4D inversion for automated near real-time ERT monitoring applications

Paul Wilkinson[1], Cornelia Inauen[1], Philip Meldrum[1], Oliver Kuras[1], Sebastian Uhlemann[1,2], Giulio Curioni[3], Jonathan Chambers[1]

(1) British Geological Survey, Environmental Science Centre, Keyworth, Nottingham, UK
(2) ETH Zürich, Institute of Geophysics, Zürich, Switzerland
(3) Department of Civil Engineering, University of Birmingham, Birmingham, UK

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4D inversions for time-lapse ERT monitoring data have been developed in recent years that apply regularization in both the spatial and temporal dimensions. Such methods have advantages over other approaches (standalone inversion, difference inversion, or constraints against previous models) in that subsurface changes during data acquisition can be taken into account; changing noise conditions can be accommodated; change artefacts and non-uniqueness are reduced; no time-directional bias is introduced; and baseline/preceding data does not have to be assumed to be more accurate than subsequent data.

Temporally constrained 4D inverse methods might appear unsuitable in the context of automated ERT monitoring since they normally operate on the full sequence of monitoring data, which would preclude the delivery of inverse results until data far in the future of an interesting event had been acquired. But in this study we demonstrate, using real data from field monitoring installations, that applying 4D methods to short duration time windows (comprising e.g. 3 or 5 time-steps) produces inverse models very close to those obtained by inverting the full time sequence (containing many tens to hundreds of time-steps). This permits the advantages of temporal regularization to be applied in a near real-time monitoring context, with only a minimal delay in reporting results.

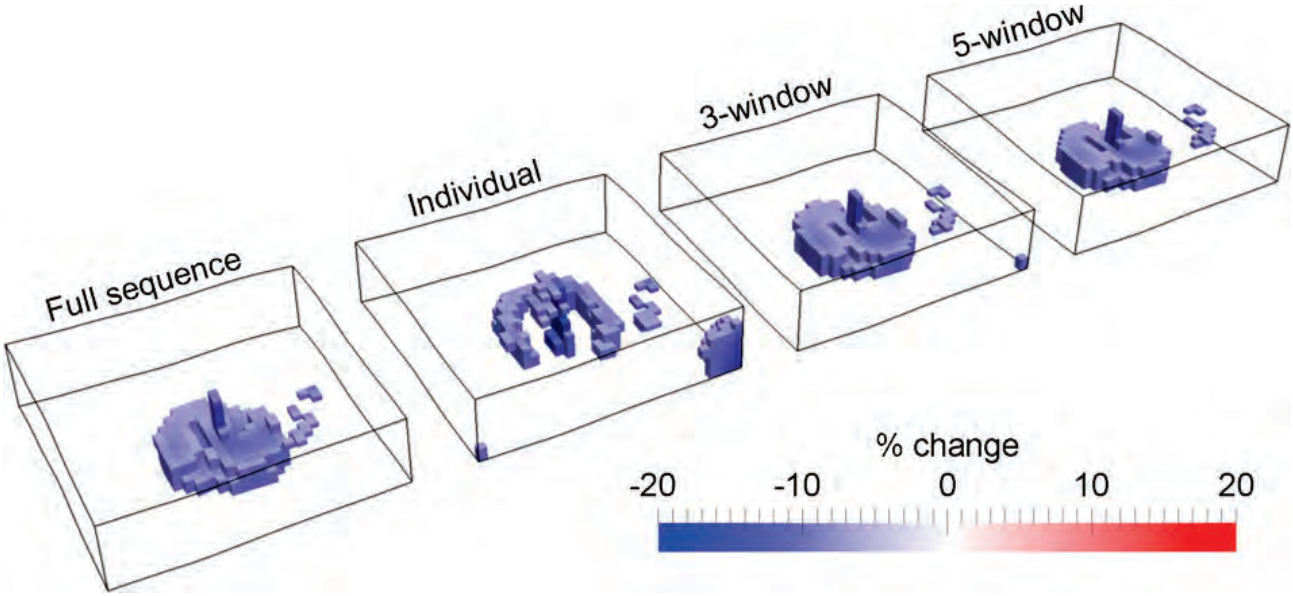

Figure 1: Resistivity changes caused by a controlled water leak in a monitoring experiment (cut-off at -10%). 4D temporally regularized inversions using moving windows of length 3 and 5 show much greater similarity to the full sequence inversion than individual standalone inversions without temporal constraints.