

Clim. Past Discuss., author comment AC2  
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## Reply on AC1

Peixin Zhang et al.

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Author comment on "Low-latitude climate change linked to high-latitude glaciation during the Late Paleozoic Ice Age: evidence from the terrigenous detrital kaolinite" by Peixin Zhang et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-108-AC2>, 2021

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Detailed responses to reviewer #1's comments:

### Reviewer #1:

- The paper is well written and presents interesting results concerning past climate conditions for North China. However I identified a fundamental issue requiring clarification. Indeed the authors investigate local climate conditions **without presenting and discussing the geological setting of the area**. In the absence of data highlighting the geological evolution of this site, most of statements presented in the discussion (4.2) remain too speculative to support authors' conclusions. I encourage the authors to resubmit their article after significant rewriting of the manuscript, with a full description of the continental environment and its temporal evolution (which explains why I recommend "rejected" rather than "major revision").

**Response:** We thank the reviewer for their comments here. We added the contents about the geological background and environmental evolution of the study area in section 4.2, and we have added additional figures to demonstrate this.

The details are as follows: "Changes in continental plate position, land-sea distributions, ice extent in Gondwana, atmospheric CO<sub>2</sub> and monsoonal rainfall are considered the main factors controlling climate change in low latitudes during the LPIA (Tabor and Poulsen, 2008; Cao et al., 2017). In the study area, local paleomagnetic data demonstrate that no large-scale plate motion occurred from the early to late Early Permian (Zhu et al., 1996). Through this time interval, the region remained in an equatorial humid climate zone (Zhu et al., 1996) on the southern margin of the North China Plate (NCP) in proximity to the sea (Fig. 9). Following regression of the epicontinental sea in the earliest Permian (Fig. 9a, b), sedimentary environments gradually developed from coastal tidal flat deposition to a series of shallow-water delta sedimentary systems comprising fluvial and tidally influenced offshore peat-bearing deposits (Zhu et al., 1996; Yang and Lei, 1987; Fig. 9). Fossil plants were widespread and abundant, comprising stable, tropical, ever-wet communities dominated by lycophytes, equisetophytes, marattialean ferns and pteridosperms (Zhu et al. 1996; Yang and Lei, 1987; Yang, 2006; Hilton and Cleal, 2007). Collectively, this

information builds a picture of stability in continental plate position and land-sea distributions. The sedimentary record provides no evidence of monsoons. Consequently, we consider that waxing and waning of ice sheets in high latitude Gondwana and changes in global atmospheric CO<sub>2</sub> were the main factors affecting climate change in the study area through the LPIA.”

**[Please see pdf for revised figure]**

**Figure 9.** Lithofacies palaeogeography map from late Bashkirian to Wordian in the North China Plate (modified from Shao et al., 2014).

We collected palaeomagnetic data from the Dafengkou section in Yuzhou coalfield from early to late Early Permian. These data show that from the early to late Early Permian, the paleolatitude change in the study area is between 11.0°N and 11.4°N, that is, it is within the equatorial humid climate zone (Zhu et al., 1996).

Table 1 Permian ancient geomagnetic parameters and latitude in Dafengkou section

Period	sampling point	mean direction of magnetization	$\alpha_{95}$	stability valuation	Paleomagnetic pole position	Paleolatitude position
D (°)	I (°)	K (°)	Plat.(°N)	Plong.(°N)	Dp	Dm
P <sub>2</sub> <sup>1</sup>	6	143.2	-21.2	12.9	19.4	R
P <sub>1</sub> <sup>1</sup>	3	124.9	-22.0	82.1	13.7	R
P <sub>1</sub>	9	136.9	-21.7	16.1	13.2	

**[Please see pdf for revised figure]**

**Figure 11.** Comparison of climate change, glaciations,  $d^{18}O$ , and  $pCO_2$  records from the Gzhelian Stage of the Carboniferous to the Roadian Stage of the Permian. Age stratigraphic framework from Shen et al. (2019); **a**, Climate stages interpreted from the studied section; **b**, Interpreted climatic records with blue representing intervals of climate cooling while yellow represents climatic warming based on fluctuating climate signals from kaolinite content from the studied section, and climate type interpreted from the studied section. **c**, Records of glaciation events in Australia from Fielding et al. (2008), Frank et al. (2015), and Garbelli et al. (2019); **d**, Oxygen isotope values from Korte et al. (2005) and Grossman et al. (2008); **e**, Global  $pCO_2$  concentration from Montañez et al. (2007), Foster et al. (2017) and Richey et al. (2020). Note: the red line from Foster et al. (2017), the black line comes from Richey et al. (2020). Abbreviations: Gzh. = Gzhelian; Sak. = Sakmarian; Cli. S. = Climate stage; Clim. type = Climate type; 2<sub>1</sub># = Coal 2<sub>1</sub> seam; Temp. = Temperature.

#### References:

- Cao, W., Williams, S., Flament, N., Zahirovic, S., Scotese, C. and Muller, R. D.: Palaeolatitudinal distribution of lithologic indicators of climate in a palaeogeographic framework, *Geol. Mag.*, 156(2), 331–354, doi:10.1017/S0016756818000110, 2019.
- Cecil, C. B., Dulong, F. T., West, R. R., Stamm, R., Wardlaw, B. and Edgar, N. T.: Climate controls on the stratigraphy of a Middle Pennsylvanian cyclothem in North America, in *Climate Controls on Stratigraphy*, pp. 151–180, SEPM (Society for Sedimentary Geology), 2003.
- Clapham, M. E. and James, N. P.: Paleocology Of Early-Middle Permian Marine Communities In Eastern Australia: Response To Global Climate Change In the Aftermath Of the Late Paleozoic Ice Age, *Palaios*, 23(11), 738–750, doi:10.2110/palo.2008.p08-022r, 2008.
- Frank, T. D., Shultis, A. I. and Fielding, C. R.: Acme and demise of the late Palaeozoic ice age: A view from the southeastern margin of Gondwana, *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 418, 176–192, doi:10.1016/j.palaeo.2014.11.016, 2015.
- Koch, J. T. and Frank, T. D.: The Pennsylvanian-Permian transition in the low-latitude carbonate record and the onset of major Gondwanan glaciation, *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 308(3–4), 362–372, doi:10.1016/j.palaeo.2011.05.041, 2011.
- Lowry, D. P., Poulsen, C. J., Horton, D. E., Torsvik, T. H. and Pollard, D.: Thresholds for Paleozoic ice sheet initiation, *Geology*, 42(7), 627–630, 2014.
- Montañez, I. P. and Poulsen, C. J.: The Late Paleozoic Ice Age: An Evolving Paradigm, *Annu. Rev. Earth Planet. Sci.*, 41(1), 629–656, doi:10.1146/annurev.earth.031208.100118, 2013.
- Montañez, I. P., Tabor, N. J., Niemeier, D., DiMichele, W. A., Frank, T. D., Fielding, C. R., Isbell, J. L., Birgenheier, L. P. and Rygel, M. C.: CO<sub>2</sub>-Forced Climate and Vegetation Instability During Late Paleozoic Deglaciation, *Science* (80-. ), 315(5808), 87–91, doi:10.1126/science.1134207, 2007.

Poulsen, C. J., Pollard, D., Montañez, I. P. and Rowley, D.: Late Paleozoic tropical climate response to Gondwanan deglaciation, *Geology*, 35(9), 771–774, doi:10.1130/G23841A.1, 2007.

Powell, M. G.: Latitudinal diversity gradients for brachiopod genera during late Palaeozoic time: links between climate, biogeography and evolutionary rates, *Glob. Ecol. Biogeogr.*, 16(4), 519–528, doi:10.1111/j.1466-8238.2007.00300.x, 2007.

Richey, J. D., Montañez, I. P., Goddérís, Y., Looy, C. V, Griffis, N. P. and DiMichele, W. A.: Influence of temporally varying weatherability on CO<sub>2</sub>-climate coupling and ecosystem change in the late Paleozoic, *Clim. Past*, 16(5), 1759–1775, doi:10.5194/cp-16-1759-2020, 2020.

Roy, D. K. and Roser, B. P.: Climatic control on the composition of Carboniferous-Permian Gondwana sediments, Khalaspir basin, Bangladesh. *Gondwana Res.*, 23, 1163–1171. doi: 10.1016/j.gr.2012.07.006, 2013.

Stemmerik, L.: Influence of late Paleozoic Gondwana glaciations on the depositional evolution of the northern Pangean shelf, North Greenland, Svalbard, and the Barents Sea, *Resolv. Late Paleoz. Ice Age Time Sp.*, 441, 205, 2008.

Tabor, N. J. and Poulsen, C. J.: Palaeoclimate across the Late Pennsylvanian-Early Permian tropical palaeolatitudes: A review of climate indicators, their distribution, and relation to palaeophysiographic climate factors, *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 268(3–4), 293–310, doi:10.1016/j.palaeo.2008.03.052, 2008.

Waterhouse, J. B. and Shi, G. R.: Evolution in a cold climate, *Palaeogeogr. Palaeoclimatol. Palaeoecol.*, 298(1–2), 17–30, doi:10.1016/j.palaeo.2010.08.022, 2010.

Yang, G.: The Permian cathaysian flora in western Henan province, China-Yuzhou flora., 1–76, 2006.

Yang, Q. and Lei, S.: Depositional Environments and Coal-forming Characteristics of Late Palaeozoic Coal Measures in Yuxian, Henan Province., 1987.

Zhu, H., Yang, G. and Sheng, A. X.: A study on palaeomagnetism of Permian strata in the Dafengkou section, Yuzhou, Henan Province, *Acta Geol. Sin.*, 70(2), 121–128, 1996.