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Tropical Cyclone Induced Air-Sea Interactions Over Oceanic Fronts

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Recent severe tropical cyclones underscore the inherent importance of warm background ocean fronts and their interactions with the atmospheric boundary layer. Central to the question of heat and moisture fluxes from the ocean to the atmosphere, the amount of heat available to the tropical cyclone is predicated by the initial depth of the mixed layer and strength of the stratification level that set the level of entrainment mixing at the base of the oceanic mixed layer. For example in oceanic regimes where the ocean mixed layers are thin, shear-induced mixing tends to cool the upper ocean (and sea surface temperatures) quickly which reduces the air-sea fluxes. This is an example of negative feedback from the ocean to the atmosphere. By contrast, in regimes where the ocean mixed layers are deep (usually along the western part of the gyres), warm water advection by the nearly steady currents reduces the levels of turbulent mixing by shear instabilities. As these strong near-inertial shears are arrested, more heat and moisture is available through the sea surface. When tropical cyclones move into favorable or neutral atmospheric conditions (low vertical shear, anticyclonic circulation aloft), tropical cyclones have a tendency to rapidly intensify as observed over the Gulf of Mexico during Isidore and Lili in 2002, Katrina and Rita in 2005, Dean and Felix in 2007 in the Caribbean Sea, and Earl in 2010 just north of the Caribbean Islands. To predict these tropical cyclone deepening (as well as weakening) cycles, coupled models must have ocean models with realistic ocean conditions and accurate air-sea and vertical mixing parameterizations. These effects and possible impact on TC deepening and weakening underscores the necessity of having complete 3-D ocean measurements juxtaposed with atmospheric profiler measurements.