

Statistical Analysis and Correlation of Antenna Impedance of Electric Filed Antennas

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1. Introduction

Knowledge of the characteristics of wire antennas in space plasma used as sensors for electric field observations by scientific satellites in geospace is necessary to determine the absolute intensity and the phase of the electric field wave because the observation data about electric field are available as voltage signal. Two important characteristics are the effective length and the antenna impedance. Determination of the impedance can be especially difficult since the impedance depends on the medium surrounding the antenna, and the impedance is affected primarily by the plasma sheath created around the antenna.

2. Antenna Impedance

The instruments for measurement the antenna impedance of wire antennas onboard the scientific satellites for the electric field observation. The antenna impedance are calculated from response data obtained by impressing voltage signal to the antennas.

The impedance of the antennas onboard Geotail was measured by Tsutsui et al.[1] by using the calibration function onboard Geotail where a modulated square wave test signal was applied to the antenna elements. They found that the impedance depended mainly on the electron density and the satellite spin. The dependences of the impedance measurement on the satellite spin are caused by the fluctuation of the photoelectron emissions from the antenna surfaces.

On the other hand, the impedance onboard Akebono was measured by Hashimoto et al.[2], where the results also depended on the electron density and the satellite spin. However the photoelectrons do not play an important role in the impedance measurement, because the spin axis of Akebono always points to the sun.

3. Analysis and Results

The antenna impedance of Akebono is measured 3 times for one day. However Akebono have taken a flight for 20 years, and its measurement data are obtained enough for statistical analysis. In this study, according to the statistical analysis of measurement data of the antenna impedance on Akebono, the correlation between the antenna impedance and the altitude of Akebono (the electron density) were found.

4. References

- [1] M. Tsutsui, I. Nagano, H. Kojima, K. Hashimoto, H. Matsumoto, S. Yagitani, and T. Okada, "Measurement and analysis of antenna impedance aboard the Geotail spacecraft," *Radio Sci.*, vol.32, 1997, pp. 1101-1126.
- [2] K. Hashimoto, I. Nagano, T. Okada, M. Yamamoto, and I. Kimura, "Antenna vector impedance measurement by the EXOS-D (Akebono) very low frequency plasma wave instrument (VLF)," *Geophys. Res. Lett.*, vol.18, 1991, pp. 313-316.