Reference

Morozumi, H. M. 1965. Diurnal variation of aurora zone geophysical disturbances. *Report of Ionosphere and Space Research in Japan,* 19(3): 286-298.

Midlatitude optical observations from Siple Station, Antarctica, and Roberval, Quebec

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Siple Station is a unique location for the study of magnetospheric wave phenomena. There are several experiments at Siple to study various aspects of wave particles and related phenomena. The Lockheed Palo Alto Research Laboratories have been involved in optical diagnostics of particles that precipitate from various regions of the magnetosphere. At higher magnetic latitudes than Siple the intense fluxes of these particles cause visible auroras. At lower latitudes, there are also interesting phenomena that have very weak but detectable optical signatures. These signatures were monitored at Siple throughout the 1974 austral winter.

In the Siple vicinity, the magnetospheric cold background plasma undergoes an abrupt reduction in number density. This is known as the plasmapause. The locations of these regions are monitored by very low frequency (VLF) techniques developed by Stanford University. Following a period of magnetic activity, the enhanced energetic particles are thought to interact with the cold plasma-generating waves. These waves are also thought to cause a type of optical emissions known as stable auroral red (SAR) arcs. Simultaneous monitoring of VLF and optical data permits investigation of the relative location of red arcs and the plasmapause. Preliminary analysis of the Siple 1974 data shows that in a sample case the SAR arc occurs just inside the high density plasma (i.e., equatorward of the plasmapause).

A promising technique is to probe the magnetosphere by means of the artificial injection of waves. The Stanford University transmitter at Siple has been successful in exciting many interesting magnetospheric wave modes. Several experiments are planned to investigate the effectiveness of these excited waves in perturbing high energy particles and causing them to precipitate in the atmosphere. In one of these the precipitating particles would be detected optically by measuring the emitted (auroral) light. In the first of a series of experiments in 1975 we are deploying a special high-sensitivity instrument at Roberval, Quebec (Canada), the magnetic conjugate of Siple. In the experiment, the Siple transmitter produces a pulsed wave train. This wave train interacts with the particles. The optical detector is switched on, after a slight delay following the transmitter pulse, to receive the optical signatures of the transmitter generated wave. The optical signals are added for many transmitter pulses to produce signal-to-noise ratio enhancement. This should bring us closer to understanding production mechanisms in both natural and artificial phenomena, and eventually to artificial control of these phenomena.

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Cosmic ray intensity variations

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The fact that transient intensity decreases are observed in the polar regions implies that galactic cosmic rays are modulated by interplanetary plasmas of solar origin. Generally, these decreases are ascribed to some sort of magnetic barrier moving outward from the sun and sweeping the incoming cosmic radiation. Several modulation mechanisms involving different magnetic configurations have been proposed. Our studies, in which the antarctic observations are absolutely crucial (Nagashima *et al.,* 1968; Duggal and Pomerantz, 1970, 1971; Pomerantz and Duggal, 1972), have established that north-south anisotropy is an integral feature of every cosmic ray storm, and it is clear that this phenomenon is of key significance in theoretical studies of the relevant plasma dynamics.

We have investigated cosmic ray storms in a search for correlations between the north-south asymmetry and solar and space data. The most recent, and successful, attempt has focussed on the relationship between the direction of north-south anisotropy and the inclination of associated shock

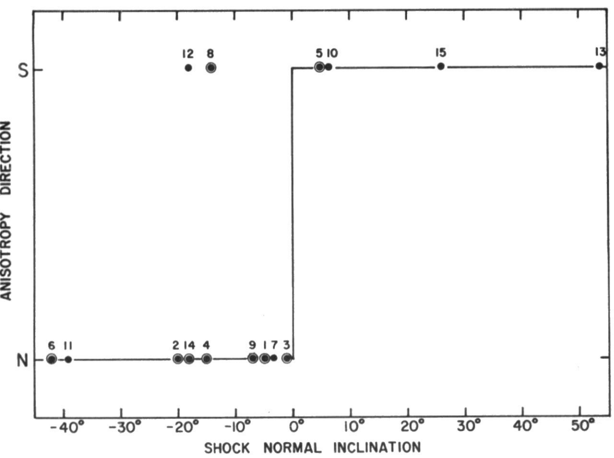
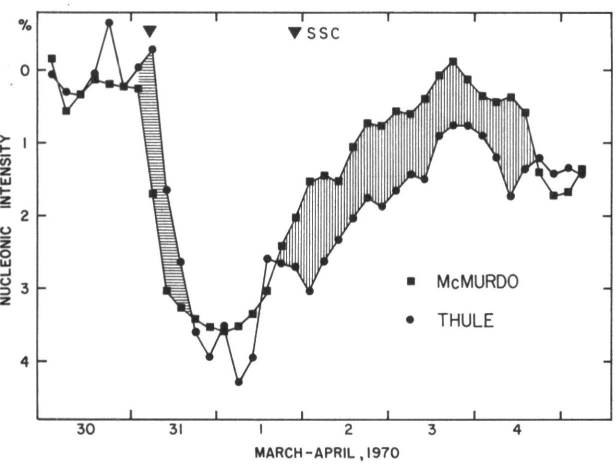


Figure 1. Graphical representation of the statistical correlation between the direction of north-south anisotropy and the inclination of the shock normal with respect to the ecliptic for 15 epochs. The shock parameters for the circled points are regarded as relatively more reliable.

Figure 2. A phase inversion event, in which the sense of the north-south asymmetry changes abruptly. The associated storm-sudden commencements denoting the arrival at earth of interplanetary shock waves are indicated.



waves with respect to the ecliptic plane. For each cosmic ray storm that coincided with interplanetary shocks for which the parameters had been well defined, the north-south anisotropy was evaluated using an analytical procedure that we have developed for this purpose. The results are summarized in figure 1, where the sense of north-south anisotropy (that is, the direction from which the larger cosmic ray flux arrives) is plotted as a function of the inclination of the associated shock wave (Chao and Lepping, 1974). It is clear that, in most cases, a north-directed anisotropy is associated with a shock arriving from south of the ecliptic, and vice versa. Further, a similar analysis of the same events has established that the north-south anisotropy is unrelated to the heliolatitude of the associated solar flare, in accordance with our earlier conclusion (Duggal and Pomerantz, 1970).

In light of this new result, we are attempting to understand the highly complex and interesting events during which the sense of the north-south anisotropy changes its direction abruptly (Pomerantz and Duggal, 1972). Figure 2 shows an example of such a phase inversion event. In this storm of March 1970, the axial anisotropy produces lower intensity at the arctic station Thule than at McMurdo during the onset phase, and the reverse effect during the recovery phase. It is striking that the change in direction is associated with a geomagnetic sudden storm commencement. This suggests that the reversal of the phase in the cosmic ray anisotropy perpendicular to the plane of the ecliptic is probably attributable to the effects of the arrival of the additional interplanetary shock wave.

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References

Chao, J. K., and R. P. Lepping. 1974. A correlative study of SSC's, interplanetary shocks, and solar activity. *Journal of Geophysical Research,* 79: 1799.

Duggal, S. P., and M. A. Pomerantz. 1970. Transient north-south asymmetries of cosmic radiation. *Acta Physica Hungaricae* (supplement 2), 29: 351.

Duggal, S. P., and M. A. Pomerantz. 1971. Cosmic ray anisotropies perpendicular to the equatorial plane. 12th International Conference on Cosmic Rays. *Proceedings,* 2: 723.

Duggal, S. P., and M. A. Pomerantz. In press. Interplanetary shock waves and the north-south anisotropy in cosmic rays. 14th International Conference on Cosmic Rays. *Proceedings,* MG 7-10.

Nagashima, K., S. P. Duggal, and M. A. Pomerantz. 1968. Cosmic ray anisotropy in three-dimensional space. *Planetary and Space Science,* 16: 29.

Pomerantz, M. A., and S. P. Duggal. 1972. North-south anisotropies in the cosmic radiation. *Journal of Geophysical Research,* 77: 263.

Auroras at the South Pole

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An important subject in magnetospheric physics during the last several years has been the role of