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(*Last Number of Vol.* 3.)

THE GROUND DAY VISIBILITY

AT

CRANWELL, LINCOLNSHIRE,

DURING THE PERIOD

1st April 1920 to 31st December 1923

BY

W. H. PICK, B.Sc.

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Erratum.

Professional Notes, No. 35 (Vol. 3).

Fig. 6. The title should read "Vector Diagrams of the Difference $8 - \frac{1}{2}(7 + 9)$.

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THE GROUND DAY VISIBILITY AT CRANWELL, LINCOLNSHIRE, DURING THE PERIOD 1ST APRIL 1920 TO 31ST DECEMBER 1923

By W. H. PICK, B.Sc.

1. **Introduction.**—The object of the present paper is to investigate the relationships existing between the horizontal ground visibility at Cranwell, Lincolnshire, and various other meteorological characteristics prevailing at the same place. The period over which the investigation extends is from the 1st April 1920 to the 31st December 1923.

The relationships investigated are those between the horizontal ground day visibility on the one hand and, on the other hand, (*a*) the surface wind direction, (*b*) the surface wind velocity, (*c*) the pressure type, and (*d*) the presence or absence of convection currents up from the ground respectively.

2. **Arrangement of Data.**—Observations from 0900 to 1700 G.M.T. (inclusive) are counted as " day " observations.

The visibility observations throughout are divided into three groups :—

(*a*) those in which the visibility was 13 miles or more, termed hereafter " good or very good " ;

(*b*) those in which the visibility was 2¼ miles or more but not reaching 13 miles, termed hereafter " indifferent or fair " ;

(*c*) those in which the visibility was less than 2¼ miles, termed hereafter " bad or poor."

3. **Distribution of Visibility Observations.**—The distribution of the visibility observations (visibility measured hourly from 0900 to 1700 inclusive) in the three groups already defined is shown in Table I.

TABLE I.—DISTRIBUTION OF VISIBILITY OBSERVATIONS.

Total Number of Hourly Observations taken.	Good or Very Good.	Indifferent or Fair.	Bad or Poor.
11,790	2,604	7,847	1,339

4. **Wind Direction and Visibility.**—All winds considered in what follows are those measured by an anemobiagraph whose head is 43 feet above ground level at Cranwell, the station itself being 236 feet above sea level.

The distribution of visibility with regard to wind direction, the wind being divided into eight groups, is shown in Table II.

A certain number of observations were neglected owing to missing or faulty anemobiagraph readings. Columns 4, 6 and 8 of this table give the results expressed in percentage form. It will be noticed from Table II that the highest percentages of "good or very good" visibility were obtained with winds from the two groups NE'N*–ENE and S'E–SSW, whilst the lowest percentages of such visibility were obtained with the two groups SE'E–SSE and calm. It will be noticed also that the highest percentages of "bad or poor" visibility were obtained with the two groups SE'E–SSE and calm. The low percentages of "bad or poor" visibility with the three groups SW'S–WSW, S'E–SSW and NE'N–ENE are noteworthy.

TABLE II.—THE DISTRIBUTION OF VISIBILITY WITH WIND DIRECTION.

Wind Direction.	Total No. of Observations.	Classification of Visibility.					
		Good or Very Good.		Indifferent or Fair.		Bad or Poor.	
		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
N'W–NNE	1,008	233	23·1	672	66·7	103	10·2
NE'N–ENE	1,175	398	33·9	689	58·6	88	7·5
E'N–ESE	848	185	21·8	505	59·6	158	18·6
SE'E–SSE	881	86	9·8	572	64·9	223	25·3
S'E–SSW	1,408	413	29·3	904	64·2	91	6·5
SW'S–WSW	2,657	647	24·4	1,861	70·0	149	5·6
W'S–WNW	2,129	427	20·1	1,508	70·8	194	9·1
NW'W–NNW	1,451	227	15·6	1,035	71·3	189	13·1
Calm	122	14	11·4	74	60·7	34	27·9

5. **Wind Velocity and Visibility.**—The distribution of visibility (visibility measured hourly from 0900 to 1700 inclusive) with regard to wind velocity, the wind being divided into five velocity groups, is shown in Table III. A few observations are omitted owing to missing or faulty anemobiagraph readings.

TABLE III.—THE DISTRIBUTION OF VISIBILITY WITH WIND VELOCITY.

Wind Velocity.	Total No. of Observations.	Classification of Visibility.					
		Good or Very Good.		Indifferent or Fair.		Bad or Poor.	
m./hr.		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
0–5	1,813	246	13·6	1,134	62·5	433	23·9
6–10	2,599	305	11·7	1,770	68·1	524	20·2
11–15	3,464	707	20·4	2,476	71·5	281	8·1
16–20	2,582	501	31·0	1,701	65·9	80	3·1
over 20	1,332	545	40·9	766	57·5	21	1·6

* "NE'N" is used as an abbreviation of "NE by N," *i.e.*, the direction midway between NE and NNE.

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Considering Table III, the most noteworthy points appear to be the very small number of observations of bad or poor visibility with winds greater in velocity than 15 mi/hr. and the high percentage of observations of good or very good visibility when the wind exceeded 15 mi/hr.

6. **Visibility and Pressure Type.**—The synoptic chart for 0700 of each day in the period under investigation was examined and classified under one of the twenty-eight types of pressure distribution laid down by E. Gold.* The visibility at 1300 of the same day was then taken as representative of the day ground visibility of the day. Further, the observations were divided into "winter" and "summer," winter being counted as from the 1st October to the 31st March and summer as from the 1st April to the 30th September.

The results of the comparisons made are shown expressed in percentage form in Table IV.

TABLE IV.—PRESSURE TYPES AND GROUND DAY VISIBILITY. APRIL 1920 TO DECEMBER 1923.

Pressure Type following the Classification by E. Gold.	Winter.				Summer.			
	Total Number of Occasions.	Percentage of such Occasions Visibility was :—			Total Number of Occasions.	Percentage of such Occasions Visibility was :—		
		Good or Very Good.	Indifferent or Fair.	Bad or Poor.		Good or Very Good.	Indifferent or Fair.	Bad or Poor.
I, Ia	83	12	80	8	138	35	65	0
II	47	21	70	9	37	35	65	0
III	19	26	74	0	19	53	47	0
IV, IVa	44	14	72	14	95	21	79	0
V, Va	97	26	63	11	75	28	71	1
VI, VIa	76	5	72	23	22	28	67	5
VII, VIIa, VIIb, VIIc	103	14	63	23	99	47	51	2
VIII, VIIIa, VIIIb	36	31	50	19	31	48	52	0
IX, IXa, IXb	26	35	53	12	47	36	57	7
X	18	23	55	22	27	44	56	0
XI, XIa	25	4	60	36	45	18	78	4
XII	18	11	67	22	17	12	82	6
XIII, XIIIa	4	25	50	25	7	28	72	0
XIV	30	10	63	27	34	26	71	3
XV	12	33	50	17	39	51	49	0

For ease of summarising the pressure types in what follows are designated by their numerals, letter suffices being neglected. Thus, a reference to type I means the two types I and Ia;

* E. Gold, F.R.S. "Aids to Forecasting," Meteorological Office, London. *Geophysical Memoirs* No. 16, 1920. (Fifteen of these types are illustrated in *Professional Notes* No. 37.)

a reference to type VII, the four types VII, VIIa, VIIb and VIIc, and so on. No confusion occurs as they are similarly grouped in the table.

Winter.—So far as "winter" is concerned, the most noteworthy results appear to be the extremely low percentages of good or very good visibility occurring with the pressure types XI, VI, XIV, XII and I.

Type XI very easily gives the highest percentage of bad or poor visibility, while types IX, XV and VIII give the highest percentage of good or very good visibility.

The complete absence of any bad or poor visibilities with type III is noteworthy.

Summer.—In "summer" the very high percentages of good or very good visibility given with types III, XV, VIII, VII and X are noteworthy, as are the low percentages of such visibilities given by types XII and XI.

7. **Visibility and Convection Currents.**—One of the factors affecting the visibility prevailing at any time is the presence of atmospheric pollution such as dust or smoke.

If there be present also convection currents from the ground upwards, it seems reasonable to suppose that any obscurity of the atmosphere brought about owing to the presence of such dust or smoke should be materially lessened, inasmuch as the convection currents should carry some of the dust or smoke particles upward, just removing them from the comparatively thin layer of air proximate to the ground, which is the part of the air whose visibility is measured in horizontal visibility determinations. In short, a day characterised by the presence of convection currents upward from the ground should show better horizontal visibility than a day not so characterised. That question is now examined.

As convection currents of the type in question are more pronounced in summer than at other times, the four summers 1st April—30th September 1920, 1921, 1922 and 1923 were brought under review.

The horizontal visibility determined at 1300 G.M.T. of each day during the summers in question was taken as representative of the horizontal visibility of that day, and the visibilities so obtained were subdivided into the three groups already defined.

In the absence of temperature observations from the ground upward to 3,000 or 4,000 feet, the problem of which days should be regarded as convection days presented some difficulty. Finally it was decided to make the presence of cumulus or cumulo-nimbus clouds at 1300 the deciding factor, calling all days when either of those clouds was present a convection day. It is recognised that this probably means that certain days upon which convection was present, but when the other conditions for

cloud formation were lacking, were missed, but the number, in view of the fact that the hour was 1300, must be small.

A consideration of the table seems, therefore, to justify the belief that convection days are more likely to be accompanied by good or very good visibility than are non-convection days, and are very unlikely to be accompanied by bad or poor visibility.

TABLE V.—GROUND VISIBILITY AT 1300 DURING THE SUMMERS 1920, 1921, 1922 AND 1923, ON ALL OCCASIONS WHEN CUMULUS OR CUMULO-NIMBUS CLOUDS WERE PRESENT, AND WHEN SUCH CLOUDS WERE ABSENT.

Cu. or Cu.-nb.	Total No. of Observations.	Ground Visibility.					
		Good or Very Good.		Indifferent or Fair.		Bad or Poor.	
		Total	Per cent.	Total	Per cent.	Total	Per cent.
Present -	467	192	41·1	274	58·7	1	0·2
Absent -	265	56	21·1	198	74·7	11	4·2

8. **Summary.**—The main results which seem to emerge from the complete investigation may be briefly summarised as follows, it being remembered that the results apply to the Cranwell area :—

(*a*) that bad or poor day visibility is most frequent with the two groups CALM and SE'E–SSE in the order named. (Table II)

(*b*) that good or very good visibility is most frequent with the two groups NE'N–ENE and S'E–SSW, in the order named. (Table II)

(*c*) that good or very good day visibility very seldom occurs with winds in the group SE'E–SSE. (Table II)

(*d*) that bad or poor day visibility very seldom occurs with winds in the groups SW'S–WSW and S'E–SSW. (Table II)

(*e*) that winds greater in velocity than 15 m/hr. are seldom accompanied by bad or poor day visibility. (Table III)

(*f*) that nearly half the winds of velocity greater than 20 mi/hr. are accompanied by good or very good day visibility. (Table III)

(*g*) that in winter there are few occasions of good or very good visibility occurring with the pressure types XI, VI, XIV, XII and I, and that type XI very easily gives the highest percentage of bad or poor visibility. (Table IV)

(*h*) that in summer pressure types III, XV, VIII, VII and X are accompanied by very high percentages of good or very good day visibility, and that pressure types XII and XI seldom give such visibility. (Table IV)

(*i*) that convection days are more likely to be accompanied by good or very good visibility than are non-convection days, and are very unlikely to be accompanied by bad or poor visibility. (Table V)

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