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Long-Term Trend of Carbon Tetrachloride (CCl_4) from Ground-based High Resolution Infrared Solar Spectra recorded at the Jungfraujoch

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The long-term trend of carbon tetrachloride (CCl_4) has been retrieved from infrared high resolution solar absorption spectra encompassing the 1999 to 2010 time period. The measurements were recorded with a Fourier transform spectrometer at the northern mid-latitude, high altitude Jungfraujoch station in Switzerland (46.5˚N latitude, 8.0˚E longitude, 3580 m altitude). Total columns were derived from the region of the strong CCl_4 ν_3 band at 794 cm^{-1} accounting for all interfering molecules (e.g. H_2O, O_3) with significant improvement in the residuals obtained by also taking into account the line mixing in a nearby CO_2 Q branch, a procedure not implemented in previous remote sensing CCl_4 retrievals though its importance has been noted in several papers. The time series shows a statistically-significant long-term decrease in the CCl_4 total atmospheric burden of -1.18±0.10 %/yr, at the 95% confidence level, using 2005 as reference. Furthermore, fit to the total column data set also reveals a seasonal cycle with a peak-to-peak amplitude of 10.2%, with minimum and maximum values found in mid-February and early August, respectively. This seasonal modulation can however be attributed to tropopause height changes throughout the season. The results quantify the continued impact of the regulations implemented by the Montreal Protocol and its strengthening amendments and adjustments for a molecule with high global warming potential. Although a statistically significant decrease in the total column is inferred, the CCl_4 molecule remains an important contributor to the stratospheric chlorine budget and burden.