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Harmonic spline modelling of satellite lithospheric magnetic anomaly field data

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Harmonic splines (HS) are global basis functions concentrated in localised regions that can be used to model geopotential data without loss of resolution. Here, we apply HS modelling to produce a global model of the Earth's lithospheric anomaly field from satellite data. Shure et al. (1982) developed a minimum norm algorithm applicable to global datasets, which involves solving a data-by-data system of equations. This approach cannot be applied directly to large satellite dataset owing to the computational burden involved, but because the satellite 'footprint' is small, most of the matrix elements are negligibly small. We therefore use sparse iterative matrix methods, with Jacobi preconditioning to improve convergence, to downward continue the lithospheric anomaly field measured by satellite. We use the dataset of Stockman et al. (2009) which allows a direct comparison with the results of their spherical tesselation modelling method, including the fit to the data. We produce equivalent spherical harmonic coefficients of the HS model for comparison with more conventional methods. Originally developed for vector component data, scalar data are incorporated into the HS model using the method of Langel and Whaler (1996). Regional high resolution near-surface (e.g. aeromagnetic) data are combined with the global satellite dataset in a joint HS model, though the number of such data and the lack of matrix sparseness means modifications to the method (e.g. the depleted basis method of Parker and Shure (1982)) resulting in some loss of resolution are necessary. The best prospects for the method are therefore to resolve the spectrum at intermediate wavelengths given the appropriate large-scale or long flight/marine line surveys, avoiding artefacts that can be introduced by compiling multiple near-surface datasets without exercising the longer wavelength control that satellite data bring.