Poleward shift in the Southern Hemisphere westerlies synchronous with the deglacial CO_2 rise

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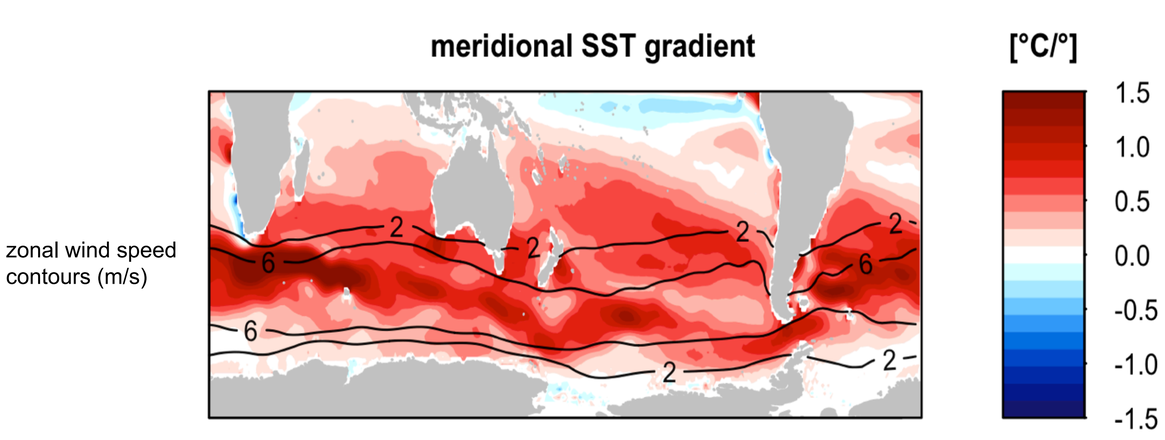
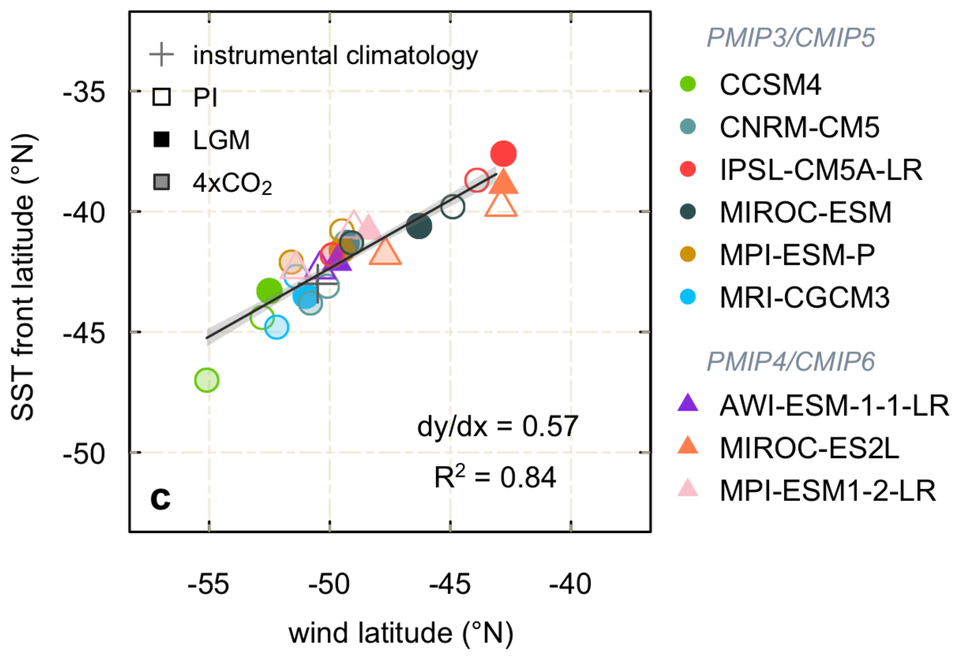
Summary: Past changes in southern westerlies are poorly constrained. Here we reconstruct the latitude of peak surface westerlies over the last deglaciation using a good SST proxy ($d^{18}O$ of calcite in planktic foraminifera) and a multi-model relationship between SST gradient and winds. The reconstructed poleward shift of westerlies mirrors the rise in atmospheric CO_2. Model experiments further show that an equatorward shift of winds can slowdown deep-ocean overturning and increase ocean carbon storage. The findings back the hypothesis of a tight coupling between southern westerlies and climate.

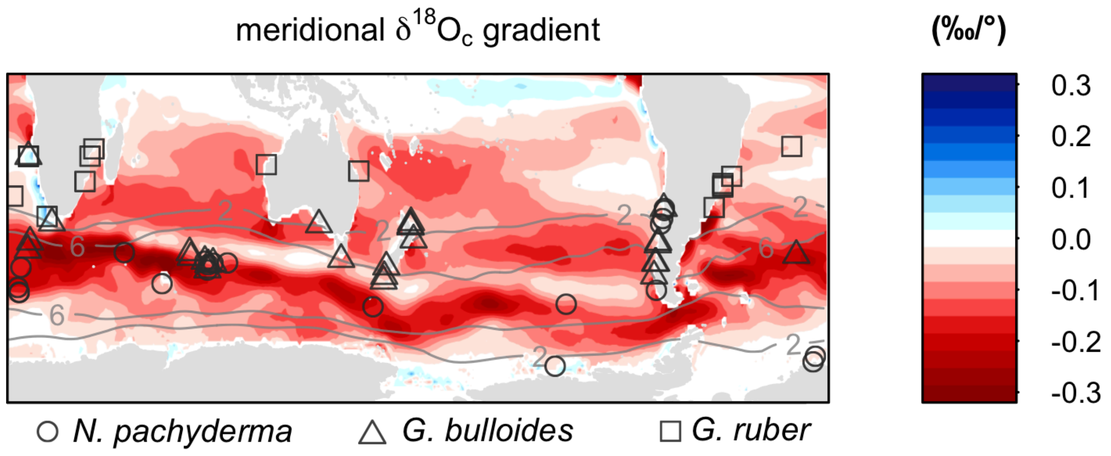
Two-way coupling between mid-latitude meridional SST gradient and westerly winds at the hemispheric scale.



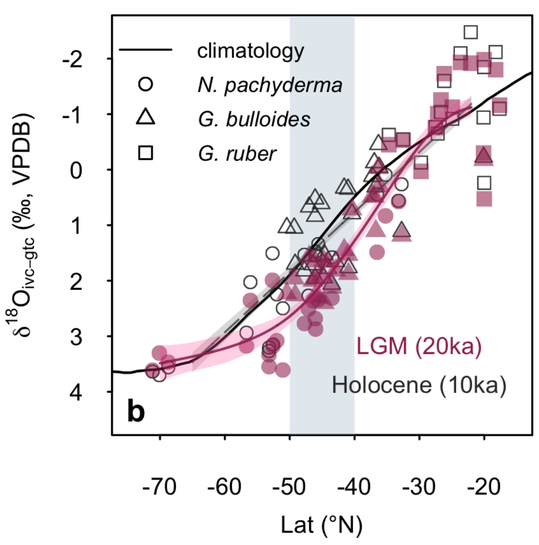
Emergent relationship between SST front latitude and wind latitude in PMIP/CMIP ensemble:

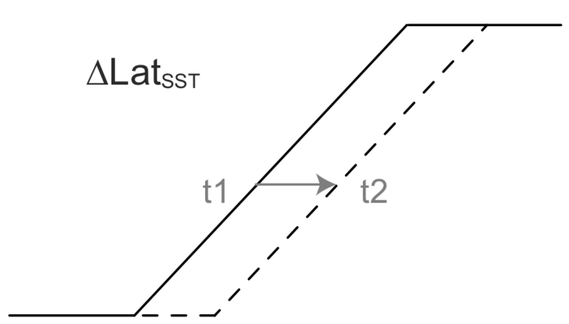


SST dominates the pattern of $d^{18}O_{calcite}$. We can use meridional profiles of $d^{18}O_{calcite}$ to locate the SST front.



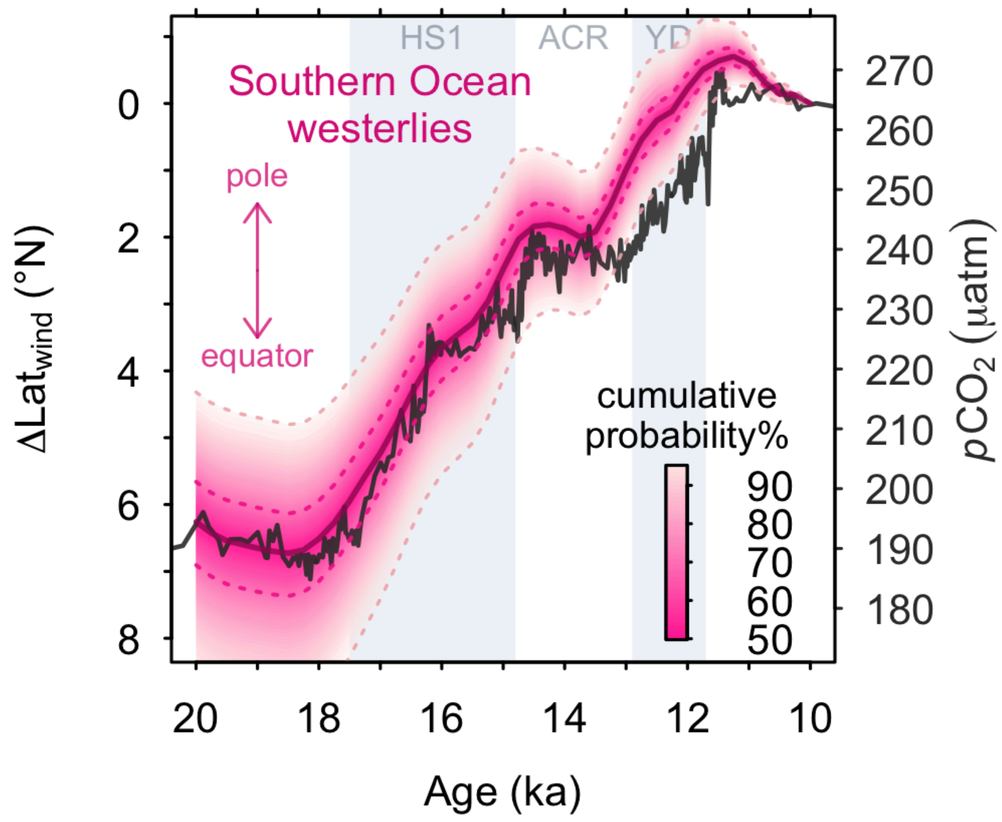
Basin wide compilation of planktic foraminiferal $d^{18}O$: 64 records spanning the last deglaciation.





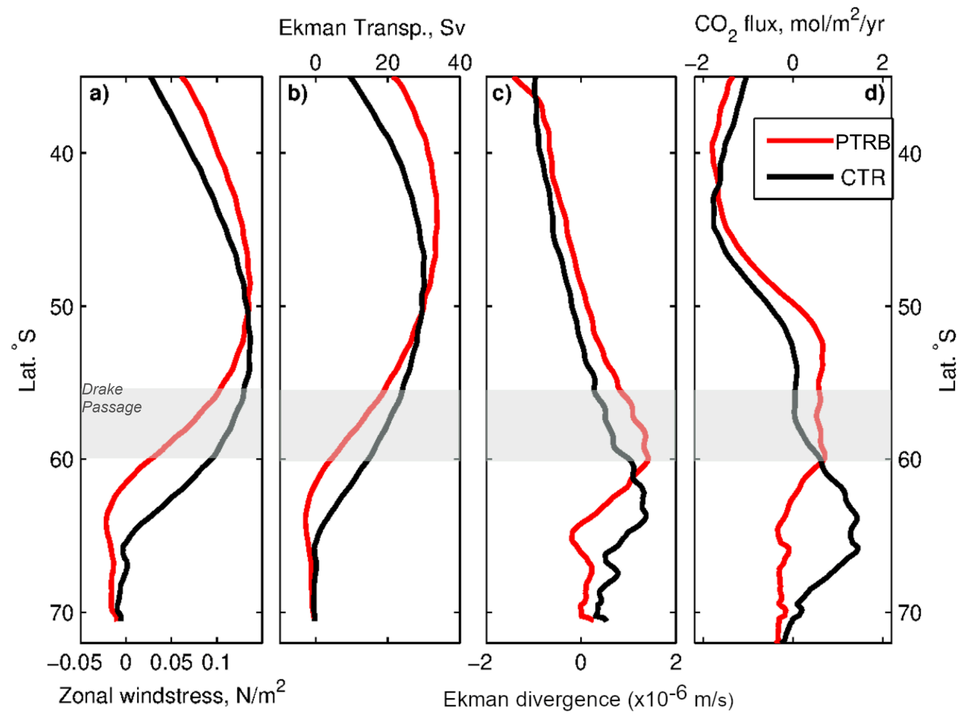
ΔLat_{SST} – shift that minimises area between curves at different time steps

LGM westerlies were 5±2° (95% CI) equatorward of their mid-Holocene position. Poleward shift over deglaciation mirrors the rise in atmospheric CO_2 (R^2=0.95).



Apparent lead of winds over CO_2 of ~300 years. Did the wind shift play a driving role in the deglacial CO_2 rise?

MOM5-SIS-WOMBAT ¼ degree model experiments:



Wind shift causes slowdown of overturning circulation below 2 km and increased oceanic carbon storage.