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Product water mass formation by turbulent density currents from a high-order nonhydrostatic spectral element model

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In light of the pressing need for development of parameterizations of gravity current entrainment in ocean general circulation models, the behavior of turbulent gravity currents in the presence of ambient stratification is studied via numerical simulation, for cases in which equilibrated product water masses are formed. The main objective is to explore how the ambient stratification impacts entrainment and the properties of product water masses, which are of ultimate interest to ocean and climate modelers. Numerical experiments are conducted by employing the high-order nonhydrostatic spectral element model Nek5000. It is investigated how the separation level of the current from the bottom, the propagation speed, the salinity of the product water masses, and the transport and entrainment of the gravity current are affected as a function of the strength of the ambient stratification and the slope angle. Results show that, for the case of constant slope angle and linear ambient stratification, the gravity current separates from the bottom such that the entrained mass flux is independent of the slope angle. The entrainment mass transport, product mass transport, and product salinity then depend only on the ambient stratification, and these quantities are approximated as simple algebraic functions of the ambient stratification parameter that modify the source properties.