Relationship between north-south component of magnetic field in sheath regions and coronal magnetic fields

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Southward interplanetary magnetic field (IMF) is a crucial factor that causes geomagnetic storms. A majority of geomagnetic storms is associated with magnetic clouds (MCs) or sheath regions, since a large southward component of IMF is likely to occur in these regions. Therefore, it is important to understand north-south (NS) component of IMF associated with MCs and sheath regions for space weather forecast. MCs are studied by many researchers using flux rope models. However, the origin of IMF at sheath regions is poorly investigated and it is still not clear how IMF in sheath regions is related to coronal magnetic fields. We investigate the relationship between the NS component of IMF in sheath regions and coronal magnetic fields. Here, we assume that coronal magnetic fields around prominence eruption sites move outward and are then convected into the interplanetary space to be observed at the Earth during the passage of sheath regions. In this study, we calculate coronal magnetic fields from the Kitt Peak/NSO photospheric magnetic field data using the PFSS model [Hakamada, 1998] and extrapolate these fields radially outward to 1AU at background solar wind velocity. The background solar wind velocity is given from interplanetary scintillation observations at ISEE via the tomographic analysis. The coronal magnetic fields are projected to 1AU using the background solar wind velocity data and the 1D-HD solar wind model developed by K.Hayashi. We examine whether the sign of the NS component (in RTN coordinates) of the projected coronal magnetic field agrees with that of the field observed by ACE spacecraft prior to MC arrival at the Earth. We make the comparison three hours before the MC start time (pre MC time) and at the MC start time (MC time) for five MC events during 2006–2007. As a result, we find that the sign of NS component of the magnetic field extracted from 1.1 solar radius (R_s) or 1.2 R_s agrees with ACE observation at the MC time for all MC events analyzed here. The same result is obtained from the analysis that uses UCSD time-dependent tomography [Jackson et al., 2013] for solar wind model (this result was reported at the JPGU 2016). The result indicates that the coronal magnetic field at low height erupts and the field is observed at the MC time. We also determine the solar sources of the MCs and those of the projected coronal magnetic fields. We find that the sign of NS component at the source of projected coronal magnetic field agrees better with that of NS field observed at the Earth at the MC time than the source of MC. This result indicates that the IMF observed at the sheath comes from the source region of the background solar wind, not from the source region of MC.

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