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# Seasonal Variations in Bottom Water Temperatures and their Influence on Subaquatic Permafrost Thermal Regimes

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The thermal regime in sediment below the ocean or lakes is mostly governed by the sea or lake bed temperature and by the geothermal heat flow. This thermal regime will determine whether permafrost beneath water bodies is preserved or how rapidly it thaws. Thermal modelling uses mean annual bottom water temperatures to calculate permafrost presence or absence, while predictions of shallow sediment thermal regimes must be forced with time series of changing bottom water temperatures that also account for freezeback of the water column to the bottom, forming bottom-fast ice. However, continuous, annual measurements of bottom water temperatures in Arctic lakes and coastal marine settings are hard to obtain and therefore scarce. Waves and sea ice movement make deployment and recovery of instruments difficult.

We provide a parameterization of the bottom water temperature function that relies on easier to obtain variables, such as the mean, minimum and maximum air temperature and the water depth, by comparing measured and modelled shallow sediment thermal regimes from the Arctic. We use a parameterization based on a simple cosine for the water temperature with mean temperature, amplitude and time shift and add the minimum water temperature to obtain a 4 parameter function. For shallow regions with bottom-fast ice, additionally the duration of the ice-growth and -melting period as well as the minimum air temperature are needed.

We test our parameterizations with a globally unique data set of 4 years of ground temperature data collected from the seabed to a depth of 10 m from the near shore zone of the Mackenzie Delta. At the instrumented sites, permafrost is present beneath mostly freshwater bottom-fast and floating ice. Forward modeling of sediment temperatures is performed using the 1D heat transfer model CryoGrid with depth dependent thermal properties. We neglect advective processes and long-term temperature trends in the bottom water temperatures.

Rough parameterization of the annual variation of water bottom temperatures reproduce measured water temperatures with a RMSE of 20-40 %. The resulting modeled sediment temperature field based on 10 years of repeated parameterized bottom water temperatures matches the modeled sediment temperature field based on measured water temperatures in terms of permafrost characteristics, including the depth of the active layer defined by the 0°C

isotherm over the year. However, both modelled temperature fields yield significantly higher sediment temperatures than the measured sediment temperature field. This may be the result of choice of sediment thermal properties in the thermal model or shifts in the duration of bottom-fast ice contact or on-ice snow Since modelled temperature fields from both repeated measured and parameterized bottom water temperatures show the same deviation, it suggests that the bottom water temperatures were warmer during the measurement period than the average over the previous 10 years.