Southern freshwater impacts and global ocean circulation

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The sensitivity of the ocean circulation to changes in North Atlantic surface fluxes has become a major factor in explaining climate variability. The role of the freshwater impacts in the Southern Ocean (SO) on the global ocean thermohaline circulation (THC) has received much less attention than such impacts in the northern North Atlantic. Such a research bias limits the development of a complete understanding of decadal to millennial time-scale climate change. Our numerical experiments show that some additional freshwater at the sea surface in the SO can dramatically change the southern deepwater source and substantially alter the THC pattern. Additional analyses indicate that the Southern Hemisphere led the Northern Hemisphere changes in some of the glacial cycles of Pleistocene, implying a seesaw-type oscillation of the global ocean conveyor. The potential for melting of sea ice and ice sheets in the Antarctica associated with global warming can cause a further slowdown of the southern deepwater source. We present the results of systematic model simulation targeting the ocean circulation response to changes in surface salinity in the high latitudes of both Northern and Southern Hemispheres. We demonstrate that meltwater impacts in one hemisphere may lead to a strengthening of the thermohaline conveyor driven by the source in the opposite hemisphere. This, in turn, leads to significant changes in poleward heat transport. Further, we show that THC restructuring can lead to deep-sea warming translating to thermal expansion of abyssal water, and thus causing a substantial sea level change even without a major ice sheet melting.

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