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Reconstruction of the Sector Structure of the Interplanetary Magnetic Field by Geomagnetic Station Data

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Abstract—This paper describes a new method for reconstructing the polarity of the interplanetary magnetic field. The technique is based on the Svalgaard–Mansurov effect. We ause geomagnetic data of high-latitude stations with a long observation period, including the presatellite era. This method is designed to improve the quality and accuracy of reconstructed polarity, complementing the results of previous methods of Svalgaard (1975) and Vennerström et al. (2001). For the large presatellite period from 1926, the accuracy of the method is estimated to be around 89% of overlaps with the interplanetary magnetic field polarity determined from satellite data.

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1. INTRODUCTION

It is known that the interplanetary magnetic field (IMF) of different polarity (from or to the Sun) causes opposite variations in the geomagnetic field at near-polar stations. This is the so-called Svalgaard–Mansurov effect discovered by Svalgaard (1968) and Mansurov (1969). It was soon found (Friis-Christensen and Wilhjelm, 1975) that these variations are caused by the DPY ionospheric current system, located near cusp latitudes (~75–80°). This made it possible to obtain data (with some error) on the IMF polarity without the use of satellites. The first techniques for the reconstruction of polarity were developed by the authors of that discovery (Svalgaard, 1975; Mansurov, 1984). The Svalgaard catalog is of great scientific interest because it covers an earlier period, operating with data from 1926 (through the use of the Godhavn subauroral station in the technique). At the same time, as noted in (Russell and Rosenberg, 1974), the results of polarity reconstructions by the Svalgaard technique depend on the level of geomagnetic activity: more disturbed days were predominantly specified as days of negative polarity. Also taking into consideration that the accuracy of these results is sufficiently high (around 82% of overlaps according to (Wilcox et al., 1975)), the Svalgaard catalog requires verification. Another catalog of the IMF polarity over a long presatellite period was presented in (Vennerström et al., 2001). These results have a relatively high accuracy and are independent of the level of geomagnetic activity. However, in this paper, our aim is not to compare these catalogs. In case of a discrepancy between them, one cannot exactly prove which of the catalogs is more reliable because the accuracy estimates were obtained on the basis of current data and can be insufficiently valid for the presatellite period. Our aim is to compile a new catalog on the basis of a new technique. Thus, three variants (obtained by three different techniques) will provide one with much more confidence in making conclusions about the presence of one or the other IMF polarity on a given day.

2. DATA

A list of the stations used is shown in Table 1. Also, this table shows the geomagnetic latitude and time of operation of each station. These stations are mostly characterized by a rather long period of observations in the presatellite era of interest to us, i.e., until 1965. All numerical data were taken from the website of the World Data Center for Geomagnetism, Kyoto (http://wdc.kugi.kyoto-u.ac.jp/). The results of polarity reconstructions are verified using satellite data on IMF components in the GSE system based on the OMNI NSSDC database (http://omniweb.gsfc.nasa.gov/).

3. DETERMINATION OF THE DIURNAL CURVE

The selection of geomagnetic field variations is based on the calculation of the "zero" level. In our case, to determine the average daily polarity, we should find a 24-h diurnal curve of the geomagnetic field corresponding to zero values of B_{YGSM}, i.e., with no Svalgaard–Mansurov effect. A diurnal curve calculated by averaging over some time interval reflects the diurnal variation in the geomagnetic field accordingly under certain average conditions. In reality, these conditions