

Poleward shift in the Southern Hemisphere westerly winds synchronous with the deglacial rise in CO₂

WILLIAM R GRAY¹, CASIMIR DELAVERGNE², ROBERT CJ WILLS³, LAURIE MENVIEL⁴, PAUL SPENCE⁵, MARK HOLZER⁶, MASA KAGEYAMA¹ AND ELISABETH MICHEL⁷

¹Laboratoire des Sciences du Climat et de l'Environnement (LSCE/IPSL)

²LOCEAN Laboratory, Sorbonne Université-CNRS-IRD-MNHN

³Department of Atmospheric Sciences, University of Washington

⁴Climate Change Research Centre, University of New South Wales

⁵School of Geosciences, University of Sydney

⁶School of Mathematics and Statistics, University of New South Wales

⁷Laboratoire des Sciences du Climat et de l'Environnement (LSCE/IPSL), Gif-sur-Yvette

Presenting Author: william.gray@lsce.ipsl.fr

The Southern Hemisphere westerly winds influence deep-ocean overturning and carbon storage. While the westerly winds are hypothesised to play a key role in regulating atmospheric CO₂ over glacial-interglacial cycles, past changes in their position remain poorly constrained. Here, we use a compilation of planktic foraminiferal $\delta^{18}\text{O}$ from across the Southern Ocean and an ensemble of climate models to track changes in the latitude of the westerly winds over the last deglaciation. We find a $5\pm 2^\circ$ (95% CI) equatorward shift in the westerlies during the Last Glacial Maximum (~20,000 years ago) relative to the mid-Holocene (~6,000 years ago). Our reconstruction shows that the poleward shift in the westerlies over the deglaciation closely mirrors the rise in atmospheric CO₂. Using an eddy permitting ocean-sea-ice-carbon model we show that an equatorward shift in the westerlies substantially reduces the upwelling of deepwaters, leading to a suppression of CO₂ outgassing from the Southern Ocean. Our results indicate a key role for the westerly winds in driving the deglacial rise in atmospheric CO₂ and suggest that enhanced CO₂ outgassing from the Southern Ocean is likely to act as a positive feedback as the westerlies shift poleward due to anthropogenic warming.