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First long-term observations of SF_6 and N_2O in the extra-tropical tropopause region

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Sulfur hexafluoride (SF_6) and nitrous oxide (N_2O) are greenhouse gases with continuously increasing atmospheric mixing ratios. While SF_6 is an entirely industrial gas, N_2O is emitted from both natural and anthropogenic sources, including the use of fertilizers. Several monitoring networks have included SF_6 and N_2O in their measurement program, and time-series of atmospheric observations reach back to the 1970s, but have been restricted to ground-based measurements.

In 1997, the CARIBIC project (Civil Aircraft for the Regular Investigation of the Atmosphere Based on an Instrument Container, www.caribic-atmospheric.com) started to provide regular aircraft based observations of various atmospheric constituents. Once per month an instrumented air freight container is deployed during flights of a passenger aircraft. Besides a wide range of high resolution measurements being performed in-flight, whole air samples are collected and analyzed for greenhouse gases, including SF_6 and N_2O. At cruise altitudes between 9 and 12.5 km the aircraft frequently crosses the tropopause, and in the extra-tropics about 40% of the flight time is spent in the transition layer above the tropopause. SF_6 and N_2O both only have sinks in the stratosphere and therefore exhibit pronounced gradients across the tropopause. This in combination with their continuous increase makes them ideal indicators of stratospheric air. Especially SF_6 with its long atmospheric lifetime of ~ 3200 years has frequently been used as a tracer for atmospheric transport.

The CARIBIC record represents the first long-term time-series of regular SF_6 and N_2O measurements in the upper troposphere and lowermost stratosphere, covering the periods 1998–2002 and 2006–present. Focusing on the northern hemisphere mid-latitudes we will present upper tropospheric trends in SF_6 and N_2O mixing ratios, and we will also analyze gradients across the extra-tropical tropopause.