



Fig 3 Phase and amplitude variation with season of lunar midnight values at various stations.

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## Annual, semi-annual and solar cycle variations in Sq, and ring current effects

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The difference of  $H$  at two magnetic observatories on the same meridian, but having latitudes equatorwards and polewards of the latitude of the Sq focus, yields a measure of Sq intensity largely free from disturbance. This is because the Sq variations are of opposite sign at the two observatories whereas the disturbance variations, having the same sign and roughly equal magnitudes, almost cancel each other in the difference. As a consequence, data from all days may be used

to study Sq, rather than from quiet days alone, and this results in improved time resolution so that Sq is easily examined from month to month and the seasonal variation of Sq is clearly delineated.

Data from pairs of observatories in both the northern and southern hemispheres have been examined and it is found that as well as an annual variation of the range of Sq, with a maximum in local summer and a minimum in local winter,

there is also a substantial semi-annual variation with equinoxial maxima. There is no corresponding semi-annual variation in the electrical conductivity of the E-region of the ionosphere. It is suggested that the semi-annual variation in Sq is driven by the observed semi-annual variation in the thermospheric neutral temperature (though the origin of the temperature variation is not known). The differencing procedure also yields a clear delineation of the solar cycle variation of Sq.

There is a clear annual variation of several gammas in the

midnight values of  $H$  (previously reported by other workers). This variation appears to exist at all hours and is not restricted to midnight hours. It is not an Sq variation (i.e. is not of ionospheric origin) but appears to be due to an annual north-south motion of the ring current arising from the inclination of earth's rotation axis with respect to the plane of the ecliptic. It is concluded that this non-Sq variation does not affect the validity of taking midnight values as the baseline from which to measure Sq.