ALTITUDE OZONE PROFILES OVER THE FARADAY/VERNADSKY STATION 1975-2009
BY UMKEHR METHOD

The total ozone column and the vertical ozone distribution were measured at the Antarctic Station Faraday/Vernadsky since 1957. According the World Ozone and Ultra Violet Data Centre classification (WOUDC), the station number is 232. Ozone observations have been provided using the Dobson spectrophotometer. During the analysed period, three spectrophotometers were used for measurements of ozone parameters at the station. Two instruments - Dobson 073 and Dobson 031 - were used at the Faraday station. After the transfer of the station to Ukraine in 1996, two spectrophotometers - Dobson 031 and Dobson 123 - were used. We have processed the results of a unique series of ozone observations obtained since 1973.

To retrieve profiles of the vertical distribution of ozone, the Umkehr method of observation was used. The observation is based on analysis of the sunlight scattered from the sky during sunrise or sunset for zenith angles ranging from 60 to 90 degrees. The Umkehr method is based on changes in the intensity ratio of two different wavelengths at which ozone strongly/weakly absorbs UV radiation [1–4].

After analysing the data quality obtained during the observation period 1975–2009, 1136 days of Umkehr observations were chosen (Figure 1).
During the processing of observations for each of the spectrophotometers, we used the corresponding calibration tables, which gave us the opportunity to build profiles of the vertical distribution of ozone over the Faraday/Vernadsky station precisely in the years of the formation of the ozone hole over Antarctica. The standard software package of the World Ozone and UV radiation Data Centre (WOUDC) was used to create vertical distributions [4].

After processing [5], 263 profiles of the vertical distribution of ozone over the station were obtained. Also we investigated variations in the vertical ozone distribution in September – October when the ozone hole is observed by dropping the total ozone column to less than 220 DU values.

According to observational data, 39 profiles of the vertical distribution of ozone were obtained for the 1975–1979 (Figure 2). The range of ozone values in the maximum concentration is within 56 – 134 DU/layer at the range of altitudes 13 -19 km.

Profiles built from observations in September – November are characterized by a larger spread of the value of ozone in the maximum concentration. 15 profiles of the vertical distribution of ozone were obtained for the period (Figure 3). The maximum value of ozone in the maximum concentration is within 134 DU/layer 6 November 1978. The minimum value of ozone in the maximum concentration is within 56 DU/layer of 12 November 1975.
Fig. 3. Distribution of ozone with altitude for September – November 1975-1979. Profiles are presented in units of DU/layer

During this period, according to our results, the ozone hole was not recorded. For the period 1980–1989, 42 profiles of the vertical distribution of ozone were obtained (Figure 4). The range of ozone values in the maximum concentration is within 39–100 DU/layer at the range of altitudes 13-19 km.

Fig. 4. Distribution of ozone with altitude for 1980–1989. Profiles are presented in units of DU/layer

The first vertical profile of the ozone distribution, which describes the "ozone hole", was constructed using data of September 23, 1989. For this day the total ozone content (TOC) was ~227 DU (Figure 5).

Fig. 5. Vertical ozone distribution which describe the "ozone hole" detected in September 23, 1989 over the Vernadsky station (left); the assimilated plots of the ozone distribution from the TEMIS (right)
The largest number of profiles (107) of the vertical distribution of ozone has been received for the 1990–1999 period (Figure 6). The range of ozone values in the maximum concentration is within 26–132 DU/layer at the range of altitudes 13–25 km.

Fig. 6. Distribution of ozone with altitude for 1990 – 1999. Profiles are presented in units of DU/layer

Profiles in ozone hole conditions have two maxima and an area of significant drop in ozone partial column. The detailed analysis of all profiles and comparison with satellite data will be provided in next consideration. The assimilated plots of the ozone distribution from the TEMIS website (https://www.temis.nl/protocols/O3global.php) confirm the presence of an ozone hole over the station for the dates with "double maxima" observed.

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