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Turbulent Mixing in Patagonian Fjords and Channels

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Abstract. The fjords and channels of Chilean Patagonia form a complex estuarine system where freshwater input, tidal currents, and stratification interact to modulate vertical mixing. We combined velocity microstructure profiles (VMP-250) and CTD-SRDL observations collected between 2023 and 2025 to quantify turbulent kinetic energy dissipation (ε) and vertical diffusivity (K_{shear}) across northern (42–46°S) and southern (52–55°S) Chilean Patagonia. Dissipation rates spanned 10^{-9}–10^{-5} W kg^{-2} with maxima near sills and narrow passages such as Paso Desertores, where semidiurnal tides dominate energy input. Northern Patagonia exhibited seasonal stratification driven by freshwater inputs, while southern Patagonia remained weakly stratified and vertically well mixed throughout the year, aided by strong tidal currents and westerly winds. The tidal mixing parameter h/U^3 indicated that semidiurnal tides account for ~97% of energy dissipation in the north and ~77% in the south. These findings highlight the strong spatial heterogeneity of turbulent mixing in Patagonian fjords and the key role of the interaction between tidal forcing and stratification in controlling vertical exchange. The results provide a framework for understanding how fjord systems may respond to changing freshwater inputs and atmospheric forcing under a warming climate.