Influence of diabatic processes on the PV development in a warm conveyor belt

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Warm conveyor belts are frequent features of extratropical cyclones in the Northern Hemisphere. In the strongly ascending airstreams clouds are forming and the latent heat release leads to the intense cross-isentropic upward motion. The potential vorticity (PV) in the conveyor belt is strongly influenced by the latent heating associated with the various microphysical processes occurring during the formation and evolution of clouds. The first order effect is that PV increases below the level of maximum diabatic heating and decreases above. Thus, the conveyor belt reaches the upper troposphere with low PV values. Due to the coherency of the flow, this cross-isentropic transport of low-PV air has the potential to significantly influence the large-scale dynamics mainly downstream of the conveyor belt outflow region. In order to quantitatively assess the influence of the different microphysical processes like condensation, freezing, evaporation, sublimation, etc. on the diabatic heating rates and associated PV development during the ascent, a Lagrangian analysis is used in this study and applied to regional model simulations of selected warm conveyor belt events. First, simulations with the COSMO Model are performed in order to calculate the individual diabatic heating rates caused by various transfer processes between the different hydrometeor species. Then, the diabatic heating rates and the associated change in PV are calculated along trajectories in a warm conveyor belt. The relative role of the different microphysical processes is quantified for the latent heating and the diabatic PV modification, for which the gradient of the latent heating plays the crucial role. It is shown, that ice phase processes as well as condensation/evaporation strongly modify the PV during the ascent. Therefore, small-scale microphysical processes have the potential to modify the large-scale dynamics due to the outflow of warm conveyor belts in to the extratropical upper troposphere.