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Vigorous Internal Wave Generation at the Continental Slope North of Svalbard

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Mixing along the pathway of Atlantic Water in the Arctic Ocean is crucial for the distribution of heat in the Arctic Ocean. The warm boundary current typically flows along the upper continental slope where energy conversion from tides to turbulence and tidally driven mixing can be important; however, observations -and thus understanding- of these spatiotemporally highly variable processes are limited.

Here we analyze yearlong observations from three moorings (W1, W2 and W3) spanning the continental slope North of Svalbard at 18.5°E over 16 km from 400 m to 1200 m isobaths, deployed between September 2018 and October 2019. Full-depth current records show strong barotropic diurnal (i.e., sub-inertial) tidal currents, dominated by the K_1 constituent. These tidal currents are strongest at mooring W2 over the continental slope (~700 m isobath) likely due to topographic trapping far north of their critical latitude (30°N). The diurnal tide undergoes a seasonal cycle with amplitudes reaching minima of ~4 cm/s in March/April and maxima of ~11 cm/s in June/July. Associated with the diurnal tide peak at W2 in summer 2019 is a strong baroclinic semidiurnal signal up to 15 cm/s around 4.5 km further offshore at W3 between 500 m and 1000 m depth. This semidiurnal current signal exhibits a fortnightly modulation and is characterized by upward energy propagation, indicative of generation at the bottom rather than the surface.

We hypothesize that the semidiurnal baroclinic waves are generated by the barotropic diurnal tide about 15 km upstream. There, the slope is oriented approximately normal to the major axis of the tidal current ellipses, maximizing the cross-isobath flow and thus the tidal energy conversion potential. The topographic slope angle approaches criticality for frequencies close to the second harmonic of K_1 ($2K_1$, with a semidiurnal period of 11.965 h) around the 620 m isobath and may thus facilitate an efficient generation of second harmonic internal waves. Linear superposition of a $2K_1$ wave with the rather weak (~5 cm/s) ambient M_2 tide would explain the observed fortnightly modulation. The super-inertial wave (w_{2K1}>f) propagates freely and its pathway is presently not known.

Although further research on the generation mechanism is needed, the strong baroclinic semidiurnal currents observed at the continental slope have direct implications for deep mixing. Furthermore, energetic diurnal tidal currents impinging on a steep continental slope are also

known to generate non-linear internal lee-waves that can also lead to substantial turbulence and consequent mixing.