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Data assimilation of the solar wind in the inner heliosphere to estimate the source function and solar wind variation

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We develop a technique for predicting variations of the solar wind and source functions by incorporating wind velocity data from interplanetary scintillation (IPS) into a three dimensional magneto-hydrodynamic (MHD) solar wind model in the context of data assimilation using the Ensemble Kalman filter. In the data assimilation process, we constrain the solar wind source function which relates the observable magnetic field on the solar surface and terminal solar wind velocity. Previous studies estimated the function statistically, while we estimate the best fit model coefficients in this study.

We perform the "twin experiments" to evaluate the data assimilation method and containment of the source function and obtain results as follows : i) Variations of the solar wind and source function coefficients are well reproduced by the data assimilation. ii) Case for Ensemble number of being larger than 15 shows good estimation for 40 data per day case. iii) IPS data positions do not affect the prediction effectively because the source function affects large structure. The number of the state of a system is 21 (radial) x 360 (longitude and latitude) x 8 (MHD parameter) + 2 (source function coefficients) = 60,482, while SOHO/MDI magnetic field data is referred at the inner boundary and IPS observation ~40 per day is assimilated. We discuss the applicability of this method to the observed solar wind.

Keywords: solar wind, data assimilation, simulation, MHD