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Dynamic ancient ice caps in the sub-Antarctic suggested by new mapping of submarine ice-formed landscapes

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Recent bathymetric investigations have provided hints of significant past glaciations on several Southern Ocean sub-polar islands. The extent and behaviour of ice cover in these regions is important because it provides critical limits on the evolution of refugia and marine benthic organisms, as well as unique far-field constraints for improving polar ice-sheet model sensitivity. However, despite improvements in regional mapping, sea-floor acoustic data from key shelf areas have still not been of sufficient quality, or broad enough in their coverage, to resolve the number, form or flow of past glacial episodes. Hence the history and style of sub-Antarctic glaciation remains poorly known. Here we use a compilation of multibeam bathymetry and fisheries echo-sounding data to provide evidence for dynamic, widespread ice caps on sub-Antarctic South Georgia during past glacial periods. We present a hitherto unmapped record of sea-bed glacigenic structures, including end moraines and subglacial landforms, from which the flow and form of at least three major, entirely marine-terminating configurations is resolved. The largest glaciation covered the majority of the continental shelf, and included fast-flowing outlets, possible switching of internal flow, meltwater activity, warm-based ice erosion, and substantial marginal deposition during retreat: all features of dynamic ice-cap behaviour. Existing biological evidence suggests the largest glaciation likely pre-dated the Last Glacial Maximum, which may have been restricted in extent reaching to the island's fjord mouths, while a third mid-shelf limit appears partially recorded. Work on dating the relict landscape of ancient ice cap advance and retreat is ongoing, but our preliminary age model suggests that South Georgia's history is unique from the Antarctic polar glacial record, and may be more similar to that of past ice caps on Patagonia. The glacial configurations revealed by these data will provide the basis of new boundary conditions for polar ice sheet models, and must have been significant for the evolution of Antarctic benthic habitat.