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A new methodology to improve modelling of the internal magnetic field

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The geomagnetic field is generated by several sources, the main one being located in the liquid outer core of the Earth. These sources involve various temporal and spatial scales which overlap each other and thus it is difficult to separate the different contributions. Thus, models of the internal field often suffer from contamination of the magnetospheric and ionospheric external fields, which limits the model accuracy it is possible to obtain with actual data. Even for highly developed and parameterised geomagnetic models, mid and low latitude data still show highly correlated model residuals corresponding mainly to unmodelled magnetospheric contributions. It is thus necessary to understand how this contamination contributes to uncertainties and to develop new methods to minimise it in order to improve the resolution of models of the internal field.

We propose here a new methodology to deal with this problem, applying the method to data from the CHAMP satellite. For every orbital track, for geomagnetically quiet times, the residuals between vector measurements and a model are calculated; these are correlated in a way depending primarily on the geometry of the mismodelled external field. An external field model is estimated from these residuals, which provides an estimate of the dominant data uncertainty. Data are decimated to calculate a new model, but with errors motivated by the modelled external field – a covariant error weighting is applied which gives lesser weight to the data component in the direction of the contamination. This methodology follows past methods, for example to take account of the effect of the spacecraft attitude uncertainty in the Ørsted satellite (Holme, 2000). We calculate models with both uncorrected data and also corrected by the external field estimate. The latter is along-track filtering which reduces noise but also risks eliminating real field structure. We examine whether the downweighting improves model prediction, and whether covariant errors reduce the potential harm of filtering. We discuss possible implications for the Swarm mission.

R. Holme, Modelling of attitude error in vector magnetic data: application to Ørsted data. Earth Planets Space, 52, 1187-1197, 2000.