

REVIEWER 1:

Review of "CHELSA-TraCE21k v1.0. Downscaled transient temperature and precipitation data since the last glacial maximum" by Karger and others

Summary

The manuscript describes an approach to produce high-resolution climate data by downscaling the output of a long simulation of a general circulation model using additional data sources. Most of the text is rather technical, a description of the downscaling process and validation of the resulting temperature and precipitation data. The paper ends with a potential use case of the produced dataset, the application to a problem in paleo-biology.

General comments

Overall, I appreciate the manuscript as an interesting contribution to facilitate paleo modelling work, which relies on high resolution past climate data. In my view, however, there is a number of severe shortcomings in the paper that need to be addressed before it can be published.

My first question was if the manuscript is well placed in the context of CP. The manuscript largely reads like a model description paper and may be better placed in a journal specialised for such content (e.g. GMD). The comments I will raise further on will not depend on this decision. But I will suggest revisions that bring out the modelling aspect even more, asking for further details that are currently lacking.

Response: The manuscript has actually been transferred from GMD from the editors as the fit was considered higher with CP.

The manuscript is giving a good overview of 'what' is done, but has severe shortcomings in explaining 'why' and 'how'. I believe there is need to improve on describing the motivation for most of the decisions and clarifying the details of the processes (see specific comments below). The use of symbols is confusing and inconsistent and should be improved. The aim should be to put interested readers in the position to understand and reproduce the work that has been done. Additional figures/illustrations may help to achieve that.

Response: We included two new figures highlighting the downscaling procedure in the revised manuscript. The figures are highlighting the procedure. The reproducibility is given by the publication of the source code of the model as well.

There may be a conceptual problem with the reconstruction of past surface elevations for glaciated regions. It is not clear to me why past sea surface elevation (i.e. global sea-level) is needed to correct the elevation (l109). The surface elevation of a glaciated region is the result of changing ice thickness and changing bedrock elevation. Neither of these changes is

related (linearly) to sea-level changes. A better explanation is needed to justify the presented approach.

Response: The model we present includes the ice thickness from ICE6G as indicated in line 108. The sea level is included as the high resolution DEM is based on a current bathymetric DEM. Not including the sea level changes would result in an orography that still has today's sea level, which is incorrect for past time steps. The model does not include a changing bedrock on the high resolution (1km) elevation however. We will add a comment on this in the revised manuscript.

Line 168: "Although this approach includes changes in the glacial surface and sea-level rise, it ignores changes in bedrock elevation due to upwelling after glacier melt."

The same applies to the coupling with temperature, which appears to modify the elevation estimate. Again, this is not well motivated and described.

Specific comments

Abstract

l12 Suggest to start a new sentence after (ICE6G) and lay out in simple terms what the temperature coupling entails. This has not become clear to me throughout the manuscript. The amount of ice at a certain place is not determined solely by local temperature, if that is what is happening here.

Response: The amount of ice is of course a balance of precipitation fluxes and temperature changes, which can be physically modeled with a numerical model. This is however not feasible at 1km resolution due to computational limitations and not due to the approach presented here. We use mean annual temperature as a proxy for an interpolation approach. The entire approach is still an interpolation and needs a local correction which we describe in lines 149ff. We see from the reviewer comments however that there have been several misunderstandings on the interpolation procedure and our focus on a mathematical description may not have been easy to understand. We therefore will also include a figure (Fig. 2) highlighting the interpolation algorithm that creates the orography better.

l13 At this stage the reader will not know what CCSM3-TrCE21k and CHELSA stand for. This requires a bit more explanation already in the abstract.

Response: We will include a short description.

Line 13: TraCE-21k (Transient Climate Evolution of the last 21,000 years) based on the Community Climate System Model version 3 (CCSM3). Based on the reconstructed paleo orography, mean annual temperature and precipitation was downscaled using the CHELSA (Climatologies at high resolution for the Earth's land surface areas) V1.2 algorithm.

l16 Here the species distribution is described as a validation of the dataset, while later it is an application of the forcing data. Which one is it?

Response: Both. Paleoclimate models often get validated by specific proxy variables, as we are lacking direct measurements. Applying the dataset to model the distribution of species is the 'application'. Checking if the results make sense is not a 'validation' as such, but a 'plausibility test'.

I31 It is not clear to me how satellite data can be used to 'bridge the gap between the coarse GCM output and the high resolution needed'. The two sources are distinct and have their own biases. Can you explain?

Response: Maybe this is misleading at this point. Deleted.

I43 'ice shields' --> 'ice sheets'. Correct this also in the rest of the manuscript.

Response: Changed

I43 'along the poles' --> 'in polar regions'

Response: Changed

I58 How does a simulation that starts at 21k-BP with 100 yr time steps come out at 1990?

Response: This is based on the timesteps of CCSM3 TraCE-21k. The last timesteps for the 20th century go until 1990.

I59 Isn't paleo-orography an *input* to the downscaling procedure? Here it looks like an output.

Response: The output of one timestep (t) is the input for the next time step (t+1).

I62 It would be useful to distinguish between the model (CCSM3), the specific simulation (TraCE-21k) and the output of that model for a specific simulation (CCSM3 TraCE-21k).

Response: Changed

I69 Should add here that the model is run with a fixed topography (which one? PD, LGM) and fixed land-sea mask (if that is so). Is the fixed land-sea mask not a problem for the downscaling? How does your process deal with regions that change from land to ocean with deglacial sea-level rise?

Response: No, there is no fixed topography. The modeling of the paleo-orography is explained in paragraph 3.1 and 3.2. This is also why we include the sea level in the estimation of paleo-orography. There is now also a figure (Fig. 2) that describes this better.

I73 What does the acronym CHELSA stand for?

Response: Climatologies at High Resolution for the Earth's Land Surface Areas. Included

I76 Explain what GPCC stands for.

Response: Included.

I78 ICE-7G appears to be available since 2018. Can you explain why you are using ICE6G? What is the difference between ICE6G and ICE6G_C and why did you chose the 'C' variant?

Response: ICE6G_C was the latest version when we made the calculations in 2017. ICE-7G was not available at that point. An update is not feasible at this point due to the high computational demand.

I78 Same point as above, is ICE6G_C the model the simulation or the data?

Response: The output of the model (the data).

I80 To my knowledge ICE6G is not a dynamic ice sheet model and does not explicitly model changes in ice thickness.

Response: That is not what is stated on their webpage nor in the file metadata: "Each file contains information for points on a 1x1 degree global grid. The model's ice thickness field is given by the variable stgit." <https://www.atmosp.physics.utoronto.ca/~peltier/data.php>

I82 Topography update is every 500 years, but according to I57 climate updates every 100 years. How do you deal with this issue?

Response: This is indeed not described. The nearest time step has been used. We will add this at the respective point.

Line 225: As ICE6G has a 500 year resolution we used the ICE6G orography used that is closest to each timestep.

I85 It could be useful to explain here or elsewhere that the given extent mask is not necessarily in agreement with ICE6G at LGM. When is LGM defined in Ehlers et al., (2011). Is there a possible temporal mismatch with ICE6G?

Response: This is correct. We will mention this.

Ehlers et al. 2011 defines the LGM as 21 kBP (Page 10, Figure 1.5), similar to the definition used for the LGM in TraCE21k. ICE6G_C has data that extends further into the past. We used the 21 kBP timestep in ICE6G_C. We are defining it in more detail now:

"As the extent of the glaciers during the LGM (Last Glacial Maximum, hereafter defined as 21 kBP similar to Ehlers et al. 2011) , we use data from Ehlers et al. (2011) that presents an up-to-date, detailed overview of Quaternary glaciations all over the world, not only with regard to stratigraphy but also with regard to major glacial landforms and the extent of the respective ice sheets."

I88 What year do you assign to this dataset, what does 'current' mean specifically?

Response: This cannot be clearly stated as GLIMS does not give this information unfortunately.

I94 What does 'derived' mean. What is different and what is the same compared to the original CHELSA V1.2. Again, is CHELSA V1.2 the algorithm (as stated here) or the dataset originating from it?

Response: As stated.

The model is:

Karger, D. N., Conrad, O., Böhner, J., Kawohl, T., Kreft, H., Soria-Auza, R. W., Zimmermann, N. E., Linder, H. P., and Kessler, M.: Climatologies at high resolution for the earth's land surface areas, *Scientific Data*, 4, 170122, 2017a.

The dataset is:

Karger, D. N., Conrad, O., Böhner, J., Kawohl, T., Kreft, H., Soria-Auza, R. W., Zimmermann, N. E., Linder, H. P., and Kessler, M.: Data from: Climatologies at high resolution for the earth's land surface areas, <https://doi.org/10.5061/dryad.kd1d4>, 2017b.

I96 Why is GMTED2010 not described as input data in section 2? It should.

Response: Included.

"The Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010) (Danielson and Gesch, 2011) dataset contains elevation data for the globe collected from various sources. Here we use the 30 arcsec. version of the data that represents the mean elevation of all 7.5 arcsec. grid cells that represent the highest available resolution of the data."

I98 Why is the Miller data not described as an input dataset in section 2? It should.

Response: Included.

"We used data from Miller et al. 2005 for the estimation of global sea-level change from 21 kBP to 1990. The data provides global estimates of sea level change over the last 100 million years ago. The entire time series of sea-level change is based on a variety of proxy data, with the data used here, that dates back to the LGM, being mainly from dating using tropical reefs (Miller et al., 2005)."

I100 Could state here that the details 1-4 are described in the following sub-sections. It would be useful to describe the overall process in a flow diagram or other schematic to make it easier to understand the different steps. Add motivation at every step why things are done the way they are and how in detail.

Response: We will included two new figures (Fig.1, 2) in the revision and make sure to better describe each step in the respective paragraphs in the text. Each paragraph describing a step is also included in Fig. 1 so that it is easier for the reader to follow both figure 1 and the text. The algorithm is however, still complex, but we hope it is clearer now.

I102-104 It seems that this part still belongs to the general intro section 3 assuming that 3.1 is only about orography.

Response: We rearranged this.

I105 Explain what the purpose of combining Ehlers and ICE6G is. Motivate this by laying out your assumptions (do you trust Ehlers more than ICE6G in terms of accuracy?). What does Ehlers give you that ICE6G doesn't and vice versa? It may be useful to illustrate the whole process with a figure for one or several example location. Maybe a cross section through the margin of an ice sheet?

Response: We will included a new figure (Fig. 2). Ehlers gives a high resolution that can be used to delineate glacial boundaries at 1km. ICE6G gives a temporal signal of the elevation only of the major ice sheets but does not have a high resolution.

I106 Explain the choice and significance of taking 100 samples? How many samples are left (on average, max) after removing the outliers. Is ICE6G distributed at 1 degree resolution? If so mention it in section 2.2. If not, why work at that resolution?

Response: 1° the native resolution. 100 samples is arbitrary in this case. It seemed a good compromise between size of the resulting sample and accuracy.

I106 Not clear what "extracted the height of the glacier plus the surface elevation" means. Maybe 'height of the glacier' is ice thickness? Or is it height as in surface heigh? Is $e_{\{t\}}^{\{ice\}}$ the surface elevation or the surface elevation + glacier height?

Response: We clarified this and also made sure that we use orography, topography, and glacier thickness more distinct.

I107 What does the subscript 't' stand for?

Response: Timestep. Clarified.

I107 Explain why these points are omitted. What is the reason for further extracting the point locations on the boundaries?

Response: Otherwise there would be a surface elevation of a glacier where there is no glacier.

I108 What does 'DEM' stand for and what is the data source for it?

Response: Digital Elevation Model. Changed. Data source is GMTED2010.

I109 Is 'past sea surface elevation' from Miller? Explain why this correction to sea-level is needed. As mentioned in the general comments, I don't understand why this is done and suspect a conceptional problem. Please explain this.

Response: Please see our response above. We don't understand what the conceptual problem could be, please elaborate what you expect. Our intent was to a) provide evidence for land where there was land in the past, and b) to use accurate and realistic orography data for downscaling the climate data from TraCE21k.

I116 What does subscript 'c' stand for.

Response: cell. changed.

I have tried to give exhaustive comments on page 4 to show the level of detail that is in my mind required to make this a useful description. Similar comments could be made in the sections that follow.

l120 Explain up front why the B-spline interpolation is needed and what the main ideas of the iterative approach are.

Response: A B-Spline interpolates data to higher resolutions, the iterative process (hence: "Multilevel" B-Spline) makes sure that the error of the interpolation decreases.

l131 What is this 'change factor'? Explain what it serves for in the approach.

Response: To remove the bias in the GCM as already stated in the sentence.

l131 What time period is $\text{tas}_{\text{cur}}^{\text{mod}}$ averaged over? Why do you resample to 0.5 degree resolution?

Response: Changed

l138 What is the significance of levels 26 and 20. What pressure/altitude do they represent?

Response: They are close to the surface and are needed for the CHELSA V1.2 algorithm . We tried to better explain this.

l146 The main ideas of that temperature coupling process have to be explained. What assumptions go into that approach? How is temperature assumed to modify orography?

Response: The assumption is that increasing temperatures are related to melting of glaciers (and vice-versa).

l155 Where does 'glacial melt' come from in this approach?

Response: Probably better explained as reduction in glacier extent.

l166 What process is assumed to modify orography?

Response: In this case only the changes in size/thickness of the glaciers. It is explained in step 3.1

l195 in l184 the grid is described to have 4km resolution. Why the change to 3km?

Response: Simply a typo, Corrected.

l225 text here appears to be repeated in l227.

Response: Corrected.

Figure 1

Suggest to (additionally) show anomalies relative to the present day. For now, it is difficult to make out clear differences in these plots.

Response: The figure has been removed

Suggest to show the present day reference temperature field for comparison.

Response: The figure has been removed

The '-' in 22k-BP should be removed. It reads like a minus sign.

Response: Changed throughout the text

Is this a perceptually uniform colour map? If not, consider using one (e.g. <https://www.nature.com/articles/s41467-020-19160-7>)

Response: The figure has been removed

Results should be shown relative to a long-term average rather than one year (1990). If this is the case, what period is the data averaged over?

Response: 1950-1990 as this is the only period where we have a overlap between models and observations.

I288 Motivate why it is needed to project the data to another map? Details like projection parameters can be presented elsewhere (table, appendix).

Response: Excluded

I290-294 What is the underlying physical assumption for the 1/0 assignment? Clarify.

Response: 0 means there is no glacier, 1 means there is glacier. This binary information is then tested. Why does this need a physical assumption? Please elaborate.

I314 Is the strong correlation maybe related to the fact that the data was bias corrected to a similar product? How do you explain such impressive match?

Response: The bias correction certainly has an influence as well, but so does the downscaling. The CHELSA model decreases the bias and increases the correlation usually (for more details see. e.g. Karger et al. 2017, 2020, 2021 Scientific Data);

I334 'idiosyncratic' Strange choice of word. Reformulate?

Response: Changed

Figure 5

The strong mismatch at LGM could suggest that the lapse rate correction plays out in an unexpected way. It should be checked if that mismatch arises from climate model bias, lapse rate corrections or the bias corrections that are applied in the process.

Response: It could be all of the above plus inaccuracies in the proxies. It cannot be disentangled at this point, as we have no data to check the degree of bias in LGM climate simulations (the coarse resolution model output, which is input to the downscaling algorithm) or the proxy data.

We are now including this statement in the discussion.

“The bias observed after downscaling might be related to factors to a bias in all the different input sources, such as the TraCE21k bias being amplified, a bias in the ice-core proxy data itself, or the bias correction using the relatively simple change factor method. With the available data, these potential causes cannot clearly be disentangled, but should be kept in mind for applications of the data.”

I344 It is not clear to me how glacier extent is meant to validate the downscaling process. It may serve to validate ICE6G and may reveal a mismatch between ICE6G and Dyke, but that is not really at stake here. Could you explain how that comparison can constrain your approach? How does unmodified ICE6G compare to Dyke. Is that improved with your modifications?

Response: We compare the 1km predictions estimated using our algorithm, not ICE6G at 1° resolution. The 1km predictions of glacial extent are the most derived parameter from our dataset with the highest uncertainty attached to it (as it requires several input parameters with high uncertainty itself).

I360 This section comes with unexpected new concepts and models (GLM, KISSMig) that were not introduced before. After going through the technicalities of the sections before, this is a steep change of register. In the abstract this part is introduced as another aspect of the model validation, while here it is written as a use case for the produced dataset. In either case, I suggest this part has to be better linked with the rest of the paper or, maybe better, extended and conceived as a separate paper.

Response: Its part of the validation with the idea that it simultaneously presents a case study as a plausibility test. We will add more basic information about the reasons for applying this case study and about the underlying models used such as KISSMig.

I381 Why is yet another projection needed in this case? Motivate.

Response: Since KISSMig is a grid based dynamic species migration model, it uses an equal area projection to avoid spatial bias in the simulations.

I418 What trends are to be preserved? Clarify. Reference to (Hempel et al., 2013) is probably better placed in the description in section 3.2.

Response: Changed.

REVIEWER 2:

CHELSA-TraCE21k v1.0. Downscaled transient temperature and precipitation data since the last glacial maximum", Karger et al.

General comments:

This manuscript presents a method of downscaling climate model data, using an algorithm, with objective to create high-resolution global monthly climatology for precipitation and temperature for the period of last 21000 years. The manuscript consists of description of the method, evaluation of obtained results and an example of potential use of created high-resolution climate data set in paleo-ecology to detect refugia of plant species at the end.

The final product of this research, in format of high-resolution climate data set, presents an important result, that should hopefully find its application in several scientific fields. I highly appreciate efforts to get the final data set, which, I believe, was a difficult, time-consuming and very technical task. That technical part is well presented and documented within the manuscript. However, I find that the rest of the manuscript has serious shortcomings, especially the evaluation of the obtained data set, what is expected to be the central part of this research. There are also serious issues in manuscript structure. Some figures are presented without any deeper analysis, while on the other hand there are chapters that describe validation of the obtained data set, but without figures, that actually follow in subsequent chapters, which affects significantly the readability of the manuscript. At the end, there is a well described chapter about potential application of the high-resolution data set, however, without clear connection with the rest of the manuscript. It could represent a highlight of this research and be a crucial proof for efficient application of the data set, but it is not even mentioned in the main objective (although it exists in abstract and is mentioned in introduction). There are also inconsistencies in use of terms and symbols throughout the text that, for example, lead to confusion in understanding of some parts of the manuscript, of some figures and even in understanding of correct name of the algorithm in the abstract.

This manuscript has some good material and important results, but it requires significant improvements and better structure in order to be considered and at the end accepted for publication in this journal. Therefore, I would suggest a major revision, to give the authors a chance to improve it, but with caution to stay within the scope of this journal. My further specific comments are listed as follows:

Response: Thank you for your judgment on the value of the generated climate datasets. The generation of this dataset was our main aim, and the evaluation of its usefulness will be improved.

Specific comments:

Line 9, Line 14: What is the name of the algorithm? Is it "CHELSA-TraCE21k downscaling algorithm" or "CHELSA V1.2 algorithm"? Please, be consistent in using specific terms throughout the text. In Line 17 it says "CHELSA TraCE21k output" (without hyphen), which leads to confusion since the very beginning. In addition, in the title of the manuscript it says: "CHELSA-TraCE21k v1.0", and that part "v1.0" does not appear at all in any part of the manuscript.

Response: Will made several modifications and tried to be more consistent by better explaining the terms and by cleaning the text accordingly.

Lines 26-29: There are several applications mentioned, where temporal and spatial variability of temperature and precipitation matter. I would like to see at least one more of these applications described in detail, where your high-resolution data set can be used. I believe it could demonstrate the added value of created high-resolution data set. However, that would probably lead to writing of a completely new manuscript, possibly out of the scope of this journal.

Response: It seems odd that this is mentioned here, as we gave one application an entire chapter (Chapter 6). We are not sure how we can add more here. We added a short paragraph on other applications that are already accepted or published and use this dataset (as it is available already for quite some time). Performing such applications would render the manuscript too heavy and hard to read. It would also deviate readers from the main aim of the manuscript.

Line 58: How do you end up with the year 1990, when you start from 21K BP and use 100-years time steps? And, please, do not use hyphen in "21K BP", it is not correct, unless it is an adjective.

Response: This is based on the timesteps of CCSM3 TraCE-21k. The last timestep for the 20th century goes until 1990.

Lines 60-72: What is the main reason to use exactly this model? Please, justify.

Response: The model is transient and can therefore also be used for dynamic modeling, as for example highlighted in chapter 6. Additionally the data is readily available. It needs to be noted that we did not run the CCSM3 simulation ourselves, but simply downscale the model output.

Lines 67-72: If you say in Lines 66-67 that CCSM3 is global climate with coupled ocean, atmosphere, sea-ice and land surface components, then try to maintain the same order of the Earth system components when you describe characteristics of each one, in order to maintain consistency.

Response: Changed.

Line 74: What is CHELSA? Is it a data set or an algorithm? It is very confusing. What does this acronym stand for?

Response: Climatologies at high resolution for the earth's land surface areas. It's both the name of the output dataset and the algorithm. Explained in the revised version.

Lines 245-248: Very confusing, at the and, I don't understand what is presented in Figure 1. Especially due to use of hyphen in the figures, that gives impression it is a "minus" (22k-BP). Please, avoid that in all other figures, too. Also, there is no any discussion about that figure, only the statement in the legend that it shows "exceptional climate dynamics". Please, avoid use of such strong words, especially if they are not supported by any explanation.

Response: We removed the figure. Instead we now present a figure showing the steps of the algorithm.

Lines 258-264: It is not very clear what is shown in this figure. Did you calculate difference of all mentioned 100-year BP periods from 1990 year only? Or from some annual mean of 1960-1990 period, or 1900-1990? Also, there is no any discussion about this figure and the same comments stand as for the previous one. In addition, I see some strange separation in anomaly sign in southern hemisphere, approximately around 10 S and 40 S. Is there maybe some problem with the downscaling algorithm for that region? Or there is some physical explanation for this pattern?

Response: The anomalies are actually taken directly from the CCSM3-TraCE21k dataset and therefore cannot be caused by the downscaling approach itself.

Lines 265-359: I would suggest to reorder and rewrite chapters 4.1, 4.2, 4.3, 5.1, 5.2 and 5.3. In a current form, it is difficult to follow. It would look much better and improve readability if you could merge 4.1 with 5.1, 4.2 with 5.2 and 4.3 with 5.3.

Response: Thank you for the suggestion. We will reorder the manuscript accordingly by merging the respective chapters.

Line 266: What is the resolution of GHCN? Is it comparable with your data set?

Response: GHCN consists of point measurements.

Lines 360-409: This whole chapter does not seem to have a good connection with the rest of the manuscript, although it gives an important application of the obtained high-resolution data set. A suggestion could be to remove it from this manuscript and to try to improve the rest with more profound and more comprehensive evaluation of the data set. Current chapter could be used with several other examples of potential applications of the high-resolution data set with objective to create another manuscript.

Response: In the beginning of the review you stated that a potential highlight for an application would be needed. The chapter is included to show exactly such a use case. The application also serves as a plausibility check of the downscaled data. If the glacial refugia cannot be modeled correctly, the downscaled data might be wrong, which is not the case here.

Technical corrections:

Line 25: Spatial resolution should not be expressed in square kilometers. I would rather say "at spatial resolutions lower than 1 km", for example

Response: Changed.

Lines 73 and 78: Repeated chapter number

Response: Changed.

Line 76: Acronyms ERA and GPCC are mentioned for the first time in manuscript, therefore, it is expected to write their meaning.

Response: Changed.

Line 177: It seems there is an extra space between the words "level resulting"

Response: Changed.

Lines 184, 186, 195, 196: Please, use the hyphen when you have number, followed by unit when it is an adjective (4-km grid resolution, 3-km grid cell) and spacing when you have number and unit when it is not an adjective (1 km, not 1km). Try to maintain consistency throughout manuscript in all other similar cases.

Response: Changed.

Line 210: It is not understandable, is it a continuation of the sentence, that should be separated by comma and followed by small letter or something else?

Response: Will be changed.

Line 215: One "being" extra, please, remove it.

Response: Will be changed.

Line 216 and 240: 30-arc sec. resolution/grid

Response: Changed.

Line 229: windward-leeward equations

Response: Changed.

Line 234: Are these 2 dots instead of comma? Please, correct it.

Response: Changed.

Line 245: 1-km paleoclimatic dataset

Response: Changed.

Lines 255 and 263: Why is it written "8.2 kiloyear", when in all other cases you use only "k"? Please, maintain consistency in use of symbols throughout the manuscript.

Response: Changed.

Lines 282, 344, 373, 380, 395, etc.: 18k PB and 1k PB. Please, maintain consistency throughout the manuscript by correcting other similar cases

Response: Changed.

Lines 302-303: Another different way of writing 18k BP and 1k BP; 1-km resolution

Response: Changed.

Line 305, 308 and 316: It is RMSE, not RSME.

Response: Changed.

Line 320: Taylor diagrams; typing error with an extra "f"

Response: Changed.

Lines 328-343: "CHELSA_TraCE21k model", "CHELSA_TraCE", "TraCE21k", "TraCE", "CHELSA-TraCE21k time series data", "CHELSA V2.1" - so many similar and confusing names in this short paragraph, that it is impossible to follow. Please, rewrite it and try to be consistent in using specific terms.

Response: Changed.

Lines 354-359: ice sheet, not ice shield

Response: Changed.

Line 390: Typing error "the"

Response: Changed.

Line 420: "comparably well when compared". Please, try to find better words

Response: Changed.