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Notes

On the relationship between the magnetic field variations and meteor showers

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The magnetic *Z* field variation for the period 9-25 Dec. 1996, recorded at the stations Sodankyla (67.37°N, 26.63°E), Tromso (69.67°N, 18.95°E), Abisko (68.30°N, 18.82°E), and Hornsund (77.00°N, 26.63°E) (http://swdcwww.kugi.kyoto-u.ac.jp) are compared with the Geminids (12-15 Dec. 1996) and Ursids (20-23 Dec. 1996) showers as reported by Yrjola (http://www.rmob.org). The correlation studies show that it is difficult to prove conclusively that the magnetic field fluctuations observed at Sodankyla are due to the dust particles in the meteor showers and the associated changes in the ionospheric currents due to them.

Keywords: Magnetic field, Meteor showers, Ionospheric current

The E- region dynamo currents in the ionosphere are correlated especially with daily variations in magnetograms. These currents are carried by electrons whose origin needs investigation. From the analysis of magnetic field variations in the auroral region, it is hinted that the ionization by solar radiations is the main source for these electrons[1] rather than the bombardments of high energy electrons from the magnetosphere.

The collisional fragmentations of debris from comets are known to release the amount of material between 0.25 tons/sec and 20 tons/sec. The input from these sources into the earth's atmosphere is $\approx 10^4$ tons/yr. The meteor deposition of dust and smoke particles is maximum[2,3] in the height region 80-90 km. Dusts due to atmospheric friction, melt and re-form as spherical objects. The particle sizes vary as r_o^{-4} (r_o being the radius in microns) and their masses are in the range 10^{-14}-10^{-6} gm. Asteroids, comets and comet-dust-tails are the other sources. The composition of interplanetary dust is mainly due to Fe, Mg, C and S. Therefore, the meteors are good sources of metallic ions Fe^+, Mg^+ and Na^+ which are seen in large numbers in the E-region[4]. Mc Neil *et al.*[5] modelled metallic ion distribution in the ionospheric heights.

Meteors can alter currents by introducing a significant ionization. If the dust particles are created, these can change currents by changing conductivities by altering collision frequencies. From the electron densities available in the E-region, the charging time scale for a micron size dust particle is in the range of milliseconds or less. Therefore, it can be assumed that the charging is instantaneous. On the whole, we can expect notable variations in currents under any or all the above effects and subsequent identifiable magnetic field variations.

We selected the station Sodankyla and the period 9-25 Dec. 1996, because the radio meteor records show a largest number for the Geminids and the Ursids meteor showers during this period over the above station. This year is also a solar quiet year. For the comparison with the data available at Sodankyla, the magnetic field *Z* variations at Tromso, Abisko and Hornsund are selected.

Figure 1 shows the hourly variations of the magnetic field values at Sodankyla (51600 nT), Abisko (52000 nT), Hornsund (53000 nT) and Tromso (51200 nT) in nano-teslas around the mean values shown in the brackets. The observed hourly values of radio meteor data are plotted at the bottom. From Fig.1, it is seen that the variations at Sodankyla are not appreciably different from those of the other three stations, especially, at the period when the meteor shower is the strongest. Figure 2 shows the meteor showers, *Z* average variations and the A_p indices. Here the peaks of magnetic field variations coincide more closely with those of A_p indices rather than of the meteor showers.

At Sodankyla, the meteor shower is large. Therefore, one expects an occurrence of a large number of dust particles at the height region around 70-90 km. These dust particles can diffuse upward. Since the diffusion time scales are large, there will be

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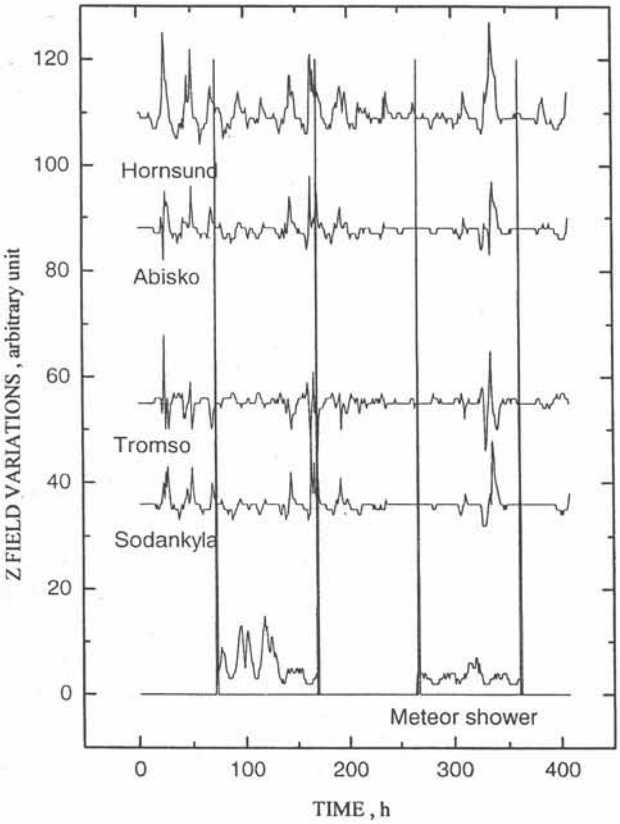

Fig. 1—Hourly variations of magnetic fields at Sodankyla, Tromso, Abisko and Hornsund. (The meteor shower is at Sodankyla)

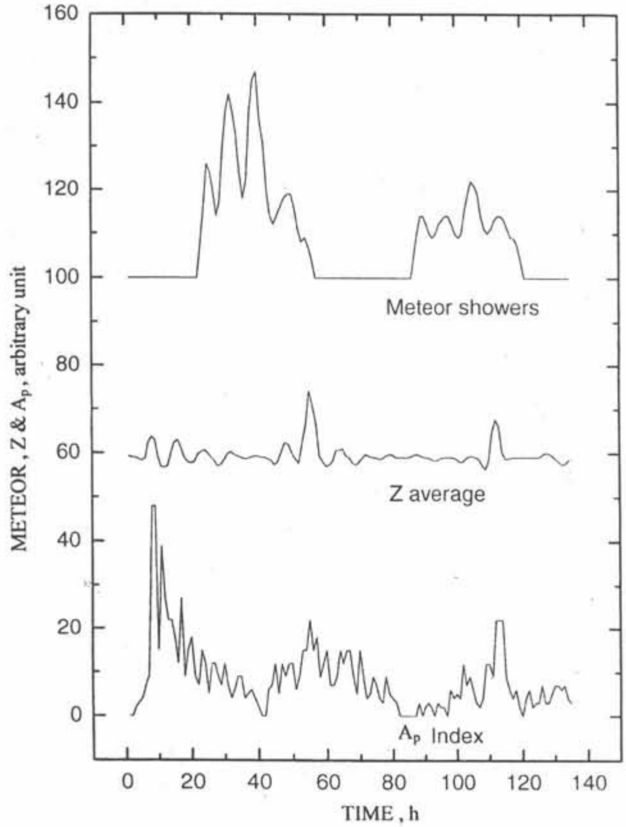

Fig. 2—Curves showing the hourly variations of Ap indices, magnetic Z values and meteor shower

a continuous variation of dust densities, which will give a broader shift, which could not be identified. The strong magnetic field variations introduced by the auroral electrojet can easily mask the weak variations by the meteor showers. Therefore, the identification of magnetic field variations with meteor showers has become difficult. It is also possible that the meteor showers considered above did not produce significant dust particles at 70-90 km heights or that they did not have significant dust particles of micron sizes.

In conclusion, with the study of Z variations of magnetic fields at Sodankyla and the meteor shower, it is not possible to identify the effects of dusts of meteoric origin on the ionospheric currents.

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