Global Climate Impacts of Greenland and Antarctic Glacial Melt: A Comparative Study

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The continental glaciers of Antarctica and Greenland have lost ice mass from iceberg calving and basal melting at an accelerating rate over recent decades. Rapidly increased ice losses of these two glaciers have the large-scale climate impacts, most of which are hemispheric asymmetry due to different feedback processes and mechanisms. In this study, we undertake a series of meltwater perturbation experiments using a fully coupled climate system model to quantitatively compare the global impacts of Greenland and Antarctic melting. The Atlantic meridional overturning circulation, that has a long-term control on the ocean meridional heat transport and temperature distribution, shows a pronounced decline due to Greenland melting and a slightly intensifying due to Antarctic melting. In the ocean, with the enhanced stratification due to meltwater injection from the two polar regions, overturning cells experience a slowdown, but subsurface temperature has opposite changes in sign between an anomalous cooling to the north and an anomalous warming to the south. The global average atmospheric variations, including surface cooling, sea ice growth and circulation changes, are dominated by Antarctic melting. Based on the analyses of ``climate response functions'' and linear convolution projection, the global atmospheric response to Antarctic melting in the 21st century is projected to be at least an order of magnitude greater than that to Greenland melting.