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Interactive comment on "Observations and simulation of intense convection embedded in a warm conveyor belt – how ambient vertical wind shear determines the dynamical impact" *by* Annika Oertel et al.

Jeffrey Chagnon (Referee)

jchagnon@fsu.edu

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Summary:

This article presents a thorough and careful analysis of Lagrangian particles in the warm conveyor belt (WCB) of a cyclone that was simulated using the high-resolution COSMO model. Cyclone Sanchez was also the subject of an Intense Observing Period (IOP) during the NAWDEX field campaign. The study establishes that 1) the convective nature of the WCB in Cyclone Sanchez was simulated reasonably well in COSMO compared to observations, 2) the intensity of convection varied according to the location along the cold front, and 3) only a weak horizontally-oriented potential vorticity dipole accompanied the convective trajectories. This third result, which is perhaps the most interesting outcome of the analysis, is hypothesized to be a consequence of the very weak vertical shear of the environment where ascent took place. A previous case study by Oertel et al. (2020) demonstrated a much larger amplitude PV structure in a cyclone where the environmental shear was larger.

The paper is well written, well organized, and very well presented. The analysis leverages a suite of tools for the analysis of trajectories that have time and again proved their value in revealing the detailed structure and dynamics of extratropical cyclones. I can find no major errors in the design, execution, and interpretation of the experiments. Overall, this work makes a valuable contribution to an ongoing area of research concerning the role of embedded convection in modifying the structure and evolution of an extratropical cyclone. I am therefore pleased to recommend publication. I have several general comments for the authors to consider, but I endorse publication in its current form.

General comments:

1. The relationship between the environmental shear and the PV dipole orientation/amplitude is consistent with theory. The authors have now demonstrated this in two cyclones (i.e., Sanchez and Vladiana). The differences between these two cases are quite remarkable. Given a sample size of only two, how robust and generalizable are these results? We know that the environmental shear where parcels ascended convectively was quite different in these two cases. How representative are these two storms of the bigger population of extratropical cyclones? What accounts for the difference in shear? What might we expect of storms in different parts of the world or in different months? What else besides the shear distinguishes these two storms and may contribute to the differences? I appreciate that the analysis of a single case is a significant labor, so the scope of this paper is appropriate, and the authors do allude to

this issue in the very last sentence of the paper. Nevertheless, the conclusions section could benefit from an expanded discussion.

2. The focus of the discussion around Figure 8 (which shows the composited PV structures) is on the horizontal orientation of PV dipoles relative to the trajectories. A vertically-oriented dipole structure is also evident in the sections from Cyclone Sanchez. The negative pole of the vertical dipole is of large amplitude [i.e., O(1 PVU)] and appears to have a broad horizontal extent near the tropopause level. Why isn't this vertical dipole structure and its consequences discussed? It is noteworthy that such a structure is not as evident in the case of Cyclone Vladania. What accounts for the difference?

3. Finally, I am curious about the relationship between trajectory location, PV tendencies, and the fidelity of compositing PV from trajectories. The trajectories are selected based on their ascent rate. It is therefore likely that trajectories are collocated to regions of maximum diabatic warming. The associated PV tendencies are therefore likely to be minimized along the trajectories (and maximized on the periphery). In compositing the PV structures associated with many trajectories, one could envision a significant degree of destructive interference. This interference might be most significant when trajectories are positioned next to one another across the PV dipole axis (i.e., stacked on top of one another for vertical dipoles; horizontally adjacent to one another in a direction perpendicular to the shear for horizontal dipoles). Have the authors considered this?

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