

Clim. Past Discuss., referee comment RC1  
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## Comment on cp-2022-90

Anonymous Referee #1

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Referee comment on "On the climatic influence of CO<sub>2</sub> forcing in the Pliocene" by Lauren E. Burton et al., *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2022-90-RC1>, 2022

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The manuscript presented the first assessment of the relative contribution of CO<sub>2</sub> and non-CO<sub>2</sub> forcing on the warming of mid-Pliocene. The authors applied a linear factorisation method to several climate variables, i.e., surface air temperature, sea surface temperature and precipitation from seven PlioMIP2 model ensembles. The results from PlioMIP2 are consistent with several individual model results and previous PlioMIP1 results, with some differences in quantitative attributions. The energy balance analysis points out that CO<sub>2</sub> forcing dominates the changes in temperature (56% for SAT and SST) and also slightly dominates the changes in precipitation (51%) in the Pliocene climate. The assessments also highlight the regional response to CO<sub>2</sub> forcing and non-CO<sub>2</sub> forcing. The direct CO<sub>2</sub> forcing is dominant in the tropics while the different feedbacks amplified the warming in the high latitudes in particular in northern high latitudes. The larger uncertainties are also found in Northern mid-high altitudes compared with the previous PlioMIP1 assessment, which may be due to the higher climate sensitivity in CMIP6 models.

This work provided a quantitative evaluation of the drivers of Pliocene climate warming, and discussed how to use the Pliocene climate as an analogue for near future climate. They proposed some suggestions on the consideration of sensitive regions and variables to the GHG forcing, the fast and slow feedbacks in the climate system and the climate state (transient or equilibrium).

The manuscript is well-structured and well-written. I have one comment on the response of precipitation. In P15 L352, "The largest increases in precipitation are generally driven by non-CO<sub>2</sub> forcing, seen over northern Africa and the Indian subcontinent, ....", the responses in the high-latitudes may be related to the opposed feedbacks due to the changes of topography and ice-sheet. But what are the non-CO<sub>2</sub> forcing for the low latitudes? Given that most models use the prescribed vegetation. It would be good to separately discuss the precipitation response in high and low latitudes. Some discussions may need in particular for the eye-catching precipitation pattern in north Africa as shown in Fig6b and Fig1d.

Below lists a few minor questions and comments.

P3-4, Fig1, Are the CMIP6 future scenarios using the same models as those 16 models in PlioMIP2?

P3, L70, the text mention "There are also comparable spatial patterns of climate anomalies ... in the form of polar amplification", one can notice that Pliocene has polar amplification in both the Arctic and Antarctic, but SSP2-4.5 only show amplification in the Arctic but not in the Antarctic. One also can notice a dramatic difference between Pliocene and SSP2-4.5 in the precipitation over North Africa including the middle east. The reasons for these differences are mentioned in the late part of the manuscript, would be good to point out this obvious difference here when the figures are presented.

P9, L211, in equation (4), it should be  $SW \cdot (1-\alpha)$  not  $SW - (1-\alpha)$