Ventilation and evolution of storm structure
during extratropical transition of tropical cyclones

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Predictability of midlatitude weather systems is frequently compromised by tropical cyclones that undergo extratropical transition (ET) in the far upstream region. This loss in predictability has its origin in uncertainties in the evolution of the ET system itself. These uncertainties ultimately project onto midlatitude Rossby wave packets and may affect a near-hemispheric region.

This study focuses on the origin of the forecast uncertainties and analyzes the deep convection near the storm center and the complex dynamics and thermodynamics that govern the changes of storm structure during extratropical transition.

The basic hypothesis is that the intrusion of low-entropy environmental air into the ET system’s convection plays a key role in the overall evolution of the storm and its structure. To gain a better insight into this highly nontrivial ventilation processes, we apply a Lagrangian trajectory analysis to identify the main streams of cold and dry ambient air into the inner-core convection of the storm. We will analyze convection-permitting COSMO simulations with online-trajectories for two contrasting ET cases. One case is the ET of Karl (2016), which was a rather weak tropical cyclone that was sampled during a recent field campaign. The other case is the ET of Katia (2011), which was a major Hurricane.

To identify the main air streams associated with an ET system and differentiate between trajectories that enter the inner-core convection through the boundary layer and trajectories that intrude from above the boundary layer, we objectively identify subsegments of trajectories using a partition-and-group approach. The storm ventilation is characterized by the evolution of the thermodynamic properties along these air streams. A concomitant analysis of the storm structure in terms of vortex tilt, convective asymmetries and incipient low-level frontogenesis links storm ventilation to structure change.