File Revision Date:
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Data Set Description:

PI:	Valery Sinyakov
Instrument:	Visible spectrometer
Site(s):	Issyk-Kul (42.62N, 76.98E)
Measurement Quantities:	NO2

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Reference Articles:

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Instrument Description:

Instrument number 1 (1983-2000)

The instrumentation set for measurements of total nitrogen dioxide by the three-wave-length twilight method consists of a monochromator with the diffraction grating with 600 grove/mm, a photoreceiver (the photomultiplier FEU-106) and a computerised registering unit. The spectral resolution was 0.6 nm. The spectrum scanning rate was 0.4 nm/s. The time of registering an operating spectral wave range 437-442.5 nm was 15s.

Instrument number 2 (2001-present)

The instrument is a 0.6 m spectrometer with asymmetric optical Fastie's scheme. It has an aperture F/6 using 100x100 mm, 1200 grove/mm grating optimized in 500 nm, with spectral dispersion 1.3 nm/mm. The slits width is 0.5 mm nominal to provide a resolution 0.65 nm FWHM. The detector is a photomultiplier. Wavelength is scanned by rotating the grating using a sine bar mechanism driven by stepper motor. One step of the motor is equivalent to 1/300 nm step of wavelength. The working scanning rate is 51.2 nm/min and is synchronized with ADC (analog-digital converter) operation by a master quartz generator, so that one step of the stepper motor corresponds to one conversion of ADC. The wavelength region measured is 434 to 451 nm. Normal processing uses 435 to 450 nm of this spectrum. Forward and reverse scans together take 40 s. Polarization effect of the instrument is less than 15%. The use of a photomultiplier as a defector does not require correction procedure due to polarization effect.

This instrument was certified by results of the intercomparison of instruments for NO2 measurement in September, 1997 (Zvenigorod, Russia)

Algorithm Description:

1983-2000

For determining nitrogen dioxide total content the intensities of the solar radiation at the wave lengths of 437.6, 439.8 and 442.0 nm scattered in the atmosphere were registered at the zenith angles of 85-920 at sunrise and sunset. The first and the third wave lengths coincide with a relative minimum, the second one corresponds to maximum of solar radiation absorption by nitrogen dioxide. Quasimonochromatic radiation intensities outside the atmosphere at these wave lengths were found from spectra registered at noon on clear days when the absorption of radiation by nitrogen dioxide was negligibly small. Total nitrogen dioxide was determined at solving a system of three equations of the Bouguer law, every equation being correspondent to a certain wave length. Besides the solar radiation absorption by nitrogen dioxide the radiation absorption by ozone, the radiation molecular scattering and aerosol attenuation were accounted for in these equations.

2001-present
Detected spectrum is proposed to be the sum of the solar spectrum exponentially attenuated by NO2 and O3 absorption and by Rayleigh and aerosol scattering, and a constant. The constant is believed to include effects of detector dark current, spectrometer stray light leakage, and the Ring effect. To determine of the NO2 slant content the difference of logarithms of the observation spectrum and the reference spectrum is calculated to remove the dominant Fraunhofer features. The fitting of the difference of logarithms to laboratory cross-sections is carried out using a least square method. Air mass factors for NO2 are calculated using a spherical single-scattering model for solar radiation and a nonstationary one-dimensional photochemical model with Ox-NOx photochemistry. Parameters of the models are seasonally dependent.

Expected Precision/Accuracy of Instrument:
The random error of determination of slant column NO2 content is about 10%.

Instrument History:
1983-2000, instrument number 1
2001- present, instrument number 2