IONOSPHERIC DRIFTS AT BRISBANE

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Summary

Examination of fading of signals recorded at closely spaced receivers has been used to measure the velocity of horizontal drifts of ionization in the ionosphere. Systematic observations have been made for a period of 2 years, on a frequency of 2·28 Mc/s.

The results show good agreement with the horizontal velocities of ionized irregularities in the E and F_2 regions of the ionosphere as determined by other methods at similar latitudes. The speeds are less than those observed at higher latitudes.

The results for the E region have been analysed for 24, 12, and 8 hr solar harmonics. The 12 and 8 hr harmonics show large seasonal phase changes in the northward component. The phase for the 12 hr northward component is in fair agreement with the results at higher latitudes in summer only, whereas the phase for the eastward component is generally consistent with the results at higher latitudes for all seasons.

The F region 12 hr harmonic has a larger seasonal phase change in the eastward component than in the northward component.

I. Introduction

From July 1952 to November 1954, systematic recordings have been taken at Brisbane of the fading of echoes from the ionosphere received at spaced aerials, using the technique described by Mitra (1949) and Phillips (1952). The frequency was 2·28 Mc/s with a pulse repetition frequency of 50 pulses per second. The aerials were spaced at three corners of a square of side 100 m. The recording film speed was 2 in/min and records were taken for 5 min every half-hour on three days each month.

Since 1954, automatic equipment has been used which has obviated the need for personnel to monitor E_s and F echoes at night. This equipment will be described in a later paper.

II. Analysis of the Records

The film records were viewed by projection from an enlarger. These were examined for the time shift necessary to give the " best fit " between half-minute sections of the records from each receiver. All sections of records with poor correlation were rejected and a limit of 5 pairs of time shifts was set for each 5 min record.

The north-south, east-west component drift velocities computed from the time shifts were plotted against local time for each month and a smooth curve drawn through the scatter diagram. From July 1952 to June 1953, the component velocities from each pair of time shifts were used in the compilation

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of results; after this period an average value for each 5 min record was used. This average value was obtained from a mean of the time shifts if these were consistent or a mean of the component velocities if the time shifts varied haphazardly. For convenience, these periods are referred to in the text as 1952–53 and 1953–54 results.

At the frequency of 2·28 Mc/s only E region echoes are recorded during the day; at night both F and sporadic E echoes are recorded. In the analysis of the records no attempt was made to separate normal E and sporadic E echoes, but E and F region results were dealt with separately.

All wind speeds quoted are half ground speeds (Pawsey 1935) and directions are those towards which the motion takes place.

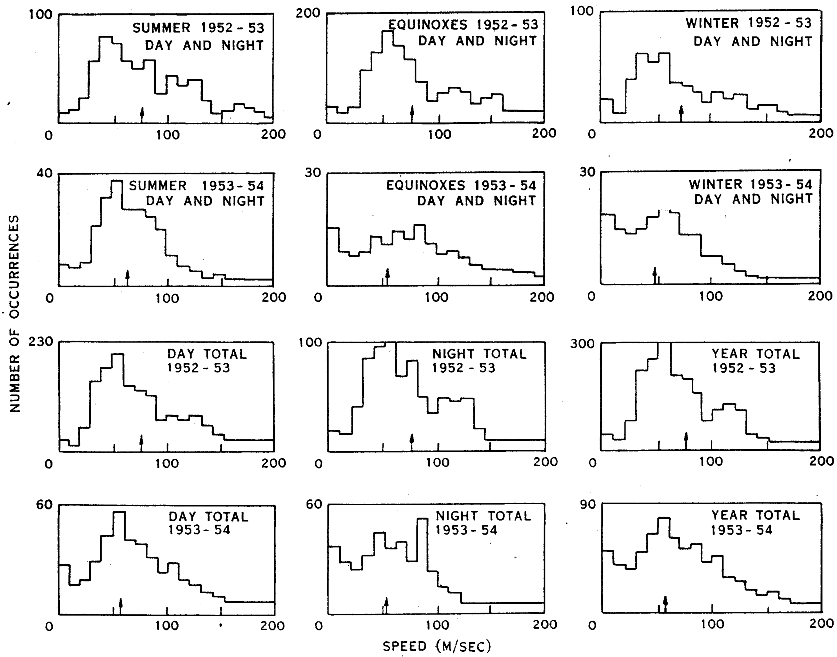

Fig. 1.—Speed distributions for the E region, 1952–53 and 1953–54. The mean is indicated by an arrow.

III. Results

(a) *Magnitudes*

Figures 1–3 show histograms of the distribution of speeds for the E and F regions for the two years. For Figure 2 each average value for 1953–54 has been weighted with the number of values used in obtaining it before adding to 1952–53 results. In the histograms for the F region at night (Fig. 3), except for Figure 3 (g), all values of speeds obtained have been shown, neglecting the effect, if any, of the E_s region on the phase and amplitude of the echo reflected from the F region. Figure 3 (g) contains only those values obtained when E_s was not recorded at 2·28 Mc/s. (In agreement with the estimate of Thomas (1956), it was found that

E_s, at night, records approximately 60 per cent. of the time. Thomas also found fairly uniform probability of occurrence throughout the night.)

The more frequent occurrence of low speed values appearing in the 1953–54 histograms is probably due to the slightly different method of analysis used for

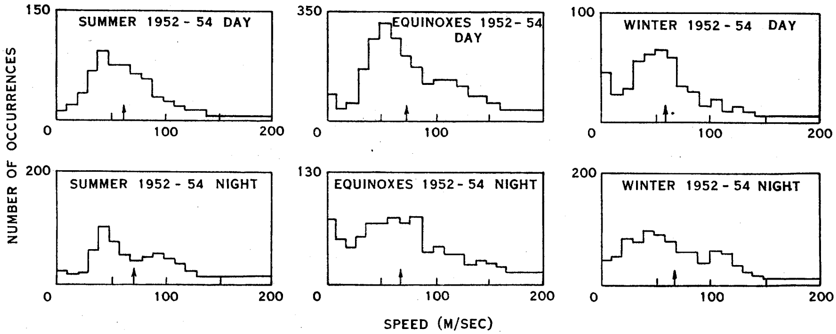

Fig. 2.—Speed distributions for the E region day and night (1952–54). The mean is indicated by an arrow.

that group (Section II above). If the drift velocity of the ground diffraction pattern is uniform over the recording period, both methods should give the same value. If, however, changes in velocity occur during the recording period, the former method will produce a spread of values contributing fairly equally

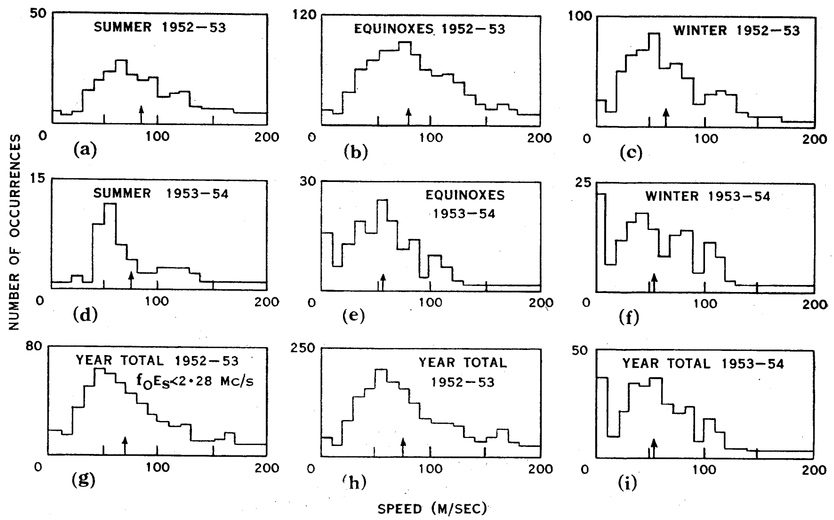

Fig. 3.—Speed distributions for the F region at night. The mean is indicated by an arrow.

to all ranges of speed, whereas the latter method tends to produce more speeds in the very low range with a mean speed somewhat less than with the former method. It is shown in Section IV (a) that the method of analysis for 1952–53 is to be preferred.

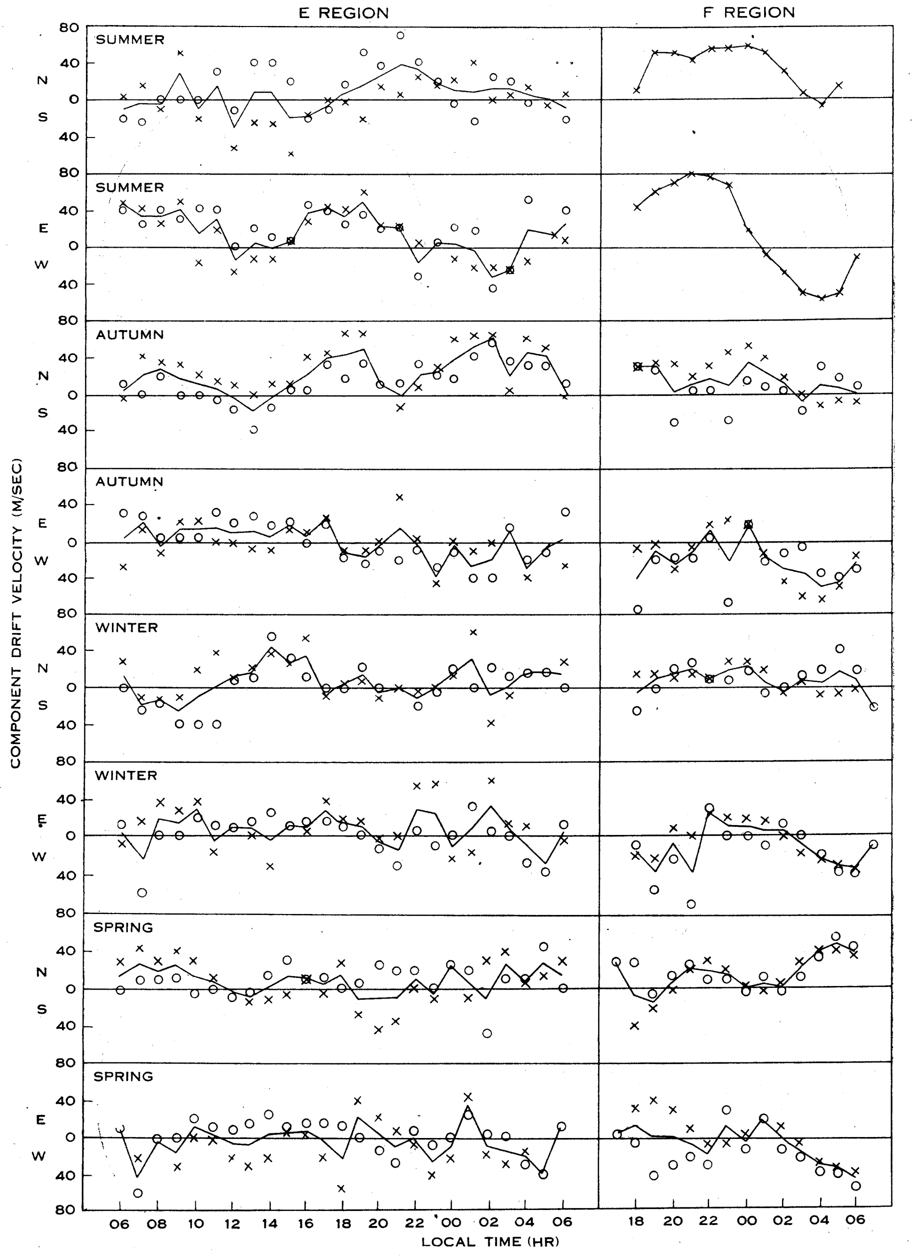

Fig. 4.—Diurnal variation of north-south, east-west component drift velocities, of E and F regions for local time. × (1952–53), ○ (1953–54).

The histograms of Figure 1 thus appear to indicate, in view of the above discussion, that the drift speed for the E region is most variable in winter, and least variable in summer, and that for the F region (Fig. 3) it shows more variation in winter and near the equinoxes than in summer.

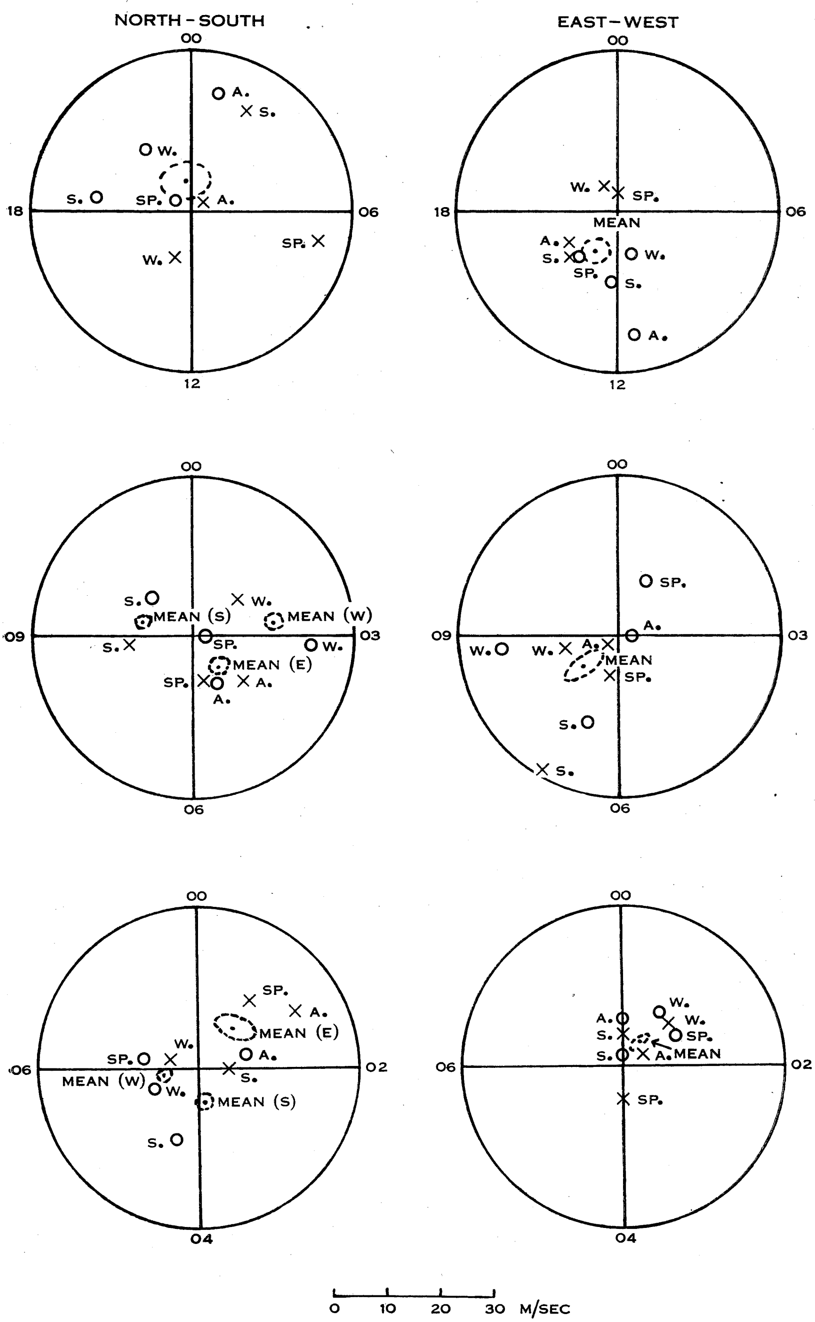

Fig. 5.—24, 12, and 8 hr solar harmonics for seasonal north-south, east-west component drift velocities in the *E* region. × (1952–53), ○ (1953–54). The mean is represented by a dot in the error ellipse of the mean.

It will be noted that the speed distribution for the E region (Fig. 2) peaks more strongly in summer than in winter both by day and by night, and that the peaking is more marked by day than at night.

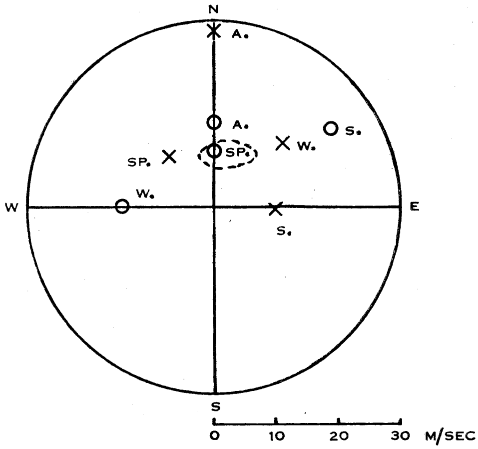

Fig. 6.—Steady component of seasonal drift velocity for the E region. × (1952–53), ○ (1953–54).

(b) *Seasonal Diurnal Variations*

The north-south and east-west component velocities for successive seasons for the E region are shown in Figure 4. The value for each hour is the arithmetic

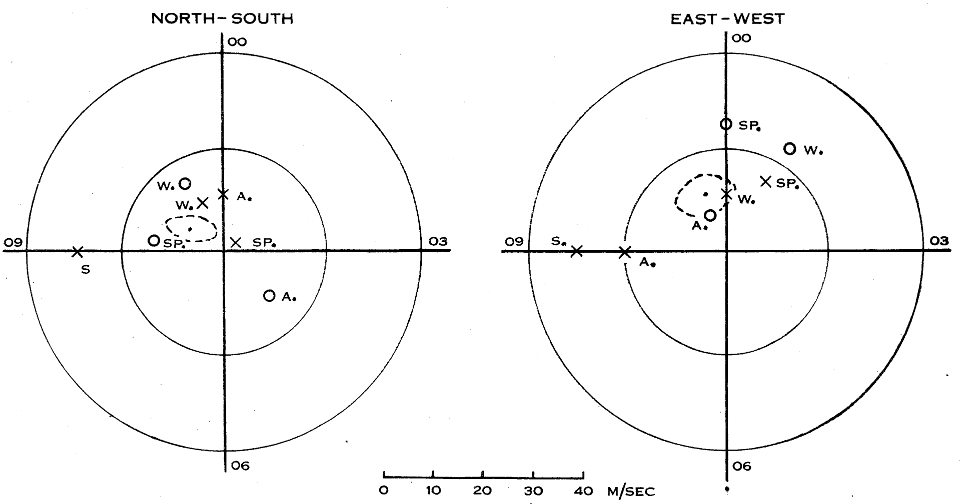

Fig. 7.—Semi-diurnal solar harmonic for seasonal north-south, east-west component drift velocities in the F region at night.

mean of all the component velocities centred about that hour obtained in the three months. The 24, 12, and 8 hr harmonics, obtained by Fourier analysis of these diurnal distributions, are shown in Figure 5 with their respective mean value and error ellipse of the mean. The values for the steady component are shown in Figure 6. The agreement between the mean of the monthly harmonics (not shown) and the appropriate seasonal harmonic was very good.

The *F* region results were averaged in seasons in a similar fashion to the procedure for the *E* region and the resultant plot is included in Figure 4. The 12 hr harmonics obtained for each season by graphical analysis are shown in Figure 7.

IV. Discussion of Results

(*a*) *Magnitudes*

Briggs and Spencer (1954) have discussed the result of previous measurements of movements of ionization at comparatively high latitudes, particularly those values obtained by the spaced receiver technique. For the *E* and *F* regions they find a most frequent speed of about 80 m/sec, which is greater than the results observed at Brisbane.

The most frequent day-time speed (50–60 m/sec) agrees well with that found by Harvey (1955) for E_s clouds at Sydney by day. Thomas and Burke (1956) found for E_s clouds at night, a most frequent speed of 75 m/sec and a mean speed of 83 m/sec. They also found good agreement between the range-zenith angle method recording the velocity of the E_s clouds and the spaced receiver technique.

For the *F* region, McNicol, Webster, and Bowman (1956) found that irregularities associated with satellite echoes have an apparent horizontal motion of mean speed 63 m/sec, with a most frequent speed of 55–65 m/sec. The histograms shown in Figure 3 are not inconsistent with their results. If winter values had been weighted in the year total with the same weight as in McNicol, Webster, and Bowman's curves, the mean speed obtained in 1952–53 would be comparable with their value. A few direct comparisons of the two systems of measurements have been obtained, with fair agreement.

(*b*) *Solar Harmonics for* E *Region Drifts*

In Table 1 the results for the diurnal and semi-diurnal harmonics obtained at Brisbane are shown for comparison with those obtained by the same method at Cambridge and New Zealand (Briggs and Spencer 1954) and at Adelaide on meteor trails (Huxley 1956, p. 30).

It will be noticed that for the semi-diurnal harmonic there is fair agreement in phase for the eastward component, but the northward component shows large seasonal phase change with best agreement in the summer months, if allowance is made for the phase reversal from northern to southern hemispheres. This large seasonal phase change is also apparent in the northward component of the 8 hr harmonic (Fig. 5).

From measurements on movement of sporadic *E* ionization, Harvey (1955) by day, and Thomas and Burke (1956) by night, have found a general tendency towards the north with a preference for the north-west quadrant. These results may be compared with the steady component at Brisbane in Figure 6.

(c) F *Region Drifts*

It may be noticed in Figure 7 that the eastward semi-diurnal harmonic shows a much larger seasonal phase change than the northward harmonic.

Briggs and Spencer (1954) found that at night in the F_2 region the drifts are to the west in all seasons and the north-south component is small. The mean seasonal drifts over Brisbane at night (Fig. 4) are to the north in all seasons and to the west in all seasons except summer. This north-western tendency is consistent with the conclusions of McNicol, Webster, and Bowman (1956) from the study of night-time velocities of F_2 ionization irregularities, as deduced from observations of F_2 " satellite echoes ".

TABLE 1

DIURNAL AND SEMI-DIURNAL HARMONICS FOR THE *E* REGION FOR BRISBANE, CAMBRIDGE, LOWER HUTT (NEW ZEALAND). AND ADELAIDE

The amplitudes are in m/sec and the time of maximum northward and eastward respectively are given in parentheses

Diurnal Harmonics

Direction	Brisbane	Cambridge	New Zealand	Adelaide
Northward ..	7 (2330)	—	—	27 (1730)
Eastward	7 (1400)	(1320)		25 (0930)

Semi-diurnal Harmonics

Direction	Brisbane	Cambridge	New Zealand	Adelaide
Northward, summer	10 (0930)	6 (0500)	31 (0000)	20 (0000)
Northward, winter	15 (0230)	40 (0100)		5 (0530)
Eastward	8 (0740)	31 (0600)	29 (0800)	12 (0720)

V. CONCLUSIONS

The results show that there is a systematic movement of ionized irregularities in the E and F_2 regions of the ionosphere. The drift speeds are less than those observed at higher latitudes. The 12 and 8 hr harmonics for the E region show large seasonal phase changes in the northward component. The phase for the 12 hr northward component in summer is in fair agreement with the results at higher latitudes.

The F region 12 hr harmonic has a larger seasonal phase change in the eastward component than in the northward component.

VI. ACKNOWLEDGMENTS

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