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Development of a prototype spectrophotometer based on an acousto-optic tunable filter for measurements of total column ozone

Eric Gonzalez Peralta (1), John Rimmer (1), Ann Webb (1), Keith Wilson (2), and Pavel Babal (2)

(1) The University of Manchester, School of Earth, Atmospheric & Environmental Sciences, Manchester, United Kingdom (eric.gonzalezperalta@manchester.ac.uk), (2) Kipp & Zonen BV, Delft, Netherlands

Acousto-optic tunable filters (AOTF) are piezoelectric optical devices capable of rapidly selecting a specific wavelength from a broadband source using an acoustic diffraction grating generated within a birefringent crystal by an applied radio frequency (RF) electronic signal. The use of a quartz birefringent crystal and a photodiode as a detector allow the development of a fast, small and portable solid-state spectrophotometer with an ultraviolet spectral response.
The aim of the proposed spectrophotometer is to determine total column ozone based on the differential optical absorption spectroscopy (DOAS) technique with an accuracy similar to Brewer spectrophotometers. A spectrophotometer has been designed which performs single wavelength measurements with spectral resolutions from 0.2 nm at 240 nm to 0.5 nm at 450 nm. This spectral range allows measurements of additional atmospheric trace gases with absorption lines in the UV, such as sulphur dioxide. A dedicated lock-in amplifier algorithm was developed in LabVIEW to enhance the signal to noise ratio by using a modulated RF signal. The RF signal controls the selection of a narrow band of light centred at a desired wavelength, achieving fast wavelength tuning without mobile parts.

Spectral line measurements of Hg, Cd and Zn sources, as well as HeCd laser lines used to calibrate the instrument are presented. Additional tests conducted at Kipp and Zonen facilities (Delft, Netherlands) in June 2018, such as temperature chamber tests, calibration lamp measurements, and an outdoor side to side comparison between the proposed instrument and a Brewer double-spectrophotometer under clear-sky conditions, will provide a more accurate characterization of the instrument.