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Dynamics of intensified downwelling circulation over a widened shelf

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This study reveals the dynamics behind intensified, down-slope, cross-isobath transport over a widened shelf during a downwelling event. We derived the unique regional dynamics from the analyses of potential vorticity (PV) and momentum balances using a three-dimensional numerical model over an idealized shelf. The intensified down-slope transport over the widened shelf was generated by a spatially strengthened positive PV advection that was removed by a concurrent PV dissipation of negative net frictional stress curl. An amplified geostrophic transport contributed the most to the down-slope transport over the widened shelf due to a strong along-isobath pressure gradient force (PGF), Py*. The down-slope transport was also partly enhanced by bottom Ekman transport. Py* was linked with the PV balance by net frictional removal of vorticity in the water column, which was largely associated with the shear vorticity field induced by downwelling jet over the widened shelf. The strengthened cross-isobath PGF, Px*, which was geostrophically formed and shaped by the spatially asymmetric isobaths of the widened shelf, determined the intensities of the jet and associated shear vorticity that regulated Py* and bottom friction transport, and, hence, the intensified down-slope, cross-isobath transport. We found that the down-slope transport over the widened shelf was strengthened in a stratified flow by the strengthened barotropic Px*, the concurrent jet, vorticity field, Py* and bottom friction due to increase of volume flux upstream of the widened shelf. The associated response in biogeochemical transport from both observation and modeling will also be presented.