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Mixing behind the head of a gravity current propagating over a free-slip boundary ALBERTO SCOTTI, Dept. of Marine Sciences — Three-dimensional numerical simulations of a gravity current propagating over a free-slip boundary show that behind the head two states are possible: a high-mixing state, characterized by the development of initially two-dimensional billows, and with characteristics similar to the ones observed for purely two-dimensional simulations; and a low-mixing state, in which the primary mode of instability is a mix of spanwise convective and centrifugal instabilities, and hence accessible only to three-dimensional simulations. The latter state appears at values of the Grashof number lower than the critical value Gr_c for the formation of unsteady billows in two-dimensional flows, and persists above Gr_c over the span of Grashof numbers considered. To access the high-mixing state, it is necessary to add a source of turbulence ahead of the foot of the current. At high values of the Grashof number, the intensity of rms turbulent fluctuations necessary to switch to the high-mixing state is small (0.5% of the speed of propagation) and may explain why the low-mixing state has so far eluded experimental detection. In the low-mixing state, the flow becomes three-dimensional near the head due to centrifugal instabilities caused by the curved streamlines. This instability of the outer flow is coupled to convective instabilities that develop within the heavy fluid in the head, and suppress the formation of billows.

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