NATURE OF LARGE-SCALE SOLAR MAGNETIC FIELD AND COMPLEXITY OF HCS AS OBSERVED IN INTERPLANETARY PLASMA

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1. INTRODUCTION

The properties of the interplanetary plasma and magnetic field near 1 AU is determined by the nature of large-scale solar magnetic field and the associated structure of the heliospheric current sheet (HCS). Magnetic multipoles often present near the solar equator affect the solar wind plasma and magnetic field (IMF) near earth's orbit. The observation of four or more IMF sectors per solar rotation and the north-south asymmetry in the HCS are observational manifestations of the influence of solar magnetic multipoles, especially the quadrupole on the interplanetary medium (Schultz, 1973; Girish and Nayar, 1988). The solar wind plasma is known to be organised around the HCS. In this work, we have investigated the possibility of inferring i) the relative dipolar and quadrupolar heliomagnetic contributions to the HCS geometry from the observation of four sector IMF structure near earth and ii) the properties of the north-south asymmetry in HCS geometry about the heliographic equator from IMF and solar wind observations near 1 AU.

2. DATA ANALYSIS

a) Annual number of Bartel's rotations where four sector structure are observed near earth is determined from the IMF polarity data for the period 1947-1985. It is assumed that the HCS geometry near 1 AU can be approximated by

$$\theta = R_1 \operatorname{Sin} \phi + R_2 \operatorname{Sin} (2\phi - \delta) \quad (1)$$

Where R_1 and R_2 are the solar magnetic dipolar and quadrupolar contributions to the HCS, θ and ϕ are the heliographic latitude and longitude of the HCS and δ is the phase lag between the maxima of the heliomagnetic dipolar and quadrupolar moments. Fourier analysing the HCS data obtained from K-corona observations or potential field modelling (Korzov, 1982; Hoeksema and Scherrer, 1986), the yearly average R_2/R_1 defined by equation (1) is determined for the period 1971-1985.

b) The asymmetry parameters of the HCS, θ_T (transition lattitude

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of reversal of dominant polarity of IMF near 1 AU) and Δ (the asymmetry in the heliolatitudinal extension of HCS in opposite heliohemispheres) are obtained from the observations of IMF and high speed streams near 1 AU between 1971 and 1985. If L_n and L_s correspond to yearly average width of IMF sectors observed near earth with magnetic polarity identical to solar north pole and south pole respectively, we have for $L_n > L_s$, $\theta_T < 0$ and for $L_n < L_s$, $\theta_T > 0$. Using this concept, yearly mean sign of θ_T is inferred from IMF data for the period 1971-1985. Similarly if V_n and V_s correspond to the yearly average amplitude (Velocity maxima) of corotating high speed streams observed near 1 AU with a magnetic polarity identical to solar north pole and south pole respectively, then we have for $V_n > V_s$, Δ is negative and for $V_n < V_s$, Δ is positive. We have determined V_n and V_s and hence the sign of Δ for the years 1974-1976, 1978 and 1982 where there is a good coverage of solar wind plasma data and reported heliomagneic latitudinal organisation of solar wind velocity (Mavromichalaki et al, 1988, Newkirk and Fisk, 1985).

3. RESULTS AND DISCUSSION

i) The variation of the annual occurrences of four sector IMF near earth correlates well with the change in average (R_2/R_1) determined from HCS data. This indicates that one can infer the relative solar magnetic dipolar and quadrupolar contributions to the HCS geometry from IMF data.

ii) The yearly average sign of asymmetry parameter θ_T of HCS determined from IMF data agree well with the same determined using HCS data (Girish and Nayar, 1989) during 1971-1985. The yearly average sign of the asymmetry parameter Δ determined from solar wind velocity data agree well with the same determined from HCS data. These results indicates that the interplanetary plasma and magnetic field data can be used to infer the shape of heliospheric current sheet geometry and the related multipolar solar magnetic field. Since the conditions of interplanetary magnetic field and high speed streams can be inferred using geomagnetic data, one can infer the long term changes in the nature of the HCS and solar magnetic field from geomagnetic activity.

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