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Estimation of shelf-slope exchanges induced by frontal instability near submarine canyons

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The dynamics generated by the propagation of structures associated with an unstable density front and their interaction with submarine canyons are simulated and analyzed with a fine-resolution three-dimensional primitive equation coastal ocean model. In a first step, the density front over the slope is allowed to adjust to two bottom topographies: an idealized straight shelf and a shelf incised by a canyon. The stationary circulation over the idealized shelf exhibits a geostrophic balance. The canyon topography breaks this balance leading to large cross-shore and vertical motions in its vicinity. In a second step, a small perturbation is superimposed on the stationary frontal circulation for the two bathymetries. The perturbation over the shelf grows rapidly into a steepened backward breaking wave, characterized by significant cross-shore and vertical motions in the upper levels. In contrast, the canyon topography stabilizes slightly the growth of the perturbation; although cross-shore and vertical motions are intensified near the canyon topography in the whole water column. Finally, a new method uses model results to determine the shelf-slope exchanges based on the cross-shore and vertical displacements of the water is applied. Results show that cross-shore and vertical motions increased by the frontal instability and the canyon topography lead to a large exchange between shelf and open ocean waters.