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The impact of tides on mixing and freshwater export in the Laptev Sea

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The vast and shallow Laptev Sea shelf is seasonally ice covered and receives large amounts of freshwater runoff from the Lena River. This shelf is an important export region for sea ice and freshwater to the Arctic basin, and features strong vertical and horizontal gradients which separate the saline basin waters from the fresh coastal waters. Processes promoting shear instabilities and diapycnal mixing are therefore of interest for physical and biogeochemical properties. The Laptev Sea shelf features considerable shear in under-ice currents largely dominated by the baroclinicity in semidiurnal tides.

We present an investigation into semidiurnal tides based on year-round oceanographic moorings from different locations across the Laptev Sea shelf. Harmonic analysis of ADCP records shows a strong depth-dependence in the clockwise tidal currents that can be linked to stratification and further shows large spatial and seasonal variability of tides. Total current magnitudes are stronger on the outer than on the inner shelf, and tides overall explain >80% of the current's variance throughout the year. On the inner shelf, tides play a comparatively greater role under sea ice (40-70%) than during open water periods (20-50%) when wind-induced inertial motions dominate. The ADCP records are further complemented by two cross-shelf microstructure transects which show episodes of intense turbulent kinetic energy dissipation in the pycnocline following the alignment of the semidiurnally rotating shear-vector and the surface forcing, hence underlining the potential influence of tides on diapycnal mixing. Our results highlight the potential of tides to vertically transport freshwater, heat and nutrients, and provide some first order insights into how the physical environment of this shelf may change with changing sea ice conditions.