A floating Transient Electromagnetic System to Acquire Dense Data on Volcanic Lakes - Investigation of the Furnas Hydrothermal System, Azores

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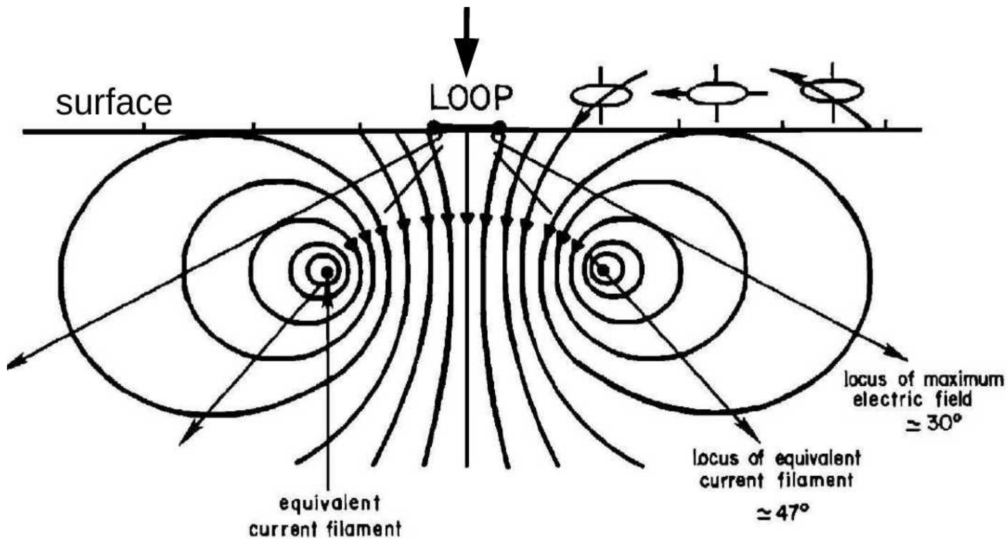
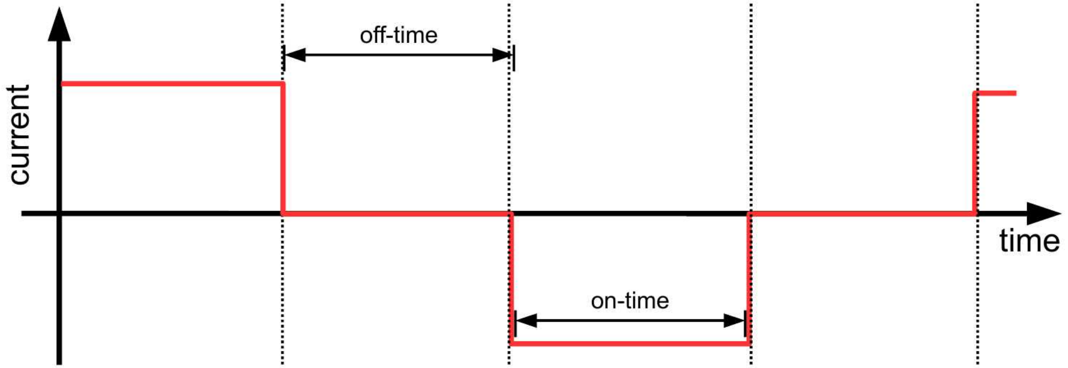
Central loop TEM - short recall of method

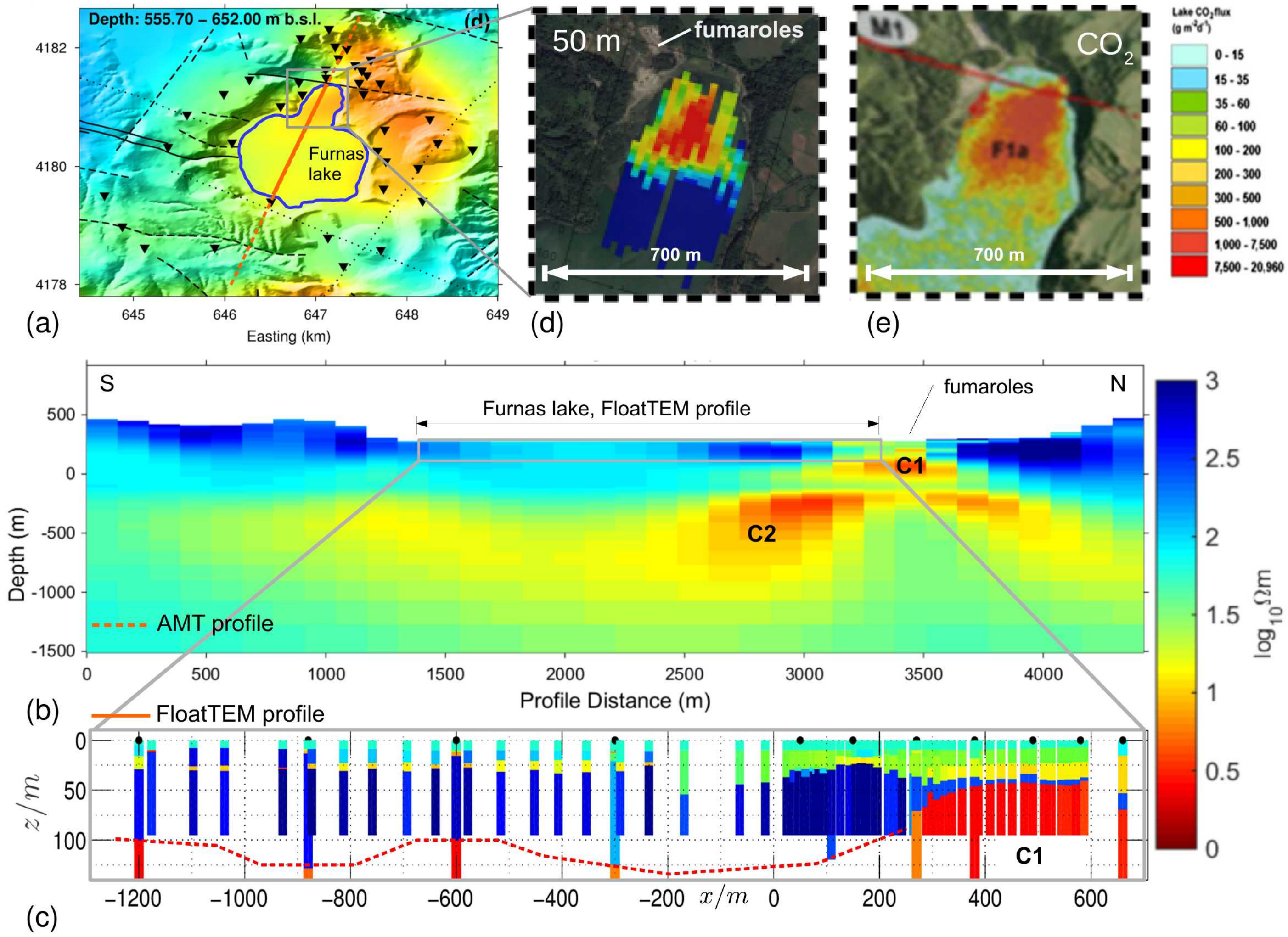




[Nabighian & Macnae, 1991]

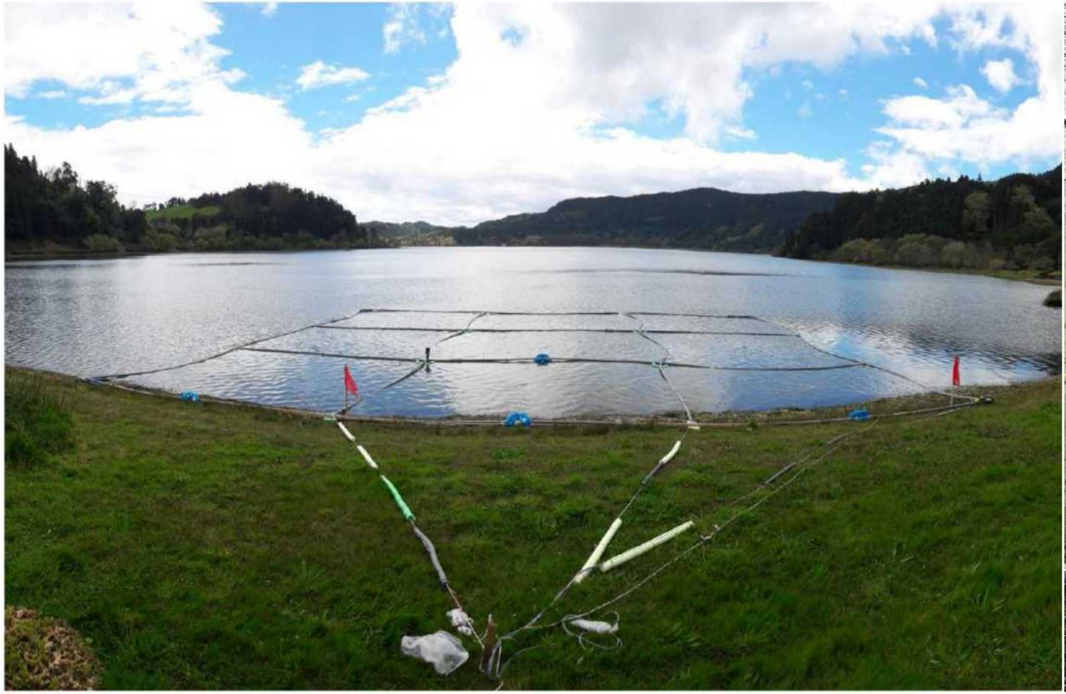
- 1D case:
  - pure TE mode E-fields
  - no horizontal components for central loop
- EM fields focused under Tx-loop
- 1D inversion of loop TEM data is **conventional approach and often sufficient**

The Furnas System & Preliminary Work done



- AMT, DCR & CO2 mapping
- 3D AMT model provided by DIAS
- FloatTEM survey with DOI down to 190 m

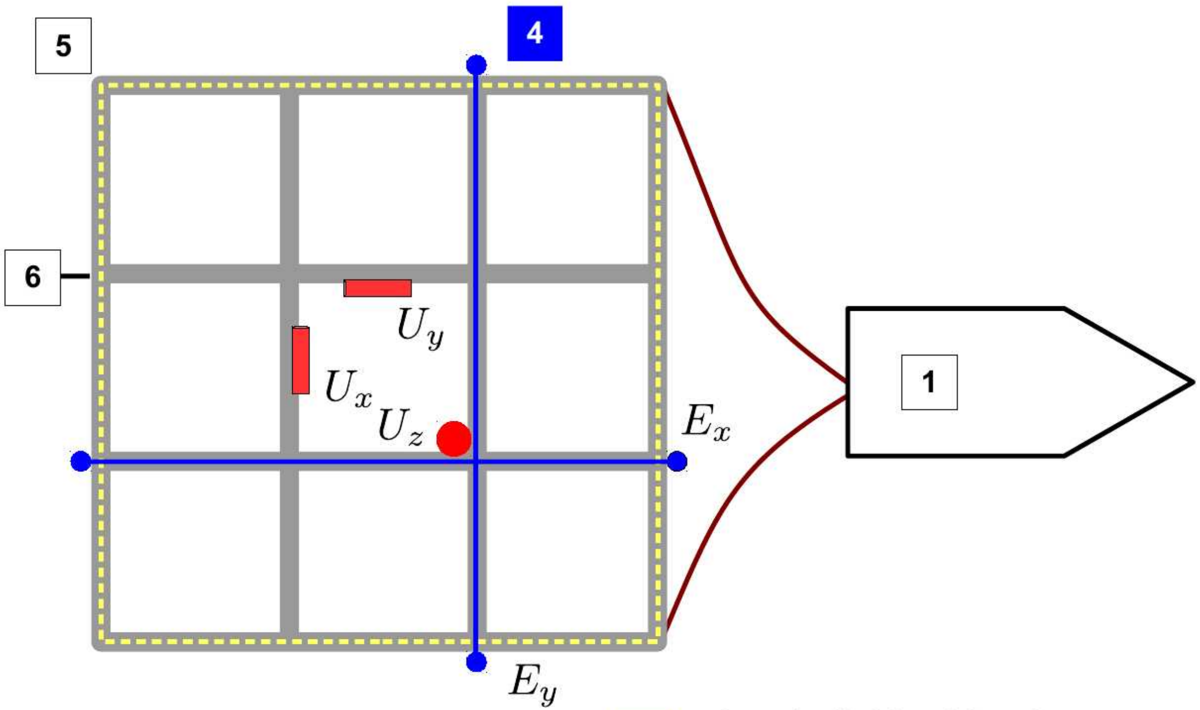
The Original FloatTEM system



The Original FloatTEM system

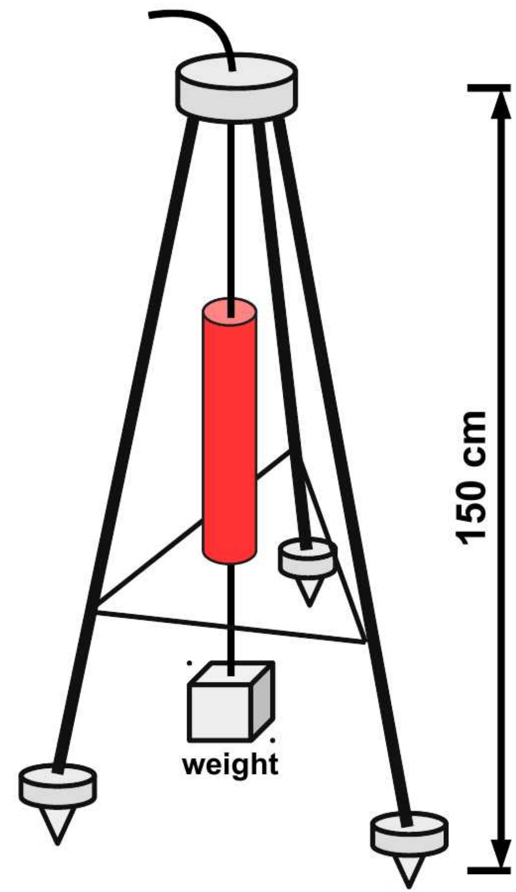
New modified 3D FloatTEM system

Modified FloatTEM tube frame

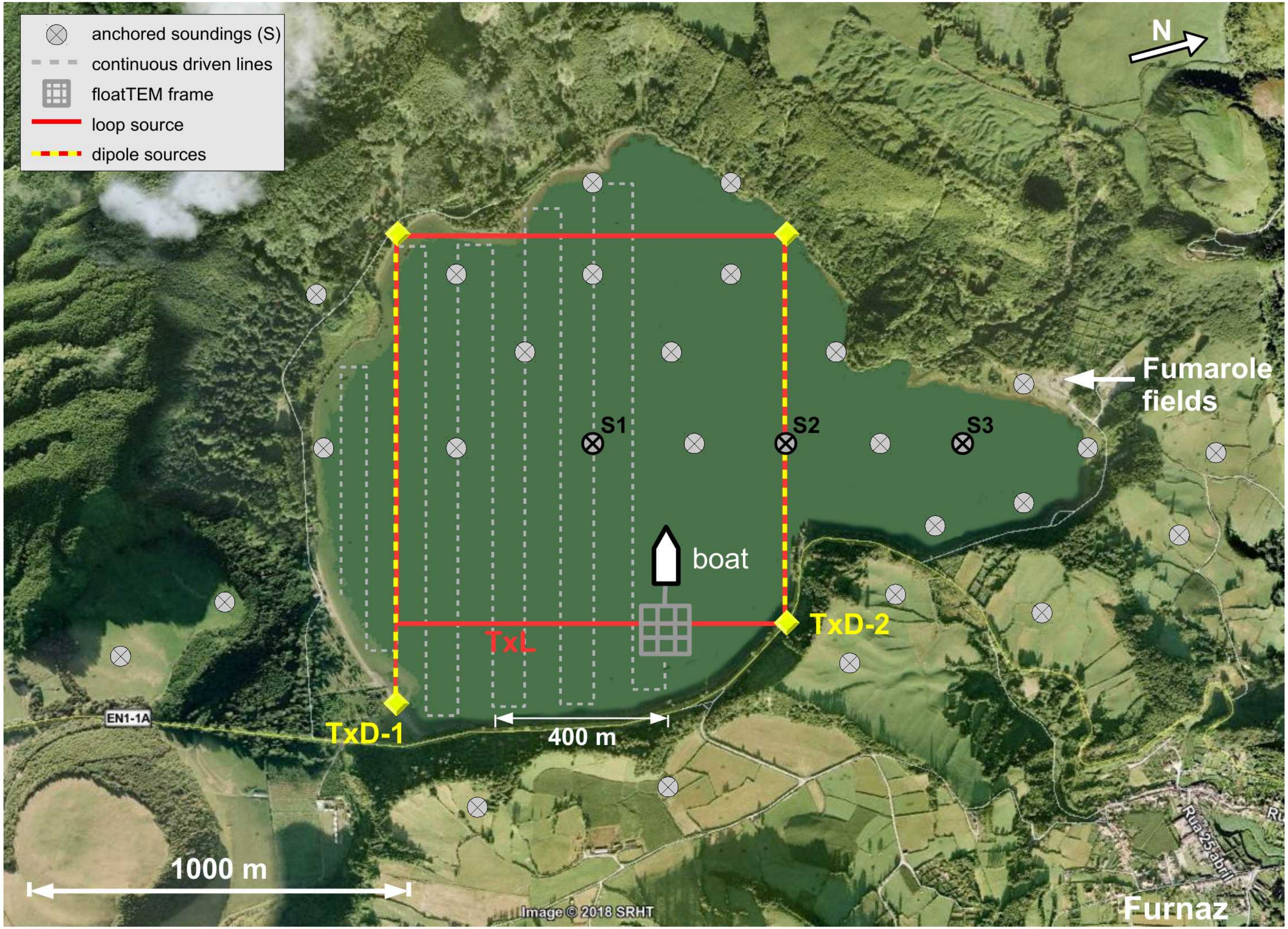


- 1 — boat with KMS logger system & 2-3 people
- 2 — Uz receiver cable with 40 turns inside outer tube frame
- 3 — pressure case with TEM-3 induction coil
- 4 — electric field cables & water electrodes
- 5 — GPS at each outer frame corner for accurate positioning
- 6 — second boat for anchoring & stabilizing system

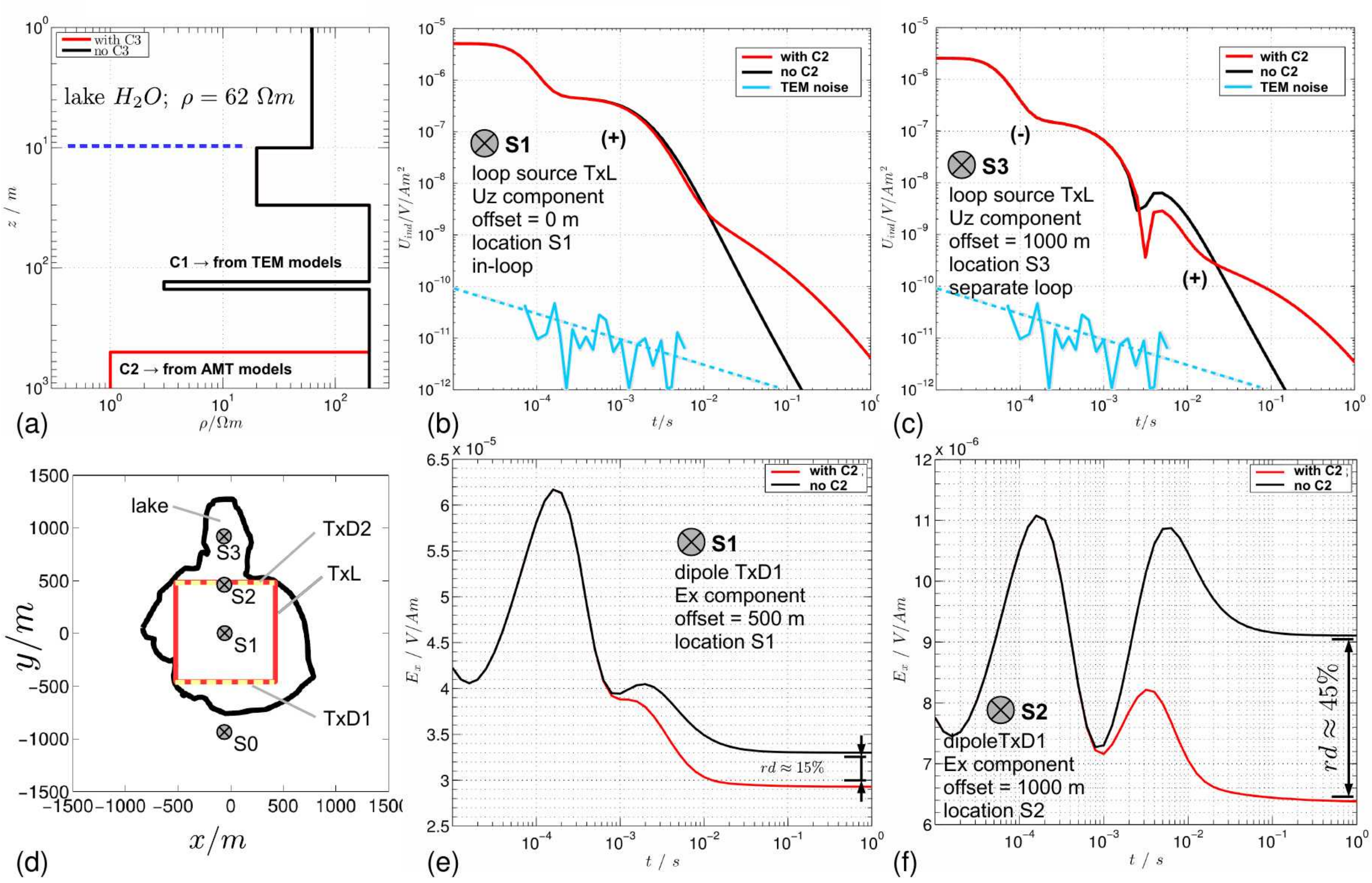
TEM-3 underwater - tripod



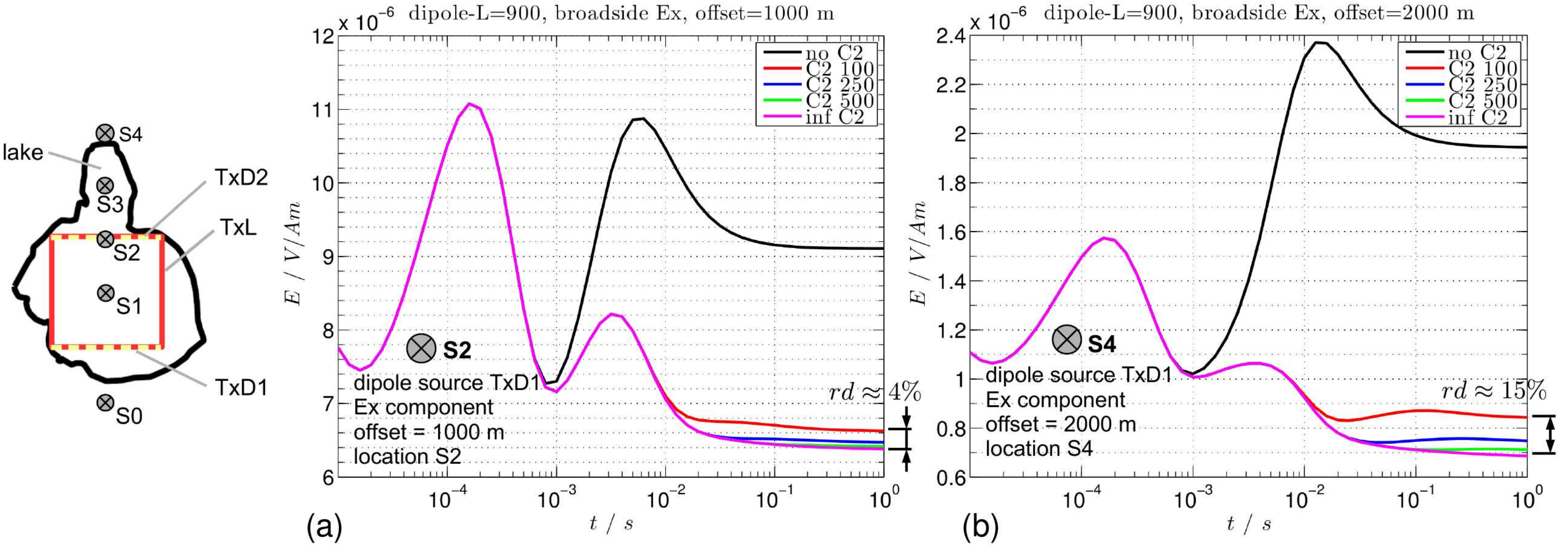
Proposed 3D FloatTEM system



1D Modeling of top of the deep conductor C2

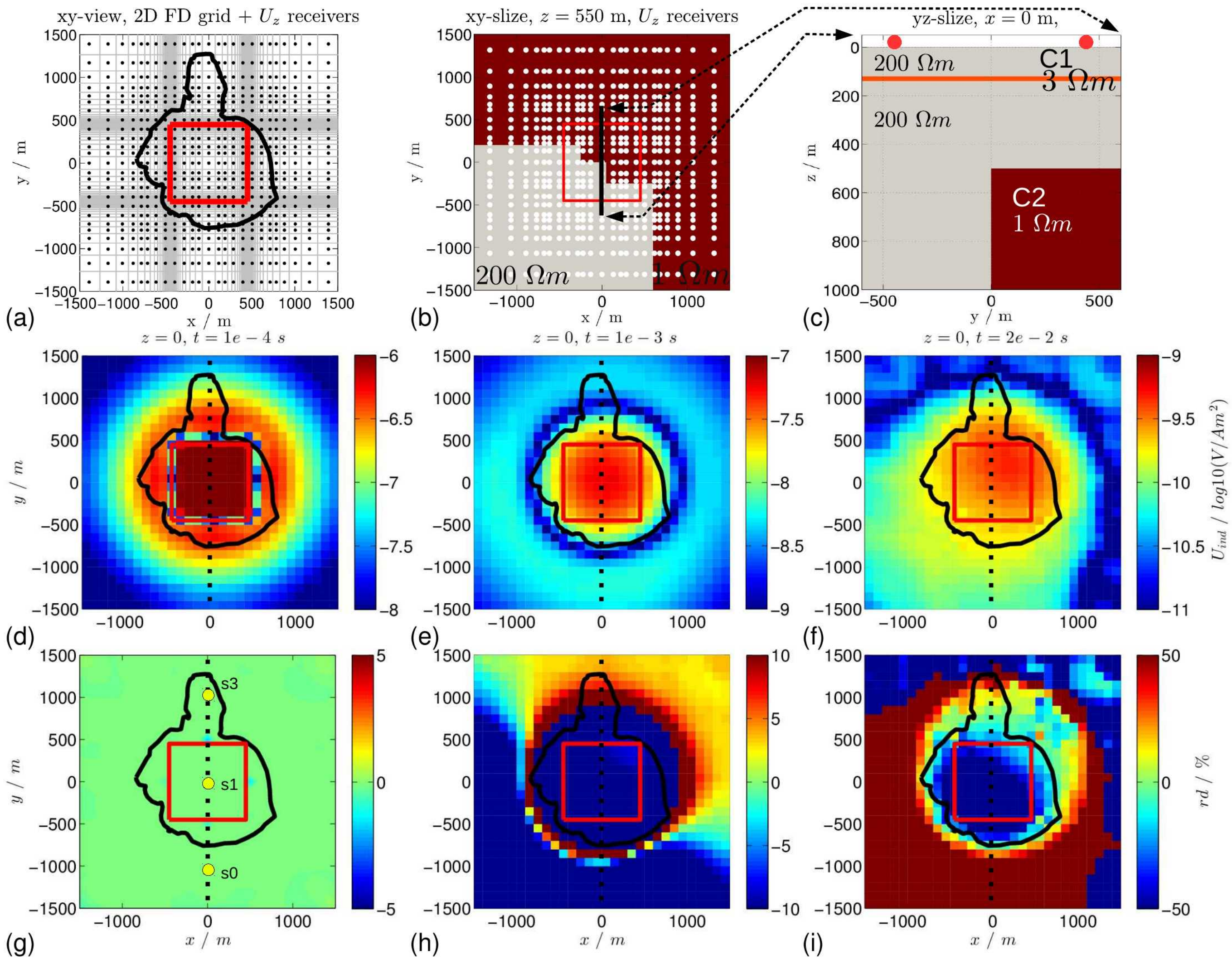


1D Modeling of lower boundary of conductor C2 / dipole setup

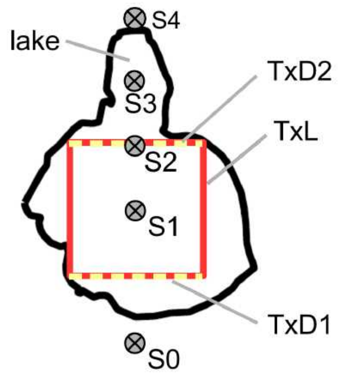


→ lower boundary only resolved with E-fields and with limited resolution

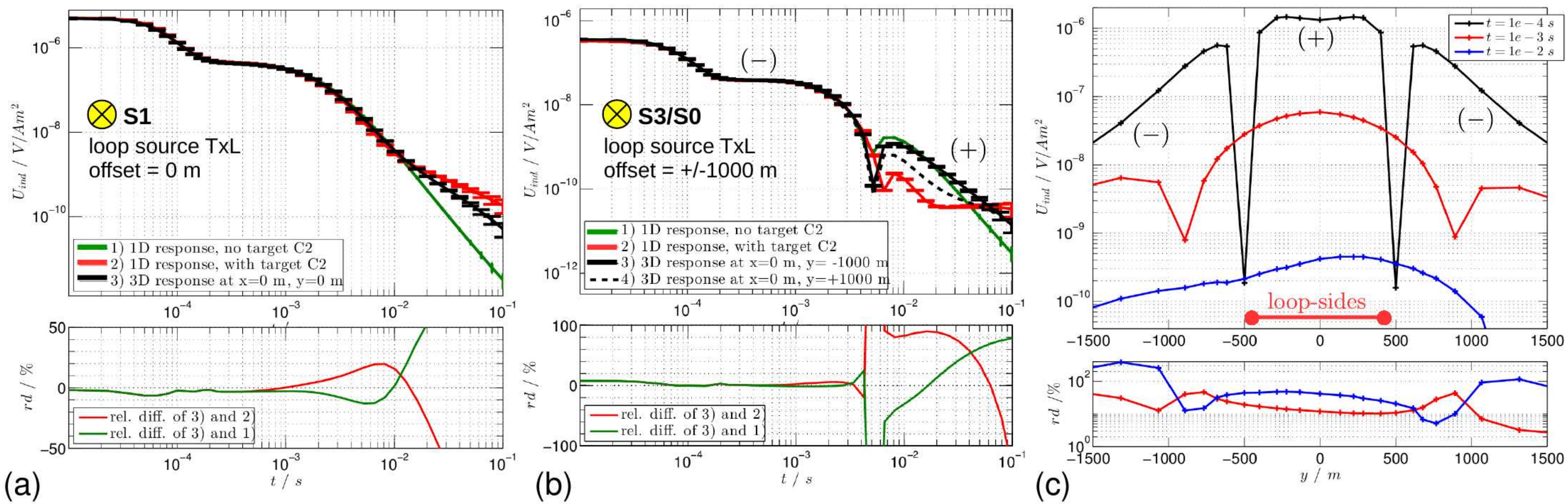
3D Modeling of deep continuous/discontinuous conductor C2



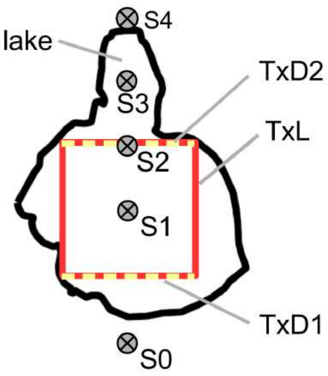
3D Modeling of deep continuous/discontinuous conductor C2



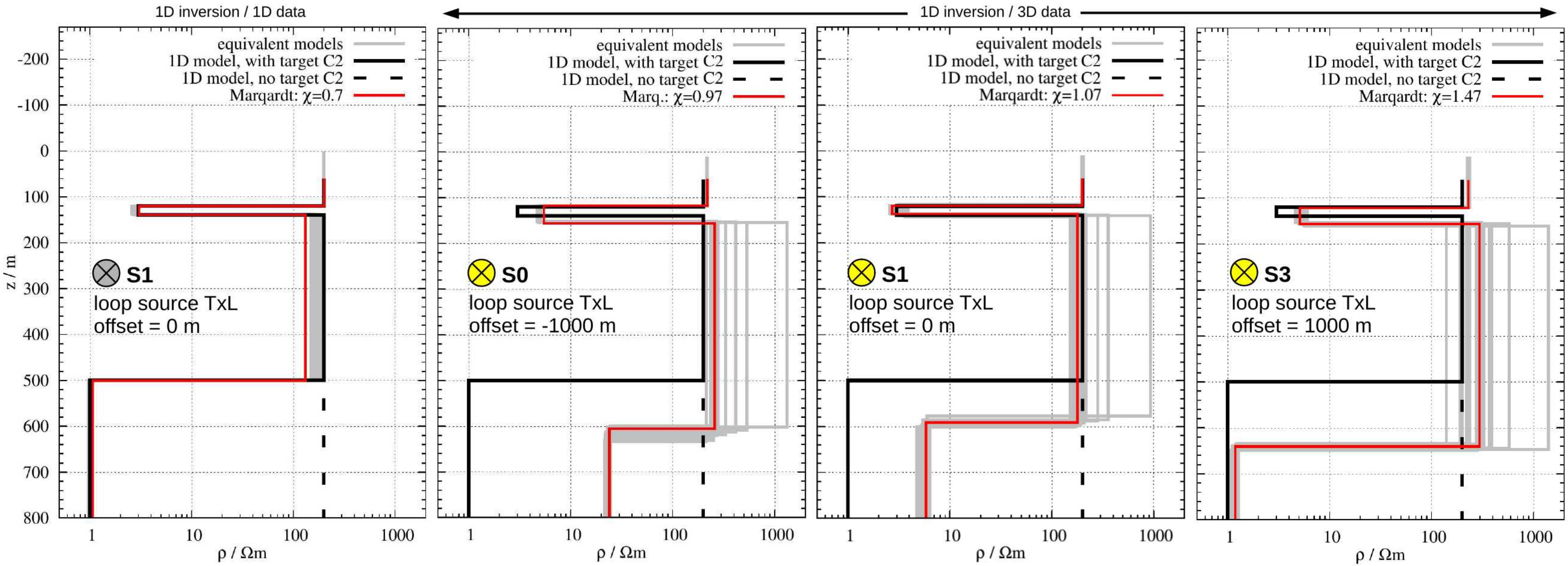
→ distortion effects clearly visible in soundings
→ asymmetric 3D response along profile line



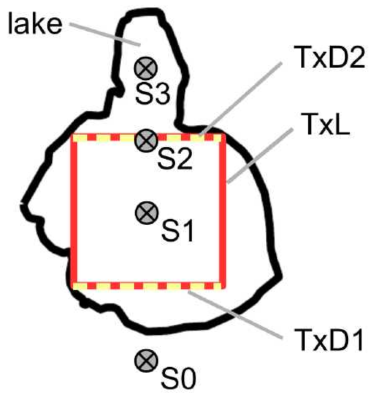
1D inversion of 3D data - discontinuous conductor C2



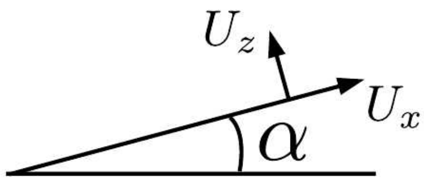
1D inversion
→ data fitted optimal
→ false/wrong models
→ miss-interpretations if no 3D inversion applied



Effect of sensor attitude / sensor rotation - dipole source



$tilt\ angle\ \alpha$

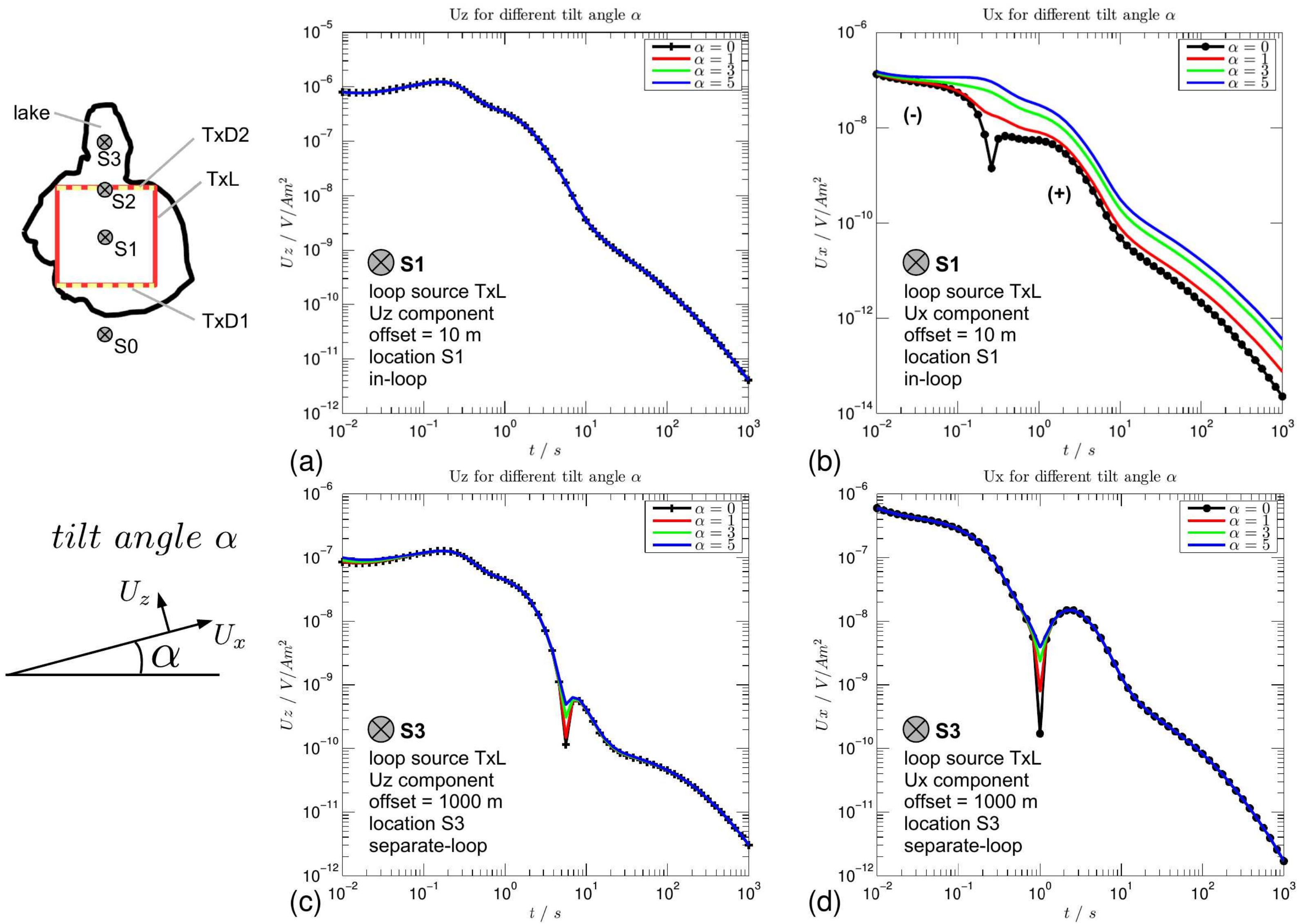


- receiver system affected by motion (yaw, pitch, roll)

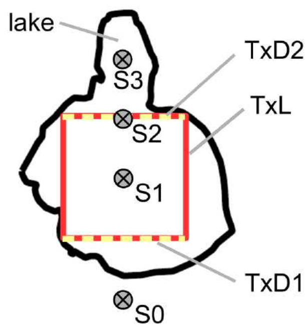
$$U_{x,\alpha} = \sqrt{((\sin(\alpha)U_z)^2 + (\cos(\alpha)U_x)^2}$$
$$U_{z,\alpha} = \sqrt{((\cos(\alpha)U_z)^2 + (\sin(\alpha)U_x)^2}.$$

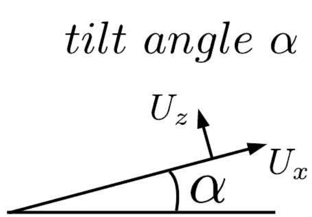
- E.g. small effects for Uz in-loop; large effects of seperate loop data
- dipole source data is affected stronger
- correction of sensor attitude required (processing approach follows Nittinger et al. 2017 as used in DESMEX project for Semi-airborne data)

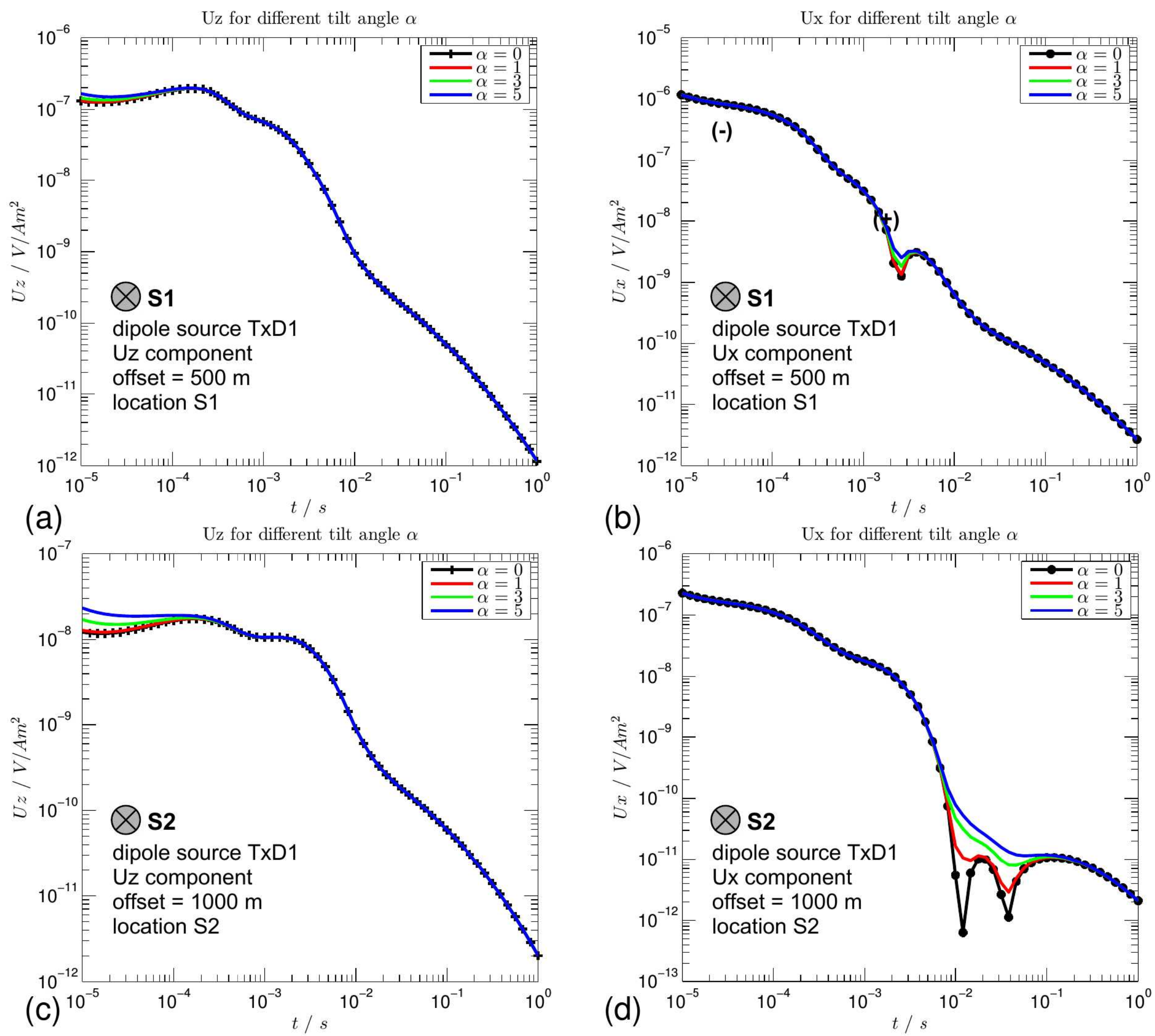
Effect of sensor attitude / sensor rotation - loop source



Effect of sensor attitude / sensor rotation - dipole source







Summary / Conclusions

→ 3D FloatTEM concept presented
  → currently AMT / FloatTEM data lack deep resolution below lake
  → reconstruction of deep hydrothermal reservoir below lake Furnas
→ dense multi-source & multi-component EM data
→ new / innovative approach for EM on water
→ combination of land-based sources with floating receivers
→ dipole & loop sources for increased resolution for conductive and resistive structures