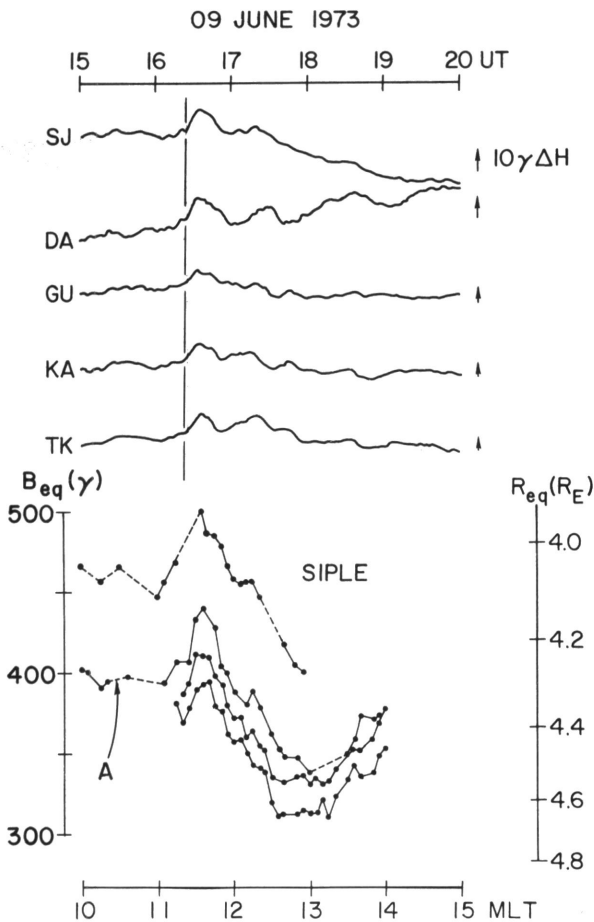


# Quiet-time circulation of the magnetospheric plasma

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**Figure 2.** Whistler detection of the effects of a sudden impulse. Above are transcriptions of the horizontal magnetic component at several medium-latitude stations (made available by World Data Center A). Below are results from whistlers recorded at Siple.

inward drift velocity of the path is 500 meters per second in the equatorial plane, and the corresponding induced electric field is 0.2 millivolts per meter.

Spatial coverage and time resolution can be greatly improved in future studies. The versatile very low frequency (VLF) transmitter at Siple can be used in these studies to complement natural whistlers. Such studies hopefully will help to better understand the dynamics of solar wind-magnetosphere interactions.

This research was supported by National Science Foundation grants GV-28840, DES 74-20084, and GA-32590.

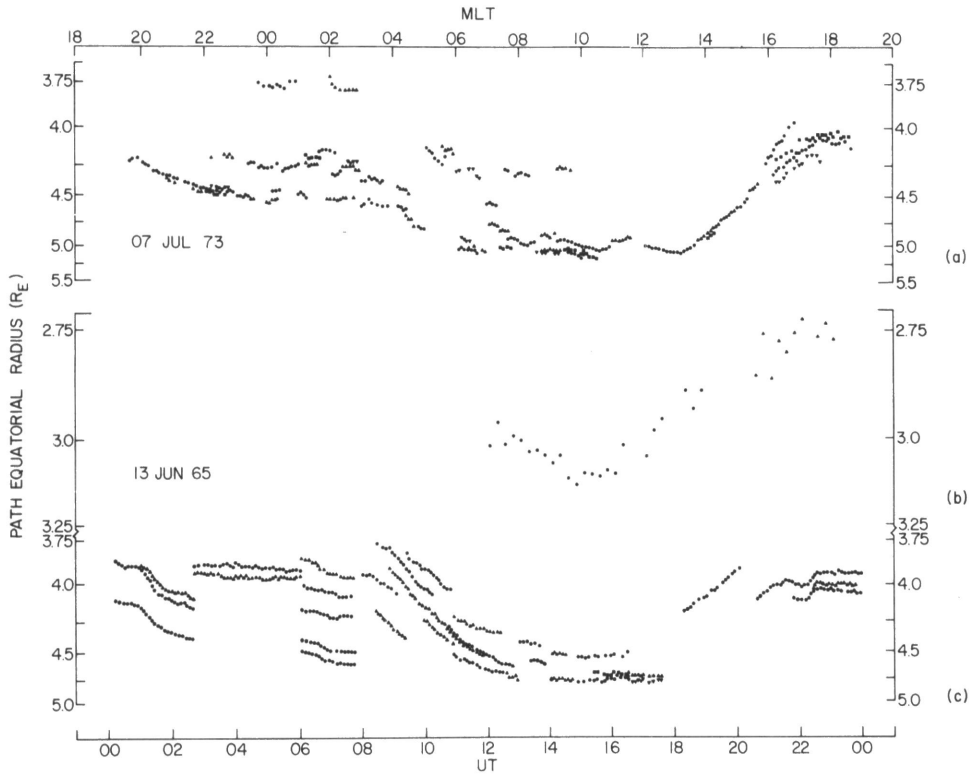
### Reference

Carpenter, D. L., and N. Seely. 1975. Quiet-time circulation of the magnetospheric plasma. *Antarctic Journal of the U.S.*, X(5): 217-218.

The quiet-time circulation of the plasma within the earth's dipole-like inner magnetosphere is a subject of major interest in solar-terrestrial physics. The plasma in this region is organized by the earth's magnetic field into tube-like volumes that follow the magnetic field geometry between conjugate hemispheres and extend several earth radii into space from magnetic latitudes of  $50^\circ$  to  $65^\circ$ . These volumes then drift across the magnetic field lines, preserving their field-aligned form but expanding, for example, as they move into regions of weaker (typically more distant) magnetic field. During magnetically disturbed times, this circulation is apparently dominated (at least beyond a geocentric distance of about three equatorial earth radii) by processes occurring in the magnetosphere. During quiet times, however, it is believed that the principle plasma motions are caused by a "dynamo" process originating at relatively low altitudes ( $\approx 100$  to 200 kilometers). This process involves motion of neutral air across the earth's magnetic field lines under the influence of solar heating as well as that of solar and lunar gravitation. Detailed knowledge of the quiet-time magnetospheric circulation is needed to evaluate the importance of the dynamo process. A quiet-time reference description is needed in studies of the important disturbed regimes of magnetospheric "weather."

Theoretical predictions of the circulation have been hindered by the fact that models of the worldwide motions of the neutral air associated ionized region at  $\sim 100$  to 200 kilometers in altitude are difficult to construct. Further, it is difficult to make quantitative measurements from satellites of the slow motions of the plasma, or to use ground-based probing techniques for study of slow motions as they occur at 100- to 200-kilometer altitudes. These difficulties are usually associated with limits on system sensitivity or with problems of interaction between a satellite and the medium.

Whistlers provide an excellent opportunity to study quiet-time magnetospheric circulation because the signals act as natural probes of magnetospheric field lines. At Siple Station, whistlers occur in great enough numbers to permit accurate tracking of the slow motions of field-aligned ducts, or



Variations with time of whistler path equatorial radius during two exceptionally quiet 24-hour periods. Each closely spaced sequence of a particular symbol represents a particular whistler path.

enhancements of ionization, in which whistler energy propagates from hemisphere to hemisphere. At present, the whistler method is only able to detect the component of plasma motion in the radial (meridional) direction; direction-finding techniques are being developed to provide longitude as well as latitude of a duct. The patterns that have been deduced, however, are detailed enough to yield substantial information on what appears to be the worldwide flow structure. It has been found, for example, that plasma motions are largest on the day and dawn sides of the earth; in contrast, motions induced by the solar wind during disturbed times tend to be largest at night and near dawn and dusk. Because of the many days and months of observing time available in the whistler method, it is possible to select data acquired during relatively rare periods of prolonged quiet. The results obtained during such periods show subfeatures of the quiet-time drifts that have not been detected by probing techniques that are more limited in terms of spatial and temporal coverage.

The figure shows plots of equatorial radii of whistler paths tracked during exceptionally quiet 24-hour periods on 7 July 1973 and 13 June 1965 from, respectively, Siple Station and Siple's predecessor, Eights Station. Path equatorial radius is

plotted, increasing downward, versus universal time (below) and magnetic local time (above). The data, while representing slightly different sampling and measuring techniques (less frequent sampling at Siple), show a generally repeated trend of fast outward motion near local dawn (see upper scale) and an inward drift in the afternoon.

We do not yet know to what extent the motions observed are of dynamo origin and to what extent the solar wind influence is present. Some features of the data suggest that a dynamo process is dominant on the quietest days. Further studies should clarify these relationships and permit publication of an empirical model of quiet-time magnetosphere flow at equatorial distances of several earth radii.

This research was supported by National Science Foundation grants GV-41369 and DES 75-07707.

More detailed versions of the two preceding articles, including references, are in press (*Journal of Geophysical Research*).