Warm conveyor belts: dynamical significance and forecast verification

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During their intensification and in the mature stage, extratropical cyclones are typically associated with three coherent major airstreams – the dry intrusion, the cold conveyor belt and the warm conveyor belt (WCB), respectively. These airstream are important for the dynamics of the cyclone evolution. Climatologically, they are key for the meridional and vertical transport of water vapor and heat, and they link the atmospheric boundary layer with the tropopause region.

The rapid ascent of WCBs from the boundary layer to the upper troposphere in about 1-2 days leads to cloud formation, (intense) precipitation and the release of latent heat. Through diabatic processes their potential vorticity (PV) value is modified in a significant way. Typically WCBs reach the tropopause level with low absolute PV values (~0.5 pvu) and through this cross-isentropic transport of low-PV air they can amplify the upper-level Rossby waves and contribute to the formation of PV streamers downstream. These in turn can act as precursors of extreme weather events and/or trigger the genesis of another cyclone. Considering the quality of numerical weather predictions, an underestimation of the frequency and/or intensity of WCBs can lead to an underprediction of the intensity of upper-level ridges and in turn develop into a poor-quality medium-range weather forecast. It is therefore important to quantify the quality of WCBs in numerical weather forecasts and to investigate in detail the effects of a misrepresentation of WCBs on the downstream flow.

In this study, WCBs are determined in operational analyses and deterministic forecasts from the global ECMWF model. WCBs are identified from comprehensive trajectory calculations that select air parcels in the vicinity of cyclones with a minimum ascent of 600 hPa in 48 hours. Using a slightly modified variant of the feature-based verification technique SAL, errors in the location and intensity of WCBs in the ECMWF forecasts are quantified for three winters with a particular focus on the North Atlantic. First results indicate that several episodes with a poor forecast performance in terms of the 300-hPa geopotential height anomaly correlation coefficient are also characterized by significant errors in the representation of WCBs. A few of these cases will be analyzed in greater detail.