PHYSICAL PROCESSES IN A WESTERN ANTARCTIC PENINSULA FJORD

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Abstract

The western Antarctic Peninsula (wAP) is lined with glacio-marine fjords which connect the coastal ocean with the terrestrial ice sheet. The physical oceanography of these fjords is relatively unexplored despite their potential importance for regional glaciology, oceanography, and geochemistry, as well as for the productive marine ecosystems in the fjords. This dissertation explores the physical oceanography of a glacial wAP fjord, and identifies and examines key dynamical processes which occur in the system. The analysis is built around comprehensive oceanographic and atmospheric observations from Andvord Bay, a glacial fjord located on the northwestern wAP. Measurements were collected between December 2015 and March 2017 during three research cruises, and with moored sensors, as part of the *FjordEco* project.

In the first part of the dissertation, I describe the physical environment of Andvord Bay, including the atmospheric and glaciological forcing conditions, and the hydrography and energetics of the fjord in relation to the outside ocean. Since Andvord Bay is located just north of the present influence of relatively warm modified Upper Circumpolar Deep Water, the fjord glaciers are not currently in retreat, and glacial mass flux into the ocean occurs predominantly in the form iceberg calving. Meltwater runoff, mean winds, tidal currents and mixing are all weak inside the fjord, and as a result the fjord is dynamically quiet compared to the outside ocean. The lack of a strong mean circulation provides beneficial conditions for phytoplankton blooms, and partially isolates the fjord from temperature variations in the Gerlache Strait. Seasonal water mass exchange is likely driven by low-frequency dynamics of the Gerlache Current as well as by occasional katabatic wind events.

The second part of the dissertation examines the effects of katabatic wind events on the ocean within a wAP fjord. A strong, down-fjord katabatic wind event observed during December 2015 cruise appears to have had significant and immediate effects on the fjord waters, effectively flushing out the surface layer and altering the stratification in the upper 100 m. A series of idealized numerical experiments were conducted in order to explore the effect of such forceful down-axis winds on fjord water masses and exchange with the exterior ocean. Based on these simulations and observations, I discuss how episodic wind events may drive significant fluxes of nutrients, ice and water properties in otherwise quiescent Antarctic fjords.

The final part of the dissertation examines buoyant plumes generated by ice-ocean interactions at the glacier terminus. Mid-water intrusions of anomalously cold and turbid water were observed in ocean profiles from inner Andvord Bay during all three research cruises. I characterize the spatial distribution of the intrusions, and examine the water properties observed during near-glacier surveys using hydrographic profiles and an autonomous underwater vehicle. Using water mass analysis and a pre-existing analytical model, it is shown that the observations are consis-

tent with a deep, localized source of submarine meltwater. Glacial plumes in Andvord Bay are relatively weak compared to comparable fjord environments with subglacial discharge of highly buoyant freshwater. While the plumes are unlikely to drive significant melt or ocean circulation, they may be an important vertical pathway of sediment, trace metals and other geochemical tracers of terrestrial origin from the glacier grounding line to the upper ocean.