A comparison of dynamical and thermal tropopause pressure from ERA-40 reanalysis data

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1. INTRODUCTION and OBJETIVE

During the last years, the tropopause region has received an increased interest as the transition boundary that separates the troposphere from the stratrosphere, two regions with significantly different aspects: dynamics, radiation and chemistry. Tropopause is characterized by changes in atmospheric properties (temperature vertical gradient, potential vorticity and chemical species), therefore there are several definitions. In the present study, the location of the tropopause is obtained by applying the dynamical and thermal definitions, for the Northern Hemisphere and latidudes extratropical (20°-80°) and only the pressure of the tropopause is considered. Seasonal climatology of the tropopause pressure for the period (1960-2001) of the ERA-40 reanalysis data for both definitions have been compared.

2. SEASONAL CLIMATOLOGIES

Thermal Tropopause

Dynamical Tropopause

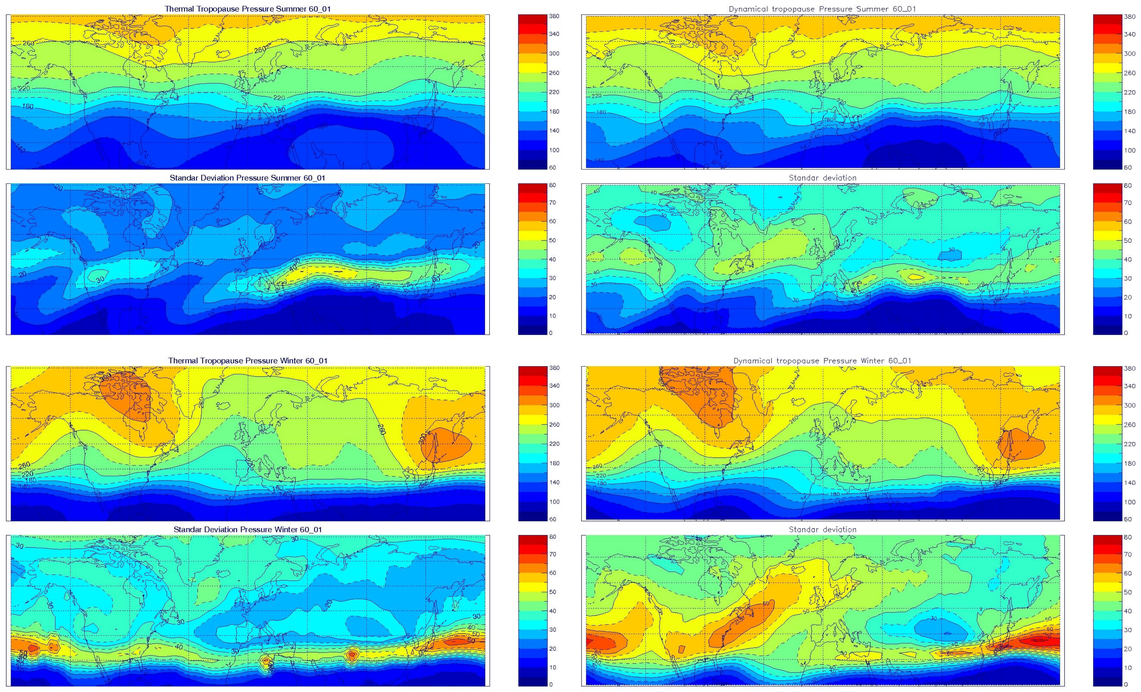

Figure 1. Pressure distribution and variability (standard deviation) for the dynamical tropopause of 3.5 PVU: summer (JJA) (top right); winter (DJF) (bottom right), and for the first thermal tropopause: summer (top left), winter (bottom left). The pressure is in hPa

The definition thermal[1] is defined as the lower boundary of a layer in wich the temperature lapse rate is less than 2 K km^{-1} for a depth of at least 2 km.

The definition dynamical is characterized by a sharp gradient on a critical value of the isentropic potential, that separates low potential vorticity values in the troposphere from high values in the stratrosphere. Following the work of Hoerling[2] it has been used the value of 3.5PVU for extratropical latitudes.

Difference

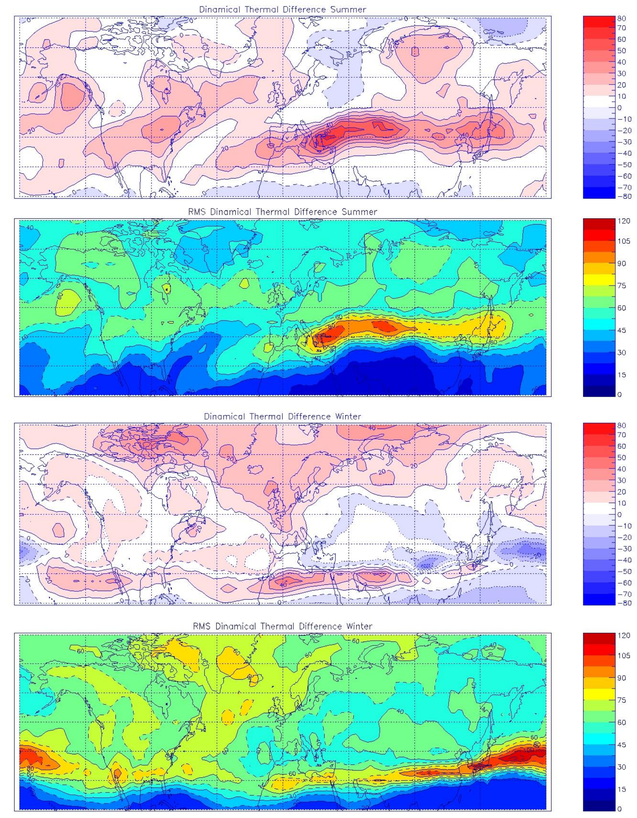

Figure 2. Mean of pressure differences (dynamical tropopause minus thermal tropopause) and RMS (root mean square) of the differences. The pressure increment is 10 hPa.

Mean seasonal pressure structure for the thermal and dynamical tropopause is clearly similar but there is a higher variability for the dymamical tropopause. An overestimation of the dynamical tropopause versus thermal tropopause is observed, particularly in summer and above the subtropical jet stream.

3. PROFILES and TRENDS

Meridonal Profiles

There is a good relationship between the meridional profiles of thermal and dynamical definitions, especially in winter. Dynamical tropopause pressure (height) is slightly higher (lower) than the thermal tropopause in both seasons. The dinamic's results are within the range of one standard deviation of the thermic's results.

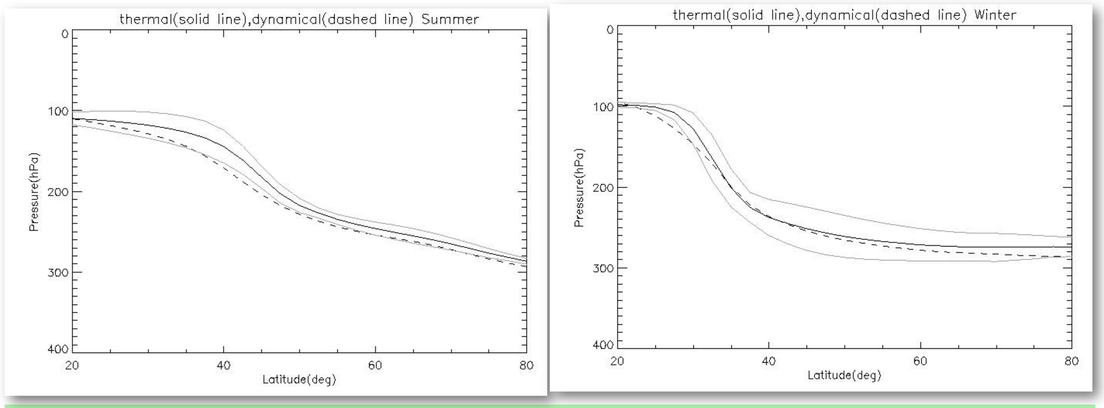

Figure 3. Seasonal meridional profiles for thermal and dynamical tropopause. Thermal tropopause (solid line); dynamical tropopause (dashed line). Grey lines represent ±1σ of the thermal profile.

Trends

For both definitons the trends follow the same pattern in summer and winter.

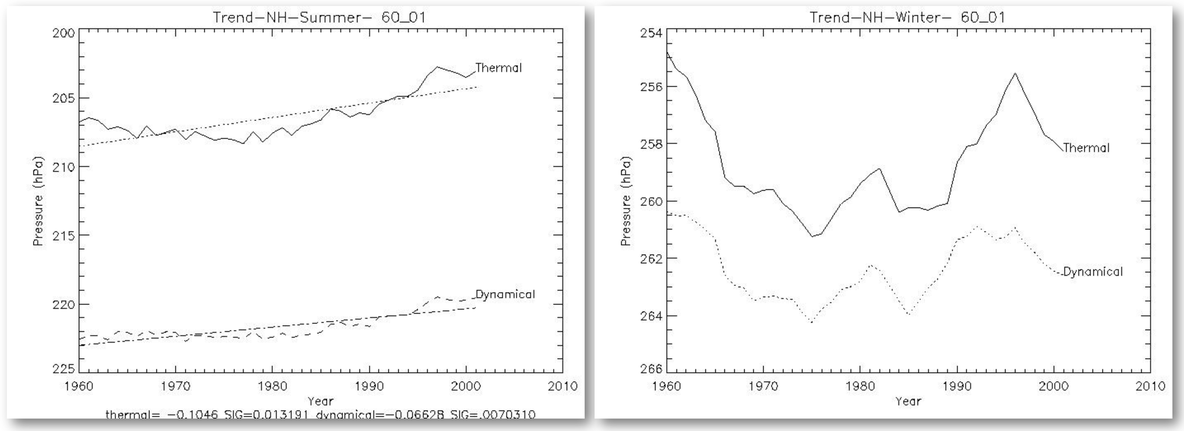

Figura 4. Interannual variability of tropopause pressure for the region between 40° and 60° North. A linear function was used to fit the summer's trend. The data have been smoothed through a moving average.

4. CONCLUSIONS

- First thermal tropopause and dynamical tropopause of 3.5PVU reflect a similar structure.
- An overestimation of the dynamical tropopause versus the thermal tropopause is observed and it's higher above the subtropical jet stream and in summer.
- The meridional profiles show a good agreement between both tropopauses, and a same pattern in the trends is observed for the period (1960-2001).

References

1. WMO, 1957:Definition of the tropopause. *WMO Bull., 6, 136.*

2. Hoerling M. P., T. K. Shaack and A. J. Lenzen: Global objective tropopause analysis. *Mon. Wea. Rev., 119, 1816-1813 (1991).*

Acknowledgments

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