The role of tropopause polar vortices in the intensification of summer Arctic cyclones by Gray, Hodges, Vautrey and Methven: Response to editor

The editor's comments are copied below in black with our point-by-point responses in blue.

- In your response to the reviewer's first comment, you state that "We do not assume that Arctic cyclones evolve from a tilted structure to a less tilted structure.". This is a bit in contrast to your statement in line 240 of the revised manuscript: "These feature separation thresholds were chosen assuming that the Arctic cyclones evolved from a tilted vertical structure to a less tilted vertically-aligned structure at maturity (maximum intensity)", which I think the reviewer was referring to. I understand that the assumption of the tilt is only needed to argue for the smaller required distance at the time of maximum intensity, but maybe you can still adapt the formulation a bit to avoid this contrast between the manuscript and your response.

The reviewer's first comment was "1) The assumption that Arctic cyclones evolve from a tilted structure to less tilted structure may apply for midlatitudes, but not necessarily the Arctic. While there is no question it applies for baroclinic waves, the Arctic may be a mix of waves, vortices, or both, but should theoretically be dominated by vortices (e.g., Hakim 2000)…"

Yes, you are correct of course Stephan that we do impose a smaller distance matching constraint at maximum intensity time than at the maximum growth rate time of the cyclone development. In our response we were referring to the fact that the tilt evolution and composite plots show how the structure of both the matched and unmatched composite cyclones evolve to be approximately barotropic at maximum intensity time – hence the un-tilting is a result of our analysis. Note that the matching distance is rather generous (increased to 5^{o} in the revised paper) at maximum intensity time and so this is unlikely to be a strong constraint, even for tilted systems. The appropriate scales for considering Arctic cyclones as vortices or waves are already discussed in the paper.

- In your response to another comment, you state that: " The composites are generated using cross-sections are centred on the cyclones and so will include all upper-tropospheric features (and any TPVs) in the vicinity of those cyclones at the reference time used for compositing.". I'm not sure that I understand this point: Of course, TPVs in any direction are considered in your matching approach, but in the vertical cross section, I only see anomalies along the direction of cyclone motion, right? So theoretically there may be vorticity anomalies in another direction (e.g., perpendicular to the track) that are not considered in these plots (corresponding to the "satellite TPVs" mentioned by the reviewer). Can you comment on this?

I'm sorry that our response was not clear here. Any TPV that influences the fields along the cross section taken along the direction of the movement of the cyclone will be included in the cross sections. It is possible that there are TPVs that do not strongly affect these fields, though in that case these TPVs would be unlikely to influence the development of the cyclone through the release of baroclinic instability. The following sentence has been added at line 442: "It is assumed that any TPV that affects the evolution of the cyclone lies approximately along these cross-sections, as required for growth by baroclinic instability release." To further demonstrate this point, the figure included here shows the cross-track (S-N if the cyclone travels eastwards) cross section of relative vorticity, potential temperature and potential vorticity through the composite matched cyclone at the time of maximum growth rate. This can be compared to Fig. 9f in the paper, which shows the same plot but for the along-track cross section. As can be seen here, the relative vorticity structure is

approximately vertical, unlike the rearward tilted structure in Fig. 9f. Hence, there is no indication that strong TPV features systematically exist in a direction normal to the cyclone motion at this time.

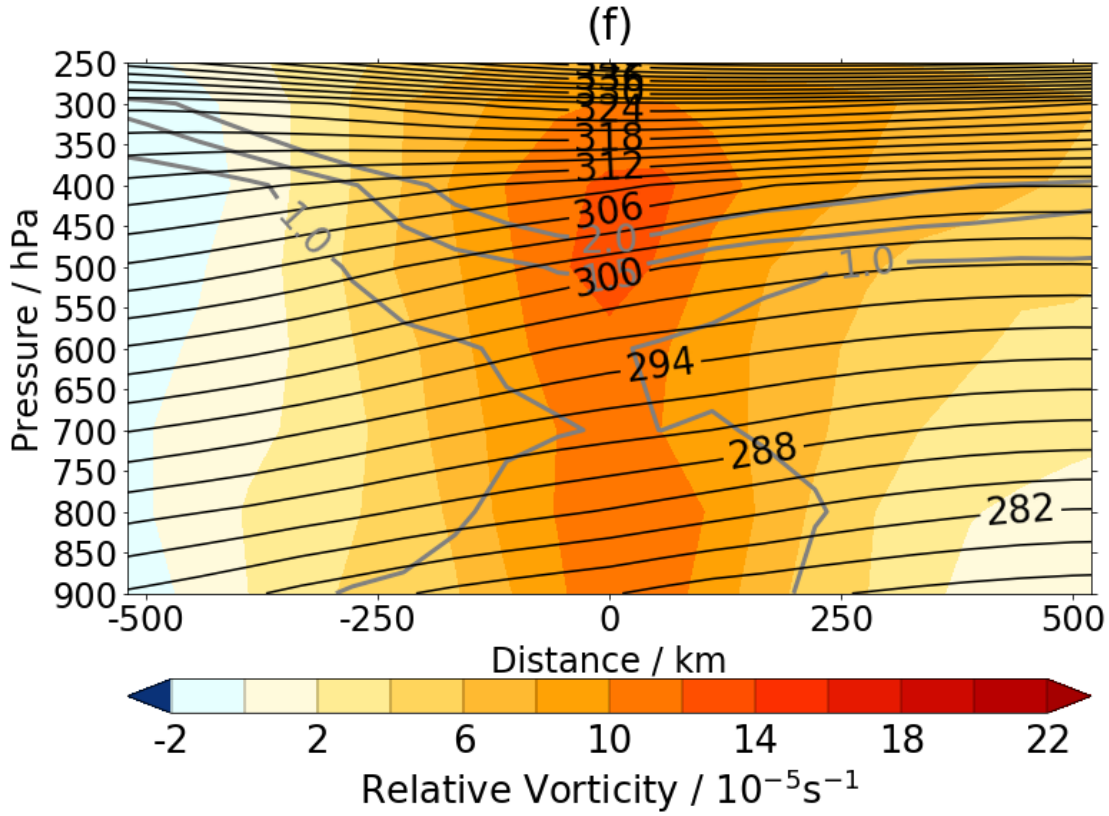

Figure 1: As for Fig. 9f but in the cross-track direction with the composite cyclone motion directed out of the page.