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The role of Antarctic Ice Shelves in Holocene CO_2 concentrations: A study using the University of Victoria Earth System Climate Model

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The University of Victoria Earth System Climate Model (version v.9) is used to investigate carbon cycle dynamics from the Last Glacial Maximum to the present, with a particular emphasis on recreating the Holocene carbon cycle from 8000 to 150 years before present (BP). Without the explicit representation of peatlands, coral reefs and land-use change, the UVic model simulation of the natural carbon cycle over the above Holocene period is characterized by a decline in the atmospheric CO_2 concentration, from 260 to around 250 ppm, in contrast to the increase from 260 to 280 ppm actually observed during this period. However, these results are highly sensitive to the configuration of land ice shelves near Antarctica, with more extensive land ice leading to deeper vertical circulation in the Southern Ocean, less Antarctic-generated bottom waters globally, and a higher atmospheric CO_2 concentration (260 ppm) at 150 yr BP. The remaining observed 20 ppm CO_2 increase was likely caused by a combination of changes in land use, ocean circulation and ocean chemistry associated with coral reef migration between 8000 and 150 yr BP. The 5-8 ppm contribution of ice shelf extent may well be an important contributor to the higher analogue CO_2 levels during the Holocene interglacial, as current data and reconstructions suggests that these ice shelves are indeed more extensive today than during many previous interglacial periods.