MODELING A GRAVITY CURRENT IN CORPUS CHRISTI BAY USING A SIGMA COORDINATE MODEL

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On the Texas Coast, a dense gravity current of hypersaline water has been observed flowing into Corpus Christi Bay out of Oso Bay. Episodic hypoxic conditions have also been observed in the bottom waters of Corpus Christi Bay [1], and recent field studies by the authors and associates show a correlation between the gravity current and hypoxia. Understanding and modeling the physics of underflows in a shallow system may help determine the cause and extent of this hypoxia.

Our ability to capture the physics of gravity currents via numerical models has increased dramatically in the past 10-20 years. The present work examines the formation and transport of a gravity current in a sigma coordinate model. We discuss the impact of vertical grid resolution on gravity current flow, and how model errors may affect predictions of thin-layer stratification in a shallow bay. We apply these results to a simplified model of the Oso Bay inlet into Corpus Christi Bay.

The work presented herein is both a conceptual study of gravity current representation in the Environmental Fluid Dynamics Computer Code (EFDC) [2], and an application of our results to a simulation of Corpus Christi Bay. EFDC is a three-dimensional, hydrostatic, primitive-equation model with a 2.5 level Mellor-Yamada turbulence closure. We examine the numerically-induced changes in flow characteristics resulting from grid resolution to determine the appropriate resolution for simulating the underflow exiting Corpus Christi Bay. Field data is used for initial conditions and to validate our simulation results. Because Corpus Christi Bay is both shallow and stratified, we isolate the forces acting on the bay in an effort to understand the role each force plays on the system.

The impact of numerical effects on modeling a shallow bay are discussed and illustrated in modeling the underflow from Oso Bay into Corpus Christi Bay that was documented by field studies in 2005. Numerical entrainment caused by poor vertical grid resolution results in artificial mixing and smoothing of the density gradient. This artificial mixing lowers the work required by wind forcing to mix the water column, and bottom water isolation may therefore be under predicted. These complications and their implications for modeling Corpus Christi Bay are discussed.

References

[1]C. Ritter and P. A. Montagna, "Seasonal hypoxia and models of benthic response in a Texas Bay," *Estuaries*, **22**, 7-10, 1999.
[2]J. Hamrick "A Three-dimensional Environmental Fluid Dynamics Computer Code: Theoretical and Computational Aspects," The College of William and Mary, Virginia Institute of Marine Science, Special Report 317, 1992.

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