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Internal Waves and Mixing Near the Yermak Plateau, Arctic Ocean

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Recent findings show that i) moderate mixing levels typical of mid-latitude can erode or even remove the Arctic cold halocline layer, and ii) internal wave induced mixing is enhanced in the absence of sea ice. In the prospect of a seasonally ice-free Arctic Ocean, mixing levels sufficient to remove the cold halocline layer, can be anticipated as a result of wind energy input over large areas of open water. The ice is then easily exposed to the relatively warm Atlantic water, possibly leading to a strong positive feedback. The Yermak Plateau, located in the Marginal Ice Zone northwest of Svalbard, where the West Spitsbergen Current (WSC) carries the warm Atlantic Water into the Arctic Ocean, is a site where insight can be gained. Earlier studies have identified the Yermak Plateau as a region of enhanced tidal variability, internal wave activity and turbulent mixing. Here we report on observations of oceanic currents, hydrography and microstructure made in the southern Yermak Plateau in summer 2007 on both sides of the Arctic Front. Time series of approximately one-day duration from five stations (upper 520 m) and eight-day duration from a mooring are analyzed to describe the characteristics of internal waves and turbulent mixing.

Internal waves generated in response to the tidal flow over this topographic feature locally contribute to mixing and remove heat from the Atlantic Water. The spectral composition of internal wave field over the southern Yermak Plateau is 0.1-0.3 times the mid-latitude levels and compares with the most energetic levels in the central Arctic. Dissipation rate and eddy diffusivity below the pycnocline increase from the noise level on the cold side of the front by one order of magnitude on the warm side. Here, 100-m thick layers with average diffusivity of 5×10^{-5} m^2 s^{-1} lead to heat loss from the Atlantic Water of 2-4 W m^{-2}. Dissipation in the upper 150 m is well above the noise level at all stations, but strong stratification at the cold side of the front prohibits mixing across the pycnocline. Close to the shelf, at the core of the WSC, diffusivity increases by another factor of 3 to 6. Here, near-bottom mixing removes 15 W m^{-2} of heat from the Atlantic layer. Internal wave activity and mixing vary spatially, thus the path of WSC will affect the cooling and freshening of the Atlantic inflow. When generalized to the Arctic Ocean, diapycnal mixing away from abyssal plains can be significant for the heat budget. Around the Yermak Plateau, it is of sufficient magnitude to influence heat anomaly pulses entering the Arctic Ocean, however, diapycnal mixing alone is unlikely to have regional significance in cooling of WSC.