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Tropopause folding detection using WRF 30 km resolution simulations initialized with JRA data

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The work presented is enclosed in a major research project that will lead to a 10 year (1999-2008) climatology of tropopause folding covering the European area. The dynamical tropopause is an important meteorological concept, that under adiabatic and frictionless conditions acts as a material surface between the troposphere and the stratosphere, and special deformations of this layer such as foldings have an important influence on midlatitude weather systems. Moreover, nonconservative processes in the decaying phases of tropopause foldings are a major mechanism of stratosphere-troposphere exchange. In the vicinity of folds, large vertical and horizontal gradients of Potential Vorticity (PV) are found, so that high resolution data is required for a direct characterisation of these structures. For this reason, the folding detection is carried out over the Japanese 25-year reanalysis (JRA-25) dataset refined through WRF (Weather Research and Forecasting) model simulations in order to downscale the data until a 30 km resolution grid. In the vertical, other aspects have been improved to better simulate the dynamical tropopause: extension of the upper boundary model domain up to 10 hPa and increase of the vertical levels from 24 to 50 with special emphasis on the lower stratosphere and upper troposphere. About 25 of the 50 levels cover the relevant region for folds between 600 and 100 hPa. This refinement clearly recreates finer physical features not observed in the original global dataset leading to a significant improvement in the folding detection. Pressure and potential temperature maps over the 2 PVU (1PVU = 10^{-6} m^2 s^{-1} K kg^{-1}) surface serve as a topography for a dynamical characterization of the tropopause. A three dimensional geometric algorithm based on a topographic definition of the folded dynamical tropopause is used for the final folding detection following a similar method used in Sprenger et al. (2003). The methodology applied allows us to distinguish between different fold depths and requires no assumptions on the dynamical origin of foldings. Satellite Water Vapor (WV) images (MSG 6.2 μm) have been used in order to assess tropopause folding episodes. According to Santurette & Georgiev (2005), data from WV channels (MSG 6.2 μm and 7.3 μm) provide useful information on the flow patterns in the middle and upper troposphere. Potential Vorticity fields and satellite WV channel counts show correlation in the circulation system of extratropical cyclones (Appenzeller and Davies, 1992). Superposition between satellite data and PV fields shows the ability of WV 6.2 μm channel images to represent the upper-level dynamics. In summary, the combined use of WV images, outputs of mesoscale numerical models and PV analysis constitutes an ideal tool to characterize the tropopause structure and its evolution. Results over one year of data show good agreement with other existent tropopause folding climatologies.

References

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