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Antarctic Peninsula warming triggers enhanced basal melt rates throughout West Antarctica

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The acceleration of ice-shelf basal melt rates throughout West Antarctica, as well as their potential to destabilize the ice sheets they buttress, is well documented. Yet, the mechanisms that determine both trends and variability of these melt rates remain uncertain. Explanations for the intensification of melting have largely focused on local processes in seas surrounding the ice shelves, including variations in wind stress over the continental slope and shelf. Here, we show that non-local freshwater forcing, propagated between shelf seas by the Antarctic Coastal Current (AACC), can have a significant impact on ice-shelf melt rates.

We present results from a suite of high-resolution (~3-km) numerical simulations of the ocean circulation in West Antarctica that includes a dynamic sea-ice field, ice-shelf cavities and forcing from ice shelf-ocean interactions. Motivated by persistent warming at the northern Antarctic Peninsula since the 1950's, freshwater perturbations are applied to the West Antarctic Peninsula. This leads to a strengthening of the AACC and a westward propagation of the freshwater signal. Critically, basal melt rates increase throughout the WAP, Bellingshausen and Amundsen Seas in response to this perturbation. The freshwater anomalies stratify the ocean surface near the coast, enhancing lateral heat fluxes that lead to greater ice-shelf melt rates. A suite of sensitivity studies show that changes in meltrates are linearly proportional to the magnitude of the freshwater anomaly, changing by as much as 30% for realistic perturbations, but are relatively insensitive to the distribution of the perturbation across the WAP shelf. These results indicate that glacial run-off on the Antarctic Peninsula, one of the first signatures of a warming climate in Antarctica, could be a key trigger for increased melt rates in the Amundsen and Bellingshausen Seas.