Review comments on WCD manuscript egusphere-2026-2700

General comments:

This paper investigates the role of diabatic (radiative) cooling over the Eurasian continent in association with cold air outbreaks around the Sea of Japan in modulating baroclinicity and the storm track activity over the North Pacific in winter. The influences of upstream radiative cooling on the evolution of cold air outbreaks and the extratropical cyclone tracks over the North Pacific may be new findings of this paper. However, the focus of this paper seems to be unclear, because the relationship between radiative cooling and cold air outbreaks and the relationship between cold air outbreaks and storm track activity are not separate in the analyses. It is advisable to reconsider the structure of the paper. In addition, there are errors and inconsistencies in figures and captions, which make it difficult to evaluate this paper. I therefore recommend major revision.

Specific Comments:

[1] I could not understand why the influences of diabatic cooling were compared only when cold air outbreaks (CAOs) in the Sea of Japan occur. The influence of whole CAOs on the storm track and its relative importance in the North Pacific storm track variability have not been explored in this paper, so the importance of the difference between the effects of large and small C_{BCAR} is not clear to the reader. It might be more straightforward to examine the impact of upstream diabatic cooling variations on the storm track variability in the North Pacific, regardless of occurrence of CAOs.

[2] (L100-105) Though the trajectory of large C_{BCAR} shows stronger cooling than that of small C_{BCAR}, the difference between them is 0.26 K/day (Fig. 1b), that is, only 1.04 K per 4 days. On the other hand, the mean θ exhibits a difference of about 4 K at -7 days between the large and small C_{BCAR} trajectories. It seems that near surface diabatic cooling has relatively small effects on CAOs compared to other factors, such as the origin of air mass and advection of cold air. What is the motivation for comparing CAOs with large and small C_{BCAR} in this paper?

[3] (L200-219) The effect of radiative cooling is emphasized here, but heating such as sensible and latent heat fluxes from the sea surface, and advection of warm and moist air from the south may be important as well, since baroclinicity is related to meridional temperature *gradient*, not to low temperature.

[4] (Section 3.2) A comparison of Figs. 6a and 6b gives the impression that the magnitude of VMT is large at all levels while ADV is large only at upper levels, and therefore the vertically integrated VMT

is much stronger than the vertically integrated ADV. However, Figure 5b shows the contributions of ADV and VMT are of similar magnitude. What makes this (seeming) inconsistency?

(The comments below are relatively minor ones.)
[5] Figure 1 shows that even for the small C_{BCAR} events, the air underwent potential temperature decline of several degrees. What made this diabatic cooling?

[6] (Section 2.4) The Eq. (2) seems to be an equation for the surface pressure, not for SLP. How is the difference between SLP and surface pressure adjusted in the analysis?

[7] (L 146) The value of p_2 should be specified.

[8] I think that L172-178 is about the "subsequent" cyclones, though the word "subsequent" does not appear here. It might be better to clarify in the text.

[9] What are "rotated latitude" and "rotated longitude" that appear in Figs. 6d-f? Please insert a description.

[10] (Figure 6) The terms in Eq. (3), ADV, VMT, DIAB are vertically integrated quantities and therefore have no vertical structure. However, vertical profiles are plotted in Figs. 6a-6c. What kind of quantities are plotted here? In addition, why is the unit in Fig. 6c different from the unit in Figs. 6a and 6b?

[11] (L261) "This contributes to an overall reduction in the uncertainty"
… Why can uncertainty be reduced? The use of temperature tendency data from the reanalysis may make interpretation of the results simpler, but it would increase the dependency on the model physics.

[12] The caption of Fig. 7 is not consistent with the figures. The labels of ordinate read, -6 days, -4 days, -2 days, CAO, -2 days(?), but the caption says, (a,b) -5d, (c,d) -4d, (e,f) -3d, (g,h) -2d, (i,j) t_{CAO}, (k,l) +2d. In addition, there are no (k,l) panels in the figure.

[13] (Figure 8d). I could not find the definition of "area".

[14] (L318-320) The differences in the maximum deepening rate and the maximum depth between the two types of PRIM cyclones are very small and I do not think they are meaningful.

[15] (L365-366) Considering the marginal difference between cyclone characteristics between the large and small BCAR shown in Fig. 8, I do not think it very convincing that diabatic cooling over land promotes the growth of deep cyclones.