Letters to the Editor

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NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 78.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Tides in the Upper Atmosphere

THE exploration of the physical state of the upper atmosphere by radio waves has, so far, been principally concerned with the investigation of the distribution of ionization and with the regularities and irregularities in this distribution due to solar control. In a series of measurements made during the past year, we have endeavoured to extend the employment of radio waves to the investigation of upper-atmospheric oscillations. Such oscillations would include tides produced by the gravitational influence of the sun and the moon, and would result in both vertical movements of individual air particles and also in variations of the atmospheric pressure at a given level. The influence of the moon has been examined first, since, the effect being purely gravitational, there is no need to unravel, as in the solar case, the simultaneous effects of tidal motion and varying height of ion-production. Further, for various theoretical and experimental reasons, attention has been confined to the level of Region E of the ionosphere.

For the investigation of the lunar tide, it was necessary to eliminate the variation of the height of the reflecting layer with angle of the sun, since this variation is many times the expected lunar oscillation. This was accomplished in the two following ways:

(a) A series of quarter-hourly measurements of equivalent height of reflection for a number of days (usually six to eight in a period of twelve days) was plotted to exhibit the diurnal variation. The departures from the smooth mean curve were then plotted as a function of lunar hour.

(b) A series of noon values of equivalent height were plotted to exhibit the seasonal variation, and the daily departures from the smooth curve were plotted as a function of lunar hour.

The accompanying diagram shows the hourly mean departure as a function of lunar hour, the full curve giving the semi-diurnal lunar variation of equivalent height as deduced from the points by harmonic analysis. The curve is derived from quarter-hourly measurements made, during different groups of days, throughout a period of eight months.

A seasonal set of measurements has indicated a tide of the same magnitude and phase, the maxima being about $\frac{1}{2}$ hour before the lunar transits.

We hope to publish elsewhere a full account of the evidence which leads us to regard this tidal amplitude as significant, together with a discussion of the

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relation of these results to previous work. We may, however, mention here that we regard them as showing a pressure oscillation of relative amplitude ($\delta p/p$) of 0.068 at a level of 110 km., whereas the measurement of the lunar barometric oscillations at ground-level show a corresponding relative amplitude of 0.0000115¹. The tide at 110 km. is thus 5,900 times that at ground-level. Further, to the accuracy of the experimental results, the phase of the upper-atmospheric tide is the same as that at ground-level at Greenwich, a result in disagreement with deductions made from the lunar magnetic variations, assuming such variations to arise from currents flowing in Region E.

These experiments have been conducted as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research.

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¹ Chapman, *Quart. J. Royal Meteor. Soc.*, 44, 271 (1918).