Climate of the Past Discussions

Clim. Past Discuss., referee comment RC1
https://doi.org/10.5194/cp-2022-21-RC1, 2022

Comment on cp-2022-21

Anonymous Referee #1

Referee comment on "Simulations of the Holocene climate in Europe using an interactive downscaling within the iLOVECLIM model (version 1.1)" by Frank Arthur et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2022-21-RC1, 2022

Summary

The authors apply a "dynamical" downscaling technique to an orbital-only Holocene-long climate simulation and obtain a resolution of 0.25 degree over Europe. The downscaling is performed for temperature and precipitation. The authors were able to show that the downscaled precipitation matches precipitation and temperatures in mountain regions more realistically. In particular, the simulated trends of the downscaled data resemble reconstructions from different proxy archives.

General

The study touches a highly important topic in paleo climate, namely the mismatch between local climate proxy information and the rather coarsely resolved paleo climate modelling. The authors present an approach to bridge the gap of scales by a downscaling approach. Clearly the topic desires publication in the Climate of the past, but the current study shows a number of short comings. Besides some structural problems (see below) there is a lack in presenting the state of knowledge in the introduction as a large number of recent studies on dynamical downscaling for paleo climatic studies is missing. Then the results lack a clear discussion of seasonality differences in the proxy data. Also the method itself is to my opinion named wrongly: the authors called it dynamical downscaling and explain that the basic idea is to reproduce the model physics and NOT the dynamics. Due to my rather long list of comments (not sorted into major or minor) I recommend at least major revision of the manuscript.

Comments

Title: The authors use only orbital and GHG forcing so I would not call it a Holocene Climate simulation, rather an orbital-GHG-only simulation for the Holocene period.

L 60 and the following paragraphs: There is growing literature on real dynamical downscaling using RCMs on the Paleo perspective so please make a reasonable review on the existing knowledge. Here is a collection of possible publications:

Bromwich, et al. (2004). Polar MM5 simulations of the winter climate of the Laurentide ice sheet at the LGM. Journal of Climate, 17(17), 3415–3433.

Gómez-Navarro, J. J. et al.: Internal and external variability in regional simulations of the Iberian Peninsula climate over the last millennium, Clim. Past, 8, 25–36, doi:10.5194/cp-8-25-2012, 2012.

Gómez-Navarro, et al.: A regional climate palaeo simulation for Europe in the period1500–1990 – Part 1: Model validation, Clim. Past, 9, 1667–1682, doi:10.5194/cp-9-1667-2013, 2013

Gomez-Navarro, et al. 2015: A regional climate palaeosimulation for Europe in the period 1501-1990. Part II: comparison with gridded reconstructions. Climate of the Past, 11, 1077-1095

Ludwig, P et al. (2016), Regional atmospheric circulation over Europe during the Last Glacial Maximum and its links to precipitation, J. Geophys. Res. Atmos., 121, 2130–2145

Ludwig, P., et al. 2017: Impacts of North Atlantic Surface Temperatures on European Climate during the Last Glacial Maximum in a regional climate model simulation. Geophys. Res. Lett., 44, 5086-5095.

Velasquez P., et al. 2021: The role of land cover on the climate of glacial Europe. Climate of the Past, 17, 1161-1180.

Velasquez P., et al. 2020: A new bias-correction method for precipitation over complex terrain suitable for different climate states. Geoscientific Model Development, 13, 5007-5027.

Russo, E., and U. Cubasch, 2016: Mid-to-late Holocene temperature evolution and atmospheric dynamics over Europe in regional model simulations. Clim. Past, 12, 1645–1662

Russo, M., et al. 2022: The long-standing dilemma of European summer temperatures at the Mid-Holocene and other considerations on learning from the past for the future using a regional climate model, *Climate of the Past*, https://doi.org/10.5194/cp-2021-101

L61: There a several approaches to statistical downscaling simulation. An example is Latombe et al. 2018, but there are several more publications so I encourage the authors to make a lit. search to add it to the introduction.

Latombe, G. et al., 2018: Comparison of spatial downscaling methods of general circulation model results to study climate variability during the Last Glacial Maximum. Geosci. Model Dev., 11, 2563–2579

L65: The publication Feser et al. is not dealing with paleo research questions so why is it cited?

L80-85: Here is another place to add model publication of real dynamical downscaling.

L95: Units are not in italic.

L100 and following: There are several more studies doing Holocene long simulation. A recent one is Bader et al. but please check again the literature. There are also approaches which first use a coarse resolved AO GCM and then a high resolved A GCM forced by the SST and sea ice distributions, please check Merz et al. and Hofer et al. publications.

Bader, J., et al. 2020: Global temperature modes shed light on the Holocene temperature conundrum. Nat. Commun., 11, https://doi.org/10.1038/s41467-020-18478-6.

Hofer, D., et al. 2012: The impact of different glacial boundary conditions on atmospheric dynamics and precipitation in the North Atlantic region, Climate of the Past, 8, 935-949

Hofer, D., et al. , 2012: Simulated winter circulation types in the North Atlantic and European region for preindustrial and glacial conditions, Geophys. Res. Lett., 39, L15805

Merz, et al. 2013: Greenland accumulation and its connection to the large-scale atmospheric circulation in ERA-Interim and paleo-climate simulations, *Climate of the Past*, **9**, 2433-2450

Introduction in general: A discussion on the so-called 'Holocene temperature conundrum' is missing. Please check Bader et al 2020 and Liu et al. 2014.

Liu, Z., et al. 2014: The Holocene temperature conundrum. Proc. Natl. Acad. Sci., 111, 3501–3505, https://doi.org/10.1073/pnas.1407229111.

L125: Please change in the caption to "extent".

L 129: Why do you go from section 2 to subsubsection 2.1.1? This makes no sense. This is happening several times. There are also sections where there is only one subsection which is again awkward. Please correct the structure according to the rules of the journal.

L140: The ECBilt model is a quasi-geostrophic model so the most important mode of variability in the climate system ENSO is not included in the model by definition. So how does this shortcoming impact your results knowing that ENSO has an influence on the Europe?

Section 2.1.2: The authors do NOT apply a dynamical downscaling as they correctly say that the only try to reproduce the model physics and not the dynamics so it is awkward to call the method "dynamical downscaling. This is an important point as real dynamical downscaling implies the application of a regional climate model with incudes dynamics. So I recommend that the authors change the wording in the entire manuscript.

L158-59: If I understand this correctly the method conserves the precipitation amount so that I would average over the same area as the coarse grid I would obtain the same precipitation also in the fine grid. If this is correct I do not understand why precipitation is different in Figure 5and e.g. in Fig 4 if we look at the grid point over Scotland. So either the figure is wrong or the description of the methods is incorrect.

L159-164: Well isn't this logical as the method does not include a dynamical part (only

physics is changed) one would expect that it is not able to change the biased large scale atm. circulation.

Section 2.1.3: To my understanding I would not call this a Holocene simulation as important external forcing agents are missing, i.e., solar forcing and volcanic eruptions. It is clear that the authors cannot rerun the simulations using all forcings so I suggest to make it clear that the authors performed a r an orbital-GHG-only simulation for the Holocene period. So name the simulation always "an orbital-GHG-only simulation for the Holocene period." Just for curiosity why do you only use orbital and GHG forcing and not include the other two?

L245: Why do the authors compare their results to PMIP2 and not to PMIP3 or 4? There are newer studies e.g. Liu et al. 2014, Russo et al. 2022 and PMIP4 studies.

L253-54: please change to "Overall the native grid (T21/11.5_Standard) is still seen on the 11.5K_Down model results in many regions for all times slices. "

Fig.4: The downscaled data looks weird, e.g. in panel d we see at 50N a clear boundary with a change from +100 mm/yr to -100 mm/yr with no gradient in between. This makes no sense.

3.2.1 is the only subsubsection which makes no sense.

4.1.1 The authors compare their results to proxy data which is good. Still I miss a clear discussion on the seasonality of the proxy data which might play an important role in interpreting the proxy data especially the trends. E.g. tree rings and pollen data are biased to the growing season but these data are compared to yearly means of the simulation. Check out the Bader et al 2020 publication on this.

L442: Brayshaw et al. does not simulate the entire Holocene. He rather simulated time slices distributed during the Holocene. So it is not a transient simulation he performed. Please be more specific about this.

L475 and paragraph: Again only PMIP2 is used, why not using the updates of PMIP3 and 4 ?

4.1.2 This subsection is rather short compared to the 4.1.1 so just merge it to one section 4 Discussion.

L485-87: I think there is a caveat which makes the data not so useful as the authors think as the coarse grid sometimes remains preserved in the downscaled data leading to boundaries (see Fig. 5). I think the authors need to be more cautious about this and not overrate their results.

Reference list contains a lot of errors please correct them.

The quality of the figures is bad please use at least 300 dpi.