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Internal wave propagation sensitivity to model vertical coordinate and resolution

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Oceanic General Circulation Models (OGCM) can almost be solely defined by their vertical coordinate. The necessary discretization of the physical space to apply numerical methods can lead to a misrepresentation of some physical processes. This is particularly the case at small spatial scales where mixing is involved as OGCMs do not have a sufficient spatial resolution to represent these processes. This work focuses on the role of the model vertical resolution on the Internal waves (IW) propagation and on the modal representation of IWs using idealized numerical experiments. We show how the model vertical resolution and the choice of isopycnic or eulerian (i.e., geopotential or terrain following models) coordinate impact the IW propagation in an idealized context. The IW are generated over a continental slope and forced by an S2 barotropic tide in a two dimensions domain. Three different initial stratifications are used to allow for IW propagation: a two-layer ocean, a depth constant Brunt-Väisälä frequency (N) and a mixed layer above a depth constant N. Step stratifications can be challenging for OGCMs and any model vertical coordinate inducing abrupt changes in the water masses properties. These changes would imply a modification of the IW characteristics with respect to time in eulerian coordinate ocean model. Despite a spurious diapycnal mixing associated with the fixed vertical coordinates, we show that model solutions converge for high model vertical resolution (80 levels) and for all the stratifications. Coarser model vertical resolutions (40 levels) show that there is a wave phase lag and/or amplitude modulation between the isopycnic and eulerian vertical coordinates. For these vertical resolutions, an isopycnic experiment using a time-evolving stratification from an eulerian coordinate simulation is ran as an initial conditions. Because there is no diapycnal mixing in a fully-isopycnic coordinate system, the changes in the IW wave field due to the spurious mixing is diagnosed. The actual model vertical resolutions are likely to induce biases in the internal wave field and their propagation thus inducing unrealistic vertical mixing rates in global/regional simulation. With this study, we aim to define a vertical model resolution threshold for OGCMs below which, these biases could vanish or be negligible.