Internal wave-driven mixing on the Amundsen Sea Shelf, West Antarctica

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Recent results on turbulent dissipation and mixing in the Southern Ocean have revealed that topographically rough regions are the prominent location for the generation and breaking of internal waves with associated diapycnal diffusivities K_{ρ} of $O(10^{-4}\text{–}10^{-3})$ $m^2\ s^{-1}$. However along the Amundsen coast where the observed thinning and acceleration of glaciers produces the majority of Antarctica’s contribution to sea-level rise little is known about the level of mixing. Mesoscale eddies play a key role for exchanges across the Antarctic shelf break, their interaction with small-scale topography is believed to generate internal lee waves. Enhanced generation of internal waves of tidal frequency is expected on the Amundsen Shelf due to its geographical location relative to the critical latitude (74°28’ S) for lunar semi-diurnal M_2 tide. We show that the critical latitude coincides with near-critical topography on the shelf and this condition favors the generation of M_2 internal waves. In this work, we describe and estimate the intensity and spatial distribution of the rates of turbulent kinetic energy dissipation ϵ and K_{ρ} on the Amundsen Sea Shelf and study the relationship between the observed turbulence and the internal wave field in this region. Estimates of K_{ρ} were obtained using fine-scale parameterizations. Higher mixing rates up to 5.4×10^{-3} $m^2\ s^{-1}$ were seen in the depth between 200 and 600 m. The highest mixing rate exceeding 10^{-2} $m^2\ s^{-1}$ was also seen in the southern end of Pine Island Glacier, attributed to observed shear. A latitudinal variability in K_{ρ} near the bottom is reported, with K_{ρ} increases near the critical latitude for M_2 tides. We show that the critical latitude coincides with near-critical topography on the Amundsen Shelf and this condition favors the generation of internal waves of M_2 frequency. Analysis of current time series from the moored instruments reveals a thickening of the frictional bottom boundary layer near the critical latitude. Although a weak semi-diurnal tidal dynamics was observed at the continental shelf, its combination with the critical latitude effects lead to enhanced mixing that potentially affects the heat budget and the circulation of the Circumpolar Deep Water below the ice shelves.