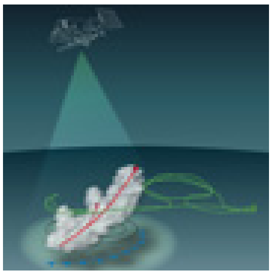

Contribution ID: **18**

Type: **Oral presentation**

The importance of warm conveyor belts for (upscale) error growth

Tuesday, 10 March 2020 11:25 (25 minutes)

This presentation introduces a quantitative potential-vorticity (PV) framework to quantify the processes governing the amplification of forecast errors and forecast uncertainty. The framework is based on the well-established PV perspective of midlatitude dynamics. A tendency equation is derived for error-potential enstrophy and applied to a series of numerical upscale error-growth experiments, in which the only difference between the ensemble members lies in the random seed of the stochastic convection scheme. Our analysis identifies distinct stages of error growth: In the first 12h, latent-heating differences induced by the convection scheme dominate the error growth near the tropopause. In the following 1.5 days, the dominant error-growth contribution is given by upper-tropospheric divergence displacing the strong midlatitude PV gradient. After two days, differences in the nonlinear Rossby-wave dynamics near the tropopause dominate the error growth. Prominent upper-tropospheric divergence is often associated with warm conveyor belts (WCBs). Our analysis thus indicates that WCBs play an essential role for upscale error growth by projecting errors from moist processes into the tropopause region.
The results from the upscale error-growth experiments are compared with the amplification of forecast uncertainty in an operational ensemble forecast covering the NAWDEX Golden Case "Karl". With a newly developed framework, we quantify the contributions of individual processes to the evolution of ensemble spread. Averaged over the midlatitudes of the Northern Hemisphere, the amplification of ensemble spread is dominated by near-tropopause dynamics, highlighting that the uncertainty related to the initial conditions is still larger than the uncertainty related to moist processes. Locally, however, there can be large differences as in the region where tropical storm Karl interacts with the Rossby-wave pattern during extratropical transition. In this region, the variance amplification is mostly related to the moist baroclinic cyclone development, including strong upper-tropospheric divergence, which again indicates a prominent role of WCB development for projecting forecast uncertainty onto the large-scale circulation.

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Session Classification: Session 2

Track Classification: Workshop: Warm Conveyor Belts –a challenge to forecasting