Aeronomy and astrophysics

Magnetic impulse events measured at Pc 1 frequencies and at multiple sites

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Magnetic impulse events (MIEs) are impulsive fluctuations in the Earth's ambient magnetic field; these fluctuations have periods that range from a few seconds to several hundred seconds and have durations that are on the order of the period. At present, the designation *MIE* refers to relatively isolated events, although in reality, during periods of frequent magnetic activity, a large number of MIEs may constitute the activity. The ground signal is created by the closure in the ionosphere of those magnetospheric currents that produce the large-scale magnetospheric disturbance. Figure 1 gives an example of an MIE seen at Sondre Stromfjord, Greenland, which is a high-latitude site at the same geomagnetic latitude as South Pole but 2 hours ahead of South Pole in local time. The high frequency (about 0.5 hertz) Pc 1 waves associated with the MIE are evident. In an analysis of several hundred MIE, these Pc 1 waves are present about 70 percent of the time.

It is generally understood that the high-frequency Pc 1 magnetic pulsations are generated as a result of ion resonance interactions occurring in the magnetosphere, presumably in or near the equatorial plane. Wave energy will be derived from anisotropic ion distributions as they move toward isotropy and stability. This resonance interaction can represent a loss of ions trapped in the Earth's magnetic field or ions newly injected on high-latitude field lines by boundary-layer dynamics. Because the Pc 1 waves are of sufficiently short wavelength, they travel in the magnetosphere as wave packets instead of representing a resonance of the large-scale field. In such a mode of propagation, the Pc 1 waves can be used as probes of the topology of the geomagnetic field. Their resonant generation by ions and modification of their propagation by cold ion populations indirectly provide a study of these particles.

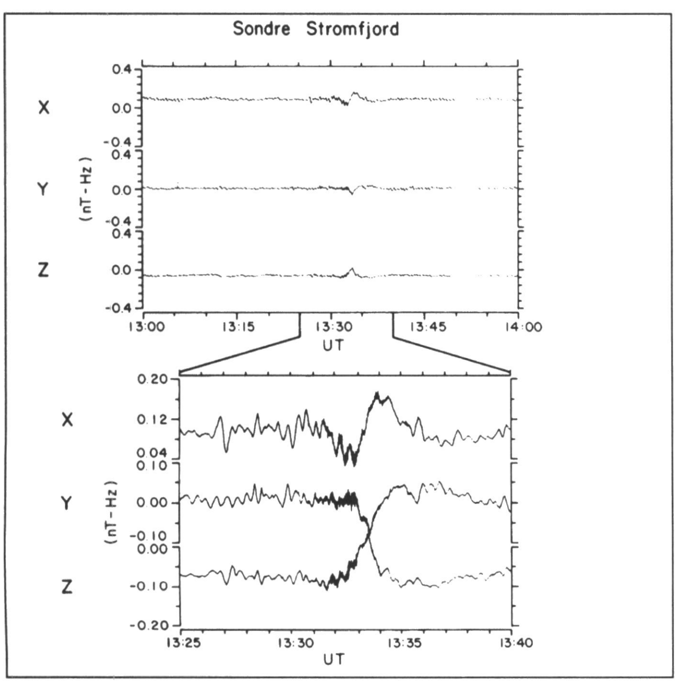

Figure 1. Broadband data (with scale enhancement) showing an MIE and accompanying Pc 1 pulsations. (nT-Hz denotes nanotesla-hertz.

A current study, which correlates ground, high-latitude Pc 1 waves associated with MIE and the data collected by the AMPTE-CCE satellite in the equatorial plane, finds that when the satellite is at apogee within an hour of the time sector sampled by the ground instruments, the high-frequency Pc 1 signals are identical. This result indeed places the origin of the high-frequency waves in the equatorial plane. They presumably result from the perturbation field of the MIE.

We have identified and analyzed some 300 Sondre Stromfjord and South Pole MIE events, including the events identified and studied by Lanzerotti et al. (1991) in 1985 and 1986. Lanzerotti et al. (1991) found that about half of their South Pole events were accompanied by conjugate events at Iqaluit, Northwest Territories, Canada. Surprisingly, our study using South Pole and Sondre Stromfjord, which are not nominally conjugate, found a very similar ratio, but only about half the time when Sondre Stromfjord measured an MIE coincident with South Pole did Iqaluit see an MIE. This result, which is possibly telling us something about the duration, motion, and scale size of these events, needs much further study. When an opposite hemisphere event occurs, the events are not simultaneous between South Pole and Sondre Stromfjord, quite likely because their local times differ by almost 2 hours. An example of an MIE measured at Iqaluit and Sondre Stromfjord (in the same hemisphere but separated in local time by 2 hours) is given in figure 2. For this event, the Iqaluit MIE was measured earlier than the MIE at Sondre Stromfjord. In a quick study of this nonsimultaneity between opposite hemisphere MIEs using April and May 1986 data, we have found an interesting result given in figure 3 (solid dots). If the MIE

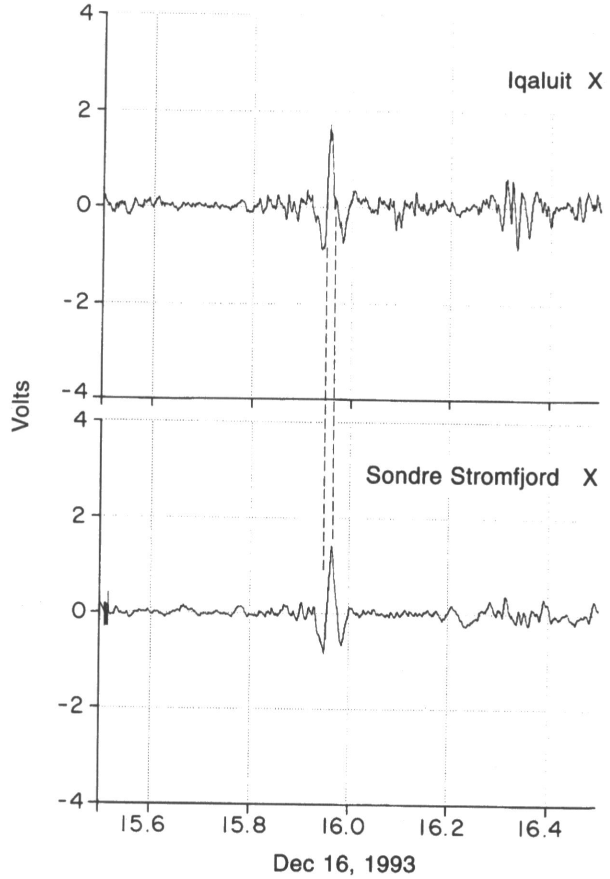

Figure 2. MIE events measured at Iqaluit and Sondre Stromfjord illustrating the timing difference between the two Northern Hemisphere stations.

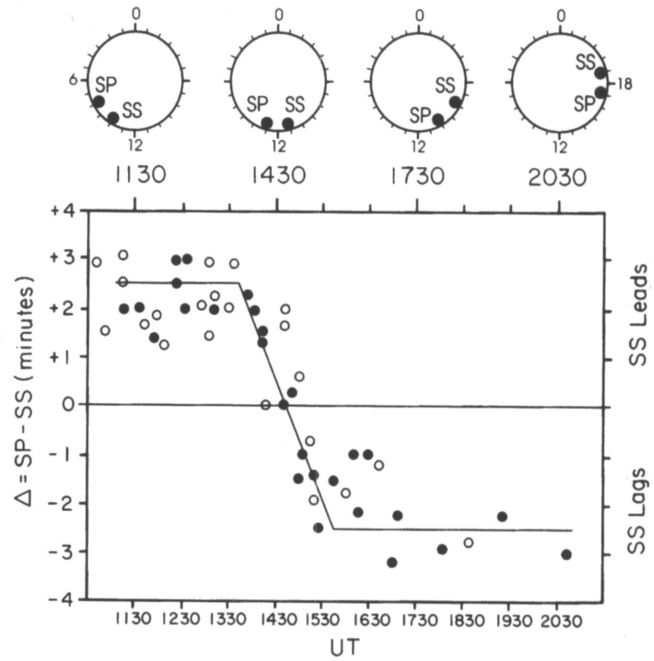

Figure 3. Timing analysis of South Pole (SP) and Sondre Stromfjord (SS) MIE events (solid dots) and Iqaluit and Sondre Stromfjord MIE events (open circles).

occurred at 1430 universal time (UT), when Sondre Stromfjord is 1 hour after local noon and South Pole is 1 hour before local noon, the events are simultaneous. On the other hand, if the UT of the MIE is before 1430, then South Pole lags the Sondre Stromfjord event, whereas the opposite is true if the MIE UT is greater than 1430. Using 1993–1994 data from Iqaluit and Sondre Stromfjord, a similar analysis gives the same result, which is indicated by the open circles in figure 3. These limited analyses suggest that the MIEs are initiated close to the subsolar point and then propagate down both flanks of the magnetosphere, with a speed of about 8 kilometers per second, somewhat higher than the speed Friis-Christensen et al. (1988) use in their modeling of the traveling vortices. Except that the analysis of Lanzerotti et al. (1991) gives no change in MIE polarization as one crosses noon, this result begs a Kelvin-Helmholz model for the MIE.

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References

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