How to use conversion matrixes for Akebono/PWS/PY data

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1. Introduction

Due to the spacecraft spin (7.5 rpm), the directions of two electric field components (E_1 and E_2) and three magnetic filed components ($B_{1'}$, $B_{2'}$, and $B_{3'}$) provided in ak_h1_pws_py_yyyymmdd_v01.cdf change depending on time. So, some matrixes for conversion from antenna's coordinate system to equatorial coordinate system are also provided in the same data file. How to obtain two electric field components in equatorial coordinate system (E_x and E_y) is described in Section 2. How to obtain three magnetic field components in equatorial coordinate system (B_x, B_y, and B_z) is described in Section 3.

2. How to obtain two electric field components in equatorial coordinate system

In CDF file, you will find zvar named "MatE_SC" with 4 components, and zvar named "MatSC_EQ" with 9 components. From these variables, you can obtain the following two conversion matrixes:

$$M_{E-SC} = \begin{bmatrix} \mathrm{MatE\_SC}[0] & \mathrm{MatE\_SC}[1] & 0 \\ \mathrm{MatE\_SC}[2] & \mathrm{MatE\_SC}[3] & 0 \\ 0 & 0 & 1 \end{bmatrix} \tag{2.1}$$

$$M_{SC-EQ} = \begin{bmatrix} \mathrm{MatSC\_EQ}[0] & \mathrm{MatSC\_EQ}[1] & \mathrm{MatSC\_EQ}[2] \\ \mathrm{MatSC\_EQ}[3] & \mathrm{MatSC\_EQ}[4] & \mathrm{MatSC\_EQ}[5] \\ \mathrm{MatSC\_EQ}[6] & \mathrm{MatSC\_EQ}[7] & \mathrm{MatSC\_EQ}[8] \end{bmatrix} \tag{2.2}$$

Then, two electric field components in equatorial coordinate system (E_x and E_y) can be obtained as follows:

$$\begin{bmatrix} E_x \\ E_y \\ 0 \end{bmatrix} = M_{SC-EQ} M_{E-SC} \begin{bmatrix} E_1 \\ E_2 \\ 0 \end{bmatrix} \tag{2.3}$$

3. How to obtain three magnetic field components in equatorial coordinate system

In CDF file, you will find zvar named "MatB_SC" with 9 components, and zvar named "MatSC_EQ" with 9 components. From these variables, you can obtain the following two conversion matrixes:

$$M_{B-SC} = \begin{bmatrix} \text{MatB\_SC}[0] & \text{MatB\_SC}[1] & \text{MatB\_SC}[2] \\ \text{MatB\_SC}[3] & \text{MatB\_SC}[4] & \text{MatB\_SC}[5] \\ \text{MatB\_SC}[6] & \text{MatB\_SC}[7] & \text{MatB\_SC}[8] \end{bmatrix} \tag{3.1}$$

$$M_{SC-EQ} = \begin{bmatrix} \text{MatSC\_EQ}[0] & \text{MatSC\_EQ}[1] & \text{MatSC\_EQ}[2] \\ \text{MatSC\_EQ}[3] & \text{MatSC\_EQ}[4] & \text{MatSC\_EQ}[5] \\ \text{MatSC\_EQ}[6] & \text{MatSC\_EQ}[7] & \text{MatSC\_EQ}[8] \end{bmatrix} \tag{3.2}$$

Then, three magnetic field components in equatorial coordinate system (B_x, B_y and B_z) can be obtained as follows:

$$\begin{bmatrix} B_x \\ B_y \\ B_z \end{bmatrix} = M_{SC-EQ} M_{B-SC} \begin{bmatrix} B_{1'} \\ B_{2'} \\ B_{3'} \end{bmatrix} \tag{3.3}$$