The impact of midlatitude cyclones on Rossby wave packets: a composite-study.
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The formation, movement, and decay of midlatitude cyclones are closely related to the propagation of Rossby wave packets (RWPs) along the midlatitude jet. It is often expected that RWPs, as large-scale flow features obeying balanced dynamics, exhibit a large degree of predictability, which may then be inherited by smaller-scale weather features such as midlatitude cyclones. On the other hand, cyclones feed back on the evolution of RWPs, e.g. by promoting baroclinic wave amplification and by ridge building due to upper-tropospheric, diabatic outflow. The latter process, in particular, is associated with increased forecast uncertainty and may compromise medium-range predictability in the downstream region.

To obtain a more complete understanding of the upscale impact of cyclones, we investigate the processes governing RWP evolution relative to the life cycle of midlatitude cyclones. A quantitative potential vorticity (PV) – potential temperature framework is employed, in which the governing processes manifest as group propagation of Rossby waves, baroclinic growth, the impact of upper-tropospheric divergent flow, and direct diabatic PV modification. Up- and downstream of cyclones, individual troughs and ridges are examined from a composite perspective, which is based on the phase of the cyclone’s life cycle. A first-order impact of upper-level divergent flow is found for the amplification of the downstream ridge. We interpret this amplification as an indirect impact of latent heat release associated with cloud processes below. Our preliminary results indicate that the diabatic ridge building occurs earlier during the cyclone’s life cycle than ridge amplification by baroclinic growth. Based on these results, we suggest extending the prevailing paradigm of downstream baroclinic development to include the systematic impact of moist processes.