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What does vertical velocity tell about the behavior of numerical schemes ?

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Vertical velocities are often overlooked when assessing the realism of ocean simulations. This is legitimated by the intensity of grid-scale fluctuations in the vertical velocity fields especially in z-coordinates models and the absence of direct observations. Nonetheless, vertical velocities provide an indication of the numerical noise and dynamical imbalances and might provide guidelines to improve ocean models on physical bases. Here, we show that small-scale vertical velocity structures provide information about simulated current-topography interactions.

Widespread biases associated with badly resolved current-topography interactions (Gulf Stream overshoot, absence of eddy-driven topographically-locked structures) are drastically reduced in the global 1/4° DRAKKAR model, i.e. the OPA9 z-level ocean model coupled to the LIM multi-layered sea-ice component, when partial-step topography is used in combination with an enstrophy-and-energy-conserving momentum advection scheme. Analytical studies and sensitivity tests with the DRAKKAR 1/4° North Atlantic model have been performed to investigate the origin of these improvments.

Partial step topography is shown to reduce significantly small-scale vertical velocity structures in the vicinity of steep topographic slopes. Different momentum advection schemes are compared and their sensitivity with respect to grid scale structures is tested. The results suggest that the partial-step topography and the enstrophy-energy-conserving momentum advection scheme act jointly via grid-scale vertical velocity structures, and ultimately via energy dissipation, to shape the vertical structure of

simulated currents. This stresses the importance to look at vertical velocities in order to improve coupled physical-biological models.