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Mantle conductivity obtained by 3-D inversion of magnetic satellite data - An approach and its validation

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We present an approach to determine the three-dimensional (3-D) conductivity distribution of the Earth's upper mantle from magnetic satellite data. The approach is based on a minimization of the misfit between the measured and modeled (predicted) magnetic field using a quasi-Newton method, solving for blockwise constant conductivities on a given 3-D spatial mesh. The predicted induced space-time satellite signal is obtained numerically using a frequency-domain modeling based on the integral equation (IE) approach, and using a space-time structure of external (inducing) field as found from globally distributed geomagnetic observatories. Due to the high computational load of a 3-D inversion (requiring thousands of forward calculations), a comprehensive numerical framework is developed to increase the efficiency of the inversion. In particular, we take an advantage of specific features of the IE approach and perform the most consuming-time part of the IE forward simulations (the calculation of electric and magnetic tensor Green's functions) only once. Approximate calculation of the data sensitivities also gives essential speed up of the inversion. We validate our inversion scheme using synthetic induction satellite data calculated in the framework of the Swarm End-To-End Mission Simulation Study (ftp.dsri.dk/swarm/E2E).