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Diabatic potential vorticity anomalies in extratropical cyclones in idealized simulations of changed climates

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The response of extratropical cyclone intensity to climate warming is governed by several partly opposing mechanisms, whose representation in models is associated with substantial uncertainties. Here the role of one specific mechanism, the contribution of latent heat release due to cloud formation to cyclone intensification, is investigated with the help of idealized climate model simulations in an aquaplanet setup and making use of the potential vorticity (PV) framework. A simple diagnostic theory is developed that quantifies the contribution of latent heating to PV anomalies within cyclones. The theory is able to explain the increase of lower-tropospheric PV in intense cyclones with climate warming over a wide range of simulated climates. As this rise in PV goes along with an increase also in cyclone intensity (measured in terms of near-surface relative vorticity), the theory provides a useful framework to understand the increasing importance of diabatic processes for cyclone intensification in warmer and more humid climates.