Climate Change and US East Coast Cyclones

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Previous studies have investigated a wide range of potential climate warming impacts, including shifts in the midlatitude storm tracks, and changes in the frequency and intensity of midlatitude cyclones. Fewer studies have directly investigated the effect of climate warming on the dynamics of individual cyclones. Determining the effects of this warming on extratropical cyclones is complicated by competing processes within the atmosphere. Northern Hemispheric near-surface baroclinicity is projected to decrease as a result of Arctic amplification, while upper tropospheric baroclinicity is projected to increase at some altitudes. Atmospheric water vapor concentrations also increase with warming, which presents the possibility of increased condensational heating in extratropical cyclones, and thus the potential for enhanced diabatic potential vorticity change. In order to better understand the cumulative effects of these processes, quasi-idealized extratropical cyclone composites are studied for the winter months (DJF) along the United States East Coast. The Weather Research and Forecasting (WRF) model is used to simulate a generic composite coastal storm, as well as each individual event comprising the composite. End-of-century thermodynamic changes derived from five Intergovernmental Panel on Climate Change (IPCC) General Circulation Model (GCM) simulations, for the A2 emissions scenario, are applied to initial and boundary conditions to isolate the affects of these thermodynamic changes on the cyclone dynamics. Cyclone composites are divided into subsets based on storm characteristics including coastal cyclogenesis type, deepening rate and precipitation rate. Individual cases of particular interest and sensitivity of results to compositing technique are also addressed. Analysis of individual cases and composites shows that US East Coast cyclones move more quickly and track further east in a warmer climate. Despite moving more quickly, future cyclones also produce a greater amount of precipitation, implying a large increase in precipitation rate. Changes in cyclone intensity are more uncertain and require additional analysis. Rain rate, snowfall, and near-surface wind speed changes are also investigated.