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CONTINUOUS MEASUREMENTS OF THE TOTAL OZONE CONTENT IN THE FULL MOON PERIOD

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ABSTRACT

Presented are the experimental data on the total ozone content obtained during continuous measurements (day-night-...-night-day) by Brewer 044 spectrophotometer near the Issyk Kul Lake (42.59N, 77.04W) at 1650 m above the see level at full moon from 13 to 18 October 1989 under anomalously high transparent atmospheric conditions (the horizontal visibility range exceeded 50 km). At night the total O_3 content decreased regularly to about 20% of the average daytime values. The minimum values at night were observed in 1-2 hours after the maximum solar dip below the horizon. In the daytime the measurements were carried out from direct Sun, at night - from the Moon. The values of the total ozone content for adjacent measurements from the Sun and from the Moon in the evening as well as in the morning are in good agreement.

1. INTRODUCTION

In the first decade of October 1989 near the mountain Issyk Kul Lake at 1650 m above the see level the anomalous warm and dry weather was observed under the influence of the south-west periphery of the anticyclone. On 11-12 October the zonal circulation accompanied by intrusion of cold air mass from the north was disturbed that resulted in the drop of surface air temperature by 10 - 11°C and in the significant increase of atmospheric transparency (the horizontal visibility range exceeded 50 km). All this together with established dry and cloudless weather and favourable Moon and Sun passage in the celestial dome offered unique scope for continuous many day measurements of the total ozone content in the full Moon period from 13 to 18 October 1989. It should be noted that ever since during 1990-1991 in no case we succeeded in such measurements: in the tropics (March-May 1990)measurements from the Moon were impossible for high atmospheric turbidity, in the Arctic (January-March 1991)-measurements from the Sun because of large zenith angles, and at middle latitudes (April-November 1991) there were no

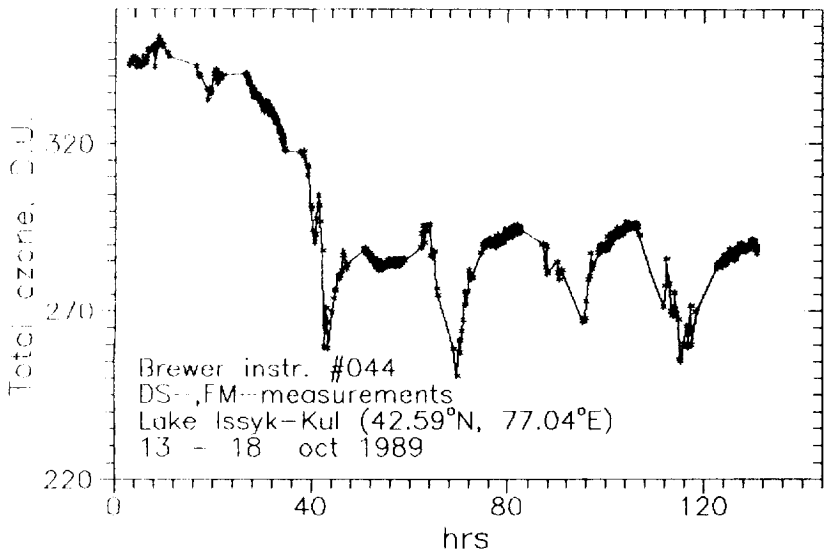

Fig. 1. Results of continuous many day measurements of the total ozone content near the Issyk Kul Lake at 1650 m above the see level in the full Moon period from 13 to 18 October 1989 under anomalously high atmospheric transparency conditions. On the abscissa 0 corresponds to 00.00 Greenwich for 13 October.

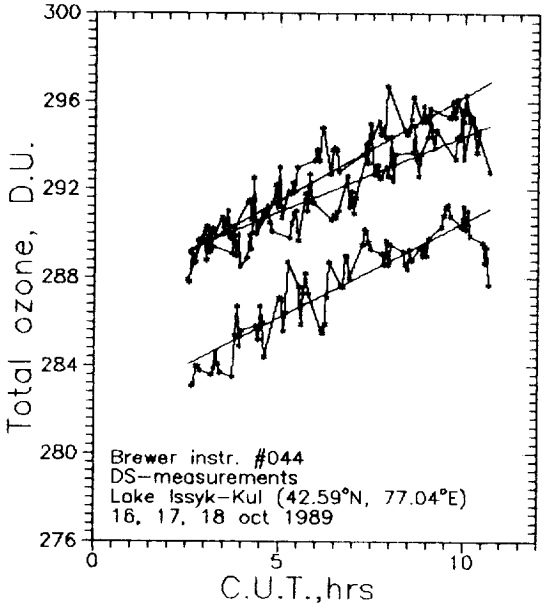

Fig. 2. The daytime course of the total ozone content. The local time passes ahead of the Greenwich time by 6 hours.

observations in the periods of fine cloudless weather during some days and the zenith angles of the Moon were too large.

2. QUALITY OF OZONE DATA

The total ozone content was measured by Brewer 044 spectrophotometer in the daytime from direct Sun, at night - from the Moon. The period of a single simultaneous measurement of the total ozone content from the Sun is 30 sec, from the Moon - 2.5min. The results of 5 adjacent single measurements are combined into one DS- or FM-measurement. According to the Operators Manual of the firm - manufacturer (Brewer Ozone Spectrophotometer. Operators Manual. Canada, 1987) the DS-measurement error of the total ozone content with Brewer 044 spectrophotometer is less than 1%. It is confirmed also by the results of its comparison with the reference Brewer 017 spectrophotometer carried out in July 1989 in Alma-Ata to the north of the Issyk Kul Lake at about 70 km. The Operators Manual of the firm-manufacturer does not contain any information on the measurement accuracy of the total ozone content from the Moon. It seems to be equal to 3% as the scatter in the total ozone content values obtained from 5 adjacent single measurements combined into one FM-measurement, does not exceed 10 D.U. and a similar scatter for measurements from direct Sun - not more than 3 D.U.

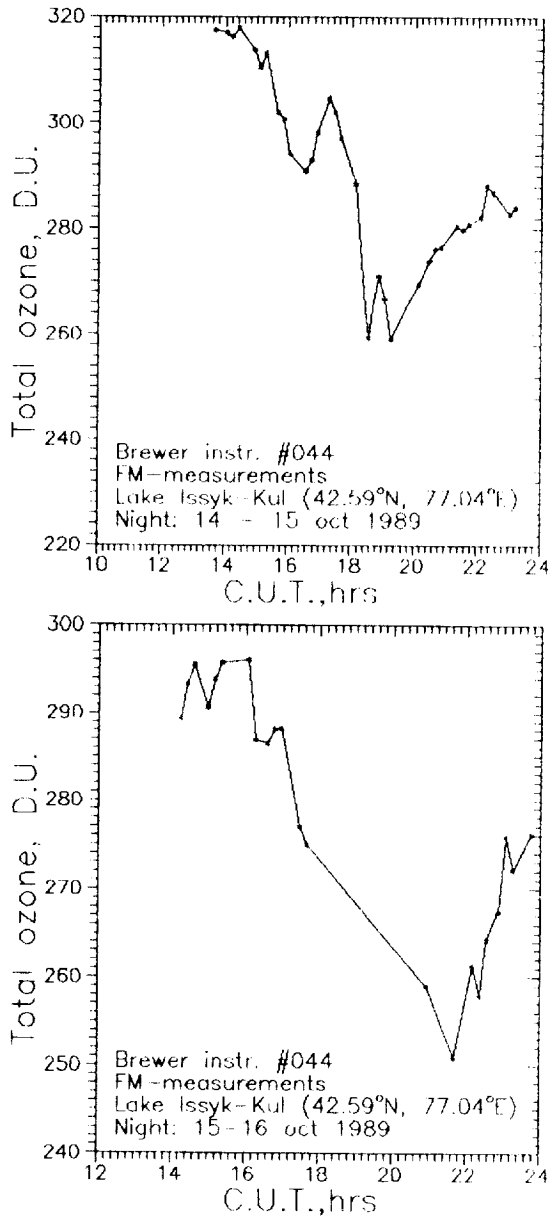

Fig. 3a,b. The nighttime course of the total ozone content.

In the period from 13 to 18 October the equipment was operated during twenty four hours in the continuous measurement regime that allowed to obtain a long series of values for the total ozone content, nearly continuous for 6 days. There are gaps up to several hours in the experimental data for morning and evening when one type of measurement is already impossible and another type is still impossible. The case is that the DS- as well as FM-measurements give reasonable results on the total ozone content at the zenith angles of the Moon

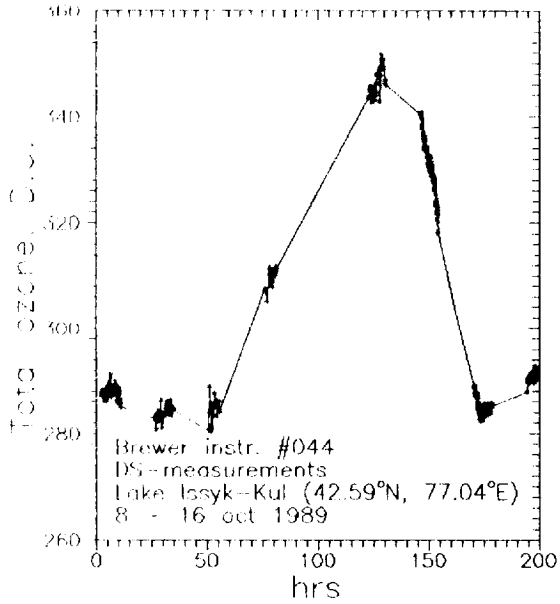

Fig. 4. An abrupt increase in the total ozone content when cold air masses introded into the site, on 11-12 October with its subsequent abrupt decrease to the original values from DS-measurements. On the abscissa 0 corresponds to 00.00 Greenwich on 8 October.

and Sun not more than 75° and besides, measurements from the Moon are to be carried out in the full absence of illumination from the Sun. Small gap up to several hours are also observed in the daytime as well as at night due to the presence of individual clouds and need for regular verification of correct apparatus operation.

During measurements the device orientation to the radiation sourse was followed regularly, failures were not found. The device temperature varied significantly. Therefore each morning and evening as well as each time when the device temperature was varied by 2°C the device was tested with the mercury - discharge and highly stabilized standard lamp. The device temperature in the daytime varied from +13 to +33°C, at night-from +11 to +24°C, and the operating temperature tanged from -20 to +42°C.

Therefore regular variations of the total ozone content at night considered below can not be specified by incorrect operation of the device, As special calculations showed, they can not be also specified by the method used to calculate the values of the total ozone content. They seem to reflect the processes of ozone transformation really observed in the Earth's atmosphere.

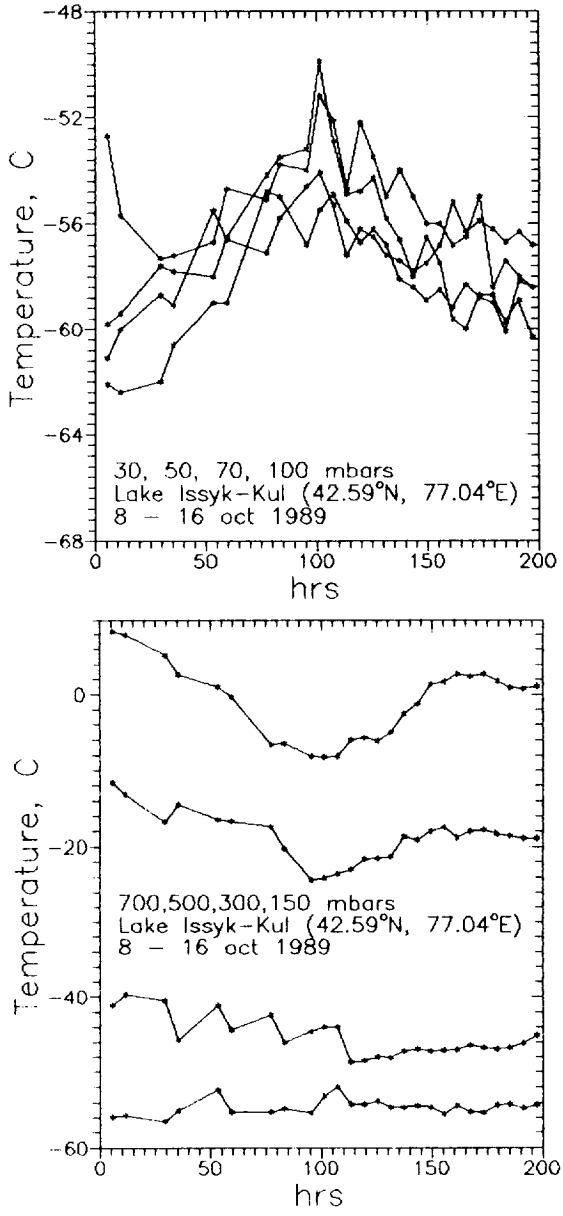

Fig. 5a,b. Different variations in the air temperature at various atmospheric levels when cold air masses introded into the site on 11-12 October.

3. OZONE DATA

A nearly continuous series of the total ozone content values for the Issyk Kul Lake from 13 to 18 October 1989 is presented in Fig.1.More detailed results of daytime and nighttime measurements of the total ozone content are presented in Figs. 2 and 3. Fig. 4 illustrates an abrupt increase in the total ozone

Table. Results of adjacent total ozone content measurements (X, D.U.) from the Moon and from the Sun and its minimum values registered at night (asterisk): θ - zenith angles in degress of the Sun or Moon depending on the type (DS- or FM-) measurements, δ - root-mean-square deviations in the total ozone content values obtained from five adjacent single measurements combined into one DS- or FM-measurement.

Date	Time		θ	X,D.U.	δ
13.10.89	9:37:58	DS	64.9	349.2	0.9
	10:47:18	DS	75.7	346.0	0.8
	15:38:06	FM	46.5	357.0	9.7
	16:11:30	FM	42.8	352.4	7.4
	16:23:03	FM	41.8	348.6	5.4
	16:34:35	FM	40.9	343.0	7.2
	18:54:04	FM	42.0	333.0*	6.8
	21:52:57	FM	67.0	340.4	8.4
	22:04:29	FM	69.0	335.6	6.7
14.10.89	2:34:19	DS	75.0	340.5	0.4
	2:37:43	DS	74.5	340.8	0.6
	10:25:52	DS	72.5	318.6	0.4
	10:29:15	DS	73.1	317.9	1.5
	13:40:18	FM	68.5	317.5	4.9
	14:02:07	FM	64.6	317.0	2.3
	19:16:00	FM	33.0	259.1*	5.6
	23:24:01	FM	68.8	278.6	4.0
	23:43:30	FM	72.2	278.8	8.8
15.10.89	2:44:02	DS	73.7	288.8	1.2
	2:47:27	DS	73.1	288.8	0.7
	10:43:24	DS	75.7	285.7	0.5
15.10.89	10:46:48	DS	76.2	285.1	0.2
15.10.89	14:13:25	FM	68.2	289.4	2.8
	14:24:56	FM	66.1	293.3	2.2
	21:40:45	FM	37.7	250.8*	6.6
	23:45:37	FM	58.7	276.1	4.8
16.10.89	0:29:12	FM	66.3	279.8	3.5
	0:40:45	FM	68.4	280.2	5.4
	2:31:35	DS	76.0	287.9	0.7
	3:02:06	DS	71.0	290.3	2.1
	10:20:56	DS	72.4	293.7	0.6
	10:24:21	DS	72.6	294.7	0.2
	15:02:12	FM	66.6	290.1	8.8
	15:35:28	FM	60.7	283.1	7.7
	23:12:13	FM	39.3	267.1*	7.1
17.10.89	1:06:56	FM	59.4	282.8	5.1
	1:18:27	FM	61.4	283.8	8.6
	2:34:12	DS	75.8	287.8	0.3
	2:37:35	DS	75.2	289.1	1.8
	10:09:55	DS	71.0	295.2	1.4
	10:13:17	DS	71.5	295.3	1.1
	15:42:13	FM	68.2	271.4	9.2
	16:03:00	FM	64.5	277.7	7.9
17.10.89	19:49:38	FM	25.2	244.1*	9.9

content with the intrusion of cold northern air to the site on 11 - 12 October with its subsequent absupt decrease to initial values according to the DS-measurements of 8-11 and 11-16 October. There were no measurements on 12 October. It was cloudly and rainy. Fig.5 shows the air temperature decrease during this period at 700 and 500 mbar, its constancy at 150 mbar and its increase at the 100, 70, 50 and 30 mbar levels from standard aerological sounding in the Cholpon-Ata site, also located on shore of the Issyk Kul Lake but by 10 km to the south from the place where the total ozone content was measured. The results of individual DS- and FM-measurements for 13-17 October are also presented in the Table. They show that the results of adjacent DS- and FM- measurements in the daytime as well as in the evening and the minimum values of the total ozone content registered at night are in good agreement.

CONCLUDING REMARKS

The presented experimental data unambiguously indicate that at night a regular (up to 20%)decrease in the total ozone content was registered.The minimum values at night were seemingly observed in 1-2 hours after the maximum solar dip below the horizon. Such a conclusion is confirmed the Table,considering that the maximum solar dip below the horizon was observed at 18.5 Greenwich and on 16 October here were no measurements 19 to 23 hours. The local time passed ahead of the Greenwich time by 6 hours.

Following the general ideas of the ozone formation and destruction processes in the Earth's atmosphere there are no reasons to propose that the total ozone content at night remains constant. Rather the reverse is the case because in passing from day to night the regime of atmosphere illumination by solar UV radiation varies significantly and also the regime of horizontal and vertical motions in the atmosphere especially at the landspacious water surface interface. At the same time the diurnal course of the total ozone content, presented in Fig.1, is unexpected. However this fact is established experimentally. It is possibly involved only for the Issyk Kul Lake region under weather conditions observed during measurements.