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First upper Tropospheric and lower Stratospheric Ozone Observations with the UV DIAL System at the High Altitude Research Station Jungfraujoch

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An ozone UV Differential Absorption Lidar (DIAL) system was developed and added to the existing multi-wavelength lidar operated at the High Altitude Research Station Jungfraujoch (HARSJ, 3580 m ASL, 46.55° N, 7.98° E).

The system uses the quadrupled Nd:YAG laser emission at 266 nm to produce the ozone UV DIAL wavelengths (284, 304 nm) in a high pressure Raman cell filled with N2 by stimulated Raman scattering. The 76 cm diameter Cassegrain telescope in the HARSJ's astronomical dome is used as receiver for measurements up to the tropopause. For the sake of simplicity, the existing multi-wavelength polychromator fixed at the telescope rear end is equipped with the additional ozone detection channel. Thereby, a concave imaging diffraction grating is used for the spectral separation of the ozone UV DIAL wavelengths. With the current design, the ozone UV DIAL system provides hourly-averaged ozone profiles reaching from 6 km to 12 km ASL with a vertical resolution better than 400m at 6 km ASL and 1000m at 12 km ASL. The relative statistical error of the profiles is 10% at 12 km ASL.

The performance of the system is illustrated by an inter-comparison with eight quasi simultaneously obtained ECC ozone sonde profiles from the Swiss Meteorological Institute - Payerne (SMI, 491 m ASL, 46.83°N, 6.96 E) 80 km in north western direction from HARSJ. The relative differences between the UV DIAL and the sonde profiles were found to be lower than 20% in a horizontally homogeneous atmosphere. This intercomparison has shown that the ozone UV DIAL system is capable to accurately reproduce the vertical ozone distribution within its operational range domain. An intercomparison with vertical profiles taken in the vicinity of HARSJ by an airplane-borne UV-photometer confirmed the performance of the ozone UV DIAL system. First time series (up to 21 hours) of hourly averaged ozone UV DIAL profiles were taken in August and September 2009. From these measurements, an ozone rich layer of air with a possibly stratospheric origin persisting between 6 and 7 km ASL is presented as example.