

**Heavy Water Isotope Precipitation in inland East Antarctica  
Accompanied by Strong Southern Westerly Winds during the Last  
Glacial Maximum**

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## Introduction

This supporting information provides the following:

(i) Text S1:

The method to integrate every experiment is described.

(ii) Figure S1:

Sea surface boundary conditions used in this study are shown.

(iii) Figure S2 and S3:

Global evaluation results.

(iv) Figure S4:

LGM minus PI anomalies in annual zonal mean climatologies. Air temperature (shades), zonal wind (green contours; m/s), and meridional vapor flux (gray contours; g/kg•m/s) are shown as in the model vertical coordination (from 0 to 1 represented from the top to the bottom of the atmosphere).

(v) Figure S5:

Anomalies between our different LGM simulations in annual mean evaporation, induced by SST and sea ice replacements, are shown.

(vi) Figure S6:

Anomalies for LGM\_G minus LGM\_M simulations in annual mean  $\Delta\delta^{18}\text{O}_{\text{pa}}$ ,  $\Delta\delta^{18}\text{O}_{\text{p}}$ , and SAT, induced by SST and sea ice replacements, are shown. W

(vii) Figure S7:

Anomalies between our different LGM simulations in annual mean precipitable water, induced by SST and sea ice replacements, are shown.

(viii) Table S1:

Experimental settings are summarized. For further description, see Section 2.2.

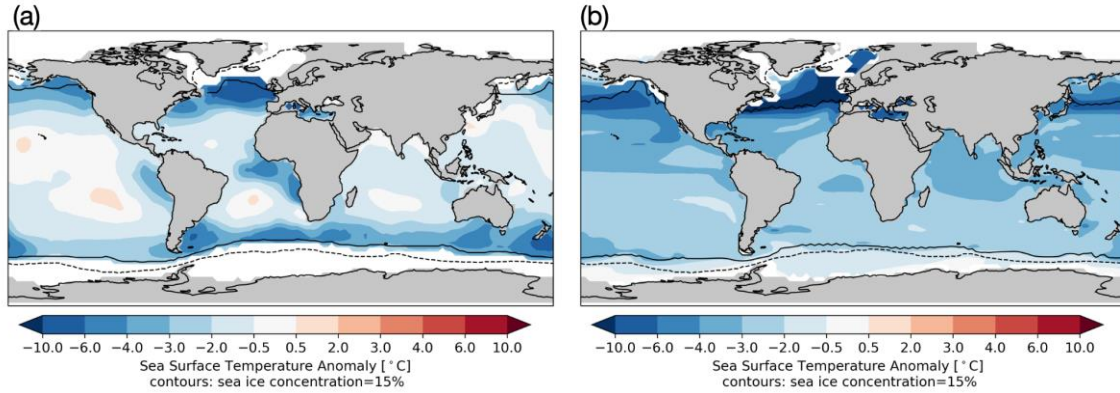


**Text S1.**

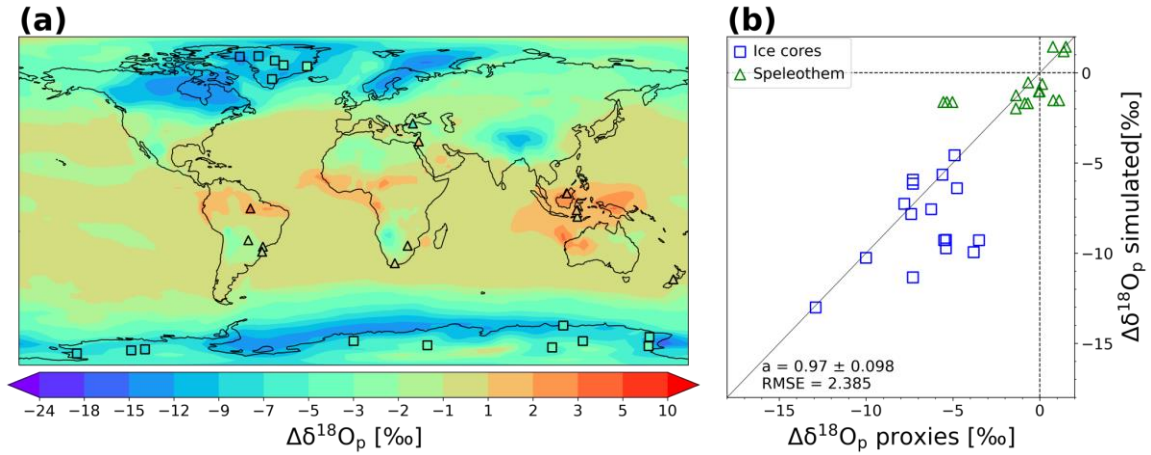
For GLOMAP, the provided horizontal grid was converted to T42, according to the MIROC grid manner. The ocean grids sandwiched between the sea ice and the ice sheets were regarded as sea ice.

For MIROC, monthly climatologies for SST and sea ice averaging the last 100 years in the quasi-equilibrium state were used. The monthly climatology in the pre-industrial simulation provided by Sherriff-Tadano et al. (submitted) was subtracted for SST to remove the model biases. Obtained anomalous SST and SST used in the PI experiment were added and applied in this study.

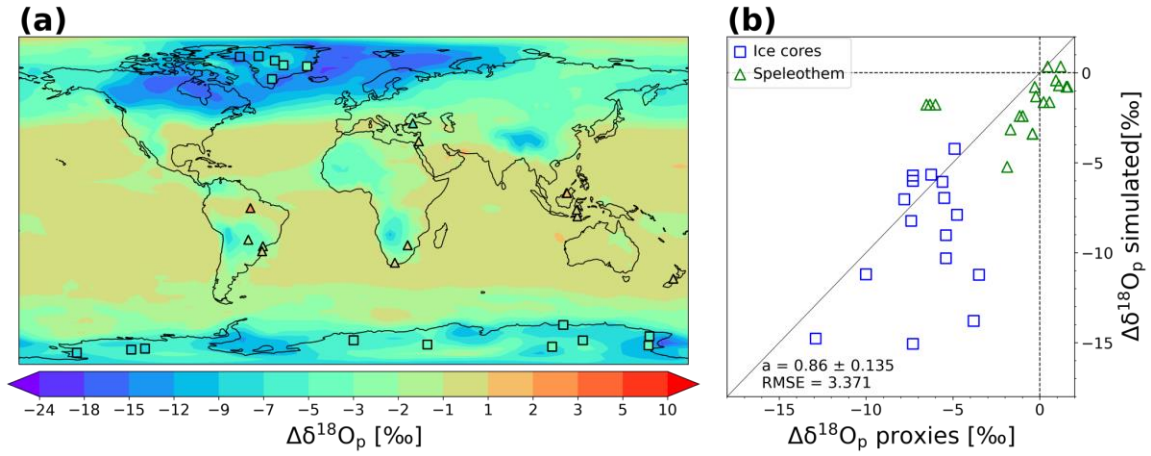
PI was integrated after the 1980 CE by Kino et al. (2021) until reaching quasi-equilibrium states of the global mean temperature and mean  $\delta^{18}\text{O}_p$ . Then We used the other 30 years for analyses. LGM experiments were integrated after PI in the quasi-equilibrium state. Boundary conditions were changed step-by-step to avoid initial numerical instability. Firstly, LGM\_M and LGM\_G were integrated only with GHG, SST, and sea ice in the respective LGM conditions. After reaching the quasi-equilibrium state, the ice sheet distributions were replaced with GLAC-1D reconstruction. After additional integration and the simulations reached quasi-equilibrium states again, their land-sea masks and  $\delta^{18}\text{O}_{sw}$  were changed to the LGM conditions; finally, the simulations were in the entire conditions. After additional integration and the simulations reached quasi-equilibrium states again, the other 30 years were used for analyses. LGM\_Mw/Gice, the sensitivity experiment, was extended after LGM\_M with the sea ice in the southern hemisphere to be the same as LGM\_G. It was integrated to reach a quasi-equilibrium state of the global mean temperature and  $\delta^{18}\text{O}_p$ . Then the other 30 years were used for analyses.



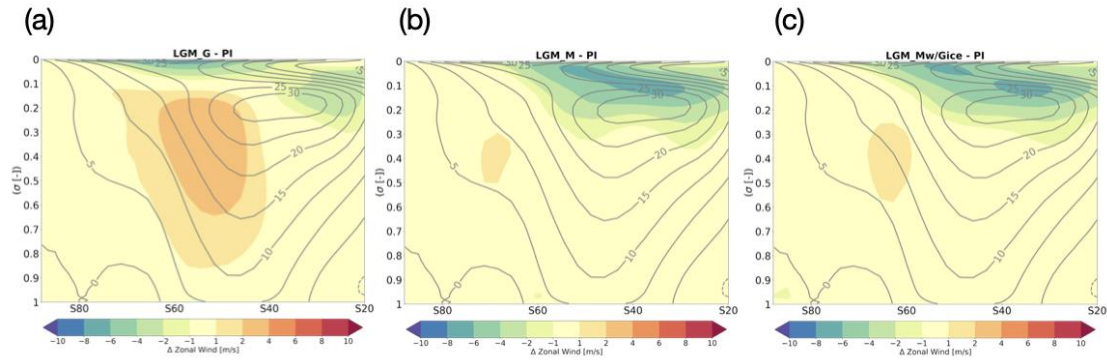
**Figure S1. (a)** Differences in sea surface boundary conditions between LGM\_G (GLOMAP; Paul et al., 2021) and PI (AMIP2; Taylor et al., 2000; averaged over the period 1870 to 1899). Shades are the annual mean sea surface temperature anomaly (LGM\_G minus PI). Sea ice in 15 % concentrations is shown as black lines in solid (LGM\_G) and dashed (PI) respectively. **(b)** Same as **(a)** but for LGM\_M (Sherriff-Tadano et al., ).



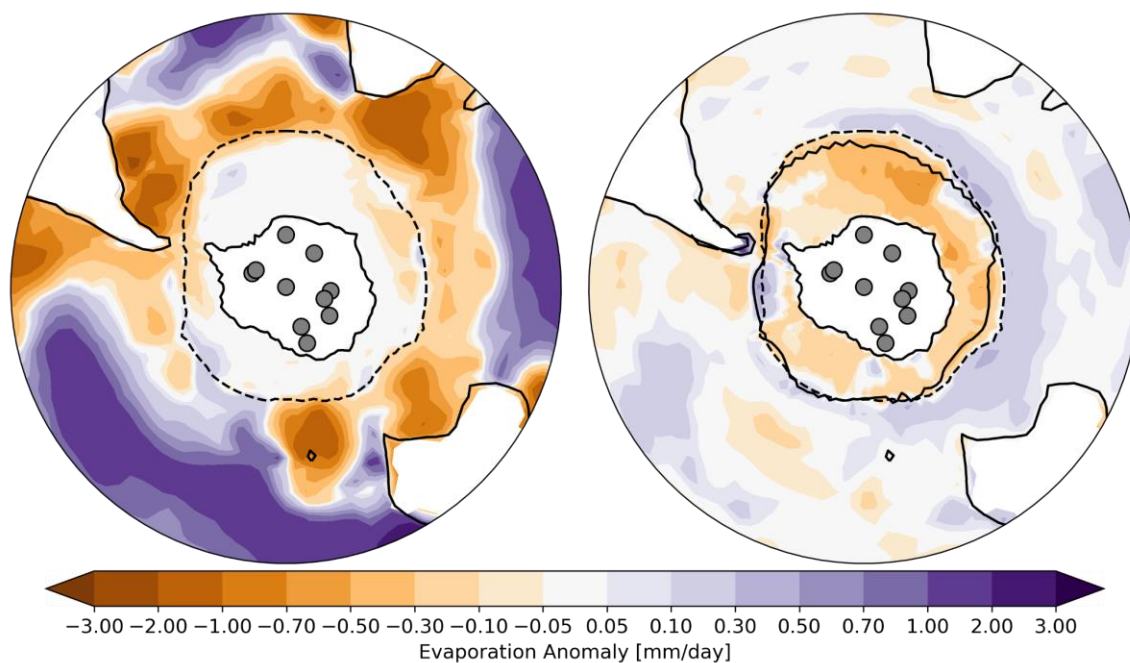
**Figure S2.** Annual  $\Delta\delta^{18}\text{O}_{p,w}$  for LGM\_G minus PI. For **(a)**,  $\Delta\delta^{18}\text{O}_{p,w}$  are shown as shades; the proxy data consist of ice core records (squares) and speleothem records (triangles). For **(b)**,  $\Delta\delta^{18}\text{O}_{p,w}$  of simulated vs. proxies at the different sites of speleothem (green triangles) and ice core (blue squares) locations; the gradient of the linear regression fit ( $a$ ) and the value of root mean square error (RMSE) are shown.



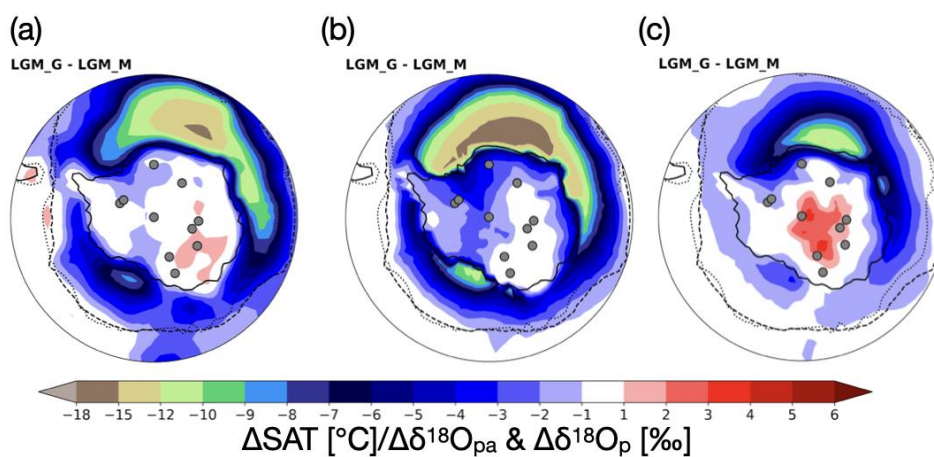
**Figure S3.** Same as Figure S2, but for LGM\_M.



**Figure S4.** Differences in annual mean zonal wind (shades; m/s) in the model vertical coordinates (values of 0 and 1 represent the top of the atmosphere and the surface). (a) LGM\_G minus PI, (b) LGM\_M minus PI, and (c) LGM\_Mw/Gice minus PI. For (a-c), absolute values in PI are also shown as gray contours.

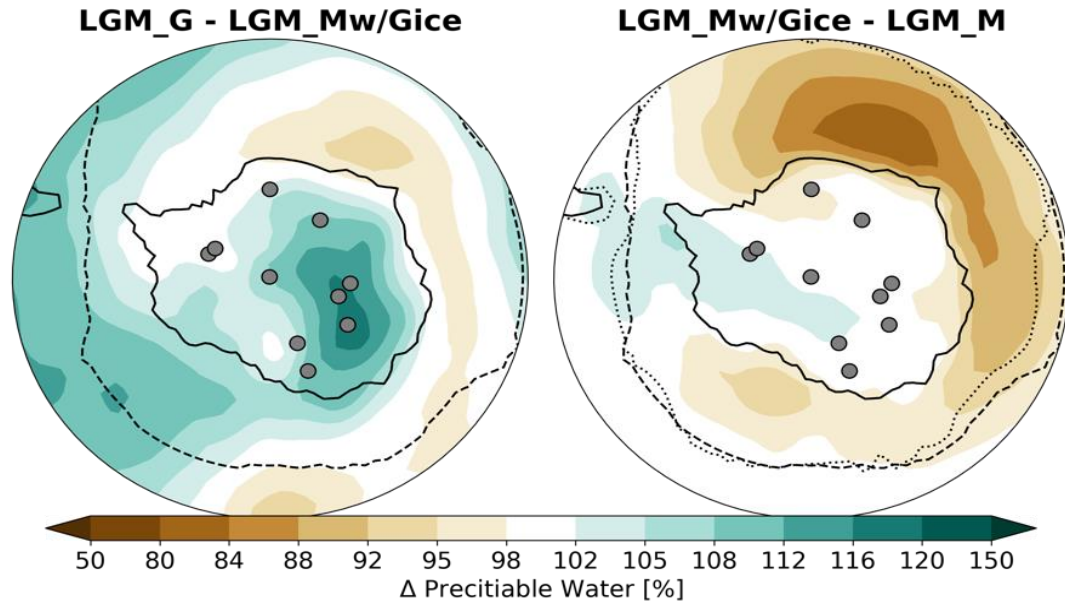


**Figure S5.** Differences in annual mean climatological evaporation for **(a)** LGM\_G minus LGM\_Mw/Gice and **(b)** LGM\_w/Gice minus LGM\_M. Antarctic ice core sites listed on Table S1 are shown as gray circles; sea ice 15 % concentration lines are shown as solid (MIROC) and dashed (GLOMAP) lines.



**Figure S6.** Same as Figures 2a-c, but for LGM\_G minus LGM\_M.





**Figure S7.** Same as Figure S5, but for precipitable water.

**Table S1.** Experimental designs (see Section 2.2 and Text S1 in detail). In every experiment, Hist, PI, and LGM represent boundary conditions for MIROC5 (Watanabe et al., 2010), the pre-industrial, and the last glacial maximum, respectively. NH and SH indicate the northern and southern hemispheres. M and G denote the sea ice boundary conditions provided by MIROC4m (Sherriff-Tadano et al., accepted) and GLOMAP (Paul et al., 2021).

Experimental name	Greenhouse gases & orbital parameters	Land surfaces		Ocean surfaces			
		Ice sheets & land-sea mask	others	SST	SIC in NH	SIC in SH	$\delta^{18}\text{O}_{\text{sw}}$ [‰]
PI	PI	PI	Hist	PI	PI	PI	0
LGM_G	LGM	LGM	Hist	G	G	G	+1
LGM_M	LGM	LGM	Hist	M	M	M	+1
LGM_Mw/Gice	LGM	LGM	Hist	M	M	G	+1