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Turbulent oceanic western-boundary layers at low latitude

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Low latitude oceanic western-boundary layers range within the most turbulent regions in the worlds ocean. The Somali current system with the Great Whirl and the Brazilian current system with its eddy shedding are the most prominent examples. Results from analytical calculations and integration of a one layer reduced-gravity fine resolution shallow water model is used to entangle this turbulent dynamics. Two types of wind-forcing are applied: a remote Trade wind forcing with maximum shear along the equator and a local Monsoon wind forcing with maximum shear in the vicinity of the boundary. For high values of the viscosity ($> 1000 \mathrm{m}^2\mathrm{s}^{-1}$) the stationary solutions compare well to analytical predictions using Munk and inertial layer theory. When lowering the friction parameter time dependence results. The onset of instability is strongly influenced by inertial effects. The unstable boundary current proceeds as a succession of anti-cyclonic coherent eddies performing a chaotic dynamics in a turbulent flow. The dynamics is governed by the turbulent fluxes of mass and momentum. We determine these fluxes by analyzing the (potential) vorticity dynamics. We demonstrate that the boundary-layer can be separated in four sub-layers, which are (starting from the boundary): (1) the viscous sub-layer (2) the turbulent buffer-layer (3) the layer containing the coherent structures and (4) the extended boundary layer. The characteristics of each sub-layer and the corresponding turbulent fluxes are determined, as are the dependence on latitude and the type of forcing. A new pragmatic method of determining the eddy viscosity, based on Munk-layer theory, is proposed. Results are compared to observations and solutions of the multi-level primitive equation model (DRAKKAR).