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Circulation and Impacts of Circumpolar Deep Water in a Western Antarctic Peninsula Glacial Fjord

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Along the west Antarctic Peninsula (AP), coastal bays and fjords are important sites of primary and secondary productivity linking the large-scale ocean to the margins of the West Antarctic Ice Sheet. In recent decades, widespread retreat and increased mass loss from marine-terminating glaciers have been noted along the AP, potentially triggered by submarine melting resulting from the advection of warm, Circumpolar Deep Water (CDW) across the shelf towards the glacial termini. These changes may have important consequences for the mass balance of the West Antarctic Ice Sheet, rates of freshwater (glacial meltwater) export, as well as for marine ecosystem processes through changes in physical and chemical properties of downstream surface waters. Yet due to a lack of observations, our understanding of regional ice-ocean processes and of their consequences remains limited. Here, we present oceanographic data collected from Barilari Bay during a January-February 2010 cruise to the Antarctic Peninsula. Modified CDW was present at depth throughout the fjord to the glacier terminus. Temperature, salinity, and oxygen isotope (18O) sections reveal the presence of glacially modified water in the top 100 m of the water column, indicative of submarine melt. A concomitant enhancement of surface macronutrient concentrations was also observed in this layer relative to outside the fjord, resulting from the entrainment of nutrient-rich deep waters towards the surface in a glacially modified plume near the ice-ocean interface. This buoyancy-driven circulation provides a mechanism for enhanced stratification and nutrient input to the euphotic zone in these systems, which could help sustain the high phytoplankton biomass and rates of primary production observed during the cruise. Our results highlight the close connection between ice-ocean interactions and the marine ecosystem, while providing observational evidence of CDW influence near the margins of the ice sheet along the coastal AP.