A RELATION BETWEEN IONOSPHERIC DRIFTS AND ATMOSPHERIC DYNAMO CURRENT SYSTEMS*

By L. H. Heisler†

Travelling ionospheric disturbances have been studied at this laboratory over a considerable period using fixed frequency observations on 5·8 Mc/s. They are observed as anomalies in height on ionospheric records at three stations, spaced approximately 40 km apart. Munro (1950) has used normal triangulation techniques to determine speeds and directions and has shown (Munro 1958) that their average speed is 7 km/min with median directions 30° east of north during the winter and 120° east of north by day, during the summer months. In both seasons there is a marked easterly component. However, in recent sunspot maximum years during summer, a predominant westerly component is evident on certain days.

Martyn (1955) has intimated that east-west ionization drifts in the F_2 region are produced by a north-south electrostatic field, communicated from the main conducting region of the ionosphere by the highly conducting path along the lines of magnetic force. Moreover, he suggests that there should be a consequent reversal in direction of drift, depending on the position of the observing station relative to the centres of the atmospheric dynamo current systems. This

* Manuscript received December 16, 1959.

† Radio Research Board Laboratory, Electrical Engineering Department, University of Sydney.

has recently been confirmed by Rao and Rao (1958) and Skinner, Hope, and Wright (1958), who have found drift directions near the magnetic equator, towards the west during the day and towards the east at night, in complete contrast to observations at higher latitudes by Briggs and Spencer (1954).

It seemed probable, therefore, that the observed reversal in east-west component at Sydney (33° 52′ S., 151° 11′ E.) is due to a shift in position of the current focus relative to the observing station. The transitional latitude of

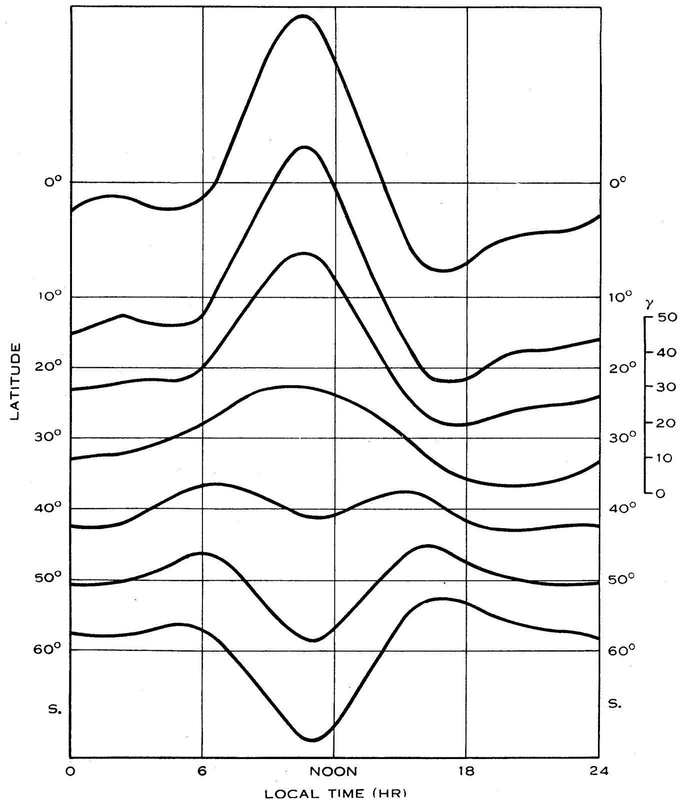

Fig. 1.—Solar daily variation of the north component of the terrestrial field at latitudes 10° apart at the equinoxes in the sunspot-minimum year 1902 (after Chapman and Bartels).

this current centre can change markedly from day to day or even from hour to hour, as shown by Bartels (1932) or in a very complete analysis by Hasegawa (1936). Its relative position can be determined, approximately, from curves expressing the quiet-day diurnal variation of the X component of the Earth's magnetic field for southern latitudes 10° apart during sunspot minimum equinox 1902 (after Chapman and Bartels 1940) as shown in Figure 1. It will be noticed that above 40° the X component displays a maximum, while at high latitudes there is a pronounced minimum in the X component curve. The transition occurs at 40°, the approximate current focus centre. If, therefore, the diurnal curve of X component shows a maximum, the current focus is south of the observing station and vice versa.

Figure 2 is a set of curves of variation in H, the horizontal component of the Earth's magnetic field at Watheroo (30° 19′ S., 115° 52′ E.), for the magnetically quiet days January 15, 24, 26, 1955. Since variation in declination is very small, these are effectively graphs of the north component of the Earth's field, X. There were numerous disturbances recorded on all days and the median values of the east-west component of the disturbance velocity are 4·3, 3·3, and 4·3 km/min east respectively. The curves are consistent with a current

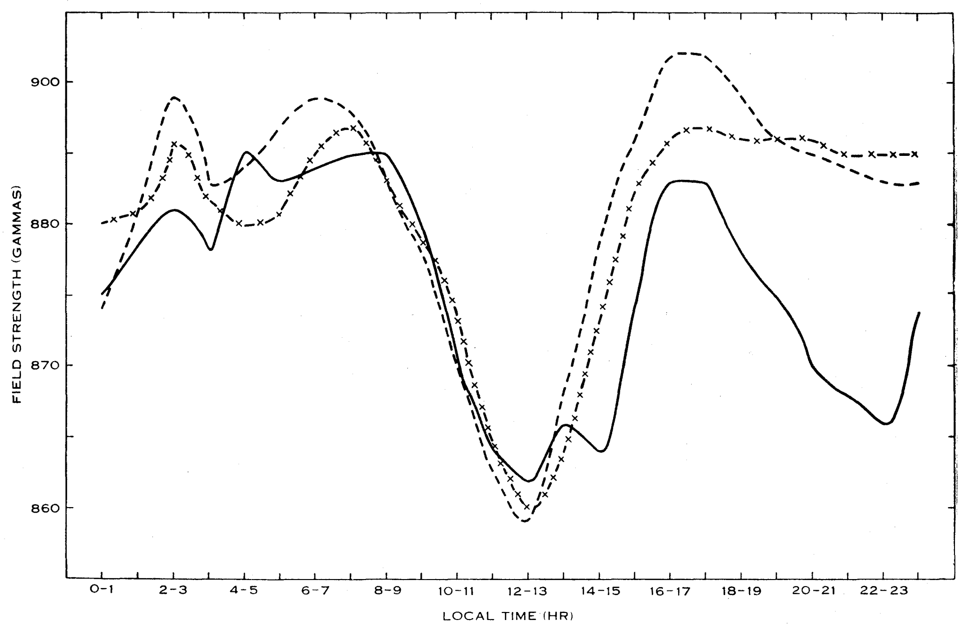

Fig. 2.—Variation in the horizontal component of the Earth's magnetic field at Watheroo for the magnetically quiet days January 15, 24, 26, 1955.
– – – January 15, —— January 24, —×— January 26.

focus travelling to the north of Watheroo and subsequently to the north of Sydney, since Sydney is approximately at the same geographical latitude. A similar set of curves in Figure 3 for the magnetically quiet days January 5, 13, and 14, 1957 are consistent with a current focus travelling to the south of Sydney. Again there were numerous disturbances on all days, but in this case median component velocities were 6·3, 6·4, and 4·4 km/min west respectively. These observed drift directions agree with those suggested by Martyn for the same relative positions of current focus.

Munro (1958) also reports a marked change of directions towards the west after midday during the summer months of the sunspot maximum years 1956–1957. This again is probably due to a southerly movement of the current focus after 1200 hr local time, due to some form of solar control only evident at sunspot maximum.

Observations show that disturbances always have a dominant north-south component. The east-west component, which has a diurnal reversal (Munro 1958), can be explained by the drift hypothesis of Martyn discussed above. The north-south component, however, reverses with season and is apparently independent of geomagnetic control.

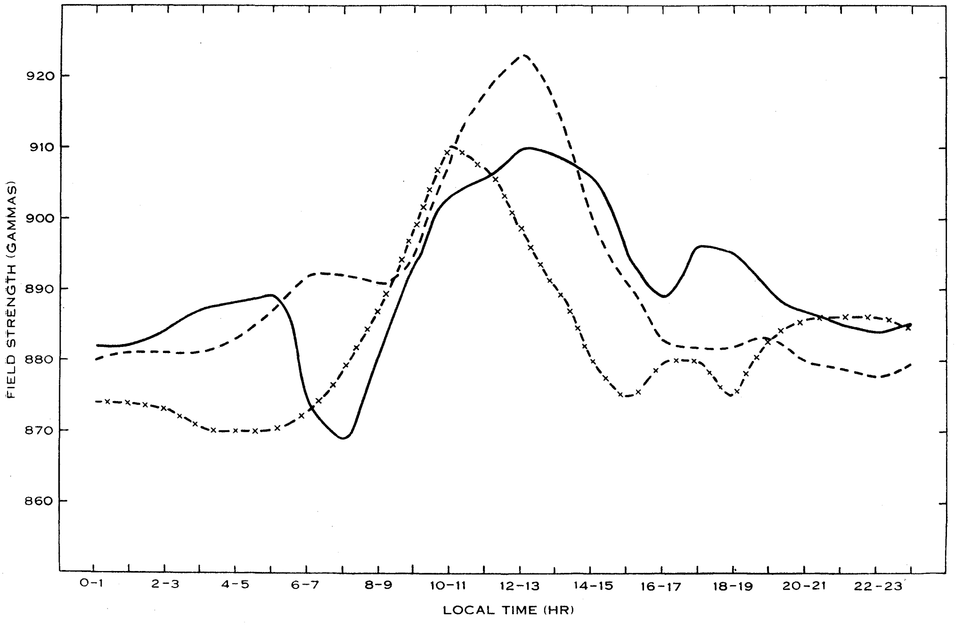

Fig. 3.—Variation in the horizontal component of the Earth's magnetic field at Watheroo for the magnetically quiet days January 5, 13, 14, 1957.
—×— January 5, – – – January 13, —— January 14.

Observation of east-west drift is only possible because of perturbations in the medium. It seems probable, therefore, that the observed directions and velocities of travelling ionospheric disturbances are due to perturbations travelling north-south in an ionized medium which is drifting east-west.

References

Bartels, J. (1932).—*Terr. Magn. Atmos. Elect.* **37** : 291–302.
Briggs, B. H., and Spencer, M. (1954).—*Rep. Progr. Phys.* **17** : 245–80.
Chapman, S., and Bartels, J. (1940).—" Geomagnetism." (Clarendon Press : Oxford.)
Hasegawa, M. (1936).—*Proc. Imp. Acad. Japan* **12** : 80–90, 225–8, 277–80.
Martyn, D. F. (1955).—" The Physics of the Ionosphere." pp. 163–5. (Phys. Soc. : London.)
Munro, G. H. (1950).—*Proc. Roy. Soc.* A **202** : 208–23.
Munro, G. H. (1958).—*Aust. J. Phys.* **11** : 91–112.
Rao, B. R., and Rao, E. B. (1958).—*Nature* **181** : 1612.
Skinner, N. J., Hope, J., and Wright, R. W. (1958).—*Nature* **182** : 1363.