Density current and internal waves interactions - observations in the Louisiana Bight

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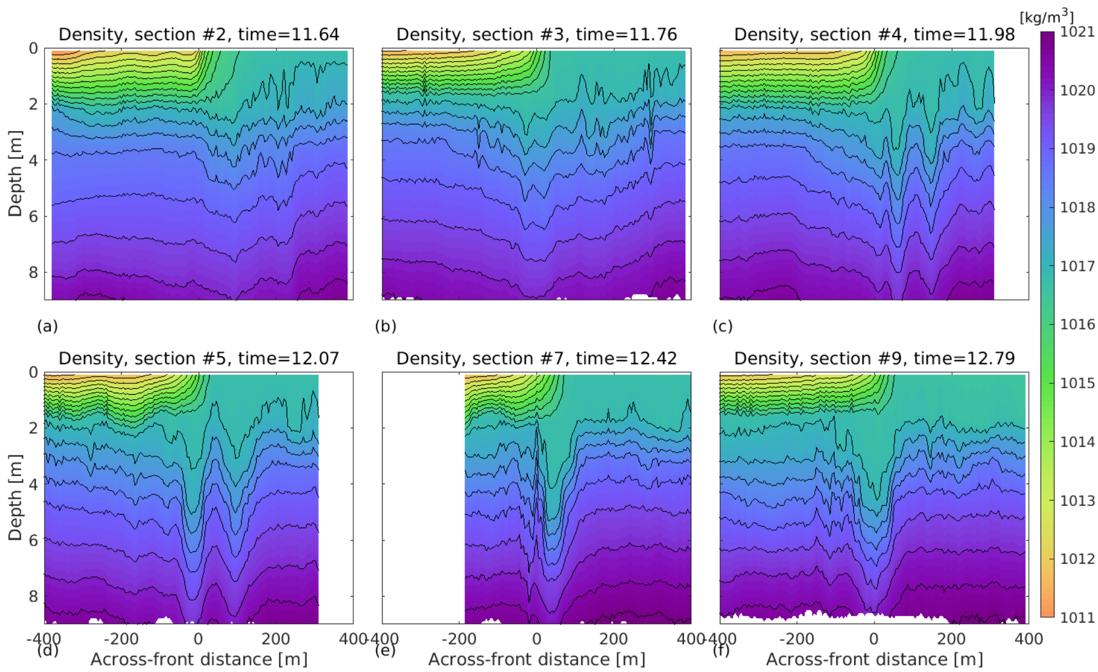
Density currents are ubiquitous in diverse natural environments, a very partial list including desert dust storms (Haboobs), mud-floods (e.g., Lahars), Katabatic winds, sea breezes, and sewer outflows to the sea. We present concurrent in-situ and remote-sensing observations of a buoyant density current formed by the outflow of the Mississippi river into the Louisiana Bight. Unlike most observations hitherto the ambient conditions were strongly stratified. We therefore present the first comparison of recently developed *stratified* density current theory (e.g., Ungarish 2006) against field observations. The stratified conditions can support internal gravity waves (InGW), which we indeed observe as well. We observe a series of regime changes in InGW amplitude, and in density current speed occur over the observational period. The regime changes are controlled by changes in the Fr number, i.e., density current speed relative to long InGW speed, consistently with theory. We solve the Taylor-Goldstein equation and the Korteweg-de Vries equation, respectively, for determining the speeds of small and finite-amplitude InGW. In the critical regime (Fr~1) finite-amplitude InGW appear and are locked to the density current front. In this case, nonlinearity appears crucial to InGW sustainment as it enhances the linear wave speed significantly. The observed density current speed is in good agreement with steady stratified theory for Fr>=1. However, in the subcritical regime (i.e., Fr<1), in which InGW overrun the front, density current speed is reduced significantly, consistent with lab experiments in which the reduction occurs through interaction with InGW. Finally, we demonstrate that the Fr changes and hence the regime changes are spurred by a reduction in InGW speed as the density current propagates to shallower water. Time permitting, I will also discuss the role of discharge fluctuations in forcing cross-bight motion of the plume, as well as the density current frontal convergence field and vertical mixing within it.



Density measurements down to 9 meters across the density current front. Measurements taken by boat using a towed-instrument-array during the propagation of the front. Finite-amplitude internal gravity waves develop at the density current front.