Studies of solar wind models using SUSANOO-SW

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Because the interaction with solar wind is a primary cause of magnetospheric disturbances, the prediction of solar wind is crucial for the space weather forecast. In recent years, our group have developed a space weather prediction model: SUSANOO-SW (Space-weather-forecast-Usable System Anchored by Numerical Operations and Observations-Solar Wind), which can predict the solar wind profile at the Earth's orbit on the basis of three-dimensional MHD simulation [Shiota et al., 2014]. The input data is a series of observed daily photospheric magnetic field maps only. In SUASNOO-SW, the potential field source surface (PFSS) model and the Wang-Sheeley model [Arge and Pizzo, 2000] are applied to coronal magnetic field and the speed solar wind, respectively. Although SUSANOO-SW may reproduce the large-scale three-dimensional structures of solar wind, the model is not yet able to well reproduce the observation of solar wind in shorter time-scale than about one Carrington rotation and the amplitude of solar wind speed.

In this research, we study the cause of deviation between the model and the observations focusing on the solar wind speed model which is used to specify the solar wind distribution on the inner boundary condition of SUSANOO-SW. The Wang-Sheeley model depends only on the expansion factor of magnetic flux. In order to improve it, we adopt a new solar wind speed model [Fujiki et al. 2014] taking into account not only of the expansion factor but also of the magnetic field strength. The new model is consistent also with the theoretical work by Suzuki [2006]. We quantitatively evaluated the performance of the new model, and found that the results of the new model show better agreement with the in-situ observation in 2009.

However, we also found the modeled speed profile in a specific period on September 2009 is not improved by the new model. Because both speed models commonly use the information of the coronal magnetic field calculated from the observed magnetic field on the photosphere and the PFSS model, the reproducibility of the coronal magnetic field can cause the deviation during the period. Especially, we focused on the possibility that the error in the photospheric field maps may cause the deviation of solar wind from the observations. When a sunspot group appears on the backside of the Sun, which cannot be observed, it may make a significant influence on the global coronal field structure in this period. This failure of taking information into the observation may lead the worse reproducibility of magnetic field calculated by PFSS model. We tried to improve this problem by modifying coefficients of spherical harmonics in PFSS model while considering sunspot group which cannot be observed. This modification will be presented.