Hot water drilling and subshelf measurements at Langhovde Glacier, East Antarctica

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The Antarctic ice sheet is fringed by ice shelves and glacier floating tongues along 74% of its coastal margins. Basal melting of these ice bodies is an important ice sheet ablation process and considered as the driver of recent ice mass loss in Antarctica. It is thus important to study water properties and circulations underneath Antarctic ice shelves and floating tongues. Moreover, subshelf ocean and sea floor are unique environments for studying a marine ecosystem and sedimentation. Despite these importance and interests, in-situ measurements are difficult under several hundred-meter-thick ice, and thus only limited amounts of observational data are available. To better understand subshelf environments of Antarctic outlet glaciers, we performed hot water drilling and subshelf measurements at Langhovde Glacier in East Antarctica.

Langhovde Glacier is located on the Soya Coast in Lutzow-Holm Bay, approximately 20 km south from a Japanese Antarctic base Syowa Station. The glacier is ~3 km wide and flows at a rate of 130 m/a near the calving front. The lower part of the glacier forms a floating tongue over several kilometers from the ice front. Field activity was carried out from December 2017 to February 2018 as a part of the 59th Japanese Antarctic Research Expedition. We drilled four boreholes through the floating part of the glacier at 0.5-2.5 km from the ice front using a hot water drilling system. Sea floor under the drilled region deepens downglacier from 380 to 510 m below sea level, whereas ice thickness decreases from 410 to 235 m. The boreholes were utilized to lower down a CTD (conductivity, temperature and depth) profiler, current meter, video camera, and water and sediment samplers into the subshelf ocean. Two boreholes were permanently instrumented with mooring systems for long-term measurements of temperature, salinity, current and pressure.

Potential temperature of the sea water in contact with the ice sole was between -1.4 and -1.1 degree C, which was about 1 degree C warmer than freezing temperature. Temperature slightly increased towards the ocean floor, and similar vertical temperature profiles were obtained at all the drilling sites. Salinity was fairly uniform around 34.30 with a spatial variability in the vertical columns within 0.05. Mooring measurements over four weeks showed short-term (day to weeks) variations in temperature (0.2 degree C) and salinity (0.1). Water flowed upglacier, except for the layer directly below the ice shelf where water moved towards the ocean. Sediment sampling suggested spatial variabilities in particle size and degree of consolidation, e.g. finer sediments were collected from boreholes closer to the glacier front. Video images captured a wide variety of living creatures, including fish, krill and jellyfish. Subshelf water was sampled at several depths for isotope measurement.

In the presentation, we report the results of the above borehole measurements and discuss implications for basal melting and subshelf environments of Antarctic outlet glaciers. This study was carried out under the ROBOTICA (Research of Ocean-ice BOundary InTeraction and Change around Antarctica) project.

Keywords: Antarctica, Ice shelf, Hot water drilling

