

E4D-MP: Time-Lapse Multiphysics Simulation and Joint Inversion Toolset for Large-Scale Subsurface Imaging

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Abstract : A variety of geophysical techniques are available to image the opaque subsurface with little or no contact with the soil. It is common to conduct time-lapse surveys of different types for a given site for improved results of subsurface imaging. Regardless of the chosen survey methods, it is often a challenge to process the massive amount of survey data. The currently available software applications are generally based on the one-dimensional assumption for a desktop personal computer. Hence, they are usually incapable of imaging the three-dimensional (3D) processes/variables in the subsurface of reasonable spatial scales; the maximum amount of data that can be inverted simultaneously is often very small due to the capability limitation of personal computers. Presently, high-performance or integrating software that enables real-time integration of multi-process geophysical methods is needed. E4D-MP enables the integration and inversion of time-lapsed large-scale data surveys from geophysical methods. Using the supercomputing capability and parallel computation algorithm, E4D-MP is capable of processing data across vast spatiotemporal scales and in near real time. The main code and the modules of E4D-MP for inverting individual or combined data sets of time-lapse 3D electrical resistivity, spectral induced polarization, and gravity surveys have been developed and demonstrated for sub-surface imaging. E4D-MP provides capability of imaging the processes (e.g., liquid or gas flow, solute transport, cavity development) and subsurface properties (e.g., rock/soil density, conductivity) critical for successful control of environmental engineering related efforts such as environmental remediation, carbon sequestration, geothermal exploration, and mine land reclamation, among others.

Keywords : gravity survey, high-performance computing, sub-surface monitoring, electrical resistivity tomography

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