EGU21-1516
https://doi.org/10.5194/egusphere-egu21-1516
EGU General Assembly 2021

A compact solar occultation instrument for the UV/Visible spectral range: instrument design and performance testing

Karolin Voss, Philip Holzbeck, Ralph Kleinschek, Robin Herlan, Katja Grossmann, Klaus Pfeilsticker, and André Butz
Heidelberg University, Institute for Environmental Physics, Heidelberg, Germany (kvoss@iup.uni-heidelberg.de)

Spectroscopic direct sun remote sensing of the atmosphere offers an essential tool for determining atmospheric trace gas concentrations. The monitoring of ozone-depleting substances, such as halogen oxides in the middle atmosphere, contributes to observing the progress in restoring the ozone layer.

Here, we present a new compact solar occultation spectrometer for the UV/visible spectral range that can be mounted on stratospheric balloons such as deployed within the European HEMERA infrastructures. Due to its compactness, the instrument is suitable as a secondary payload.
The instrument, consisting of a solar tracker providing direct sunlight for two grating spectrometers, is designed for deployment on a high altitude balloon to measure total bromine and iodine inventories using solar occultation and the DOAS method. All components of the setup have been chosen to withstand low temperatures (>-80°C) and low pressures (>5 mbar) as expected during the flight, and to have minimal power consumption while being compact, lightweight and only cooling radiatively. To perform solar occultation measurements, the device can track the sun down to 10° below its horizon.

The solar tracker is based on a two-camera setup following the Camtracker [1]. One camera with a fish-eye lens (FoV 185°) that observes the sky gives the sun´s coarse position. The Alt-Azimuth mount projects direct sunlight onto a screen. When reaching this coarse position, the image of the second camera is used to center the solar image on the spectrometer entrance telescopes by adjusting both mirrors within a 100 Hz control loop.
The tracker can reach a tracking precision of ≤0.05° for expected perturbations of smaller than 2° s^{-1}. In lab experiments it was shown, that the tracker could handle even faster perturbations (larger than 3° s^{-1}).
The sunlight is coupled into the two spectrometers via a fiber-telescope setup.

Two stabilized spectrometers (Ocean Optics QE Pro Series, resolution 0.5 nm) with a wavelength range for UV (305 to 385 nm) and vis (415 to 515 nm) are assembled within an evacuated box inside a water-ice bath. The vacuum avoids vapors condensing on the CCD an it ensures a constant refractive index within the spectrometers throughout the flight. At the same time the water-ice bath acts as a thermal buffer to stabilize the temperature of both spectrometers. Stable water-ice bath temperatures were achieved for >12 hours with deviations smaller than 0.5°C.

Preliminary testing of the setup was conducted on a three-day stationary roof-based test campaign with nearly clear-sky conditions. We plan on further investigating the instrument´s performance under field conditions and finally deploy the instrument on a stratospheric balloon flight from Kiruna in summer 2021.

[1] Gisi, M. et al.: Camtracker: a new camera controlled high precision solar tracker system for FTIR-spectrometers, Atmospheric Measurement Techniques, URL www.atmos-meas-tech.net/4/47/2011/, 2011.