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Complete spatiotemporal freshwater flux budget for a major Greenland glacier-fjord system

Twila Moon (1), David Sutherland (2), Dustin Carroll (2), Laura Kehrl (3), Fiamma Straneo (4), and Denis Felikson (5)

(1) Bristol Glaciology Centre, University of Bristol, Bristol, UK (twila.moon@bristol.ac.uk), (2) Department of Earth Sciences, University of Oregon, Eugene, OR, USA, (3) Polar Science Center, University of Washington, Seattle, WA, USA, (4) Woods Hole Oceanographic Institution, Woods Hole, MA, USA, (5) Institute for Geophysics, University of Texas, Austin, TX, USA

Freshwater flux from ice sheet mass loss raises global sea level, influences large-scale ocean circulation and stratification, and affects biological systems. Freshwater flux in glacial fjords comes from several sources: ice sheet surface melt discharged subglacially at the glacial termini, terrestrial runoff, submarine terminus melt, and melt from icebergs throughout the fjord (here, including icebergs, bergy bits, and melánge). Melt from icebergs is poorly constrained; previous efforts use limited-footprint satellite images and fail to distinguish iceberg freshwater flux from other melt sources. We have developed a new method, combining in situ and remote sensing observations with a parameterized iceberg melt model and climate reanalysis data, to calculate freshwater flux from icebergs and create a spatiotemporally complete fjord freshwater budget. Here, we apply this method to Sermilik Fjord, a major glacier-fjord system in southeast Greenland. We generate complete freshwater budgets for summer and winter periods during 2008-2013 as well as mean monthly estimates of iceberg freshwater flux over a full year. Along with this enhanced understanding of iceberg freshwater flux across time, our estimates also spatially resolve meltwater flux across the full water depth of the fjord. We find that more than 70% of iceberg melt production occurs below 10 m depth. We also compare iceberg melt flux to other freshwater sources, demonstrating that iceberg melt dominates freshwater production. Our work provides the first calculation of iceberg freshwater flux across the full fjord water depth, estimates the first complete freshwater budget for a major Greenland glacier-fjord system, and provides monthly to interannual comparisons across freshwater sources. Ultimately, these results provide a path forward in accurately representing freshwater flux, including iceberg melt production, in large-scale climate models.