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Three-dimensional generation of nonlinear internal tides in the Strait of Gibraltar

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The generation of large-amplitude internal waves in the Strait of Gibraltar has been examined for the first time with a three-dimensional, fully nonlinear, non-hydrostatic numerical model. The aim of numerical efforts was the assessment of transversal effects, potentially significant in the area due to the irregular bottom topography of Camarial Sill (the main sill of the strait), variable background stratification (variable pycnocline depth across the channel due to Earth's rotation) and spatially-dependent barotropic tidal forcing. Model results show that during the flood tide, under moderate tidal forcing, two distinct hydraulic jumps are generated upstream over the eastern edge of Camarinal Sill. Downstream the baroclinic field is characterized by a plunging pycnocline where Mediterranean Water accelerates downslope over the western flank of the sill. These structures exhibit significant cross-channel spatial dependence and may appear alligned together across the channel leading to a complex baroclinic structure difficult to interpret from remote sensing images. Under strong barotropic forcing (spring tides) the usptream hydraulic jumps are shifted to the lee side of Camarinal Sill where a unique hydraulic jump is formed. The occurence of additional remarkable first and second-mode hydraulic jumps near smaller secondary sills in Tangier basin is also possible under moderate and strong tidal forcing, thus extending intense tidal mixing and energy dissipation to other areas of the Strait.