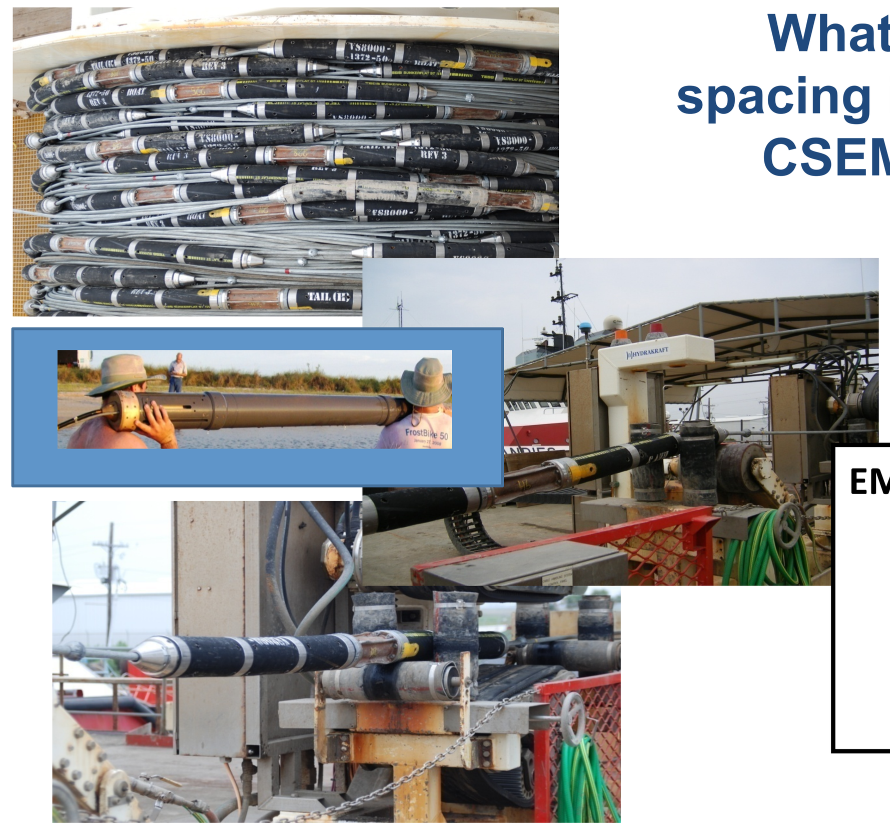
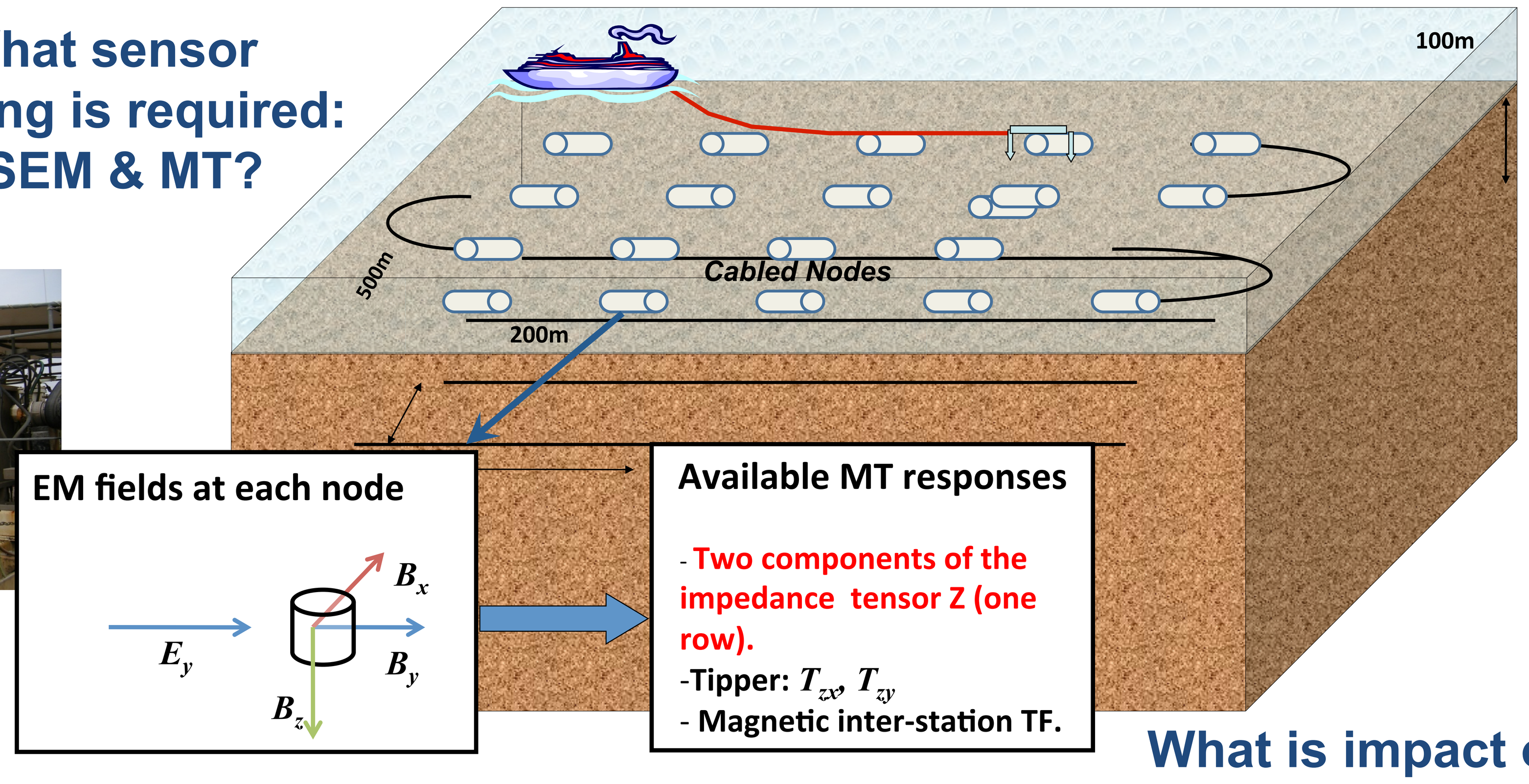
Cabled marine magnetotellurics: denser data at lower cost & higher information content

Gary Egbert, Oregon State University; Naser Meqbel, GFZ Potsdam; Kurt Strack, KMS Technologies*

Prototype cabled marine EM system: CSEM + MT



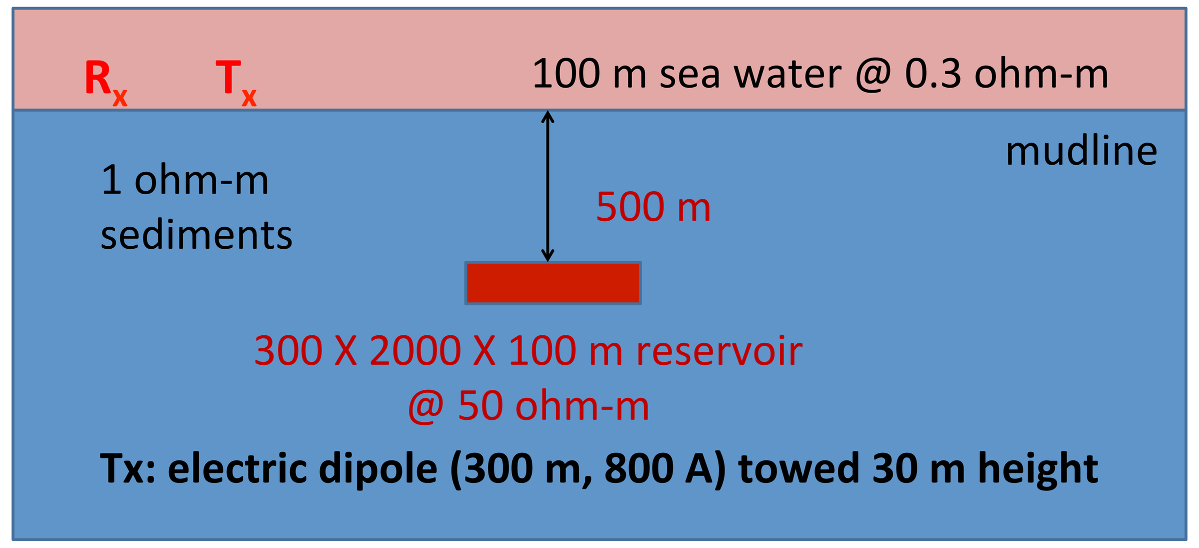
What sensor spacing is required: CSEM & MT?



What is impact of missing components on 3D MT inversion?

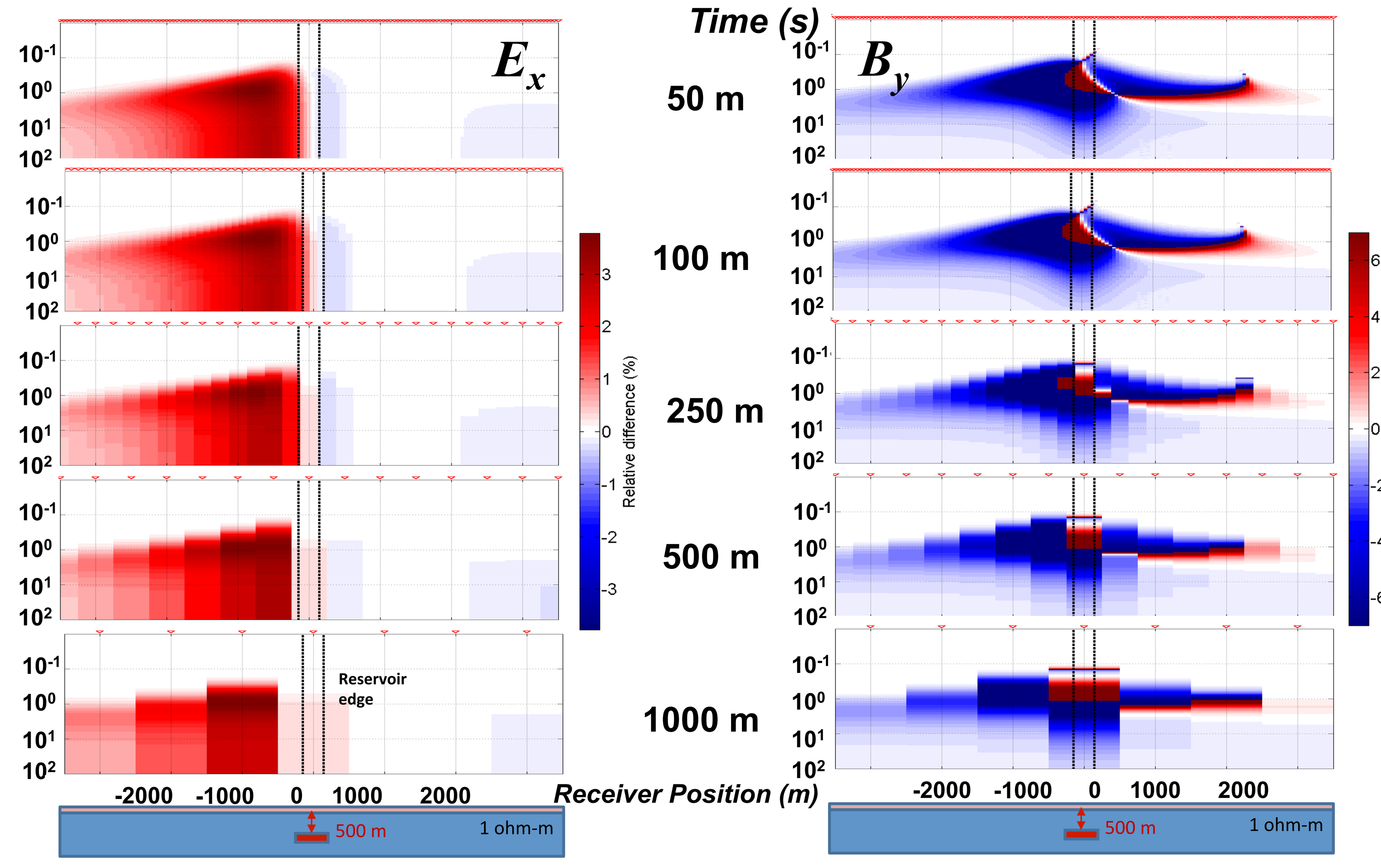
CSEM: Impact of sensor spacing:

- 3D modeling study
- Thin resistive reservoir in conductive sediments



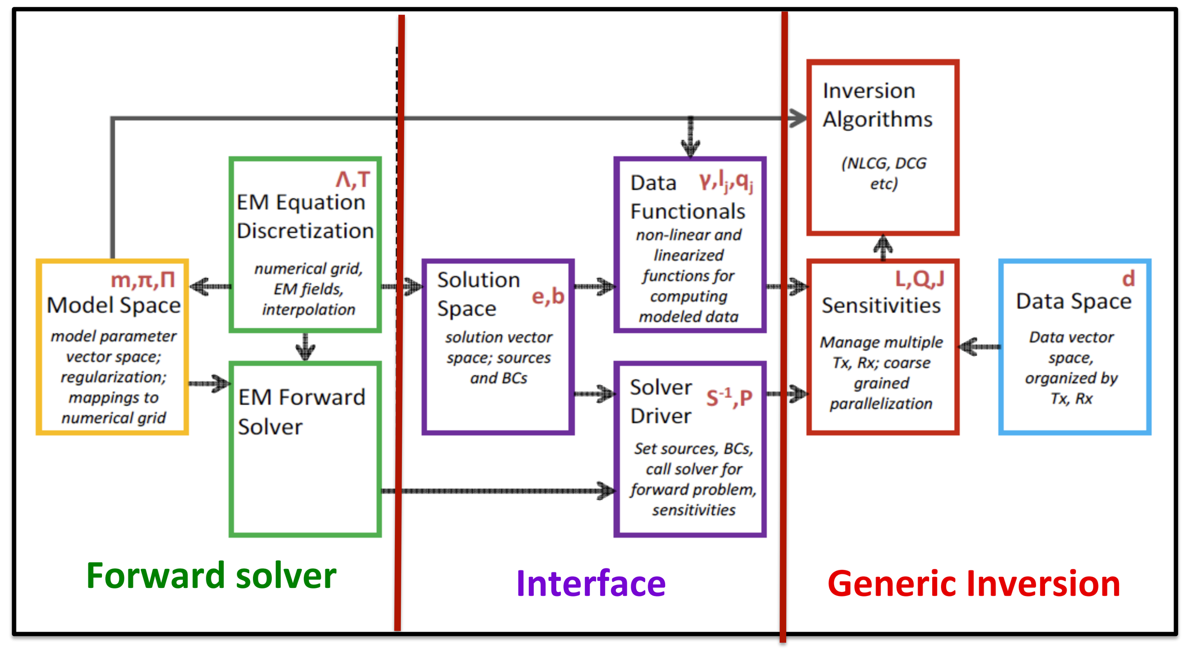
High sampling density (ΔRx < 250 m) required to adequately image this simple target

Modeled relative difference response
Common offset 1000 m, different sensor spacing



ModEM: A general system of software for regularized (linearized) inversion of 3D EM data

- Allow inversion methods developed for one problem to be transitioned to other EM problems (e.g., MT→ CSEM)
- Efficiently implement multiple inversion schemes; prototyping/ testing new approaches
- Simplify code extensions (e.g., add new transmitter/receiver configurations or data types, as in this study)
- Take advantage of advances in forward modeling (e.g., faster, more flexible non-structured grids)

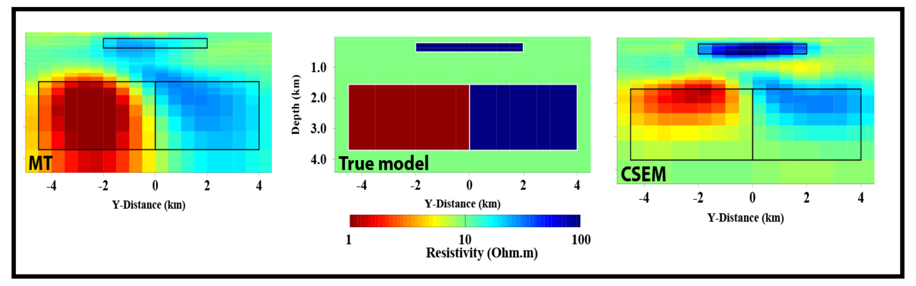


Uses same finite-difference numerical modeling implementation

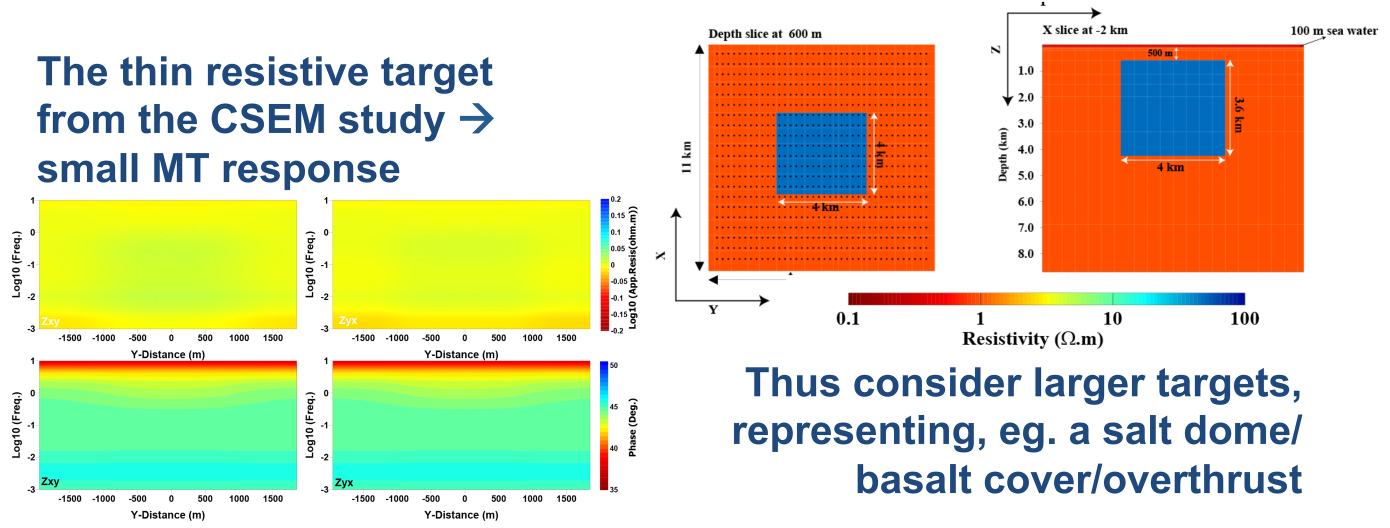
Modify:
- Data Functionals—simplified receivers
- Forward Solver Interface — secondary field formulation

Uses same (generic) inversion routines (including parallelization)

Extensions of ModEM : MT +CSEM Inversion
(N. Meqbel & O. Ritter)

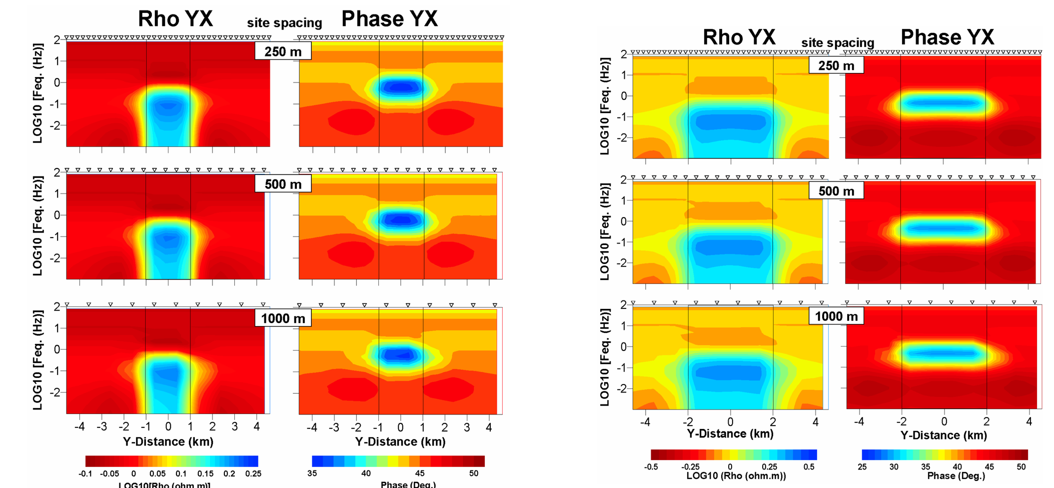


The thin resistive target from the CSEM study → small MT response



Thus consider larger targets, representing, eg. a salt dome/ basalt cover/overthrust

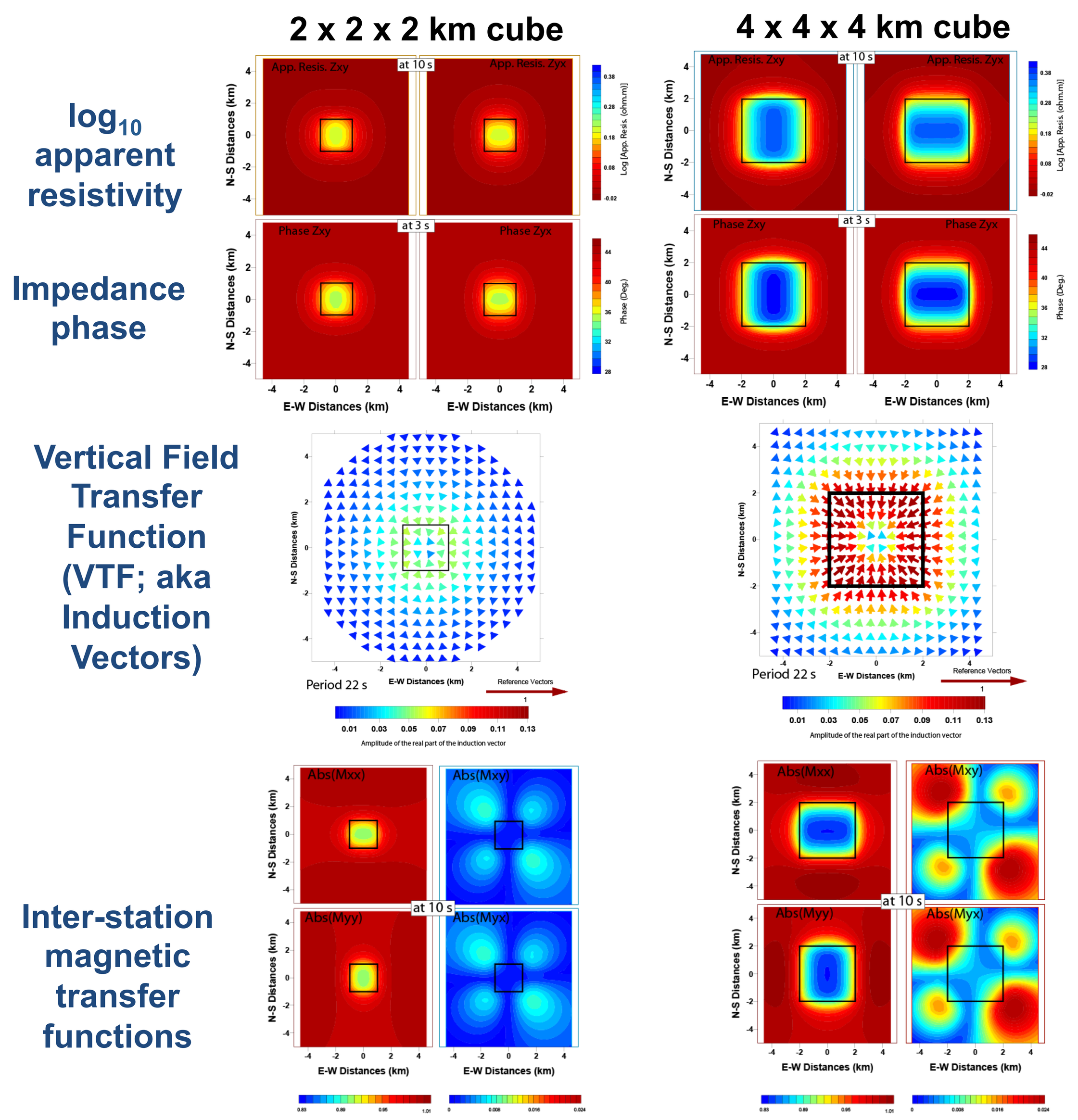
3D MT modeling & inversion tests

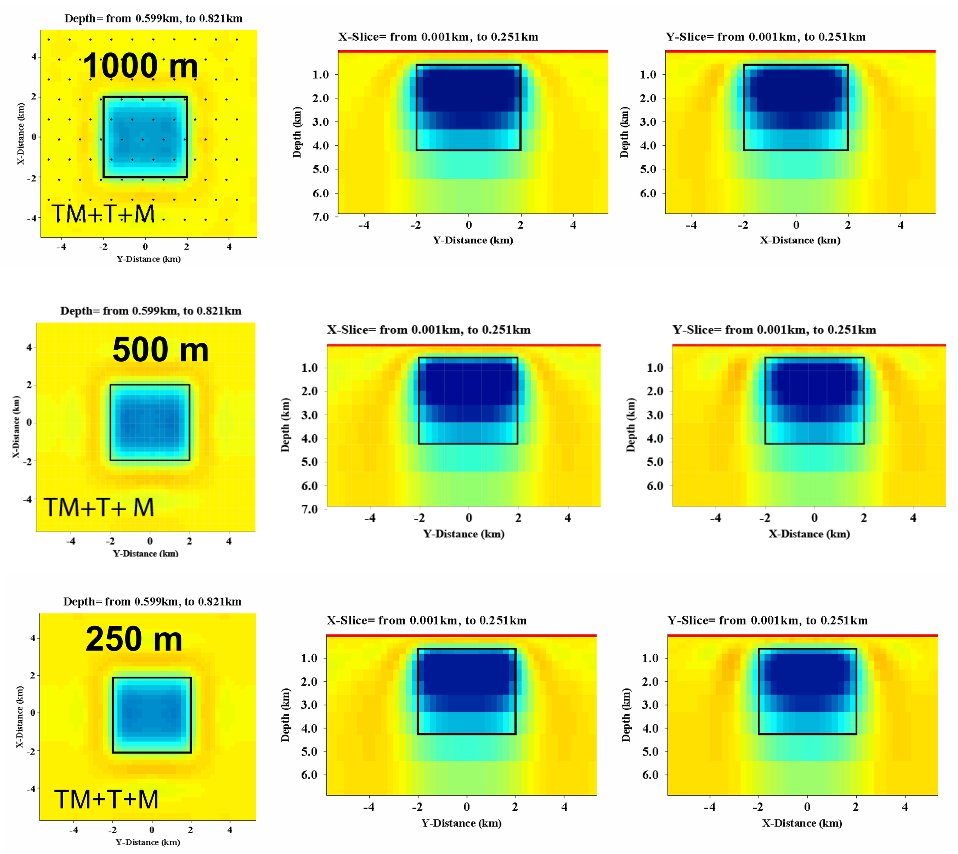


MT responses from simple targets (of detectable size) are resolved with coarser sampling than required for CSEM, where galvanic modes are important

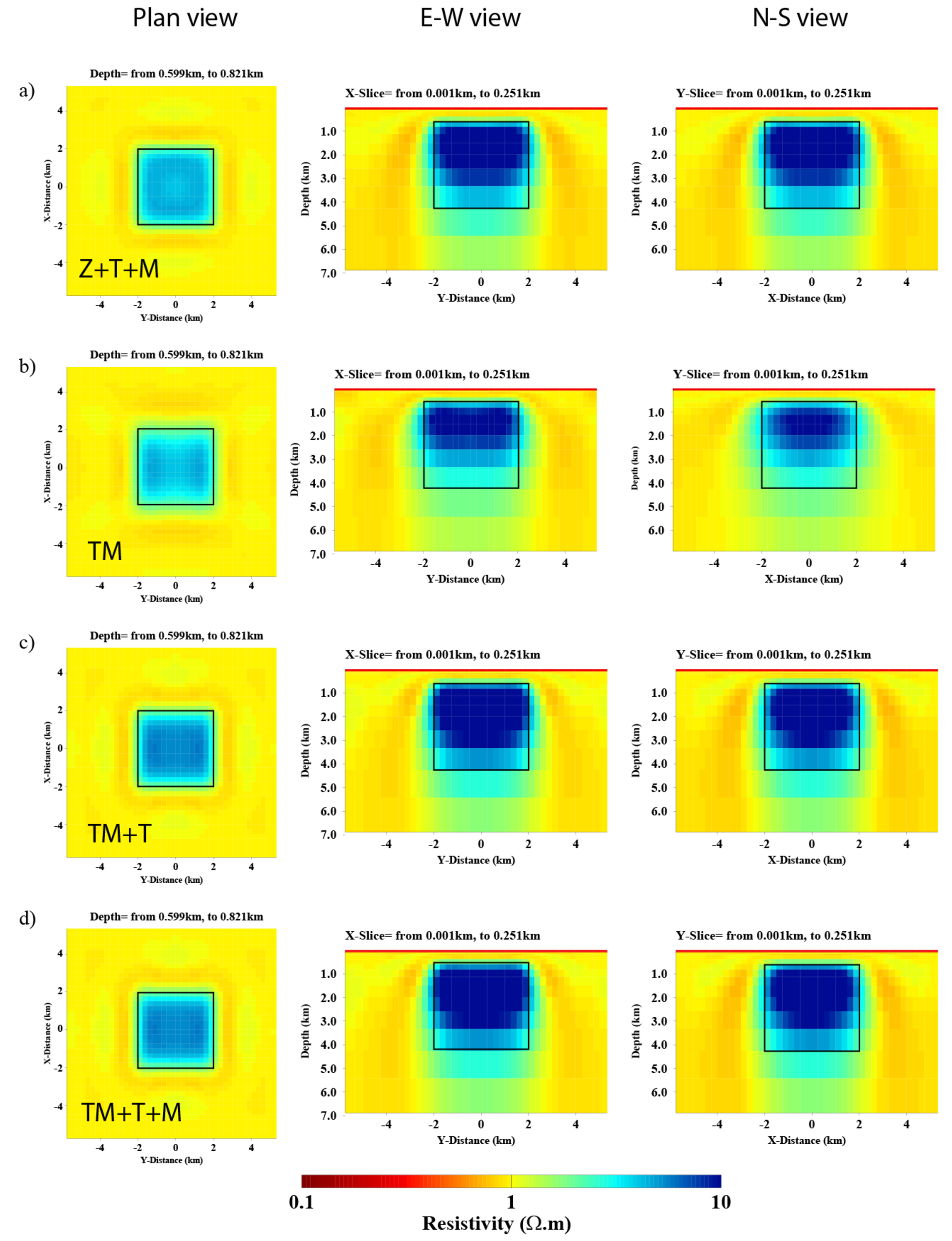
Near surface complications (e.g. topography, more complex shallow structure) would likely require higher sampling density

MT responses: spatially smoother than CSEM





Compare images of the resistive block obtained with full impedance tensor (Z), one row of Z (corresponding to the cable sampling configuration --"TM"), one row of the impedance + VTF (TM+T), and these two TFs plus magnetic TFs (TM+T+M)



Including VTFs improves recovery of the resistive block when one row of the impedance is missing. Note that in all cases amplitudes of the resistive block are substantially reduced.

→ Use denser data – even for MT AND
→ vector interpretation for optimized resolution