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Regional large scale 3-D EM inversion of ground based geomagnetic Sq data. A concept and results from the analysis of the AWAGS data

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We present a numerical solution to the problem of 3-D EM inversion of ground based geomagnetic Sq variations on a regional large scale. The 24 h periodicity of the Sq variations allows for mapping conductivity at depths between 100 and 520 km, which is a challenging depth range in 3-D EM studies of the Earth due to the complexity of the Sq source. Our approach to determine the Sq source makes use of a 3-D Earth model which consists of a surface shell of known laterally variable conductance and either a 1-D or 3-D conductivity structure underneath. The external spherical harmonic coefficients, which describe the Sq source, are obtained by analysis of the time spectra of magnetic field from global net of geomagnetic observatories. The recovery of the 3-D conductivity model is based on a quasi-Newton method with efficient calculation of the gradient using the adjoint sources method. The forward engine to calculate magnetic fields at observation sites exploits an integral equation formulation. We apply our inverse scheme to the AWAGS (Australia Wide Array of Geomagnetic Stations) data. The AWAGS network comprised 53 observation sites regularly distributed over the Australian mainland and equipped with portable vector magnetometers. With these unique data we image the 3-D conductivity distribution beneath Australia at upper mantle depths and compare our results with those of independent studies.