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An Equivalent Source Method for Modelling the Global Lithospheric Magnetic Field

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We present a new technique for modelling the global lithospheric magnetic field at Earth's surface based on the estimation of equivalent potential field sources. As a demonstration we show an application to magnetic field measurements made by the CHAMP satellite during the period 2009-2010 when it was at its lowest altitude and solar activity was also remarkably quiet. Both scalar and three component vector field data are utilized. Estimates of core and large-scale magnetospheric sources are removed from the measurements using the CHAOS-4 model. Quiet-time and night-side data selection criteria are also employed to minimize the influence of the ionospheric field. The model for the remaining lithospheric magnetic field consists of magnetic point sources (monopoles) arranged in an icosahedron grid. The corresponding source values are estimated using an iteratively reweighted least squares algorithm that includes model regularization and Huber weighting. Data error covariance matrices are implemented, including both the latitude dependence of data error variances and covariances between the vector field components due to unmodelled sources. Results show good consistency with the field structures obtained in the CHAOS-4 and MF7 models using more conventional spherical harmonic based approaches. Advantages of the equivalent source method include its local nature, allowing e.g. for regional grid refinement, and the ease of transforming to spherical harmonics when needed. Future applications will make use of Swarm data in combination with high resolution aeromagnetic measurements.