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Historical buttressing effects on present-day Dotson and Crosson Ice Shelf dynamics

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For almost three decades, the Dotson and Crosson Ice Shelves have withstood various degrees of velocity increases, basal melt, weakening shear margins, and grounding line retreat. The two ice shelves, located along the Amundsen Sea Embayment, are fed primarily by Kohler, Smith, and Pope Glaciers. The ice shelves were once thought to be separated by a landmass connecting Bear Island to the mainland, but there is no evidence from 75 years of available data supporting this partition. Recent research shows that the changes in dynamics undergone by both ice shelves and their outlet glaciers are due largely to basal melt driven by warm circumpolar deep water (CDW); however, the scope of those changes varies between the two sectors with the Crosson Ice Shelf experiencing the more extreme transformation. Observations from trimetrogon aerial imagery (late-1940s) and Landsat Thematic Mapper data (mid-1980s) reveal the northern edge of the Crosson Ice Shelf terminating at Holt Glacier and its southeastern edge buttressing against Haynes Glacier. Studies show that in the mid-1980s, a decrease in sea ice concentrations led to the migration of the detached Thwaites Ice Tongue which, with fast ice, aided in containing fragments of Thwaites Glaciers—around this time the retreat of Haynes Glacier's ice tongue also began. We hypothesize it is this decrease in buttressing from ~35 years ago that began a continuous trend (still observed today) in ice shelf thinning, initiation of rifts, and outlet glacier speed increases and grounding line retreats. In contrast, the Dotson Ice Shelf is flanked by Bear Island and Martin Peninsula and has undergone less dramatic alterations in dynamics than the Crosson Ice Shelf. We quantify the impact of buttressing on the two connected ice shelves with the following analyses: extended temporal scale of outlet glacier hypsometry from 1960-the present; detailed 16-year study of grounding line migrations and hydrostatic equilibrium boundaries using CReSIS MCoRDS/2 level one data; estimated shear stresses from multi-year velocities; modeled back stresses acting on both ice shelves. Results of this study will help to improve modeling ocean-ice sheet interactions and better constrain CDW impacts.