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The Tropical Tropopause Layer: ERA-40 versus ERA-Interim reanalyses

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The Tropical Tropopause Layer (TTL) is currently a region of interest in climate studies, not only because it represents the interface between two different dynamical regimes, but also because it is the "gate" from the troposphere to the stratosphere for many atmospheric tracers. Although great progress has been recently made in understanding the TTL, there are still some aspects that need to be studied.

It is well known that reanalyses are powerful tools widely used in climate studies, and many efforts are made to reach a realistic representation of the atmospheric circulation. In the framework of the SPARC Project, an intercomparison of middle-atmosphere climatologies identified ERA-40 as the dataset that better reproduced tropical processes in the stratosphere among other ten climatologies (Randel et al., 2004).

Many key aspects affecting the stratospheric circulation were improved in the latest ECMWF reanalysis, i.e. ERA-Interim, respect to ERA-40. In the present work we analyze how the TTL is represented in both reanalyses.

Our analysis of the TTL shows that ERA-Interim reproduces better the properties of this peculiar region: several deficiencies observed in ERA-40 have been eliminated in the new reanalyisis. Recent studies showed that the stratospheric residual circulation, excessive in ERA-40, was much improved in ERA-Interim. In agreement with this result, we have identified too intense upwelling in the TTL region using ERA-40 data. This enhanced upward mass flux in ERA-40 changes the static stability and thus the vertical structure of the TTL, extending the tropopause-like properties to upper levels. The unreal tropical upwelling in ERA-40 also affects tracer concentration in the stratosphere outside the tropical regions. In particular, we have found relevant differences between both databases when analyzing the distribution and transport of water vapor and ozone.

In order to understand the origin of the differences in tropical upwelling between both ECMWF reanalyses, we have evaluated the wave activity. We have seen relevant discrepancies in the Eliassen-Palm flux divergence, both in the extratropical and the subtropical region. Our results suggest that the improved wave activity observed in ERA-Interim contributes to reach a more realistic representation of the tropical upwelling. In turn, this better representation of the TTL in ERA-Interim could be of great help in solving the current controversy on what processes are driving tropical upwelling.

Randel, W. J. and 17 co-authors (2004): "The SPARC Intercomparison of Middle-Atmosphere Climatologies", J. Climate, 17, 986-1003.