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Sensitivity of tropical cyclone forecasts

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In this study, linear sensitivity analysis in the form of singular vectors is applied to understand the relationship between tropical cyclone structure and motion, and to examine the influences of the background flow on tropical cyclone movement. Singular vectors represent the fastest growing (linear) perturbations to a given trajectory. The SVs are calculated using the dry tangent and adjoint models of the Navy Operational Global Atmospheric Prediction System (NOGAPS) that have been linearized about the full-physics high-resolution operational forecasts. We use the SV tools to study the large-scale dynamical processes that influence storm motion. This sensitivity can occur in regions both local and remote to the initial tropical cyclone. It is found that straight-moving and recurving storms exhibit systematic differences in initial sensitivity patterns. The straight moving storms are particularly sensitive to the analyses of the rear quadrants of the storm, about 5 degrees from the storm center, where the vortex potential vorticity (PV) gradient changes sign. The recurving storms also exhibit sensitivity where the PV gradient changes sign. However, for these recurving cases, there is no preferred quadrant, and the maximum sensitivity is collocated with the inflow region with respect to the storm center. Recurving storms also exhibit strong sensitivity to the upper-level potential vorticity field in regions of confluent flow. The importance of PV gradient structure on the storm evolution is discussed. Implications for adaptive observing will also be discussed.