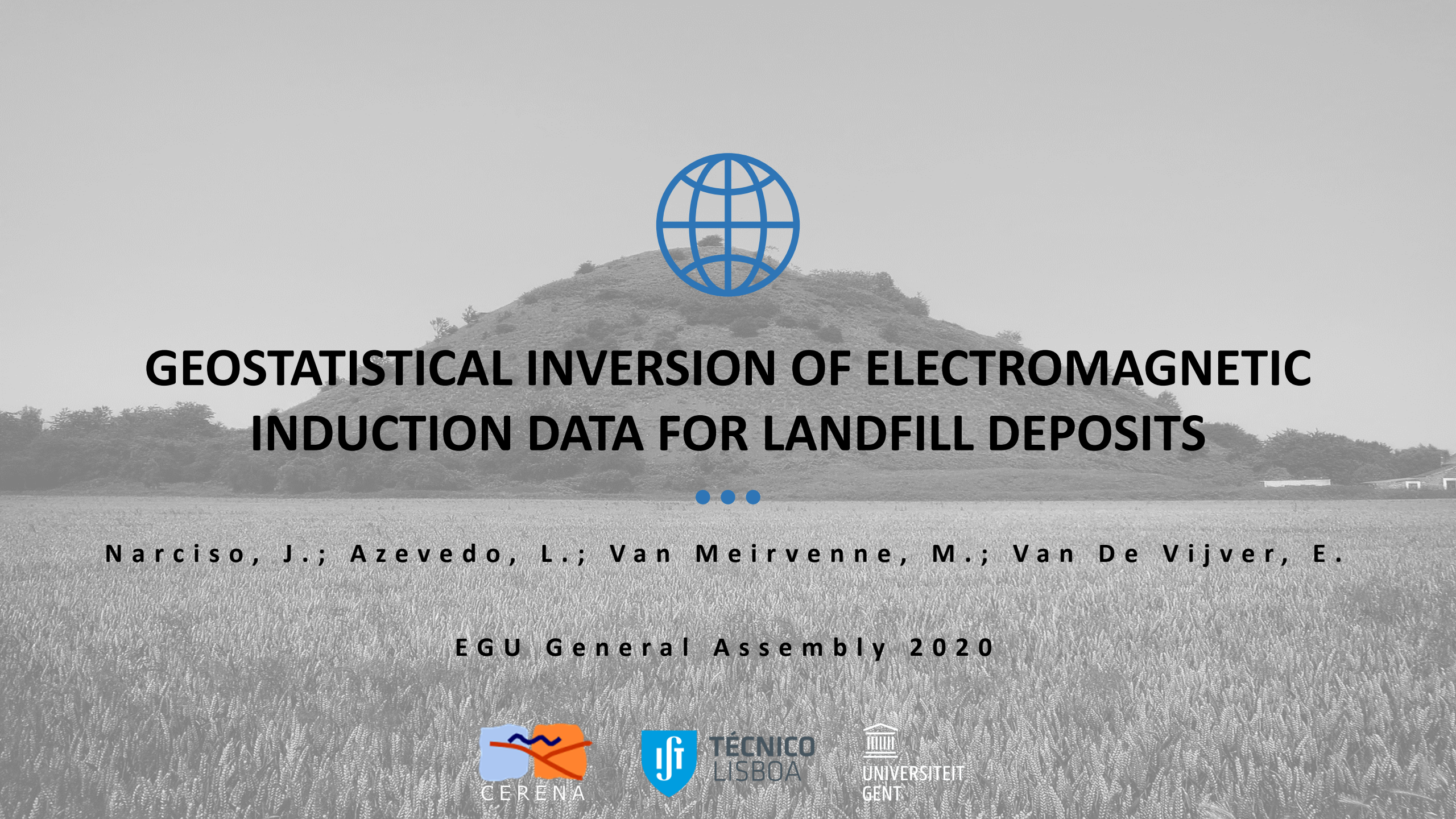

GEOSTATISTICAL INVERSION OF ELECTROMAGNETIC INDUCTION DATA FOR LANDFILL DEPOSITS

Narciso, J.; Azevedo, L.; Van Meirvenne, M.; Van De Vijver, E.

EGU General Assembly 2020

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TÉCNICO LISBOA

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OUTLINE

- Motivation / Objectives
- Method
- Data
- Results
- Conclusion

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MOTIVATION/OBJECTIVES – IMPROVE LANDFILL MODELLING

Main Motivation

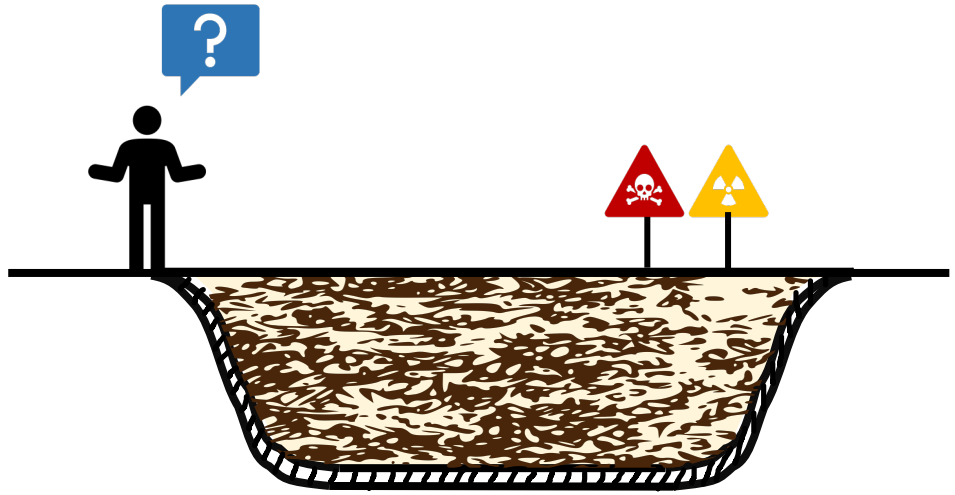
Enhance the current landfill deposits modelling

500.000+ landfills in Europe

(28 European Union countries)

Large heterogeneity of deposited wastes

Challenging to characterize using only direct interpretation of geophysical measurements.



Geostatistical Approach

Allows a more detailed description of the spatial distribution of the properties of interest and the associated uncertainty.

Data integration

Integrate borehole data and electromagnetic data in a geostatistical framework.

Sensitivity modelling

Uses the sensitivity of the EM response toward changes in a physical property of interest

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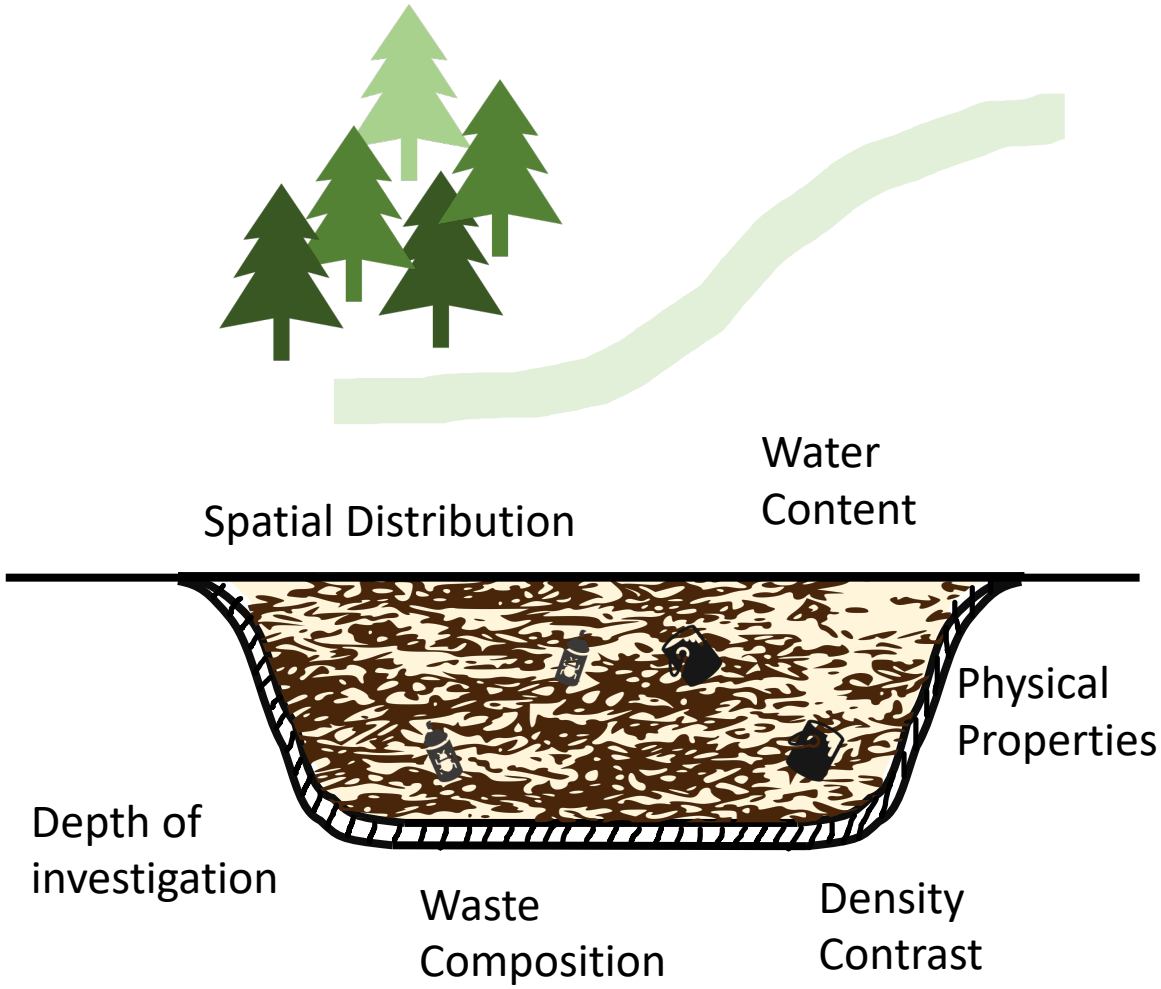

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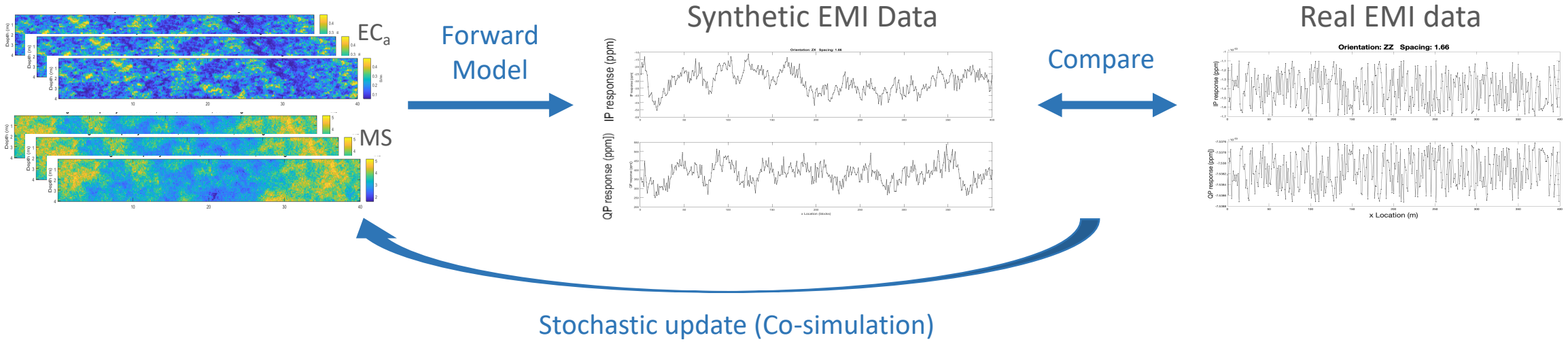
METHOD – ITERATIVE GEOSTATISTICAL INVERSION



Iterative geostatistical inversion using well-log data, spatial continuity (semi-variograms) and real EMI data.

Model generation with stochastic sequential simulation and co-simulation.

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

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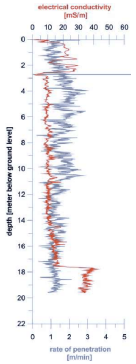
METHOD – ITERATIVE GEOSTATISTICAL INVERSION

Input data:

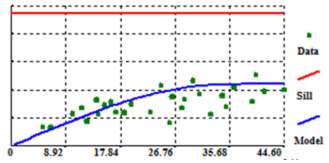
Borehole data from ECa and MS (a);

(a)



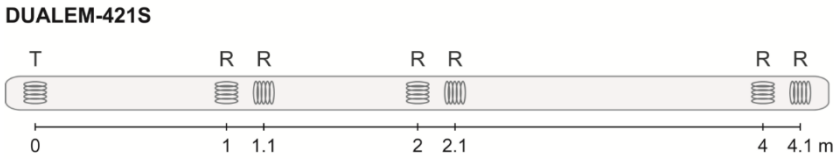
Variogram model (b);

(b)



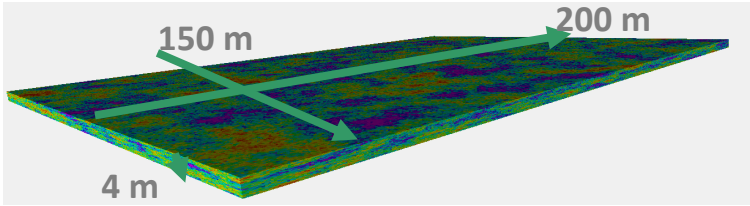
Sensor characteristics (c);

For example (c):



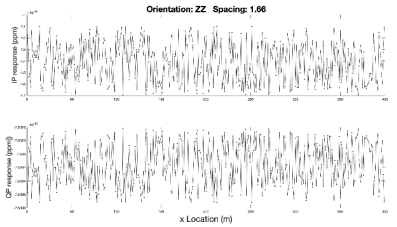
Model characteristics (d);

(d)



Observed data (d_{obs} EMI) (e).

(e)



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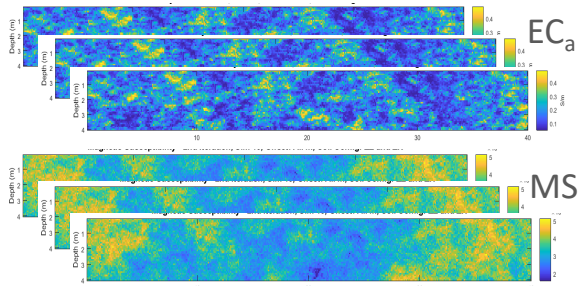
METHOD – ITERATIVE GEOSTATISTICAL INVERSION

Input data

Use Stochastic Simulation

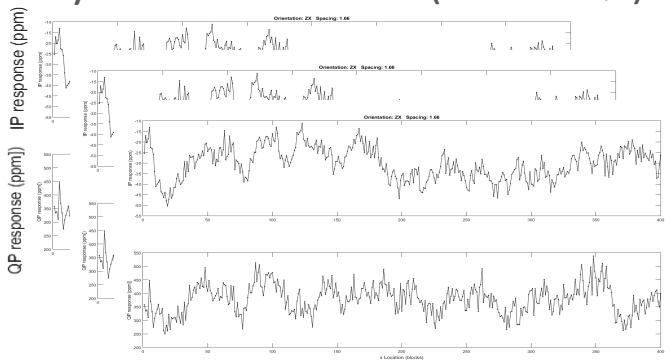


Forward Model

$\mathbf{F_{EM}}$

From Hanssens et al. (2019)

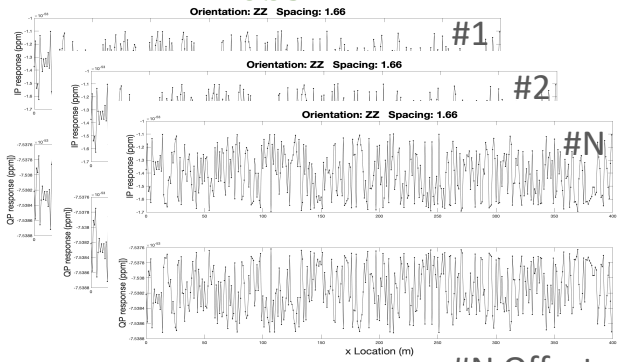
Synthetic EMI Data (IP and QP)



Compare

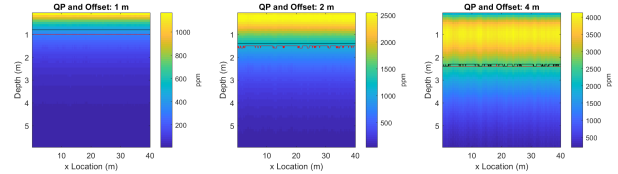
Real EMI data (IP and QP)

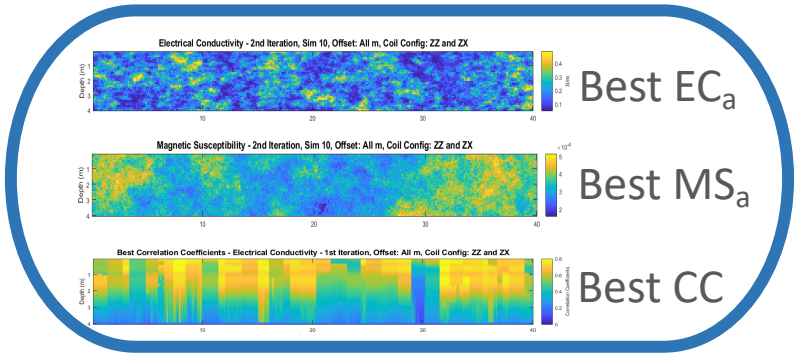
$\mathbf{d_{obs\ EM}}$



#N Offsets

Use Sensitivity Analysis





Use local correlation and Best Property Model for co-Simulation

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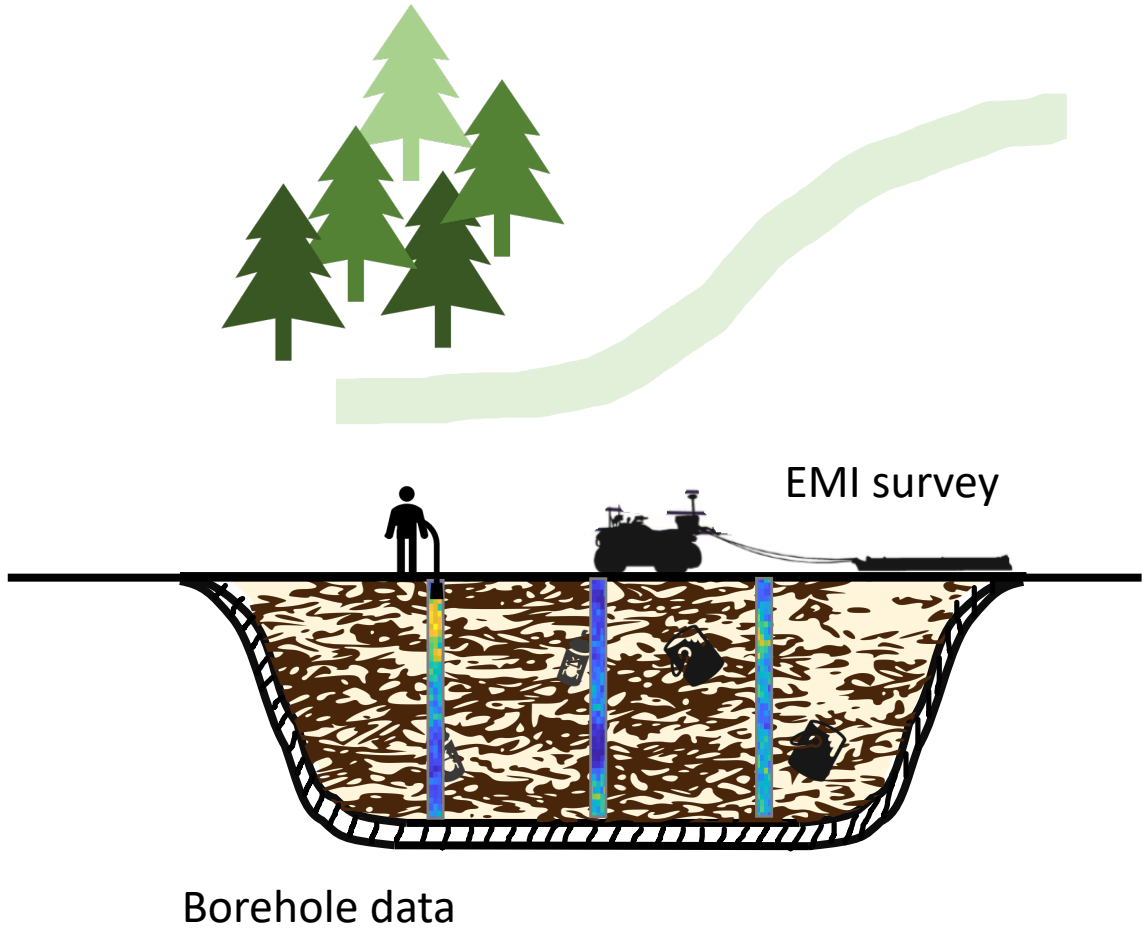

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DATA

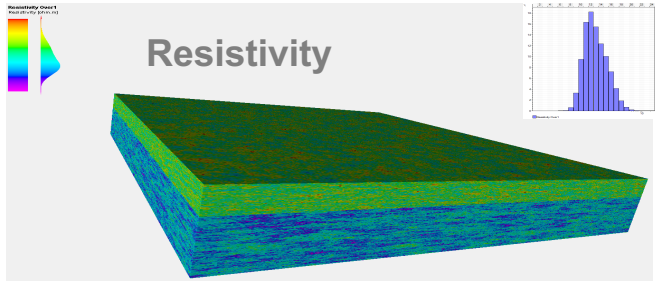
Synthetic landfill dataset created based on real data observations made at a mine tailing:

Lab mearurements

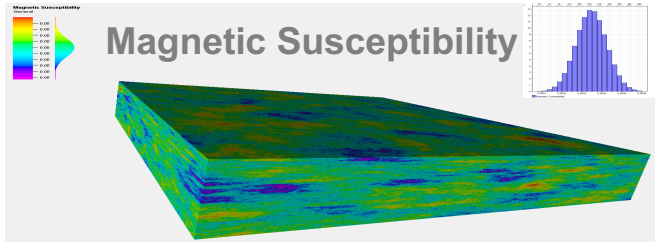
Material	Porosity (%)	Particle Density g/cm^3
Fine shaly-sands material (2.80-0.05)	49.4	2.825
	49.4	2.802
	49.3	2.773
Mean	49.3667	2.797
Gravel from fine to coarse quartz schist (19.00-1.00)	51.4	2.937
	51.2	2.897
	51.5	2.869
	51.1	2.865
Mean	51.3	2.892

1st – Simulate **porosity** in all volume from sequential gaussian simulation algorithm and lab mearurements from Panasqueira tailing.

2nd – Co-simulate **particle density** and **water content** using porosity and co-SGS.



3rd – Modelling **resistivity** from porosity and Archie equation, and simulate **magnetic susceptibility** using SGS.



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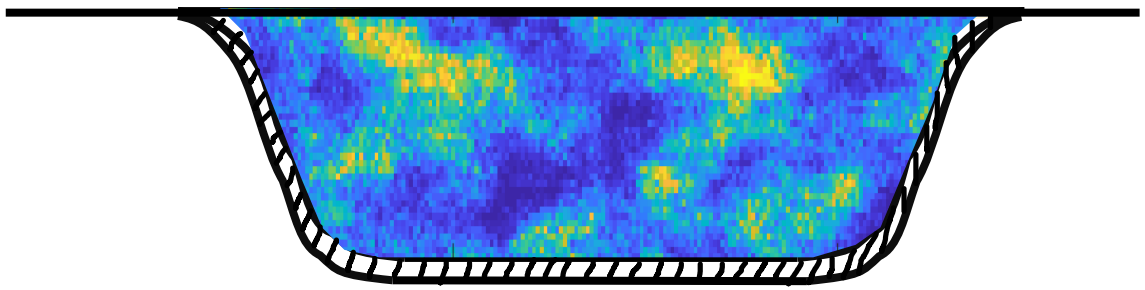

Electrical Conductivity Model

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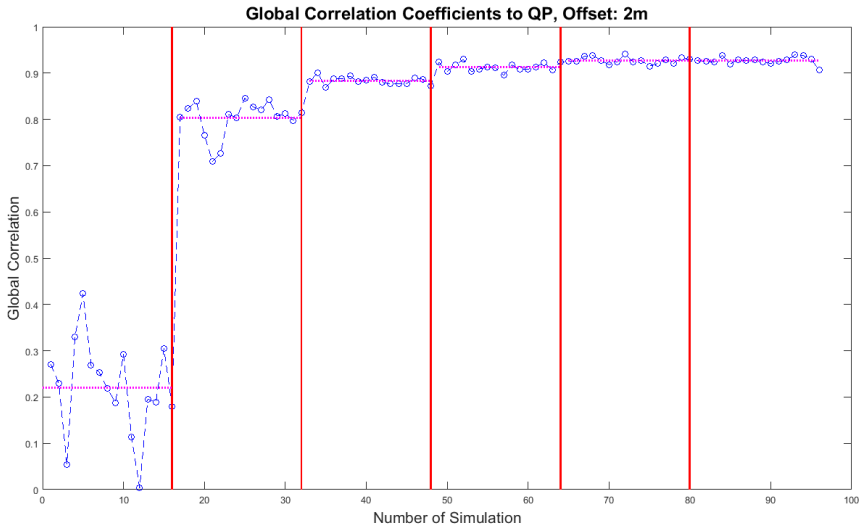
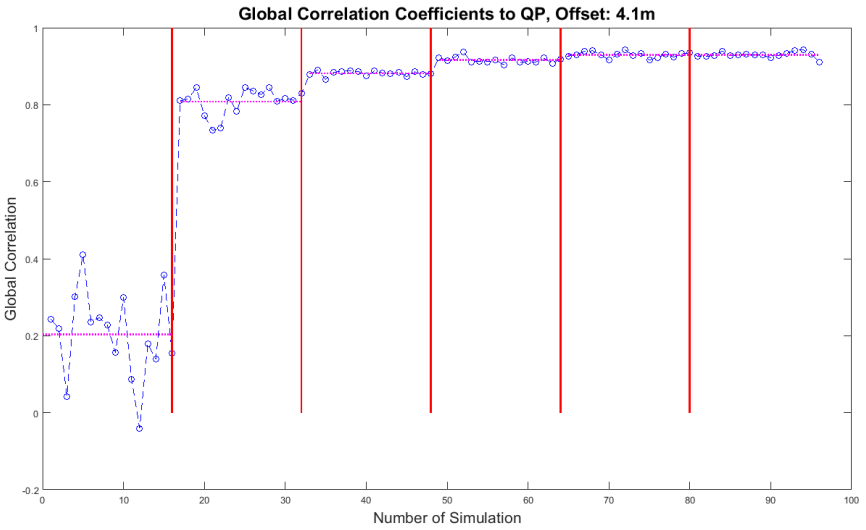
RESULTS

- 6 iteration
- 32 simulated models per iteration
- 10 Offsets (for 1 m up to 20 m)
- 2 coil orientation (PRP and HCP)
- Global Correlation more than 0.8. 2 Examples:





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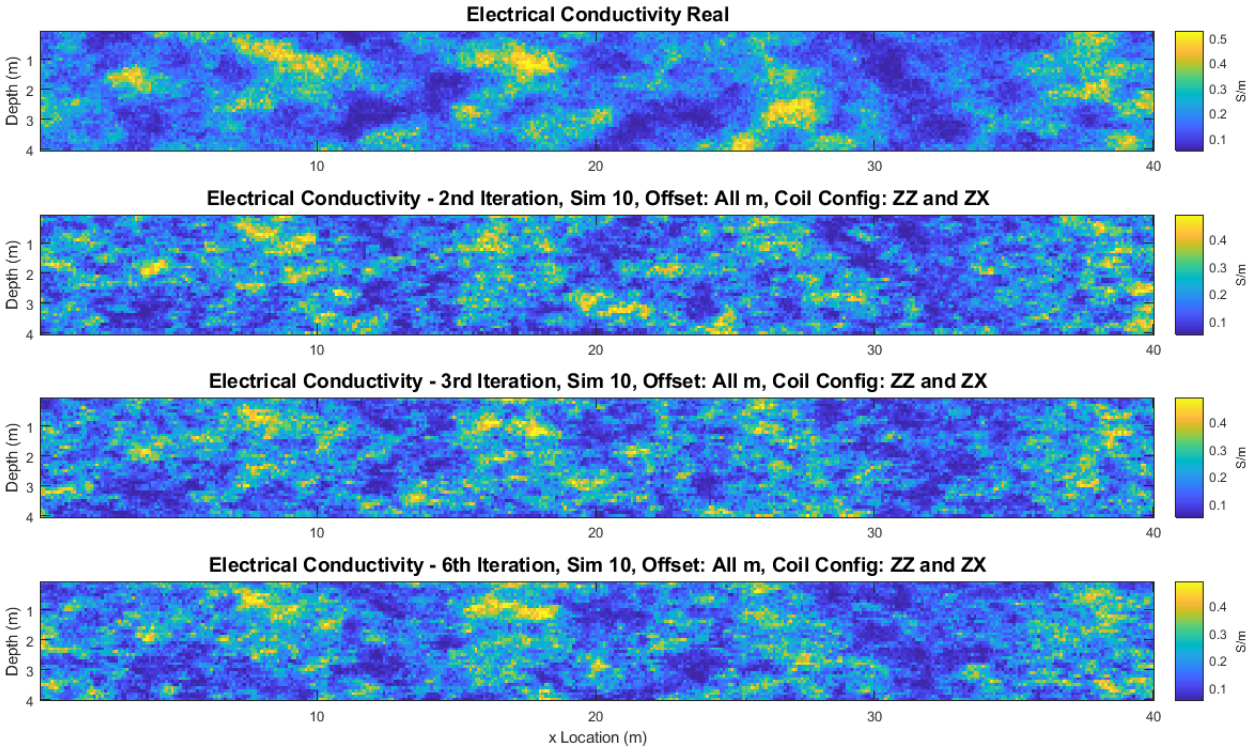
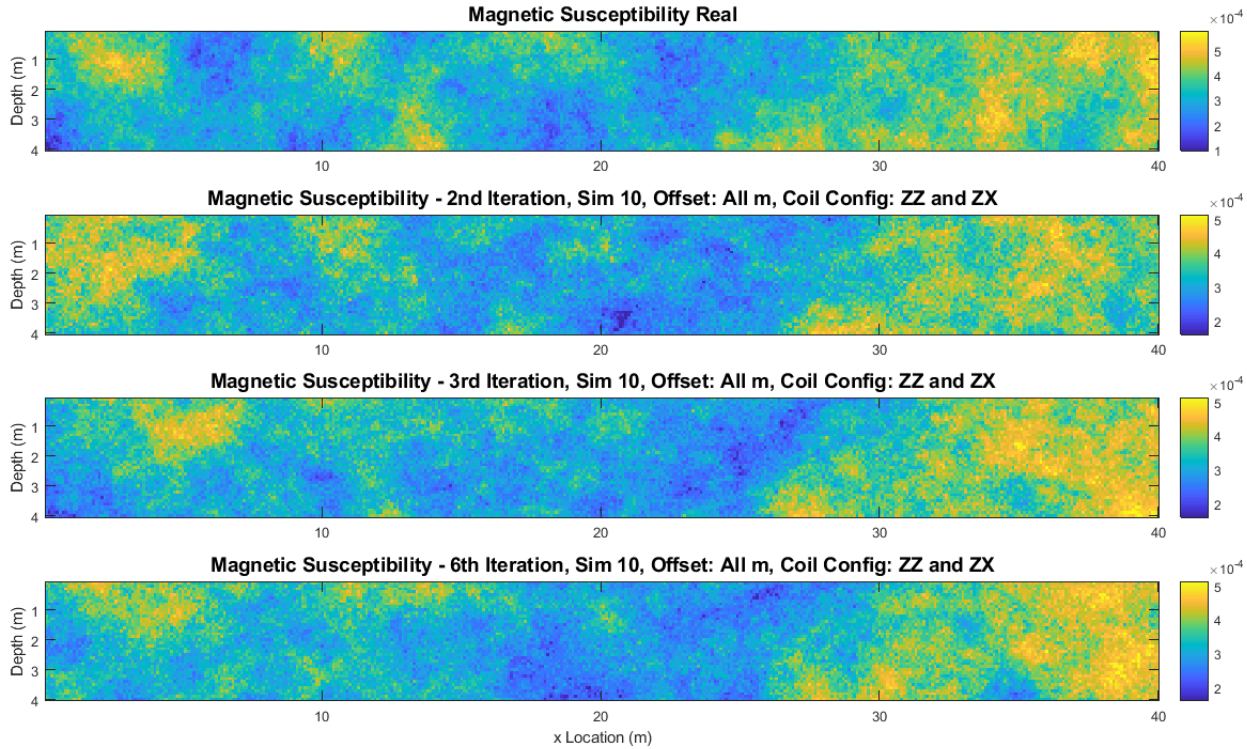
RESULTS – SIMULATED MODELS OF EC_a AND MS





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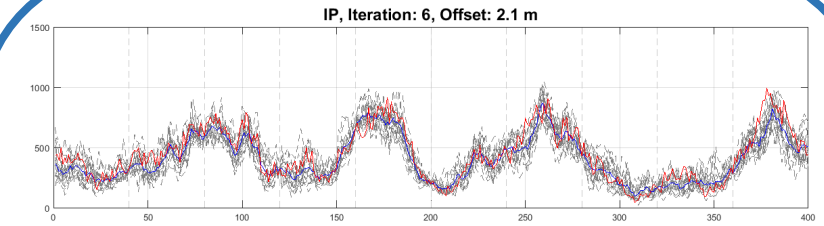
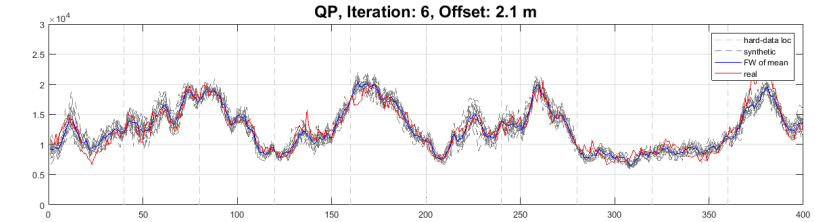
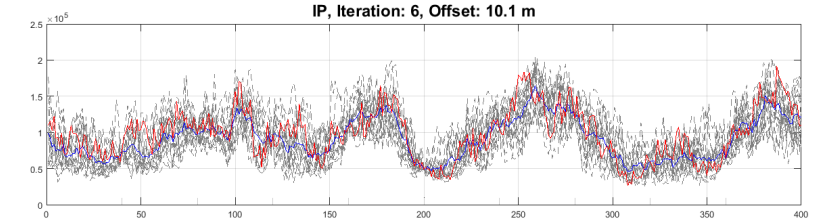
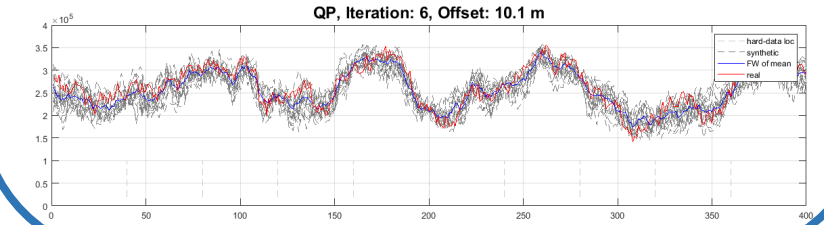
RESULTS – REAL VS. SYNTHETIC EMI DATA

PRP coil orientation

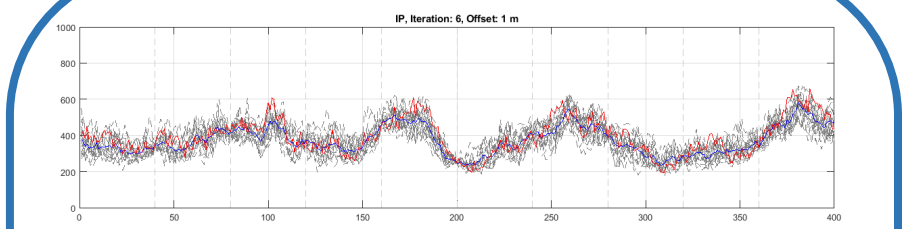


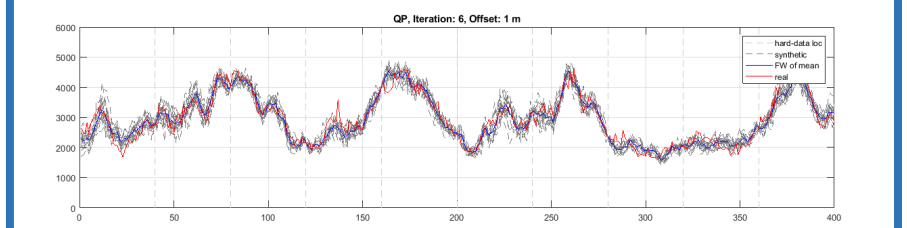


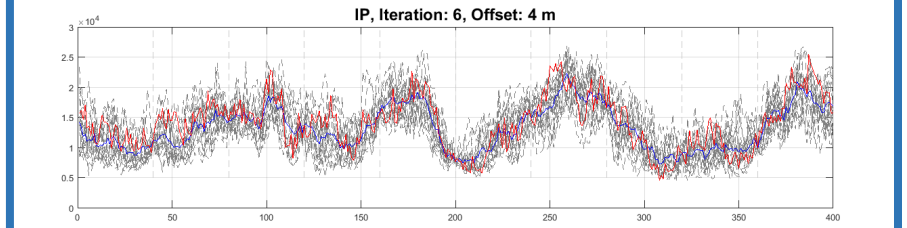


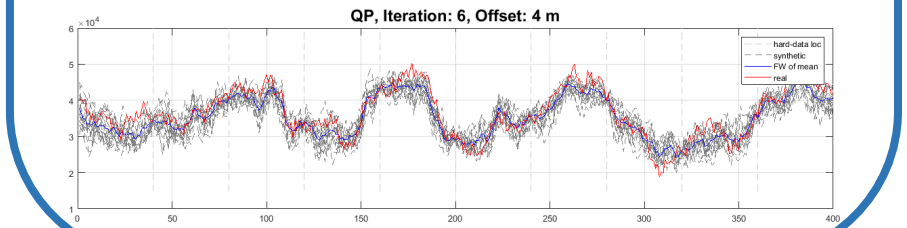


HCP coil orientation









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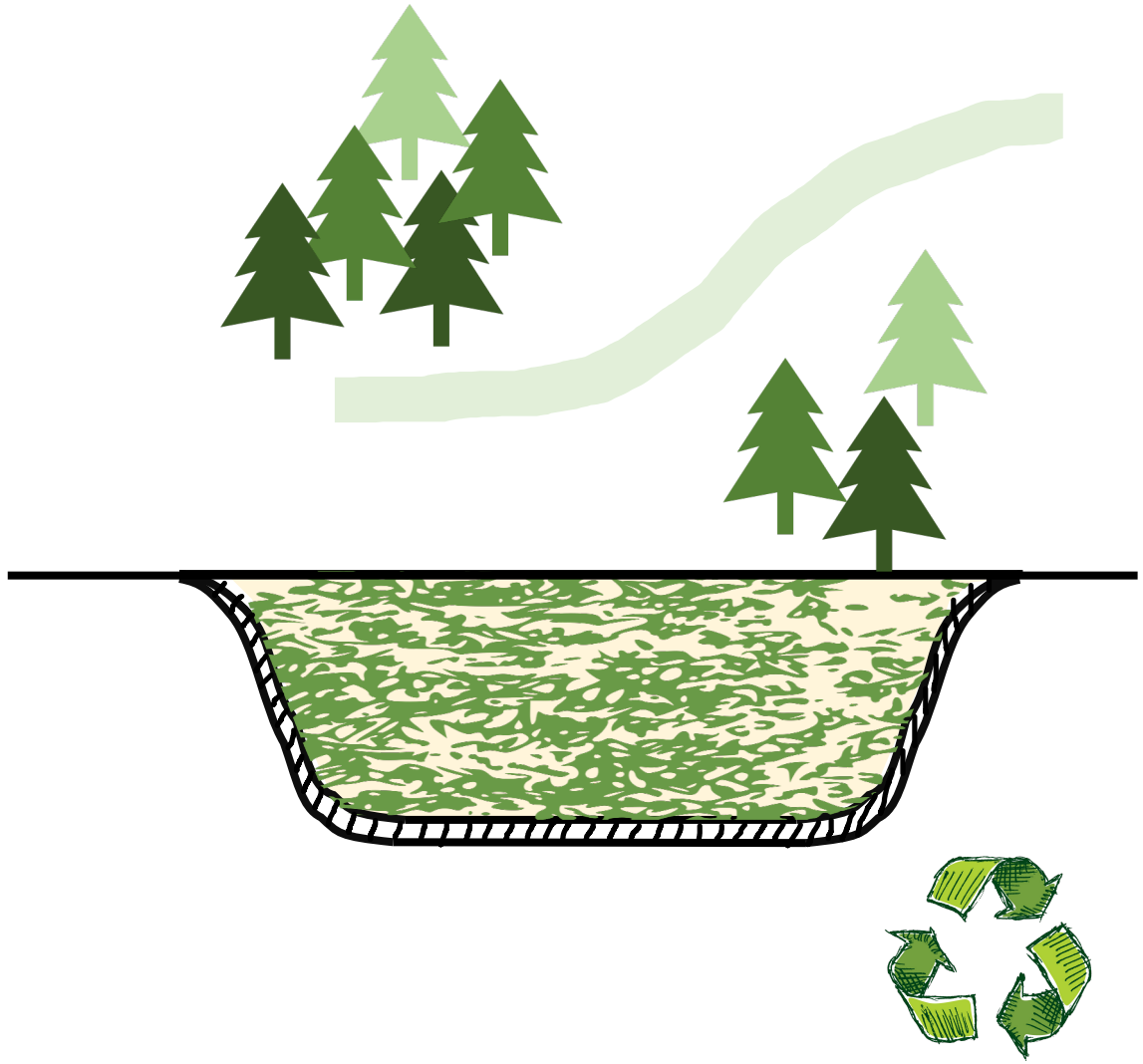

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CONCLUSION

This new geostatistical inversion technique able for the **simultaneous inversion** of FDEM data for EC and MS, which optimize the landfill modelling procedure and is sensitive towards change on the physical properties of interest.

The geostatistical framework enables to address the **uncertainty** of the modelling procedure and allows a more detailed description of the **spatial distribution** of the properties of interest by a spatial continuity pattern imposed by a variogram model.

By providing a flexible framework for integrating different kind of data, the simulated models are simultaneously conditioned by existing **borehole data** and **frequency-domain electromagnetic data.**

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Acknowledgements

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