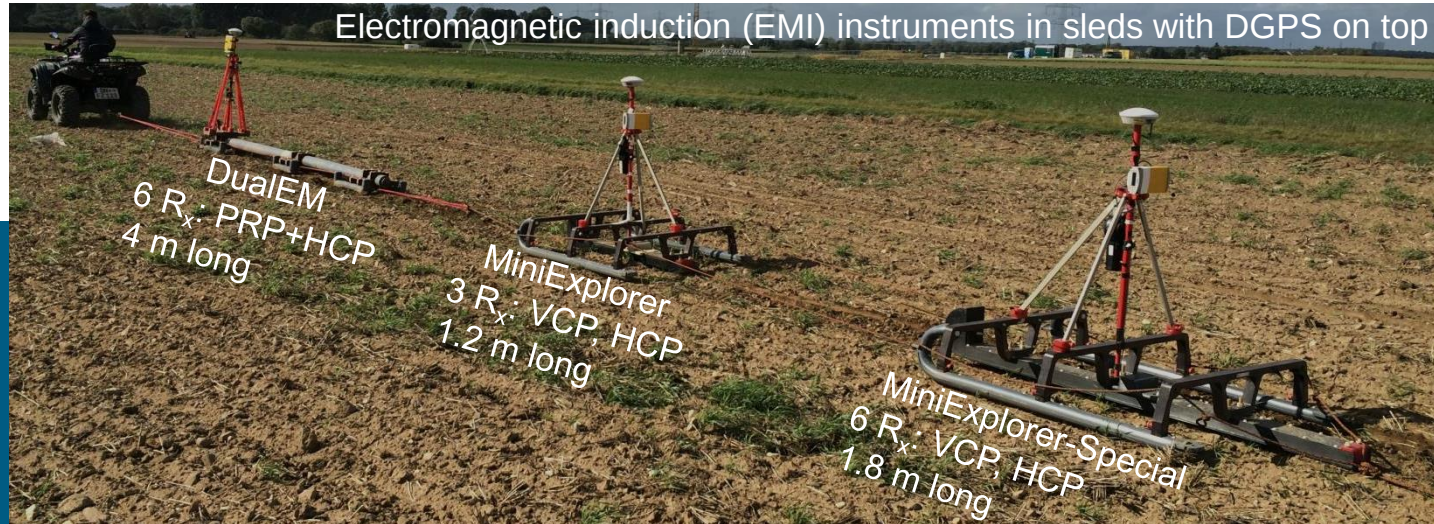




Essence of Multi-coil EMI data: Applications and quantitative inversions for large-scale subsurface characterizations

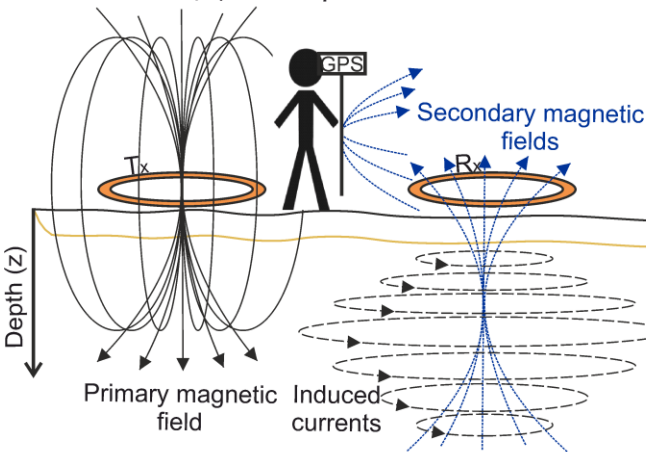
C. von Hebel

Institute of Bio- and Geoscience, Agrosphere, IBG-3

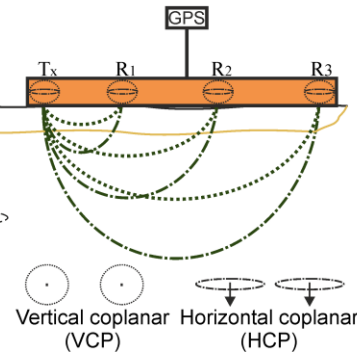
16. Januar 2019

c.von.hebel@fz-juelich.de

(a) Principle of EMI

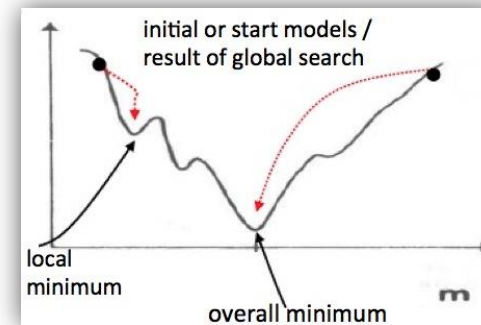


(b) Multi-coil EMI device senses integrated depths



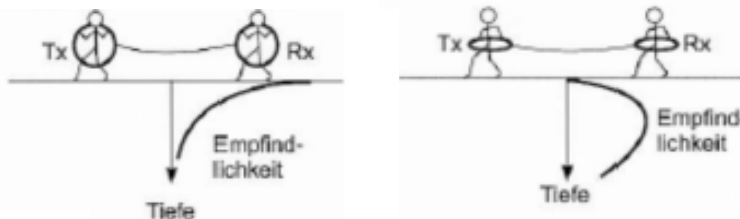
Inversion

- Estimate parameter that relate model and data
- Optimize: data – modelled data $\stackrel{!}{=} 0$



- $T_x \rightarrow$ primary magnetic field (H_p)
- $H_p \rightarrow$ Eddy currents in subsurface
- Eddy currents $\rightarrow$ secondary magnetic field (H_s)
- $H_s/H_p \rightarrow$ measured at receiver R_x , related to apparent electrical conductivity (ECA)

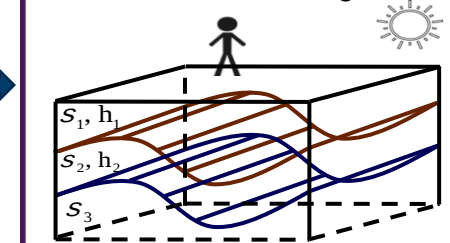
VCP: Highest sensitivity at surface. Depth of investigation (DOI) is 0.75s. **HCP:** Peak sensitivity at depth. Depth of investigation (DOI) is 1.5s (s:= coil separation)



Optimized parameters at spatial regular grid nodes

σ_1, h_1	σ_1, h_1	σ_1, h_1
s_2, h_2	s_2, h_2	s_2, h_2
s_3	s_3	s_3

3D structural image



Summary of quantitative EMI inversion

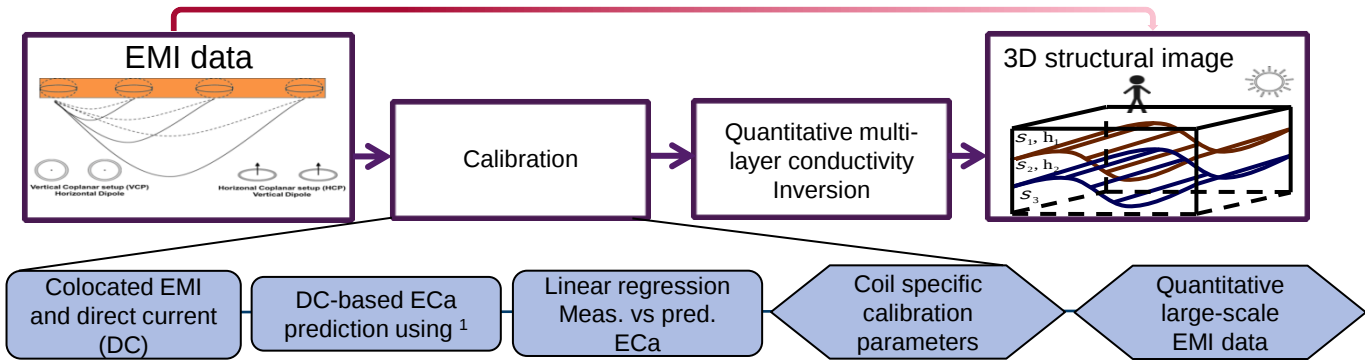
Inversion scheme:

Shuffled complex evolution (SCE)*

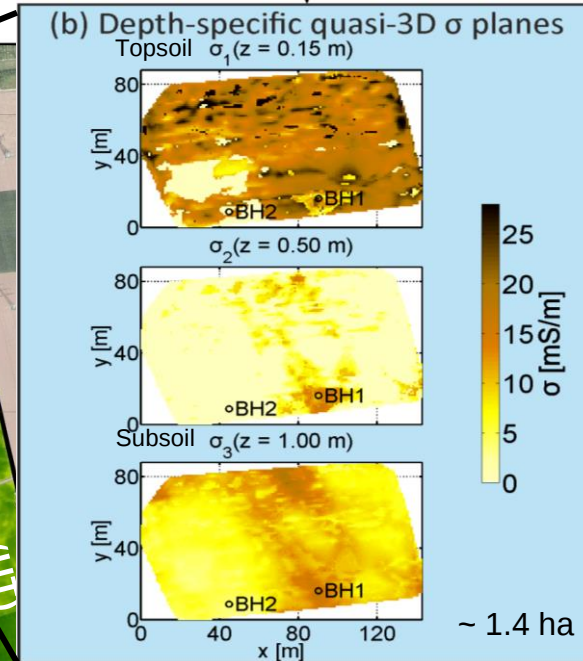
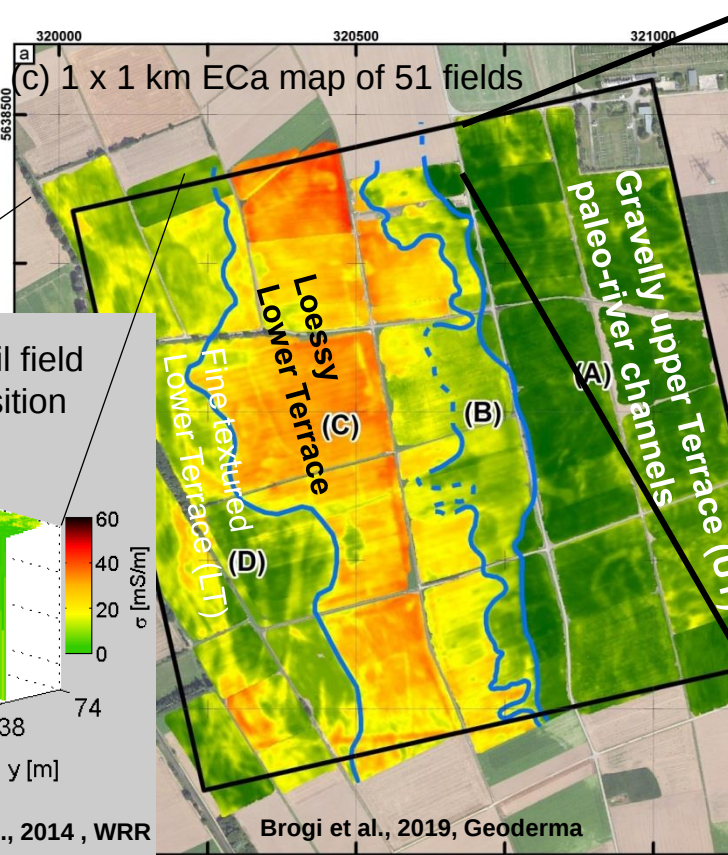
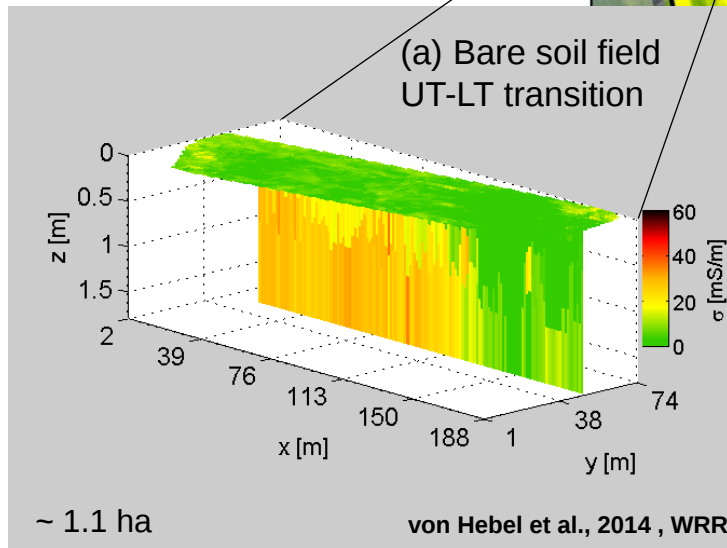
- ✓ Global optimization
(* Duan et al. 1996)
- ✓ L1-norm, no regularization
→ Sharp layer boundaries

¹Exact Maxwell-based EMI forward model

- ✓ Horizontal layer
- ✓ No assumptions except quasi-static approximation



Must: Calibration of multi-coil EMI data for reliable quantitative inversions.



von Hebel et al., 2018, GRL