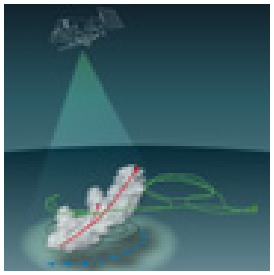

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Rapid ascents embedded in a warm conveyor belt observed and modeled at kilometer-scale resolution

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During the NAWDEX field campaign, the RASTA Doppler radar aboard the French Falcon-20 provided unique cloud and wind measurements inside the warm conveyor belt (WCB) of the "Stalactite"cyclone. Vertical structures of high radar reflectivity—of ˜20-km width and 2–4-km height—were observed embedded in a broad cloud structure extending over the whole troposphere. A low-level jet with wind speed above 35 m/s was found below at 1 km altitude, while the upper-level jet stream reached 45 m/s aloft.

A convection-permitting simulation using the Meso-NH model reproduces the observed structures well and highlights vertical velocities up to 0.5 m/s. A Eulerian budget analysis shows a peak in diabatic heating at 6–7 km altitude due to condensation and deposition on ice crystals within the WCB. Lagrangian trajectories computed online during a 12-h window allow identification of rapidly and slowly ascending WCB air masses. Rapid WCB ascents, as defined by a 2-h pressure decrease above 100 hPa, are associated with the vertical structures of high reflectivity and located behind the cold front. They are characterized by the presence of graupel and low static stability below the upper-level jet, while slow WCB ascents are found in the upper part of the broad cloud structure.

Extending the analysis to the whole simulation domain shows that one third of WCB trajectories exhibit phases of rapid ascent and confirms their preferred location at the cold-frontal edge of the WCB and at lower altitude than slow ascents, which are more widespread across the core of the WCB. The large majority of rapid ascents ends up in the cyclonic branch of the WCB but, compared to slow ascents, a larger fraction exhibits outflow with negative potential vorticity. This result suggests that rapid ascents impact the evolution of both the cyclone and the upper-level dynamics.

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