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Submarine Melt Water from the 79 North Glacier (79NG, Nioghalvfjerdsbræ), northeast Greenland

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The Greenland Ice Sheet faces accelerated melting under warming climate conditions. The involved processes are surface melting, iceberg calving, and submarine melting through the contact of warm water with marine terminating glaciers. The Nioghalvfjerdsfjorden Glacier (79 North Glacier, 79NG) is the largest marine terminating outlet glacier of the Northeast Greenland Ice Stream and has still a floating ice tongue. In the cavity, the heat of inflowing warm and saline Atlantic Water melts the floating ice shelf at its base, and the colder and fresher outflow is exported towards the shelf break and presumably south with the East Greenland Current. However, freshwater from submarine melting is hardly distinguishable from other freshwater sources off the sources by salinity alone. To identify and to quantify the fraction and distribution of submarine melt water on the northeast Greenland shelf, we use helium (He) and neon (Ne) observations, obtained directly at the calving front of the 79NG, in its close and far vicinity on the northeast Greenland shelf, and beyond the shelf break in Fram Strait during a Polarstern expedition in 2016. These lighter and low soluble noble gasses provide a unique tool to identify submarine melt water and to quantify its fractions. We calculate a submarine melt water formation rate of 14.5 ± 2.3 Gt per year, equivalent to a basal melt rate of 8.6 ± 1.4 m per year of the 79NG. Submarine melt water fractions are present on the shelf, but dilute from 1.8% at the 79NG calving front to nonsignificant in Fram Strait. A surplus of Ne on most of the shelf region indicates that up to 10% of the original water mass had been transformed to sea ice.