ART. II.—*The Direction of Motion of Cirrus Clouds.*

By H. B. DEVEREUX, F.R.Met.Soc.

[*Read before the Auckland Institute, 11th December, 1912.*]

OVER four years of systematic observation of cirrus clouds at Waihi, and their direction of motion, has shown not only their value as an adjunct to amateur forecast work, but an invaluable key to the study of those westerly waves of low pressure which are the predominant type of cyclonic systems which transit the Dominion in rear of the anticyclones.

By a strange coincidence, the writer was engaged on this paper when the Australian Monthly Weather Report for December, 1910, came to hand, containing therein a paper by Mr. E. T. Quayle, B.A., on the "Annual and Seasonable Variation in the Direction of Motion of Cirrus Clouds over Melbourne." In this paper the term "cirrus" means cirrus and cirro-stratus. The daily observations of these high-level clouds have not been confined to any particular hour, as the appearance has been generally found to be coincident with time about or after the early morning or afternoon diurnal barometric minimum.

In these investigations the first seven months of 1912 are included, as this year has been unusually favourable for cirrus observations, fifty-eight being recorded, or over 20 per cent. of the total under review.

The following table shows not only the principal points of the compass from which cirri moved, but the seasonal variation.

Table showing for each Month the Total Number of Days on which Cirrus Clouds were observed moving from the Principal Compass-points during the $4\frac{7}{12}$ Years 1st January, 1908, to 31st July, 1912.

—	N.	N.N.W	N W.	W.N.W.	W.	W.S.W.	S.W.	S.S.W.	S.	S.S.E	S.E	E S E.	E.	E N E	N.E.	N.N.E	Total Obs.
January	0	0	7	1	2	1	1	2	2	0	2	0	2	0	0	0	20
February	1	2	1	4	6	4	3	1	1	0	1	1	0	0	1	0	26
March	2	0	9	4	4	1	0	0	1	0	1	0	3	0	0	0	25
April	0	0	8	5	5	1	1	1	2	0	0	0	1	0	0	0	24
May	0	0	7	6	7	1	3	0	1	0	0	0	1	0	0	1	27
June	1	1	3	4	6	7	1	3	2	0	1	0	0	0	0	0	29
July	0	1	5	2	6	4	3	0	2	0	0	0	1	0	0	0	24
August	2	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	6
September ..	0	0	10	2	4	1	0	0	0	0	0	0	0	0	0	1	18
October	3	1	3	5	6	3	1	0	4	0	0	0	0	0	0	0	26
November ..	1	0	11	3	11	4	1	0	2	0	0	0	0	0	0	0	33
December ..	1	0	4	3	6	4	0	0	0	0	1	1	1	0	0	0	21
Total ..	11	5	68	40	63	32	14	7	17	0	6	2	9	1	1	3	297
Percentage of Obs...	4	2	24	14	23	11	5	2	6	0	2	1	4	0	0	1	..

In the above table no observations have been entered of cirri whose direction of motion was not determinable.

By inspection of this table we find the following :—

(*a.*) Cirrus is most frequently observed in November, with the least frequency in August.

(*b.*) The seasonal variation shows maxima in the spring and autumn. In the former season the greater frequency is undoubtedly accounted for by the known greater energy and magnitude of the antarctic disturbances which transit the Dominion ; whilst in the autumn season the greater frequency can be attributed to those monsoonal systems which affect all that portion of the North Island lying between about longitudes 173° and 178° E. and north of the parallel of 38° S.

(*c.*) Cirri are usually moving from some westerly point. From due west, 23 per cent. of the total number observed ; from W.N.W., 14 per cent. ; from N.W., 24 per cent. ; and from W.S.W., 11 per cent. : these four points accounting for 72 per cent. of total observations. The mean direction computed from all observations is W. 7° 16′ S., or nearly west. In Mr. Quayle's investigations of the movement of cirri at Melbourne the mean direction of motion is shown to be a little north of west; but his investigations cover a period of sixteen years, or four times the scope of this paper, so that the longer period would naturally give a truer mean, and would in a measure eliminate any variation due to cyclical movements. Both results, however, demonstrate the west-to-east drift of the upper currents in these latitudes. Melbourne and Waihi lie almost on the same parallel of latitude.

It is perhaps necessary to refer to the few observations of cirrus with an easterly component. During the passage of low pressures to the eastward of the Bay of Plenty, those which approach from the northward or north-east, cirrus is frequently observed ; but owing to the prevalence of lower clouds at these times the true direction of motion of the cirri is often very difficult of determination : their direction is usually from the eastward.

In the "Transactions of the New Zealand Institute," vol. 37, p. 563, 1905, Captain Edwin refers to cirri-movements during the passage of cyclones to the northward or eastward of East Cape, and the drift from the eastward.

General Remarks as to Cirrus Formations.

Frequently the first appearance of cirrus is peculiar. A patch is projected above the horizon a little south of west, in shape not unlike a fan-shell, the radiations answering to the radial lines on the latter. The formation is sometimes striated, and when this happens a westerly wave-depression not infrequently follows, with wintry weather and electrical disturbances.

If a wave-depression is of greater extent than usual, detached cirrus plumes are frequently observed travelling eastward, with heavy showers of thunder type following, often accompanied by hail. They may be described as miniature cyclones, or swirls, traversing the country, integrals of an extensive system. Their passage is marked by frequent rise and fall of the barograph-trace, the amplitude being about $\frac{8}{100}$ in.

Cirrus and cirro-stratus may often be observed low down on the W.S.W. horizon, of a distinct "smoky" coloration, the ends being frequently brushed back, as it were, and recurving on themselves. If cirrus main

tains this direction for twenty-four or thirty-six hours, the advent of an antarctic depression is portended.

Sometimes when the lowest pressure of an antarctic "low" has passed the meridian of the Bluff great cirrus plumes, moving fast, appear to the S. or S.S.W.: the barometer then rises slowly, and later very rapidly, a southerly storm following up the east coast of the South Island. If the rise of the barometer is due to the advent of the anticyclone following in rear of the antarctic system, the "southerly" usually extends to the latitude of East Cape, and a rough sea makes into the Bay of Plenty.

These westerly wave-pressures are usually most pronounced in the spring of the year, and they have been very fully described by Captain Edwin in the Transactions.

Occasionally cirrus, frequently striated, is seen moving very rapidly from the N.W.: a change in the weather then occurs shortly, winds from between N.E. and E., and heavy rain on the northern coastal districts.

Art. III.—*Harmonic Tidal Constants of New Zealand Ports—Wellington and Auckland.*

By C. E. Adams, M.Sc., F.R.A.S., Government Astronomer of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

The harmonic tidal constants given in columns (1) and (4) of the attached schedule were obtained from an harmonic analysis of the hourly ordinates from the automatic tide-gauges at Wellington and Auckland. For each port the tidal abacus of Sir G. H. Darwin was used, and the whole of the calculation has been carried out in duplicate. For the additions the Mercedes adding-machine has been found to be of the greatest assistance, while the Brunsviga calculating-machine, with printing attachment, and the Millionaire calculating-machine have been invaluable in the numerous calculations. For the fine plotting of curves the Coradi co-ordinatograph has been very useful.

From the constants given in columns (1) and (4) the tides for Wellington and Auckland have been predicted, and are published in the "British Admiralty Tide-tables" and in the "New Zealand Nautical Almanac." Comparisons between the predictions and *actuality* prove the correctness of the constants. For these comparisons see New Zealand Tidal Survey: Report of Department of Lands and Survey, Wellington, 1910–11 and 1911–12.

Other values of the tidal constants—(1) by the United States Coast and Geodetic Survey, and (2) by Mr. T. Wright—are given in columns (2) and (5) and (3) and (6) respectively.