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Application of data assimilation techniques to heliospheric modelling: two preliminary studies

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Data assimilation techniques are a way to obtain a better estimate of the state of a system by combining modelling (i.e., simulations) and measures of relevant quantities. Let us assume that an evolution law for the system is known and that observations of the system are available. A transfer matrix which maps the state to the observations is also known. Then, it is possible to obtain an 'a posteriori', improved estimate of the system state by correcting an 'a priori'estimate with a factor obtained by appropriately combining observations, the a priori estimate and a measure of the reliability of the model and of the observations. Data assimilation methods are routinely used in fields, such as meteorology, ionospheric modelling, radiation belt dynamics, oceanic studies, where a variety of observations are available. Their application to heliospheric or solar modelling is just in its infancy.

We present here two preliminary studies. In [Innocenti et al, 2011], Kalman filtering techniques are applied to an empirical solar wind forecasting model [Vršnak et al, 2007]. It is shown that Kalman filtering can improve the quality of the forecasts and extend the period of applicability of the baseline model. In a subset of cases, some degree of robustness toward solar transient activity not accounted for in the original model is also provided. In [Skandrani et al, 2014], the representers technique is used to assess how process and model state errors propagate in a MagnetoHydro Dynamic (MHD) code, FLIP-MHD, used for the simulation of solar wind propagation from the source surface to the Earth. The aim is to understand the impact of source surface input parameters on the evolution of MHD heliospheric models and the potentialities of data assimilation techniques in solar wind forecasting. The representer technique allows one to understand how far from the observation point the improvement granted from the assimilation of a measure propagates.

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