Meridional migration of the Antarctic Circumpolar Current over the last glacial cycle

XUYUAN ELLEN AI1,2, LENA M THÖLE3,4, ALEXANDRA AUDERSET1, MAREIKE SCHMITT1, SIMONE MORETTI1, ANJA S STUDER5, ELISABETH MICHEL6, MARTIN WEGMANN3, ALAIN MAZAUD7, PETER K BIJL4, DANIEL M. SIGMAN2, ALFREDO MARTINEZ-GARCIA1 AND SAMUEL L JACCARD3

1Max Planck Institute for Chemistry
2Princeton University
3University of Bern
4Utrecht University
5University of Basel
6Laboratoire des Sciences du Climat et de l’Environnement (LSCE/IPSL)
7Laboratoire des Sciences du Climat et de l’Environnement

Presenting Author: Xuyuan.ai@mpic.de

The Southern Westerly Winds (SWW) drive upwelling south of the Antarctic Polar Front that vents CO₂ to the atmosphere. During the ice ages, a northward (equatorward) shift of the Antarctic Circumpolar Current (ACC) fronts may have reduced this CO₂ venting, helping to explain the lower atmospheric CO₂ concentration of those times. However, direct evidence of frontal migration is scarce. In this study, we report biomarker-based surface layer temperature reconstructions from marine sediment cores at different latitudes in the Southern Indian Ocean across the last glacial cycle. Using a quantitative framework for the effect of the ACC fronts on meridional SST gradient, we show that the ACC was ~2° equatorward relative to its modern position during the ice ages and ~4-6° poleward than its modern position at the end of the last two glacial terminations, consistent with ACC migration playing a role in glacial-interglacial CO₂ change. Further comparison of the temporal evolution of ACC latitude with other observations posits a role for Earth’s axial tilt in the strength and latitude range of SWW-driven upwelling. This has implications for past and future atmospheric CO2 concentrations and may explain previously noted deviations in atmospheric CO₂ from a simple correlation with Antarctic climate.