Controls on the Extratropical Tropopause
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Introductions

• Birner et al. (2006) revealed the sharpness of the extratropical tropopause when tropopause-based averaging is used instead of ground-based one which tend to smear out this characteristic.

• Bell and Geller (2008) proposed the idea of ESTL, defined as the vertical distance from the local maximum of N² at the tropopause to the local minimum in the stratosphere based on the stability profile, and showed latitudinal variations of ESTL depth for annually and seasonally averaged high-resolution radiosonde data.

• Son and Polvani (2007) found that they could use simplified GCM to generate TTL and reproduce Bell and Geller’s (2008) results by adjusting the specified pole-equator temperature difference. But neither Bell and Geller nor Son and Polvani give an explanation for the latitudinal variations of annual and seasonal tropopause height and sharpness.

Tropopause sharpness

• Wirth (2004) proposed that the sharpness of extratropical tropopause is greater when upper troposphere relative vorticity is anticyclonic. Randel et al. (2007) found that observed cyclonic/anticyclonic asymmetry does not account for the observed sharpness. Thus, they suggested that other forcing might be needed (i.e. radiative cooling).

Hypothesis 1

• Baroclinic mixing is an irreversible process that is likely to be responsible for the sharpness of the extratropical tropopause.

Hypothesis 2

• Son and Polvani (2007) found that the tropopause is more sensitive when they changed the horizontal resolution, whereas little change occurred when the vertical resolution was changed.

• It has been noted that more small-scale filamentary structure is seen in the tropopause potential temperature in winter than in summer, and also more is seen poleward than equatorward of the jet (e.g., Nielsen-Gammon, 2001).

• Our hypothesis is that proper resolution of the filamentary mixing is necessary to reproduce the observed tropopause sharpness. The plan is to use high-resolution, mechanistic GCM modeling to test our hypothesis.

Ongoing Work

• I have shown in my master thesis that the partial correlation between the distance from the jet and the tropopause height is higher than that between the upper tropospheric relative vorticity for 3 stations in a winter.

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• Want to visualize the filaments at different resolutions for comparison to observations.
• Calculate PV from the instantaneous (U, V, T, P) output of CAM5.
• Try to use potential temperature filaments on tropopause PV surface to visualize the mixing and compare to observations (e.g., Nielsen-Gammon).
• Might have to use more sophisticated visualization.
• See if the correlation between the jet and the tropopause height can also be seen from the model output as was seen in my master thesis.