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Quantifying turbulent mixing and oxygen fluxes in a Mediterranean-type, microtidal estuary

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Abstract: Experiments were carried out on an intermittent estuary during its closed (summer) and open (winter) states to identify the physical processes responsible for vertical mixing across the halocline, and to quantify vertical fluxes of oxygen and salt between water layers. During the blocked phase a two-layer structure was observed, with a brackish, surface layer overlying old seawater. Within a deep basin the wind-driven turbulent mixing was consistent with the measured surface-layer turbulent dissipation but the dissipation in the bottom layer appeared to be driven by internal seiching. In the shallow regions of the estuary vertical fluxes of dissolved oxygen were indicative of oxygen demand by respiration and re-mineralizatin of organic material in bottom water and sediments. During the estuary's open phase a three-layer structure was observed, having a fresh, river-derived surface layer, a middle layer of new seawater, and a bottom layer of old seawater. In the shallower regions surface-layer turbulent diffusion was consistent with the strong, gusty winds experienced at the time. The dissolved oxygen of the incoming seawater decreased to very low values by the time it reached the upstream deep basin as a result of the low cross-pycnocline oxygen flux being unable to compensate for the oxygen utilization. At least 50% of the cross-pycnocline salt fluxes in the shallow reaches of the open estuary are suggested to be driven by Holmboe instabilities.