A Pilot Study for Electromagnetic Surveying of Freshwater Resources Beneath the US Atlantic Continental Shelf

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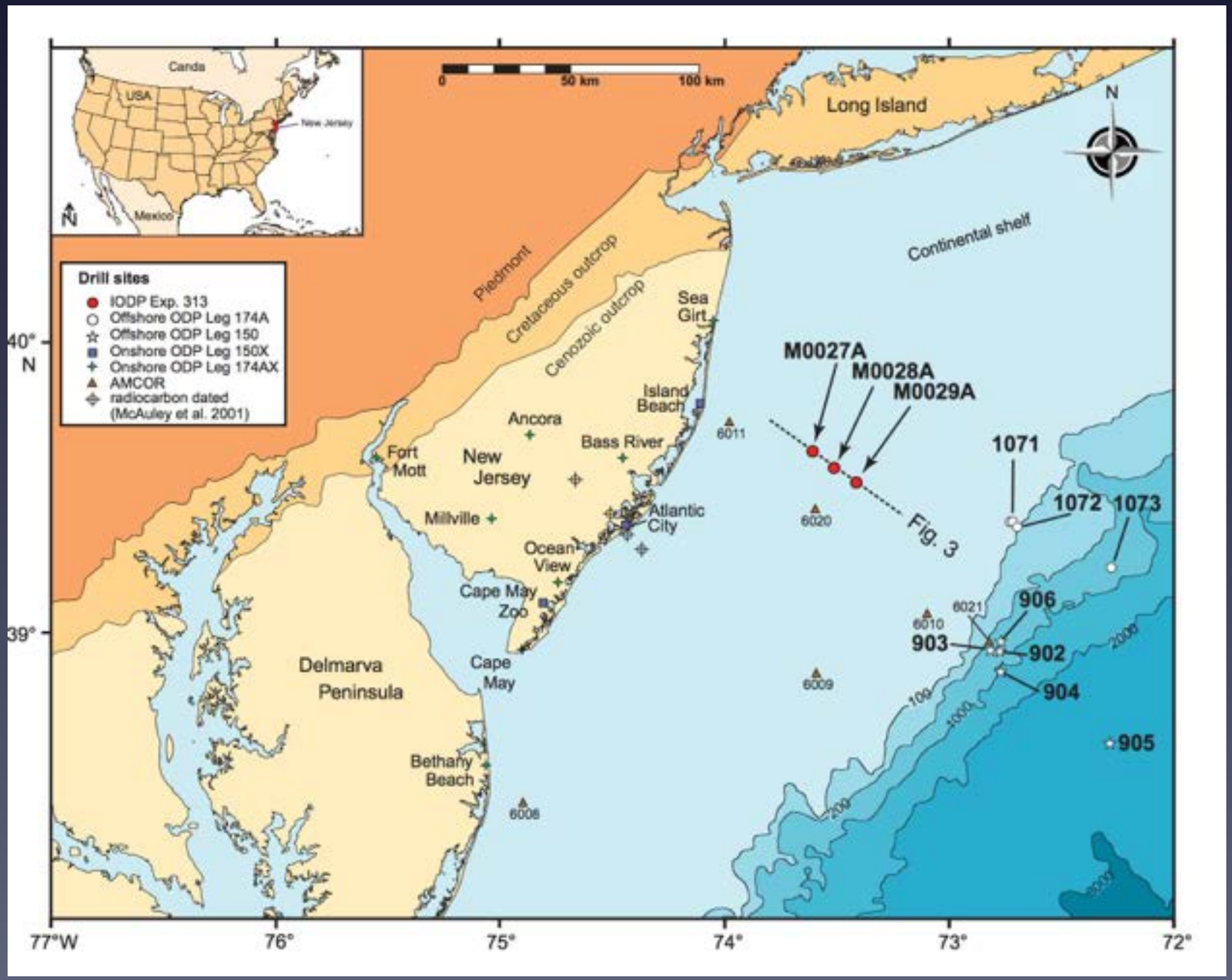
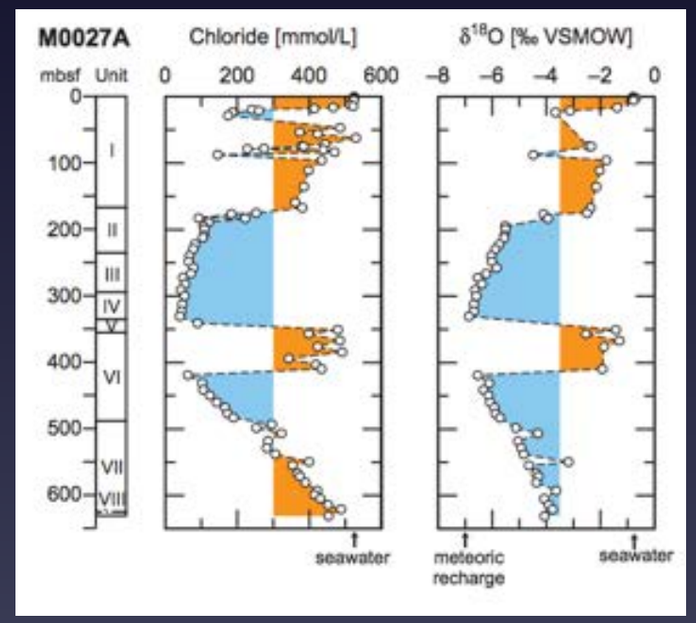
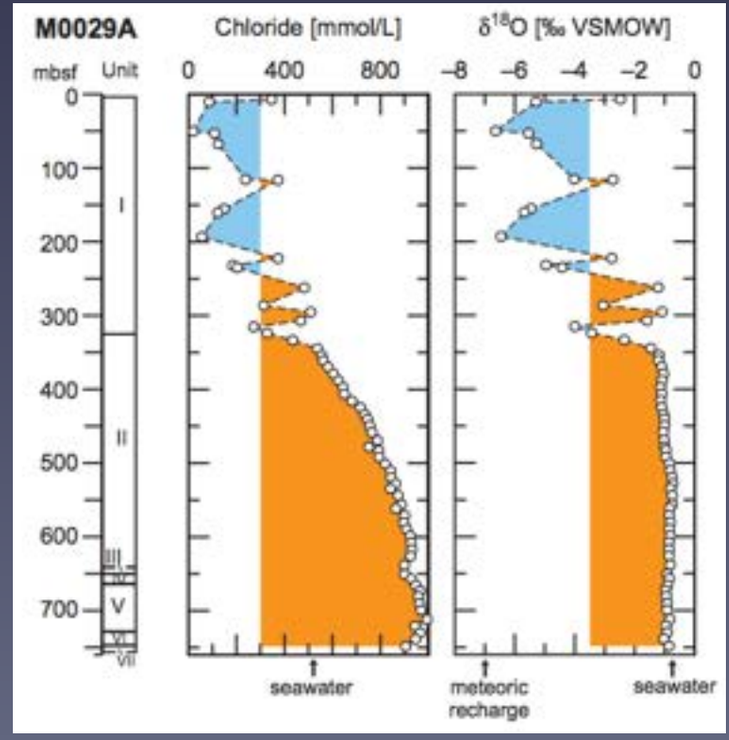
Motivation:
Freshwater detected on the New Jersey Shelf

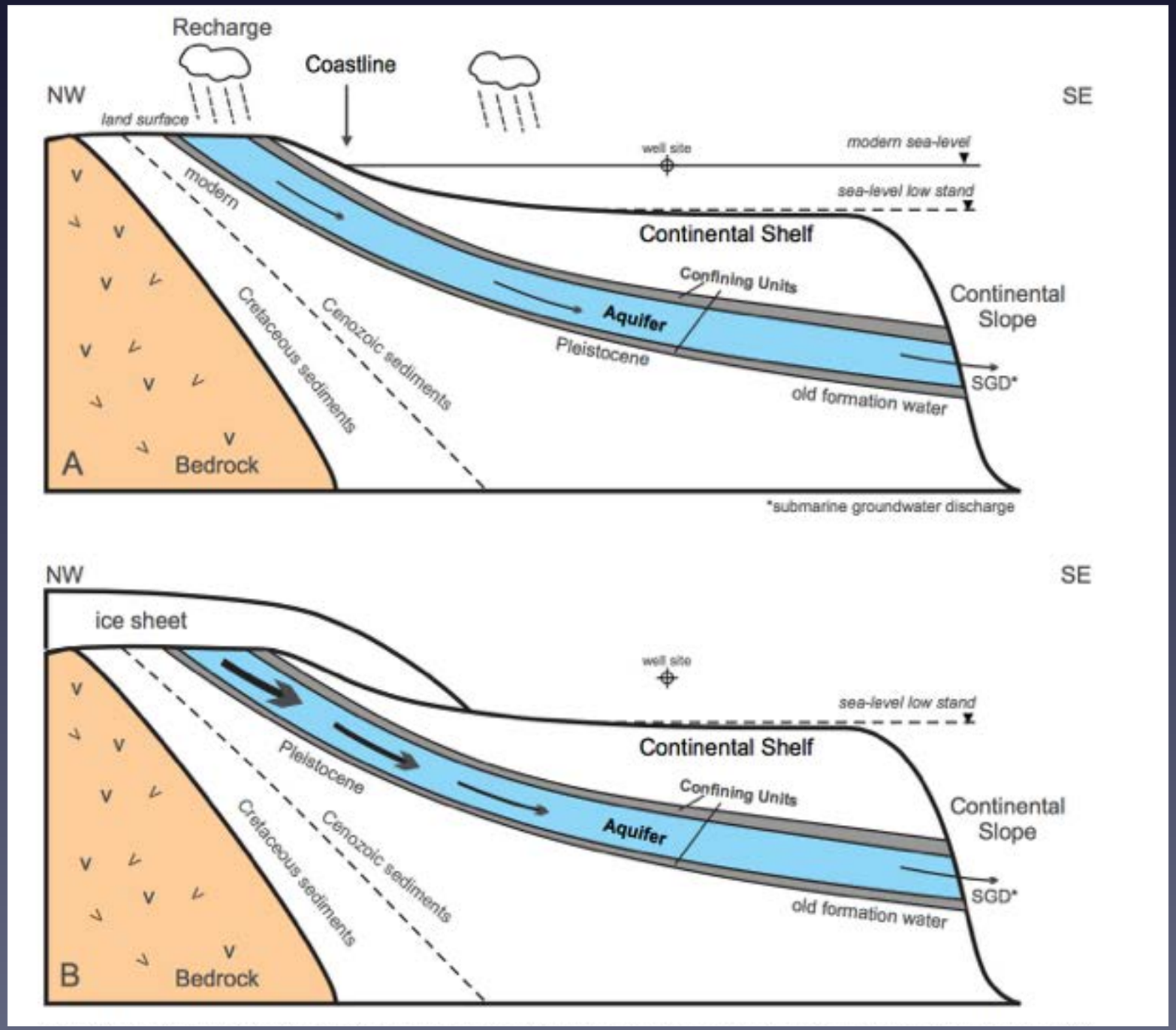


van Geldern et al. (2014)



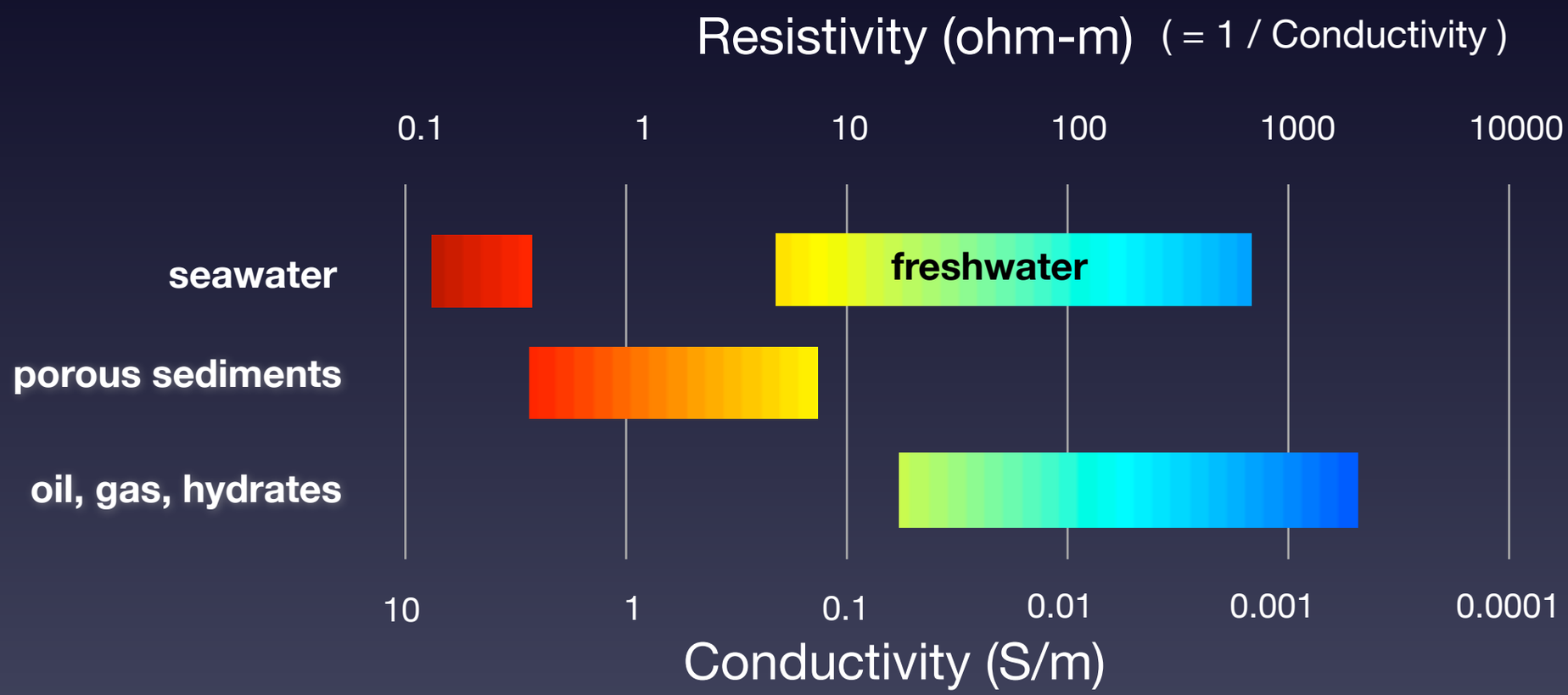


Conceptual models to explain emplacement of freshwater to 50+ km offshore:

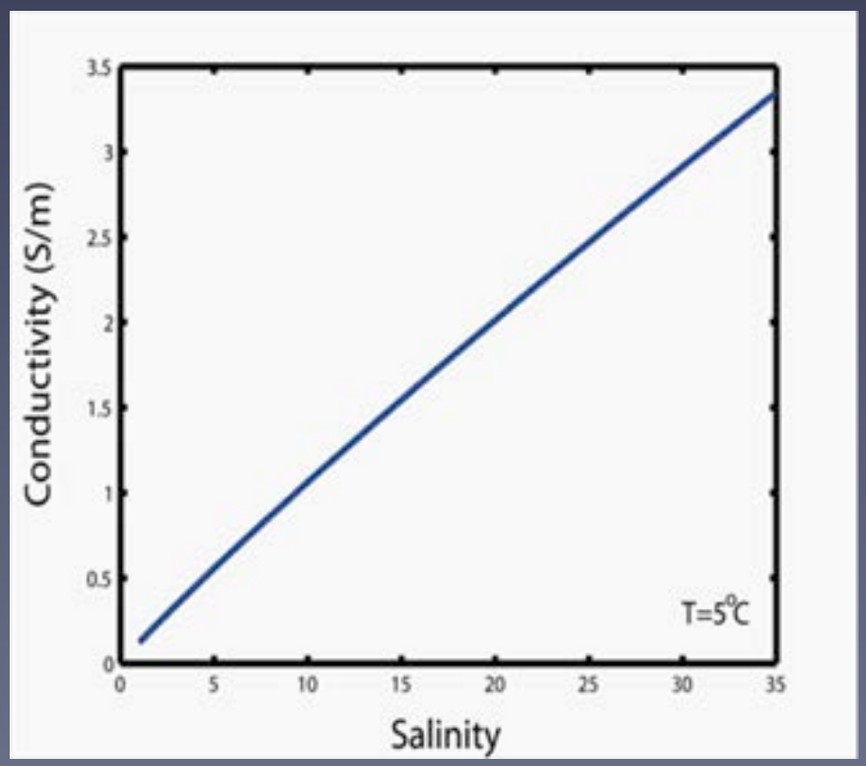


van Geldern et al. (2014)

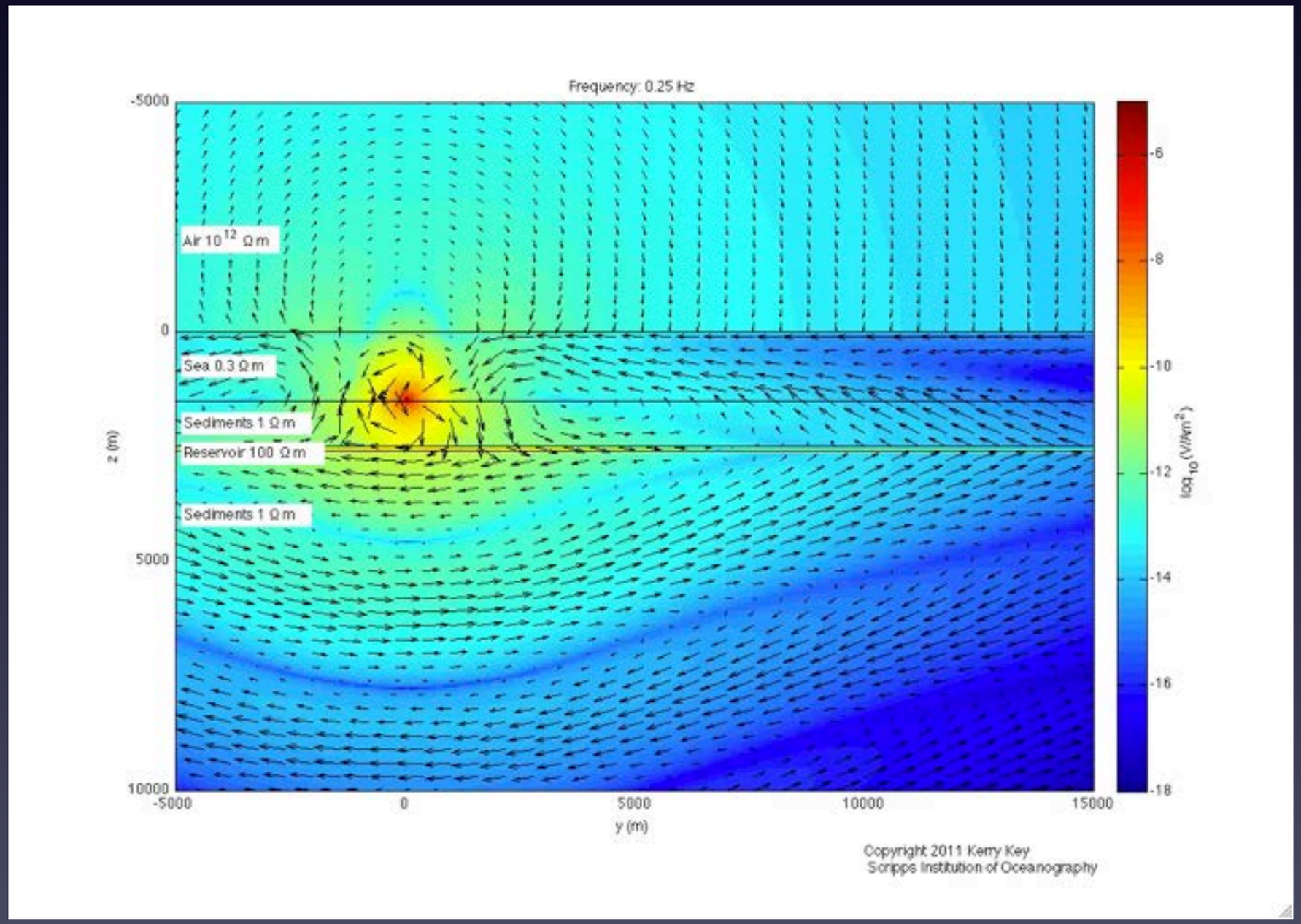
Electrical Conductivity of Sediments and Fluids



Water conductivity as a function of salinity:



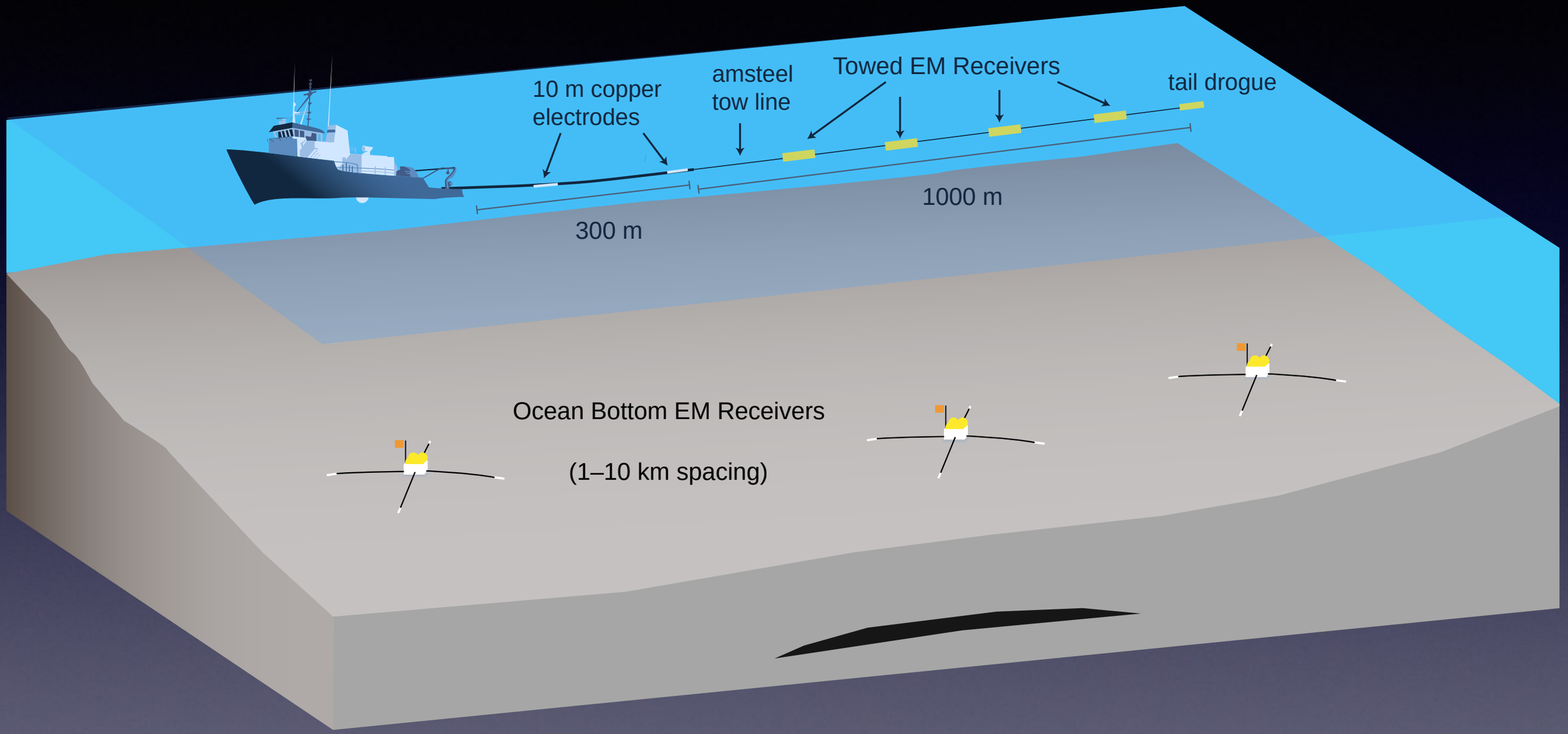
Electromagnetic diffusion in a thin resistive layer:



- Controlled-source EM works for mapping offshore hydrocarbon layers (thin resistors)
- Offshore groundwater is an obvious application but has remained untested…

Controlled-Source Electromagnetic (CSEM) Method:

Surface-towed acquisition system for shallow water



- 336 m dipole transmitter, surface towed, 100 A current
- 4 towed receivers (250, 500, 750, 1000 m) offsets
- 10 seafloor EM/MT receivers

CSEM and MT survey off New Jersey and Martha's Vineyard: September 3-14, 2015

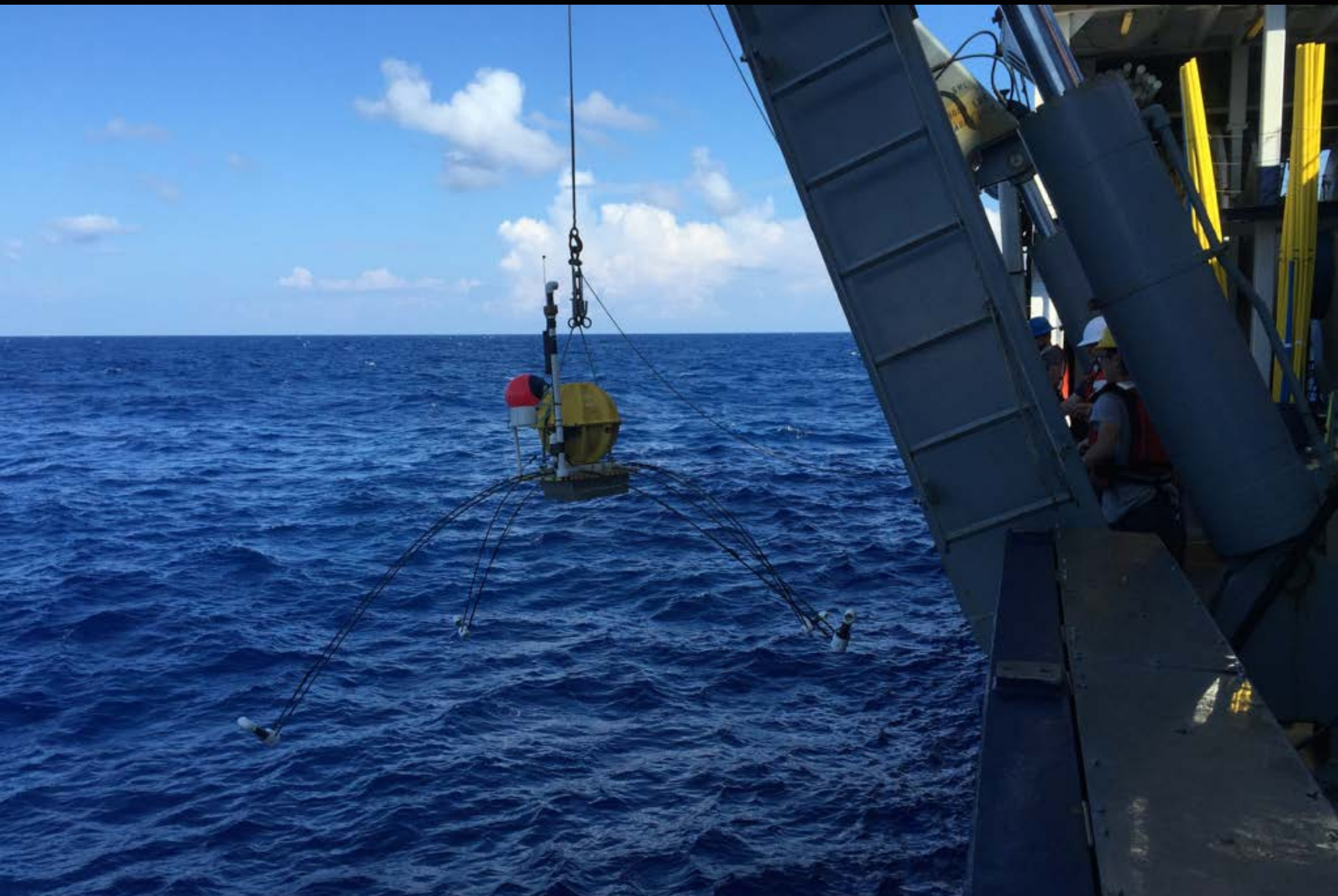
Objectives for our EM/MT Survey:

- Demonstrate the capabilities of marine EM methods for mapping offshore hydrology
- Understand the spatial extent of chlorinity anomalies already detected in wells off New Jersey
- Test whether similar anomalies exist off southern New England
- Identify if freshwater is leaking into the ocean through localized discharge

Scripps OBEM Receiver Deployment Movie

Scripps OBEM Receiver Recovery Movie

New WHOI OBEM Receiver Deployment

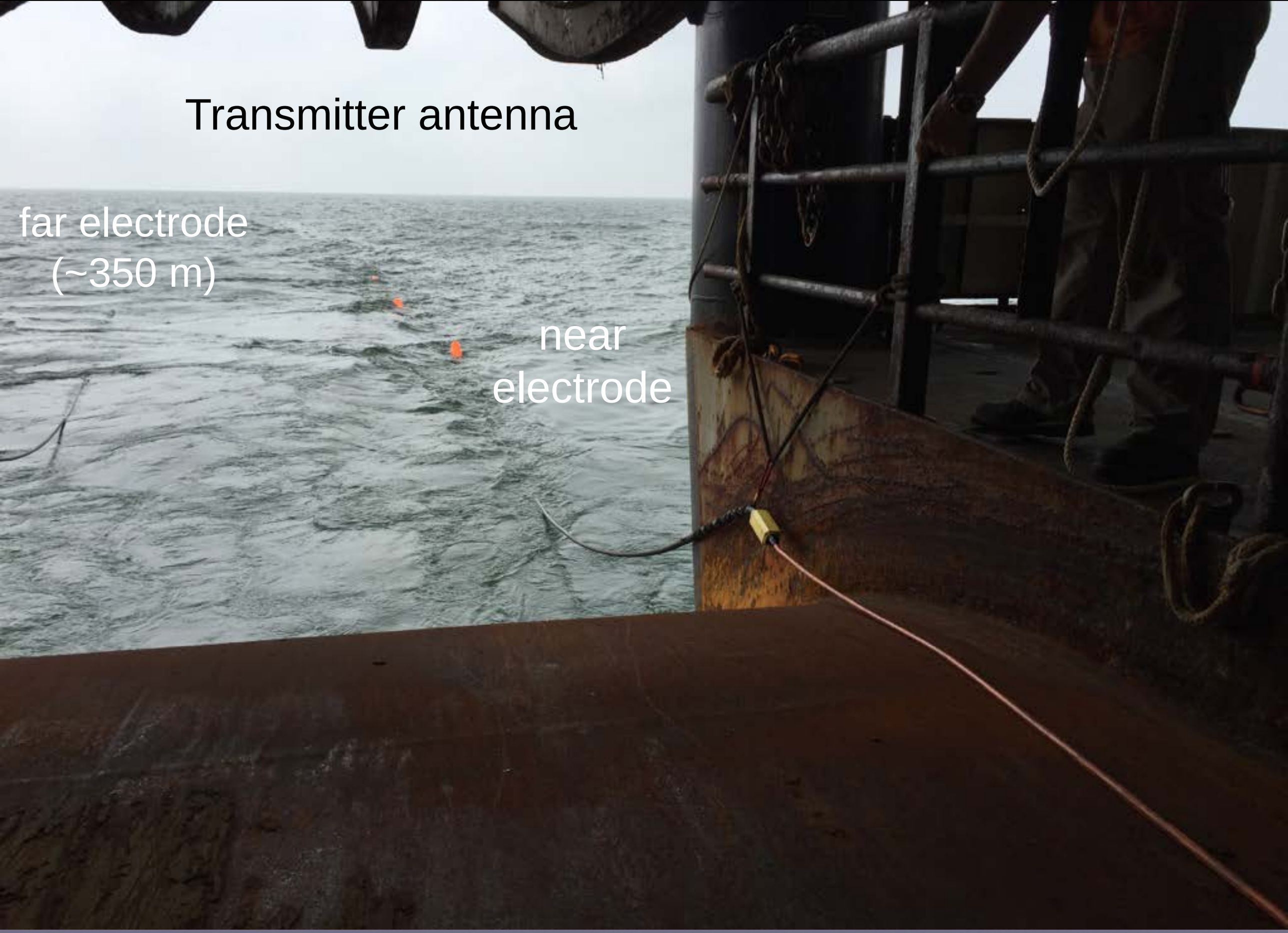


Winch for towed receiver array and antenna cables

Towed EM receiver “Porpoise”

- Modified from seafloor OBEM logger
- Single 2 m electric dipole
- GPS mast with flashing strobe
- Designed to be towed under tension to reduce tilt noise

Transmitter antenna

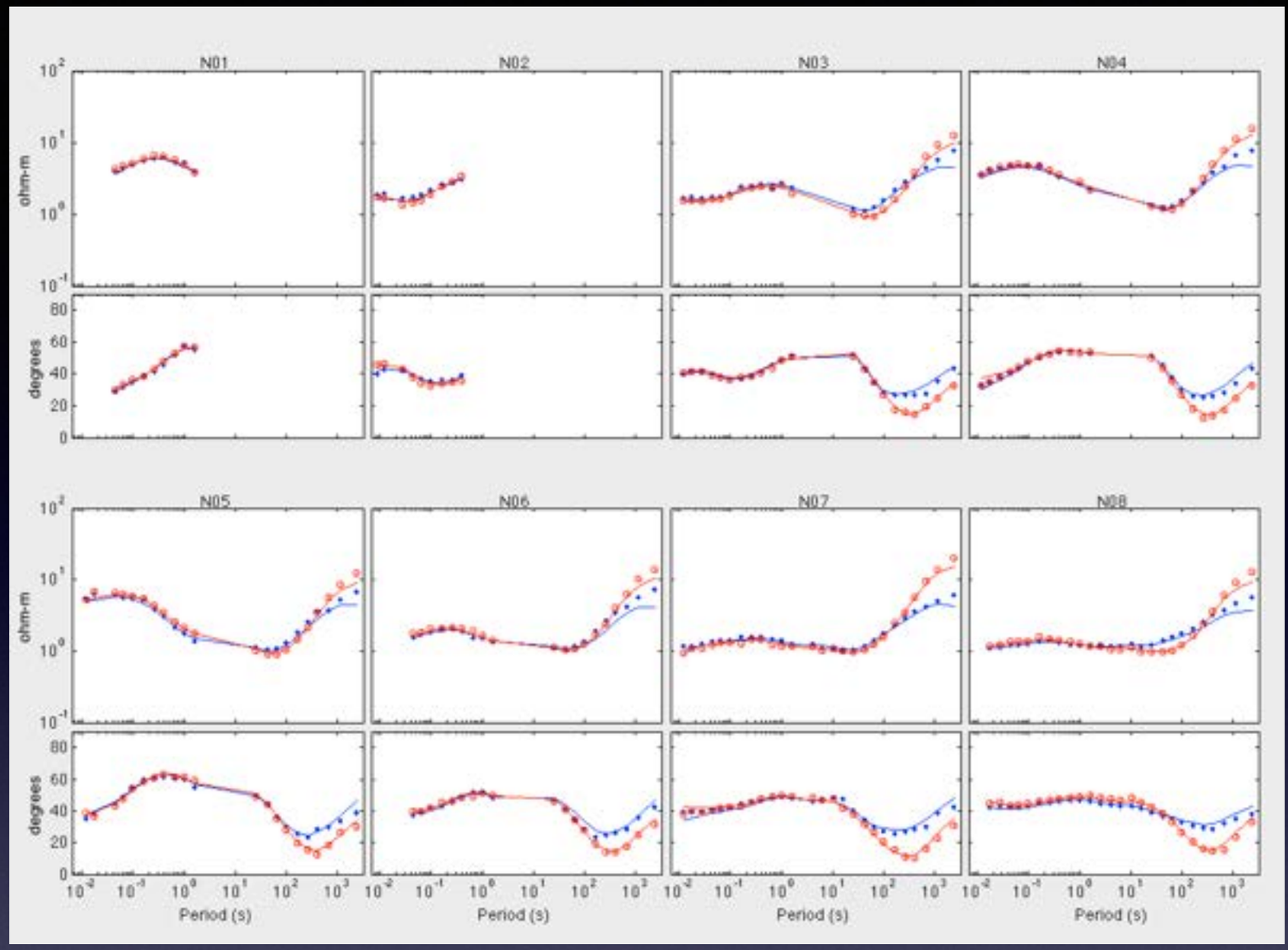

Transmitter antenna
far electrode
(~350 m)
near
electrode

Transmitter power supply and controller

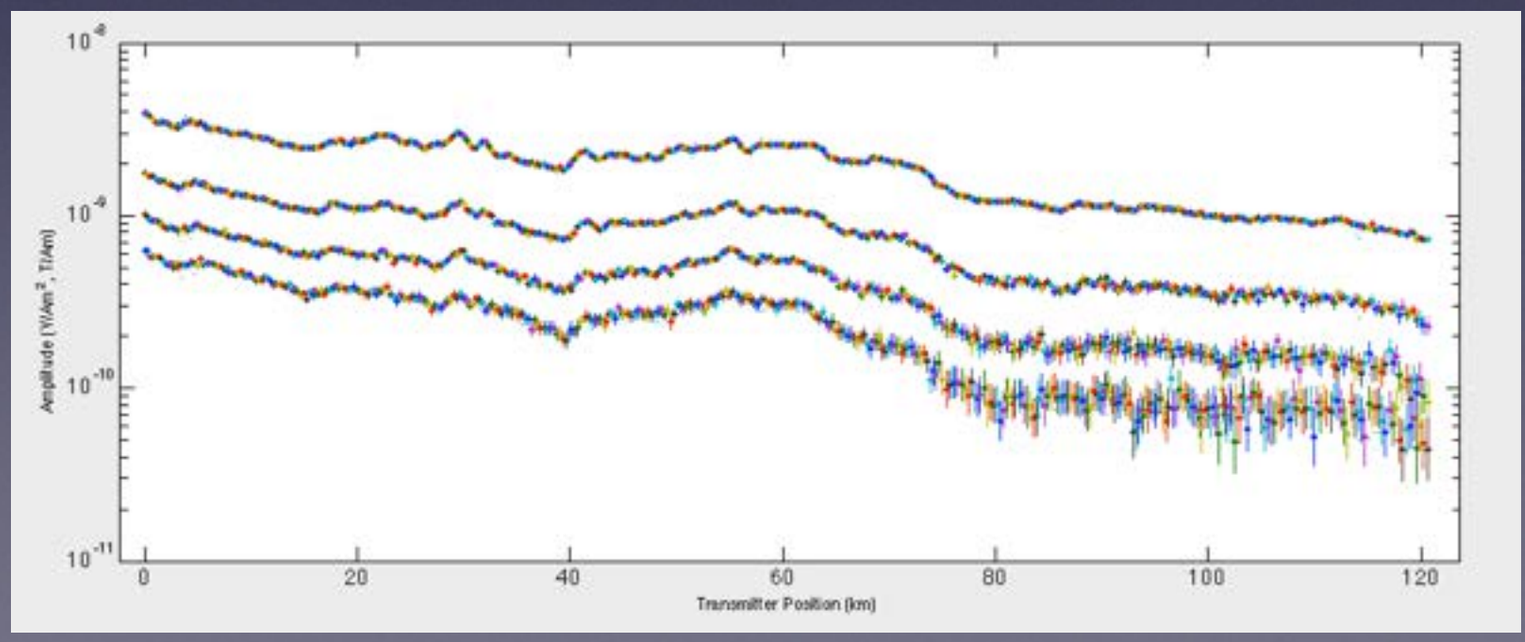
Surface Towed CSEM Movie

New Jersey Data:

- MT responses good to 100 Hz in 20-80 m water depths!
- noisy wave band at 0.1 to 0.8 Hz for some stations, not all
- Data mostly 1D
- Two near-shore stations have large 3D skews at long periods

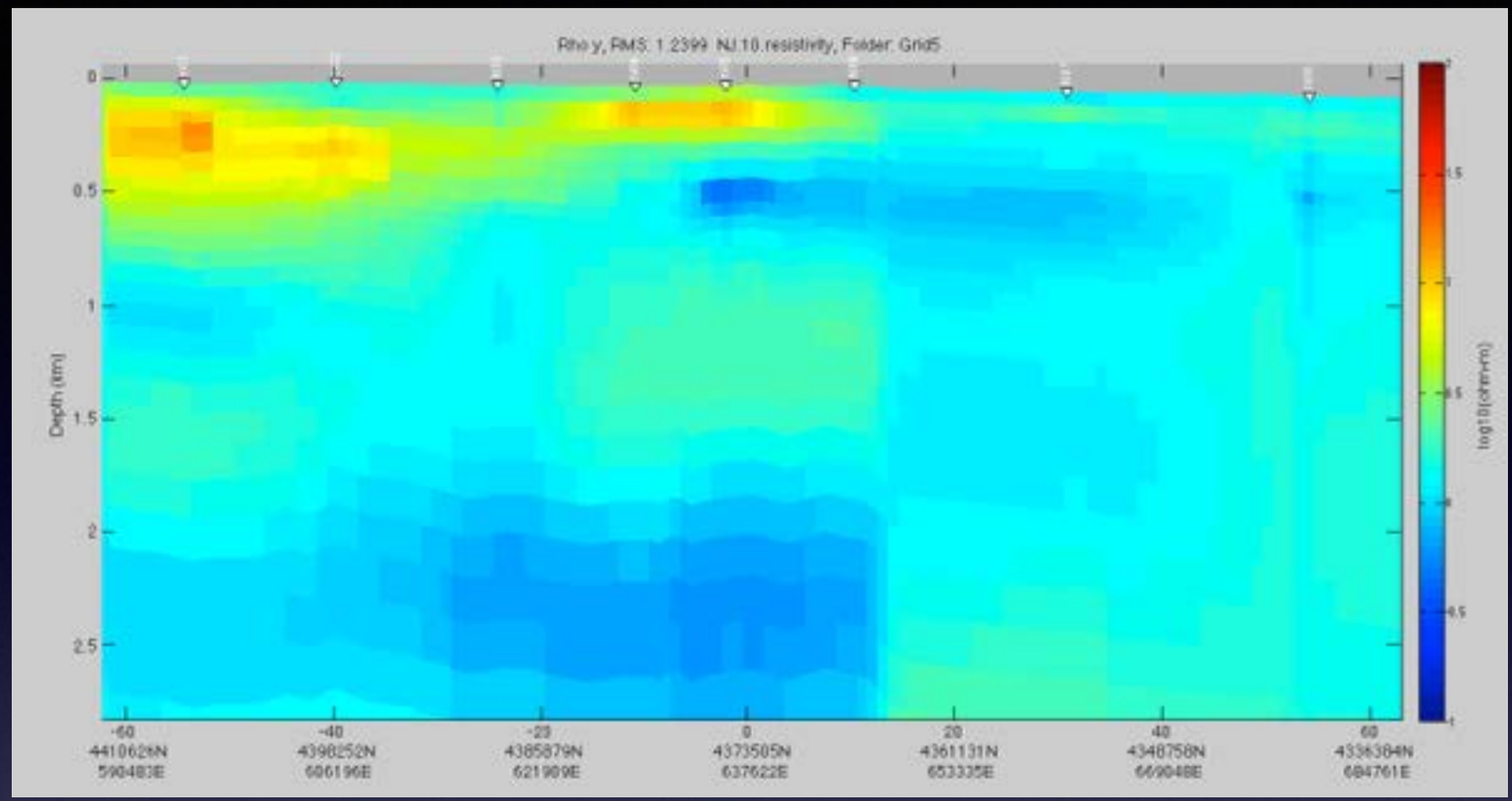


- Surface-Towed CSEM at 0.75 Hz:

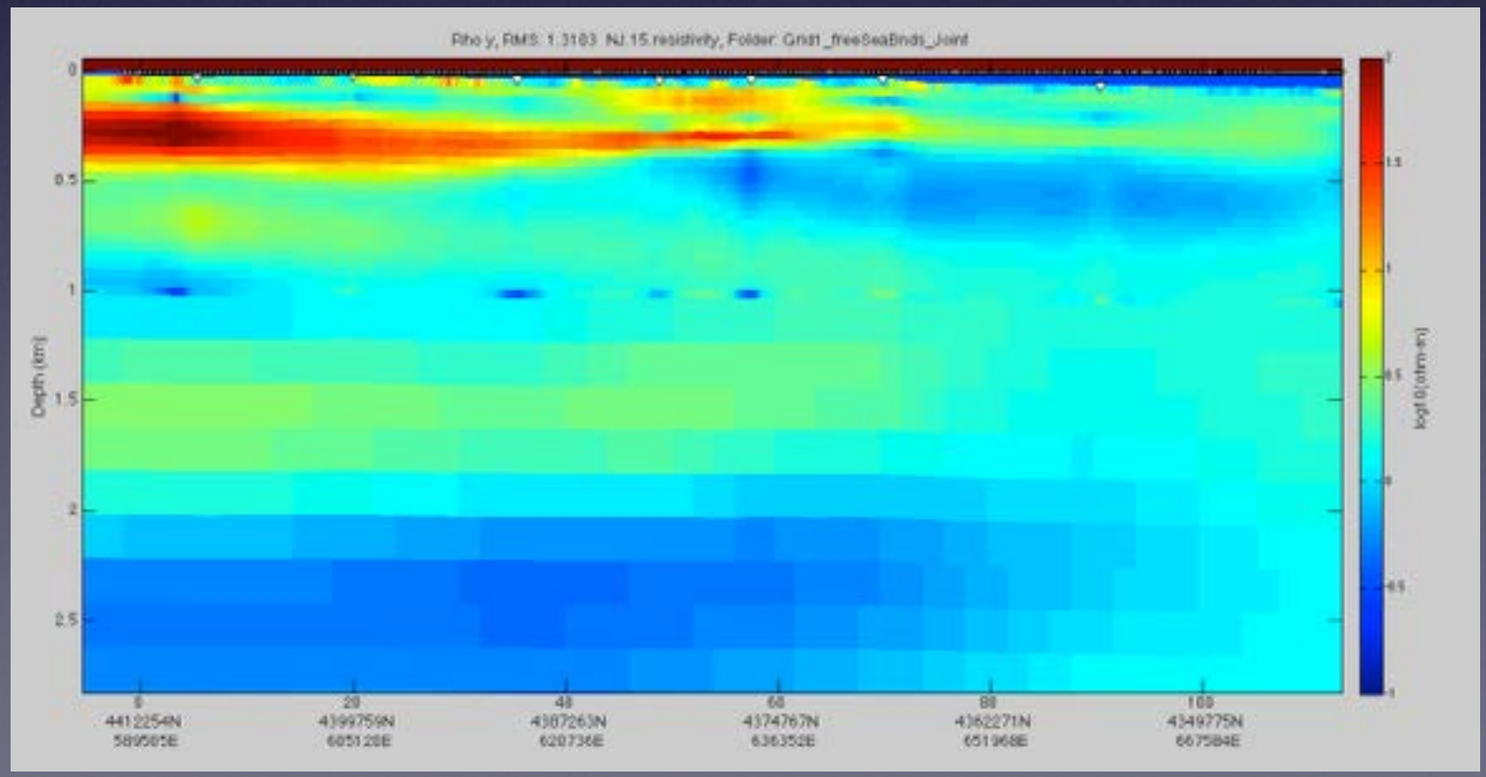


Preliminary inversions of New Jersey data

- **MT inversion**
- sees the aquifer



- **Joint MT & surface-towed CSEM inversion**
- maps aquifer even better
- inversion run on UCSD cluster, launched remotely from R/V Langseth



Acknowledgments

- NSF funding support
- Captain and crew of RV Marcus Langseth
- Steve Constable and the Scripps Marine EM Lab
- Students and volunteers who helped on the cruise