

File Revision Date:

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Data Set Description:

PI: Hartmut BOESCH
DOAS UV-Visible Spectrometer
Site(s): NY-AALESUND 78.9 N 11.9 E
Measurement Quantities: O3, NO2

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Reference Articles:

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Instrument Description:

Briefly, scattered light from the sky is collected by a telescope and focused onto a depolarising quartz fibre bundle, which transmits the light to the entrance aperture of two Czerny-Turner spectrographs, one for the UV, one for the visible wavelength range. Linear diode array and later 2d CCD detectors are used allowing simultaneous measurements over a large wavelength range. The instrument observes in the near-UV and visible in the range 327–566 nm having a FWHM of 0.5 nm (UV) and 0.7 nm (Visible). Zenith sky spectra are measured every day for solar zenith angles smaller than 96°. Since 1999, horizon measurements and later measurements at different elevations and azimuths were added for tropospheric observations.

Algorithm Description:

The spectral analysis is described below. After a precise wavelength alignment with the use of the Fraunhofer solar absorption lines, actual spectra are divided by a reference spectrum recorded at high sun on a clear and unpolluted day. Large scale variations of the signal (mainly due to scattering) are then removed by subtracting a polynomial resulting in an atmospheric differential spectrum, into which narrow features corresponding to absorption by ozone, nitrogen dioxide, O₄ (oxygen dimer), and other trace gases are remaining.

Slant columns are then calculated by least squares fitting between the signal and the differential cross sections of each absorber in an iterative process in which the contributions of the various species are calculated and removed sequentially. Ozone and NO₂ are measured in the visible (435–490 nm).

Expected Precision/Accuracy of Instrument:

Converting slant columns relative to a given reference spectrum into vertical columns requires the knowledge of the optical path of the light scattered at zenith, that is the Air Mass Factor (AMF) and the residual amount of constituent still present in the reference spectrum. The AMF is calculated by modelling the radiative transfer of the sunlight into the atmosphere. These calculations are carried out by the model package SCIATRAN.

The precision of the total column measurements at twilight (86°–91° SZA) is 2 Dobson Unit for ozone and 1.5 10¹⁴ mol/cm² for NO₂.

The accuracy, including uncertainties of cross-sections and their temperature dependencies and that of Air Mass Factors (vertical profiles of the constituent, stratospheric temperature seasonal changes and photochemical changes for NO₂) is: $\pm 10\%$ for ozone and +25, -45% for NO₂ (for small amounts in early spring and late autumn).

Instrument History:

starting date: 1995/02/20/

spectrometer: Acton Research SpectraPro500, grating: 300 gr/mm, 330-490nm, FWHM: 0.7nm

detector: IKS Diode Array, 1024 pixel

entrance slit: 100 microns

telescope unit: zenith-sky only

starting date: 1999/04/15/

spectrometer: Acton Research SpectraPro500, grating: 300 gr/mm, 330-490nm, FWHM: 0.7nm

detector: IKS Diode Array, 1024 pixel

entrance slit: 100 microns

telescope unit: zenith-sky and horizon

starting date: 2000/02/20/

spectrometer: Acton Research SpectraPro500, grating: 300 gr/mm, 330-490nm, FWHM: 0.9nm

detector: EG&G Diode Array, 1024 pixel

entrance slit: 150 microns

telescope unit: multiple elevations

starting date: 2003/03/11/

spectrometer UV: LOT Oriel 257Y, grating: 600 gr/mm, 325-413nm, FWHM: 0.7nm

detector UV: Andor CCD, 1024 x 256 pixel

entrance slit UV: 150 microns

spectrometer visible: Acton Research SpectraPro500, grating: 300 gr/mm, 397-566nm, FWHM: 0.9nm

detector visible: Andor CCD, 1024 x 256 pixel

entrance slit visible: 150 microns

telescope unit: multiple elevations

starting date: 2010/03/05/

spectrometer UV: LOT Oriel 257Y, grating: 600 gr/mm, 325-413nm, FWHM: 0.5nm

detector UV: Andor Newton CCD, 2048 x 512 pixel

entrance slit UV: 100 microns

spectrometer visible: Acton Research SpectraPro500, grating: 300 gr/mm, 397-566nm, FWHM: 0.7nm

detector visible: Andor CCD, 1024 x 256 pixel

entrance slit visible: 100 microns

telescope unit: multiple elevations, multiple azimuths