Relationship between track and structural evolution of Hurricane Sandy near landfall

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Hurricane Sandy underwent a complex extratropical transition, acquiring a short-lived warm seclusion structure as it approached landfall. The relationship between the track of Sandy and its structural evolution is explored using an ensemble of 72 Weather Research and Forecasting (WRF) Model (Version 3.8) simulations initialized at 00 UTC 27 October. Initial and boundary conditions for each simulation are obtained from global ensemble forecasts initialized at 00 UTC 25 October from the European Centre for Medium-Range Weather Forecasts and the National Center for Environmental Prediction. Regression mixture model clustering is used to partition the 72 simulated tracks of Sandy into six clusters. The cluster composites are examined, and representative members from the four most populous clusters are selected for detailed analysis.

The timing of extratropical transition (ET) varies substantially among clusters, with members of clusters in which Sandy moves more westward undergoing ET earlier than simulations in which Sandy takes a more easterly track. However, the development of a transient warm seclusion prior to landfall occurs in nearly all simulations in which Sandy makes landfall. Simulations in which Sandy moves more quickly toward landfall are associated with a more intact lower tropospheric warm core at the time of landfall.

In-depth analysis of representative ensemble members show how the synoptic and mesoscale features critical to the ET evolution of Hurricane Sandy vary among simulations, with differences in ET being linked to both absolute track and with track relative to the Gulf Stream and the mid-latitude trough over the eastern United States. Diagnostics such as frontogenesis and low-level PV evolution are used to illustrate the relevant processes and the sensitivity of these processes in governing Sandy’s ET and its secondary intensification prior to landfall.