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Atmospheric radiocarbon as a Southern Ocean wind proxy over the last 1000 years

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Measurements of radiocarbon in tree rings over the last 1000 years indicate that there was a pre-industrial latitudinal gradient of atmospheric radiocarbon of 3.9-4.5 per mail and that this gradient had temporal variability of order 6 per mil. Here we test the idea that the mean gradient as well as variability in he gradient is dominated by the strength of the winds over the Southern Ocean. This is done using an ocean model and an atmospheric transport model. The ocean model is used to derive fluxes of 12CO2 and 14CO2 at the sea surface, and these fluxes are used as a lower boundary condition for the transport model. For the mean state, strong winds in the Southern Ocean drive significant upwelling of radiocarbon-depleted Circumpolar Deep Water (CDW), leading to a net flux of 14CO2 relative to 12CO2 into the ocean. This serves to maintain a hemispheric gradient in pre-anthropogenic atmospheric delta-c14. For perturbations, increased/decreased Southern Ocean winds drive increased/decreased uptake of 14CO2 relative to 12CO2, thus increasing/decreasing the hemispheric gradient in atmospheric delta-c14. The tree ring data is interpreted to reveal a decrease in the strength of the Southern Ocean winds at the transition between the Little Ice Age and the Medieval Warm Period.