

## ***Interactive comment on “The mid-Pliocene climate simulated by FGOALS-g2” by W. Zheng et al.***

### **Anonymous Referee #1**

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#### General Comments

The paper introduces a recently developed model - the Flexible Global Ocean-Atmosphere-Land System model grid point version 2 (FGOALS-g2). After being developed the model has run a mid-Pliocene experiment according to the Experiment 2 guidelines for the PlioMIP project (Haywood et al., 2011).

The paper requires some work addressing specific issues and a number of minor typographical corrections. However the paper will make an interesting addition to the PlioMIP ensemble members due to a large Pliocene minus pre-industrial temperature anomaly. I recommend the paper is published subject to minor revisions.

#### Specific Comments

i) Throughout the manuscript, the abbreviation ‘TAS’ is used for surface air temperature.

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In keeping with other papers in the PlioMIP project, this would be better changed to ‘SAT’.

ii) Section 2.1. - Owing to the relatively recent development of the FGOALS-g2 model, a more detailed description of the model components, especially the GAMIL2.0 and the LICOM2.0 components would be useful. Additionally, owing to the quite high ‘Pliocene minus pre-industrial’ SAT anomaly, if the Charney sensitivity for the model has been calculated, this would be a useful addition to the paper, with respect to other potential PlioMIP analyses.

iii) Section 3.2.1. - The statement “The warming along the equator is slightly larger in the eastern Pacific than the western Pacific in the mid-Pliocene experiment” does not appear to be supported by Figure 3a. A slight cooling occurs in the Eastern Pacific off the coast of South America near to the equator, however the SST anomaly is displayed as fairly consistent across the Pacific.

iv) Section 4 – Data-Model Comparison – The chosen method for producing a data-model comparison (DMC) for this paper (Figure 8) requires modification. The formatting of the data used to produce the DMC is not clearly specified. Based on Figure 8, I assume the SST input fields for PlioMIP Experiment 1 have been used to generate the model minus data anomaly plot in Fig 8a and from that the zonal mean in Fig. 8b. For Figures 8c and d, I assume the deep water temperatures used to initiate the bottom oceans in the PlioMIP Experiment 2 design were used to produce the bottom water reconstruction and zonal means. However, as this data from the PRISM group is limited to a small number of sites, the interpolation to produce this comparison creates a large uncertainty in the reconstruction. The uncertainty weakens the usefulness of the data-model comparison. I would prefer to see a data-model comparison keeping Fig.8a and b, but replacing 8c and d with a site by site data-model comparison (i.e. Bragg et al., 2013; Haywood et al., 2013). The data used to create the DMCs should also be explicitly stated in the text.

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v) Figure 1 – Fig. 1a and Fig. 1b are unclear due to the inherent noise in the time series plot. I would like to see a smoothed average for radiation and temperature variation through the time series overlaid on the existing plots to enhance the clarity of the figures.

vi) Figure 2d – The scale on the x axis appears to be mislabelled for this figure. A zonal mean change in precipitation of 60 mm d-1 seems rather large at the poles.

vii) Figures (general) – For all the figures the labelling of the longitudes changes from ‘°E’ to ‘°W’ on the same axis. Personal preference would maintain a single identification, either °E or °W but not both. Specifically on Figure 6, the ticks of longitude are different between Fig. 6a and 6b, for clarity this should be changed. In figure captions I would place the units of measurement to after the variable being measured is named. As an example:

“Fig. 2. The differences of annual mean values between the mid-Pliocene and the pre-industrial simulation (3 ma – 0 ka) for a) TAS (°C), b) zonal mean TAS (°C), c) precipitation (mm d-1) and zonal mean precipitation (mm d-1)”

#### Technical Corrections

As well as line by line technical corrections there are two specific corrections to be made to the text typography:

i) Correct “pre-Industrial” to “pre-industrial” throughout the text and in figure captions.

ii) Consistency on the use of “East Asia” or “East Asian” with respect to monsoons and summer/winter winds. Through the text both are used interchangeably, and I feel it is a cleaner read if just one version is used throughout the text.

2404-2: “mid-Pliocene (3.264” to “mid-Pliocene Warm Period (mPWP – 3.264”

2404-16: “Antarctic” to “Antarctica”

2404-17: “and Greenland have” to “and Greenland were”

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2404-18: “suggested that the arid deserts decreased at” to “suggested that deserts decreased on”

2404-23: “evidences” to “evidence”

2405-11: “substantially decline” to “substantial decline”

2405-12: “an rise” to “a rise”

2405-15: “recent study” to “recent studies”

2405-16: “Pacific become” to “Pacific became”

2405-18: “condition was also though to exist in the tropical Pacific” to “conditions are thought to have existed in the tropical Pacific”

2405-19: Formatting of  $\delta^{18}O$

2405-22: “indicated a non-weaker ENSO” to “indicated similar to modern ENSO”

2405-23: “the simulation” to “the simulations”

2405-24: “(NorESM-L) (Zhang et al., 2012)” to “(NorESM-L – Zhang et al., 2012)”

2405-25: “showed a weaker” to “simulate a weaker”

2405-27: “mid-Pliocene warm climate” to “mid-Pliocene Warm Period”

2406-3/4: “coupled general circulation models (CGCMs)” to “fully coupled atmosphere-ocean general circulation models (AOGCMs)”

2406-8: “also takes part in the PlioMIP. After the hard work for development” to “submits a simulation to PlioMIP. After the development”

2406-9: “we finish the mid-Pliocene experiment designed in the PlioMIP” to “we completed PlioMIP Experiment 2 (Haywood et al., 2011) for the mid-Pliocene.”

2406-19: “The coupled climate model” to “The coupled AOGCM”

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2407-20: "for the PMIP3" to "for PMIP3"  
2407-22: "N2O, respectively" to "N2O"  
2407-24: "for the AOGCMs simulations" to "for AOGCM simulations"  
2407-25: "was described" to "were described"  
2407-28: "The altitude of topography" to "the topography"  
2408-1: "PRISM-3D dataset" to "PRISM3D dataset"  
2408-9: "Overtuning Circulation" to "Overturning Circulation"  
2408-9/10: "around the 240 model year" to "around 240 model years"  
2408-12: "several hundreds of simulations" to "several hundred simulated years"  
2408-20: "ensemble mean of 2.66°C as estimated by 8 AOGCMs in Haywood et al. (2013)" to "ensemble mean of 8 AOGCMS of 2.66°C (Haywood et al., 2013)."  
2408-23: "towards mid-high" to "towards mid to high"  
2408-24: "the ice-sheet" to "the ice-sheets"  
2409-2/3: "mean Haywood et al. (2013)." to "mean (Haywood et al., 2013)."  
2409-6: "at mid-Pliocene" to "in the mid-Pliocene"  
2409-7: "and mid-high" to "and mid to high"  
2409-12: "precipitation were" to "precipitation was"  
2409-16: "warmer at" to "warmer in the"  
2409-18: "maximum locates" to "maximums located"  
2409-21: "more pronounce" to "more pronounced"  
2409-21: "mid-latitudes of Northern" to "mid-latitudes of the Northern"

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2410-4: "simulation, which is related with the bias of inaccurate" to "simulation, a bias caused by an"  
2410-5: "the currents in North Pole that resulted in" to "currents at the North pole that results in"  
2410-6: ". By excluding" to ". Excluding"  
2410-7: "reaches the maximum in the depth between" to "reaches a maximum between"  
2410-12: "broadly follows" to "broadly follow"  
2410-13: "Ocean, Arctics" to "Ocean, Arctic"  
2410-14: "where the increased precipitation is locates," to "where increased precipitation is located"  
2410-15: "maximum locate" to "maximum located"  
2410-17: "in tropics" to "in the tropics"  
2410-21: "as that" to "as seen"  
2410-21: "Except the bias" to "Except for the Arctic bias"  
2411-4: "of AMOC" to "for AMOC"  
2411-12/13: "maximum of variation locates in" to "maximum variation is located in"  
2411-14: "35% at mid-Pliocene" to "35% in the mid-Pliocene"  
2411-16: "of the ENSO" to "in the ENSO"  
2411-25: "over the eastern" to "over eastern"  
2412-5/6: "where the warming over the land is larger than that over" to "where warming over land is larger than over the ocean"

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2412-11: “(≈7.1%)(Table 1)” to “(≈7.1% - Table 1)”  
2412-13/14: “warming is relatively larger over the land areas.” to “warming is larger over the land.”  
2412-18: “Reduction of” to “Reduction in”  
2412-22: “in mid-high” to “in mid to high”  
2412-23: “for the SST” to “for SSTs”  
2412-24: “changes of seas surface” to changes in sea surface”  
2412-25/26: “over the most parts in Atlantic” to “over most of the Atlantic”  
2412-27: “that leads to a weaker” to “causing a weaker”  
2413-10/11: “the underestimated of SST in the” to “the underestimation of SSTs in the”  
2413-12: “further studies” to “further study”  
2419-Table 1: “Molde year” to “Model year”  
2424-Fig.4 caption: “changes beyond 65” to “changes north of 65”  
2428-Fig.8 caption: “between the” to “between the”  
2428-Fig.8 caption: “changes beyond 65” to “changes north of 65”

#### References

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