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Solar plasma acceleration in the corona

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Abstract. The paper presents a simple model for backprojection of solar wind velocity measurements by IPS method to the point of origin in the corona. Using this model solar plasma acceleration in the inner heliosphere is estimated.

1. Introduction

Radio waves coming from a distant, compact radio source, are plane waves before entering the interplanetary medium (IPM). As IPM contains randomly distributed irregularities, the plane radio waves get randomly phase modulated in this medium. The randomly phase modulated waves travel towards the observer and produce random intensity variations. This random intensity variation is termed as interplanetary scintillation. As plasma irregularities in IPM are moving the stationary radio telescope scans an irregular intensity pattern. Dennison and Hewish (1967) devised a method of estimating solar plasma velocity using three radio telescopes situated at the vertices of a triangle. The method has been also used by various groups around the globe (Coles & Kaufman 1978; Kojima & Kakinuma 1990 and ref. therein). Later Manoharan and Ananthakrishnan (1990) devised a method of estimating solar wind velocity using IPS observations of one station. This method has also been considerably used by several workers (Manoharan et al. 1995, Alurkar et al. 1993). These authors, for backprojection of observed solar wind velocity assumed that solar wind velocity undergoes no variations from its origin to the point of detection in IPM. This was mainly due to (1) Distance-velocity curve was not very well established. Even to date this problem is not solved completely. (2) The acceleration process may be different for low and high speed flows. And (3) When enhanced density perturbations are present along the line of sight to the radio source, the conventional point of maximum scattering on the line of sight will not be valid for the back projections. This paper describes a slightly improved version for backprojection and presents some typical results.

2. The model and results

The schematic diagram of the present model of backprojection of solar wind velocity is shown in Fig.(1).

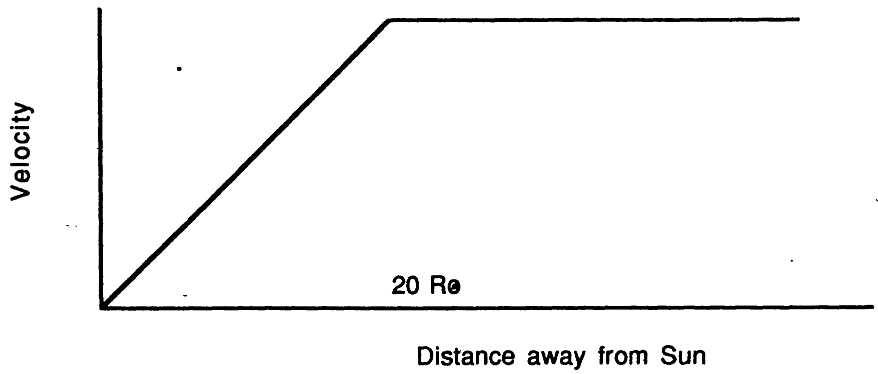

Figure 1. Model of solar wind velocity variation.

Here, the heliosphere is divided into two regions; (1) The region of uniform acceleration of solar wind and (2) The region of constant solar wind velocity. The dividing boundary is taken to be $20R_{\odot}$. Using the model and solar wind velocity data for the year 1987 (Kojima & Kakinuma, 1987), the data is backprojected and solar plasma acceleration in the corona is estimated. Thus derived solar plasma acceleration values are presented in the form of contour map (Fig.2) for Carrington rotation 1789.

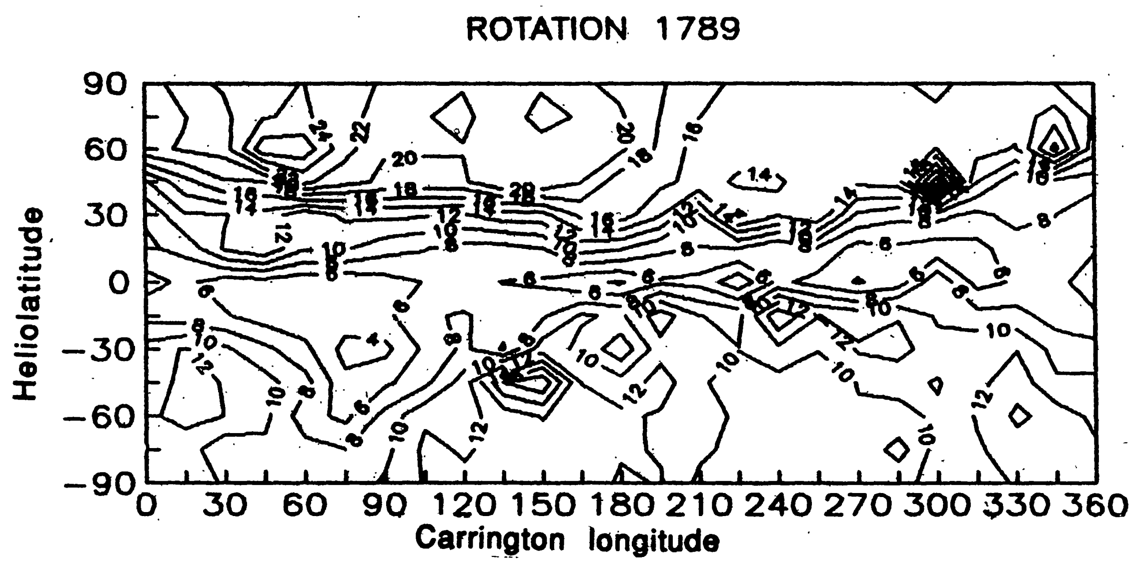

Figure 2. Contour map of solar plasma acceleration.

It is clear from Fig.2 that the acceleration is least near the equator (4-6 m/sec^2) and increases at higher latitudes (18-24 m/sec^2) on both sides of solar equator. Higher acceleration values may have slightly larger errors, because of the limitations of this analysis, however, the fact that the acceleration is higher at high latitudes than that near the equator will still hold.

The limitation of this model is arbitrary dividing boundary at 20 $R_{\odot}$. In fact not many observations are available close to the Sun to have more realistic boundary value. The model can be improved if more observations are available at microwave frequency. The IPS measurements at microwave will provide detailed informations regarding the inner heliosphere.

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