Baroclinic Mixing of Potential Vorticity as the Principal Sharpening Mechanism for the Tropopause Inversion Layer

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Previous works have shown that a dry, idealized general circulation model could produce many features of the Tropopause Inversion Layer (TIL). In particular, the following have been shown, but no explanations were given for these results.

1. A sharper TIL resulted more from increased horizontal resolution than from increased vertical resolution.
2. If the Equator-to-Pole temperature gradient was varied, the annual variation of the TIL found in observations could be reproduced
3. The TIL altitude showed excellent correlation with the upper tropospheric relative vorticity, as had been previously proposed.
4. Increased horizontal model resolutions led to TILs that were at lower altitudes.

We show that these conclusions follow from baroclinic mixing of high stratospheric potential vorticity (PV) into the troposphere being the principal sharpening mechanism for the TIL, and the increased baroclinic activity occurring in higher horizontal resolution models. We furthermore suggest that the distance from the jet exerts a greater influence on the height and sharpness of the TIL than does the upper tropospheric relative vorticity, and this accounts for the annual behavior of the TIL found in observations and reproduced with a dry, mechanistic, global model.

Keywords: Extratropical Tropopause, Tropopause Inversion Layer (TIL), Potential Vorticity