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HYDRODYNAMICS AND HYDRAULICS OF EXCHANGE FLOWS IN THE LONG SEA STRAITS: TURKISH STRAITS CASE STUDY

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Exchange flows in which fluids of differing densities move in opposing directions through a channel are of interest in geophysical hydrodynamics. The flows in the Gibraltar Strait, the Bosphorus and the Dardanelles are well-known examples. In this paper, we consider the exchange dynamics in long straits focusing on the role of strait topography, friction, mixing and non-hydrostatic effects. A two-layer hydraulic model with friction (Maderich, 2002) as well as a 3D nonhydrostatic model (Kanarska and Maderich, 2002) are applied to the problem. The latter model is a non-hydrostatic extension of the free-surface primitive equation POM model. A mode splitting technique, using decomposition of pressure and velocity fields into hydrostatic and non-hydrostatic components and sequential calculation of these components are the bases of numerical algorithm of the model. Both models are tested against laboratory experiments by Maderich (2000) on exchange flow through a long and narrow strait with sill or contraction and are applied to the modelling of water exchange through the Turkish straits. The hydraulic model, coupled with 1D models of adjacent seas, was used for the simulation of the exchange between the Black and Aegean seas in 1970-1999. The circulation in the Strait of Dardanelles for summer period is investigated by the 3D model to clarify the role of mixing in the exchange. The calculated 3D fields of currents, density, turbulence intensity and dissipation showed effects of intensive mixing at the zone of the Nara Passage. Contrary to previous studies the composite Froude number remains subcritical throughout the whole strait. It is concluded that mixing can play a crucial role in limiting the exchange through the Dardanelles at least in some periods of the year. More detailed future field studies and simulations are necessary to understand processes in the Nara Passage area.