In a final Section IV, under the heading "Miscellaneous Papers," with an introduction by R. G. K. Lempert, are grouped those contributions that could not be placed in any of the three larger classifications. Of chief interest, perhaps, are "The Element of Chance Applied to Various Meteorological Problems" and "Climate."

This book is published, as a memorial, by the Royal Meteorological Society. There is a preface by the chairman of the committee, Sir Richard Gregory, and an appreciative tribute by Dines's close friend and coworker, Sir Napier Shaw. Since Dines did not write a book embodying the results of his researches, it is particularly fitting that his contributions to meteorological science, all of them interesting, many of them of permanent value, should be available in one place for the benefit of investigators in this field. Meteorologists generally are indebted and grateful to the Royal Meteorological Society for bringing this about.

A CONTRAST IN THUNDERSTORMS

By W. J. HUMPHREYS

Every one recognizes this contrast as soon as it is mentioned, but no one says anything about it. At any rate it is not generally stressed. The contrast is this: One class of thunderstorms can not develop *without* wind; another class can not develop *with* wind. Promotion of either is prevention of the other.

Vigorous vertical convection of air rich in water vapor is essential to the genesis of any and every thunderstorm. This convection may be mechanically caused, as by a high mountain ridge across the course of the wind, or by cooler air in the path of warmer, the condition along the warm front of a cyclone. More commonly, however, it results from instability induced by cooling above or heating below, or a combination of both. The cooling above is owing chiefly to the importation of relatively cold air, accentuated more or less, especially at night when cloudy, by radiation. The heating below, on the contrary, usually is produced by sunshine, though in some cases importation of warm air is its major if not sole origin.

Two of the great causes of thunderstorms, therefore, are, (*a*) cooling above by the importation of cold air, and (*b*) warming below by insolation. The first is the "cold front" or squall-line thunderstorm, of which there are two classes, the entrapped and the driven; the second, the well-known "heat" thunderstorm. The squall-line storm is induced by a great mass of relatively cold air moving rapidly forward into or crowding against comparatively warm air. Since the velocity of the cold air is much less near the surface than it is at considerable heights, it follows that when the difference in temperature is rather small isolated masses of the warmer air are continually being entrapped by the far overrunning wedge of cooler air, and thereby forced to ascend more or less vigorously. Some of these ascending masses develop thunderstorms. Other squall thunderstorms are caused by the forced ascent of the warm air immediately ahead of the blunt front of the oncoming relatively quite cold air. In none of these cases can the warm air be entrapped or driven to a strenuous convection in front of the cold tip in the free air, except when that cold air is moving forward speedily. If it were moving very slowly it would just spread out gently beneath the warmer air, entrapping none of it, nor compelling a vigorous uprush anywhere. Hence this abundant and impressive class of thunderstorm, induced by cooling above, is caused by winds. A calm would prevent its formation—it can not occur in still air.

The heat thunderstorm, on the other hand, induced by insolation, must have rather quiet air for its genesis. It grows up from small to larger and larger convections of warm air from the surface. To be effective the chimney of warm air thus formed must remain intact and more or less vertical even though it may wander away to a greater or less distance horizontally. Obviously, however, it could neither remain vertical, if formed, nor intact in air that has any considerable horizontal velocity—could not remain vertical because the velocity of every wind varies with height, nor intact because every wind is turbulent, especially in its lower layers.

In short, and in general, thunderstorms incident to cooling above occur only in winds and never in calms, while those incident to heating below form only in calms and never in winds. And these are the greatest classes of thunderstorms—the wind-hatched and the calm-brooded.

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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING JULY, 1932

By IRVING F. HAND, Assistant in Solar Radiation Investigations

For a description of instruments employed and their exposures, the reader is referred to the January, 1932, REVIEW, page 26.

Table 1 shows that solar radiation intensities averaged well above normal values for July at all three stations at which normal incidence measurements are made.

Table 2 shows an excess in the total solar radiation received on a horizontal surface at all pyrheliometric stations except La Jolla and Twin Falls. The excess is very marked at Washington, Madison, Chicago, New York, and Fresno.

Table 3 shows diminished turbidity for the month as would be expected with the decided increase in radiation receipt at Washington.

Polarization measurements obtained on seven days at Washington give a mean of 62 per cent and a maximum of 66 per cent on the 30th. At Madison, measurements obtained on 14 days give a mean of 60 per cent and a maximum of 67 per cent on the 12th. These are average July values for Madison, but for Washington the values are considerably above the July normals.

Unquestionably the decided increase in solar radiation received, owing to the greater transmissibility of the atmosphere during July throughout the country, has been a factor in the extreme dryness of the sections which are deficient in precipitation.

TABLE 1.—*Solar radiation intensities during July, 1932*

[Gram calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	8 a.m.	Sun's zenith distance 78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
July 2	9.83		0.65		0.77						8.48
July 5	10.21			0.97	1.22	1.49					9.47
July 7	16.79						1.15				16.20
July 8	14.10				1.13	1.35					10.97
July 9	11.38	0.68	0.77	0.91	1.10	1.37					9.47
July 11	16.20		0.83	0.93	1.12	1.42					16.79
July 13	13.13				0.99	1.39	1.10				10.59
July 18	12.68			1.07							12.24
July 25	13.61				1.15	1.40					9.47
July 28	18.59			0.71	0.94						17.37
July 30	9.83			1.04	1.24	1.47					8.48
Means		**(0.68)**	**0.75**	**0.94**	**1.07**	**1.41**	**(1.12)**				
Departures		**+0.09**	**+0.08**	**+0.16**	**+0.16**	**+0.21**	**+0.13**				

TABLE 1.—*Solar radiation intensities during July, 1932*—Contd

[Gram calories per minute per square centimeter of normal surface]

Madison, Wis.

Date	8 a.m.	Sun's zenith distance 78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
July 2	7.87				1.29	1.54					7.87
July 6	14.60			0.99	1.17	1.40					13.13
July 7	13.61					1.42					9.83
July 8	11.81			0.99	1.15	1.38					10.97
July 11	10.59				1.19	1.43	1.13	1.05	0.97		10.21
July 12	9.47		0.89	1.00	1.18	1.44	1.09	0.89	0.76		13.61
July 13	18.59			0.82	1.02	1.34	1.02	0.78	0.64		19.89
July 14	13.13		0.64								19.89
July 15	18.59		0.71	0.81	1.07	1.26					22.00
July 18	13.61					1.33	1.13	0.94			15.65
July 20	14.60			0.86	1.03						18.59
July 21	19.23		0.74				1.26				17.96
July 22	10.21					1.41	1.25	1.06			10.59
July 23	10.97		0.86	1.04	1.21	1.43					10.59
July 26	16.65		0.73								19.89
July 27	10.97				1.19	1.34		0.79			11.81
July 28	16.79		0.84	0.97							13.13
July 29	9.14		0.95	1.12	1.24	1.47					9.14
July 30	10.59		0.92	1.06	1.20	1.44					10.59
Means			**0.81**	**0.97**	**1.16**	**1.40**	**1.15**	**0.92**	**0.79**		
Departures			**+0.01**	**+0.05**	**+0.10**	**+0.10**	**+0.11**	**+0.01**	**+0.01**		

Lincoln, Nebr.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
July 1	9.47					1.47	1.26	1.11	0.98	0.86	10.59
July 7	16.20					1.44	1.23	1.05	0.88	0.75	14.60
July 9	18.59						1.09				20.57
July 12	17.37					1.42	1.14	0.97	0.82	0.69	16.20
July 13	17.37		0.81	0.95	1.12	1.36					18.59
July 14	18.59			0.93	1.10	1.33	1.00	0.80	0.65		14.60
July 19	16.79		0.63	0.79	1.01	1.30					16.20
July 21	18.59				1.11	1.33					18.59
July 22	16.20						1.21	1.02			13.61
July 26	18.59	0.75	0.85	1.04	1.22	1.45	1.15	0.95	0.83	0.71	14.10
July 27	16.20					1.38	1.15	0.97	0.83	0.74	16.79
July 28	18.59		0.78	0.92	1.07						17.37
Means		**(0.75)**	**0.78**	**0.93**	**1.10**	**1.39**	**1.15**	**0.98**	**0.83**	**0.74**	
Departures		**±0.00**	**±0.00**	**+0.03**	**+0.02**	**+0.06**	**+0.08**	**+0.09**	**+0.07**	**+0.02**	

[1] Extrapolated.