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Identifying glacial meltwater in the Amundsen Sea, Antarctica

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Pine Island Glacier, located in the Amundsen Sea, is losing mass rapidly due to relatively warm ocean waters melting its ice shelf from below. The resulting increase in meltwater production may be the root of the freshening in the Ross Sea over the last 30 years. Tracing the meltwater travelling away from the ice sheets is important in order to identify the regions most affected by the increased input of this water type.

We use water mass characteristics (temperature, salinity, O_2 concentration) derived from 105 CTD casts during the Ocean2ice cruise on RRS James Clark Ross in January-March 2014 to calculate meltwater fractions north of Pine Island Glacier. The data show maximum meltwater fractions at the ice front of up to 2.4 % and a plume of meltwater travelling away from the ice front along the 1027.7 kg m-3 isopycnal. We investigate the reliability of these results and attach uncertainties to the measurements made to ascertain the most reliable method of meltwater calculation in the Amundsen Sea.

Processes such as atmospheric interaction and biological activity also affect the calculated apparent meltwater fractions. We analyse their effects on the reliability of the calculated meltwater fractions across the region using a bulk mixed layer model based on the one-dimensional Price-Weller-Pinkel model (1986). The model includes sea ice, dissolved oxygen concentrations and a simple respiration model, forced by NCEP climatology and an initial linear mixing profile between Winter Water (WW) and Circumpolar Deep Water (CDW). The model mimics the seasonal cycle of mixed layer warming and freshening and simulates how increases in sea ice formation and the influx of slightly cooler Lower CDW impact on the apparent meltwater fractions. These processes could result in biased meltwater signatures across the eastern Amundsen Sea.