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On the control of glacial-interglacial atmospheric CO2 variations by the Southern Hemisphere westerlies

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The University of Victoria Earth System Climate Model is used to investigate the effects of changes in Southern Hemisphere Westerlies (SHW) on atmospheric CO2. It is shown that a northward shift of the SHW and a decrease of their amplitude have the same qualitative effect on deep ocean carbon storage, which increases because of a deceleration of the bottom meridional overturning circulation. A southward shift or a strengthening of the SHW has the opposite effect. However, latitudinal shifts of the SHW and changes in their amplitude are not equivalent in terms of atmospheric CO2. In particular, while doubling the SHW amplitude increases atmospheric CO2 by 36 ppm and halving reduces it by 20 ppm, the latitudinal shifts (north- or southward) have no significant impact on atmospheric CO2. These different CO2 responses are due to different dynamical responses of the upper ocean circulation which, in the case of latitudinal shifts, produce a carbon storage change opposite to the one observed for the deep ocean. In all experiments, the changes in the biological carbon pump in response to a redistribution of the nutrients by the modified oceanic circulation remain small. Ultimately, the atmospheric CO2 response depends on the control the SHW exert on both the ventilation of the deep ocean and the depth of the upper ocean pycnocline.