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Impacts of variability in fjord circulation on glacier dynamics in Cumberland Bay, South Georgia

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South Georgia is a mountainous and heavily glaciated sub-Antarctic island in the Southern Ocean, lying in the path of the Antarctic Circumpolar Current. Cumberland Bay is the largest fjord on the island, split into two arms, Cumberland East and West Bay, with a large marine-terminating glacier at the head of each arm. Water circulation in such fjords, and associated transport and exchange of heat, directly governs the stability of glaciers at the ice-ocean interface and the subsequent glacier dynamics. Over the past century there has been a markedly different behaviour in the retreat rate of Nordenskjöld glacier in East Bay, compared with that of Neumayer glacier in West Bay. Fjord circulation patterns are complex with influencing factors including winds, meltwater runoff, bathymetry and coastal current systems. Precise understanding of the variability in ocean circulation and exchange in Cumberland Bay cannot be understood from limited observational data alone. Here, we use observations together with a new high-resolution numerical model built using the NEMO4 framework to determine the dominant physical drivers of variability. Nordenskjöld and Neumayer glaciers are represented as a vertical wall with a theoretical annual cycle of freshwater discharge injected at the depth of neutral buoyancy. The model is used to investigate how variability in the circulation regime couples with the associated heat transport within the two fjord arms, and to elucidate the role of such variability on glacier dynamics and rate of retreat. The sensitivity of the system to sill depth, fjord geometry and wind direction will be demonstrated through a series of model experiments, gaining a stronger understanding of the key drivers of the different retreat rates of these glaciers.