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Application of spherical Slepian functions to the inversion of virtual observatory satellite magnetic data into localised regions of flow on the core-mantle boundary

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Spherical Slepian functions (or ‘Slepian functions’) are mathematical functions which can be used to decompose potential fields, as represented by spherical harmonics, into smaller regions covering part of a spherical surface. This allows a spatio-spectral trade-off between aliasing of the signal at the boundary edges while constraining it within a region of interest. While Slepian functions have previously been applied to geodetic and crustal magnetic data, this work further applies Slepian functions to flows on the core-mantle boundary. There are two main reasons for restricting flow models to certain parts of the core surface. Firstly, we have reason to believe that different dynamics operate in different parts of the core (such as under LLSVPs) while, secondly, the modelled flow is ambiguous over certain parts of the surface (when applying flow assumptions). Spherical Slepian functions retain many of the advantages of our usual flow description, concerning for example the boundary conditions it must satisfy, and allowing easy calculation of the power spectrum, although greater initial computational effort is required.

In this work, we apply Slepian functions to core flow models by directly inverting from satellite virtual observatory magnetic data into regions of interest. We successfully demonstrate the technique and current short comings by showing whole core surface flow models, flow within a chosen region, and its corresponding complement. Unwanted spatial leakage is generated at the region edges in the separated flows but to less of an extent than when using spherical Slepian functions on existing flow models. The limited spectral content we can infer for core flows is responsible for most, if not all, of this leakage. Therefore, we present ongoing investigations into the cause of this leakage, and to highlight considerations when applying Slepian functions to core surface flow modelling.