FIRST RESULTS OF OBSERVATIONS OF NO_2 TOTAL CONTENT AND VERTICAL DISTRIBUTION OVER TOMSK

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Received January 29, 1996

This paper describes briefly the instrumentation for observation of NO_2 *total content and vertical distribution in the atmosphere. Presented are first observational results obtained in November-December of 1995 over Tomsk.*

For studying the mechanisms of ozone layer transformations, including the processes of ozone "holes" formation, it is of principal importance to have information about the components of catalytic cycles of ozone destruction. Among them, of great significance is the nitrogen dioxide NO_2 as one of the main constituents of the well-known series of "odd nitrogen" NO_x in the ozone cycle. On the one hand, NO_2 directly participates in the catalytic destruction of "odd oxygen" following the scheme

$$NO_2 + O \rightarrow NO + O_2 ,$$
$$NO + O_3 \rightarrow NO_2 + O_2 .$$

On the other hand, reacting with ClO, NO_2 forms the chloride nitrate $ClONO_2$, which is the main temporary reservoir for chlorine – one of the strongest ozone destructor in the stratosphere.

There is the well-known absorption band with the center in the blue spectral range[1] in the NO_2 absorption spectrum. In the 435–450 nm range, the NO_2 absorption spectrum is selective enough to provide retrieval of information about NO_2 content in the atmosphere using the differential absorption method.

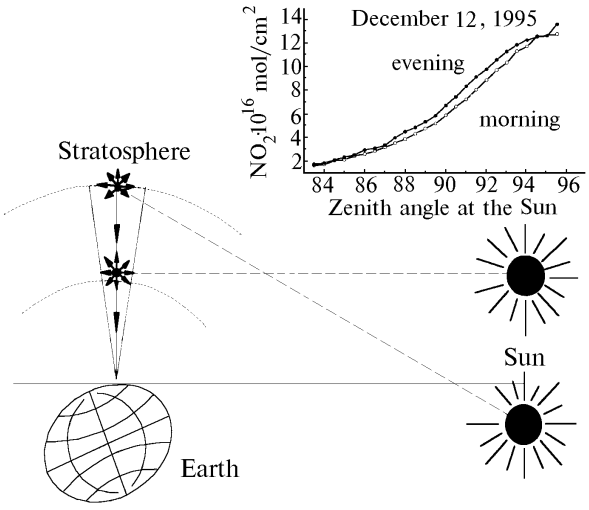

FIG. 1. Experimental geometry of NO_2 *content measurements in the atmosphere at different zenith angles of the Sun. Presented are the morning and evening measurement results.*

The basic idea of deriving the NO_2 vertical distribution is in measuring the spectra within 435–450 nm range with the resolution of 0.09 nm and computing the NO_2 content in the atmospheric column at twilight, when the solar elevation angle is ±6.5° from the horizon (Fig. 1), following the procedure described in Refs. 2–4 with the use of differential absorption. In so doing, the atmosphere is assumed spherical and single scattering with due regard for the refraction.

In collaboration with our colleagues from the Institute of Atmospheric Physics of the Russian Academy of Sciences, the spectral complex has been constructed, that comprises the MDR–23 monochromator, the recording and control unit, a computer, and the software for control over the spectral complex as well as for data collection and processing.

Figure 2 shows the functional diagram of the spectrophotometer which comprises a filter *1*, a beam-folding mirror *2*, an MDR–23 monochromator *3*, the recording and control unit *4–8*, and a computer. The diffuse solar radiation, passing through the filter *1*, which serves for cutting-off the higher-order spectra in the grating monochromator, is directed, with the beam-folding mirror *2*, to the entrance slit of the MDR–23 monochromator *3*. The field-of-view of the spectral device is $2 \cdot 5 \cdot 10^{-3} \times 9 \cdot 10^{-4}$ sr.

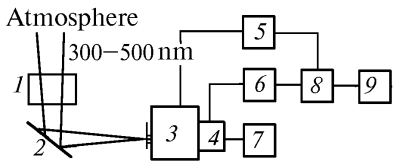

FIG. 2. Functional diagram of the spectrophotometer.

Control over the monochromator grating and the high-voltage power supply *6* as well as recording of the analog signal from PMT are done by the recording and control unit built around the single-crystal 1816VE51 controller *8* with a built-in 4 k ROM. The controller generates control signals for the stepper motor providing for the tuning rate of 22 nm/min and a step

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of 0.06 nm, and then the amplifier *5* amplifies signals to a preset value.

The spectrum is recorded with the use of a FEU–100 PMT *4*. The photocurrent signal from the PMT is amplified and then shaped into a rectangular pulse with the frequency proportional to the current in the voltage–frequency converter *7*. The frequency is measured with the single-crystal controller, which makes averaging over 10 readings at each spectral point and transmits data into a computer, where they are processed.

Figure 3 demonstrates the measurement results processed and presented as NO_2 altitude profiles for evening and morning observations. As is seen from the figure, NO_2 maximum is observed at altitude of 25–35 km, and in the evening its value is greater and it is observed at a lower level as compared to the morning one.

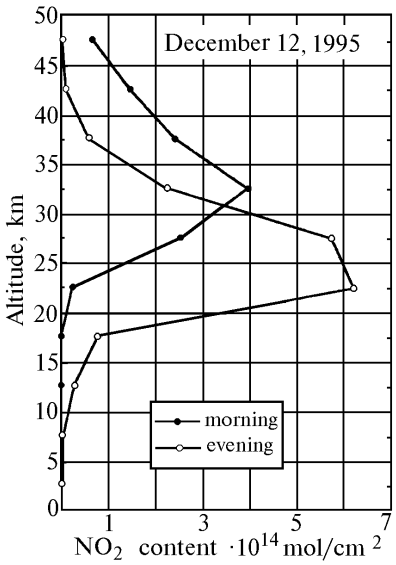

FIG. 3. NO_2 *altitude profile for the morning and evening observations. The calculations were done for layers* 5 km *thick.*

The comparison of the morning and evening values of the NO_2 total content (Fig. 4) reveals the regular excess of the evening values over the morning ones by about 25%, that reflects the change of the NO_2 content from day to night due to slow transformation of NO_2 into N_2O_5 at night with the subsequent increase in daytime as a result of N_2O_5 photodissociation.[5,6]

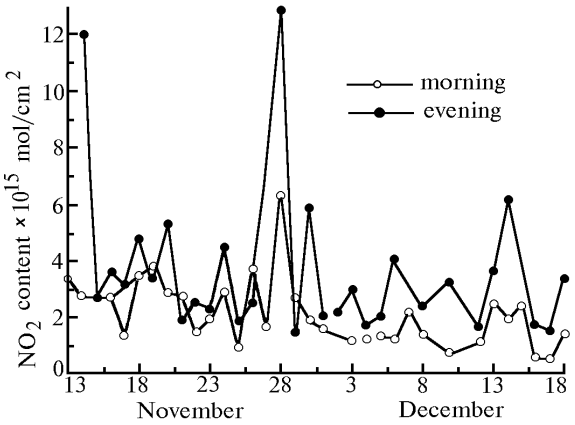

FIG. 4. NO_2 *total content. November-December of 1995.*

The analysis of thus obtained results of regular measurements as well as the data of lidar sensing of ozone we conduct will allow us to study the processes of ozone layer formation and destruction in a more detail.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the colleagues N.F. Elanskii and A.S. Elokhov (Institute of Atmospheric Physics of the Russian Academy of Sciences) for their technical and methodical help in conducting regular measurements of NO_2 content in the atmosphere over Tomsk.

The work was supported, in part, by the Russian Foundation for Fundamental Research (Project No. 96–05–64282) and the Russian Ministry of Science (Grant No. 01–611).

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