Abstract View

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Interhemispheric Asymmetry in the Transient Response of a Coupled Ocean–Atmosphere Model to a CO_2 Forcing

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ABSTRACT

Numerical experiments are carried out using a general circulation model of a coupled ocean-atmosphere system with idealized geography, exploring the transient response of climate to a rapid increase of atmospheric carbon dioxide. The computational domain of the model is bounded by meridians 120 degrees apart, and includes two hemispheres. The ratio of land to sea at each latitude corresponds to the actual land-sea ratio for the present geography of the Earth. At the latitude of the Drake Passage the entire sector is occupied by ocean.

In the equivalent of the Northern Hemisphere the ocean delays the climate response to increased atmospheric carbon dioxide. The delay is of the order of several decades, a result corresponding to previous modeling studies. At high latitudes of the equivalent of the ocean-covered Southern Hemisphere, on the other hand, there is no warming at the sea surface, and even a slight cooling over the 50-year duration of the experiment. Two main factors appear to be involved. One is the very large ratio of ocean to land in the Southern Hemisphere. The other factor is the very deep penetration of a meridional overturning associated with the equatorward Ekman transport under the Southern Hemisphere westerlies. The deep cell delays the response to carbon-dioxide warming by upwelling unmodified waters from great depth. This deep cell disappears when the Drake Passage is removed from the model.