FIRST RESULTS OF LIDAR OBSERVATIONS OF STRATOSPHERIC OZONE ABOVE WESTERN SIBERIA

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The first results of regular lidar observations of the stratospheric ozone layer are presented. The variations of the integrated ozone concentration in the layer, obtained from the lidar data, are in good agreement with the total ozone content of the atmospheric column measured by Dobson's method.

The steady expansion of the ozone "holes" over the Arctic and Antarctic regions,[1] indicating that processes that are destroying the ozone layer have been activated, makes it apparent that observations of the stratospheric ozone on a planetary scale are urgently needed. The large number of reports on this problem at the last international conference in San Candido on laser sounding of the atmosphere[2] shows that lidar methods for observing ozone stratification are being increasingly employed in addition to the traditional methods of ozonometry (using Dobson ozone sensors and spectrometers).

Lidar sounding of stratospheric ozone was first performed in 1977 with the help of a dye laser[3] and in 1979 using an XeCl excimer laser.[4] Observations of the distribution of stratospheric ozone are now conducted by a number of lidar stations located in different regions of the earth.[5,6,7,8] In our country the only attempt to perform lidar sounding of ozone was made in 1978.[9] Regular lidar observations of the state of the ozone layer were begun in December 1988 and are being conducted above Western Siberia. For this purpose we developed a UV channel for a stationary lidar with a receiving mirror 1 m in diameter; the basic parameters and layout of this lidar are presented in Ref. 10. The UV channel consists of an excimer laser based on an XeCl mixture; the pulse energy is equal to 10 mJ and the pulse repetition frequency is equal to 1–2 Hz; the channel contains an interference light filter that operates at $\lambda_1 = 308$ nm and has a bandwidth of 3.6 nm and transmission of 42%; it also contains a package of programs for data processing and documentation.

The measurements were performed at two wavelengths: at $\lambda_1 = 308$ nm in the absorption band of ozone and $\lambda_2 = 532$ nm, which is employed as a reference wavelength. About two hours were required to obtain one ozone profile combined with alternate series of measurements at λ_2, λ_1, and λ_2.

The processing of the experimental data, as well as the measurements themselves, were performed using a differential method. The contribution of the aerosol scattering at $\lambda_1 = 308$ nm was estimated from echo signals at $\lambda_2 = 532$ nm.[11] The profiles of the ozone concentration were constructed by the method of linear smoothing for separate nights in December 1988 and January, February, and March 1989 from the measurements. Some of the results are presented in Fig. 1, where one can clearly follow the ozone layer in the region of altitudes 10–25 km. The maximum ozone concentration is reached in the range 16–20 km. The values obtained for the ozone concentration at the maximum agree completely with published data. A structure with two concentration maxima can be seen in separate graphs (February 20 and March 3); this can be explained by the flow of polar air masses into the middle latitudes of Western Siberia.

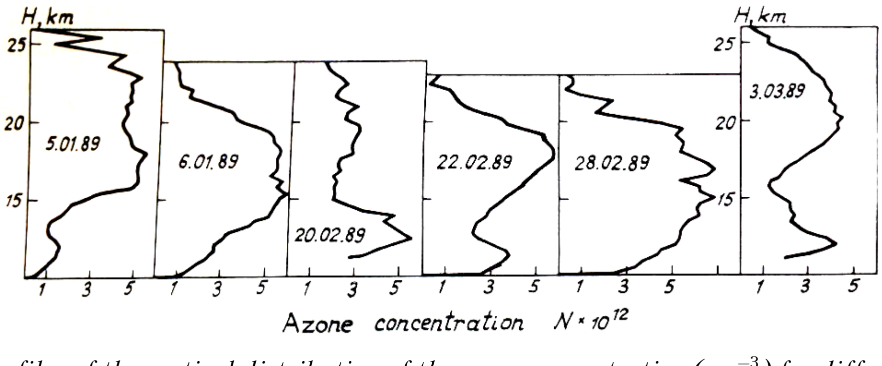

FIG. 1. Profiles of the vertical distribution of the ozone concentration (cm^{-3}) for different nights.

Figure 2 shows the variations, revealed by the lidar, in the relative (normalized to the maximum value) integrated concentrations of the ozone layer and the relative ozone content determined by the M-124 meter above the sounding point. As one can see from the figure, the independent measurements are in good agreement with the lidar measurements; the fact that the results obtained by the lidar method were obtained at night while the results obtained by the Dobson method were obtained during the day must be taken into account.

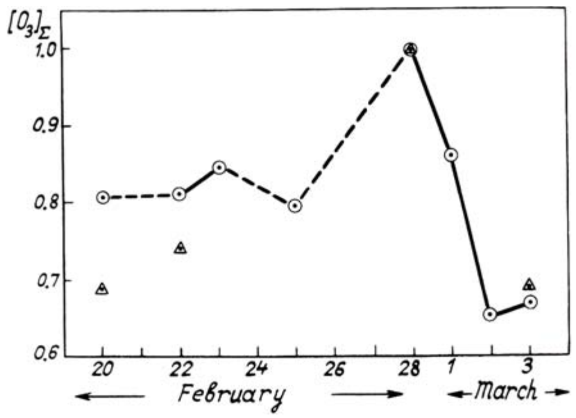

FIG. 2. The relative integrated ozone concentration in the layer (lidar measurements denoted by triangles) and in the entire atmosphere (Dobson meter marked by circles) as a function of time.

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