LUNAR TIDE IN SPORADIC *E* AT BRISBANE*

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Accurate measurements have been made at Brisbane of the virtual height of reflection of radio echoes from the *E* region of the ionosphere, using a pulse transmitter operating at 2·28 Mc/s. The recordings were made by using a cathode-ray tube displaying echoes received from virtual heights between 80 and 150 km ; black-out modulation of the cathode-ray tube trace was employed so that echoes appeared as gaps in the trace. To avoid the broadening of the gap with increase of echo signal strength, an automatic gain control was used, which kept the peak output within the time interval corresponding to 80–150 km at a fixed level. The gap width then remained fairly constant (about 16 km), and the recorded height showed no dependence on (input) signal strength. A stable triggered oscillator was used to produce height marks at 10 km intervals every 6 min on the cathode-ray display. The oscillator was started at full amplitude by a triggering wave synchronized with the transmitter modulation pulse ; there was a constant delay of 0·1 km. A typical record is shown in Plate 1.

With these precautions it has been possible to take measurements of the virtual height of *E* reflections with an accuracy of $\pm 0 \cdot 2$ km. It has been found, however, that the levels of both the normal *E* and sporadic *E* reflections vary in a random manner with a quasi-period of about 15 min and a most probable amplitude of about 1 km. This result is to be expected for sporadic *E* reflections and is now well established for the normal *E* region. For this reason there is generally little point in making height measurements to any accuracy greater than $\pm 0 \cdot 5$ km.

These accurate height measurements lend themselves to lunar tidal analysis. However, at Brisbane the day-time *E* region echo at 2·28 Mc/s may (and generally does) consist of a mixture of normal *E* and sporadic *E* reflections. Sometimes

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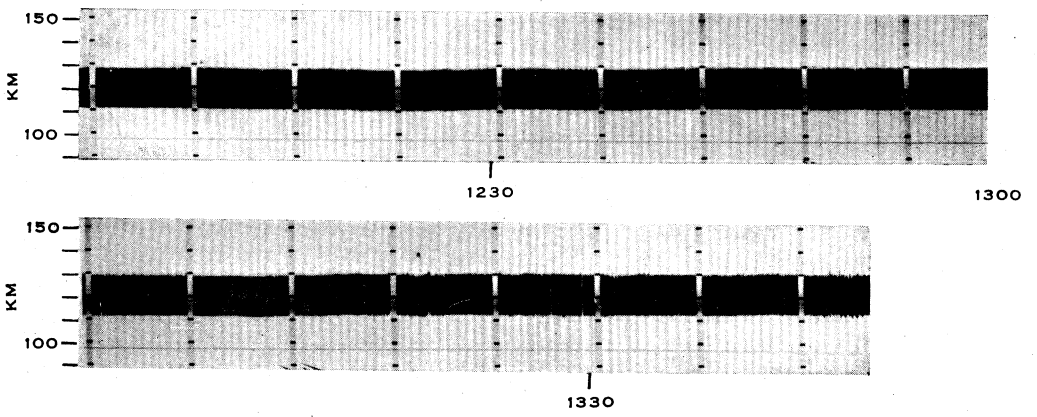

Example of $P't$ for steady conditions in E region, using A.G.C. receiver, September 14, 1953.

they may be distinguished by examining simultaneous swept-frequency ($p'f$) records, but only 15 per cent. of all records between 1000 and 1400 hr at this frequency can be positively identified as normal E region. The lunar tidal analysis of $h'E$ performed by Martyn (1948) is thus actually an analysis of a mixture of $h'E$ and $h'E_s$, with probably an emphasis on $h'E_s$. At night-time

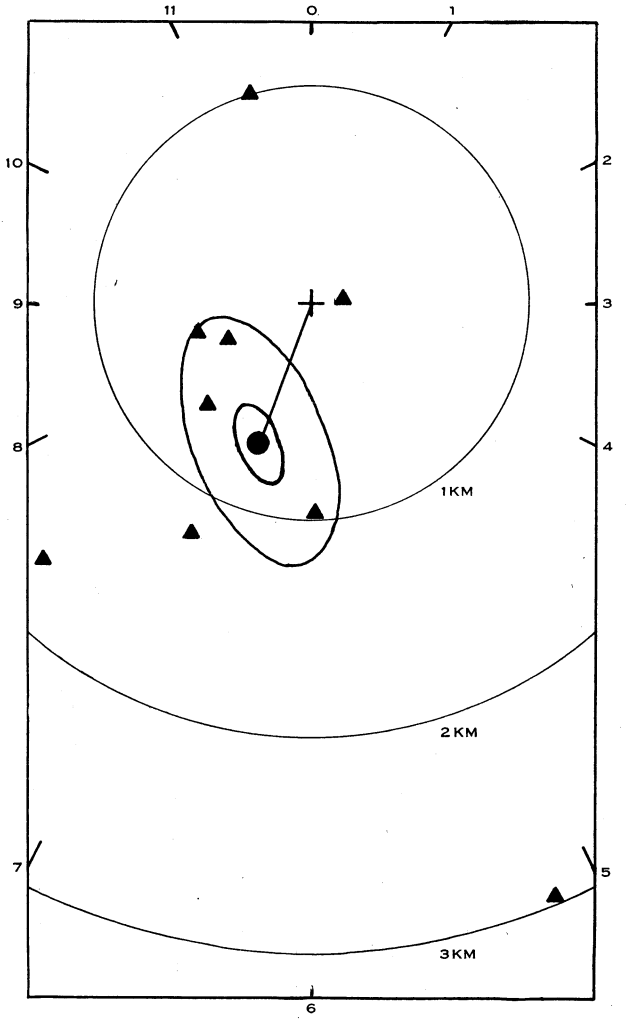

Fig. 1.—Harmonic dial for lunar semi-diurnal tide in $h'E_s$ at Brisbane. ▲ Individual months, ● mean.

all echoes are from sporadic E. There may be more than one trace appearing simultaneously on the records, but when this is the case the upper trace generally shows a slope and curvature indicative of decreasing or increasing slant range due to horizontal movements of irregularities. Such traces have been ignored for the purposes of tidal analysis, as also have the saucer-shaped traces ascribed to moving " clouds " of ionization.

A lunar tidal analysis has been made of night-time values of $h'E_s$ for the year December 1952 to November 1953. Measurements were taken at 6 min intervals throughout each night. The results are shown in Table 1, and in diagrammatic form are plotted on the 12 hr harmonic dial of Figure 1. The mean value for the semi-diurnal lunar tide in $h'E_s$ is $P_2=0\cdot69$ km, $t_2=6\cdot7$ hr. Two probable error ellipses are shown. The outermost indicates the probable error of one monthly observation, and the inner ellipse the probable error of the

TABLE 1

VALUES OF AMPLITUDE (P_2) AND PHASE (t_2) OF LUNAR SEMI-DIURNAL TIDES IN NIGHT-TIME VALUES OF $h'E_s$ AT BRISBANE

	Dec.	Jan.	Mar.-Apr.	June	July	Aug.	Sept.	Oct.	Nov.	Mean
P_2 (km)	0·14	0·67	0·96	1·69	0·42	1·00	2·96	0·55	1·20	0·69
t_2 (hr) ..	2·8	7·5	6·0	7·5	8·3	11·4	5·6	8·5	6·9	6·7

computed mean. These indicate that the result is valid, and that changes in the 12-hourly component affect the phase rather than the amplitude of the tide. The mean E_s level throughout the year was 109 km.

Matsushita (1953) has made a similar analysis for Brisbane (and other stations) using the published values of $h'E_s$ determined from $P'f$ records. A comparison of the values obtained is given in Table 2, together with the value obtained by Martyn (1953).

TABLE 2

COMPARISON OF VALUES OF LUNAR TIDES IN E REGION AT BRISBANE

	Type of Records Analysed	P_2 (km)	t_2 (hr)	Period Analysed
Matsushita ..	$h'E_s$ from $P'f$ records (nearest 10 km)	0·70	5·7	May 1951–Apr. 1952
Thomas & Svenson	Night-time $h'E_s$ from $P't$ records (nearest km)	0·69	6·7	Dec. 1952–Nov. 1953
Martyn	$h'E$ from $P'f$ records (nearest 10 km) (Mixture of $h'E$ & $h'E_s$)	0·5	4·5	June 1943–Dec. 1947

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