



GEOSTATISTICAL FDEM INVERSION: A THREE-DIMENSIONAL REAL CASE APPLICATION



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NEAR SURFACE CHARACTERIZATION OF COMPLEX DEPOSITS



Main objective

Enhance the current near surface modelling.



What is actually
in here?

- Water content ?
- Physical properties ?
- Waste composition ?
- Spatial distribution ?

We propose a method that uses:

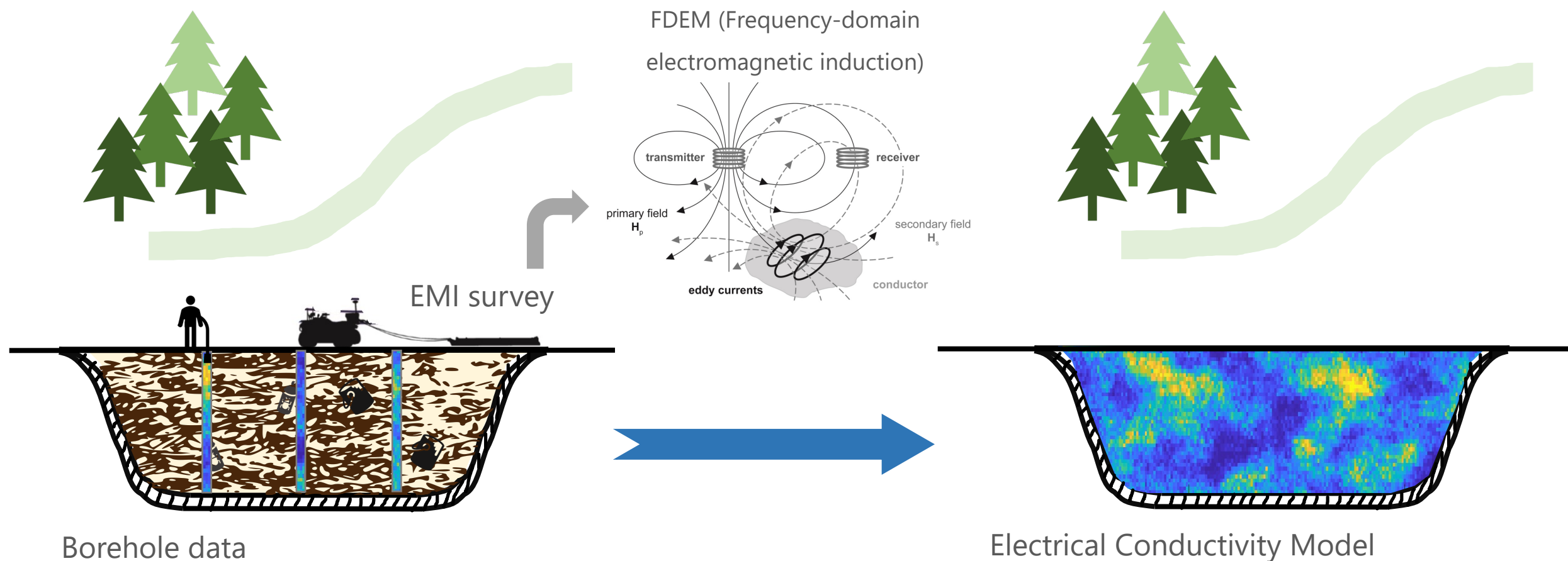
Geophysical characterization

Enhance the current near surface characterization with a geophysical-driven modelling strategy

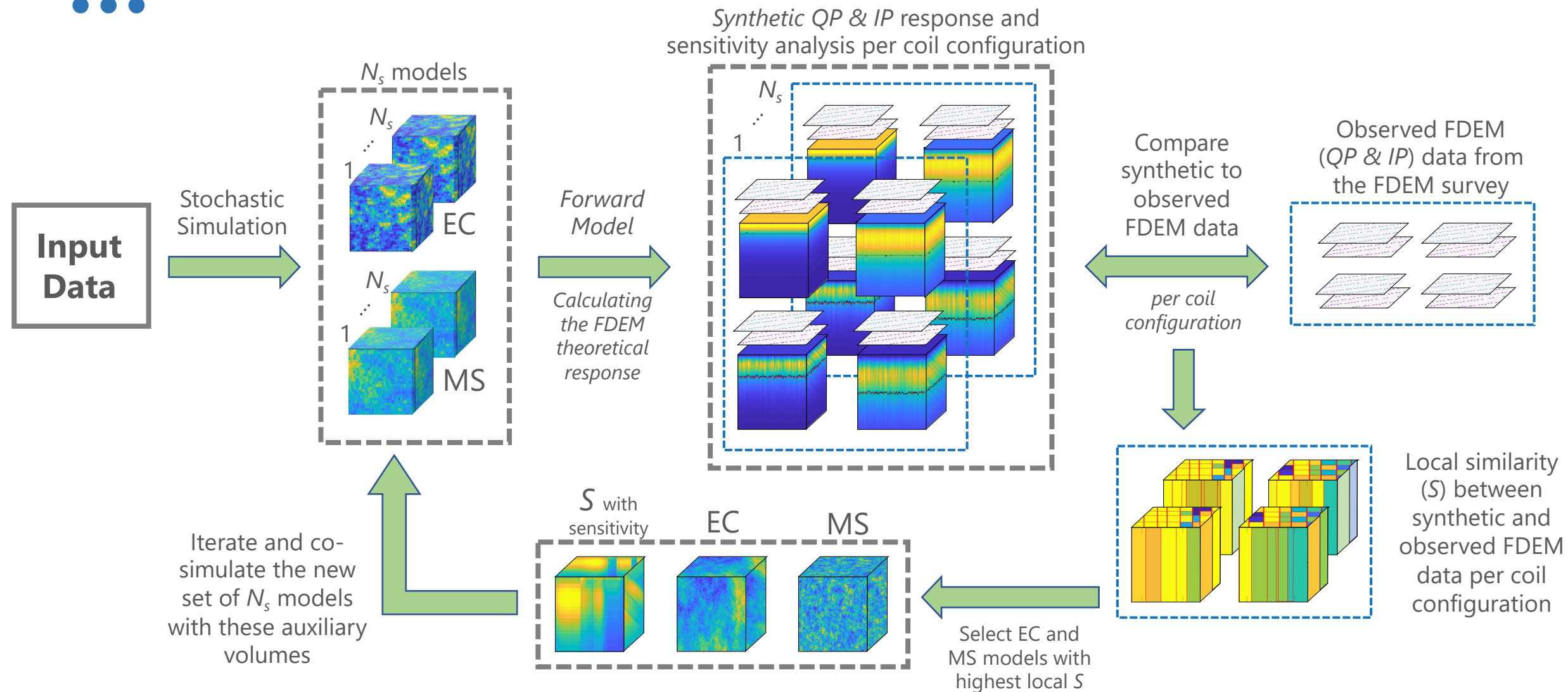
Geostatistical framework

Allows a more detailed description of the spatial distribution of the properties of interest and the associated uncertainty, and the integration of different data.

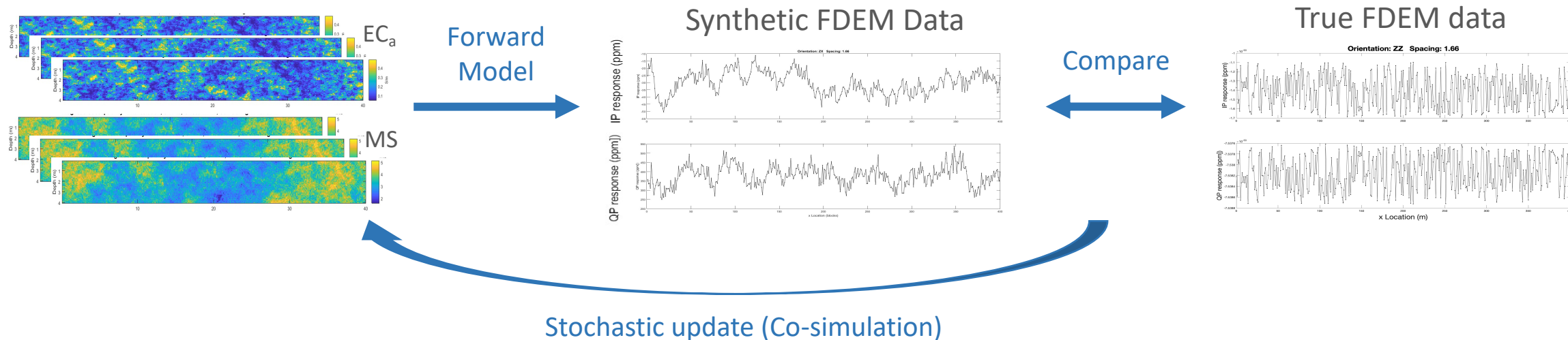
METHOD – ITERATIVE GEOSTATISTICAL INVERSION



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Iterative geostatistical inversion using well-log data, spatial continuity (semi-variograms) and observed FDEM data, as input data.



Model perturbation with stochastic sequential simulation and co-simulation.



Global optimization driven by the misfit between real and synthetic electromagnetic data.

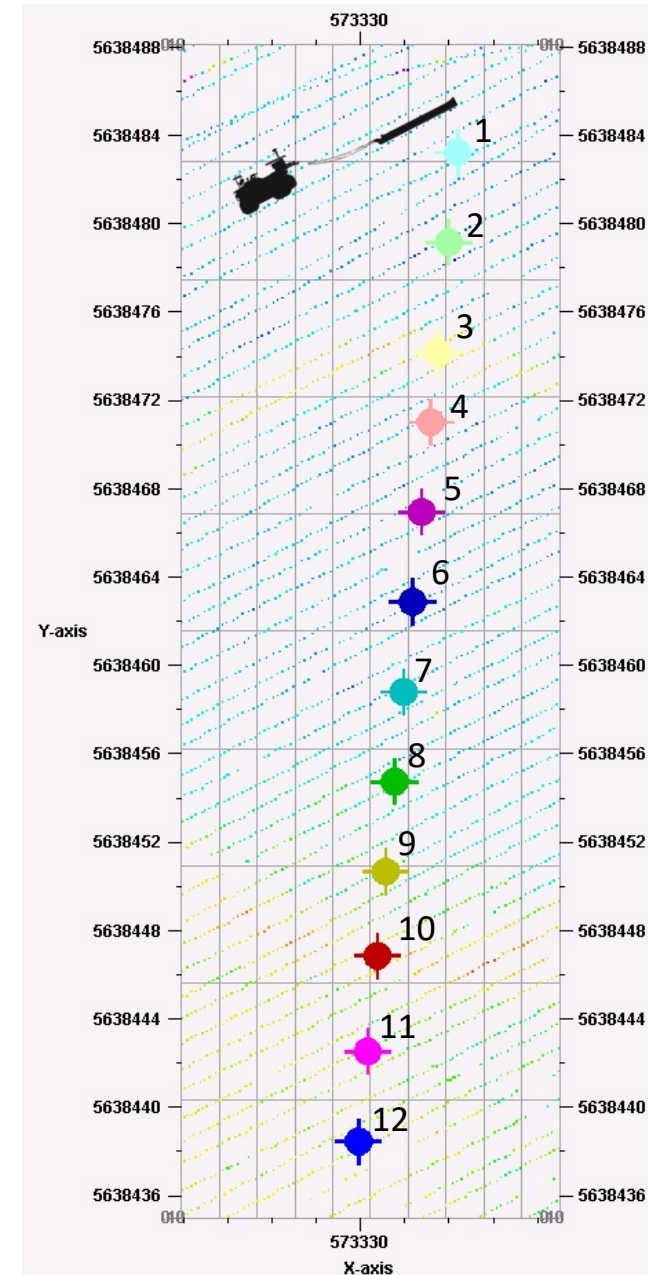
REAL DATA SET



The ~1.3 ha study area (Knowlton, UK) is a sloping arable land, characterized by Cretaceous chalk overlain by Quaternary siliciclastic deposits.

For the FDEM data collection, multi-receiver survey data were recorded using a DUALEM 21HS instrument and a quad-bike, paired with:

- **2 coplanar horizontal receiver coils** at 1 and 2 m (HCP1 and HCP2);
- and **2 perpendicularly oriented receivers** 1.1 and 2.1 m (PRP1 and PRP2).

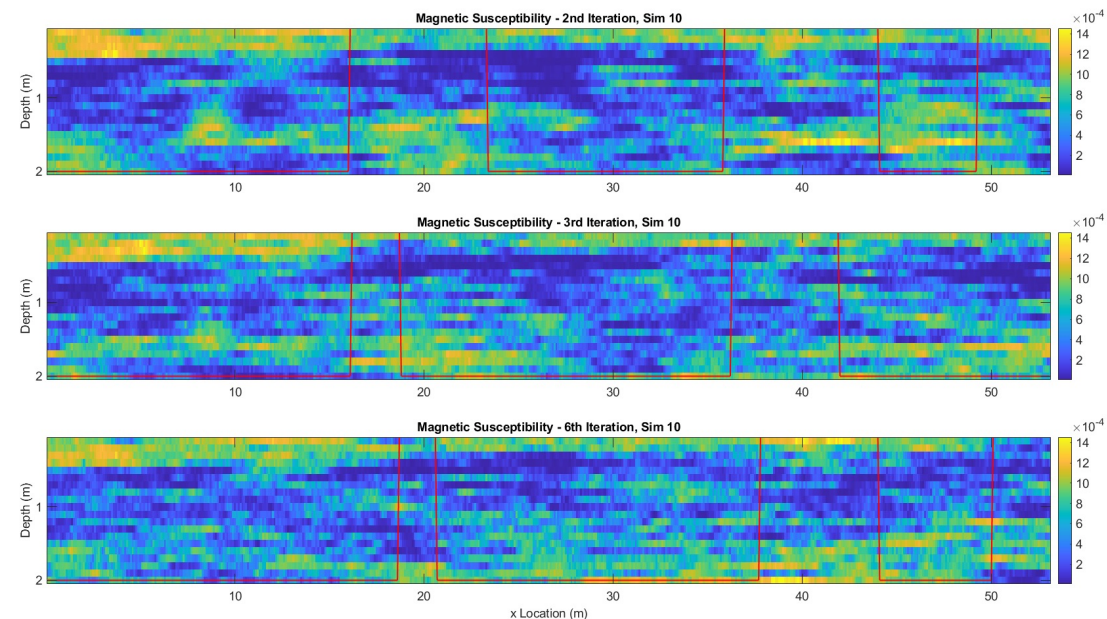
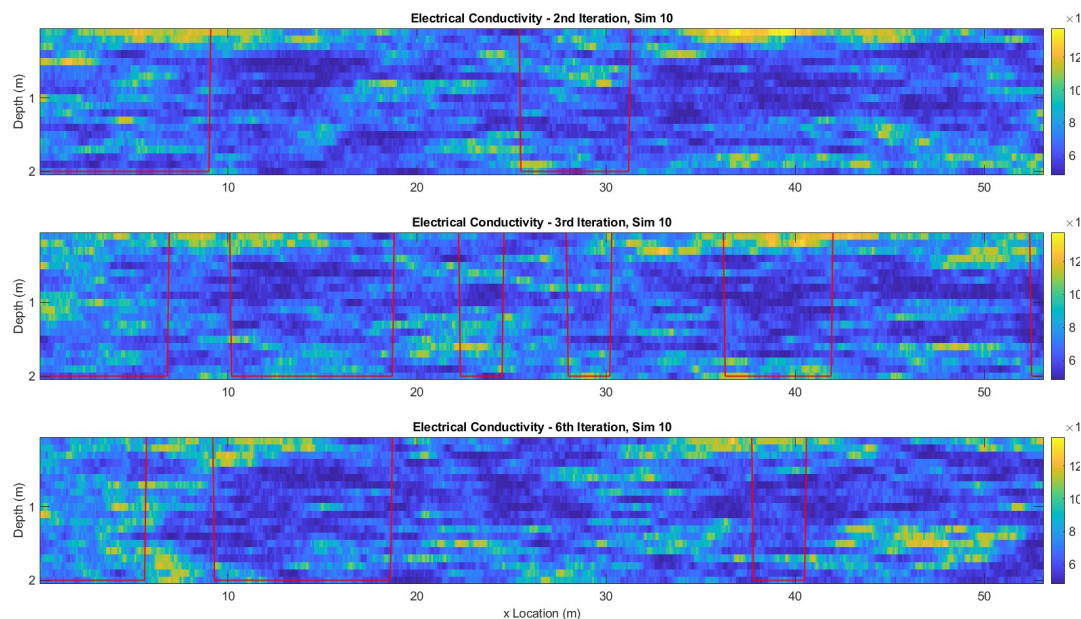


12 boreholes with
EC and MS direct
measurements

RESULTS – SIMULATED MODELS OF EC_a AND MS

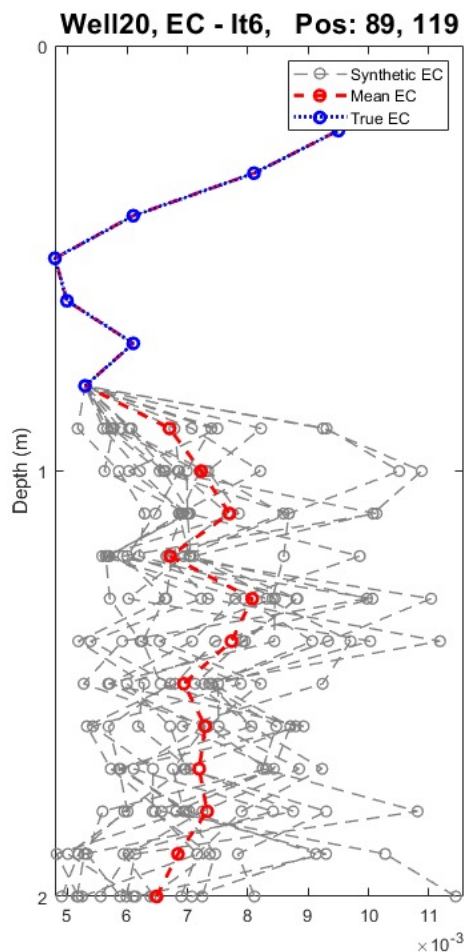


- 6 iteration, 32 realizations per iteration
- 2 coil orientations (PRP and HCP)
- 4 Offsets (for 1, 1.1, 2 and 2.1 m)



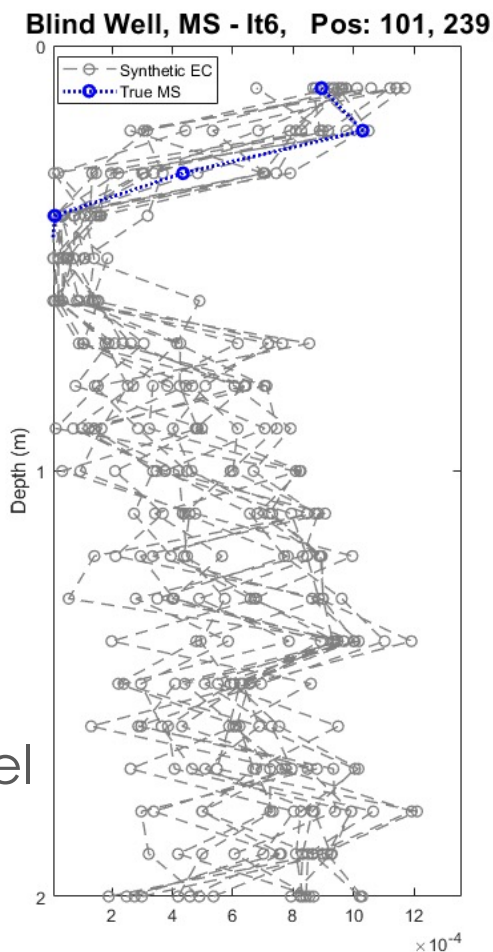
2D profiles from one 3D model realization of electrical conductivity (EC) and magnetic susceptibility (MS) of the 2nd, 3rd and 6th iteration

RESULTS – WELL-LOG DATA

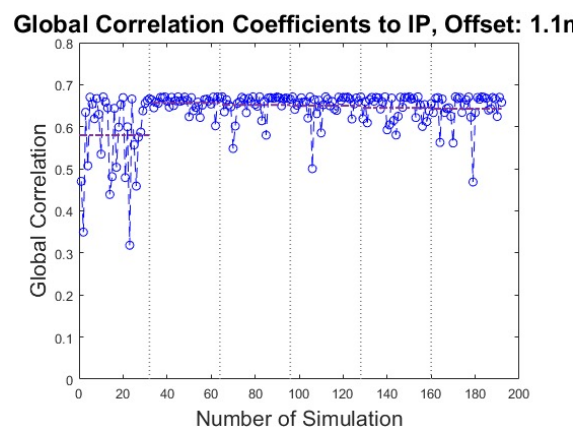
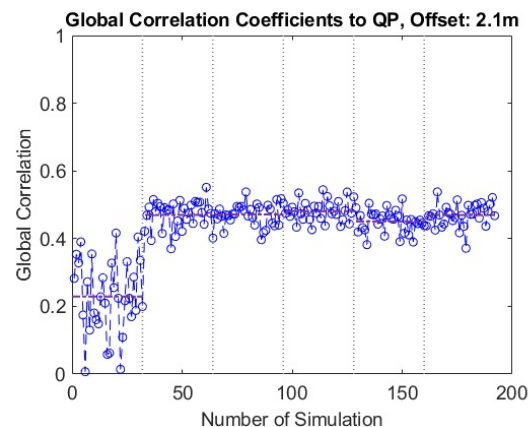
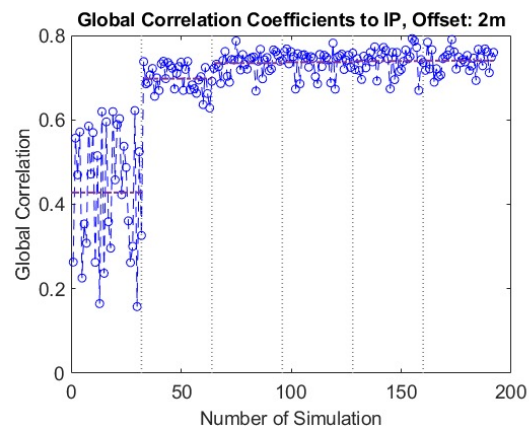
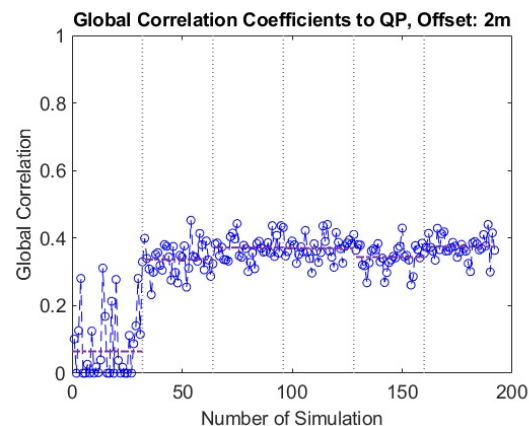


Reproduction of the
EC (and MS) well-log
data in each iteration.

Reproduction of the MS well-log
data not used in the inversion in
order to compare with the model
realizations in each iteration.



RESULTS – GLOBAL CORRELATION COEFFICIENTS



Although in this application of the proposed iterative geostatistical FDEM inversion methodology to this real data set, high global correlation coefficients between synthetic and real data are achieved in some coil configurations, in others coil configurations (e.g., HCP QP 2m) the global correlation coefficients are not satisfactory and tend not to converge.

This fact may derive from a large signal noise in these coil configurations.

CONCLUSION



This new geostatistical inversion technique:

- allows the **simultaneous inversion of FDEM data** for EC and MS;
- **address the uncertainty** of the modelling procedure;
- allows a more **detailed description of the spatial distribution** of the properties of interest;
- integrates different kinds of data.

Acknowledgements



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