

Summary:

The authors investigate the development processes of the cold-season East Asian Cyclones over the Korean Peninsula using a potential vorticity tendency analysis of cyclone-tracking composites. Through the detailed PV budget analysis, they reveal the different roles of the horizontal PV advection, vertical PV advection, latent heating release in the development of two groups of extratropical cyclones passing the Korean Peninsula (northern- and southern-track cyclones). They found that northern-track cyclones are dynamical dominant while the southern-track cyclones are both dynamical and thermodynamical driven.

Recommendation:

Several prior studies on the extratropical cyclones from potential vorticity tendency analysis have been predominantly statistical in nature. These studies put their focuses on oceanic extratropical cyclones either in North Pacific or North Atlantic. I believe that this study brings an important contribution by assessing the dynamical and thermodynamical processes in the development of continental extratropical cyclones. I thus recommend the authors to perform a major revision by considering the comments listed below.

Major comments:

The advantage of using the PV framework is that it provides a simple way to include the role of diabatic heating due to latent heating release and radiation. In this manuscript, the radiation and friction are put together into one term F_{res} as in Eq. (1). And in the following sections, the contributions from radiation and frictions are not shown as well. However, as suggested in Tamarin and Kaspi 2016, the radiation contribution seems larger than the vertical PV advection in the cyclone development. Could the authors add some discussions on the estimation of radiation effects on the East Asian extratropical cyclones?

In Fig.8, the authors quantify the relative contributions of each component to the 850-hPa relative vorticity tendency from upper troposphere and lower troposphere. However, the detailed method for the algorithm and vertical decomposition is not described in the manuscript. Is it a piecewise PV inversion method in which the wind is decomposed from upper level and lower level? Could the authors explain the reason to choose the 600-hPa level to understand the behavior of 850-hPa relative vorticity? Please also specify the range of the upper-troposphere and lower-troposphere in line 257. For example, 175-600 hPa for upper troposphere and 600-875 hPa for lower troposphere. Is it a vertical average?

Minor/Specific comments:

Line 12: "... the respective contributions to the ST cyclones are 71.8% and 43.5% for the ST cyclones..." Two times of ST cyclones are found in this sentence. Maybe delete one of them?

Line 76: travels → travel

Line 79: is selected → are selected

Line 80: More than 25 ETCs impact the region in each along the two distinct ETC tracks. Could the author specify the time period (e.g. per year) to help the reader?

Line 195: ...at a single level as in Figs. 4c and d..., perhaps the authors mean Figs. 5c and d?

Line 261: is derived → are derived

Line 291: exist → exists, then than → then