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The Tropical Tropopause Inversion Layer: Variability and Forcing by Equatorial Waves

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The Tropopause Inversion Layer (TIL) is characterized by enhanced static stability and strong temperature inversion in a narrow layer right above the thermal tropopause.

Given that static stability is a quantity used in different wave theory approximations, the high static stability values reached within the TIL shall affect the dispersion relations of atmospheric waves like Rossby or Inertia-Gravity waves and hamper the stratosphere-troposphere exchange (STE) of chemical compounds.

There is an increasing amount of research focusing on the TIL in the extratropics, but very little describing the tropical TIL. Our goal is to study the tropical TIL, its variability and forcings more in detail.

In our study we use high-resolution temperature profiles from the COSMIC satellite mission (~2000 measurements per day globally, 2007-2013) to derive TIL properties and to study the fine-scale structures of static stability in the tropics. The meteorological situation at near tropopause level is described by the 100hPa divergence fields from ERA-interim, while the equatorial winds at all levels provide the vertical structure of the QBO.

The descending phase of the westerly QBO forces a secondary stability maximum below the zero line (within the easterly side), while the TIL is slightly stronger during the westerly phase of the QBO in the lowermost stratosphere. The zonal structure of the tropical TIL shows a stronger (weaker) TIL with near-tropopause divergent (convergent) flow, a relationship similar to the TIL strength with relative vorticity in the extratropics.

We also quantify the dynamical forcing of the different equatorial waves on the vertical structure of static stability. All waves show maximum cooling at the thermal tropopause, and a warming effect above it, enhancing N2 right above the tropopause. The main drivers are Kelvin and Inertia-Gravity waves. We also find enhanced activity of all wave types near the TIL region.