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Long-term evolution of tropical stratospheric O_3 and NO_2 Columns

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The tropical region is the main entry point of the chemical species in the troposphere lifted and transported by convection in the stratosphere through the tropopause and redistributed to higher latitudes via the Brewer Dobson circulation. Thus any change in the distribution of stratospheric constituents in the tropics will have an impact on their concentration at mid-latitudes. Long time series of O_3 and NO_2 columns in the tropics are available from 2 SAOZ UV-visible spectrometers stations: in Bauru (Brazil, 22°S, 49°W) since 1995 and in La Réunion (21°S, 55°E) in the Indian Ocean since 1993. The most significant modulation for both components at both stations is the seasonal cycle ($\sim$40%). A multiple regression analysis of ozone and NO_2 columns at Bauru and la Reunion has quantified the impact of solar and geophysical parameters of their variability. Following this analysis, the cycles of the most influential parameters in the tropics are (in decreasing order): the Quasi-Biennal Oscillation (QBO) with 40 % for both species, the El-Niño Southern Oscillation (ENSO) with 25% for O_3 and 20% for the NO_2, the solar flux with 15% and 18%, and finally the stratospheric aerosols with 20% and 12%. After subtracting these influences, the long-term residual variations of ozone are not significant. In contrast, NO_2 shows a significant increase at both stations between 2001-2006, followed by a decrease after 2007. Same analysis has been applied to a merged satellite data set above the stations with GOME (1995-2002) - SCIAMACHY (2003-2011) for NO_2 columns and EPTOMS (1995-2004) - OMI TOMS (2005-2011) for O_3 columns. The long-term residual variations of those data present similar behaviour as SAOZ.
From variations of the Eddy heat flux, variations in average intensity of meridional exchange through the southern subtropical barrier related to the amplitude of planetary waves over the entire Southern Hemisphere have been identified since 2001. These distortions of amplitude of planetary waves, affecting all longitudes, have been detected through the modulation of the two tropical stations's equivalent latitude. After taking into account this influence, the NO_2 residual trend in the tropics is shown to be of 3%/decade only, that is consistent with the known increase by 2.5%/decade, of N2O the source of nitrogen oxides in the stratosphere.