

Some integral characteristics of the earth atmosphere

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1. Introduction

Atmosphere transparency is one of an important geophysical characteristics of the Earth atmosphere. It characterizes physical state of the Earth atmosphere and immediately has been connected with processes taken place in the atmosphere, moreover not only general synoptic, also formations under the influence of local conditions. Hence knowledge about atmosphere transparency has been used for atmosphere state analysis and in as an indicator of the atmosphere pollution.

Some results of experimental investigations of atmosphere integral transparency conducted in different climatic conditions at Ulaanbaatar ($\varphi=47^{\circ}56'$, $\lambda=106^{\circ}55'$, $h=1330$ meters above sea level), Ugtaal ($\varphi=48^{\circ}16'$, $\lambda=105^{\circ}25'$, 1160 meters above sea level), Darkhan ($\varphi=49^{\circ}28'$, $\lambda=105^{\circ}54'$, $h=705.5$ meters above sea level) and Sainshand ($\varphi=44^{\circ}53'$, $\lambda=110^{\circ}07'$, $h=938$ meters above sea level) has been presented in this paper.

2. Methods and data of experiments.

As a characteristics of atmosphere transparency we used so called integral transparency coefficient of the Earth atmosphere (P_2) and turbidity factor (T_2) by standard Sivkov method (Sivkov, 1968, Methods of solar radiation studies by actinometer and pyranometer, 1988). Main expression for determination of integral transparency coefficient P_2 can be written as following:

$$S_m = S_o \cdot P_2^m$$

where S_m is intensity of direct solar radiation on the Earth surface with atmosphere mass m and S_0 is incoming solar radiation on an upper boundary of the atmosphere.

Hourly values of integral transparency coefficient (P_2) and turbidity factor of the atmosphere (T_2) has been calculated from data of hourly observations conducted at observation square of the Research Centre for Geophysics of Mongolian Academy of Sciences and National University of Mongolia (RCG MAS NUM).

First of all, daily variations of the atmosphere optical states at given site has been studied depending on the values of these parameters.

A variation of the atmosphere transparency and its stability during daylight shows tendency of optical properties and atmosphere turbidity regimes. In relatively daily course of atmosphere transparency in individual days is distinguished and value of daily amplitude of transparency characteristics is varied in much limits. Consequently, mean daily, mean monthly, seasonal values of atmosphere transparency characteristics has been evaluated and studied monthly and seasonal variations studied by us.

Daily variations of atmosphere turbidity factor (T_2) at Ulaanbaatar, Darkhan and Sainshand are presented in Tables 1-3. One can see that daily course of atmosphere turbidity factor (T_2) has been conditioned by formation of nature - climatical conditions in different periods of a year in given site. Specifically, in winter period atmosphere transparency in city conditions in the morning and evening already less than in the another. Thus practically it's difficulty to determine the values of T_2 or P_2 because of available of temperature inversions and increasing of aerosol total contents in city air. In this connection has not been revealed noticeable daily course of atmosphere turbidity factor T_2 .

Visible daily course of atmosphere turbidity factor (T_2) connected with stable optical states of the atmosphere at the morning and evening and also with development of air convective movement, were observed in spring and summer seasons.

Variation of the atmosphere turbidity factor (T_2) at Sainshand has been revealed in all months of a year with natural character, and sometimes was observed stable values of turbidity factor (T_2) in the day time.

Besides daily course of atmosphere transparency we have studied its mean values in 5 - degree intervals of sun elevations. The values of atmosphere transparency coefficients on intervals of sun elevation for

Ulaanbaatar and Ugtal are given in Tables 4 and 5. One can see that atmosphere integral transparency coefficient at Ulaanbaatar in major predominant cases in the morning and evening less than at the stroke of noon in winter period and sometimes it is difficult to determine the values of P_2 . It is seen from Table 5 that atmosphere transparency at Ugtal in winter and autumn months greater than in Ulaanbaatar city.

Tables 6 and 7 show monthly mean values of turbidity factor (T_2) and atmosphere transparency coefficient (P_2) at Ulaanbaatar, Darkhan, Ugtal and Sainshand during the periods of 1991-1995.

In the country sites annual variation of atmosphere transparency parameters (P_2 and T_2) in winter season (November and December) has been chiefly connected with water vapour content in all thickness of the atmosphere and with change of air mass. However, violation of processes with natural character and decreasing of atmosphere transparency is observed in regions where has been concentrated more part of industry and density populated area. The values of integral transparency coefficient in Ulaanbaatar less than on an average 3.3-4.8% in November and 5.8-10.2% in December.

In predominant majority months of a year, recurrence of mean daily values of P_2 on Sivkov gradations is on the interval 0.722-0.764 in another word, with normal transparency. In autumn maximum of recurrence is on the increased transparency (0.765-0.805). In summer decreased transparency of the atmosphere in the interval (0.675-0.721).

Table 8 presents comparative data of atmosphere transparency coefficients at some sites of the Mongolia. One can see from here that integral transparency of the atmosphere at Ulaanbaatar less than in another sites.

Obtained results by us show that integral transparency of the atmosphere at abovementioned sites turned out on the normal and increased gradations. Atmosphere transparency variation has been connected with influence of antropogenic factors. But influence of natural factors is more powerful than antropogenic factors.

3. Conclusion

On the basis of the data obtained by us we have the following results.

- It is revealed that regime of atmosphere transparency at our sites is chiefly determined by moisture retention and influence of antropogenic factors.

Table 1. Daily variations of the atmospheric turbidity factor (T_2) at Ulaanbaatar

Months	h o u r s												
	07.22	08.22	09.22	10.22	11.22	12.22	13.22	14.22	15.22	16.22	17.22	18.22	19.22
XII													
I													
II													
winter													
III		2.48	1.97	1.95	1.97	1.92	1.97	1.91	1.92	1.86	1.91	1.76	
IV		2.03	3.50	2.52	2.03	3.36	2.06	2.02	2.60	1.66	1.66	1.76	
V	1.85	2.32	2.17	1.99	2.04	2.35		2.14	1.92	2.09	2.01	2.04	1.82
spring													
VI	1.88	2.28	2.55	2.15	2.01	2.54	2.02	2.02	2.15	1.87	1.86	1.85	1.82
VII	1.93	2.02	2.31	2.65	2.49	2.20	2.12	2.16	2.09	2.18	2.34	2.94	3.24
VIII	2.14	3.00	2.93	2.99	3.10	3.03	2.55	2.60	2.71	2.71	2.64	2.35	2.29
summer													
IX	2.04	2.14	2.48	2.37	2.73	3.75	3.60	3.21	3.67	2.65	2.51	3.09	3.68
X		2.39	2.57	2.67	2.77	2.99	2.76	2.66	2.82	2.51	2.49	2.79	3.07
XI		1.74	2.11	2.61	2.04	2.76	2.89	2.97	2.04	2.49	2.30	2.01	1.66
		1.91	1.90	2.06	2.64	1.95	2.15	2.22	2.12	2.07			
		3.57	2.55	2.51	2.86	2.62	2.49	2.30	3.21	2.44			
autumn		2.41	2.18	2.39	2.51	2.44	2.51	2.50	2.46	2.33	2.30	2.01	1.66

Table 2. Daily variations of the atmospheric turbidity factor (T_2) at Sainshand

Months	h o u r s												
	07.09	08.09	09.09	10.09	11.09	12.09	13.09	14.09	15.09	16.09	17.09	18.09	19.09
XII			3.22	2.00	1.80	2.07	2.19	2.13	2.01	2.62			
I			2.38	1.98	1.78	1.59	1.43	1.67	2.06	1.86	3.74		
II			2.80	1.99	1.79	1.83	1.81	1.90	2.04	2.24	3.74		
winter													
III		2.68	2.13	1.96	1.49	1.59	1.83	1.45	1.88	2.49	2.43	1.88	
IV		2.14	2.65	2.58	2.50	2.64	2.62	2.73	3.24	2.82	3.29	3.63	2.31
V	2.16	2.36	2.63	2.39	2.69	2.48	2.27	2.44	2.77	3.40	3.10	2.85	3.06
spring													
VI	2.16	2.39	2.47	2.31	2.23	2.24	2.24	2.21	2.63	2.90	2.94	2.78	2.68
VII	3.16	3.01	2.46	2.78	2.76	2.59	2.55	2.78	2.79	2.85	3.26	3.23	2.53
VIII	3.36	3.16	3.73	3.63	3.31	3.55	4.37	3.58	3.21	3.91	3.05	3.00	2.70
summer													
IX	3.26	2.76	2.92	3.09	3.01	3.01	3.38	3.07	2.99	3.24	3.10	3.13	2.81
X		1.92	2.11	2.63	2.44	2.59	2.77	2.82	2.61	2.56	2.50	2.38	3.00
autumn		1.65	2.33	2.22	2.35	2.05	2.25	2.41	2.13	2.75	2.48		
		1.78	2.22	2.42	2.40	2.32	2.51	2.62	2.37	2.66	2.49	2.38	3.00

Table 3. Daily variations of the atmospheric turbidity factor (T_2) at Darkhan

Months	h o u r s												
	07.26	08.26	09.26	10.26	11.26	12.26	13.26	14.26	15.26	16.26	17.26	18.26	19.26
XII	07.26	08.26	09.26	10.26	11.26	12.26	13.26	14.26	15.26	16.26	17.26	18.26	19.26
I				1.87	2.07	2.01	1.96	2.04	2.11				
II			3.43	3.21	3.56	3.58	3.62	3.68	3.72				
winter			3.43	3.88	3.96	2.62	2.75	2.68	2.62	2.56			
III			3.43	2.98	3.20	2.74	2.78	2.80	2.82	2.56			
IV			2.14	3.10	3.28	3.15	2.77	2.77	2.92				
V				2.71	2.75	2.68			2.98	2.98	3.07		
spring				3.34	3.46	3.48	3.58	3.63	3.50	3.33	3.38	3.61	3.32
VI	3.76	3.72	3.25	3.05	3.16	3.10	3.18	3.20	3.13	3.16	3.22	3.61	3.32
VII	3.25	3.48	3.66	3.74	3.62	3.92	3.74	3.77	3.80	3.58	3.50	3.57	3.90
VIII	3.36	3.16	2.95	3.34	2.86	3.15	3.13	3.12	2.68	2.70	1.93	3.10	3.16
summer													
IX	3.30	2.50	3.09	3.18	3.19	2.84	3.25	3.34	3.34	3.30	3.30	3.26	3.19
X		3.05	3.23	3.42	3.22	3.30	3.37	3.41	3.27	3.19	2.91	3.31	3.42
XI		2.20	2.82	2.78	2.85	2.88	2.84	2.86	2.96	3.04	3.20		
			2.92	2.24	2.35	2.46	2.38	2.44	2.54	3.08	3.36		
			1.98	2.00	2.02	1.93	1.93	1.97	2.13	3.31			
autumn		2.20	2.57	2.34	2.41	2.43	2.38	2.42	2.54	3.14	3.28	3.28	

Table 4. The values of atmospheric transparency coefficients on intervals
of sun elevation for Ulaanbaatar

Δh_0	m o n t h s											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
5-10	0.707	0.742	0.737	0.747	0.781	0.761	0.814	0.782	0.790	0.788	0.800	
101-15	0.731	0.730	0.736	0.744	0.778	0.764	0.780	0.704	0.796	0.785	0.812	0.736
151-20	0.775	0.742	0.738	0.726	0.761	0.760	0.766	0.754	0.794	0.792	0.799	0.793
201-25		0.748	0.770	0.759	0.772	0.772	0.804	0.754	0.791	0.790	0.811	
251-30		0.764	0.774	0.763	0.728	0.764	0.746	0.764	0.788	0.776	0.820	
301-35			0.775	0.749	0.776	0.767	0.783	0.758	0.789	0.782		
351-40			0.745	0.771	0.785	0.767	0.768	0.738	0.782			
401-45			0.793	0.806	0.737	0.746	0.762	0.746	0.758			
451-50				0.803	0.719	0.764	0.762	0.734				
501-55				0.834	0.814	0.752	0.750	0.724				
551-60						0.768	0.732					
601-65						0.740						

Table 5. The values of atmospheric transparency coefficients on intervals of sun elevation for Ugtal

Δh_0	m o n t h s											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
5-10		0.787	0.755	0.732	0.739		0.784	0.775	0.809	0.790	0.798	
101-15		0.780	0.732	0.748	0.776	0.767	0.738	0.764	0.754	0.794	0.804	0.772
151-20	0.755	0.784	0.767	0.772	0.749		0.736	0.755	0.786	0.794	0.802	0.778
201-25	0.764	0.798	0.736	0.770	0.764	0.683	0.732	0.756	0.781	0.798	0.781	
251-30		0.793	0.778	0.788	0.763		0.733	0.730	0.780	0.804	0.814	
301-35		0.803	0.768	0.785	0.777	0.754	0.744	0.751	0.791	0.794		
351-40			0.756	0.799	0.748		0.744	0.751	0.791			
401-45			0.748	0.757	0.782	0.747	0.731	0.760	0.780			
451-50				0.738	0.774	0.812	0.760	0.772	0.772			
501-55				0.728	0.774	0.773	0.761	0.746	0.820			
551-60					0.760	0.750		0.760				
601-65					0.775	0.748	0.738					

Table 6. Monthly mean values of atmosphere transparency coefficient (P_2)

a) Ulaanbaatar, 1991 -1995

Years	m o n t h s											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1991	0.867	0.810	0.781	0.769	0.762	0.778	0.763	0.756	0.777	0.782	0.741	0.722
P_2	16	20	15	18	20	17	15	17	19	11	9	8
1992	0.722	0.720	0.701	0.698	0.662	0.690	0.705	0.680	0.717	0.744	0.714	0.716
P_2	15	28	38	26	3	10	12	7	4	13	7	4
1993	0.695	0.725	0.707	0.735	0.724	0.724	0.732	0.734	0.763	0.754	0.792	
P_2	27	33	39	120	115	83	9	92	63	92	49	
1994	0.802	0.767	0.807	0.806	0.817	0.804	0.786	0.786	0.802	0.818	0.831	0.764
P_2	5	17	90	15	15	43	36	50	91	59	23	(2)
1995	0.852	0.829	0.821	0.797	0.813	0.794	0.769	0.742	0.797	0.810	0.762	
P_2	(4)	19	71	15	28	89	72	99	86	57	46	
	0.788	0.770	0.763	0.761	0.756	0.758	0.751	0.740	0.771	0.782	0.768	0.734
P_2	67	117	253	194	181	242	144	265	263	232	134	(14)
n												

b) Darkhan

P_2	0.704	0.738	0.758	0.751	0.708	0.694	0.791	0.728	0.746	0.766	0.807	0.818
n	26	8	19	24	108	170	36	170	163	184	104	47

c) Ugtal

P_2	0.759	0.812	0.789	0.798	0.796	0.781	0.779	0.769	0.801	0.811	0.794	0.779
n	171	217	235	249	263	188	147	296	190	223	278	221

d) Sainshand

P_2	0.799	0.816	0.804	0.758	0.769	0.754	0.721	0.756	0.779	0.800		
n	73	151	103	156	187	226	159	167	154	150		

Table 7. Monthly mean values of atmosphere turbidity factor (T₂)

a) Ulaanbaatar												
Years	m o n t h s											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1991	T ₂ 2.02	2.09	2.49	2.69	2.72	2.55	2.73	2.81	2.61	2.48	3.02	3.29
	n 16	20	15	18	20	17	15	17	19	11	9	8
1992	T ₂ 3.29	3.32	3.57	3.55	4.13	4.08	3.56	3.87	3.33	2.48	3.42	3.34
	n 15	28	38	26	3	10	12	7	4	13	7	4
1993	T ₂ 3.53	3.20	3.42	3.10	3.20	3.20	3.15	2.97	2.88	2.67	2.32	
	n 27	33	39	120	115	83	9	92	63	92	49	
1994	T ₂ 2.21	2.67	2.03	2.11	2.16	2.12	2.42	2.78	2.12	2.01	1.86	2.70
	n 5	17	90	15	15	43	36	50	91	59	23	2
1995	T ₂ 1.86	1.88	1.96	2.29	2.06	2.32	2.63	2.99	2.30	2.11	2.73	
	n 4	19	71	15	28	89	72	99	86	57	46	
	T ₂ 2.58	2.63	2.69	2.75	2.85	2.85	2.90	3.08	2.65	2.35	2.67	(3.11)
b). Darkhan												
T ₂	3.56	3.06	2.88	2.86	3.11	3.68	3.04	3.18	2.94	2.66	2.16	2.01
n	25	8	19	12	55	170	117	170	162	184	104	47
c). Sainshand												
T ₂	2.25	2.05	2.24	2.82	2.69	2.88	3.36	2.84	2.53	2.26		
n	73	151	103	156	187	226	159	167	154	150		

Table 8. Comparative data of the seasonal variations of atmosphere transparency coefficient at some sites of the Mongolia

Sites	winter	spring	summer	autumn	annual mean
1. Ulaanbaatar	0.764	0.760	0.750	0.774	0.762
2. Ugtaal	0.783	0.794	0.776	0.802	0.789
3. Darkhan	0.776	0.749	0.738	0.773	0.759
4. Sainshand	0.808	0.777	0.744	0.790	0.780
5. Muren	0.809	0.767	0.766	0.789	0.783
6. Dalanzadgad	0.809	0.758	0.753	0.781	0.775
7. Altai	0.824	0.780	0.764	0.795	0.791

- Analysis of obtained data by us on atmosphere transparency by gradations, proposed by S.I.Sivkov, shows that integral transparency at Ulaanbaatar is varied within the 0.722-0.764 and observed normal transparency. However, atmosphere transparency in Ulaanbaatar city below than country city sites.

- Atmosphere transparency at Ugtaal, Darkhan and Sainshand is on the normal (0.722-0.764) and increased (0.765-0.805) gradations.

Analysis of the present investigations enables to make up atmosphere transparency chart and to precise the calculations of the incoming solar radiation on the Mongolian territory. It is also can be used for building project, optimal arrangement of house-buildings in city and elaboration the measures on provision of atmosphere cleanliness and so on.

References

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