A Velocity Independent Pressure Drag for Sub-Critical Two-Layer Shallow-Water Flow Around an Inclined Oceanic Ridge : a Numerical Study

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Abstract

We present results from numerical simulations which show that the pressure drag of a sub-critical two-layer shallow-water flow, in a rotating frame, around an inclined ridge is almost independent of the fluid speed for a large range of Froude numbers. This behavior is observed for barotropic and baroclinic flows approaching the ridge. This result is a counter example to what is actually believed in geophysical fluid dynamics and employed in parameterizations of topographic effects, which are commonly based on a quadratic drag law.

The behavior is explained by the observation that for larger fluid speeds the fluid crosses the ridge at lower depth leading to a shorter path-length. As the frictional head loss is a product of the velocity and the path length, both compensate.

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