a mistake in the figure caption and the years without information are shown in Gray. We will fix this issue in the next version of the manuscript.

Technical corrections:

- Line 38 and 40: Missing space at “(Parmesan, 2006). For” and “(Beniston, 2003).This”

  Reply: Thank you, this will be corrected.

- Line 76-79: Inconsistent use of “.” and “;”

  Reply: Thank you, this will be corrected.

- Figure 4: One dataset name in the caption and plot title does not match (GFAT-grid -> UGR-SNGrid)

  Reply: Thank you for your appreciation, a new Figure 4 will be made with the correct name.