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DATA ON ATMOSPHERIC TRANSMISSION IN THE IR SPECTRAL REGION

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DATA ON ATMOSPHERIC TRANSMISSION IN THE IR SPECTRAL REGION

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Studies of the weakening of radiation by the atmosphere in the IR region of the spectrum were carried out experimentally at the Main Geophysical Observatory, Named for A. I. Voyeykov, in Voyeykovo near Leningrad. The measurements were carried out on the IKAU-1 infrared atmospheric unit, both on inclined paths for the entire thickness of the atmosphere, and on a near-earth horizontal path. The equipment and procedure of the measurements are described in studies [1,2]. /1*

1. Continuous Weakening of IR Radiation in Atmospheric Apertures of Transparency

In order to study continuous weakening in infrared atmospheric apertures of transparency, measurements were carried out in relatively clear spectral intervals.

Given in table 1 are the data of measurements of the optical thickness of the vertical column of the atmosphere (τ_z) for a series of intervals. Also indicated in the table are: the date of recording of the spectra, the number of atmospheric masses (m), the amount of condensed water in the vertical column of the atmosphere in centimeters (W_z), the aerosol component of transmission for an integral flow of shortwave solar radiation (P_{AER}), and the frequency of the centers relative to the clear spectral intervals in which the measurements were carried out. The number of atmospheric masses was determined according to the time data; the switch from the altitude of the sun to m was accomplished according to Bemporad's tables. The amount of condensed water was

*Numbers in the margin indicate pagination in the foreign text.

measured with an infrared hygrometer [3], and also calculated according to the data of radiosonde measurements, carried out at 500 m from the point of the observations. The integral flow of solar radiation was measured with an M-3 actinometer. The atmospheric transmission for an integral shortwave flow, with m=2, was determined on the basis of Sivkov's procedure [4]. The deduction of the contribution because of absorption by water vapor was carried out according to the calculation formulas given in study [5]. /2

Recording of the spectra of the solar radiation was carried out with a spectral resolution of 4 cm^{-1} at 2.14 microns, 1.5 cm^{-1} at 3.7 microns, and 2 cm^{-1} at 10 microns (given here is the breadth of the equipment function of the instrument at half altitude).

Analysis of the errors in determination of τ_z, made with respect to the presented body of data, leads to a magnitude close to ±0.02.

Carried out for the 8-12 micron spectral region was the evaluation of the contribution of continuous weakening by water vapor, based on the laboratory data given in study [6]. In order to accomplish correct calculation of this contribution, the 39 spectra given in table 1, the time of recording of which is closest to the time of triggering of the radiosonde, were taken from the entire body of data. Triggering of the radiosonde was at 1420 and 2020 local time. Thus, the calculation of continuous weakening by water vapor was carried out for each spectrum, according to specific distributions of temperature and humidity, which occur during recording of the spectrum. The results of the calculation are given in table 1 for each spectrum (τ_R).

Given in table 2 are the magnitudes of the optical thickness $\tau_{\frac{1}{KM}}$, obtained according to measurements on a horizontal near-earth path 2,070 m long. The values of $\tau_{\frac{1}{KM}}$ are given for three relatively clear spectral intervals, with centers at 4,668 cm^{-1}, 2,700 cm^{-1}, and 901 cm^{-1}. Given for each group of measurements are the data, time, and meteorological parameters: meteorological range of visibility, in km (S_M), temperature (T^oC), relative humidity (R%), and absolute humidity (E,MB). The meteorological range of visibility was determined with an accuracy of ±15-25%.

Evaluation of the errors during measurements of the transmission on a horizontal path is described in study [2]. The last, more specific analysis of the errors lead to a magnitude of random error in determination of $\tau_{\frac{1}{KM}}$ equal to ±0.015 1/km, and for the possible systematic error of the unknown sign, to a value of ± 0.02 1/km.

The resolution of the spectral instrument, during the obtaining of these data, was 6 cm^{-1} at 2.14 microns, 2 cm^{-1} at 3.7 microns, and 3 cm^{-1} at 11.1 microns. /3

Given in figure 1 are the functions of the optical thickness of continuous weakening at a wavelength of 3.7 microns on the humidity (content of water vapor on the path of the beam for an inclined path—fig. 1a, and partial pressure of water vapor for near-earth path—fig. 1b). In a number of studies, there are indications of the existence of a continuum of water vapor in these region of the spectrum. Specifically, study [7] has recently appeared, wherein results are given of laboratory measurements of the continuum for conditions close to atmospheric conditions ($T=23^oC$ and E=14.3 torrs). The results of the laboratory measurements are shown in figure 1b by the straight line segment. The line is drawn in the region of atmospheric humidities close to 14.3 torrs (19.1 millibars).

It is evident that the magnitude of the optical thickness for the water vapor continuum, determined in the laboratory measurements, is found in the region of the lower level of values of $T \frac{1}{KM}$, obtained under natural conditions, i.e., in the region of those values of $T \frac{1}{KM}$ which are obtained with the slight effect of aerosol weakening.

Thus, one can say that the laboratory data, obtained under the fixed conditions ($T=23^{\circ}C$, $E=14$ torrs) do not contradict the results of the natural measurements presented herein. However, the results of the measurements presented herein, as is evident from figure 1, show that an appreciable dependence of weakening in this region of the spectrum on humidity is not observed. This circumstance forces one to think that, in fact, the coefficient of absorption in the water vapor continuum in this region of the spectrum should be even less; here, under natural conditions, the weak dependence on humidity is probably masked by errors in measurements and the effect of aerosol weakening.

Since, at the present time, there are no data for the correct consideration of the water vapor continuum in the 4 micron region, then, with the obtaining of a spectral course of aerosol weakening, we thought that the weakening in this region of the spectrum was brought about wholly by aerosol.

Carried out for the 8-12 micron region of the spectrum was the comparison of the results of the natural measurements presented herein with the calculations of weakening by water vapor, based on the laboratory data. The comparisons were carried out both for inclined and horizontal paths. Utilized for the calculations were the date of Berch, given in study [6]. The results of the comparison are given in figure 2 and figure 3. It is evident from the figures that the experimental values lie at the level of the calcuation values, and above them. Such a relationship of the indicated magnitudes should be expected, insofar as the supplementary contribution /4 to the optical thickness which is decisive in the experiment can be made by aerosol weakening. For conditions under which the measurements were carried out, as is evident from figures 2 and 3, the contribution to weakening due to aerosol may reach a magnitude of 0.08, both for the vertical column of the atmosphere, and for the 1 km near-earth horizontal path. On the average, the value of the optical thickness of the aerosol for the vertical column of the atmosphere, according to the measurements presented herein, is a magnitude of about 0.04 in the range of the 8-12 micron aperture of transparency. Roughly these same values of the aerosol weakening are obtained for $\lambda = 3.7$ microns and $\lambda = 2.12$ microns.

For the conditions of the near-earth horizontal path, a relative average spectral course of aerosol weakening was obtained, according to measurements at four wavelengths: 0.6, 2.12., 3.7, and 11.1 microns. The optical thickness of the aerosol weakening for $\lambda = 0.6$ microns was determined on the basis of the meteorological range of visibility, according to the formula:

$$\tau_{0,6} = \frac{3,9}{S_M}$$

Deduced in the 11.1 micron region, for obtaining the aerosol weakening from the total optical thickness, was the contribution due to the water vapor continuum.

The relative spectral course of the aerosol weakening was obtained by means of dividing the aerosol weakening at each wavelength by $\tau_{0.6}$. The spectral course obtained thusly is presented in figure 4. Given in this same figure is the spectral course of aerosol weakening calculated on the basis of the aerosol models proposed in [8]. It is evident from figure 4 that the spectral course, obtained in the experiment, lies in the interval between the maritime and municipal model. The region in which the measurements were carried out is located 8 km east of a large industrial center. With westerly winds, there undoubtedly exist aerosol drifts of municipal origin. On the other hand, the climate in the region of the measurements is humid, which is explained by the proximity of the sea. Analysis of the synoptic situation shows that, in the majority of cases, the air masses enter the region of the measurements from the Atlantic. Thus, the relationship of the experimental spectral course and the indicated models agrees with the climatic features of the region of the measurements. /5

2. Data on the Spectral Transmission of the Near-Earth Horizontal Layer of the Atmosphere (Test Spectra)

Test spectra in the regions of 2,390-3,125 cm^{-1} and 710-1,350 cm^{-1} were obtained for verification of the procedures of direct calculation of the spectral atmospheric transmission, according to the data on the parameters of the spectral lines on the near-earth horizontal path. The values of transmission, with indication of the frequencies, are given in table 3. Indicated for each spectrum are the date and time of recording of the spectrum, the pressure (P, millibars), temperature ($T^{o}C$), relative and absolute humidity (R%, E,millibars), meteorological range of visibility (S_M, km), and optical thickness of 1 km, for a wavelength of 2.12 microns (T_{2MKM} 1/km).

The error in frequency surveying is ±1 cm^{-1}. The transmissions are obtained on a path 2,070 m long. The random error in determination of the transmission, proceeding from the evaluations given in study [2], is ±3%. The great portion of this error is associated with the calculation of the geometric losses during measurements on the path, and is therefore the same for the entire spectrum, while the random deviations of individual ordinates inside of a single spectrum do not exceed ± 1%. The potential systematic error for the entire body of data may be ± 4%.

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Table 1: Optical thickness of continuous weakening for vertical column of the atmosphere in the IR region of the spectrum

DATE	TIME	m	W_z	P_{aer}	4668	270I	II6I	II42	II27	I096	962	90I	86I	832	820
08.I0.7I	I5.09	3.I6	0.44	0.72	0.009	0.035	0.073	0.044	0.037	0.036	0.0I6	0.005	0.020	0.0I5	0.03
							0.009	0.009	0.009	0.009	0.0I2	0.0I4	0.0I8	0.020	0.02
I4.I0.7I	I5.42	4.29	0.65	0.67	0.024	0.072	0.I33	0.II0	0.I06	0.097	0.042	0.042	0.053	0.046	0.060
							0.0I3	0.0I3	0.0I3	0.0I3	0.0I8	0.023	0.028	0.032	0.034
I3.II.7I	I4.2I	5.95	0.24	0.70	0.02I	0.036	0.074	0.052	0.047	0.054	0.030	0.026	0.036	0.024	0.03
							0.007	0.007	0.007	0.007	0.009	0.0I0	0.0I2	0.0I5	0.0
0I.03.72	I5.06	3.23	0.45	0.69	0.032	0.05I	0.090	0.064	0.060	0.058	0.054	0.058	0.062	0.072	0.07
							0.0I0	0.0I0	0.0II	0.0II	0.0I5	0.0I9	0.023	0.026	0.028
02.03.72	I4.5I	2.95	0.42	0.67	0.0I2	0.0I9	0.076	0.042	0.040	0.037	0.026	0.026	0.025	0.033	0.035
							0.007	0.007	0.007	0.008	0.0I0	0.0I3	0.0I6	0.0I8	0.0I9
05.03.72	I4.39	2.72	0.3I	0.60	0.047	0.030	0.I08	0.074	0.074	0.069	0.062	0.053	0.048	0.050	0.049
							0.003	0.003	0.003	0.003	0,004	0.006	0.007	0.008	0.008
06.03.72	I4.3I	2.63	0.23	0.69	0.0I9	0.042	0.074	0.04I	0.04I	0.039	0.053	0.024	0.02I	0.026	0.028
							0.00I	0.00I	0.00I	0.00I	0.00I	0.00I	0.002	0.002	0.003
08.03.72	I5.08	2.79	0.26	0.66	0.026	0.033	0.085	0.047	0.052	0.052	0.035	0.035	0.023	0.035	0.040
							0.00I	0.00I	0.00I	0.00I	0.002	0.002	0.003	0.003	0.004
09.03.72	I4.36	2.53	0.24	0.67	0.0I9	0.053	0.I00	0.058	0.058	0.058	0.055	0.047	0.04I	0.044	0.039
							0.002	0.003	0.003	0.003	0.004	0.005	0.006	0.006	0.007
I0.03.72	I4.50	2.57	0.22	0.69	0.0I2	0.039	0.099	0.060	0.066	0.06I	0.055	0.049	0.036	0.042	0.05
							0.00I	0.00I	0.00I	0.00I	0.002	0.002	0.003	0.003	0.00
II.03.72	I5.I7	2.73	0.23	0.7I	0.020	0.048	0.II3	0.075	0.075	0.075	0.064	0.056	0.053	0.068	0.06
							0.00I	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.00

Continuation of Table 1

DATE	TIME	m	W_z	P_{aer}	4668	270I	II6I	II42	II27	I096	962	90I	86I	832	8
I4.03.72	I5.05	2.52	0.62	0.66	0.062	0.060	0.I3I	0.I02	0.I09	0.I04	0.III	0.I08	0.I08	0.I26	0.I2
							0.020	0.020	0.02I	0.022	0.029	0.037	0.044	0.05I	0.05
I5.03.72	I4.53	2.4I	0.5I	0.69	0.035	0.0I8	0.093	0.049	0.047	0.044	0.047	0.042	0.035	0.048	0.04
							0.0I0	0.0I0	0.0I0	0.0I0	0.0I4	0.0I8	0.02I	0.024	0.02
I7.03.72	I4.27	2.23	0.43	0.70	0.025	0.038	0.I00	0.060	0.055	0.055	0.060	0.057	0.05I	0.078	0.06
							0.009	0.0I0	0.0I0	0.0I0	0.0I4	0.0I8	0.02I	0.025	0.02
I8.03.72	I4.46	2.29	0.42	0.64	0.088	0.042	0.II8	0.088	0.09I	0.088	0.093	0.089	0.077	0.09I	0.09
							0.005	0.006	0.006	0.006	0.008	0.0I0	0.0I2	0.0I4	0.0I
2I.03.72	I3.46	2.02	I.04	0.53	0.082	0.078	0.I05	0.063	0.060	0.063	0.064	0.063	0.049	0.073	0.0
							0.026	0.027	0.027	0.028	0.038	0.048	0.058	0.067	0.
03.05.72	I4.3I	I.49	I.64	0.43	0.I04	0.I03	0.I34	0.I28	0.II7	0.I09	0.II5	0.I24	0.II3	0.I67	0.I4
							0.046	0.047	0.047	0.049	0.067	0.084	0.I0I	0.II7	0.I2
25.06.73	20.I9	5.34	2.08	0.59	0.037	0.054	0.I60	0.I38	0.I26	0.I39	0.I5I	0.I75	0.I89	0.254	0.227
							0.068	0.070	0.070	0.073	0.099	0.I24	0.I49	0.I73	0.I85
02.07.73	2I.0I	8.86	2.06	0.64	0.038	0.056	0.I58	0.I42	0.I29	0.I34	0.I59	0.I86	0.20I	0.267	0.276
							0.I03	0.I05	0.I06	0.III	0.I50	0.I88	0.227	0.263	0.28
09.07.73	20.35	6.72	I.29	0.66	0.03I	0.040	0.I02	0.079	0.07I	0.076	0.074	0.086	0.092	0.I05	0.I04
							0.036	0.036	0.037	0.038	0.052	0.066	0.079	0.09I	0.098
I0.07.73	20.I5	5.22	I.79	0.59	0.049	0.056	0.I22	0.I03	0.094	0.I08	0.I02	0.II8	0.I23	0.I28	0.I33
							0.048	0.049	0.050	0.052	0.07I	0.088	0.I06	0.I23	0.I32
I6.07.73	I9.07	3.26	I.50	0.64	0.038	0.054	0.I29	0.098	0.089	0.092	0.092	0.I07	0.I05	0.I52	0.I4
							0.053	0.054	0.055	0.057	0.078	0.097	0.II7	0.I36	0.I4
03.05.74	I5.05	I.60	0.69	0.64	0.023	0.03I	0.055	0.047	0.048	0.047	0.024	0.026	0.033	0.038	0.03

Continuation of Table 1

DATE	TIME	m	W_z	P_{aer}	4668	270I	II6I	II42	II27	I096	962	90I	86I	832	820
							0.009	0.0I0	0.0I0	0.0I0	0.0I4	0.0I7	0.02I	0.025	0.02
I3.05.74	I5.II	I.5I	0.44	0.70	0.032	0.043	0.I02	0.066	0.070	0.063	0.042	0.034	0.046	0.025	0.0
							0.006	0.007	0.007	0.007	0.009	0.0I0	0.0I3	0.0I6	0.0I
I4.03.75	I5.33	2.77	I.28	0.67	0.032	0.025	0.I0I	0.078	0.063	0.074	0.063	0.078	0.088	0.090	0.09
							0.022	0.023	0.024	0.025	0.033	0.042	0.050	0.058	0.06
20.03.75	I5.00	2.30	0.38	0.70	0.034	0.029	0.089	0.059	0.064	0.066	0.034	0.042	0.038	0.030	0.02
							0.005	0.006	0.006	0.006	0.008	0.0I0	0.0I2	0.0I4	0.0I
05.05.75	I9.I8	5.23	0.36	0.67	0.0I8	0.0I6	0.077	0.055	0.05I	0.049	0.023	0.029	0.029	0.025	0.02
							0.004	0.004	0.004	0.004	0.006	0.007	0.009	0.0I0	0.0I
06.05.75	I5.05	I.54	0.85	0.67	0.043	0.0I6	0.087	0.073	0.058	0.055	0.052	0.057	0.065	0.079	0.07
							0.0I6	0.0I6	0.0I6	0.0I7	0.023	0.029	0.035	0.04I	0.04
06.05.75	I9.32	5.97	0.89	0.68	0.020	0.009	0.082	0.069	0.054	0.055	0.046	0.056	0.060	0.062	0.06
							0.0I0	0.0I0	0.0II	0.0I2	0.0I6	0.020	0.024	0.027	0.02
I9.05.75	I5.44	I.57	I.I7	0.63	0.035	0.024	0.II6	0.I0I	0.083	0.07I	0.085	0.094	0.II4	0.I29	0.I4
							0.025	0.025	0.026	0.027	0.036	0.045	0.055	0.063	0.06
03.07.75	20.29	6.0	2.I4	0.44	0.I02	0.095	0.2I3	0.206	0.I93	0.I95	0.I98	0.223	0.276	0.309	0.3I
							0.095	0.097	0.098	0.I02	0.I39	0.I74	0.209	0.243	0.26
05.07.75	I5.43	I.46	0.99	0.63	0.053	0.052	0.I2I	0.II2	0.092	0.080	0.095	0.I0I	0.II8	0.I30	0.I2
							0.0I7	0.0I7	0.0I7	0.0I8	0.025	0.03I	0.037	0.043	0.04
05.07.75	20.I5	5.28	I.II	0.67	0.0I0	0.03I	0.II7	0.099	0.083	0.085	0.085	0.I00	0.II0	0.I20	0.I2
							0.028	0.028	0.029	0.030	0.04I	0.05I	0.06I	0.07I	0.07

Continuation of Table 1

DATE	TIME	m	W_z	P_{aer}	4668	270I	II6I	II42	II27	I096	962	90I	86I	832	820
06.07.75	I4.I4	I.29	I.98	0.63	0.088	0.I0I	0.I9I	0.I8I	0.I63	0.I53	0.I92	0.220	0.253	0.28I	0.28
							0.05I	0.052	0.052	0.054	0.074	0.093	0.II2	0.I29	0.I3
3I.07.75	I4.59	I.45	2.48	0.53	0.068	0.069	0.205	0.I84	0.I63	0.I62	0.208	0.268	0.3I6	0.398	0.40
							0.I02	0.I04	0.I06	0.II0	0.I50	0.I87	0.228	0.26I	0.27
20.05.76	20.02	6.52	0.62	0.7I	0.020	0.029	0.073	0.059	0.05I	0.05I	0.036	0.04I	0.047	0.043	0.04
							0.020	0.020	0.02I	0.022	0.029	0.037	0.044	0.05I	0.05
2I.05.76	I5.38	I.55	0.76	0.65	0.0I8	0.039	0.072	0.056	0.040	0.034	0.0I9	0.038	0.048	0.043	0.05
							0.0I6	0.0I7	0.0I7	0.0I8	0.024	0.030	0.036	0.042	0.04
2I.05.76	I9.55	5.89	0.77	0.67	0.022	0.026	0.078	0.063	0.052	0.054	0.037	0.045	0.052	0.048	0.05
							0.0I9	0.0I9	0.0I9	0.020	0.027	0.034	0.04I	0.048	0.05
22.07.75	I5.47	I.5I	I.80	0.63	0.0I9	0.020	0.I2I	0.088	0.070	0.078	0.087	0.II9	0.I29	0.I95	0.2I
							0.042	0.043	0.043	0.045	0.06I	0.07I	0.093	0.I07	0.II

Table 2: Optical thickness of continuous weakening in the IR region of the spectrum for the near-earth horizontal path

DATE	TIME	S_m	R	T	E	4668	270I	90I
I	2	3	4	5	6	7	8	9
25.05.75	I9.00	30	42	I3,0	6,3	0,029	0,05I	0,067
26.05.75	I6.07	50	49	8,4	5,5	0,020	0,025	0,040
25.07.75	II.58	7	64	23,0	I7,9	0,063	0,079	0,289
25.07.75	I2.06	7	64	23,0	I7,9	0,073	0,078	0,259
28.07.75	I4.32	I0	66	24,5	20,3	0,085	0,083	0,304
28.07.75	I4.43	I0	68	23,2	I9,3	0,085	0,073	0,304
I.08.75	I6.43	I0	74	2I,9	I9,5	0,050	0,052	0,250
5.08.75	I4.06	50	63	23,0	I7,7	0,043	0,05I	0,200
I5.07.76	I4.23	30	49	I9,4	II,0	0,042	0,050	0,I07
22.07.76	I0.40	20	6I	24,0	I8,2	0,028	0,038	0,220
22.07.76	II.58	20	54	25,0	I7,0	0,029	0,040	0,I79
23.07.76	I4.25	7	78	23,5	23,8	0,II5	0,II7	0,399
23.07.76	I6.00	6	88	23,2	25,2	0,I09	0,I05	0,4I3
23.07.76	I6.36	6	89	23,2	25,4	0,I09	0,I05	0,422
23.07.76	I7.25	5	90	23,2	25,5	0,II8	0,II5	0,47I
26.07.76	I2.I5	7	70	25,4	22,8	0,056	0,030	0,330
26.07.76	I3.45	6	68	25,7	22,3	0,05I	0,042	0,349
26.07.76	I4.40	8	67	26,3	22,8	0,05I	0,030	0,292
26.07.76	I5.24	7	64	26,7	22,5	0,050	0,038	0,297
27.07.76	II.05	7	73	2I,4	I8,6	0,06I	0,058	0,248
27.07.76	I5.47	20	50	22,6	I3,7	0,029	0,047	0,I30
27.07.76	I6.30	20	50	2I,8	I3,2	0,036	0,049	0,I37
28.07.76	I4.I0	I9	82	22,0	22,0	0,040	0,034	0,298

I	2	3	4	5	6	7	8	9
28.07.76	I5.38	20	68	24,0	I6,8	0,052	0,07I	0,I92
28.07.76	I6.25	20	57	24,6	I3,2	0,038	0,040	0,I39
5.08.76	I5.43	22	65	I6,4	I2,I	0,043	0,052	0,I58
I0.08.76	II.20	50	7I	I5,6	I2,6	0,046	0,060	0,I48
I6.08.76	I5.50	30	64	I9,9	I4,9	0,028	0,038	0,I7I
I6.08.76	I6.35	30	64	20,0	I5,0	0,039	0,054	0,202
I6.08.76	I7.I0	30	70	I9,0	I5,4	0,027	0,042	0,203
I.09.76	I2.I0	5	82	I8,9	I7,9	0,084	0,070	0,246
I.09.76	I4.I0	6	85	I8,5	I8,2	0,066	0,068	0,238
7.09.76	I7.35	20	63	I2,6	9,3	0,050	0,056	0,I09
7.09.76	I8.40	20	69	I0,8	9,0	0,047	0,05I	0,I27
30.03.78	II.30	8	89	5,4	8,0	0,206	0,I39	0,093
3I.03.78	I6.I7	20	63	8,5	7,I	0,088	0,085	0.089
4.04.78	I0.46	I4	57	0,8	3,6	0,I5I	0,I3I	0,096
4.04.78	II.50	9	57	I,I	3,8	0,I52	0,I24	0,098
4.04.78	I3.45	I2	56	I,I	3,8	0,II5	0,I04	0,080
4.04.78	I4.45	I5	55	2,5	4,0	0,09I	0,075	0,072
5.04.78	I6.25	30	50	−2,2	2,7	0,034	0,046	0,023
6.04.78	I0.30	I5	47	−0,4	2,8	0,092	0,069	0,020
6.04.78	II.20	20	47	I,0	3,I	0,058	0,059	0,02I
6.04.78	I4.30	20	46	2,0	3,2	0,056	0,062	0,030
6.04.78	I5.I0	20	48	I,6	3,3	0,052	0,054	0,034
6.04.78	I8.I7	20	46	I,3	3,I	0,096	0,092	0,060
9.04.78	I7,25	20	64	I,6	4,3	0,079	0,074	0,055
9.04.78	I8.I5	20	64	I,4	4,3	0,067	0,069	0,048

I	2	3	4	5	6	7	8	9
9.04.78	I8.55	I5	64	I,6	4,4	0,062	0,064	0,039
9.04.78	I9.45	I5	64	0,9	4,2	0,040	0,046	0,025
II.04.78	I5.04	20	48	9,I	5,6	0,048	0,048	0,03I
II.04.78	I8.30	20	45	8,2	4,9	0,056	0,059	0,038
I4,04.78	II.25	I8	76	3,0	5,8	0,II6	0,I22	0,I29
I7.04.78	I4.20	6	77	4,8	6,6	0,I05	0,093	0,096
I0.05.78	I9.50	20	59	I,8	4,I	0,037	0,048	0,045
I0.05.78	20.30	20	59	I,8	4,I	0,047	0,058	0,053
I2.05.78	I6.25	30	48	9,8	5,8	0,042	0,055	0,040
I2.05.78	I7.20	30	48	9,7	5,8	0,065	0,076	0,044
I7.05.78	I5.50	20	50	I9,4	II,3	0,063	0,075	0,I43
I7.05.78	I7.40	20	48	I9,3	I0,7	0,053	0,090	0,I29
I7.05.78	20.06	20	46	I7,3	9,I	0,030	0,056	0,I40
28.05.78	I3.I2	20	44	I7,5	8,8	0.025	0,035	0,063

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16. Abstract

The weakening of radiation by the atmosphere in the infrared region of the spectrum was studied. The instrument used for the measurements was the IKAU-1 infrared atmospheric unit, and measurements were carried out both on an inclined path and a near-earth horizontal path.

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