Abstract

Time series of tropospheric trace gases derived from ground-based FTIR measurements

This study deals with measurements and analysis of solar absorption spectra of tropospheric trace gases in the infrared spectral region, as recorded by ground-based Fourier transform infrared (FTIR) spectrometer. The objective is to study time series, variability and trends of tropospheric trace gases.

In the framework of the NDACC (Network for the Detection of Atmospheric Composition Change) long-term measurements are performed continuously by the IMK (Institute for Meteorology and Climate Research) in Kiruna (Sweden) since 1996 and in Izaña (Tenerife) since 1999. Based on these measurements, profiles and column amounts of the direct and indirect greenhouse gases CO, O_3, N_2O, CH_4, C_2H_6, and HCFC-22 are derived.

The first part deals with the analysis in the infra-red spectral region and the error analysis. In the framework of the European project UFTIR (Time Series of Upper Free Troposphere observations from a European ground-based FTIR network) time series of profiles and partial columns of the target species CO, O_3, N_2O, CH_4, C_2H_6, and HCFC-22 are reanalysed with a common retrieval method at six European FTIR stations. The seasonal variation of the individual species and the time series are discussed. The CO time series shows a latitudinal dependence and strong enhancements in 1998, 2002 and 2003 due to biomass burning. The major topic is the discussion of the CO time series due to the fact that the author coordinates a common publication in the framework of the project UFTIR for this species. The second part of the work deals with the validation of the satellite instrument MOPITT (Measurements of Pollution in the Troposphere) by comparing total columns and profiles of CO for the stations Kiruna and Izaña. The difference between MOPITT and FTIR CO total columns are 1.99%± 10.06% in Kiruna and 1.25%± 7.15% in Izaña. In addition comparisons with in situ measurements and with model calculations of the Oslo-CTM2 model are evaluated.

The fact that CO is not only a tropospheric trace gas, but also occurs in the upper stratosphere and lower mesosphere can be shown due to the increased altitude sensitivity of CO achieved through the optimisation of the retrieval methods which allows the separation of stratospheric and tropospheric CO columns. The time series of strato-mesosperic columns exhibit a seasonal variation with intrusions of mesospheric air parcels into the stratosphere in the polar vortex.

A statistical trend analysis method, the so called "Bootstrap Resampling Method" is applied to the time series of tropospheric gases at all six UFTIR sites for the time period 1995-2004. The trend for CO is slightly decreasing with some strong enhancements in years with biomass burning events, the trend for N_2O and CH_4 is quasi-linear increasing, and there is a negative trend for C_2H_6. The trend for O_3 is non-linear, slightly negative for tropospheric columns and positive for stratospheric columns. HCFC-22 is still increasing with about 4% per year in Kiruna.