

Detailed answers to the reviewers' comments

Dear Reviewers and Editors,

We would like to use this opportunity to sincerely thank the reviewers again for their detailed comments, which are very useful for improving the language in the paper. We have taken all these comments into account in the revised version of the paper.

In the following answers, all reviewers' comments are in blue, and our answers are in black.

Best Regards

Zhongshi Zhang and Qing Yan

Answers to the reviewer 1

Specific points:

Section 4.1.2 Precipitation, page 1209-1210: Although the overall pattern of the simulated precipitation is in good agreement with that of observations, perhaps the authors can also briefly point out regions where precipitation differs greatly, eg China, India and over the ocean to the west of India.

We add one paragraph at the end of section 4.1.2.

“However, large discrepancies of annual precipitation between the simulations and the observation appear in the tropics. The simulations overestimate the annual precipitation over e.g. the Arabian Sea, the South China Sea, the tropical Pacific in the Northern Hemisphere and East Asia; and underestimate the annual precipitation over e.g. the Indian Ocean and the tropical Pacific in the Southern Hemisphere.”

Line 8, page 1211: A reference to figure 7 does not appear anywhere in the text and needs to be inserted here.

Figure 7 is referenced in the Section 4.2.2 in the revised version.

Last sentence in 4.2.2 Precipitation, page 1211: It seems to me that the values given by the authors refer to boreal summer (ie figures 7b and 7e), and not to the annual mean (figures 7a and 7d). The decreases in the annual mean values over South Asia appear to be much smaller. The authors could also mention the equally large discrepancy in precipitation anomalies over the Indonesian archipelago.

The sentence is revised.

“For example over the Indian Subcontinent or the Indonesian archipelago, the simulated mid-Pliocene boreal summer precipitation decreases by 4 mm d^{-1} relative to the control experiment, but decreases by 6 mm d^{-1} relative to the pre-industrial experiment.”

Line 20, page 1212: Does “In Indian” mean “Over the Indian Ocean”, “Over India” or “Over the Indian sub-continent”?

Changed to “Over the Indian Subcontinent”

Figure 4, page 1223: It would be helpful if the authors could include sub-figures for the differences between the mid-Pliocene experiments and the other two, as it is not easy to deduce the differences from (b) and (c), especially the latter.

The zonal mean of the differences between the mid-Pliocene and the other two are illustrated in the Figure 6 and Figure 7, in the middle.

Other points

Line 1, page 1205: Change to “more attention is being paid to”

Done

Line 3, page 1205: Change “2” in “CO₂” to subscript

Done

Line 14, page 1205: Change to “was recently initiated”

Changed to “has been recently initiated”

Line 16, page 1205: Change to “experimental results”

Change to “mid-Pliocene simulations”

Line 14, page 1206: Change to “which was developed”

Done

Line 16, page 1206: Change to “in the horizontal” and “in the vertical”

Done

Line 18, page 1206: Change to “special to the”

Done

Line 19, page 1206: Change to “The minimum relative”

Done

Line 7, page 1207: 2000s is slightly ambiguous. Change to “2000-2009” or whatever the relevant period is

The SST file used in the control experiment is hurrell_sst_ifrac.1x1.050606.nc downloaded from NCAR. There is some information about the file. “Jim Hurrell (NCAR) combined the Hadley Center anomalies with the Reynolds SST climatology to produce SSTs over the ocean only (2001?).” However, NCAR does not provide reference about "Reynolds SST climatology", not the information about averaging period either. Thus, it is better to keep the original sentence used in the paper.

Lines 9 and 16, page 1207: Change to “anomaly method”

“Anomalies method” has been changed to “anomaly method” throughout the paper.

Line 4, page 1208: Change to “anomaly method”

Done

Line 6, page 1208: Change to “changes in topography”

Done

Line 9, page 1208: Delete the word “condition”

Done

Line 15, page 1208: Change to “Firstly, it is changed”

Done

Line 21, page 1208: Change to “are the same”

Change to “The vegetation and ice-sheet conditions used in this study are identical to those used in Experiments II with NorESM-L (Zhang et al., 2012).”

Line 12, page 1209: Change to “is similar in the pre-industrial and in the control experiment”

Done

Line 18, page 1209: Change to “occurs in the Antarctic”

Done

Line 19, page 1209: Change to “such a pattern”

Done

Line 23, page 1209: Change to “It is the same as”

Done

Lines 1 and 2, page 1210: Change to “at about”

Done

Line 12, page 1210: Change to “of both hemispheres”

Done

Line 13, page 1210: Change to “in the tropics of the mid-Pliocene”

Done

Line 13, page 1210: Change to “Near the equator”

Done

Line 14, page 1210: Change to “of the Southern Hemisphere”

Done

Line 21, page 1210: Change to “can also be observed”

Done

Line 24, page 1210: Change to “and by”

Done

Line 15, page 1210: Change to “of the Antarctic”

Line 25, Done

Lines 6 and 7, page 1211: Change to “in the tropics”

Done

Lines 6-7, page 1211: It may help the reader to add a reference to figure 4c.
Figure 4c and Figure 7 are added at the end of the sentence.

Line 10, page 1211: Change to “of the Middle East”
Changed to “on the coast of the Arabian Peninsula”, according to reviewer 2

Line 11, page 1211: Change to “Larger decreases in annual precipitation: : appear over Southern India”
Done

Line 12, page 1211: Change to “(on the north coast of New Guinea)” or “(on the north coast of the island of New Guinea)”
Done

Line 13, page 1211: Change to “tropical Pacific, on the coast”
Done

Line 17, page 1211: Change to “remarkably larger”
Changed to “The largest annual precipitation increment occurs over the Norwegian Sea (4 mm d^{-1}), where the SSTs are remarkably larger in the PRISM mid-Pliocene reconstructions (Dowsett et al., 2009).”

Line 5, page 1212: Change to “The basic pattern of mid-Pliocene warming in these simulations agree well”
Changed to “The simulated general patterns of mid-Pliocene warming agree with our earlier coupled simulations (Zhang et al., 2012), and also simulations from other PlioMIP groups (e.g., Chan et al., 2011; Koenig et al., 2012; Yan et al., 2012; Zhang et al., 2012; Kamae and Ueda, 2012; Contoux et al., 2012).”

Line 16, page 1212: Change to “choosing the reference experiment”
Changed to “On a regional scale, however, the choice of the reference simulation clearly influences the mid-Pliocene climate anomalies (Fig. 8).”

Line 23, page 1212: Change to “suggests employing local modern SST”
Done

Line 1, page 1213: Change to “it should be noted that, compared to”
Done

Line 6, page 1213: Change to “simulations carried out by Chan et al. (2012), but not in those by Kamae and Ueda (2012)”
Changed to “We indeed find a difference between our AGCM and AOGCM simulations (Zhang et al., 2012), and also in the simulations carried out by Chan et al. (2011). The simulations carried out by Kamae and Ueda (2012) and Contoux et al. (2012) on the other hand do not show such differences.”

Line 11, page 1213: Change to “In accordance with the PlioMIP”
Done

Line 22, page 1213: Change to “should be noted and assessed”

Done

Figure 1, page 1220: Change last sentence to “Grey represents areas covered by sea-ice”

Done

Figure 8, page 1227: Change the titles in (c) and (d) to “Anomaly difference”

Done

Answers to Reviewer 2

Throughout the paper: Atmosphere general circulation model (AGCM) experiments and atmosphere ocean general circulation model (AOGCM) experiments are being referred to by the terms "Experiments I", "Experiment II", and "experiments I". In all cases the term refers to more than one experiment, therefore I would propose to be consistent with respect to the use of the "plural -s". Furthermore, I propose to be consistent with respect to the use of upper- or lower-case.

Revised. The terms “Experiments I” and “Experiments II” are used in the revised version.

Throughout the paper: The abbreviation "SST" seems not to be defined in the manuscript. Of course, it is a standard abbreviation that the typical reader of this manuscript will be familiar with. Yet, sometimes the authors use this abbreviation, and sometimes they use the full term "sea surface temperature" (e.g. in the heading of subsection 3.1). I propose to define the abbreviation SST at its very first occurrences (which are in line 12 of the abstract and line 29 on page 1205 if I am not mistaken), and then consequently use the abbreviation. The same proposal holds for the term "surface air temperature", which is at various locations of this manuscript used in either its abbreviated or non-abbreviated form, this includes table 2, figure captions, and axis labels (e.g. in Fig. 4).

Revised. Sea surface temperature and the abbreviation appear firstly in the abstract. In the main text, only the abbreviation SST is used. The same for surface air temperature and SAT.

Throughout the paper (especially in section 4): When describing results from the simulations, the authors often use terms like "global annual mean SAT" or "zonal mean annual precipitation". Would it make sense to point out the time- and space-average nature of the data by reformulating those terms to e.g. "global mean annual average SAT", "globally and annually averaged SAT", or "zonally and annually averaged precipitation"?

The terms “global mean annual SAT/precipitation” and “zonal mean annual SAT/precipitation” are used in the revised version.

Throughout the paper (especially in section 4 and figure captions): Throughout the paper different notations of physical units are used. For example, the authors use mm day^{-1} , mm d^{-1} and $\text{mm}=\text{d}$ as unit for precipitation. I propose to choose one unit for precipitation and use this consistently for text, figure captions and axis labels.

Revised. The unit mm d^{-1} is used in the manuscript consistently.

Page 1204, lines 9-10: I think there is a grammatical error that complicates the understanding of this sentence. I suppose the sentence should be changed to "... and also assess the potential uncertainties in analyzing mid-Pliocene climate anomalies that might result from the choice of the SST forcing for the reference experiment (preindustrial or present-day)."

The sentence here is much better. Revised in the text.

Page 1204, lines 20-21: Instead of "... is thought to be an analog ..." I propose to write "... is thought to be a potential analog ...". Jansen et al. (2007) actually write in the here cited publication that "... the mid-Pliocene represents an accessible example of a world that is similar in many respects to what models estimate could be the Earth of the late 21st century." In the following sentences Zhang and Yan (2012) actually themselves write that the mid-Pliocene represents a "potential analog", so I would weaken the statement also here.

We agree. The weakened statement is used in the revised version.

Page 1205, lines 1-6: Change "the potential analog" to "a potential analog". Change "attentions are paid" to "attention is paid". Change "The recent mid-Pliocene simulation" to "A recent mid-Pliocene simulation". Change "in the Pliocene" to "of the Pliocene". Change "climate sensitivities" to "climate sensitivity". With respect to climate sensitivity to fast and slow feedbacks: Maybe add a short explanation and/or references that describe the difference between Charney sensitivity and Earth system sensitivity. Is my assumption, that there is more than one record of $\delta^{18}\text{O}$ available from the Phillipines, correct? If that is the case, then change "The $\delta^{18}\text{O}$..." to "A $\delta^{18}\text{O}$...". Change "from the coral skeletons" to "from coral skeletons". Change "do not exist" to "did not exist".

"the potential analog" is changed to "a potential analog".

"attentions are paid" is changed to "attention is being paid", according to reviewer 1.

"The recent mid-Pliocene simulation (Lunt et al., 2009) and the reconstruction of pCO_2 in the Pliocene (Pagani et al., 2009)" is changed to "A recent mid-Pliocene simulation (Lunt et al., 2009) and reconstruction of pCO_2 in the Pliocene (Pagani et al., 2009) indicate that climate sensitivity to the Earth system feedbacks is larger than climate sensitivity to the fast feedbacks."

"climate sensitivities" is changed to "climate sensitivity".

"The $\delta^{18}\text{O}$ record" is changed to " $\delta^{18}\text{O}$ records", and "demonstrates" is changed to "demonstrate".

Page 1205, lines 9-10: It is not clear to me which relationship of cause and effect between topography and ice-sheet changes that the authors want to point out here. Would it make more sense to write "the changes of orography related to changes in ice-sheets are the major reason ..."? As far as I understand, changes in the mid-Pliocene orography especially in high latitudes are less related to mountain building than to the reduction of the ice-sheets, or is that incorrect?

In the revised version, the sentence is changed to "On a regional scale, ice sheet retreat and decrease in topography caused by the ice sheets retreat are the major reasons for the stronger warming at high latitudes in the mid-Pliocene."

Page 1205, line 14: Change "is recently" to "has been recently".

Done

Page 1205, line 17: "are coming out" sounds strange to me, I propose to change this phrase to "are being published".

Done

Page 1205, line 18: Similarly, I propose to change "should be done" to "should be conducted".

Done

Page 1205, lines 24-26: In order to clarify the sentence I propose a reformulation: Write for example "mid-Pliocene experiments performed with the atmosphere component of the low resolution version of the Norwegian Earth System Model (NorESM-L), the Community Atmosphere Model version 4 (CAM4)".

Done

Page 1206, line 1: Maybe it makes sense to name here (for the sake of completeness) the atmospheric trace gas composition as the main cause for the difference between pre-industrial and present-day climate.

The sentence is changed to "due to the increased greenhouse gas levels since the pre-industrial, modern SSTs are warmer than the pre-industrial."

Page 1206, lines 8-11: I personally think this passage of the manuscript definitely needs to be rewritten. Would it make sense to write: "Section 2 introduces the CAM4 model. In addition to the information that has already been given by Zhang et al. (2012), in section 3 we present details on the source and implementation of the boundary conditions (including SSTs, topography, vegetation and ice-sheets) that have been used in the PlioMIP simulations. Section 4 gives an overview on general results of the climate simulations. In section 5 we conclude with a general discussion and summary."

Rewritten according to this comment.

Page 1206, line 14: Change "which is developed at" to "which is being developed at".

"which is developed at" is changed to "which was developed at", according to the review 1, because CAM4 became an old version of CAM now. The latest version is CAM5, which is being developed now.

Page 1206, lines 15-16: I think the following reformulation of the sentence would make the included technical information much clearer: "The horizontal resolution used in the CAM4 model is T31 (approximately 3.75x3.75 degrees) at 26 vertical levels."

We think it is better to keep the original sentence.

Page 1206, lines 18-19: Similarly, I propose to change the following sentence to "However, two parameters that are specific for the NorESM-L are described here". Is this the message that the authors would like to give here? Furthermore I somehow miss the explanation on why these parameters are named here. Does this adjustment represent a deviation from a standard high-resolution-version of this model (which would probably be of minor relevance to PlioMIP), or is this a difference to the version of the setup used for the preparation of the simulations for experiment 2 as described by Zhang et al. (2012) (which would be of importance within the framework of PlioMIP)? I assume that the prior is the case - but at least to me that is not completely clear, in particular since the "However" seems to weaken the statement of the previous sentence (that the model versions between this study

and Zhang et al. (2012) are exactly the same). It would be great if an explanation of this issue could be added to the final version of the manuscript.

These two parameters are important to make the simulation of energy balance at top close to zero, and also make the simulation of global mean SAT warm, for the low resolution version of NorESM or CESM. They are important to the low-resolution version of CESM and NorESM, but only of minor relevance to PlioMIP.

We rewrite the paragraph. “This model is exactly same as that used in the coupled simulations, and has been introduced by Zhang et al. (2012). Two parameters that are special to the NorESM-L are described here, the minimum relative humidity for low (cldfrc_rhminl) and for high (cldfrc_rhminh) stable clouds. Tuning of these two parameters can reduce cooling bias in simulations with the default parameters taken from the low-resolution version of Community Earth System Model (CESM), and thus make simulations more realistic. In the coupled simulation with NorESM-L (Zhang et al., 2012), we find that the cldfrc_rhminl set to 0.835 and the cldfrc_rhminh set to 0.800 are the best options.”

Page 1206, line 19: Delete the "s" in "minimums relative".

Done

Page 1206, line 22: Change "pre-industrial simulation with the CAM4" to "pre-industrial simulations with CAM4". It might be informative to additionally give a reference to a publication that describes the standard values of the mentioned parameters (if these are not given by Neale et al. (2010) and Eaton (2010)).

Page 1206, lines 23-25: The last two sentences of this page are difficult to read. Maybe reformulate them for example in the following way: "More information on the CAM4 model is given by Neale et al. (2010) and in the user guide (Eaton, 2010). A detailed introduction to NorESM is provided by Alterskjaer et al. (2011) and Zhang et al. (2012)."

Changed to “More information about the CAM4 is given by Neale et al. (2010), and in the user guide (Eaton, 2010) and the model validation paper for the low-resolution version of CCSM4 (Shields et al., 2012). Detailed introductions to the NorESM are provided by Alterskjær et al. (2011) and Zhang et al. (2012).”

The publication of CCSM4 with standard parameters is cited.

C. A. Shields, D. A. Bailey, G. Danabasoglu, M. Jochum, J. T. Kiehl, S. Levis, and S. Park, 2012: The Low Resolution CCSM4. *J. Climate*, in press, doi: 10.1175/JCLI-D-11-00260.1.

Page 1207, line 5: Change "created by" to "described by".

Page 1207, line 6: If the proper reference to the "Reynolds SST climatology" is not Hurrell (2005), I would add it here.

Page 1207, line 7: I would give a more accurate time period that the climatology refers to. Is it comparable to the averaging period of the HadISST set?

The SST file used in the control experiment is hurrell_sst_ifrac.1x1.050606.nc downloaded from NCAR. There is some information about the file. "Jim Hurrell (NCAR) combined the Hadley Center anomalies with the Reynolds SST climatology to produce SSTs over the ocean only (2001?)." However, NCAR does not provide reference about "Reynolds SST climatology", not the information about averaging period either. Thus, it is better to keep the original sentence used in the paper.

Page 1207, line 9: I would change the sentence to "... are created with an anomaly method similar to the one suggest by the ..."

Done

Pages 1207-1208: Some comments regarding the equations. First: Would it make sense to number the equations and then to refer to them in the text via their number (e.g. on page 1212, line 24-25)? Second: I would give a proper definition of all the "symbols" that are used within the three equations, e.g. a statement in the text that defines the meaning of "ModernPrism". Third: I propose to use the index "Prism" in its upper-case form (i.e. PRISM) as defined before on page 1205, line 18. Fourth: Maybe it makes sense to stick to a specific name pattern for the symbols. Since pre-industrial SSTs are referred to as SST_{pre-industrial}, I would write e.g. ModernSST_{PRISM} instead of "ModernPrism". Fifth: I would avoid the space in "mid-Pliocene SST_{PRISM}" and write instead e.g. "midPlioSST_{PRISM}"; similarly for "mid-Pliocene Top_{PRISM}". Sixth: Would it make sense to call symbols referring to topography "Topo" instead of "Top"? The prior simply seems to be a more common abbreviation.

The three equations are changed to " $SST_{pre-industrial} = HadISST_{1870-1900} - ModernSST_{PRISM} + ModernSST_{Local}$ ", " $SST_{mid-Pliocene} = mid-PlioceneSST_{PRISM} - ModernSST_{PRISM} + ModernSST_{Local}$ ", and " $Topo_{mid-Pliocene} = mid-PlioceneTopo_{PRISM} - ModernTopo_{PRISM} + ModernTopo_{Local}$ ". I think it is clear now, to show how we set the SST and topography conditions. The numbers of equations are added.

Page 1207, lines 13-14: Change the sentence to "Pre-industrial sea-ice area is identical to its local modern match."

Done

Page 1207, lines 15-16: Change the sentence to "The generation of mid-Pliocene SST and sea-ice forcing (Fig. 1c and f) follows as well the anomaly method (eq. 2) described by Haywood et al. (2010)."

Done

Page 1207, lines 19-20: Change the sentences to "Sea ice area follows mid-Pliocene monthly SSTs. Where SST is higher than $\square_{1:8_C}$, the sea ice coverage is set to 0."

Done

Page 1207, lines 24-25: The authors state that the reference simulation uses local modern land-sea mask and topography conditions since the pre-industrial and modern versions are "almost" the same. If they are indeed not the same but slightly different, then it would make sense to shortly explain what these differences are.

PlioMIP suggests using the modern mask and topography in the pre-industrial experiment, because our models think there are no changes in the mask and topography in the modern relative to the pre-industrial situation. But, actually not. Thus, we used "almost no changes" in the earlier version.

In the revised version, it is simplified. "Following the PlioMIP experimental guidelines (Haywood, et al., 2010), the reference experiment uses the local modern land-sea mask and topography conditions"

Page 1208, line 1: Change "used here is same as" to "equals".

Done

Page 1208, line 4: Change "anomalies method (Fig. 2)" to "anomaly method (Fig. 2 and eq. 3)".

Done

Page 1208, lines 6-9: The two sentences sound a little complicated. Maybe such a reformulation will contribute to readability: "Compared to the modern condition, large changes of mid-Pliocene topography appear in particular on Greenland and at the margin of the Antarctic because of the reconstructed retreat of ice-sheets. The Colorado and Andes mountains are higher in the mid-Pliocene simulation." Does "Colorado mountains" refer to the Rocky Mountains?

The sentence is changed to "Compared to the modern topography (Fig. 2b), large changes of mid-Pliocene topography appear in particular on Greenland and at the margin of the Antarctic because of the reconstructed retreat of ice-sheets. The Rocky and Andes mountains are higher in the mid-Pliocene topography."

Page 1208, line 14: Change "biom_veg_v1.2" to "biome_veg_v1.2". Would it make sense to speak of "the PRISM Pliocene vegetation and ice-sheet condition" rather than the "land cover condition"?

Changed to "The mid-Pliocene vegetation and ice sheet conditions are created based on the PRISM condition biome_veg_v1.2 (Hill et al., 2007; Salzmann et al., 2008)".

Page 1208, lines 18-22: I think also here is a complete reformulation needed to make the sentences more understandable. I propose to write: "Compared to the preindustrial vegetation, in the mid-Pliocene simulation the percentage of bare land is reduced, while the percentage of tress increases (Fig. 3). The mid-Pliocene extent of ice-sheets is smaller on Greenland and at the margin of the Antarctic. The vegetation and ice-sheet conditions used in this study are identical to those used in the coupled PlioMIP simulations with NorESM-L (Zhang et al., 2012)."

Done

Page 1208, line 23: Remove the "s" in "Experimental designs".

Done

Page 1208, line 24: Change "above conditions" to "above described conditions". Additionally, replace the "," between "here" and "the pre-industrial" by a ":".

Done

Page 1208, line 26: Change "experiment suggested" to "experiment as suggested". Change "the PlioMIP" to "the PlioMIP experimental guidelines".

Done

Page 1209, line 2-3: Change the sentence "In this paper, ..." to "Other results described below are based on climatological means from the last 20 yr of each simulation." If I am not mistaken, the here chosen time period for the calculation of climatologies (20 yr) differs from the experimental guidelines of PlioMIP (where 30 yr are suggested). Is the number "20" a typo, or has the calculation of climatologies actually been carried out over 20 yr? If so, then I

would point out this deviation from the experimental guidelines, since it might be of relevance for the model intercomparison.

We calculated the mean values for the last 20 years, because we think the difference between 20-year and 30-year mean is very small. In the revised version, we point out this deviation.

“Other results described below are based on climatological means from the last 20 years of each simulation. These climatological means are similar as the means of the last 30 years of each experiment, which are suggested by the PlioMIP experimental guidelines.”

Page 1209, line 8: Change "SAT 14:6 _C" to "SAT (14:6 _C)".

Done

Page 1209, line 9-10: Change the sentence to "Both simulations are warmer than estimates of the pre-industrial SAT (about 13:5_ C, Hansen et al., 2010), and ...". I did not understand the meaning of the word "but" here, and assume instead there should be an "and".

Done

Page 1209, line 12-14: I would rephrase the sentences to: "The simulated zonal mean annual average SAT (Fig. 4b) of the pre-industrial and control experiment are similar. The results agree with the zonal mean EAR-interim temperature between 1979 and 2008 (Dee et al., 2011). If one takes a close look at Fig. 4b it looks like that indeed there is good agreement in the low- and mid-latitudes, but quite some disagreement close to the poles. Maybe it would be worth to address this shortly.

Changed to “The simulated zonal mean annual SAT (Fig. 4b) is similar in the pre-industrial and in the control experiment. The results agree with the zonal mean annually averaged EAR-interim temperature between 1979 and 2008 (Dee et al., 2011), in particular in the low and middle latitudes of both hemispheres, though the discrepancy looks relatively large close to the Poles.”

Page 1209, line 18: I assume that "on the Antarctic" should be replaced by "in the Antarctic".

Done

Page 1209, line 19: I would rephrase the sentence "Such pattern ..." to "This is in agreement with the ERA-interim annual ...". When looking at the figure, the question came to mind whether the statement "there is generally good agreement between the simulation and the ERA-interim" really can be drawn from these plots. The large color range in the plots (showing absolute temperatures and precipitation) might hide differences that are actually not that small. Would the statement of "good agreement" still hold if one plotted anomalies between the simulation and the data-sets rather than absolute values?

Changed to “Such a pattern is in agreement with the ERA-interim annual temperature fields (Fig. 5c, Dee et al., 2011).”

Page 1210, lines 1-2: Change "In the two Poles" to "At the Poles". In Fig. 4c it actually seems that the value of 0:2 mm d⁻¹ given for the zonal mean annual average precipitation at the poles is only correct in the Southern Hemisphere. For the Northern Hemisphere the value should be actually around 0:4 mm d⁻¹. Is that correct? If yes, then I would adjust this information in the text.

It is changed to “At the Poles, zonal mean annual precipitation is low, at about 0.2 mm d⁻¹ at the South Pole and about 0.5 mm d⁻¹ at the North Pole.”

Page 1210, line 3: Change "coincides with" to "matches to".

Done

Page 1210, lines 5-6: I personally would change "precipitation fields are" to "precipitation is". Changed to "The overall pattern and amount of simulated global precipitation agree with the observations (Fig. 5d-f)."

Page 1210, line 9: I think the reference should be "(Table 2)" instead of "(Table 1)".

Done

Page 1210, line 12: Delete "the".

Done

Page 1210, line 13: Change the sentence "at tropics ..." to "... at the tropics in the mid-Pliocene simulation (Fig. 6)." I think the term "experiment" in this publication is already reserved for a set of mid-Pliocene and reference simulations. Also at other locations of the manuscript I would change "experiment" to "simulation" wherever this is appropriate. Changed to "in the tropics of", according to the reviewer 1.

Page 1210, lines 13-14: Add "the" before "equator" and "Southern Hemisphere".

Done

Page 1210, lines 18-19: I propose to adjust the text to "reconstructed within the PRISM Project (Dowsett et al., 2009), and also agree with PlioMIP simulations of other groups..." Changed to "Such changes, with stronger warming at high latitudes, follow the mid-Pliocene SST anomalies reconstructed by the PRISM (Dowsett et al., 2009), and also agree with PlioMIP simulations of other groups (e.g., Chan et al., 2011; Koenig et al., 2012; Yan et al., 2012; Kamae and Ueda, 2012; Contoux et al., 2012)."

Page 1210, lines 21-25: Change "also can be" to "is also"; at "anomalies fields" there is a spare "s", I propose to simply write "seasonal SAT anomaly"; instead of "northern winter" or "southern winter" I propose to use the terms "boreal winter" and "austral winter" - these terms are also used later in the manuscript; after "relative to the control experiment" add a reference to (Fig. 6); add a "the" before "Antarctic"; I propose to delete the "," after the temperature value in line 25.

"also can be" is changed to "can also be", according to reviewer 1.

Others done.

Page 1211, line 2: Add a reference to Table 2 at the end of the line.

Done

Page 1211, line 5: Change "The zonal mean precipitation shows that the mid-Pliocene..." to "The zonal mean mid-Pliocene ...".

Done

Page 1211, lines 6-7: Add a "the" before the each appearance of "tropics".

Done

Page 1211, line 7: Add a reference to Fig. 7 after "relative to the control experiment." This also ensures that Fig. 7 is referenced, which is not the case throughout the first version of the manuscript.

Done

Page 1211, line 8: Change the sentence "... precipitation anomalies map, larger annual ..." to "... precipitation anomaly map, a large annual average ..."

Done

Page 1211, line 9-10: Would it be better to write "at the coast of the Arabian Peninsula" instead of "on the coast of Middle East"?

Changed to "Arabian Peninsula"

Page 1211, line 11: Write "reduction" instead of "deduction".

Page 1211, line 11-13: The term "Southern Indian" is not clear to me, a clarification is needed; change "the New Guinea island" to "New Guinea"; write "tropical Pacific" instead of "tropical pacific"; add another reference to Fig. 7 at the end of line 13.

Changed to "Larger decreases in annual precipitation ($< -3 \text{ mm d}^{-1}$) appear over the Indian Subcontinent, the South China Sea, the Bismarck Sea (on the north coast of the island of New Guinea), and the tropical Pacific on the coast of Central America (Fig. 7)."

Page 1211, line 14: I propose to change "at middle and high latitudes" to "at mid- and high-latitudes". If you follow this advice, please also adjust other occurrences of "high latitudes" and "middle latitudes" which appear in sections 4 and 5.

Page 1211, line 15-16: It is not clear to me to what the statement "have less regional variations" refers to. It would be good to clarify to which other state or quantity this comparison refers to.

We want to use the format "middle and high latitudes" here.

Changed to "The changes of precipitation have less regional variations in the middle and high latitudes relative to in the tropics"

Page 1211, line 18: To increase readability, I propose to delete the sentence "The annual precipitation increases by 4 mm d^{-1} there." and instead give the value of the precipitation anomaly in line 16 by changing "Norwegian Sea," to "Norwegian Sea (4 mm d^{-1})."

Done

Page 1211, line 19-20: The sentence becomes clearer if it is reformulated: "The mid-Pliocene anomaly of global mean precipitation does not depend strongly on the choice of the reference simulation (i.e. the pre-industrial simulation or the control simulation)."

Done

Page 1211, line 22: Would it make sense to write "Southern Asia, especially on the Indian Subcontinent" instead of "South Asia"?

Page 1211, line 22-23: Do these anomalies really refer to annual average precipitation? The boreal summer anomaly shown in Fig. 7 is actually much larger. Could you also add a general description of the seasonal variation of precipitation? The respective subfigures of Fig. 7 do not seem to be addressed in the text.

Changed to “For example over the Indian Subcontinent or the Indonesian archipelago, the simulated mid-Pliocene boreal summer precipitation decreases by 4 mm d^{-1} relative to the control experiment, but decreases by 6 mm d^{-1} relative to the pre-industrial experiment.”

Page 1211, line 23: Change "referenced" to "relative".

Done

Page 1212, line 2: Change "described in the above sections" to "described above".

Done

Page 1212, line 3: Change "experiment agree with observations" to "experiment both agree with modern observations".

Done

Page 1212, line 5: I propose to add "and during the winter season" after "particular at high latitudes".

Done

Page 1212, line 5-6: The meaning of the sentence evades me. Did you mean to say: "The simulated general patterns of mid-Pliocene warming agree to our earlier coupled simulations"? Changed to "The simulated general patterns of mid-Pliocene warming agree with our earlier coupled simulations (Zhang et al., 2012), and also the simulations from other Pliocene groups (e.g., Chan et al., 2011; Koenig et al., 2012; Yan et al., 2012; Zhang et al., 2012; Kamae and Ueda, 2012; Contoux et al., 2012)."

Page 1212, line 9: I propose to change the sentence to "The analysis of mid-Pliocene climate anomalies necessitates a reference experiment."

Done

Page 1212, line 12-14: To clarify the sentence, I would rewrite it: "If on the other hand the pre-industrial experiment is chosen as the reference, the mid-Pliocene globally and annually averaged SAT increases by $2.7 \text{ }^{\circ}\text{C}$ ", which is 8% larger.

I think instead of 'SAT increases "by" 2.7 deg C ' the text should be 'SAT "anomaly" increases "to" 2.7 deg C '.

Done. "by $2.7 \text{ }^{\circ}\text{C}$ " is fine here.

Page 1212, line 16-17: Change "However, on a regional scale, choosing reference experiment clearly influences the analyses of mid-Pliocene climate anomalies." to "On a regional scale, however, the choice of the reference simulation clearly influences the mid-Pliocene climate anomaly (Fig. 8)."

Done

Page 1212, line 20: The meaning of "In Indian" is not clear, please refine.

Page 1212, line 21: Change "decuction" to "reduction".

Changed to “Over the Indian Subcontinent, the simulated mid-Pliocene boreal summer precipitation reduction is further enlarged by 50%, when the pre-industrial experiment is chosen to be the reference (Fig. 7).”

Page 1212, line 22: Add a reference to Fig. 7 at the end of the sentence

Done

Page 1212, line 23: Change "The PlioMIP suggests" to "The PlioMIP experimental guidelines suggest"; change "reference experiment for" to "reference simulation of".

Changed to "The PlioMIP experimental guidelines suggest", but keep the "reference experiment"

Page 1212, line 24-28: The meaning of the whole text passage is not clear to me.

Would it be correct to write: "The mid-Pliocene SST forcing is created following the anomaly method, where the PRISM mid-Pliocene SST anomaly is added onto the local (i.e. group-specific) modern SST forcing. This experimental design is useful for the calculation of climate sensitivity considering the PRISM mid-Pliocene SST anomaly. It is also a common basis for future comparisons of PlioMIP AGCM simulations." As I pointed out, the meaning of the passage is not clear to me. Please clarify it.

Changed to "The mid-Pliocene SST forcing is created according to the anomaly method, in which the PRISM mid-Pliocene SST anomalies are added on the local modern SST fields (i.e. group-specific). This experiment design is useful for calculation of climate sensitivity considering the PRISM mid-Pliocene SST anomalies. It is also a common basis for future comparisons of PlioMIP AGCM simulations."

Page 1213, line 1: Change "note, compared" to "noted, that compared"; add "(experiment 2, Zhang et al. 2012)" after "AOGCM simulations".

Changed to "it should be noted that".

Zhang et al., 2012 should not be cited here.

Page 1213, line 2: Change "anomalies" to "anomaly"; add "of this study (experiment1)" after "AGCM simulations".

It is reasonable to use plural.

"of this study" should not be added here.

Page 1213, lines 3-9: Here is another passage that might be better understandable if being rewritten. I propose to change it like this: "All PlioMIP AGCM reference simulations are based on modern SSTs, but all AOGCM reference simulations rely on preindustrial SST forcing. We indeed find a difference between our AGCM and AOGCM simulations (Zhang et al., 2012), and also in the simulations carried out by Chan et al.(2011). The simulations carried out by Kamae and Ueda (2012) and Contoux et al. (2012) on the other hand do not show such differences. This issue should be noticed and further assessed during the upcoming PlioMIP analysis and synthesis phase." Would it make sense to extend this discussion onto the data part of PlioMIP? As far as I understand, the mid-Pliocene warm phase as reconstructed within the PRISM project is as well influenced by variable climate forcing (due to the long averaging period), so the problem at the data side is somehow comparable to the issue that has been highlighted here. But maybe that would go beyond the scope of this manuscript.

Changed to "All PlioMIP AGCM simulations use modern SSTs in reference experiments, but all AOGCM experiments use pre-industrial simulations as reference experiments. We indeed find a difference between our AGCM and AOGCM simulations (Zhang et al., 2012), and also in the simulations carried out by Chan et al.(2011). The simulations carried out by Kamae and Ueda (2012) and Contoux et al. (2012) on the other hand do not show such differences. This

issue should be noticed and further assessed during the upcoming PlioMIP analysis and synthesis phase.”

We think the discussions of PRISM data go beyond the scope here.

Page 1213, lines 10-11: Change "atmosphere model (CAM4) of the NorESM-L in this paper" to "atmosphere component (CAM4) of the NorESM-L climate model".

Done

Page 1213, lines 12-13: Change "by the local modern SST fields" to "the standard CAM4 modern SST forcing".

Done

Page 1213, lines 14-15: Change "condition" to "forcing (Fig. 8a)".

Done

Page 1213, line 15: Delete "the".

Done

Page 1213, line 19: Change "SSTs in the reference experiment" to "forcing in the reference simulation".

Changed to “Choosing modern SSTs forcing in the reference experiment”

Page 1213, line 20: Add a "the" before "mid-Pliocene", change "anomalies" to "anomaly".
Want to keep the plural here.

Page 1213, line 20-22: I propose to change the sentence to: "However, on a regional scale, the potential uncertainties linked to the choice of the SST forcing for the reference simulation should be noted and assessed in the upcoming PlioMIP analysis.

Done

Page 1218, Table 1: I propose to change "Anomalies + local modern" to "PRISM topo ano. + local modern", and to define the abbreviation "ano." in the table's caption.

Done

Page 1219, Table 2: Does "Surface temperature" refer to "surface air temperature"? If so, then please write "SAT" instead. In the caption, I propose to change "Global mean value" to "globally averaged climatologic parameters", or maybe simply to "globally averaged climatology".

Done

Page 1220, Fig. 1: I propose to add the "unit" "E" to the tick labels of the longitude axis (I propose a similar change in Fig. 2,3,5,6,7, and 8). In the caption, change the last sentence to "The gray area identifies areas that are covered by sea-ice". Could you additionally add a statement on whether or not the sea-ice distribution is fractional, and could you give some information on the density of the ice-cover if that is possible?

Since we use 0~360 degree for longitude here, it is better not use unit E.

The last sentence is changed.

It is true the sea-ice distribution is fractional. However, it is difficult to plot fractions in these small figures, because the fractions are larger than 90% in most of sea-ice area. A few contours do not provide much information.

Page 1221, Fig. 2: Would it make sense to also show the absolute mid-Pliocene topography for reference?

Actually, the mid-Pliocene topography looks similar to the modern topography. The topography anomaly map here is clear enough to show the topography changes.

Page 1222, Fig. 3: I personally would use all plant types in their plural form, e.g. to write shrubs and grasses" instead of "shrub and grass". With respect to Fig. 3 e and j: Is the ice-sheet distribution really fractional? If not, I would simply write "distribution of ice-sheets" instead of "for the percentage of land ice".

It is better not to use plural here, because all plant types are copied from CESM manuals. They are not plural on the manuals.

Ice-sheet distribution is fractional. Thus, it is better to use the "percentage of land ice" here.

Page 1224, Fig. 5: It looks like some of the subfigure identifiers (e.g. "(a)") are formatted bold, while others are not. Could you check and fix this if needed, please also for Fig. 6 and 7?

Checked. They are in the same format.

Page 1225, Fig. 6: I think it is necessary to add some space between the maps and the zonal averages (or to alternatively change the location of tick marks), since the tick labels of the different axes get too close to each other. In particular, the "24" of the temperature axis and the "0" form a "240" that looks like it marks the respective degree longitude. In the last sentence of the caption, I propose to change "zonal mean values" to "zonal means".

Page 1226, Fig. 7: Also add here some space between the maps and zonal averages if that is possible.

We do not add space between the maps and the zonal, into order to make the width of the figures close to 15 cm. The label of temperature/precipitation axis is moved to the top.

Figure 6 is replotted with the same color scale used in Zhang et al., (2012).

Page 1227, Fig. 8: May it be that these results are only mentioned in the discussion and summary? Maybe it would be useful to give some additional information on the findings already in section 4. With respect to the right-hand-side plots: I suggest to add a zero-line. In the caption I propose the following adjustments: Change "Uncertainties in mid-Pliocene SAT anomalies, due to choosing SST fields in the reference experiment." to "Uncertainty in mid-Pliocene SAT anomaly introduced by the choice of the SST forcing." Change "Differences between" to "Differences between the". Change "the zonal difference" to "the zonal mean difference". Change "anomalies between" to "anomaly between".

Figure 8 is related to the main purpose of the discussion section (Section 5). Thus we only mention the figure in the Section 5.

Zero lines are added.

"Differences between" is changed to "Differences between the".

Plural of anomaly is kept here.