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Spatial and temporal characteristics of midlatitude tropopause revealed by 5-year VHF radar observations

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The study makes use of 5-year continuous observations of a 5-beam VHF-band wind profiler Doppler radar made in southern France, and radiosoundings launched twice a day at a nearby World Meteorological Organization network station (150 km away). The time and vertical resolution of the profiler data are 15 min and 375 m, respectively, and the vertical coverage extends between 1.7 km up to 16 km above ground, usually. The strong stability of the tropopause layer favors fine horizontal stratification of the atmosphere that induces specular type echoes which produce strong local enhancement of the returned radar signal at vertical incidence. An automatic detection of the tropopause height based on the research of the local radar reflectivity maximum was implemented and its assessment with radiosounding measurements is presented first. The high time resolution and the long duration of the radar time series allow to extract the characteristic cycles of the tropopause ranging from diurnal to annual. Vertical and temporal variability of the tropopause height are analyzed as a function of dynamic and thermodynamic parameters and also of total ozone content. The relations with vertical velocity and divergence are particularly investigated. One of the important results is that on a long term average the tropopause appears as the boundary between a divergent troposphere ($\sim$ -2 cms^{-1}) and a convergent stratosphere ($\sim$ 2 cms^{-1}) at the latitude of the observations. Finally examples are shown on the ability of the VHF radar to document folded or multiple tropopauses at time scales sometimes unresolvable by the synoptic radiosounding network.