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Oceanographic observations at the shelf break of the Amundsen Sea, Antarctica

D. Walker (1), A. Jenkins (1), M. Brandon (2), K. Assmann (1), and D. Shoosmith (1)

(1) British Antarctic Survey, Natural Environment Research Council, Cambridge, United Kingdom (a.jenkins@bas.ac.uk, 0044-1223-221259), (2) Department of Environment, Earth & Ecosystems, The Open University, Milton Keynes, United Kingdom

The part of the West Antarctic Ice Sheet that drains into the Amundsen Sea is currently thinning at such a rate that it contributes nearly 10% of the observed rise in global mean sea level. Acceleration of the outlet glaciers appears to be caused by thinning at their downstream ends, where the ice goes afloat, indicating that the changes are probably being forced from the ocean. Observations made since the mid-1990s on the Amundsen Sea continental shelf have revealed that the deep troughs, carved by previous glacial advances, are flooded by almost unmodified Circumpolar Deep Water (CDW) with temperatures around 3-4°C above the freezing point, and that this water mass drives rapid melting of the floating ice. Here we report observations of water properties and currents made in the region where one of those troughs reaches the continental shelf edge. We estimate the absolute circulation within the trough from a combination of detided Acoustic Doppler Current Profiler data and geostrophic shear derived from Conductivity-Temperature-Depth sections. The shelf edge region is characterised by a landward deepening of the pycnocline separating CDW from the overlying colder and fresher surface waters. This feature, the so-called Antarctic Slope Front (ASF), is almost circumpolar in extent, and is typically a full-depth feature, the pycnocline intersecting the seabed over the upper continental slope. However, the ASF is weaker in the Amundsen Sea, where it is rarely a full-depth feature. Geostrophic shear associated with the ASF leads to a weakening of the associated westward current with depth, and an eastward undercurrent of varying strength has been reported at other locations. At the time of our Amundsen Sea observations the westward surface flow was weak, giving rise to a strong eastward undercurrent flowing along the continental shelf edge and upper slope. At the upstream (western) side of the trough the undercurrent turns south, driving a net on-shelf flow of CDW in the western part of the trough, and leaving a weakened shelf edge flow that re-establishes itself on the downstream (eastern) side of the trough. An analogous feature was captured, albeit crudely, in an earlier coarse-resolution model of the circulation on the Amundsen Sea shelf, and variability in its strength, associated with variability in the surface wind stress, was the main cause of variations in the heat content of the waters on the inner continental shelf. Our observations thus lend support to the earlier hypothesis that changes in atmospheric forcing over the continental shelf edge could be the ultimate driver of changes in the West Antarctic Ice Sheet outlet glaciers that drain into the Amundsen Sea.