MONITORING OF GLOBAL LIGHTNING AND SPRITE ACTIVITY AT SYOWA STATION, ANTARCTICA

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ABSTRACT

Monitoring of ELF waveforms started at Syowa station, Antarctica in 2000 and at Onagawa Geomagnetic Observatory, Japan in 2001. The monitoring system consists of two-component search coil sensors with a flat response in the 1-500 Hz frequency range and a digital data recorder with a 1000-Hz sampling rate. Using the obtained data, the source locations of Schumann resonance transients related to sprite events were triangulated with high accuracy. Spectral analysis demonstrated that the total power of Schumann resonances has a distinct spectral peak around 24-27 days, suggesting a possible link between solar activity and global lightning activity.

INTRODUCTION

It is well-known that the amplitudes of the Earth-ionosphere cavity (or Schumann) resonances in the frequency range 6-60 Hz provide information on global lightning activity. Further, transient Schumann resonance signals (or Q bursts) provide information on occurrences of lightning-induced, high altitude optical glows referred to as sprites [1]. Monitoring of both background and transient Schumann resonance signals is therefore essential for investigating the primary factors that control global lightning and sprite activity. The purpose of this study is to analyze the ELF waveform data obtained in Antarctica and Japan to find out such factors.

OBSERVATIONS

Continuous monitoring of ELF waveforms started at Syowa station (69.0°S, 39.6°E), Antarctica in February 2000. The monitoring system consists of two search coil sensors with a flat response in the 1-500 Hz frequency range, oriented in the geomagnetic north-south (H) and east-west (D) direction and a digital data recorder with a 1000-Hz sampling rate. The same type of ELF monitoring system was installed at Onagawa Geomagnetic Observatory (38.4°N, 141.5°E) in April 2001. Sprite data were obtained from imaging observations in Colorado during the STEPS campaign period in July 2000 and imaging observations in Japan during the winter sprite campaign period in January-March 2002.

RESULTS

As an indicator for global lightning activity, we calculated the powers of the first three Schumann resonance (SR) modes at 8, 14, and 20 Hz for each of the H and D component magnetic field data. These SR powers showed different diurnal and seasonal variations, reflecting the latitudinal and longitudinal distributions of four major sources of global lightning activity, i.e., North American, South American, African, and Asian sources. The SR powers also showed distinct spectral peaks around periods of 4-5, 11-13 and 24-27 days. Since the 24-27 day periodic variation is close to the solar rotation period, this result suggests a possible link between solar activity and global lightning activity. On the other hand, occurrences of sprites were identified by waveforms of transient SR events and their source locations were determined from triangulation using the great circles of causative transient SR events, which are perpendicular to the polarization axes derived from H- and D-component magnetic field data.

REFERENCES

[1] M. Fullekrug, and S.C. Rising, "Excitation of the Earth-ionosphere cavity resonance by sprite-associated lightning flashes," *Geophys. Res. Lett.*, vol.27, pp.333-336, February 1998.