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CLIMATE RESPONSE TO FRESHWATER FORCING IN THE SOUTHERN OCEAN

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We discuss the response of the coupled climate system to freshwater forcing in the Southern Ocean using a coupled ocean-atmosphere-ice model which requires no flux adjustments to maintain a stable climate. This explores in a crude way the types of responses that might be expected from a large scale melting of Antarctic ice.

We instantaneously freshened the surface ocean layers around Antarctica, and examined the climate response over the subsequent decade. Widespread surface cooling of 1-2 degrees ensued throughout the southern mid-high latitudes, accompanied by northward advance of sea-ice. Warming occurred in the deep ocean. These effects are caused by increased stratification. In the Northern Hemisphere the response was more local, with changes in surface temperature and pressure indicative of a negative shift in the North Atlantic Oscillation.

Further experiments examined the sensitivity of these responses to the size and location of the freshwater anomaly, the season and climate state when the anomaly is applied. A continuous rather than instantaneous freshwater forcing was applied. The Southern Hemisphere cooling increases with the magnitude of the freshwater forcing, while the Northern Hemisphere response is largely independent of any changes to the initial forcing. In a century-long simulation, surface temperatures return to normal after 20-30 years, while the deep ocean remains anomalously warm.

Atmosphere-only experiments have been conducted to isolate the mechanisms behind the initial response. Forcing the atmosphere with the observed sea surface temperature anomalies from the coupled experiments suggests that the Southern Hemisphere response is driven by the ocean, while the Northern Hemisphere response is effected by the atmosphere. The results and implications of these experiments will be discussed.