Data Set Description:

PI: Andrea PAZMINO (Previous PI: Paul Eriksen)
CoI: Nis Jepsen
SAOZ UV-Visible Spectrometer
Site(s): Søndre Strømfjord 66.99 N 50.95 W 130-300 msl
Measurement Quantities: O3, NO2

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Reference Articles:

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Instrument Description:

The SAOZ is made of a commercial Jobin-Yvon CP200 flat field spectrometer equipped with a holographic grating and a Hamamatsu diode array uncooled detector, with an entrance slit allowing an average resolution of the order of 1 nm in the range 300-600 nm. The instrument is using a 360 gr/mm grating associated to a 1024 diode array detector and a 50 micron entrance slit allowing an oversampling of 2. The equipment which is ran in the outside, is placed in a sealed tight and dehydrated box on the top of which a quartz window is mounted in order to look at the zenith sky with a total field of view of 10°. As SAOZ was designed to measure especially in the Polar Regions, sometimes of difficult access, the system is completely automated, maintenance is simple (mechanical shutter).
The instrument is driven by an external computer which records and analyses the spectra in real time. Measurements are performed from sunrise to sunset until a Solar Zenith Angle (SZA) of 94°. The exposure time is adjusted automatically between 0.1s to 60s in order to optimize the signal and the spectra are co-added in memory during a 60s duty cycle. The data from a GPS device is used for SZA and time calculation. The dark current of the detector is measured each time the duration of exposure changes and subtracted. Averages of ozone and NO2 morning and evening vertical columns measured between 86 and 91 SZA are calculated and transmitted in real time to the laboratory through internet. Columns transmitted to NDACC data bank are reprocessed data, only possible after original spectra are received at the laboratory from the remote stations.

Algorithm Description:

A new version of processed algorithm (V3) was developed in 2013 in the frame of NORS/EU project.

This is the only version available on NDACC for this station. The data processing is achieved into 3 steps:

1. Level 0: acquisition of the spectrum and other parameters as GPS location and temperature inside the instrument.

2. Level 1: Spectroscopic analysis using the DOAS technique.
 - Precise wavelength alignment with the use of the Fraunhofer solar absorption lines
 - Division of the actual spectra by a reference spectrum recorded at high sun on a clear and unpolluted day.
 - Monotonic large trends are removed by subtracting the same spectrum smoothed at a broad bandpass (40nm) resulting in an atmospheric differential spectrum, into which narrow features corresponding to absorption by ozone, nitrogen dioxide, O4 (oxygen dimer), water vapour, O2 and OClO, are remaining.
 - Calculation of slant columns 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 is measured in the Chappuis

visible bands (450-550nm) where the cross sections are weakly dependent of the temperature; nitrogen dioxide in 410-530nm range; O_4 in 440-544nm; H_2O in one band 500-555nm and O_2 around 620nm.

3. Level 2: Conversion of slant columns into total columns using an Air Mass Factor (AMF).

- For ozone, daily AMF are calculated by UVSPEC/DISORT radiative transfer model (Mayer et Kylling, 2005). The model uses a multi-entry data-base from TOMS version 8 (TV8) ozone and temperature profiles climatology (Mc Peters et al. 2007). The TV8 is a monthly-zonal climatology sorted according to the ozone column. The parameters considered are fitting window central wavelength (510nm), station ground albedo and location (latitude, longitude, altitude), day of year, ozone slant column and SZA. The software is available on the Belgian Institute for Space Aeronomie (BIRA-IASB) web site (http://uv-vis.aeronomie.be/groundbased/)
- For NO_2, daily AMF are calculated by UVSPEC/DISORT radiative transfer model. The model uses a multi-entry data-base from NO_2 sunrise and sunset profiles climatology based on Satellite/SAOZ-balloon data and temperature profiles. The parameters considered are fitting window central wavelength (470nm), station ground albedo and location (latitude, longitude, altitude), day of year, time and SZA. The time of measurement is an important information since NO_2 displays a large diurnal variation. The software is available on the Belgian Institute for Space Aeronomie (BIRA-IASB).

Expected Precision/Accuracy of Instrument:

Converting slant columns relative to a given reference spectrum into vertical columns requires the knowledge of the AMF (see above) and the residual amount of constituent still present in the reference spectrum.
The residual amount of constituent present in the reference spectrum is determined by a Bouguer-Langley plot (slant column versus AMF) extrapolated to zero air mass. For more precise evaluation of the residual (0.5%), monthly Bouguer-Langley plots are used.
The precision of the total column measurements at twilight (86 - 91 SZA) is 2 Dobson Unit for ozone and 1.5 10+14 mol/cm2 for NO_2.
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 NO_2) is: ± 4% for ozone (2% cross sections and 2% AMF) and 10% for NO_2 (5% cross sections, 5% AMF).

Instrument History:

The SAOZ instrument was installed previously at Thule station. It was moved to Søndre Strømfjord in September 2017.

Starting date: 2017/09/12
Spectrometer: Jobin Yvon CP200, grating: 360 gr/mm, 270-600nm
measured FWMH: 1.17nm
Detector: NMOS, 1024 pixel
Entrance slit: 50 microns
Instrument n°: 7
Analysis software: L1/L2: SAM V5.9/Igor