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Potential vorticity diagnostic to quantify effects of latent heating in midlatitude cyclones

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The formation and intensification of midlatitude cyclones requires baroclinic instability. Beside this adiabatic energy source, latent heating (LH) due to cloud formation can be an important diabatic contribution mainly during cyclone intensification. To improve predictions of changes in midlatitude cyclone intensity, frequency, and tracks in a future warmer and moister climate, a more systematic and quantitative understanding of the role of LH is required. In this study, a diagnostic is developed to systematically quantify the LH effects over the lifetime of a midlatitude cyclone. It makes use of the first-order assumption that the low- and mid-tropospheric potential vorticity (PV) during the intensification can be explained by a balance between diabatic PV generation and its vertical advection. The simple diagnostic can be applied to output of numerical weather prediction models, (idealized) climate models, and to reanalysis data. This versatile application does not only allow us to systematically understand the role of LH in midlatitude cyclones under different climate conditions but also to quantify the sensitivity of the LH processes to different spatial resolutions of climate models.