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Data Set Description:

PI:	Margarita Yela González
Instrument:	UV-visible spectrometer
Site(s):	Belgrano, 77º52'S, 34º37' W
Measurement Quantities:	O3 and NO2 total columns

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<u>Instrument Description:</u>
NEVA-II is a robust house-made instrument developed for continuous operation in continental Antarctica. The instrument consists of two grating spectrometers measuring in UV (320-415 nm) and visible (400-550 nm) spectral ranges, respectively. They are based on a HAMAMATSU S7031-1008 (256 rows × 1024 pixels) CCD sensor. The read-out electronics is designed and developed at INTA, achieving a typical CCD node sensitivity of 2.2 μV/e-1 and typical read-out noise of 8e- operating at -40ºC. The

spectrograph is a TRIAX 180 (Czerny-Turner) holding a 1200 grooves/mm holographic grating. The system is located in a housing stabilized at 23ºC. Gas Nitrogen is supplied to keep the CCD humidity inside below 5 %. Depolarized light reaches the spectrograph through a 10 m fused silica fiber bundle. The optical telescope is designed to stand 1º field of view. Tilt telescope movement is controlled by thermally-controlled stepping motors. Measurements were performed in a continuous mode whenever SZA < 98º. NEVA-II was operating in zenith mode around twilight (SZA > 80º at dawn and SZA> 70º at dusk) and in off-axis mode the rest of the day.

Spectrometer named EVA is based on a Jobin-Yvon H20 monochromator with a ruled grating of 1200 grooves/mm and a photomultiplier tube Hammamatsu R212-UH blue enhanced as detector. Spectral resolution is 1nm FWHM and the sampling path is 0.1nm in the range 430–450 nm. A full spectrum is taken in 1.7 s. and 30 spectra per measurement are accumulated to improve the signal to noise 25 ratio. The instrument is located outdoors in a thermostatised housing. Light reaches the spectrograph by a 45º angle mirror. The instrument takes one measurement per 0.5º of SZA between 88º and 92º. NO2 from the scanning EVA spectrometer is retrieved in the 433–448.5 nm range. The instrument is in operation since the time when it was installed without any significant change.

Algorithm Description:
NO2, ozone, BrO and OClO vertical and/or slant column densities are retrieved by the method of differential optical absorption spectroscopy. In the following description, we concentrate more particularly on the NDACC products, NO2 and ozone total columns

NO2 and ozone total columns: Optical depths calculated as the log of the ratio of a reference high sun spectrum with the measured spectrum are fitted to laboratory cross-sections using a least square method. Stretching and shifting are taken into account for the fit. Ring is corrected by including a pseudo-cross section in the fitting process. Cross-sections of NO2, O3, O4, H2O, and Rayleigh are included in the analysis. The amount in the reference spectra are estimated by Langley plots (O3) and iterative approximation using twilight am and pm (NO2). Dark current is calculated from the integration time accounting by interpixel variability. DC measurements are carried out under routine basis by an electronic shutter located close to the optics.

NO2 is analyzed in the 425-490 nm spectral window, and ozone from 470 to 535 nm using the spectral analysis software suite (LANA) developed at INTA.The DOAS settings for the NO2 column retrieval follows the NDACC UV/Vis Working Group recommendations (Van Roozendael and Hendrick, 2012) whenever possible. Absorption cross sections O3, NO2, H2O and O4 have been also included in the analysis. Raman scattering cross section was generated by the Win-DOAS package (Fayt and Van Roozendael, 2001), calculated from Raman theory. Finally, the inverse of the reference spectrum was included as a pseudo cross section to account for stray light inside the spectrograph and the residual dark current of the detector. The air mass factor (AMF) used for the conversion of the NO2 slant columns to vertical columns is the NDACC NO2 standard AMF, available on the NDACC UV-Vis web page (http://ndacc-uvvis-wg.aeronomie.be/) and based on the Lambert et al., 1999 and 2000 climatology of the NO2 profiles.

For ozone columns, look-up tables of AMFs based on the TOMS V8 O3 profile climatology are used (see also Hendrick et al., 2011). Mean twilight vertical columns are obtained by averaging individual measurements between 86 and 91¦ SZA.

<u>Expected Precision/Accuracy of Instrument:</u>
A/NO2 and ozone total columns
Random errors are dominated by the uncertainties related to the slant column spectral fit and the calculations of the Air Mass factors (AMFs).The random errors associated to the spectral fit are due to detector noise, instrumental imperfections, as well as errors or unknowns in the signal modeling. The main sources of uncertainty in the AMF calculation are related to the choice of the radiative transfer model settings, i.e. the O3 and NO2 vertical profiles, the aerosol extinction profile, the cloud conditions, and in case of NO2, the inclusion or not of the rapid twilight photochemistry. In case of significant tropospheric pollution, additional errors can be introduced for NO2.
The uncertainties of the O3 and NO2 cross sections used in the spectral fit and the uncertainty on the determination of the residual amount of O3 and NO2 in the reference spectra by using the Langley-plot technique dominate the systematic error budget. Typical fitting errors range from 1–2 % under clear skies and 2–3% in cloudy conditions.
The estimated overall errors in the individual measurements are, on average, approximately 16 % for NO2 (1-2 % fit analysis; 2 % cross-sections; 2 % reference spectrum; 10 % AMF; 2 % stratospheric temperature). Systematic 4%, random, 11%.In the case of NO2, much larger errors can be obtained when tropospheric NO2 is produced or transported above the station.
For O3, 4 % for AMF calculate, 1-2% fit analysis, uncertainties of absorption cross- sections and their temperature dependencies, 3% for O3, residual column 2%. Systematic 5%, random 6%. 11%

<u>Instrument History:</u>
Starting date EVA: 1.2.1995
Ending date: -

Starting date NEVAII: 1.1.2013
Ending date:-

In 2017 Belgrano was joined NDACC.

Zenith measurements of column NO2, since 1995 with a grating scanning monochromator. Since 2012, two MAX-DOAS systems have been operating (one for NO2, O3, and IO and the other for BrO and OClO). The scanning system will continue to take measurements until 2020 in order to overlap with those by the MAX-DOAS systems.