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Long-term trends in synoptic-scale Rossby wave-breaking and the jet strength at tropopause levels

F. Isotta (1), O. Martius (1), M. Sprenger (1), and C. Schwierz (2)

(1) ETH Zurich, Institute for Atmospheric and Climate Science, Zurich, Switzerland , (2) Institute for Atmospheric Science, University of Leeds, UK

Breaking synoptic-scale Rossby waves are frequent features of the upper troposphere and lower stratosphere (UTLS) which affect both global- and regional-scale dynamics. Furthermore, they directly influence ozone distribution through meridional transport of ozone-rich air towards the south and ozone-poor air towards the north. Here, trends in the frequency of these breaking waves are assessed by analysing a 44-year climatology (1958–2002) of potential vorticity (PV) streamers on isentropic surfaces from 310 to 350 K. These streamers are viewed as breaking Rossby waves.

Two complementary techniques are used to analyse the trends. First, linear trends are computed using the least-squares regression technique. Statistically significant linear trends are found to vary in location and magnitude between isentropic levels and the four seasons. In winter significant trends are detected in the eastern Pacific between 340 and 350 K. A positive trend of stratospheric streamers in the Tropics is related to an increase of total column ozone, whereas the positive trend of tropospheric streamers in the mid-latitudes is associated with a decrease of total ozone. Secondly, a nonlinear trend analysis is performed using the seasonal-trend decomposition procedure based on Loess (STL). With this technique, the low-frequency variability of the time series is analysed during the 44-year period. For instance, over the eastern Atlantic on 350 K, a phase of decreasing PV streamer frequencies in the 1950s and 1960s is followed by a positive streamer tendency after the 1970s.
Additionally, trends of the zonal wind are investigated. One prominent outcome of this analysis is the observation that equatorial easterlies over the Atlantic are weakening. A dynamically meaningful link exists between the trends observed in both wind velocity and PV streamers.