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Retrievals of carbonyl fluoride (COF_2) from ACE-FTS and MIPAS spectra and their comparison with SLIMCAT CTM calculations

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The majority of fluorine in the atmosphere has resulted from the anthropogenic emission of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and hydrofluorocarbons (HFCs). Most tropospheric fluorine is present in its emitted 'organic' form due to the molecules having long lifetimes. At the top of the stratosphere most of the fluorine is present as the 'inorganic' product HF, which, due to its extreme stability, is an almost permanent reservoir of stratospheric fluorine. The second most abundant stratospheric 'inorganic' fluorine reservoir is carbonyl fluoride (COF_2). The major sources of COF_2 are from the atmospheric degradation of CFC-12 (CCl_2F_2), which is now banned under the Montreal Protocol, and HCFC-22 (CHF_2Cl), the most abundant HCFC and classed as a transitional substitute under the Montreal Protocol. Although the amount of CFC-12 in the atmosphere is slowly decreasing, HCFC-22 is still on the increase. The amounts of COF_2, HF, and total fluorine in the atmosphere are all still increasing.

Vertical profiles of COF_2 in the atmosphere have previously been determined from measurements taken by the Atmospheric Trace MOlecule Spectrometry Experiment (ATMOS) instrument which flew four times on NASA space shuttles between 1985 and 1994. Additionally, there have been several studies into the seasonal variability of COF_2 columns above Jungfraujoch using ground-based Fourier transform infrared (FTIR) solar observations. The concentration of COF_2 in the atmosphere slowly increases with altitude up to the middle of the stratosphere, above which it decreases as photolysis becomes more efficient, leading to the production of HF.

The use of satellite remote-sensing techniques allows the measurement of COF_2 atmospheric abundances with impressive global coverage, and the investigation more fully of COF_2 trends, and seasonal and latitudinal variability. This work presents global distributions of COF_2 using data from two satellite limb instruments: the Atmospheric Chemistry Experiment Fourier transform spectrometer (ACE-FTS), onboard the SCISAT-1 satellite, which has been recording atmospheric spectra since 2004, and the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) instrument onboard the ENVIronmental SATellite (Envisat), which has recorded thermal emission atmospheric spectra between 2002 and 2012. The observations are compared with the output of SLIMCAT, a state-of-the-art three-dimensional chemical transport model (CTM). The model aids in the interpretation of the COF_2 satellite observations, and the comparison provides a validation of emission inventories and the atmospheric degradation reaction schemes used in the model.