Effective lengths of crossed wire antennas onboard Akebono

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ABSTRACT

The effective lengths of a dipole antenna designed to pick up low frequency electric field onboard satellite have been assumed equal to a half of its physical length. However the effective length may change under the influence of plasma sheath surrounding the antenna. To observe the electric field accurately, we must estimate the accurate effective length of the antenna in space plasmas. In this study, we evaluate the effective lengths of crossed wire antennas onboard Akebono satellite by using in-situ observations of OMEGA signals. The results show that the effective lengths are almost half of their physical lengths.

INTRODUCTION

Akebono was launched in 1989 to observe particles and waves related to aurora accurately, and disclose development mechanism of aurora and behavior of plasmas in the magnetosphere. The VLF instruments onboard Akebono are designed to observe VLF/ELF plasma waves and to determine wave normal direction of the waves. Two pairs of wire dipole antennas (tip-to-tip 60[m]) crossing each other are used for the VLF electric field, and triaxal loop antennas and search coils are used for the VLF magnetic field[1]. The absolute intensities of the electromagnetic fields measured by these antennas are calculated from their induced voltages and effective lengths. The sensitivity of the sensors for magnetic field in space plasma is the same as those in free space. However the effective lengths of the wire antennas in space are difficult to be estimated because of the plasma sheath surrounding the antennas, and a few investigations about this problem have been made. In the previous studies, the effective lengths of the two dipole antennas have been assumed the same and as 30m, a half of their tip-to-tip length. In this study, we evaluate the effective length of each dipole antenna separately, which is very important to determine the wave normal direction and the Poynting flux.

CALCULATION PROCEDURE

We evaluate the effective lengths by making use of OMEGA navigation signals ($\sim$10kHz) observed as the whistler mode waves in the magnetosphere. The frequency and transmitting sequence of OMEGA signals are known. We obtain electron cyclotron frequency from MGF and the plasma frequency from PWS. The k-vectors of OMEGA signals are calculated from only the wave magnetic field under a cold plasma approximation of whistler mode propagation. For an OMEGA signal, we can calculate its electric field components theoretically from its observed magnetic field components, k-vectors and plasma parameters using the dispersion equation of the cold plasma and Maxwell's equations[2]. Finally, by comparing such calculated values with the actually observed electric fields that have been calibrated using the assumed effective length, we can determine the effective lengths of each of the two dipole antennas separately.

RESULTS

We calculate effective lengths of the two dipole antennas separately by using Australian OMEGA signals (10.2kHz) observed along the two paths, Dec. 14, 1989, and Aug. 3, 1990. Results show that each of their average effective lengths is almost a half of the actual length (60m) of the dipole antennas, 30.8m and 31.5m for x- and y-antennas for the data of Dec. 14, 1989, and 31.4m for both antennas for Aug. 3, 1990. We will present the results and discuss which parameters affect the estimation of the effective length.

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