Melt at grounding line controls observed and future retreat of Smith, Pope, and Kohler Glaciers

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Smith, Pope, and Kohler glaciers and the corresponding Crosson and Dotson ice shelves have undergone speedup, thinning, and rapid grounding-line retreat in recent years, leaving them in a state likely conducive to future retreat. We conducted a suite of numerical model simulations of these glaciers and compared the results to observations to determine the processes controlling their recent evolution. Simulations were forced using estimates of the distribution and intensity of melt from 1996-2014. The model simulations indicate that the state of these glaciers in the 1990s was not inherently unstable, i.e., that small perturbations to the grounding line would not necessarily have caused the large retreat that has been observed. Instead, sustained melt, at rates higher than the 1990s and concentrated at the grounding line, was needed to cause the observed retreat. Weakening of the margins of Crosson Ice Shelf may have hastened the onset of grounding-line retreat but is unlikely to have initiated these rapid changes without an accompanying increase in melt. In the simulations that most closely match the observed thinning, speedup, and retreat, modeled grounding-line retreat and ice loss continue unabated throughout the 21st century, and subsequent retreat along Smith Glacier's trough appears likely. Given the modeled retreat, thinning associated with the retreat of Smith Glacier may reach the ice divide and undermine a portion of the Thwaites catchment as quickly as changes initiated at the Thwaites terminus. Thus, while the Smith, Pope, Kohler catchment is small compared to Thwaites, these smaller glaciers may be important when considering the centennial-scale evolution of the Amundsen Sea region.