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Investigating the response of the climate-ice sheet system at millennial time-scale for different global warming scenarios

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A climate model of intermediate complexity (CLIMBER-2) coupled to 3D ice-sheet models for both Northern and Southern hemispheres is used to investigate the response of climate at the millennial time-scale under several global warming scenarios equivalent to an increase of the atmospheric CO2 concentration ranging from two, three, four, five and seven times the pre-industrial value (i.e.280 ppm). These values are reached by year 2140 and stabilized after that period. The climate response is mainly analyzed in terms of change in temperature, oceanic circulations and sea ice cover. Interestingly, when increasing the atmospheric CO_2 the response of the climate system appears non linear. In a narrow window around $4xCO_2$ scenario abrupt transitions occur in the AABW signal with a period of about 1.2 kyr. These millennial time-scale oscillations are not occurring before $4xCO_2$and disappear when CO_2 is increased. We show that these transitions are associated with internal oscillations of the Southern Ocean triggered by the freshwater flux coming from the destabilization of the Antarctic ice sheet. Through a series of sensitivity experiments, we also explore the range of climatic conditions and the magnitude of freshwater flux over which these oscillations can be triggered.