

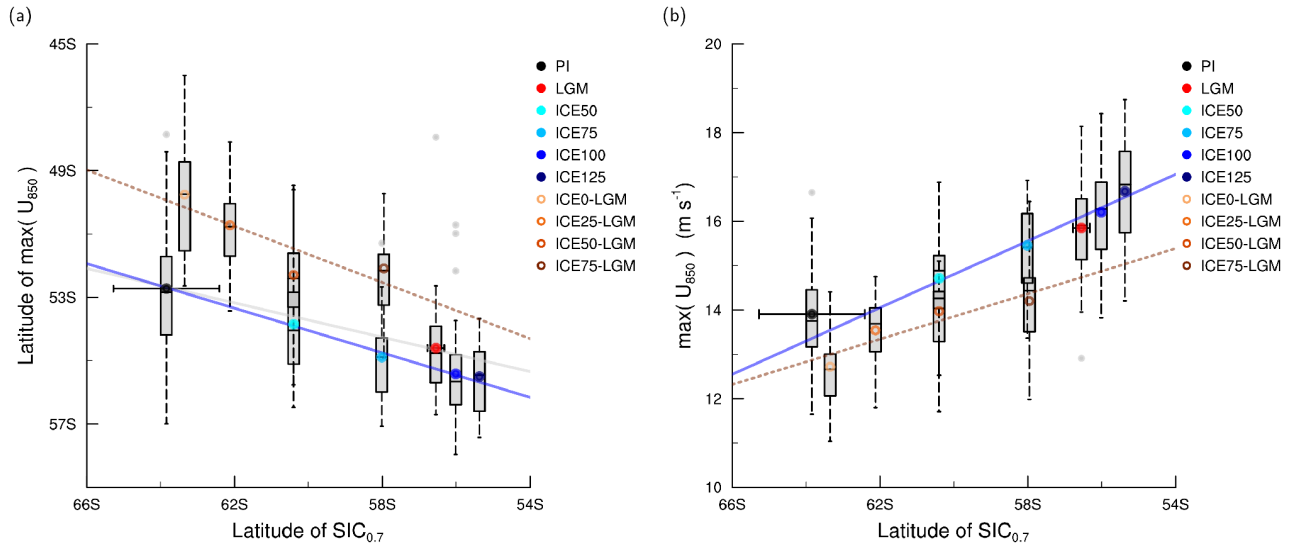


**Figure R1.** (a) Latitude and (b) strength of the maximum JJA zonal-mean zonal wind at 850 hPa against the JJA zonal-mean sea-ice edge latitude (sea-ice concentration 0.7). Panel (a) is Fig. 10 of the submitted manuscript with the new LGM-background experiments added. Filled circles: coupled PI (black) and LGM (red) simulations (model years 201–250) and the atmosphere-only experiments in the PI background (ICE50–ICE125, blue shades; PI SSTs; years 1–50). Open circles: atmosphere-only experiments in the LGM background (ICE0-LGM to ICE75-LGM, orange to brown; SST, greenhouse gases, ice-sheet topography and orbital parameters of the coupled LGM simulation; years 6–30). Circles are experiment means; boxes show the interquartile range and median of the annual values, whiskers extend to 1.5 times the interquartile range, and grey dots are outliers. Horizontal bars on the coupled simulations show  $\pm 1$  standard deviation of the ice-edge latitude. In (a), lines are fits to the coupled PI and LGM simulations (grey), to the coupled PI and the PI-background experiments (blue;  $-0.35^\circ$  per degree, as in the submitted Fig. 10) and to the LGM-background experiments (dashed brown;  $-0.44^\circ$  per degree, 95 % confidence interval  $[-0.62, -0.27]$ ). In (b), lines are fits to the means of the PI-background experiments (blue;  $+0.38 m s^{-1}$  per degree) and of the LGM-background experiments (dashed brown;  $+0.26 m s^{-1}$  per degree).

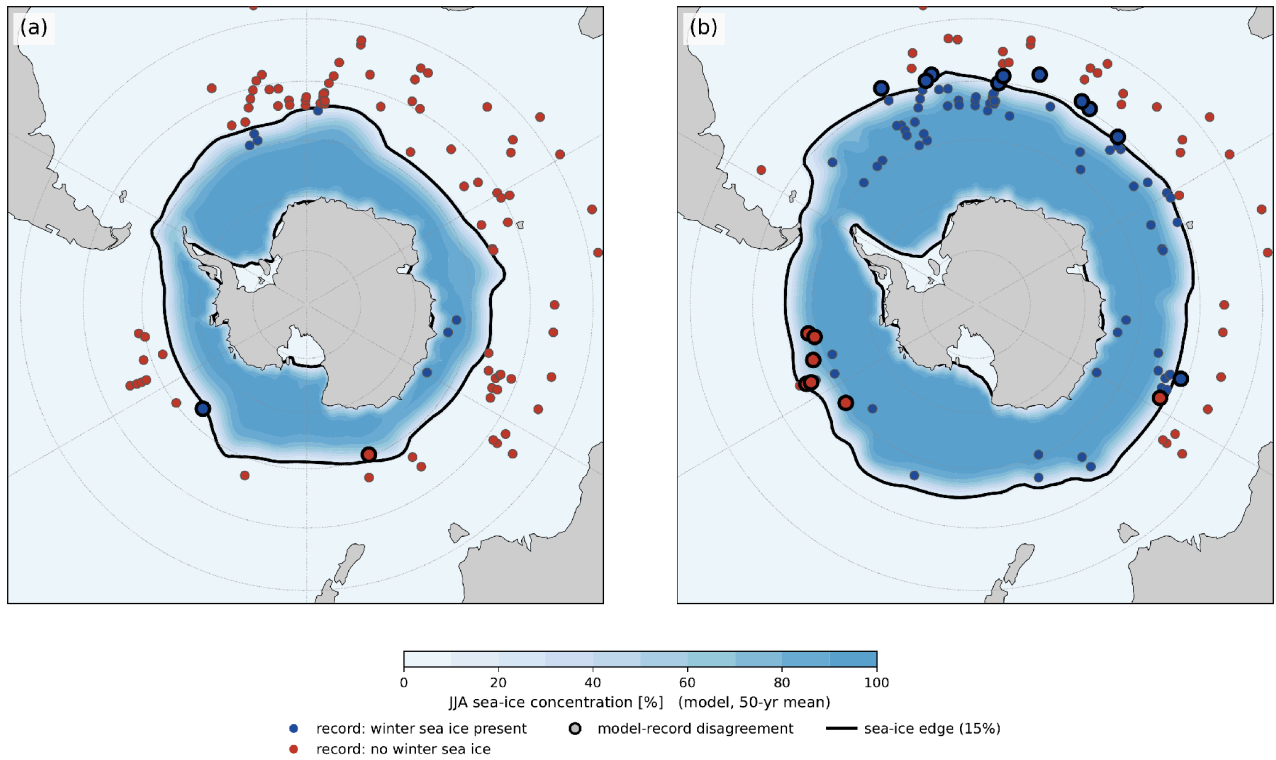


**Figure R2.** JJA sea-ice concentration (shading) and the sea-ice edge (15%; black line) in the coupled (a) PI and (b) LGM simulations. Circles show winter sea-ice presence (blue) or absence (red) at the sites compiled by Gersonde et al. (2005). Panel (a) uses modern September sea-ice concentration at the core sites, classified at 15%; panel (b) uses reconstructed LGM winter sea-ice presence. Thus, the PI comparison pairs modeled JJA conditions with a modern September reference. Model values are bilinearly interpolated to each site and classified at 15%. Larger circles indicate disagreement. Agreement is 90/92 sites (97.8%) for PI and 101/118 sites (85.6%) for LGM.