A case study of Tropopause Inversion Layer (TIL) at a mid-latitude US station

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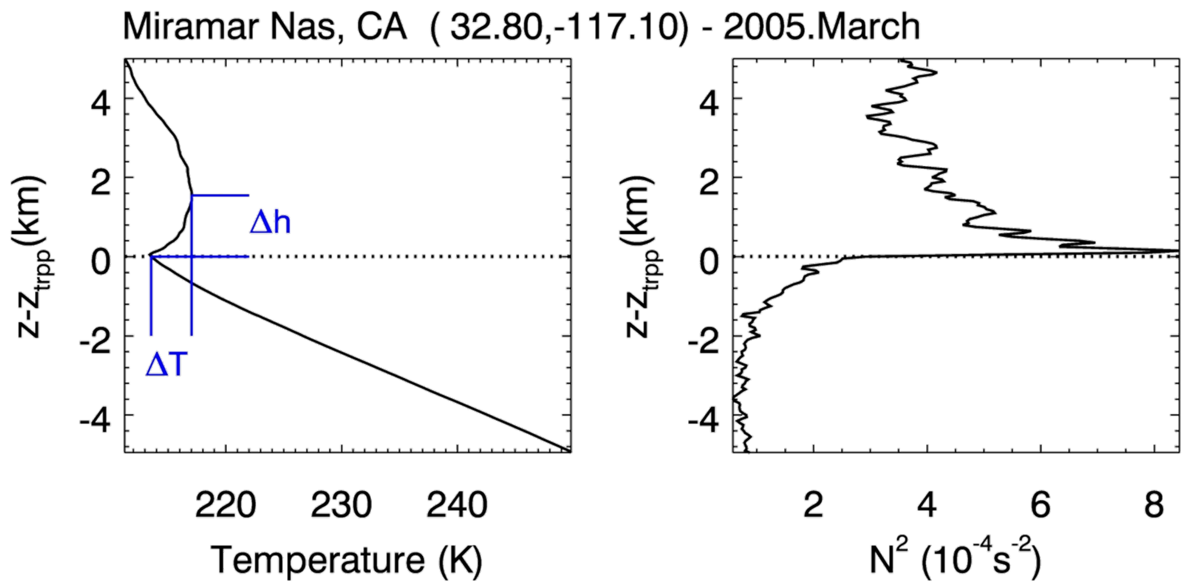
Motivation

- The layer with **an enhanced static stability (about 1-2 km) just above the tropopause** is called the tropopause inversion layer (TIL).
- The TIL can influence the vertical propagation of atmospheric waves as well as suppress the stratosphere-troposphere exchange (STE) of chemical constituents.
- Previous studies report the TIL is present during all seasons and occurs in nearly all geographical regions, mainly in the extratropics, but also in the tropics.
- The TIL is a relatively new observational feature and as yet **no final explanation** is available.
- At present, **two main mechanisms are under discussion**.
  - *dynamical processes*
  - *radiative processes*
- This study is trying to pursue the possible mechanisms of the TIL by starting with the case study at a mid-latitude US station.

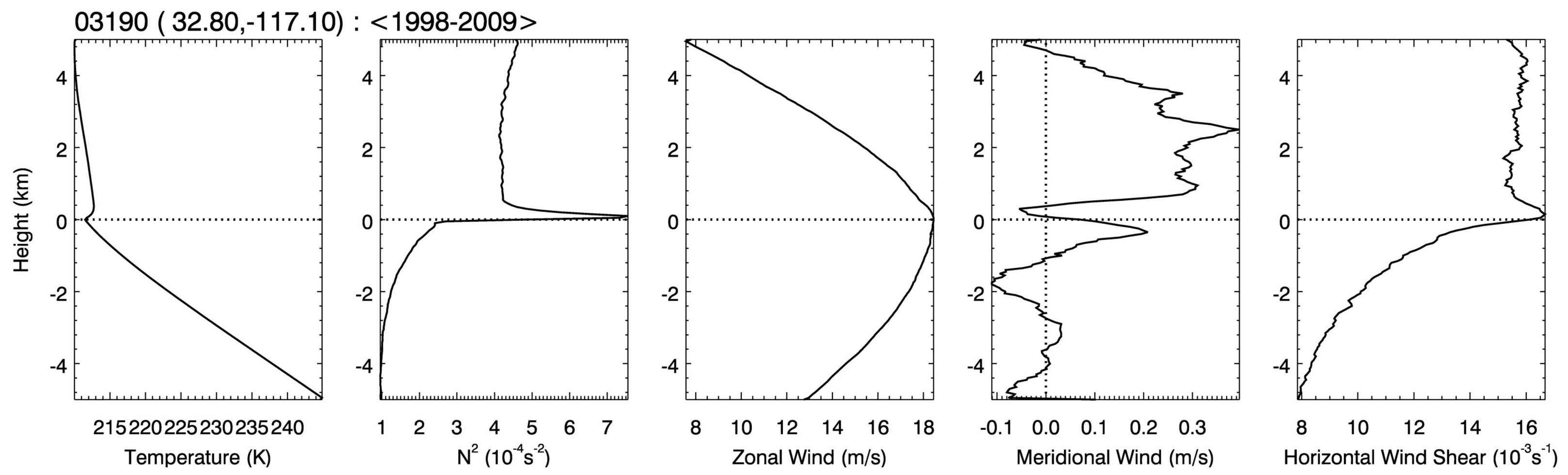
Data & Method

- The radiosonde data at the US station Miramar Nas, CA (32.87N, 117.15W) from Stratospheric Processes and Their Role in Climate Data Center (SPARC) 1998 to 2009.
- Following *Birner* [2006], the TIL in this study is described in the vertical coordinate system based on the first lapse rate tropopause.
- TIL characteristics: Δh – thickness; ΔT – intensity.
- Following the identical hodograph method by *Zhang and Yi* [2005], the gravity wave (GW) activities both in the troposphere (3-10 km) and the stratosphere (18-25 km) are studied.

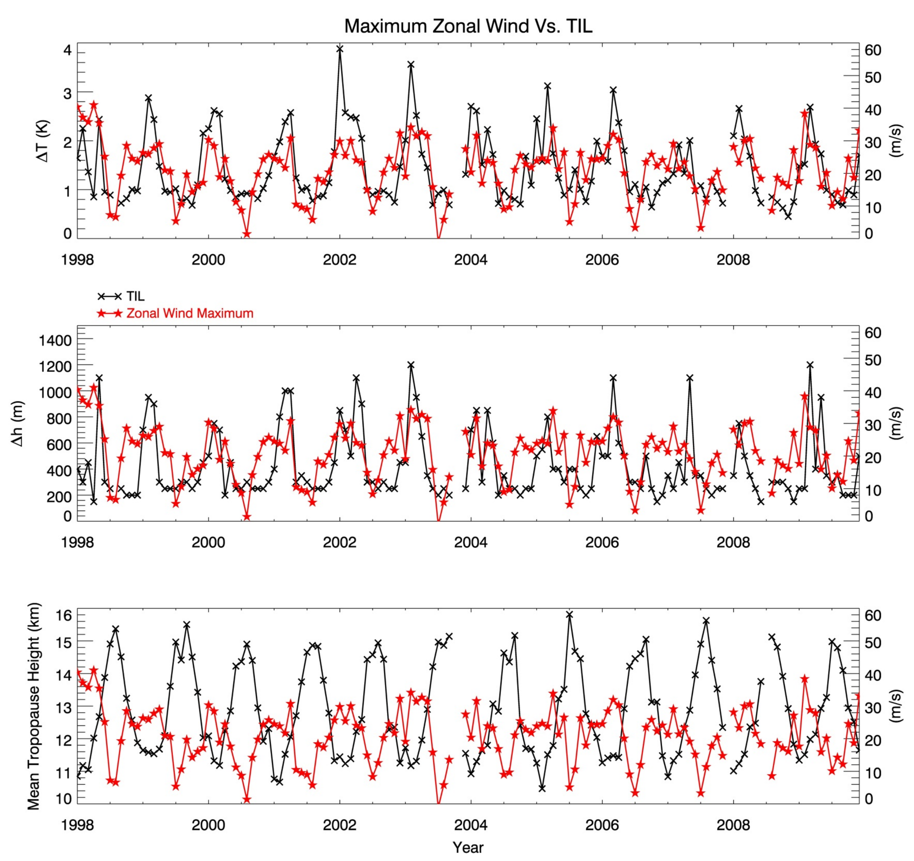
Results

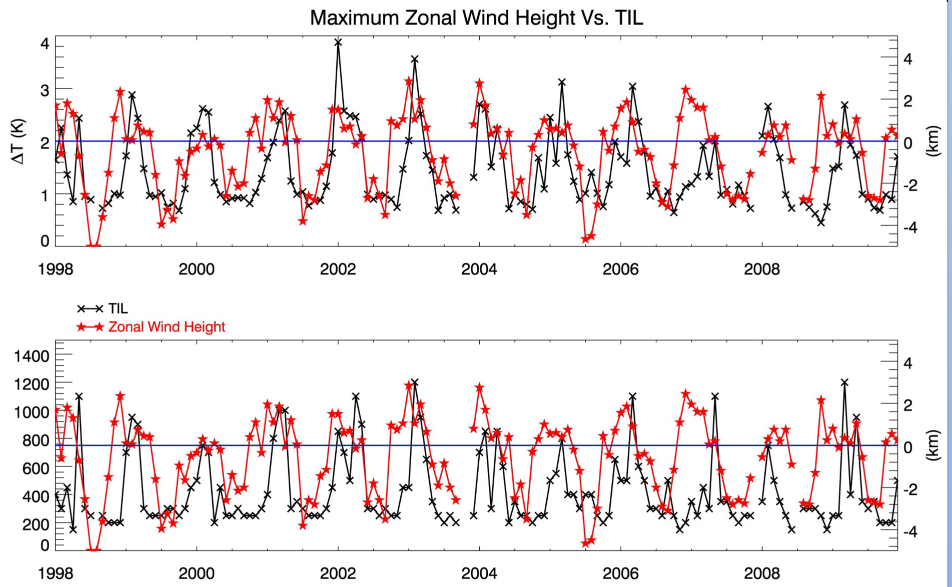


Based on the tropopause-based coordinate system, an obvious TIL is emerged in the above figure.



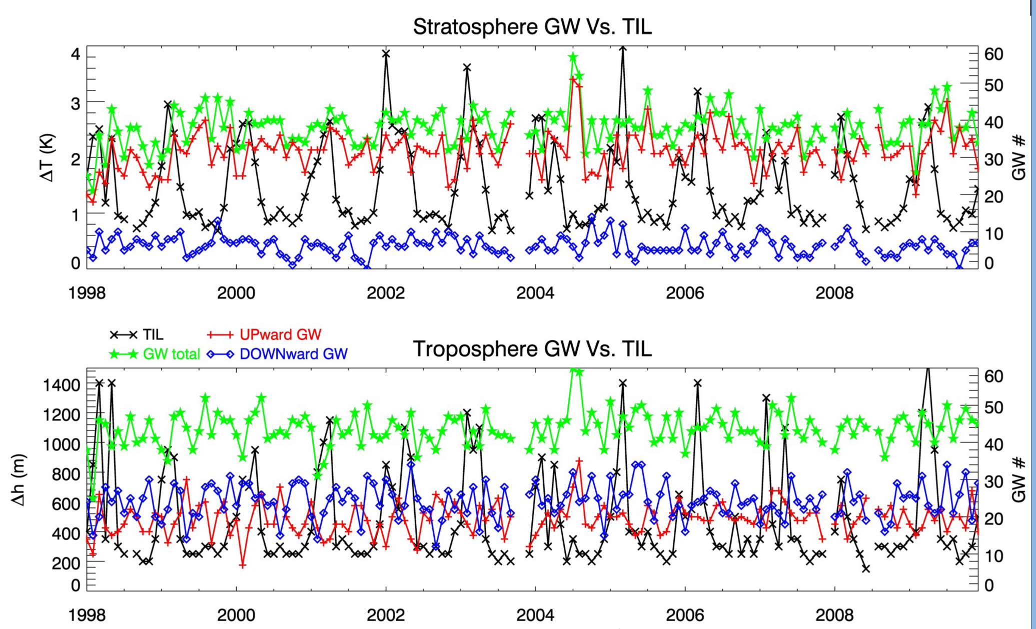
The averaged vertical profiles during the period 1998-2009 show a very good consistent between the bottom of TIL and the maximum height of the buoyancy frequency, the zonal wind and the horizontal wind shear.

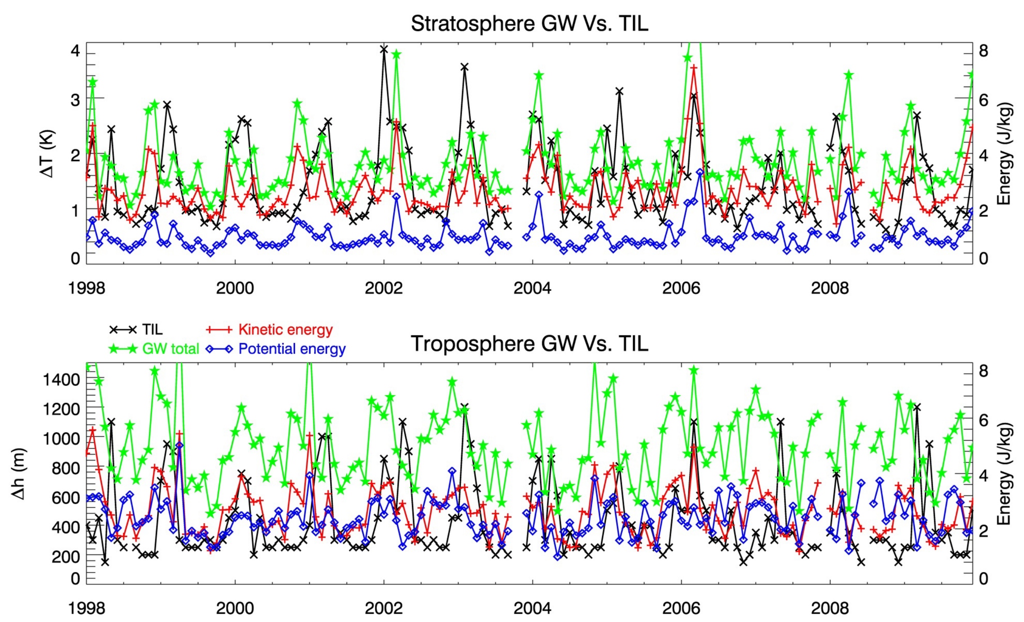




TIL features are apparently correlated with the maximum zonal wind and the occurrence height during the period.

- **According to the figures above, it seems the zonal wind gets larger before TIL does and gets smaller after TIL does during the period, except for year 2007;**





- **For the GW in the stratosphere, most GWs propagate upward, while GWs in the troposphere propagate relatively evenly in two directions.**

According to the annual variations of TIL characteristics and the GW energies in the troposphere and stratosphere, the TIL is stronger and deeper in winter and spring and is better correlated with GW activities in the stratosphere.

Conclusions

- The features of the TIL found in this study are similar to the previous studies.
- The TIL at the US mid-latitude station is stronger and deeper in winter and spring than that in summer and autumn.
- TIL features have a close relation with the maximum zonal wind and the horizontal wind shear.
- According to the gravity waves in troposphere and stratosphere, it is hard to say TIL has any impacts on the GW propagation for now; more analysis is needed. But it is obvious that most GWs in the stratosphere propagate upward.
- The TIL characteristics are more correlated with the GW activities in the stratosphere than those in the troposphere.
- There is an obvious relationship between the dynamical processes and the existence of the TIL.

Future Directions

- *These are the preliminary results on the case study of TIL.* Some more detailed analyses of relationships between TIL and GW activities will be investigated, such as GW heat flux. Different GW analysis methods will be employed, such as broad spectral data-analyzing method.
- In order to find the possible mechanisms of the global TIL, the tropical and polar regions will be also studied.
- The COSMIC data will be used to verify what we find by using the radiosonde measurements.

References

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