Study on Stratospheric Carbonyl Sulfide Transport and Chemistry using ‘Age of Air’

Chenxi Qiu, Felix Ploeger, Jens-Uwe Grooß, and Marc von Hobe
Forschungszentrum Jülich, IEK-7, Jülich, Germany (c.qiu@fz-juelich.de)

Carbonyl sulfide (OCS or COS) is the longest lived and the most abundant reduced sulfur gas in the atmosphere. As chemical loss of OCS in the troposphere is slow, it can reach the stratosphere, where it is photochemically oxidized and converted to stratospheric sulfate aerosol, being the largest source thereof in times of volcanic quiescence. Chemistry transport models show that OCS conversion occurs mainly in the ‘tropical pipe’ region, while along the lower branch of Brewer-Dobson circulation (BDC), OCS is passively transported without significant chemical loss. The OCS depleted air is transported along the upper branch of BDC and descends again at high latitudes. Using the distinct characteristics of ‘age of air’ in the upper and lower branches of the BDC, this picture of OCS transport and especially the role of the ‘tropical pipe’ as the main region of OCS conversion can be supported by looking at the relationship between age spectra and OCS mixing ratios.

In this study, we will investigate the relation of OCS mixing ratios and mean age of air as well as mass fractions of air with different transit times using satellite-based measurements from MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) and ACE-FTS (Atmospheric Chemistry Experiment - infrared Fourier Transform Spectrometer), and age spectra of air from CLaMS (Chemical Lagrangian Model of the Stratosphere).

In addition to satellite data analysis, we will investigate the distribution of OCS in the UTLS (upper troposphere and lower stratosphere) region and its relation to the age spectra using high-resolution in-situ observations of OCS. This unique dataset was obtained during the SOUTHTRAC mission in autumn 2019 by AMICA (Airborne Mid-Infrared Cavity enhanced Absorption spectrometer) on board the HALO (High Altitude Long Range) research aircraft. Flights from the main campaign base in Río Grande, Argentina (53.8S, 67.7W) covered a wide latitude range from 48° N to 70° S, even reaching the southern polar vortex where aged air masses having descended from high altitudes are typically found.

Our analysis of both satellite and in-situ data generally supports the established picture of OCS conversion in the ‘tropical pipe’.