Science 11 Dec 2020:

Vol. 370, Issue 6522, pp. 1348-1352

DOI: 10.1126/science.abd2115

https://science.sciencemag.org/content/370/6522/1348

Southern Ocean upwelling, Earth's obliquity, and glacial-interglacial atmospheric CO_2 change

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Abstract:

Previous studies suggest that during the late Pleistocene ice ages, surface-deep exchange was somehow weakened in the Southern Ocean's Antarctic Zone, which reduced the leakage of deeply sequestered carbon dioxide and thus contributing to the lower atmospheric carbon dioxide levels of the ice ages. Here, high-resolution diatom-bound nitrogen isotope measurements from the Indian sector of the Antarctic Zone reveal three modes of change in Southern Westerly Wind-driven upwelling, each affecting atmospheric carbon dioxide. Two modes, related to global climate and the "bipolar seesaw", have been proposed previously. The third mode – which arises from the meridional temperature gradient as affected by Earth's "obliquity" (axial tilt) - can explain the lag of atmospheric CO_2 behind climate during glacial inception and deglaciation. This obliquity-induced lag, in turn, makes carbon dioxide a delayed climate amplifier in the late Pleistocene glacial cycles.