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The Influence of Upper Ocean Salinity Stratification on Tropical Cyclone Intensity as Determined Through Idealized, Coupled Numerical Simulations

James Hlywiak and David Nolan

University of Miami, Rosenstiel School of Marine and Atmospheric Sciences, Atmospheric Sciences, Miami, FL, United States (jhlywiak@rsmas.miami.edu)

A common feature located in the Western North Atlantic Ocean is the Amazon-Orinoco freshwater river plume, which is a vast expanse of fresh riverine waters advected northward from the mouths of the Amazon and Orinoco river systems by the North Brazil Current. Oceanic layers comprising strong salinity gradients between the mixed and isothermal layer (ML, IL) depths, called oceanic barrier layers (OBLs), add stability to the upper ocean column in this region and resist the vertical mixing and sea surface temperature (SST) cooling that occur from intense surface wind stresses. This region is frequently host to strong tropical cyclones (TCs) during the North Atlantic hurricane season. Here, idealized ensembles of simulations using the Weather Forecasting and Research model (WRF V3.9.1.1) coupled to the 3D Price-Weller-Pinkel (PWP) model are used to show that the presence of the OBL can limit reductions of SSTs underneath TCs. This can lead to additional intensification of TCs by as much as $6 - 15$ % for OBLs 30 m thick. Sensitivity tests to atmospheric vertical wind shear, storm translation speed, and initial ocean ML temperatures show that the relationship between the OBL and TC intensity is best-correlated for storms translating at or around 4 m s-1, whereas slower storms in more marginal shear and ML temperature environments have the potential for the greatest intensity increases. Lastly, it is shown that the overall intensity results are similar when using a 3D or 1D representation of PWP, however the correlation of intensity changes to OBL thickness is stronger when neglecting upwelling and advection.