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Relevance of warm conveyor belts for the dynamics of weather systems and the radiation budget in the extra-tropics

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Warm conveyor belts (WCBs) are warm and moist airstreams in extra-tropical cyclones. They originate in the warm sector of the cyclone close to the surface and ascend in approximately two days ahead of the cold front to the upper troposphere. During the ascent, clouds and precipitation are forming and thus WCBs can be identified on satellite imagery as elongated cloud bands.
Due to the cloud formation which is associated with the release of latent heat, WCBs are important for the dynamics of extra-tropical cyclones. The main process behind is the modification of potential vorticity (PV) due to the latent heating/cooling. In a first order, PV is produced below the maximum of diabatic heating and destroyed above. Thus, WCBs produce a positive PV anomaly in the mid-troposphere and a negative PV anomaly in the outflow in the upper troposphere. The positive anomaly can be important for the cyclone intensification and/or mesoscale dynamics along the cold front whereas the negative anomaly influences the large-scale upper tropospheric PV pattern.
On the other hand, WCBs are important for the radiative budget in the extra-tropics. As they represent the main cloud producing airflow in extratropical cyclones they are responsible for the formation of a great part of condensate (liquid and ice) in the storm track regions. Subsequently, they are also responsible for a great part of the cloud radiative forcing and thus strongly influence the radiative budget in the extra-tropics.
This presentation consists of two parts. In the first part we focus on the potential of WCBs to modify the PV. It is shown how the various microphysical processes occurring during the formation of clouds modify the PV along WCB trajectories. Therefore a simulation of a WCB with the regional NWP model COSMO is analyzed in detail. It can be seen that the condensation of water vapour as well as the depositional growth of snow strongly contribute to the latent heating in the WCB and therefore also modify the PV.
In the second part, the relevance of WCBs for the liquid and ice water path as well as the cloud radiative forcing is presented. An existing WCB climatology which is based on the ERA-Interim dataset is used in order to calculate the liquid and ice water path as well as the short and longwave cloud forcing which are associated with WCBs. The results show that in the storm track regions a considerable amount of the condensate and cloud forcing is related to WCBs.