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3-D imaging of mantle conductivity based on inversion of satellite C-responses: First proof of concept

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Recently Kuvshinov et al. (2006) presented an approach to detect large-scale conductivity anomalies deeply embedded in the upper mantle by analysis of magnetic observations made by low-Earth-orbiting satellites. From the magnetic observations C-responses are estimated on a regular 2-D grid at a number of periods. Although the analysis of these C-responses can give an idea about the geometry and size of 3-D mantle anomalies, the recovery of C-responses is only a prerequisite for a detailed retrieval of the 3-D distribution of electrical conductivity in the Earth's mantle. In this work we present an efficient 3-D inversion scheme to recover 3-D mantle conductivity. It exploits a state-of-the-art gradient type optimization method, along with an optimized forward problem solver based on the volume integral equation approach. The dramatic saving in computational load makes use of a "reciprocity" approach to calculate efficiently gradients of misfit at a cost of only two additional forward modellings per period (Pankratov & Kuvshinov, 2008). In support of the efficient gradient calculation, explicit forms for elements of Green's tensors for two new types of the source have been derived. We validate our inversion scheme by inverting synthetic C-responses calculated in a realistic 3-D conductivity model of the Earth.