Target Detectability

in a

Marine Controlled-Source EM Survey

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SIO Marine EM Lab
Short Course - 17 Feb 2005

www.marineemlab.ucsd.edu

outline

Seismic method shortfalls

Creating a conductivity model

Testing common scenarios in 1-D

- Target thickness
- Target resistivity
- Target depth
- Effect of shallow resistors
  - hydrate
  - evaporite
  - salt
- Effect of shallow water

Discussion / Conclusions

seismic method shortfalls

Seismic Direct Hydrocarbon Indicator analysis is not foolproof:

- Rugose seafloor
- Large acoustic impedance contrast at seafloor

seismic method shortfalls

Seismic Direct Hydrocarbon Indicator analysis is not foolproof:

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- "Fizz gas"
- Oil-Water contact

seismic method shortfalls

Seismic Direct Hydrocarbon Indicator analysis is not foolproof:

- Rugose seafloor
- Large acoustic impedance contrast at seafloor
- "Fizz gas"
- Oil-Water contact
- mud volcanoes, gas clouds
- subsalt imaging
- complex structure

seismic method shortfalls

Will a Marine CSEM survey be sensitive to the resistivity of your target stratum?

"Do the modeling."

outline

Seismic method shortfalls

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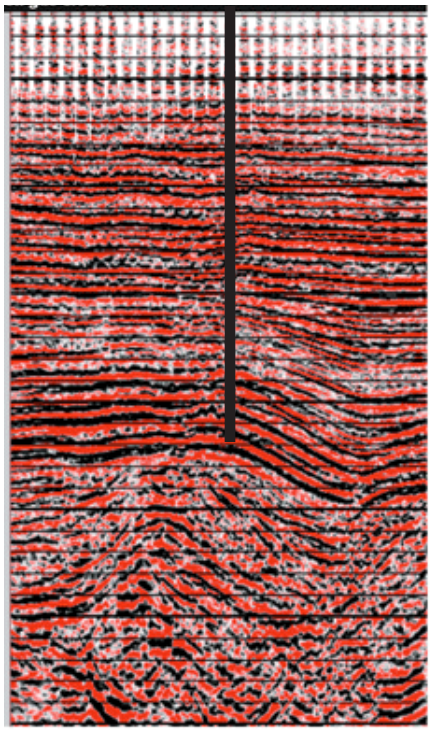
Discussion / Conclusions

creating a resistivity model

seismic section



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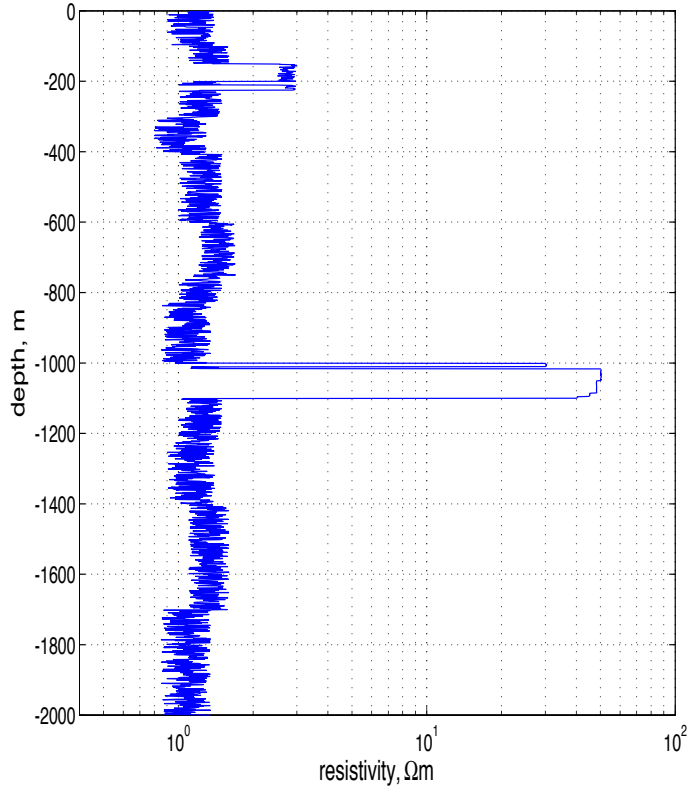
resistivity log



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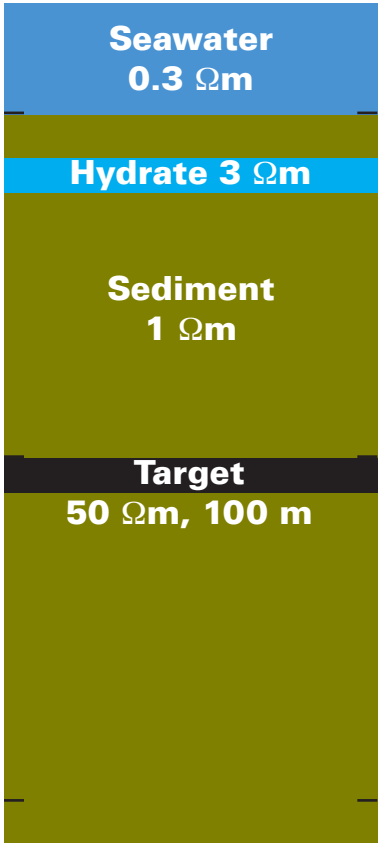
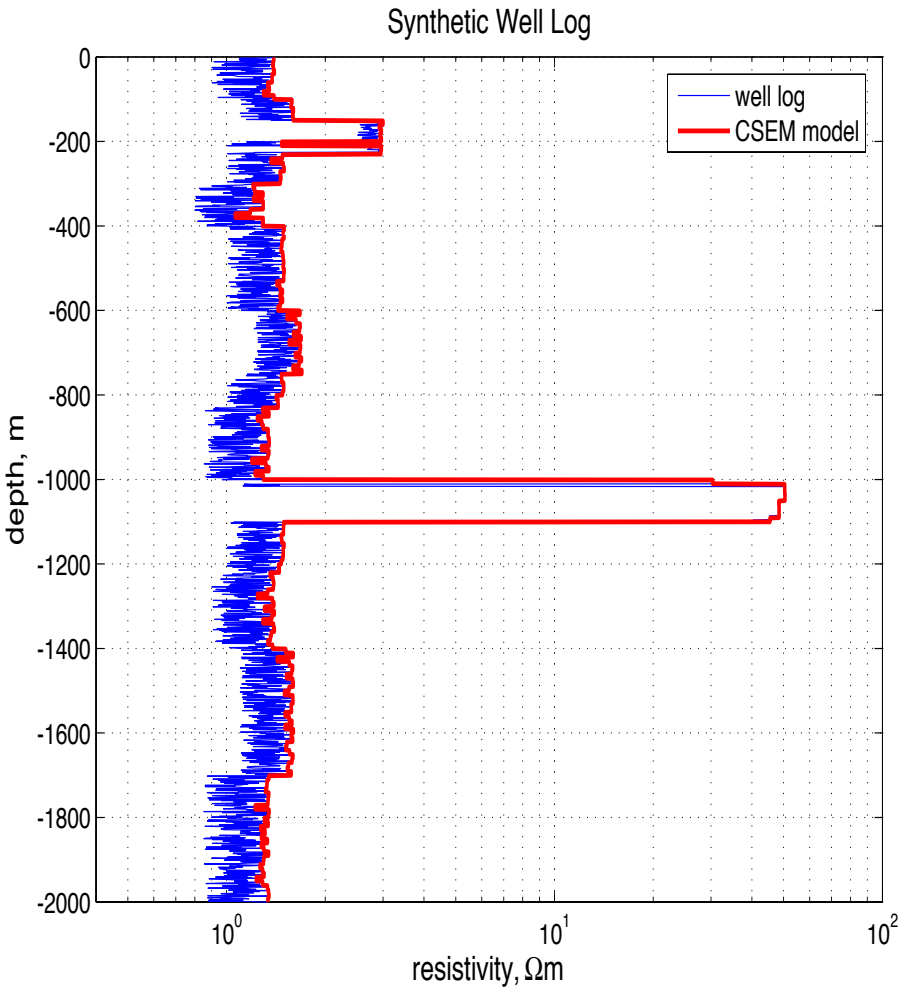


using resistivity logs



Hz - kHz range : low frequency approximation, same as CSEM

MHz range : dielectric effects, unlike CSEM

Logs can be decimated.

If directional logs are available, use vertical (or dip-normal) resistivities.

Laterolog vs. Induction tool

outline

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quick modeling studies

1 - D forward models using Flosadottir and Constable code

Available as WHAM

Instantanious

Rapid assessment of many targets / fields

quick modeling studies

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Radial mode sensitivity to target resistivity

Transmitter height 50 m

quick modeling studies

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Rapid assessment of many targets / fields

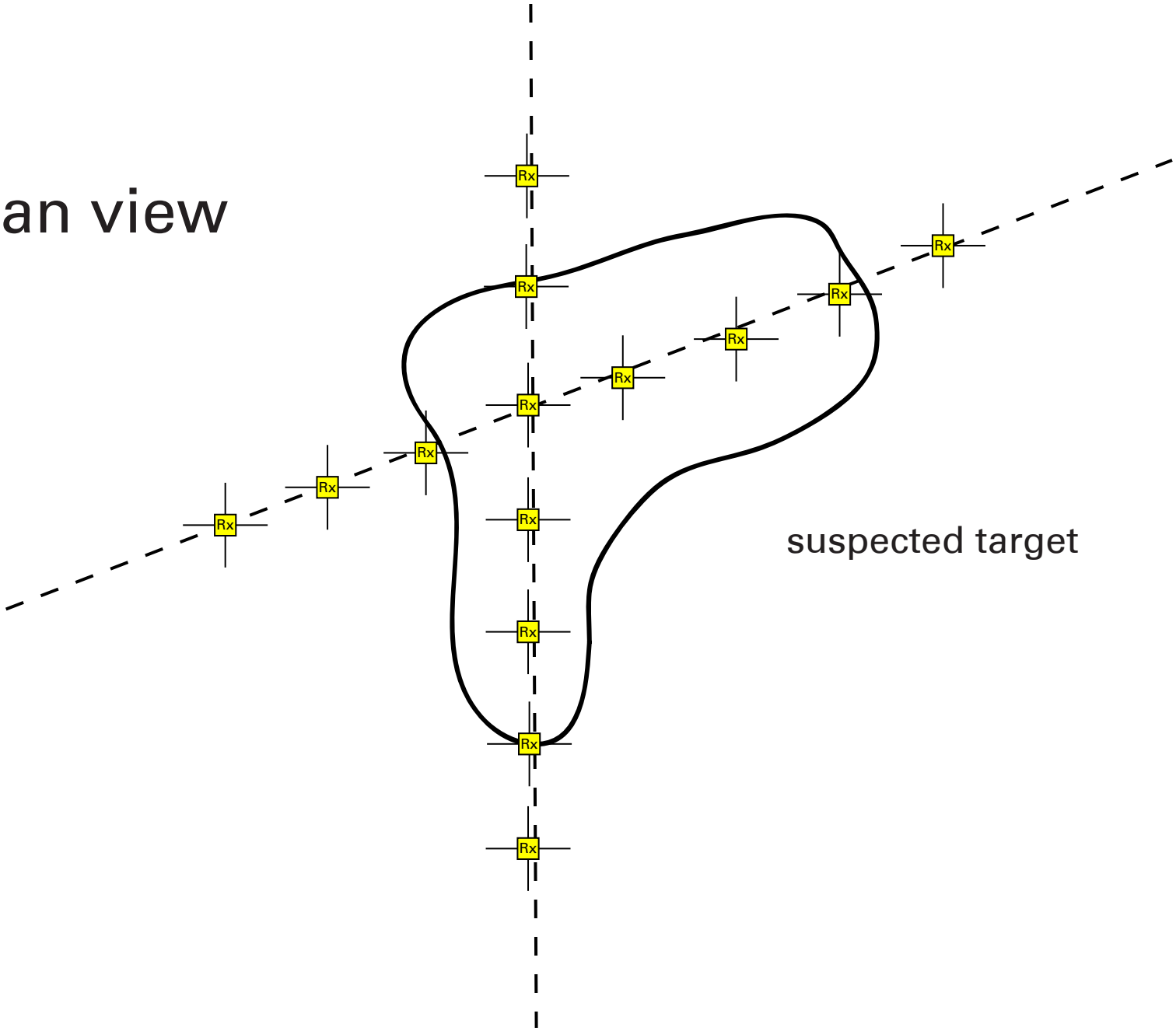
Radial mode sensitivity to target resistivity

Transmitter height 50 m

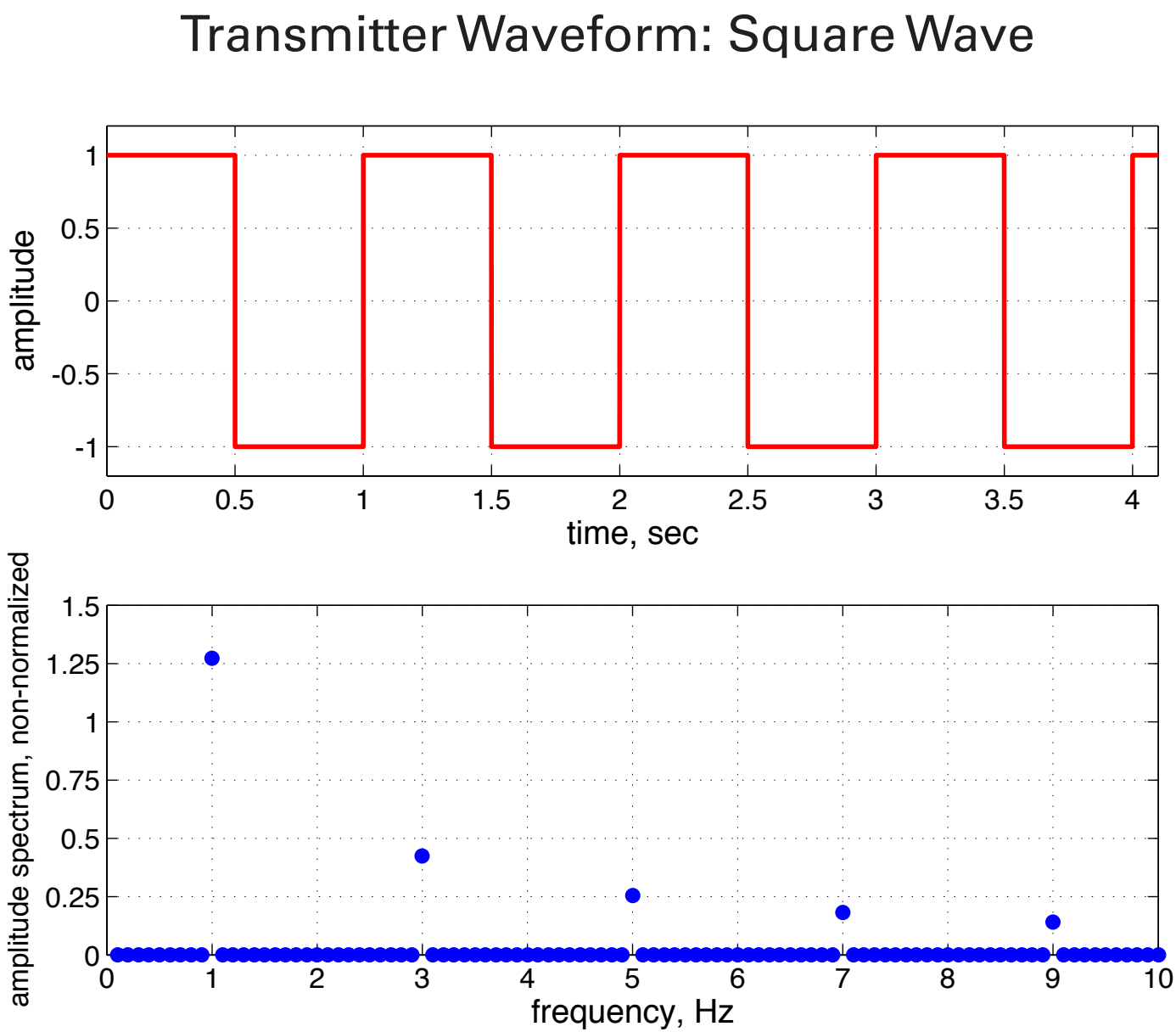
Caution: burial depth vs. lateral extent

generic survey layout

plan view



multiple frequencies available



outline

Seismic method shortfalls

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Testing common scenarios in 1-D

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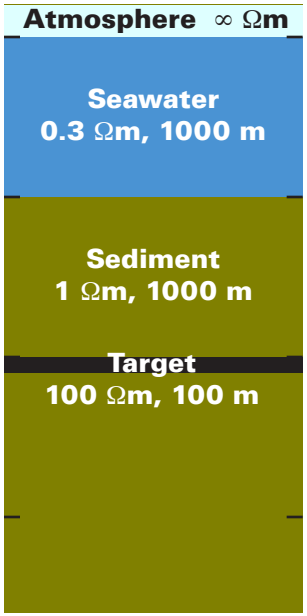
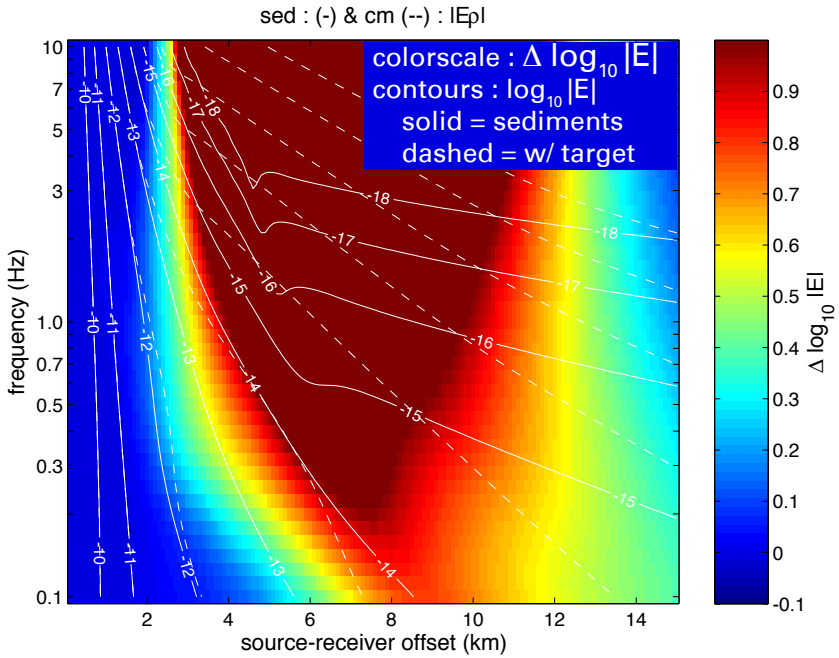
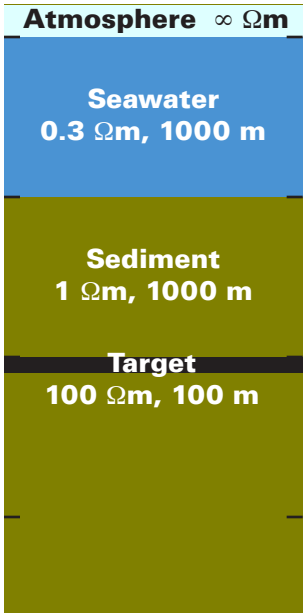
Discussion / Conclusions

reference model



reference model





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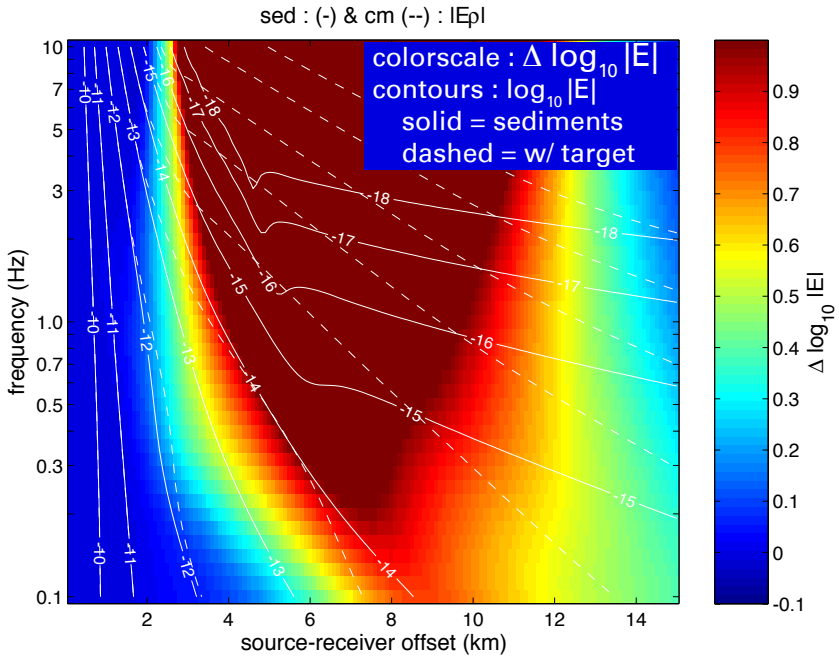
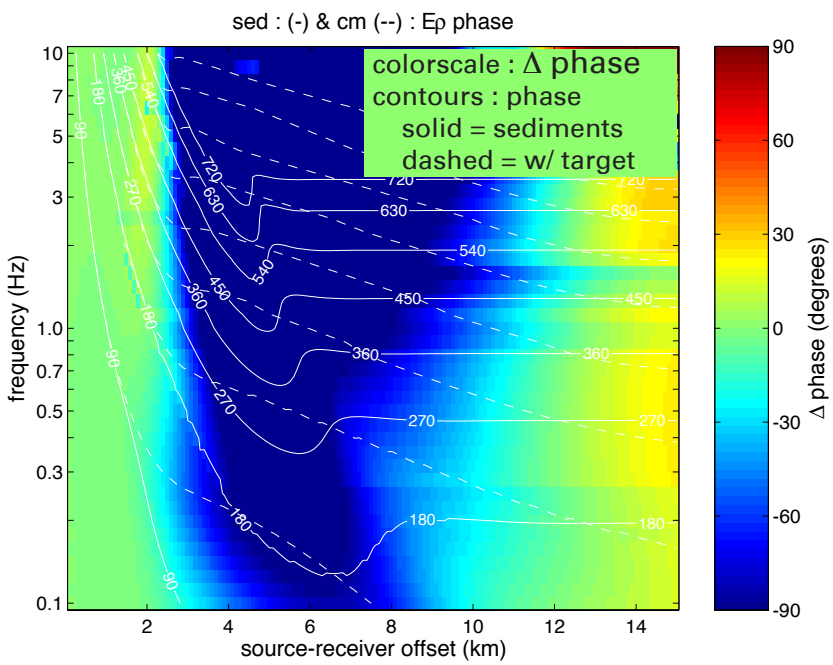
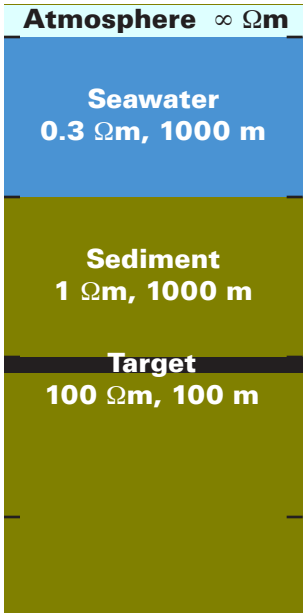
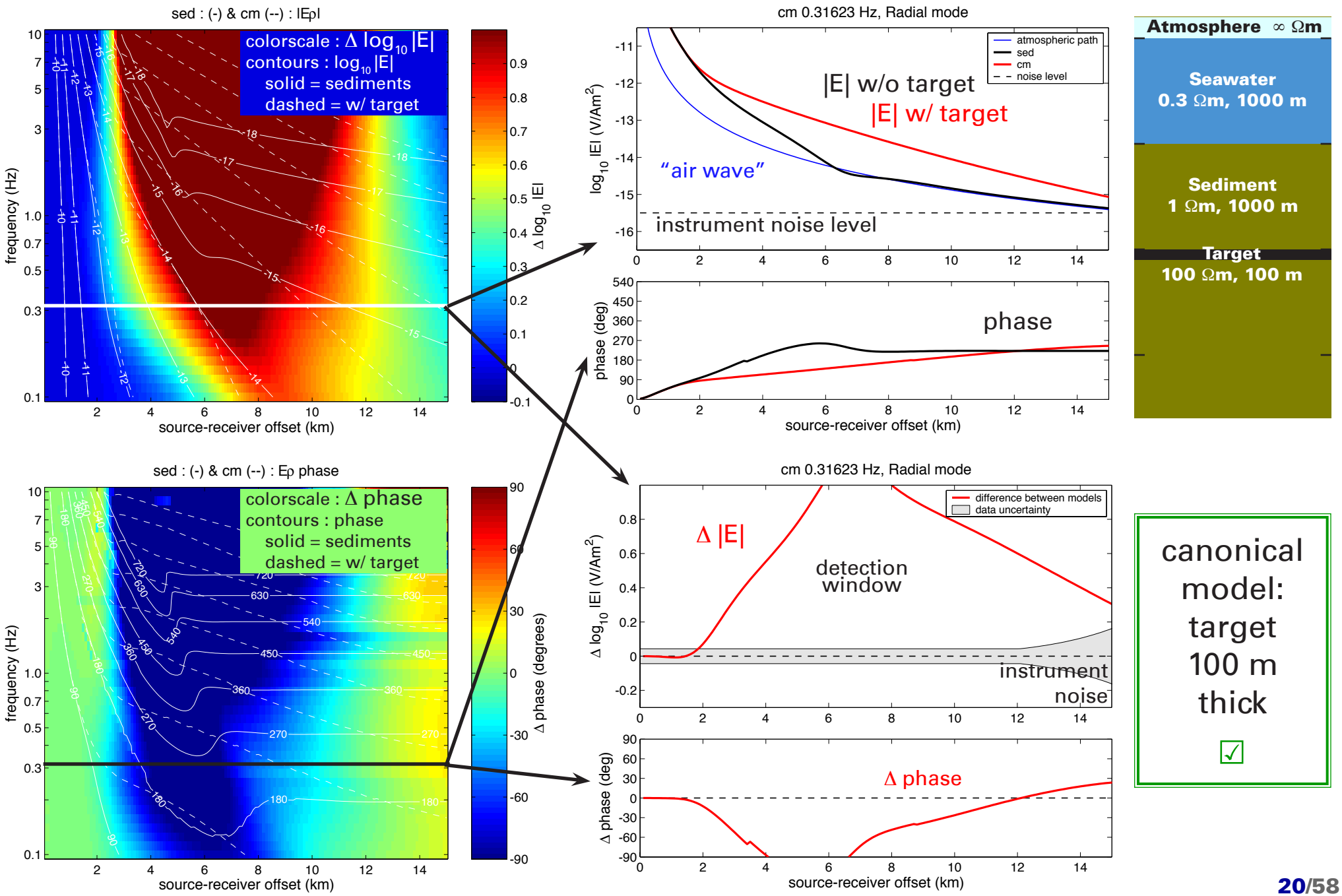




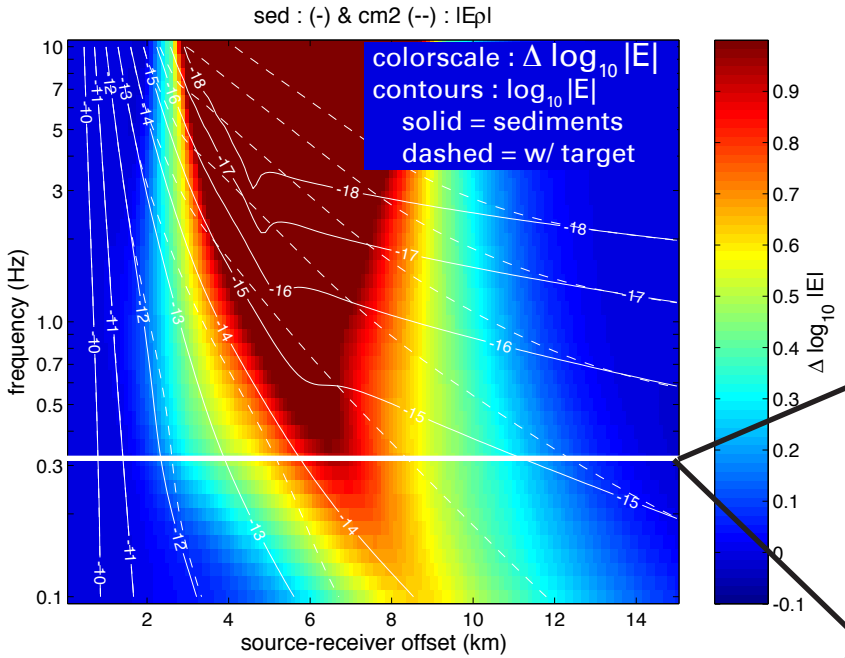


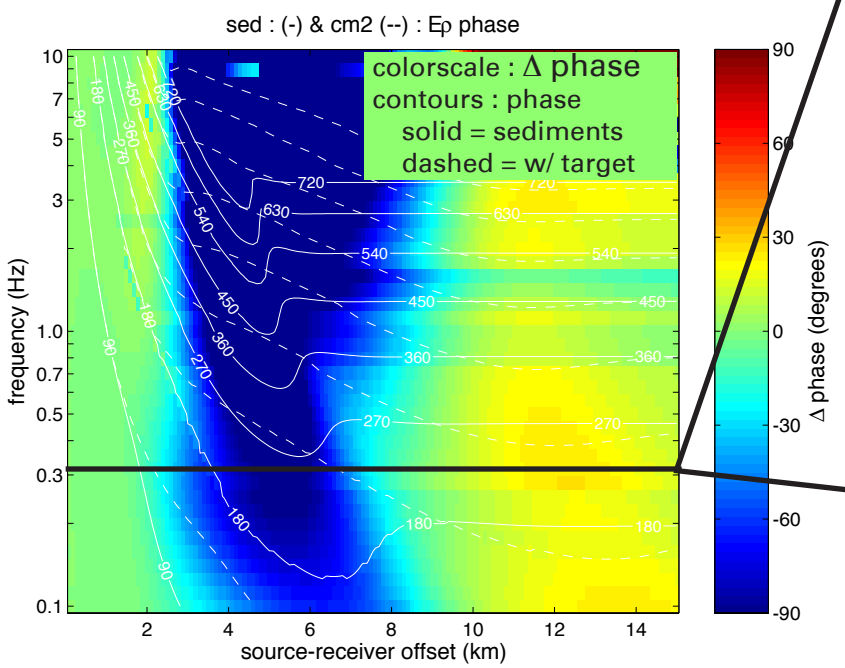
reference model: 100 m

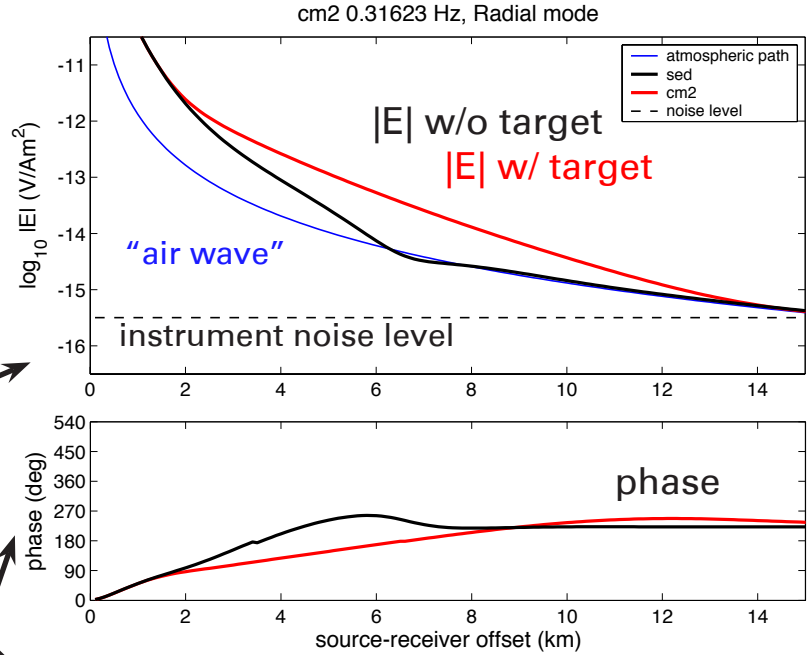


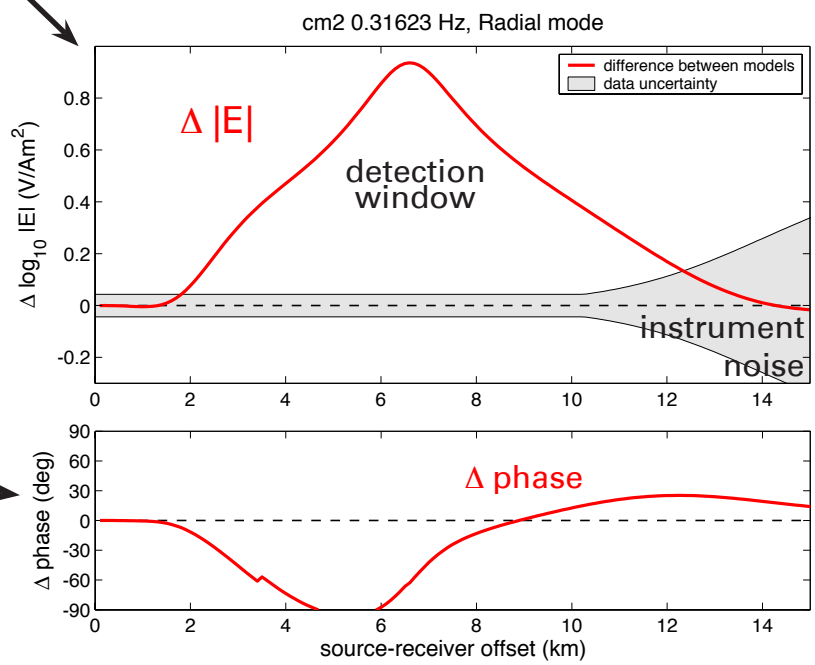
canonical model: target 100 m thick ☑

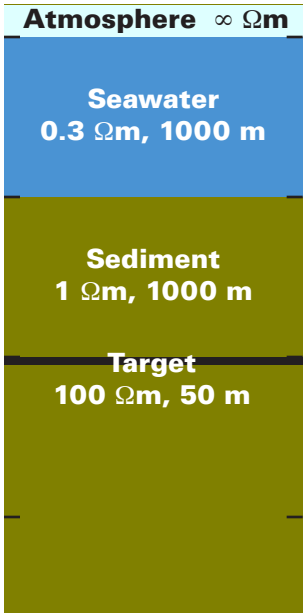
thinner target: 50 m







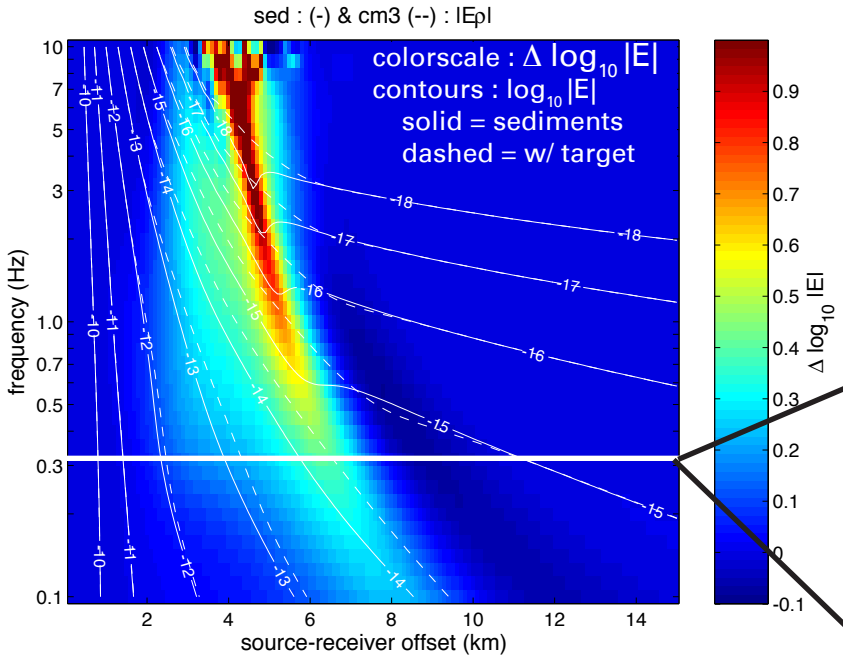


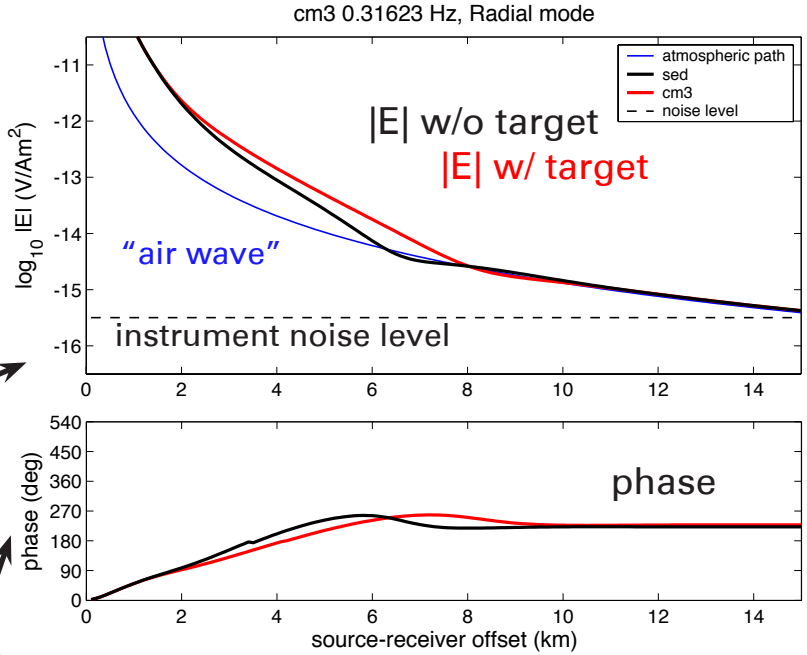


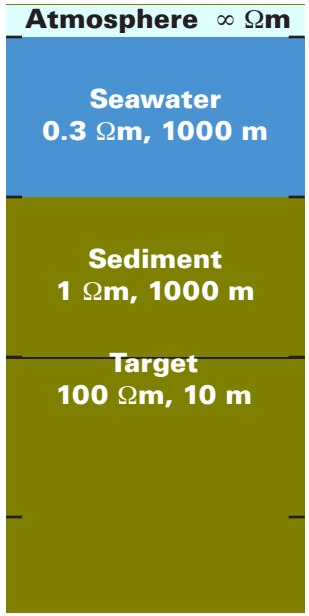
50 m thick

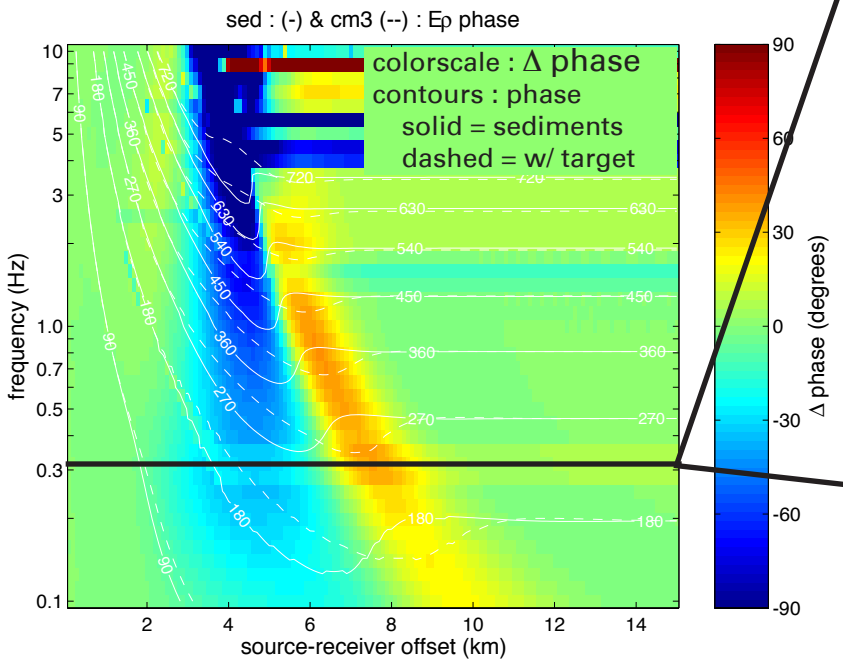
☑

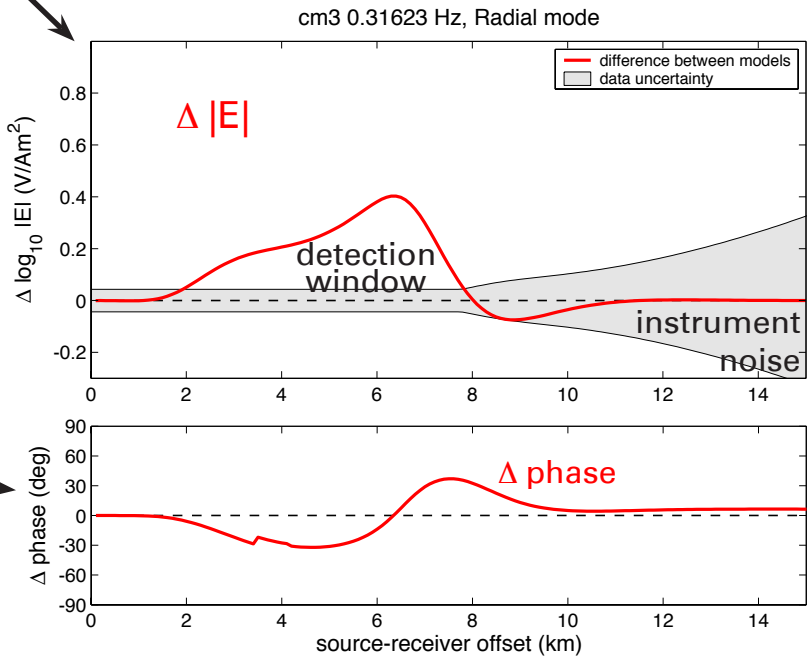
thinner target: 10 m







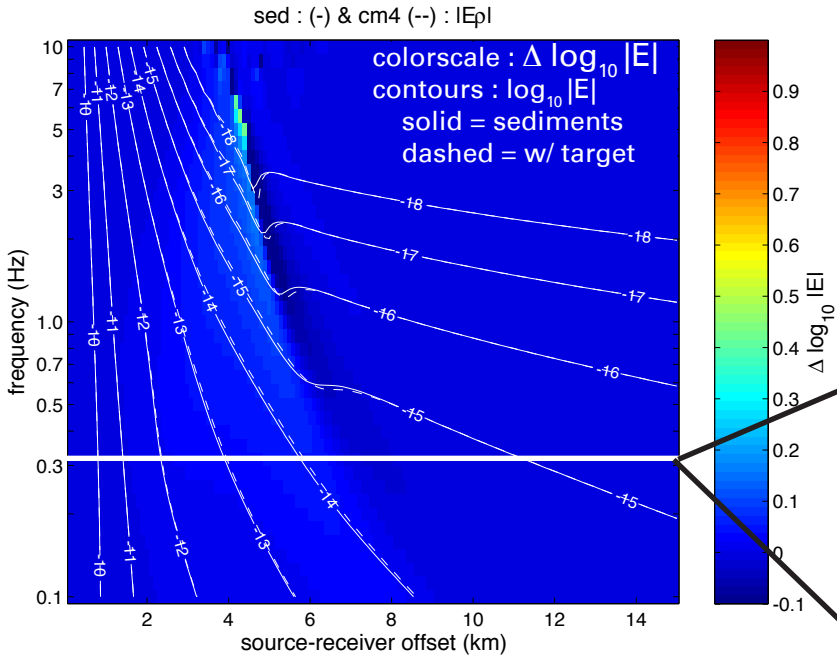


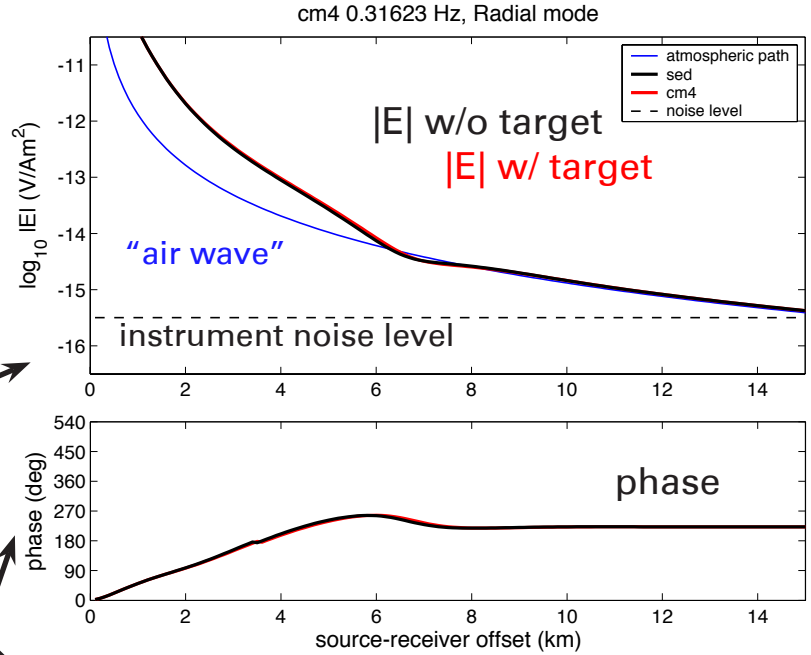


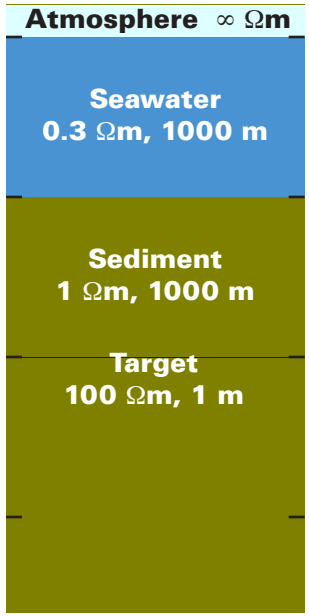
10 m thick

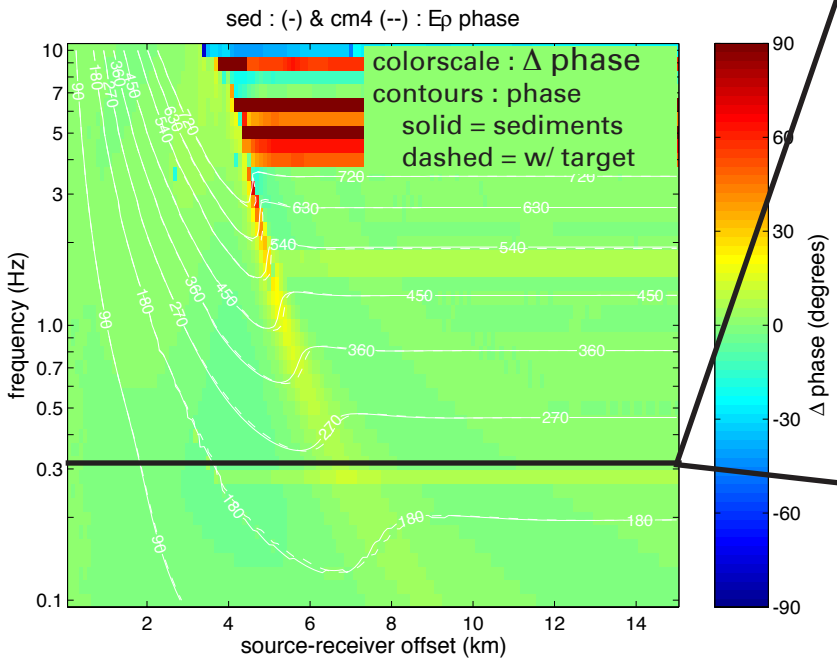
☑

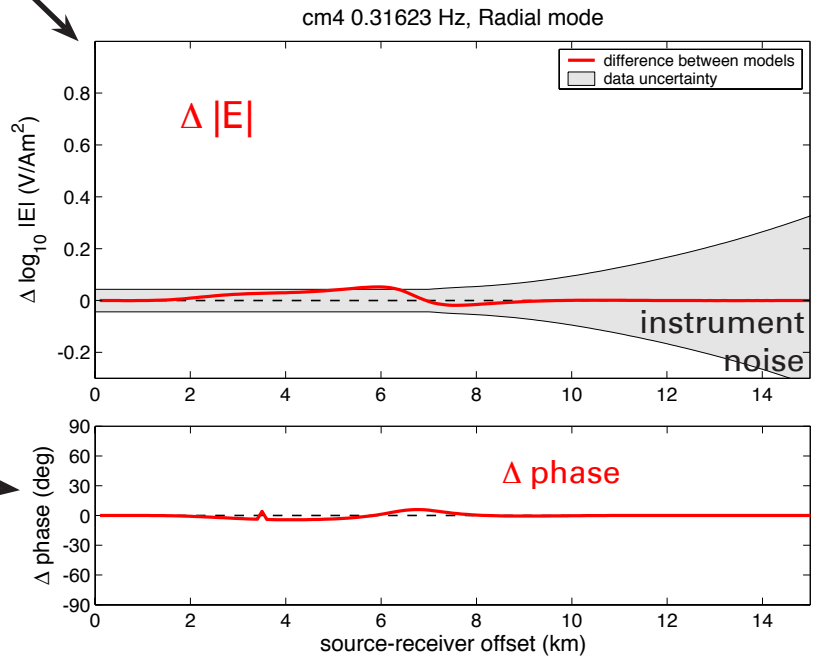
thinner target: 1 m











1 m thick

☒

outline

Seismic method shortfalls

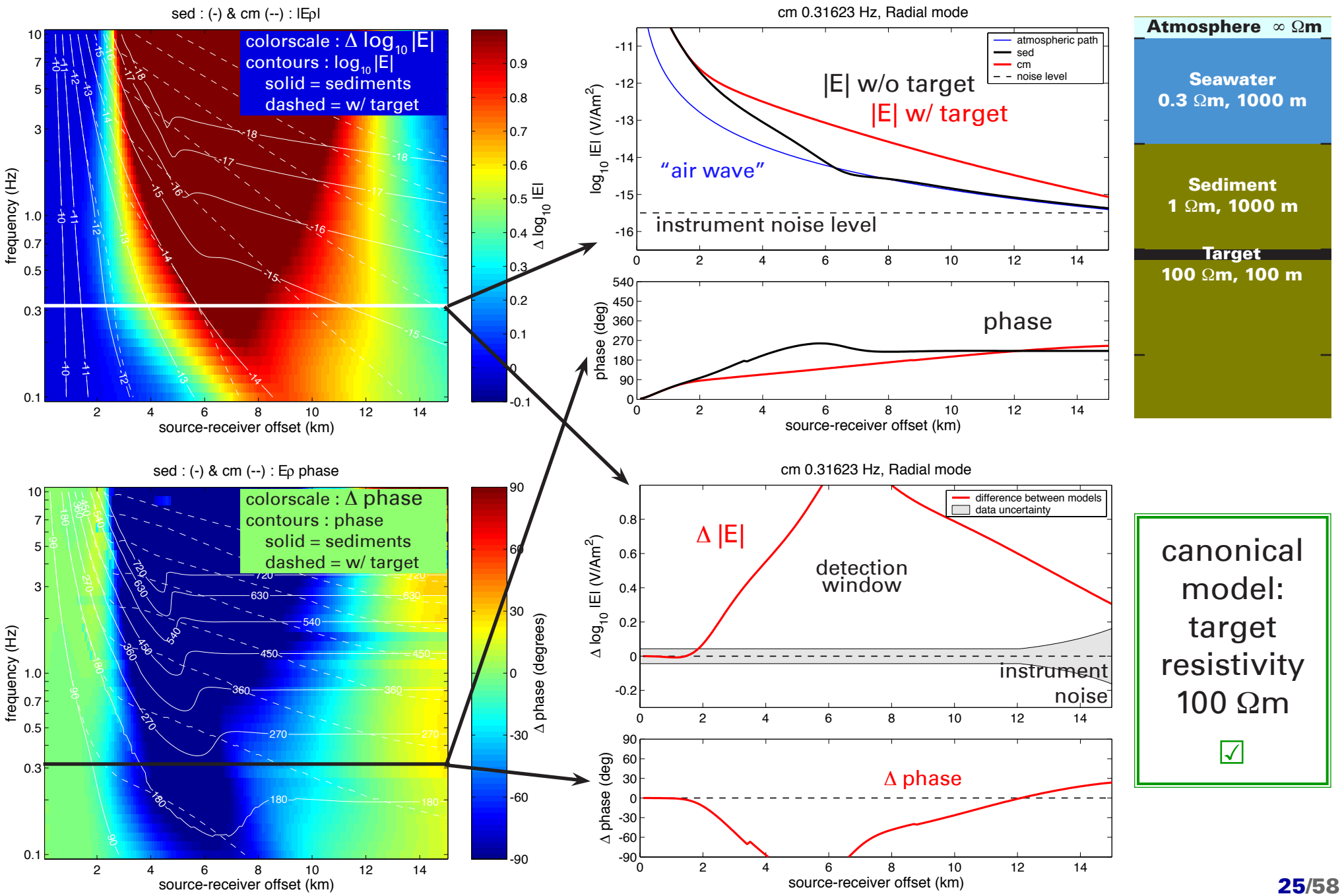
Creating a resistivity model

Testing common scenarios in 1-D

- Target thickness
- **Target resistivity**
- Target depth
- Effect of shallow resistors
  - hydrate
  - evaporite
  - salt
- Effect of shallow water

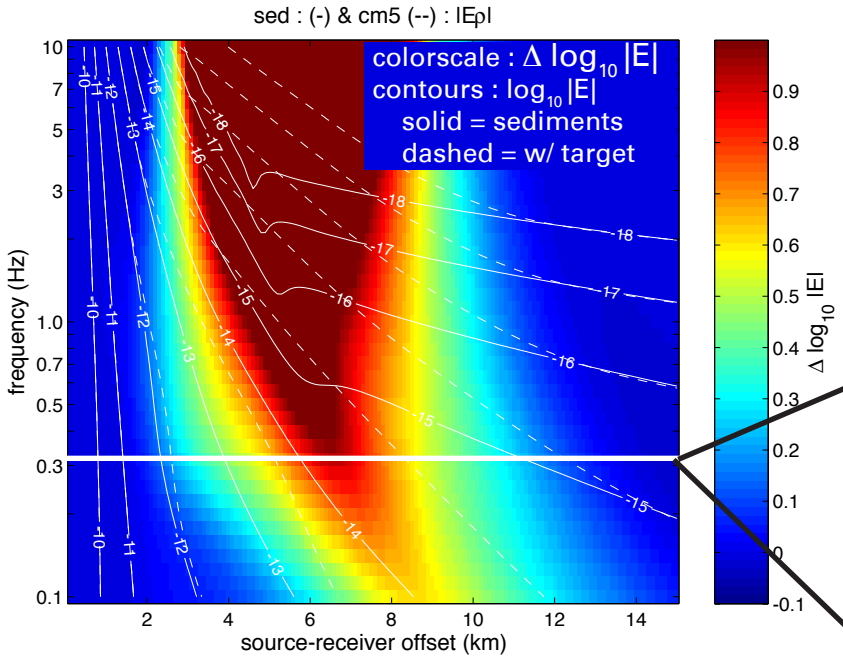
Discussion / Conclusions

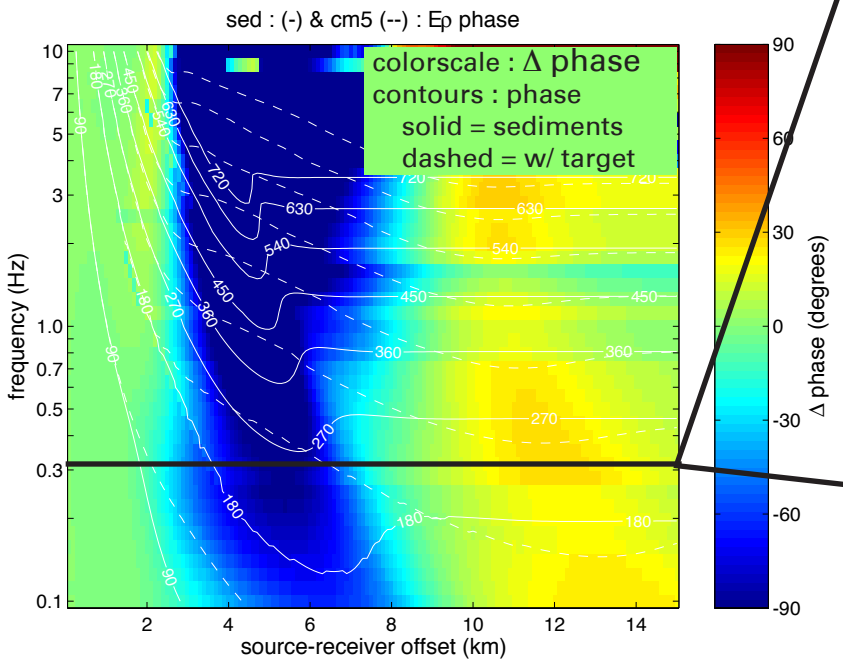
reference model: 100 Ωm

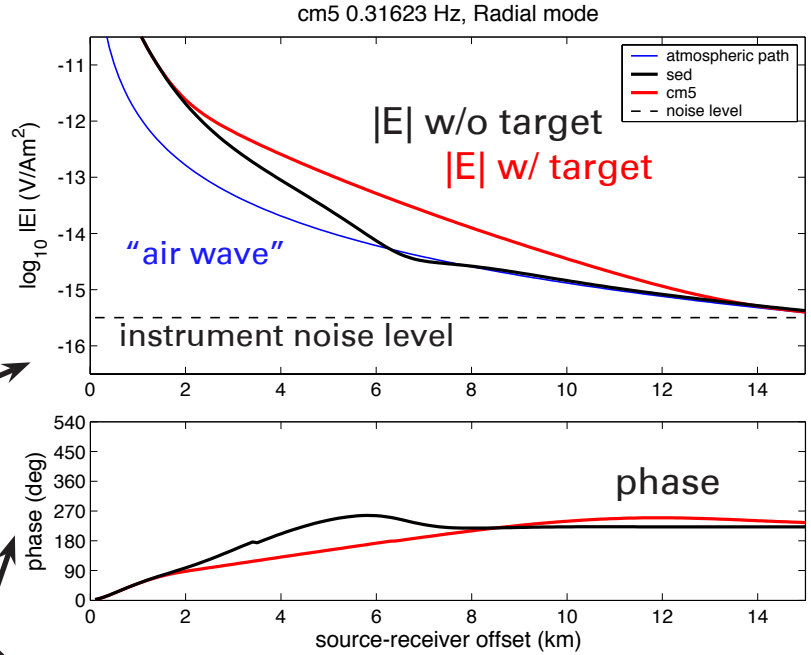


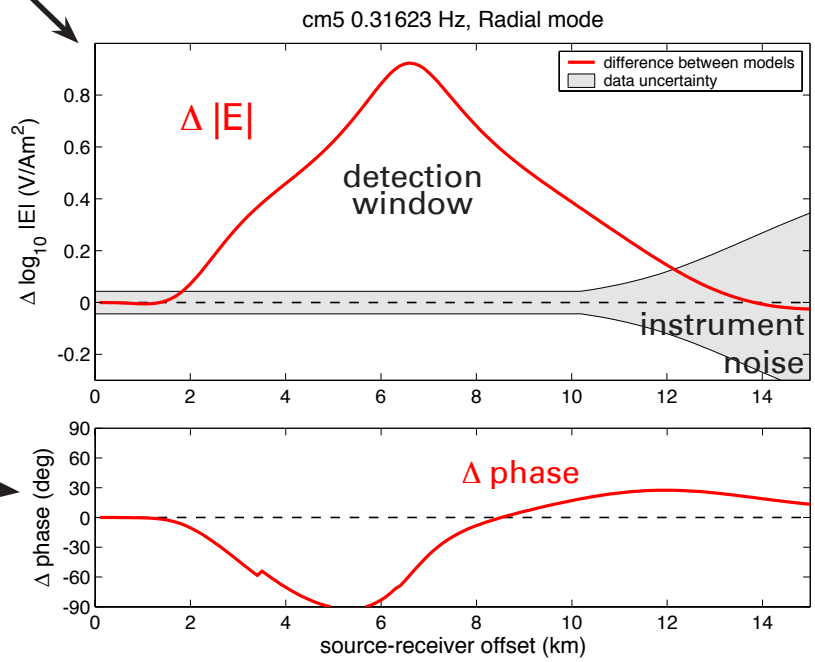
canonical model: target resistivity 100 Ωm ☑

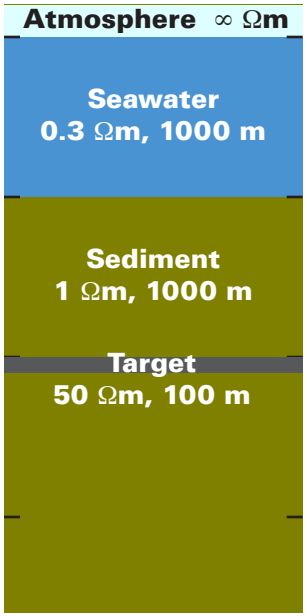
less resistive target: 50 Ωm







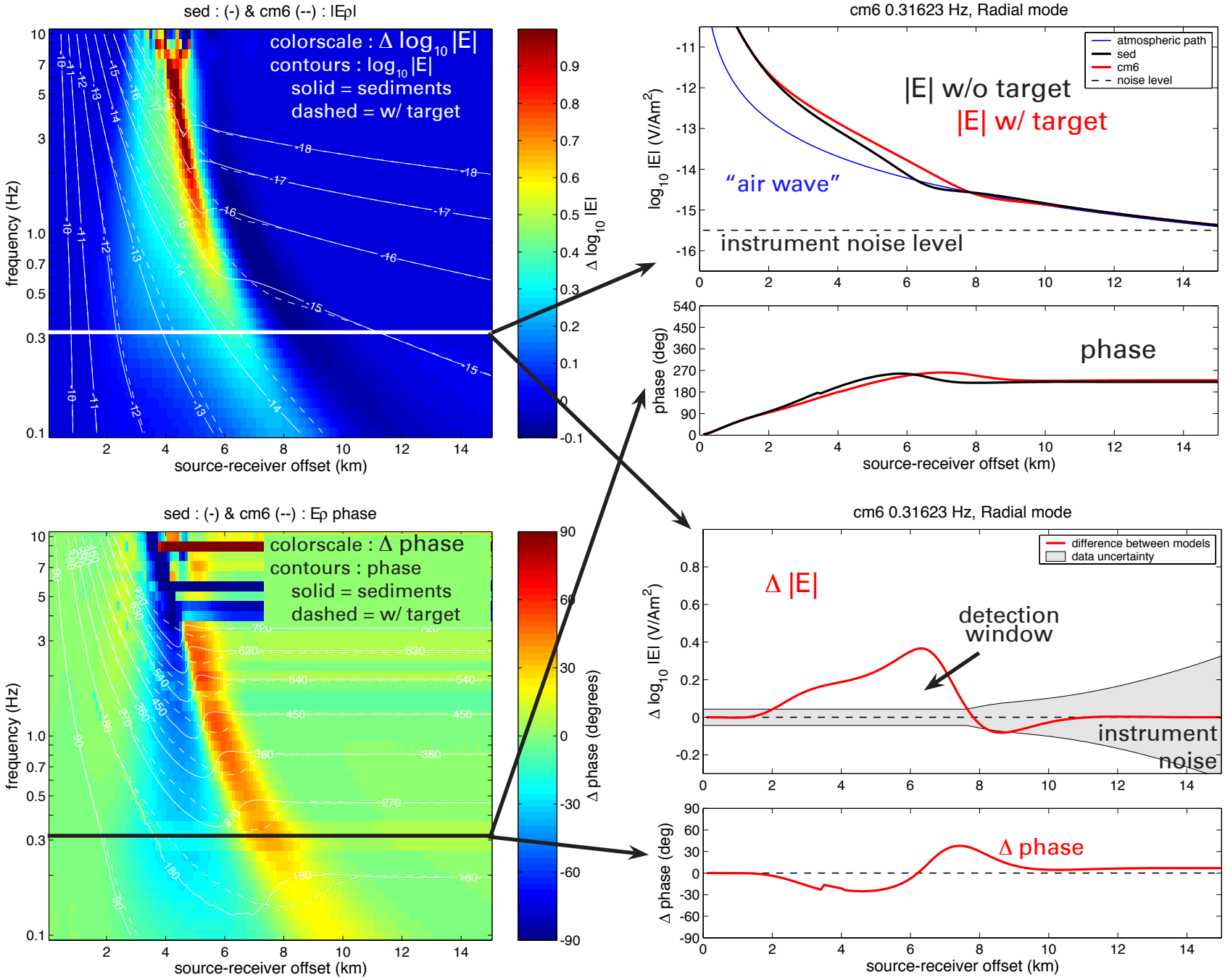


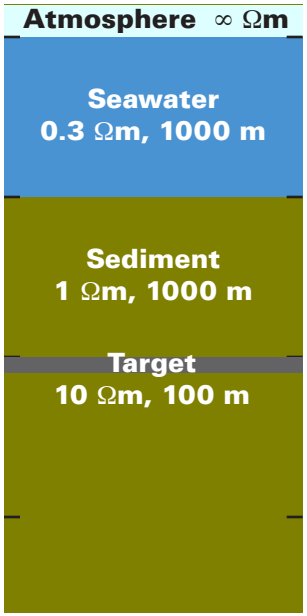


50 Ωm target

☑

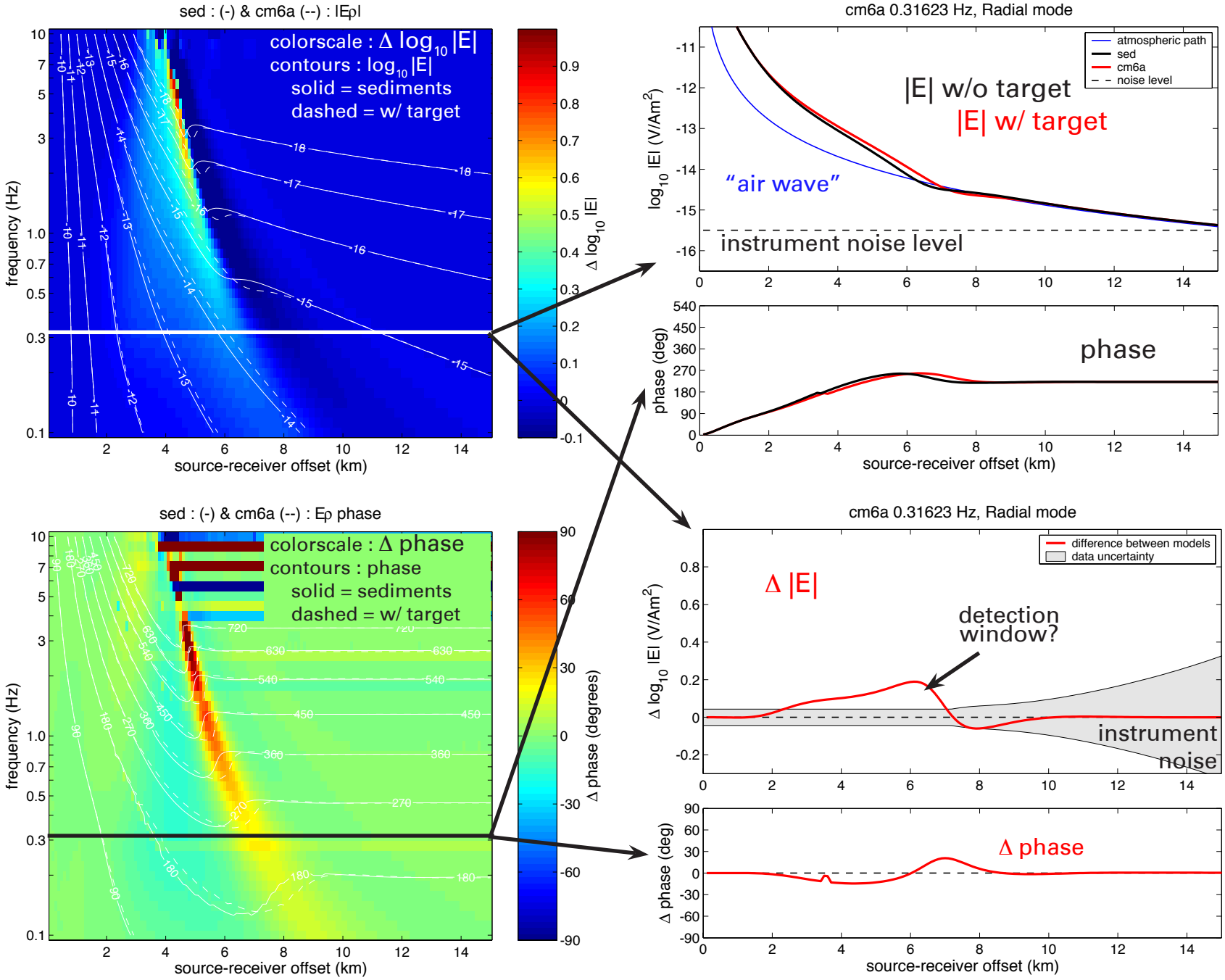
less resistive target: 10 Ωm

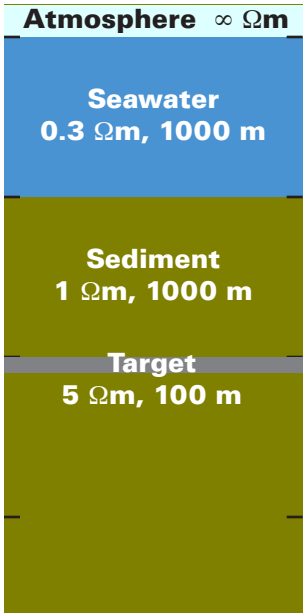




10 Ωm target ☑

less resistive target: 5 Ωm





5 Ωm target ?

outline

Seismic method shortfalls

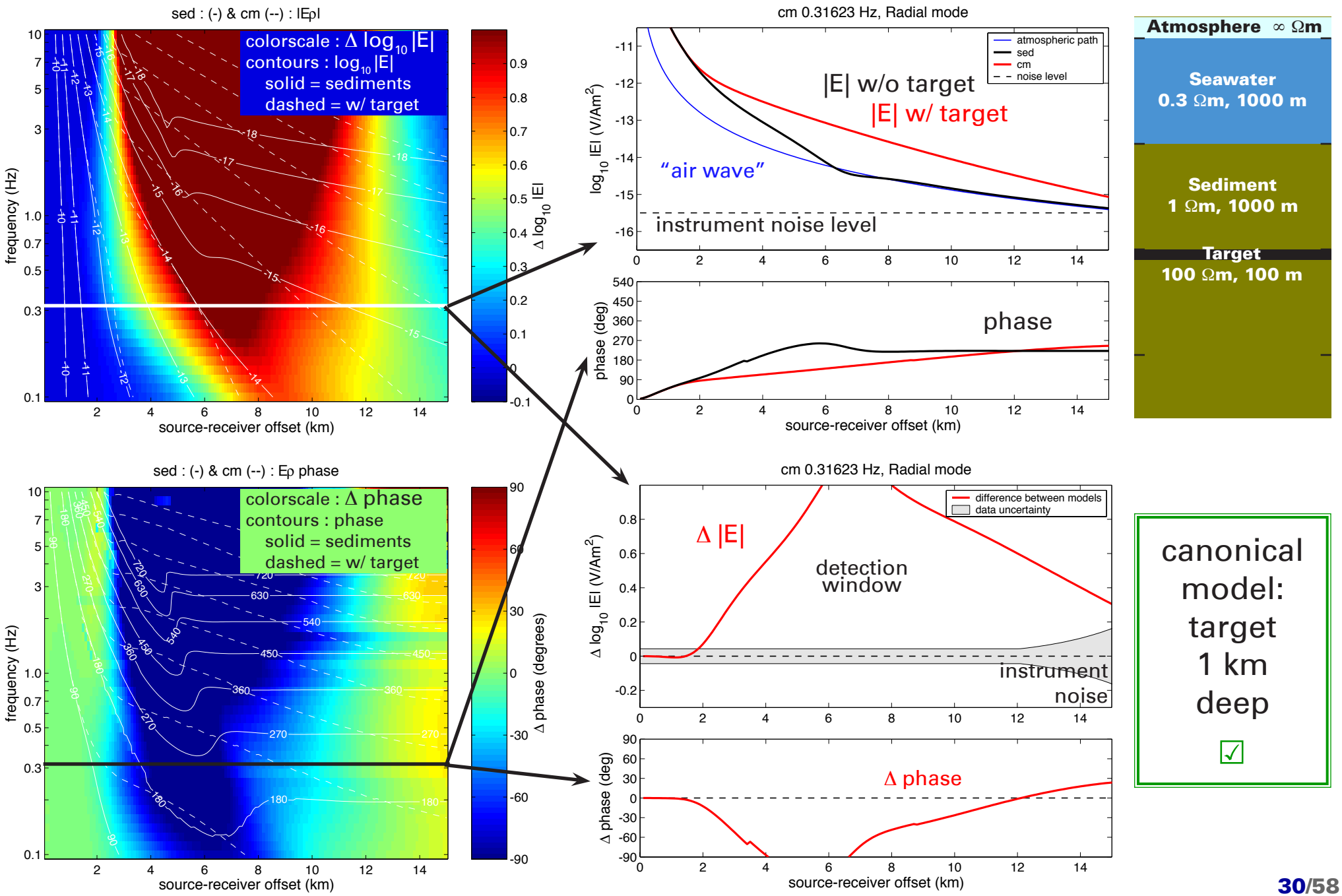
Creating a resistivity model

Testing common scenarios in 1-D

- Target thickness
- Target resistivity
- **Target depth**
- Effect of shallow resistors
  - hydrate
  - evaporite
  - salt
- Effect of shallow water

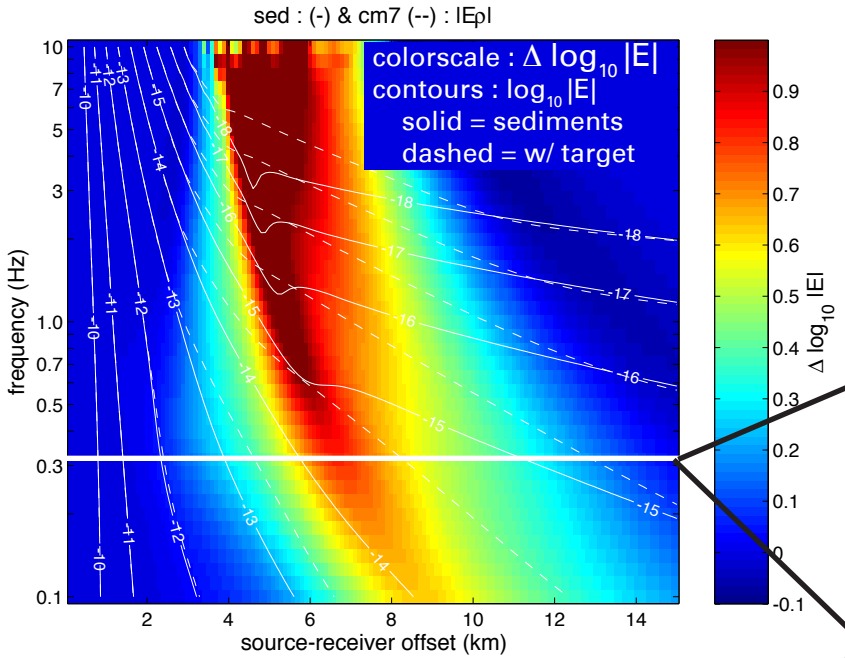
Discussion / Conclusions

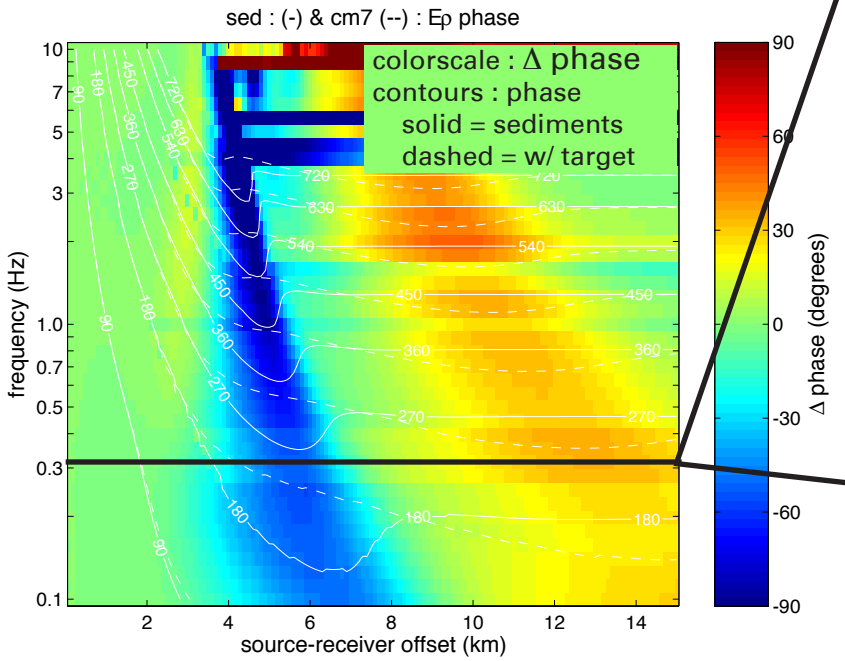
reference model: 1 km

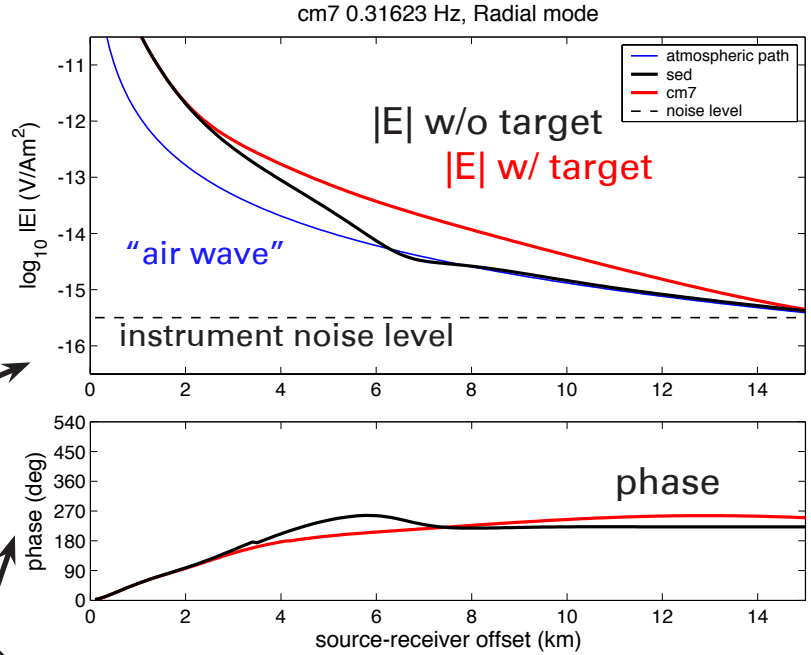


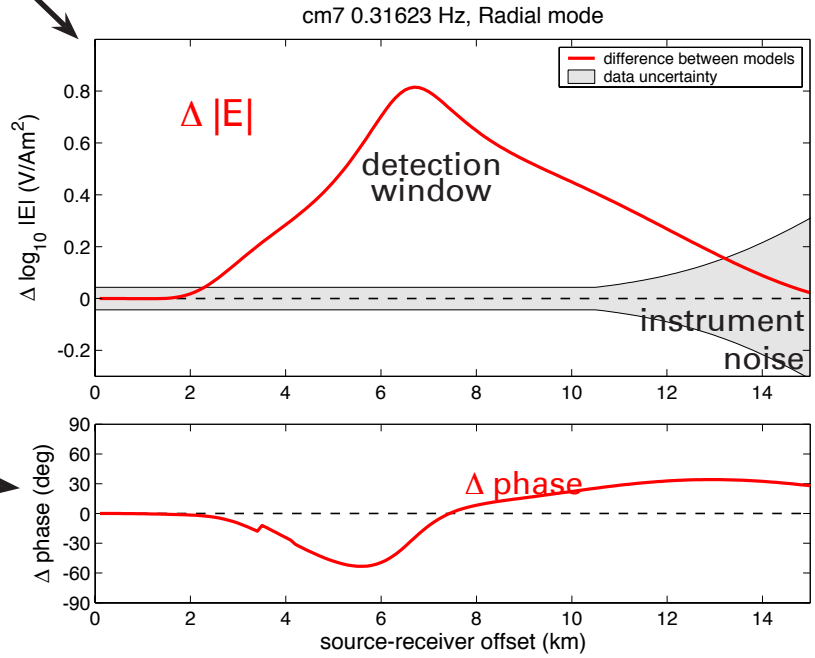
canonical model: target 1 km deep ☑

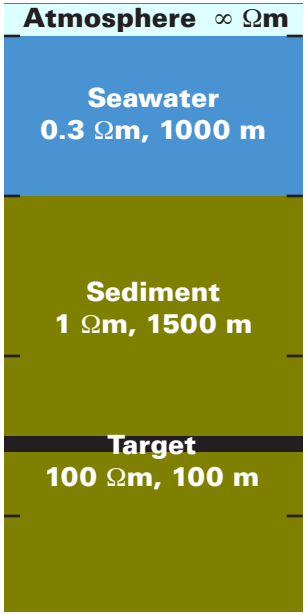
deeper target: 1.5 km







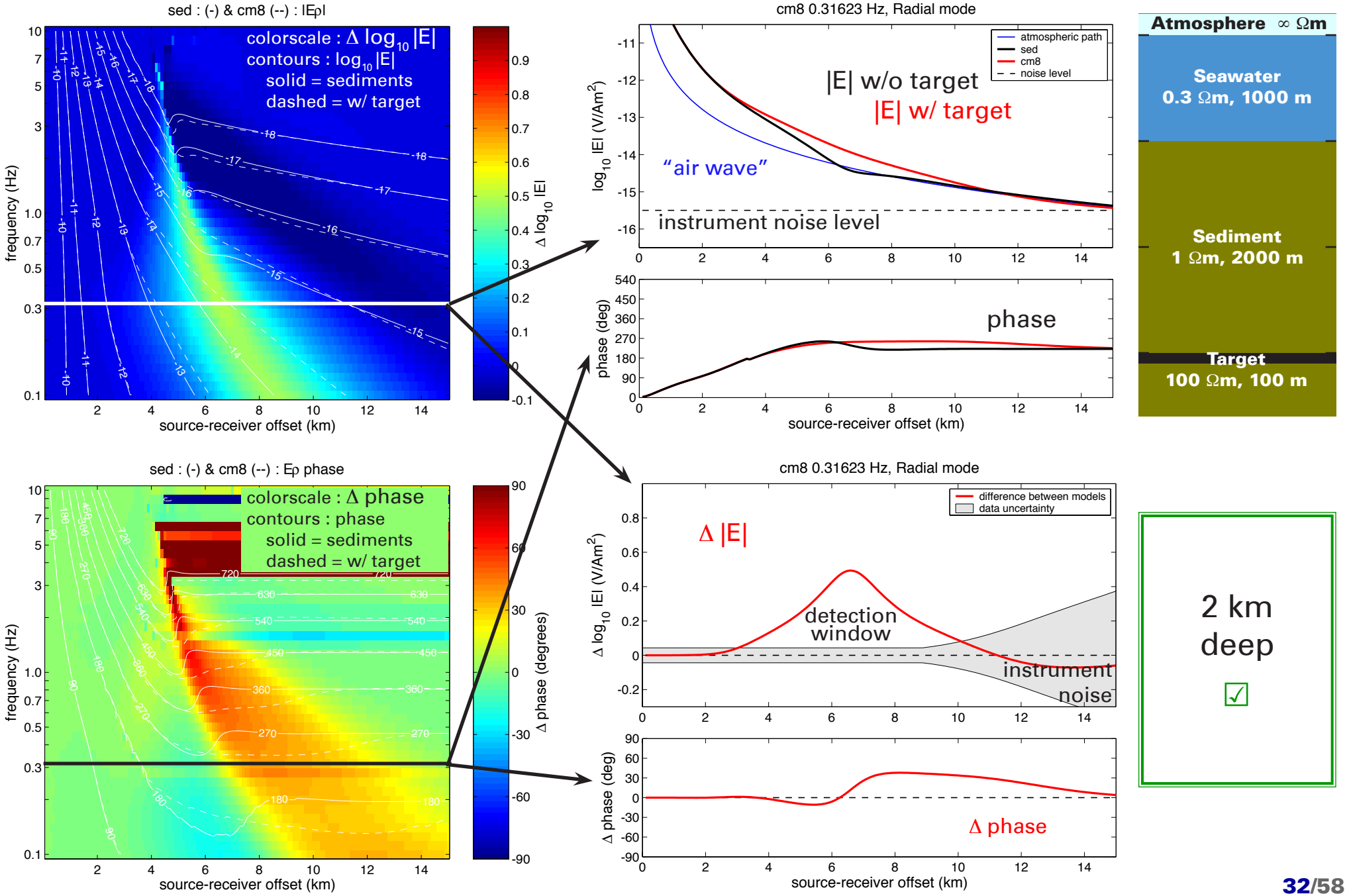




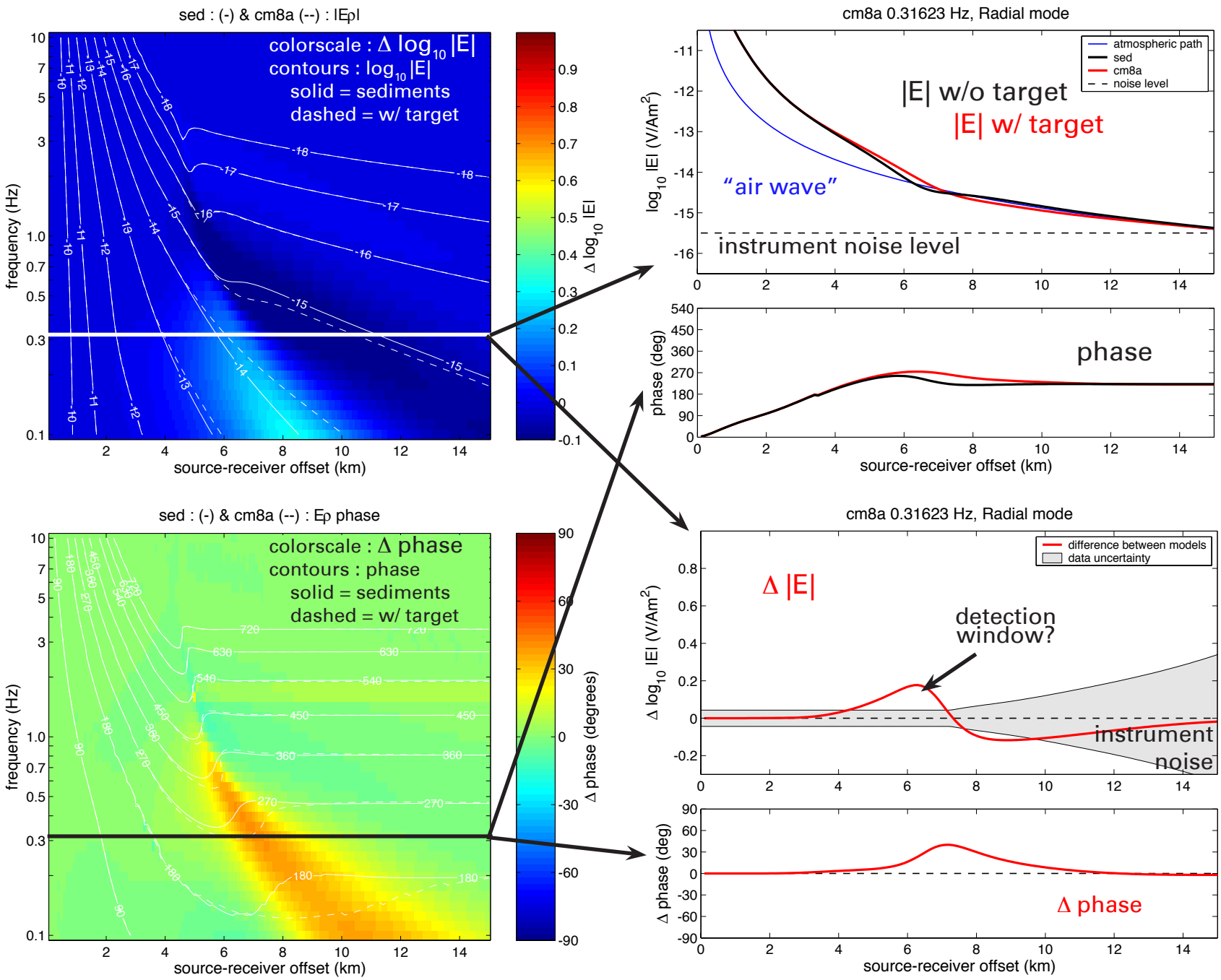
1.5 km deep

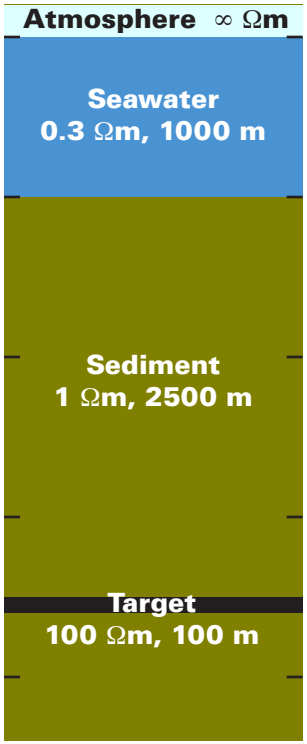
☑

deeper target: 2 km



deeper target: 2.5 km

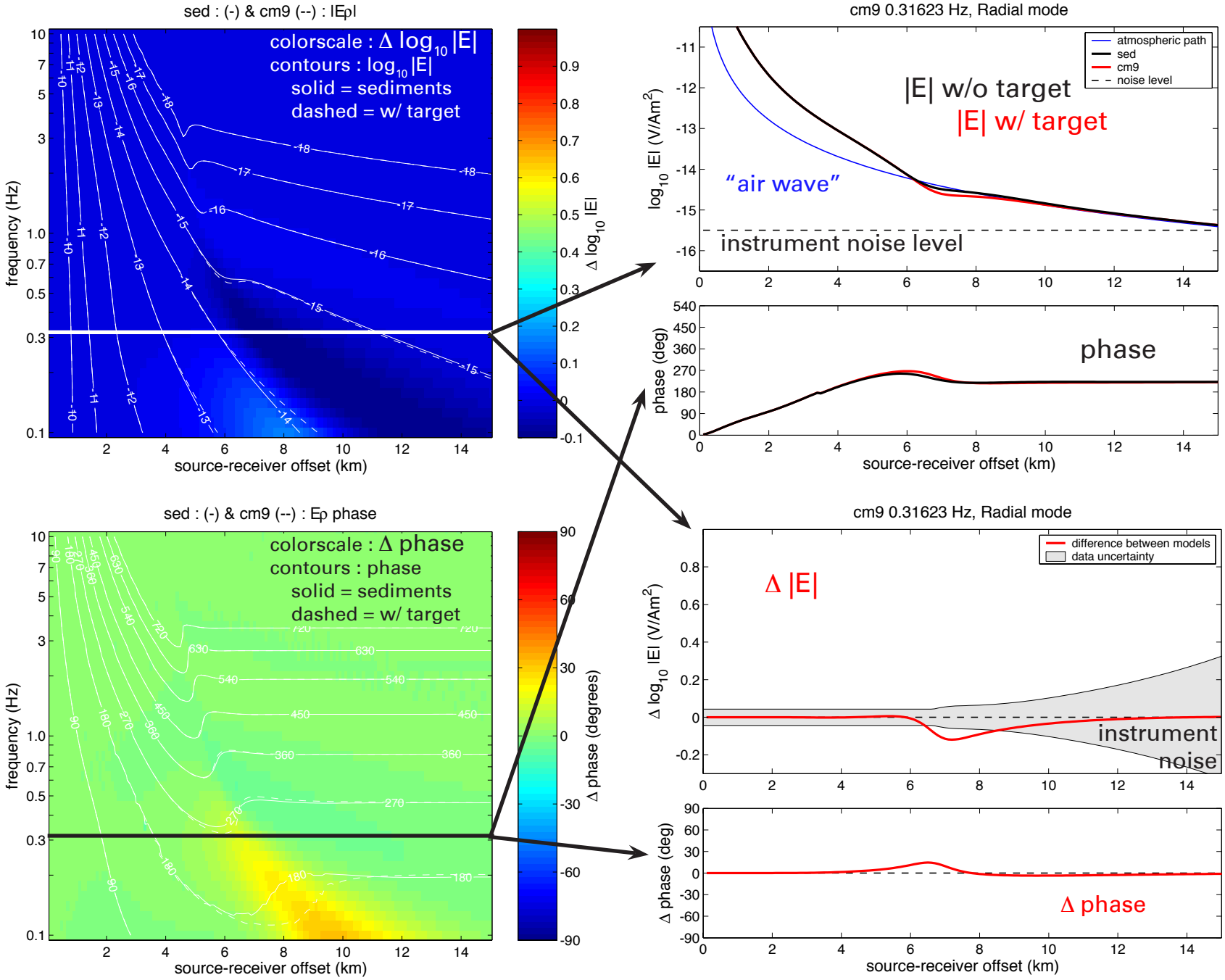


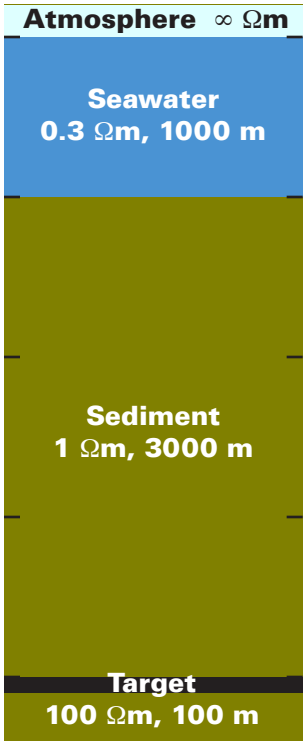


2.5 km deep

?

deeper target: 3 km





3 km deep

☒

outline

Seismic method shortfalls

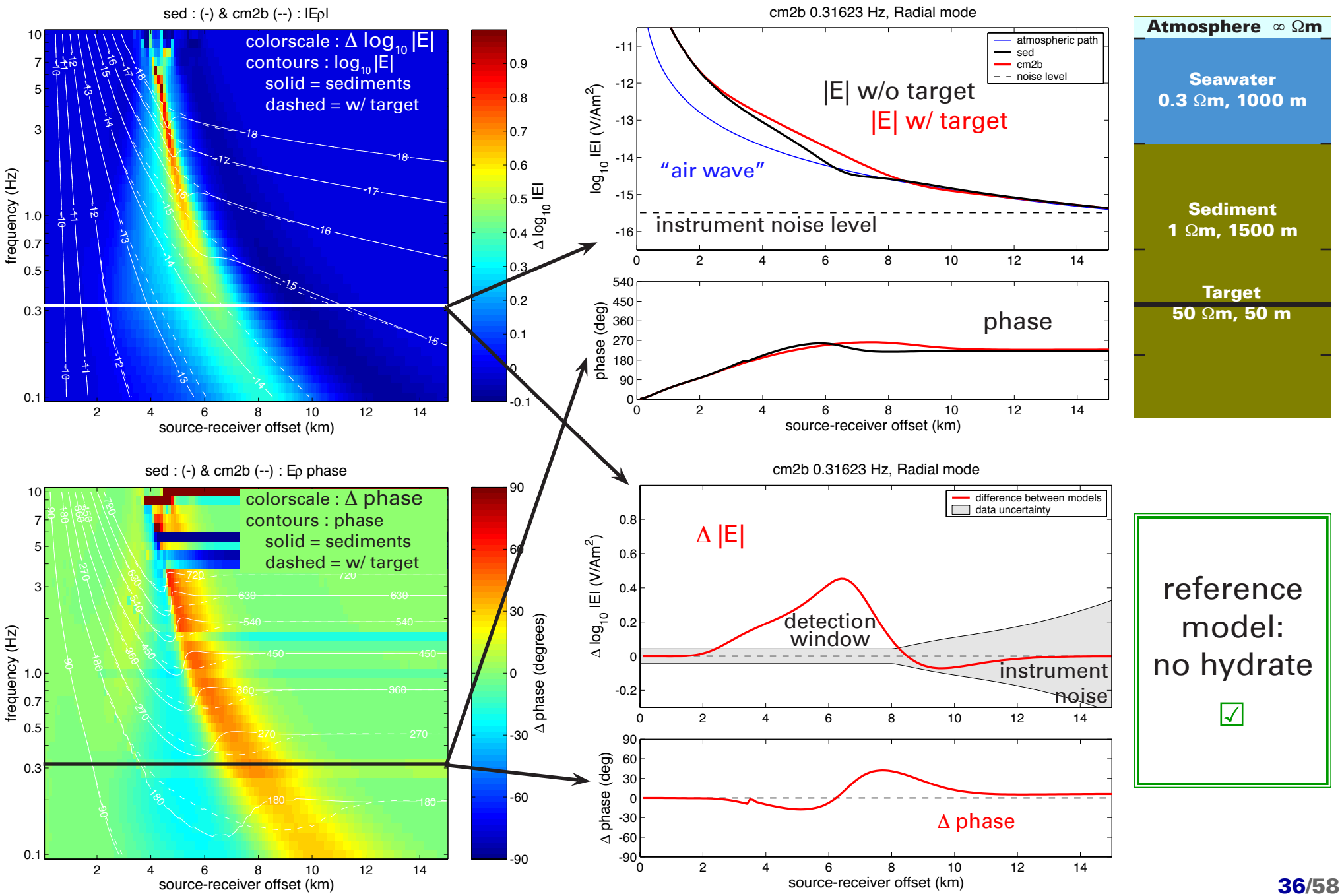
Creating a resistivity model

Testing common scenarios in 1-D

- Target thickness
- Target resistivity
- Target depth
- **Effect of shallow resistors**
  - **hydrate**
  - evaporite
  - salt
- Effect of shallow water

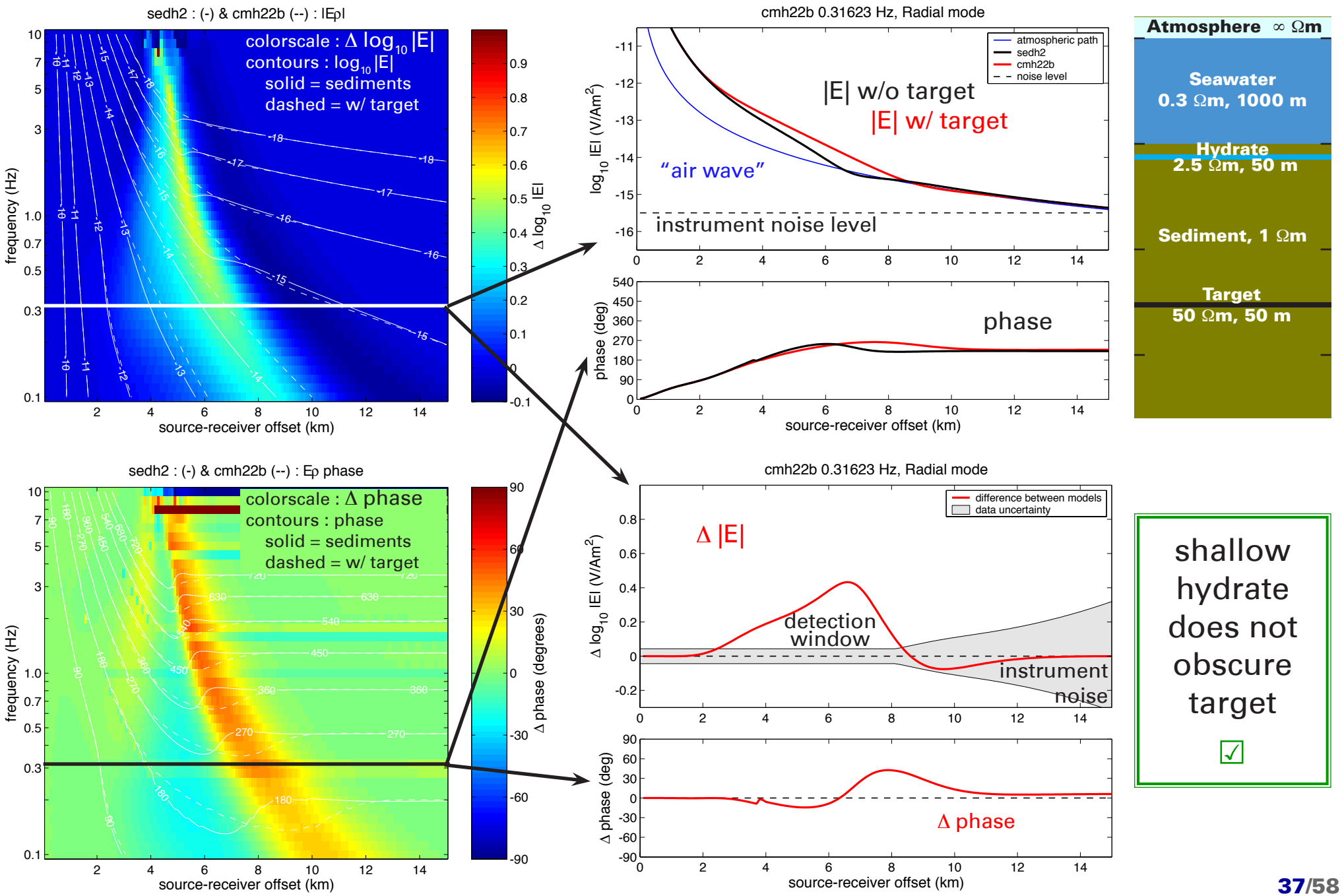
Discussion / Conclusions

reference model: no hydrate



reference model: no hydrate ☑

gas hydrate layer at 100 - 150 m



shallow hydrate does not obscure target ☑

outline

Seismic method shortfalls

Creating a resistivity model

Testing common scenarios in 1-D

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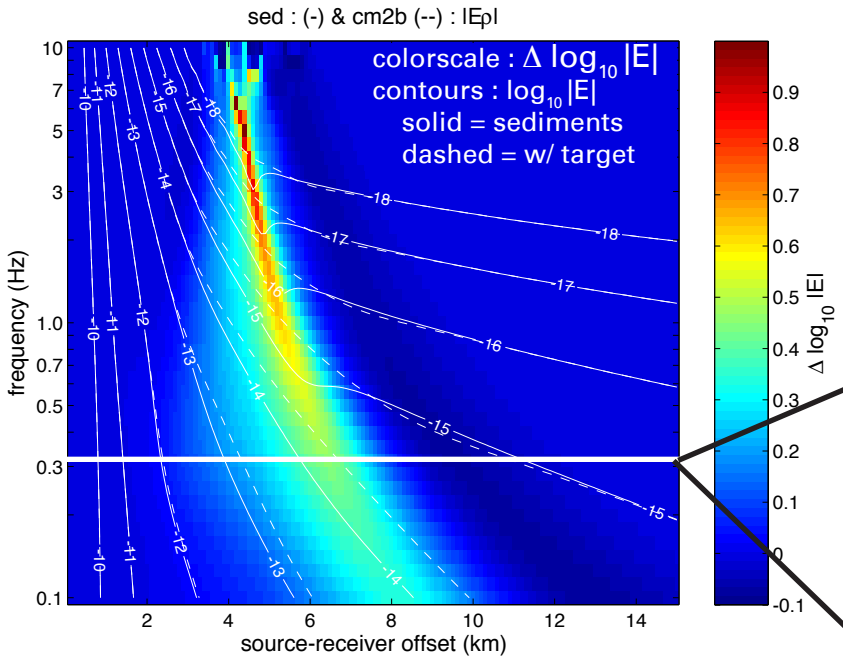
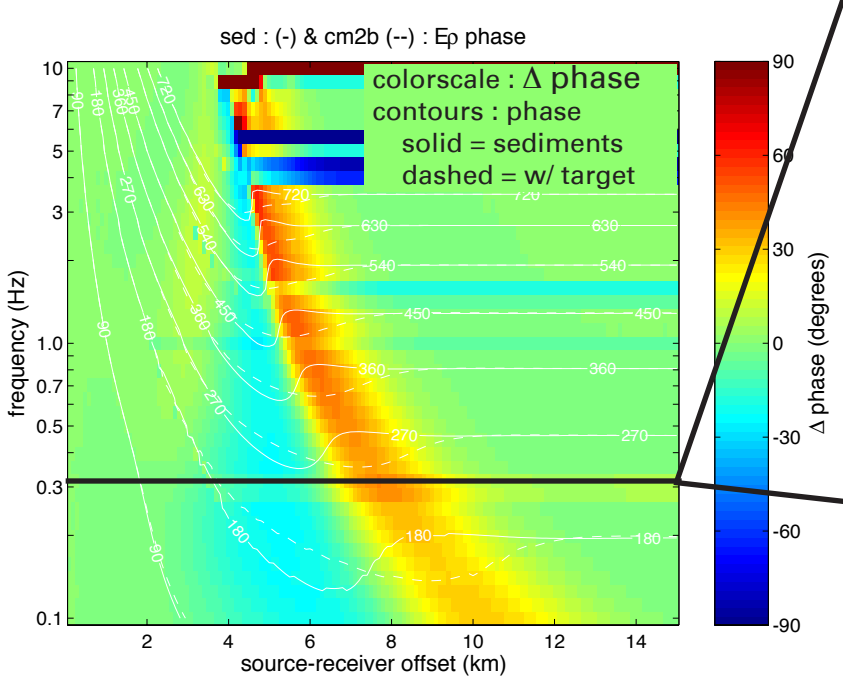
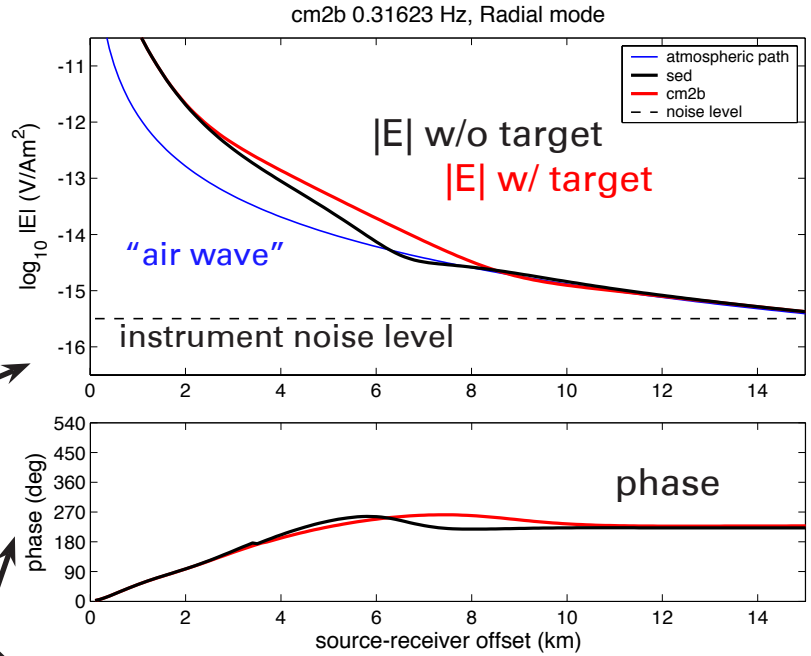
- Target resistivity
- Target depth
- **Effect of shallow resistors**
  - hydrate
  - **evaporite**
  - **salt**
- Effect of shallow water

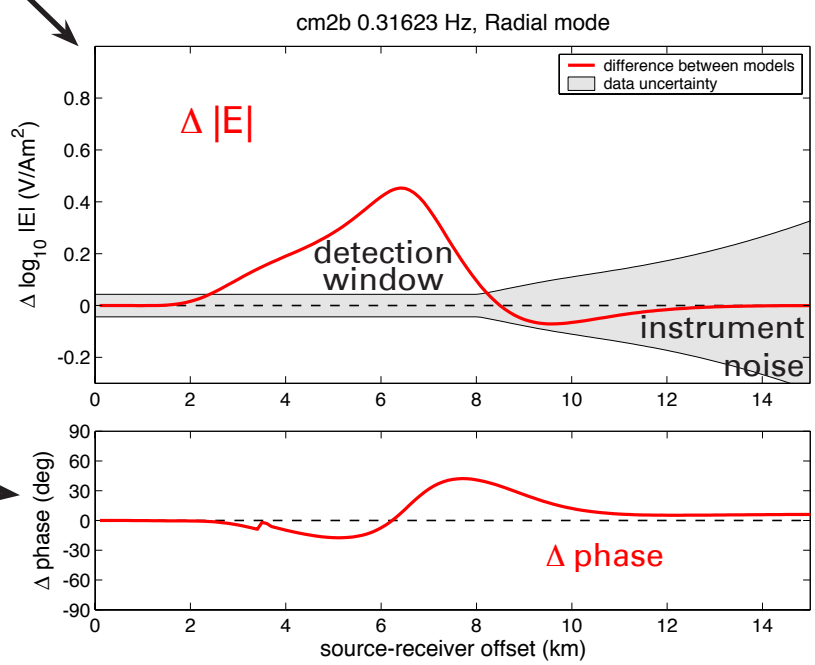
Discussion / Conclusions

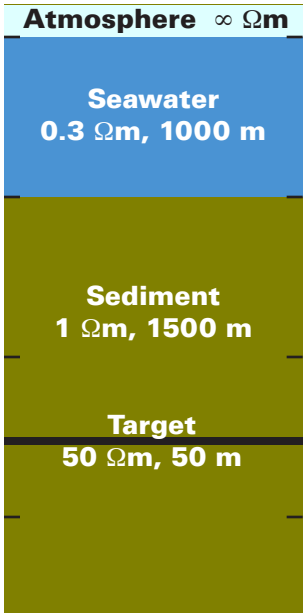
reference model: no evaporite or salt





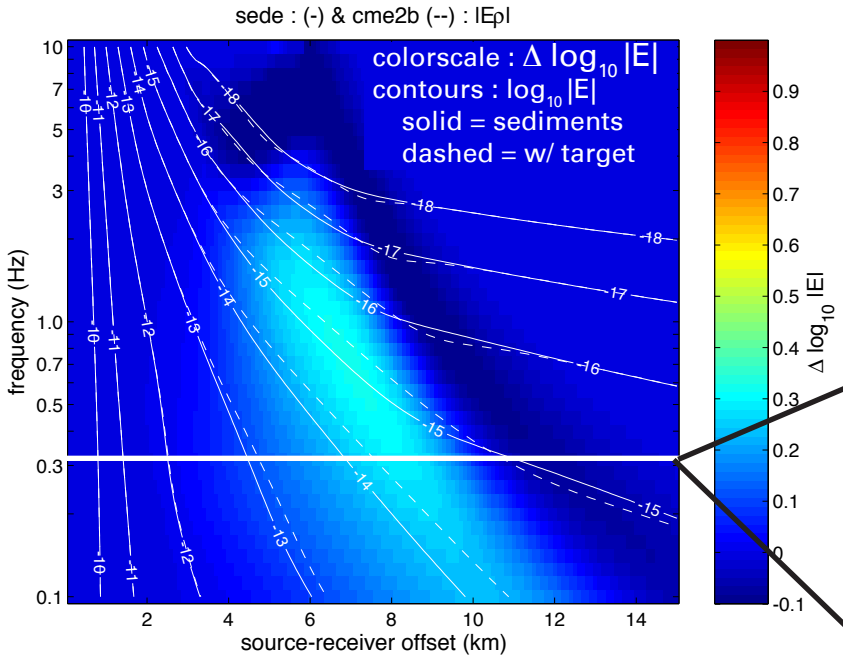


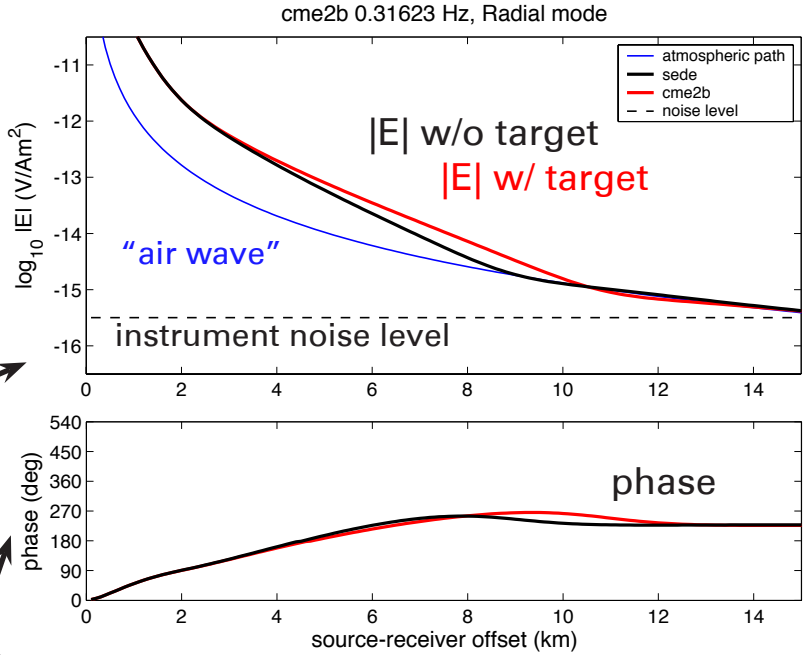


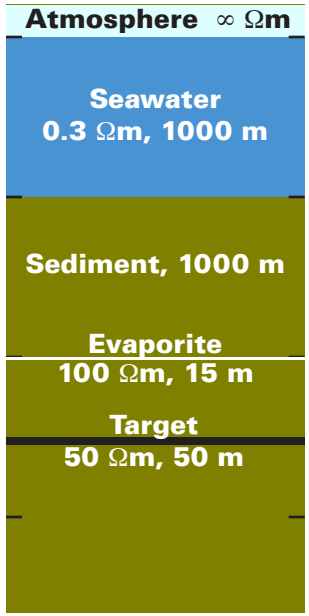


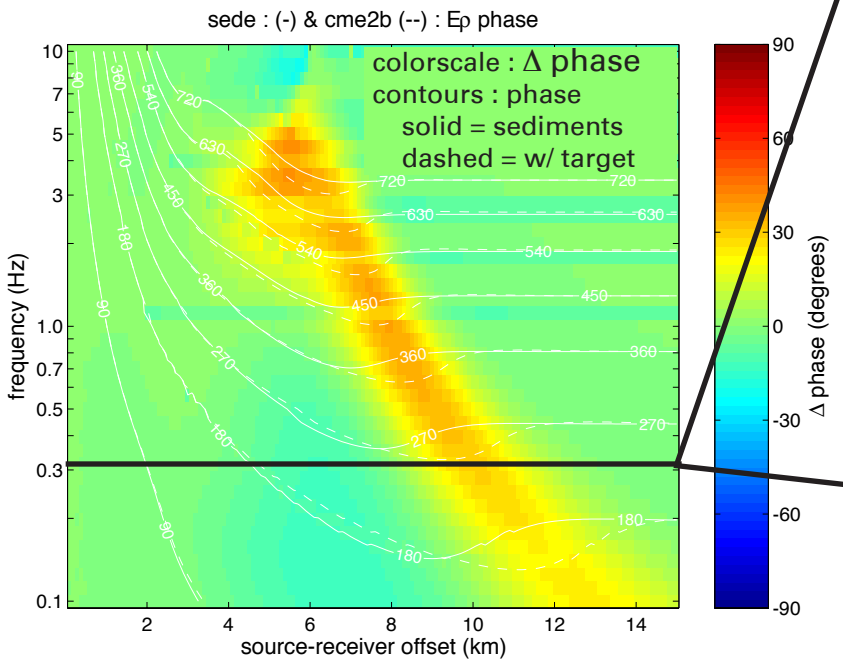
reference model: no evaporite or salt ☑

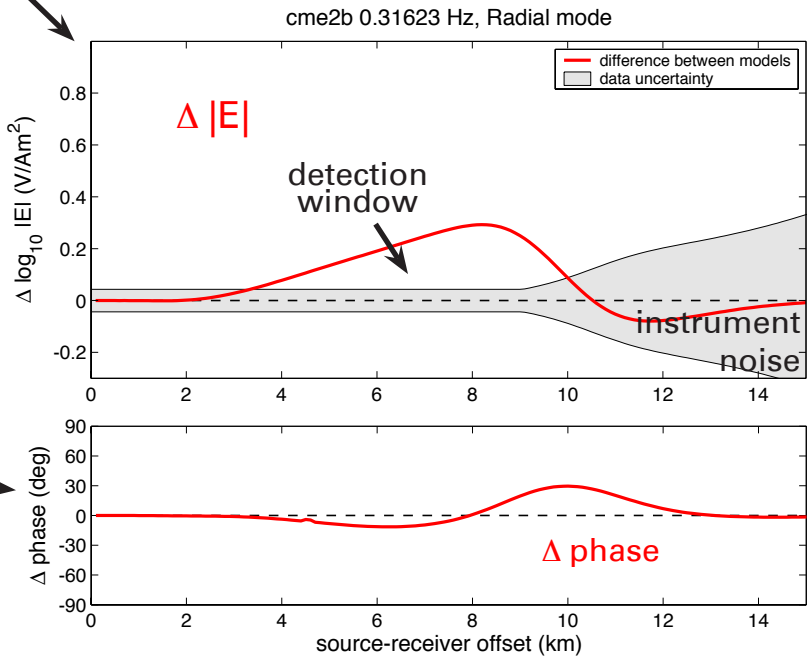
evaporite at 1 km





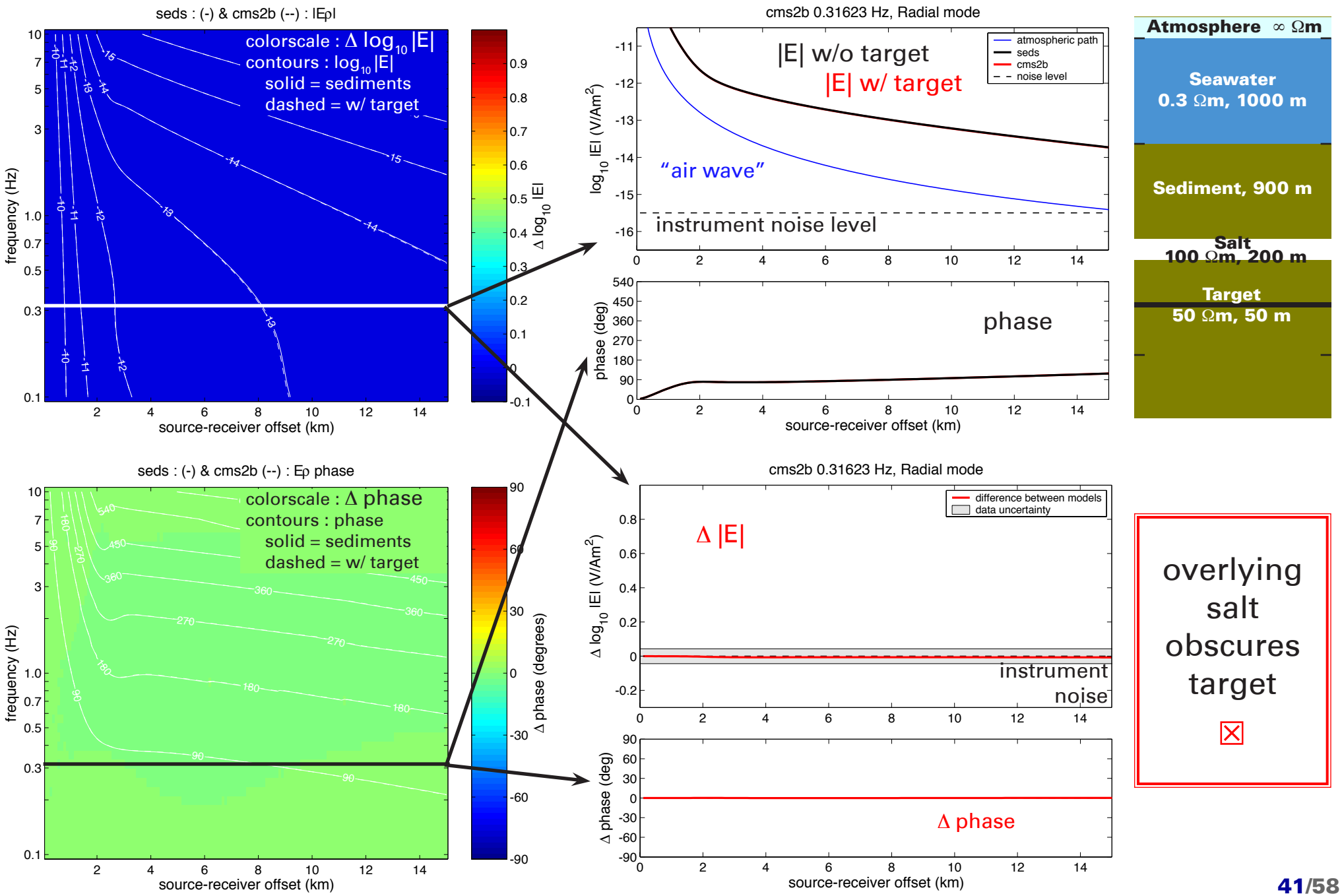






overlying evaporite does not obscure target ☑

salt centered at 1km



outline

Seismic method shortfalls

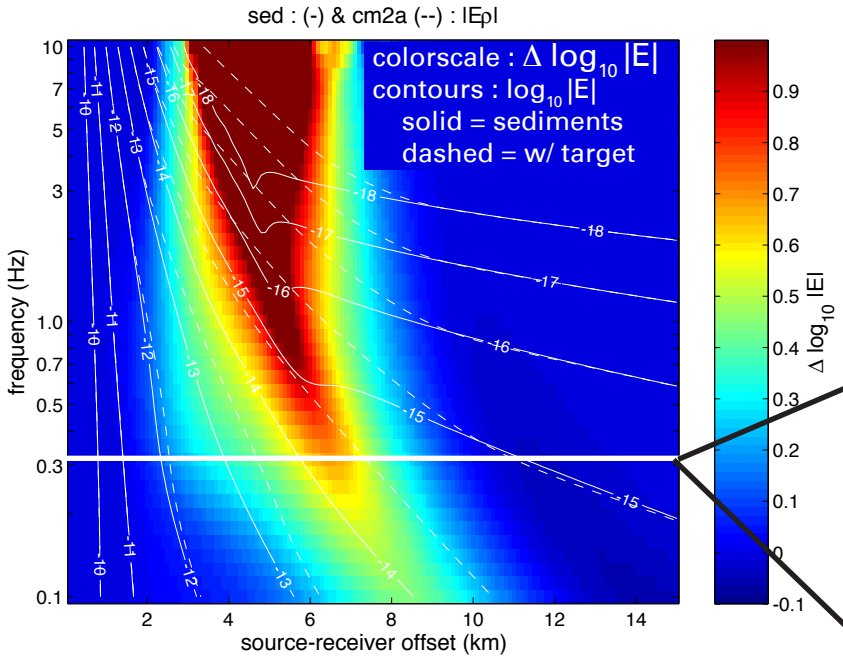
Creating a resistivity model

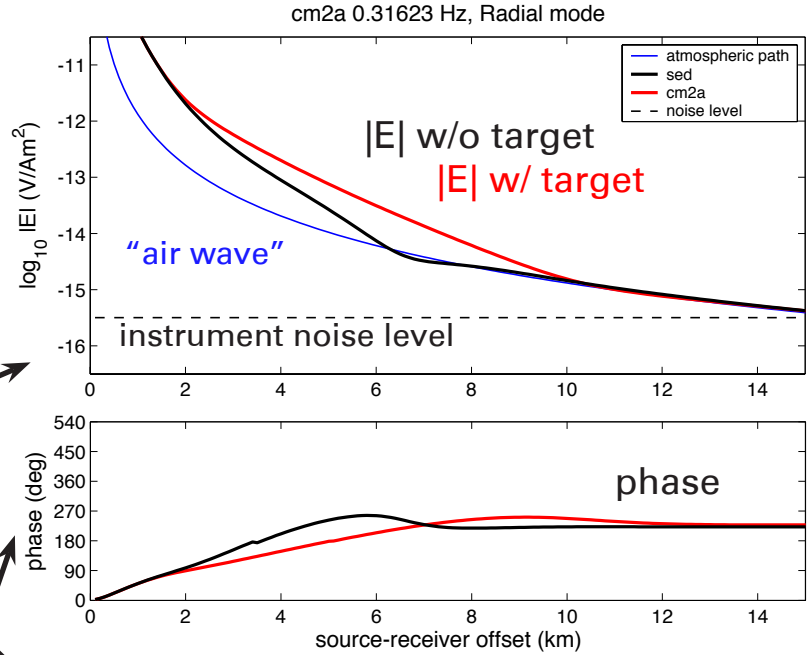
Testing common scenarios in 1-D

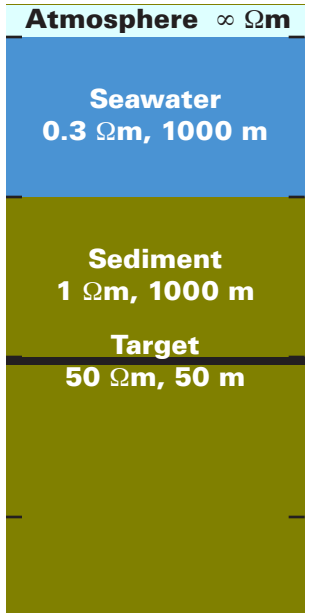
- Target thickness
- Target resistivity
- Target depth
- Effect of shallow resistors
  - hydrate
  - evaporite
  - salt
- **Effect of shallow water**

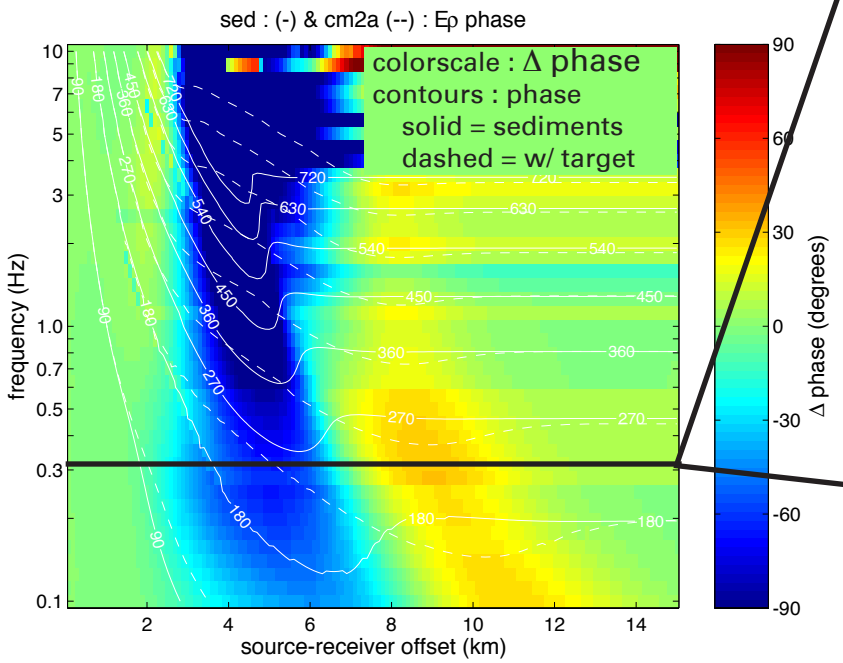
Discussion / Conclusions

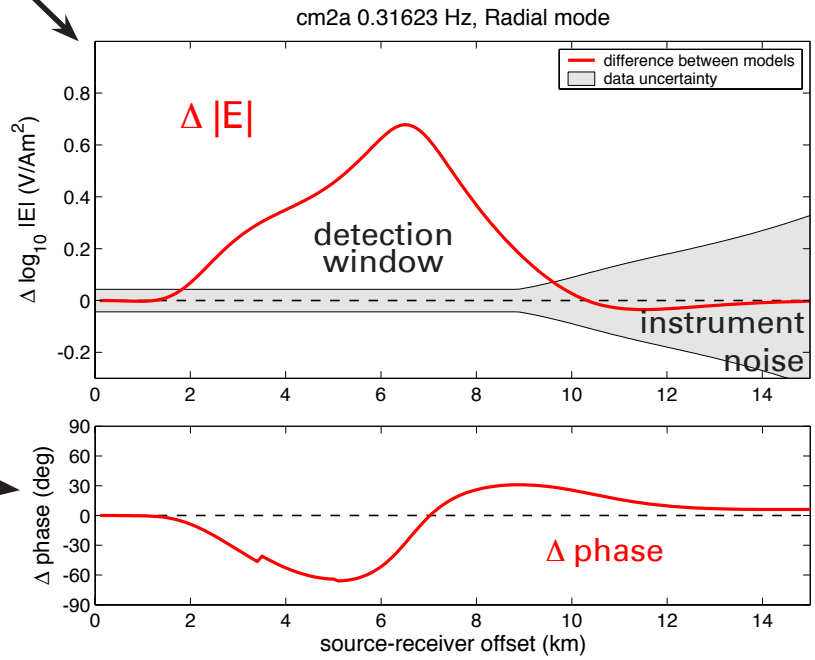
reference model: 1 km water depth





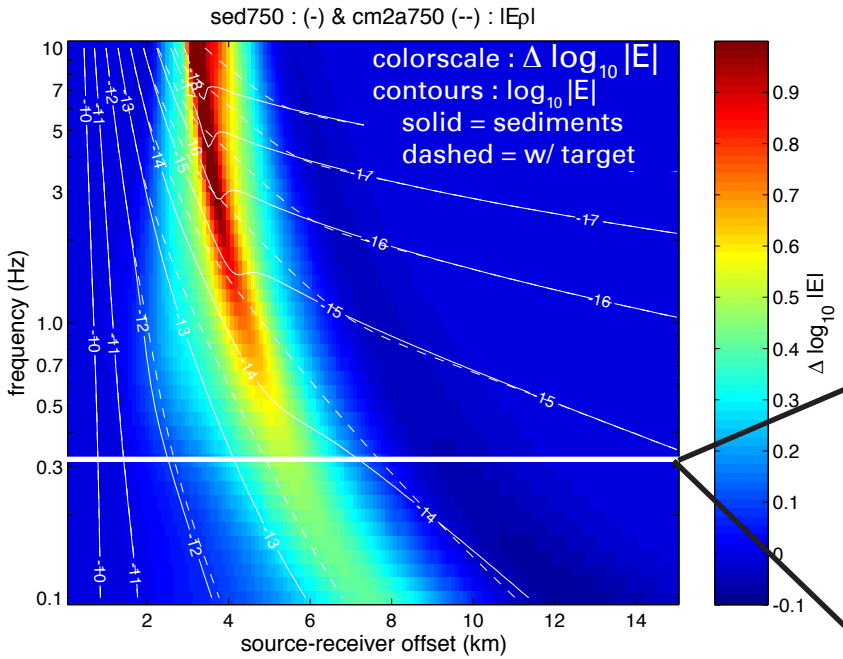


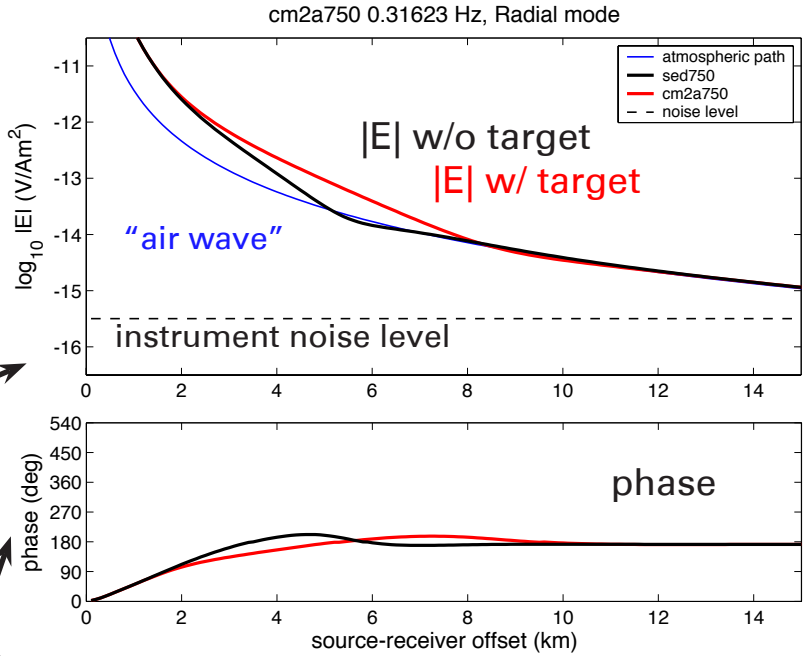


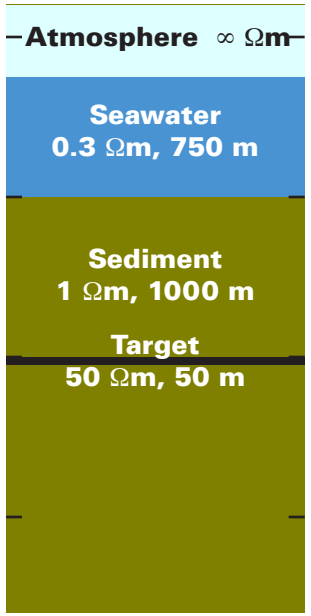


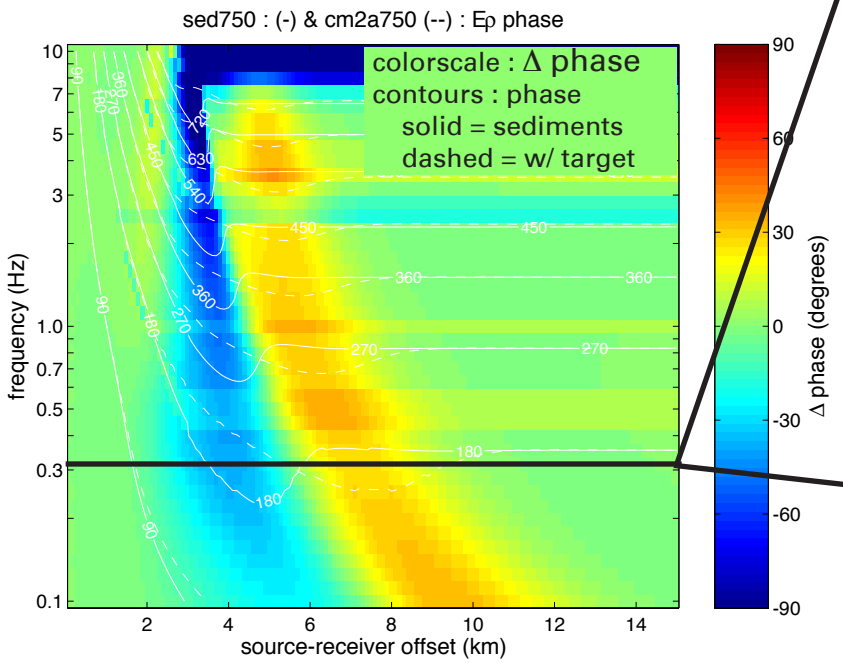
reference model: water depth 1 km ☑

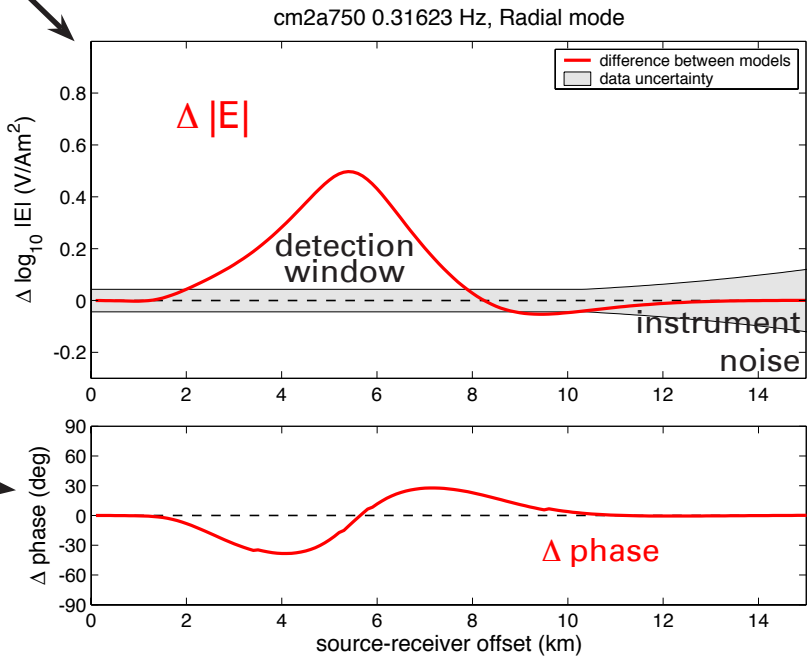
shallow water: 750 m water depth





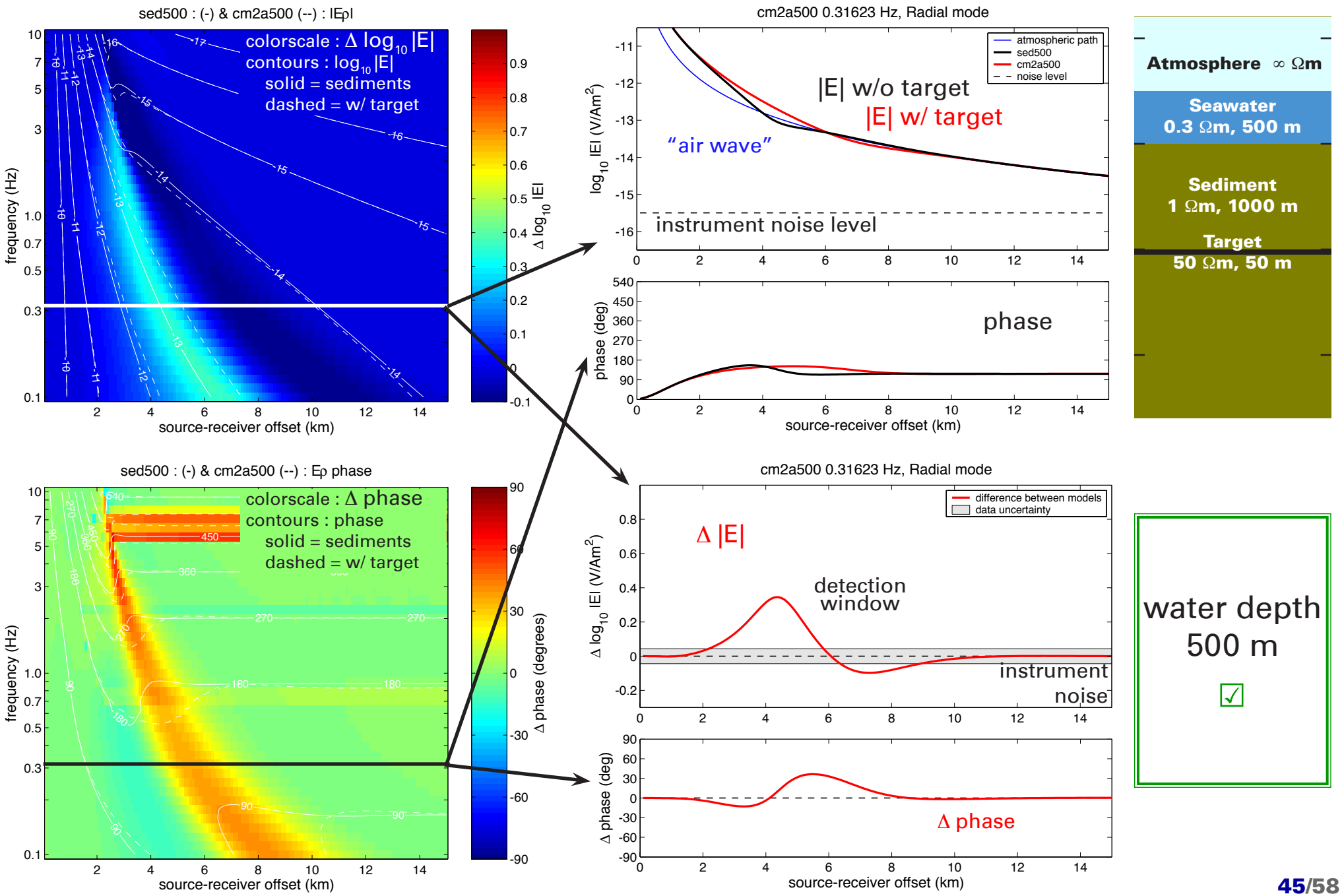




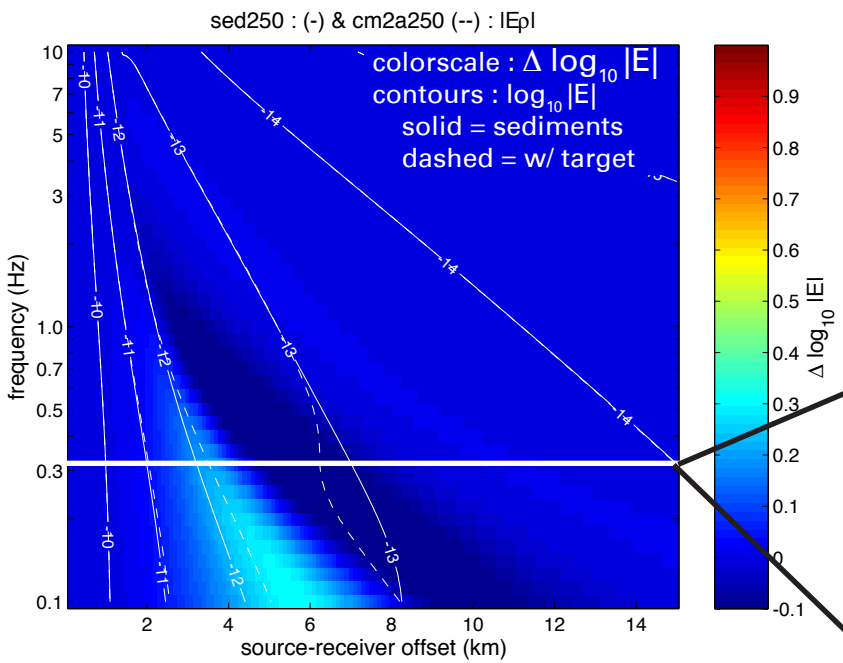


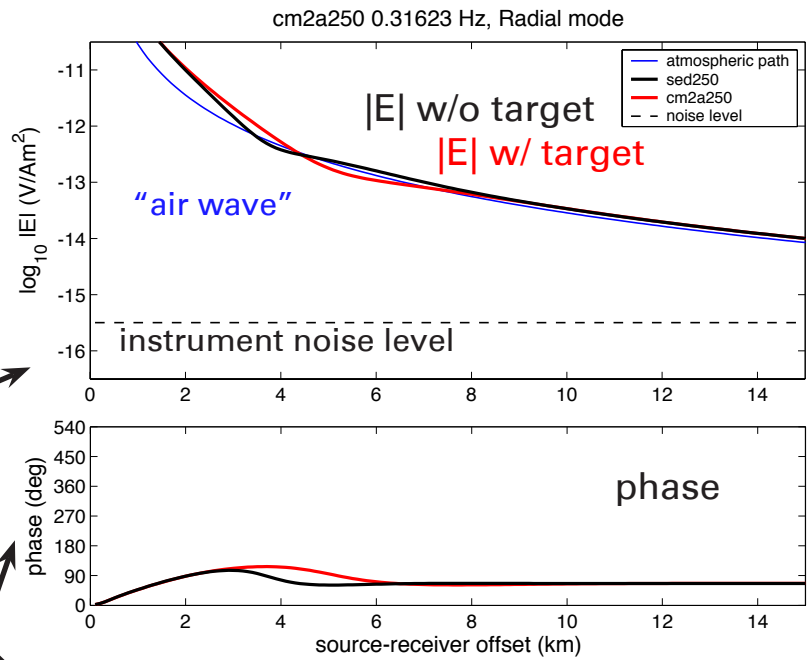
water depth
750 m
☑

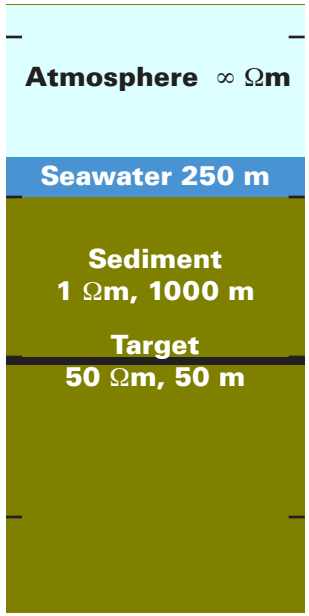
shallow water: 500 m water depth

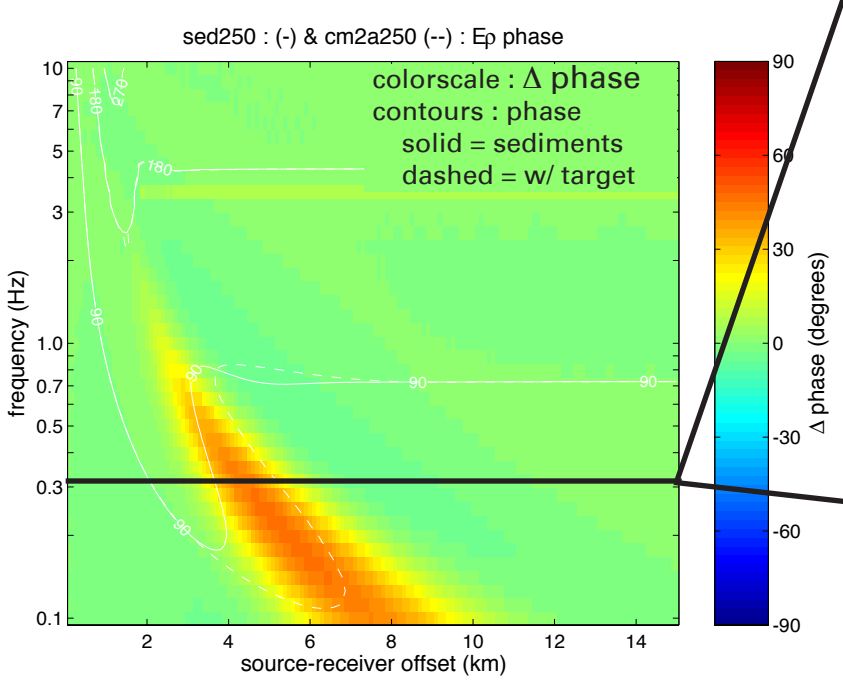


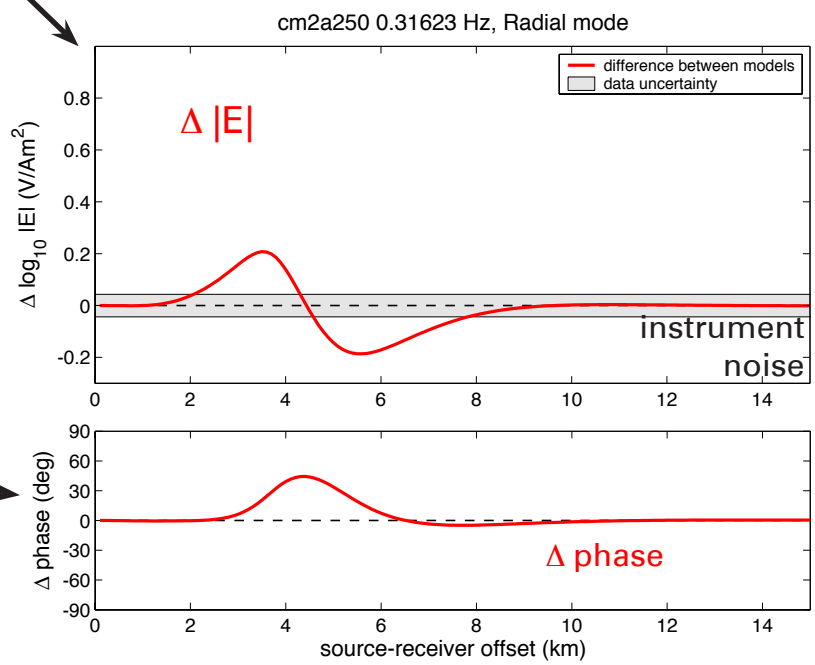
shallow water: 250 m water depth





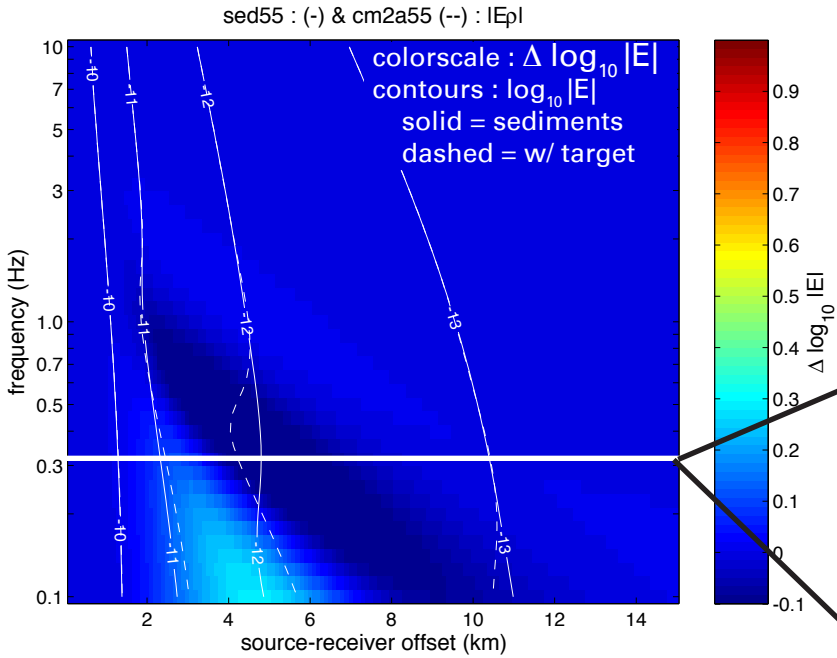


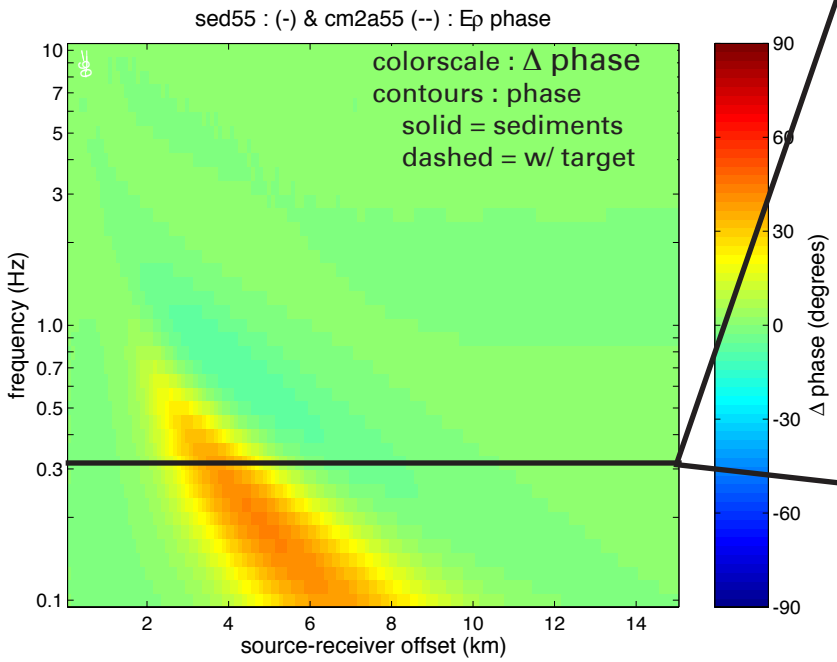


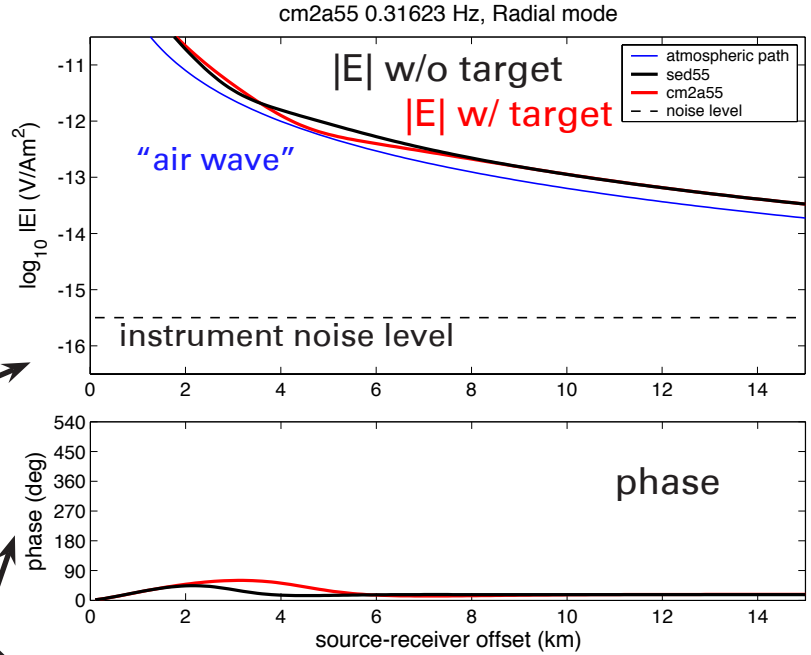


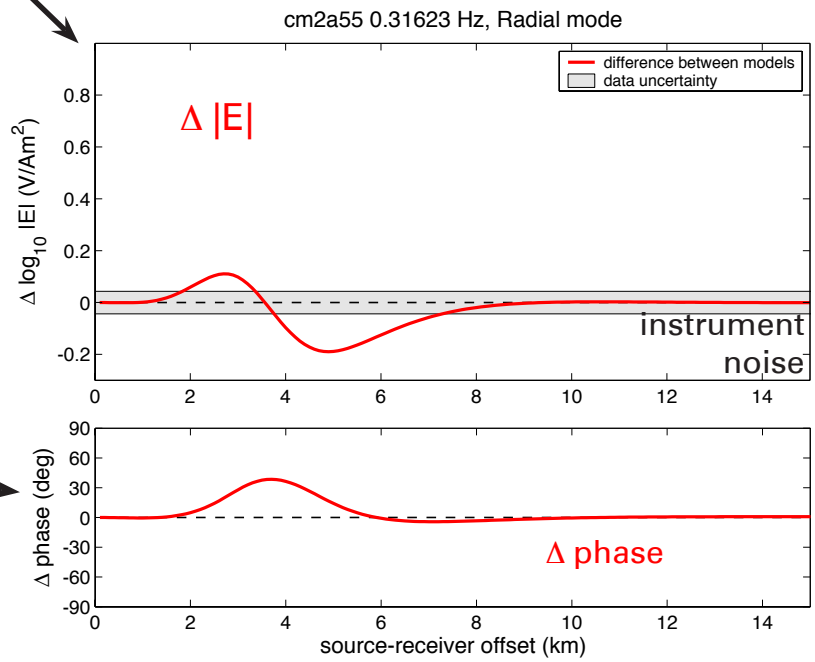
water depth
250 m
?

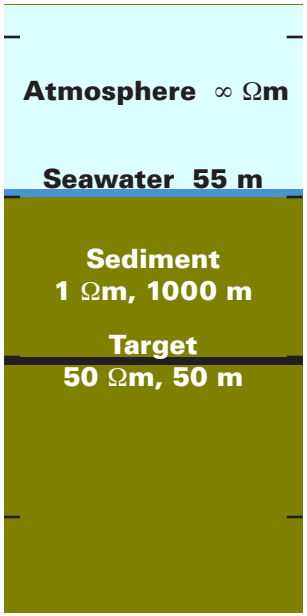
shallow water: 55 m water depth











water depth
55 m

outline

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- Effect of shallow water

Discussion / Conclusions

discussion

What to do next?

discussion

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Ask contractors to model your best target(s) in 3-D.

discussion

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If it still looks good: get on the boat.

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Drill (or don't).

discussion

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* technology and data interpretation advancing rapidly

conclusions

Seismic DHI methods aren't foolproof

conclusions

Seismic DHI methods aren't foolproof

Seismic sections + resistivity log = model

conclusions

Seismic DHI methods aren't foolproof

Seismic sections + resistivity log = model

1-D modeling for rapid assessment of targets

conclusions

Seismic DHI methods aren't foolproof

Seismic sections + resistivity log = model

1-D modeling for rapid assessment of targets

Target detectability depends on many factors

conclusions

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1-D modeling for rapid assessment of targets

Target detectability depends on many factors

Contractor capabilities differ