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A NOTE ON BUMPINESS

AT

CRANWELL, LINCOLNSHIRE,

DURING THE PERIOD

1st December, 1925 to 30th April, 1926

BY

W. H. PICK, B.Sc., and G. A. BULL, B.Sc. *



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A NOTE ON
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1. **Aim.**—The aim of this Note is to determine as well as possible the relations between the degree of "bumpiness" experienced by pilots flying at Cranwell and various meteorological factors prevailing at the time during the period 1st December, 1925, to 30th April, 1926.

2. **Data.**—The bumpiness reports on the scale 0—no bumps, 1—slight bumps, 2—occasional bumps, 3—bumpy, 4—very bumpy and 5—exceptionally bumpy, were supplied by the pilots of the No. 4 Aircraft Apprentices' Wing, Royal Air Force, Cranwell, Lincolnshire. The flights to obtain the observations were made between 0830 and 1130, and only one report each day is utilized in what follows, though often several were available to enable a just estimate to be made. Estimations were made, when possible, at the following heights:—50, 500, 1,000, 2,000 and 3,000 feet. Some days were missed owing to the fact that no flying was carried out because of bad weather or other reasons, and on some occasions estimates were made at some of the heights but not at others.

It is to be noted that the observations were carried out at a time of year when the effect of insolation in producing large convection currents is not pronounced. In general, it may be stated that there are two varieties of air behaviour that give rise to bumpiness:—(a) the convective raising of large masses of air (the corresponding descent of other masses probably takes place over a much wider area and more slowly than the chimney tube up-draught of the rising air), and (b) the general eddy motion of the air which does not extend to a very great height. Winter and early spring, the seasons dealt with in this present Note, probably ensure that it shall be this second type (b) which is the more active.

3. **Distribution of Observations.**—Table I. shows the distribution of the bumpiness observations, set out in the figure code specified above, for the various heights for each day that readings were obtained and Table II. shows the observations in a collected form.

TABLE I.—DAILY BUMPINESS FIGURES.*

Height	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
feet	Dec.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Feb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mar.	3	1	-	-	0	-	3	2	-	3	1	-	-	-	0	0	0	0	0	-	-	2	0	2	0	-	-	-	-	-	-
	Apr.	-	-	-	-	-	-	1	1	-	2	1	3	-	2	1	2	-	-	0	1	2	0	1	-	-	1	0	-	0	1	-
500	Dec.	3	1	1	-	-	-	2	2	2	3	0	-	-	3	1	-	3	2	-	-	0	-	-	-	-	-	-	-	-	-	-
	Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Feb.	1	0	-	0	-	-	0	0	1	0	0	-	-	-	-	0	-	2	1	-	-	1	1	1	-	3	0	1	-	1	-
	Mar.	3	1	-	3	-	-	2	4	-	2	2	-	-	-	0	1	0	0	0	-	-	2	0	1	0	-	-	-	-	-	-
	Apr.	-	-	-	-	-	-	1	1	-	-	1	3	-	2	1	2	-	-	0	1	2	0	1	-	-	-	0	-	0	1	-
1,000	Dec.	3	0	0	-	-	0	-	2	2	2	-	0	-	3	0	-	2	1	-	-	0	-	-	-	-	-	-	-	-	-	-
	Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Feb.	0	0	-	0	-	-	0	0	0	0	0	-	-	-	-	3	-	2	1	-	-	0	1	1	-	3	0	0	-	1	-
	Mar.	3	1	-	-	3	-	0	0	-	2	1	-	-	-	0	1	0	0	0	-	-	1	0	1	0	-	-	-	-	-	-
	Apr.	-	-	-	-	-	-	-	0	1	-	1	3	-	2	1	2	-	-	0	0	2	1	1	-	-	-	0	-	2	-	-
2,000	Dec.	-	0	0	-	-	-	0	0	0	1	0	-	-	0	0	-	0	0	-	-	0	-	-	-	-	-	-	-	-	-	-
	Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Feb.	0	0	-	0	-	-	-	0	0	0	0	0	-	-	-	-	-	1	1	-	-	0	1	0	-	-	0	0	-	-	-
	Mar.	0	0	-	-	0	-	-	0	2	-	2	1	-	-	0	0	0	0	0	-	-	0	3	0	0	-	-	-	-	-	-
	Apr.	-	-	-	-	-	-	-	0	1	-	-	2	1	0	2	-	-	0	0	0	1	0	0	-	-	-	0	-	-	-	-
3,000	Dec.	-	0	0	-	-	-	0	0	0	0	0	-	-	0	1	-	0	1	-	-	0	-	-	-	-	-	-	-	-	-	-
	Jan.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Feb.	0	0	-	0	-	-	-	0	0	0	0	0	-	-	-	1	-	0	0	-	-	0	0	0	-	0	0	-	2	-	-
	Mar.	0	0	-	-	0	-	-	0	2	-	0	1	-	-	0	0	0	0	0	-	-	0	0	3	0	-	-	-	-	-	-
	Apr.	-	-	-	-	-	-	-	0	1	-	-	0	0	0	2	-	-	0	0	-	1	0	0	0	-	-	0	-	-	-	-

* Figures in heavy type signify that the results are on days of equatorial air (see paragraph 7) and in ordinary type on days of polar air.

Table III. shows that at levels 1,000 feet and below maximum bumpiness accompanies winds at 43 feet between S'W and W, and minimum bumpiness winds at 43 feet between N'E and E. At heights above 1,000 feet winds at 43 feet between S'W and W again give the maximum bumpiness.

5. **Wind Velocity at 43 ft. and Bumpiness.**—Table IV. reveals the wind velocities at 43 feet as given by the anemobiograph at the times the flights were in progress, brought into relationship with the bumpiness at various heights estimated on those flights.

TABLE IV.

Height, ft.	Wind velocity, m.p.h.	No. of obs.	Percentage no. of obs. of each degree of bumpiness was :					
			0	1	2	3	4	5
50	0-5	11	72.7	18.2	0.0	0.0	9.1	0.0
	6-10	7	57.1	42.9	0.0	0.0	0.0	0.0
	11-15	14	7.1	50.0	28.6	14.3	0.0	0.0
	16-20	8	25.0	12.5	62.5	0.0	0.0	0.0
	above 20	3	0.0	33.3	0.0	66.6	0.0	0.0
500	0-5	15	66.7	26.5	0.0	6.7	0.0	0.0
	6-10	11	54.5	27.3	9.1	0.0	9.1	0.0
	11-15	20	10.0	50.0	20.0	20.0	0.0	0.0
	16-20	14	14.3	35.7	21.4	21.4	7.2	0.0
	above 20	3	0.0	0.0	100.0	0.0	0.0	0.0
1,000	0-5	14	71.4	14.3	7.2	7.2	0.0	0.0
	6-10	11	90.9	9.1	0.0	0.0	0.0	0.0
	11-15	20	25.0	45.0	10.0	20.0	0.0	0.0
	16-20	14	28.6	21.4	35.7	14.3	0.0	0.0
	above 20	3	33.3	33.3	33.3	0.0	0.0	0.0
2,000	0-5	12	91.7	8.3	0.0	0.0	0.0	0.0
	6-10	11	100.0	0.0	0.0	0.0	0.0	0.0
	11-15	18	83.3	11.1	5.5	0.0	0.0	0.0
	16-20	14	35.7	35.7	14.3	14.3	0.0	0.0
	above 20	3	33.3	33.3	33.3	0.0	0.0	0.0
3,000	0-5	12	83.4	16.7	0.0	0.0	0.0	0.0
	6-10	11	90.9	9.1	0.0	0.0	0.0	0.0
	11-15	19	84.2	5.3	5.3	5.3	0.0	0.0
	16-20	14	78.6	7.1	14.2	0.0	0.0	0.0
	above 20	3	66.6	33.3	0.0	0.0	0.0	0.0

Table IV. shows that at least up to 2,000 feet the stronger the wind at 43 feet the greater the bumpiness, the effect being especially noticeable at 50 and 500 feet, distinctly so at 1,000 feet and fairly distinctly so at 2,000 feet. At 3,000 feet the effect is not so noteworthy.

6. **Pressure Type and Bumpiness.**—The 0700 synoptic chart for each day upon which bumpiness observations were taken

was examined and classified under one of the twenty-eight types of pressure distribution laid down by E. Gold.* For ease of summarizing, these pressure types in what follows are designated by their numeral, letter suffixes being neglected. Thus a reference to type VII means the four types VII, VIIa, VIIb, VIIc, a reference to type I the two types I and Ia, and so on. The effect of this is to reduce the pressure groupings to fifteen.

Owing to the shortness of the period over which the observations were made, some of the pressure types did not occur sufficiently often to enable their effect to be determined. For this reason, too, it is not considered that a table showing all the results would be of any great value. Nevertheless, the results obtained seem to indicate more or less definitely that types VII and VIII were quite the calmest and type II as distinctly the bumpiest.

7. The Origin of the Air and Bumpiness.—On each day that bumpiness observations were taken an examination of the Daily Weather Reports published by the Meteorological Office, Air Ministry, was carried out with a view to determining whether the air supply at Cranwell was of equatorial or of polar origin. The type of air supply being determined for each day, the average bumpiness at each height was then computed for each of the two types. The results are set out in Table V. It needs to be stated that the average speed of the wind at 43 feet on days of equatorial air was 13·8 miles an hour, and on days of polar air, 9·1.

TABLE V.

Height, ft.	Equatorial Air.		Polar Air.	
	No. of obs.	Average bumpiness.	No. of obs.	Average bumpiness.
50	20	1·50	23	0·78
500	30	1·37	33	1·03
1,000	29	1·00	33	0·79
2,000	29	0·52	29	0·28
3,000	30	0·37	29	0·14

The table shows that at all the heights considered, equatorial air was more bumpy than polar air.

8. Clouds and Bumpiness.—As would be expected, clouds such as cumulus and cumulo-nimbus that are definitely the result of convection were found to be accompanied by pronounced bumpiness.

Interesting results were, however, obtained in many cases with skies overcast with stratus clouds, bumpiness being found to

* E. Gold, F.R.S., "Aids to Forecasting," *Geophysical Memoirs*, No. 16, Meteorological Office, London, 1920. See also *Professional Notes*, No. 42, for illustration of these types.

occur below the stratus level and to be absent in the layers above the stratus level. Thus, on 9th February at 1120, there were 10/10ths of stratus at 150 feet and occasional bumps were found at 50 feet and no bumps at 500 feet and above. Again, on 21st April at 0750, the sky was overcast with stratus at 1,000 feet, bumps being experienced up to 1,000 feet and no bumps occurring above 1,000 feet. One afternoon case, too, may be added, although it is not included in the statistics to be found in the foregoing part of this Note. On 9th February at 1520, the sky was completely covered with stratus between 1,000 and 2,000 feet, bumps being experienced up to 1,000 feet and no bumps at 2,000 and 3,000 feet.

9. Summary of Results.—(a) Much greater bumpiness prevailed at 1,000 feet and below than at the higher levels with the highest percentages of heavy bumpiness occurring at 500 feet. Least bumpiness of all occurred at the highest level examined, viz., 3,000 feet.

(b) At levels 1,000 feet and below maximum bumpiness accompanied winds at 43 feet between S'W and W and minimum bumpiness winds at 43 feet between N'E and E. At heights above 1,000 feet, winds at 43 feet between S'W and W again gave the highest percentages of bumpiness.

(c) Up to 2,000 feet inclusive the stronger the wind at 43 feet the greater the bumpiness, the effect being especially noticeable at 50 and 500 feet, distinctly so at 1,000 feet and fairly distinctly so at 2,000 feet. At 3,000 feet the effect was not so noteworthy.

(d) The Gold pressure types VII and VIII (that is, types VII, VIIa, VIIb, VIIc, VIII, VIIIa and VIIIb considered together) were the calmest with regard to bumpiness and type II the bumpiest.

(e) At all heights equatorial air was more bumpy than polar air for the time of day and during the season December to April, during which these ascents were made.

(f) With skies overcast with stratus clouds bumpiness occurred below the stratus level and was absent in the layers above the stratus clouds.

