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Synoptic-Scale Behavior of the Extratropical Tropopause Inversion Layer

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The Tropopause Inversion Layer (TIL) is a climatological feature of the tropopause region, characterized by enhanced static stability and strong temperature inversion in a thin layer (about 1km deep) right above the tropopause. It was discovered recently via tropopause-based averaging [Birner 2002]. The sharp static stability, temperature and wind shear gradients of the TIL theoretically shall inhibit stratosphere-troposphere exchange and influence the vertical propagation of planetary scale Rossby and small-scale gravity waves. High vertically resolved radiosonde and GPS radio occultation measurements show that the strength of the TIL is positively correlated with the tropopause height and anticyclonic conditions, and that it reaches its maximum strength in polar regions during summer [Birner 2006] [Randel and Wu, 2007 and 2010].

Our study takes advantage of the high density of vertical profiles ($\sim$2000 measurements per day, globally) measured by the COSMIC satellites (2007-present), in order to describe the synoptic-scale structures of the TIL and the differences between the seasonal climatologies from earlier studies and the real-time TIL. Also, using ERA-Interim reanalysis wind fields, we split relative vorticity into shear and curl terms and study separately their relation to TIL strength in cyclonic-anticyclonic conditions.

We find that the TIL has a rich zonal structure, especially in midlatitude winter, and that its strength is instantly adjusted to the synoptic situation at near-tropopause level. The peaks of strongest TIL at midlatitude ridges in winter are stronger and much more frequent than any peaks found in polar summer. The roles of shear and curl vorticity differ substantially towards higher values of relative vorticity (both cyclonic and anticyclonic).