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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Large-scale transport into the Arctic: the roles of the midlatitude jet and the Hadley Cell" *by* Huang Yang et al.

Anonymous Referee #1

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This manuscript analyzed the transport of an idealized tracer CO50 from the northern midlatitudes to the Arctic among CCMI models. Large model spread in Arctic CO50 concentration is found among models with interactive dynamics as well as specified dynamics. The authors attributed this model spread to the location of low level divergence zone, which is also correlated with the location of Pacific jet. This study provides a useful summary of the CCMI model performance, and helps to advance our understanding of the tracer transport pathways into the Arctic, which is a key factor to understand the climate changes there. I find the mechanisms proposed by the authors to be reasonable, but I also find the evidences to support the mechanism to be somewhat weak and circumstantial. I understand that such situation may be unavoidable given the limited diagnostics from the multi-model simulations and the complex nature of the tracer

transport. Nevertheless, I listed my comments below for the authors to consider.

1. Most conclusions of this paper is based on correlation analysis of climatologies among models. As the authors already pointed out, these correlation are sensitive to the choices of models included into the analysis. Thus, even a seemly high and statistically significant correlation may not be robust after all. For example, the correlation between phi_v=0 and X_CO50 in JJA is 0.65 (Fig. 10 b). But if excluding CAM-C1, WACCM-C1 and GEOS-C1, the correlation becomes much weaker and may even changes sign.

2. The authors argued the mechanisms leading to the correlation between phi_v=0 and X_CO50 is that if the divergence zone locates north of the emission, then the northward transport from the source region is limited. This mechanism should work on the interannual time scales as well as the climatologies. Yet, the interannual variation within each model does not show similar correlations to the climatologies among different models. This is evident in Fig. 10e, which shows that the interannual variations of phi_v=0 within each model is comparable to the inter-model spread of climatology, but the corresponding Arctic CO concentration does not show any negative correlation. IN models such as CMAM-C1SD, the correlation from inter-annual variations even seems to be positive.

3. The authors argue the importance of the zonal mean circulation for the tracer transport by comparing the zonal mean and eddy component in two models: GEOS-C1 and GEOS-C1SD. But as shown in Fig. 9a, GEOS-C1 is clearly an outlier in terms of the zonal mean contribution to the tracer flux. If comparing GEOS-C1SD versus WACCM-C1 instead of GEOS-C1, the difference in the zonal mean flux would be much smaller. But the Arctic CO concentration is similar in WACCM-C1 and GEOS-C1, this would implies that the eddy component may be more important to explains the difference between the two models.

4. Since the argument is about the low level divergence zone (800-950 hPa), why the

tracer flux is integrated over the whole troposphere (200-1000 hPa) rather than just the low level? The mean circulation pointing to opposite direction in the lower and upper troposphere, and hence there may be canceling effects when integrating over the whole troposphere.

Editorial comments: P4L6: “blue contours” are missing in Fig. 1 P7L22: “SE-NW” I think the jet is tilting SW-NE, especially over western Pacific. P11 L16: This sentence sounds like strong correlation between NH50 and CMF is found in both winter and summer, with stronger value in winter. But in fact, it is only found in winter. There is no correlation in summer. P27 Fig. 8: the caption for dashed and solid lines are different from the labeling in the figure. Fig. 9 and 10: There is no need to include ACCESS and NIWA in the figure legend, since they are not included in these two figures.

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