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Assessment of variability and trends of the tropopause from reanalyses data

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As the boundary between the troposphere and stratosphere, the tropopause plays a key role in regulating the entrance of air from the troposphere into the stratosphere and in controlling stratosphere-troposphere exchange. In the context of global warming, investigations of the climatological characteristics and trends of the tropopause are of particular interest. In this study, the long-term variability and trends of global tropopause characteristics from 1980 to 2021 are analyzed based on data derived from the ERA5, ERA-Interim, MERRA2, and NCEP reanalyses. We find a general increase in tropical tropopause geopotential height, which is on average about 0.05 km/decade during 1980-2021 for the WMO lapse rate tropopause and the cold point. Over the same time period, no significant trend in tropical tropopause temperature was detected in ERA5 and MERRA2. However, the tropical tropopause temperature experiences a decrease from 1980 to the early 21st century, then changes to an increasing trend (0.2 K/decade) from 2005 to 2021 in all reanalyses. Along with the increase of the tropical tropopause height, a widening of the tropics is observed from all reanalyses. The edges of the tropics are found to be extending poleward by about 0.2°/decade in the northern hemisphere and about 0.1°/decade in the southern hemisphere. Despite the multiple challenges involved in deriving the characteristics and trends of the tropopause from global reanalysis data, this study and our open data sets will help to better inform future assessments on stratosphere-troposphere exchange and chemistry and dynamics of the upper troposphere and lower stratosphere region.