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HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

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Platelet-Layer Volume with Electromagnetic Induction Sounding

SEA ICE in a changing environment
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IGS

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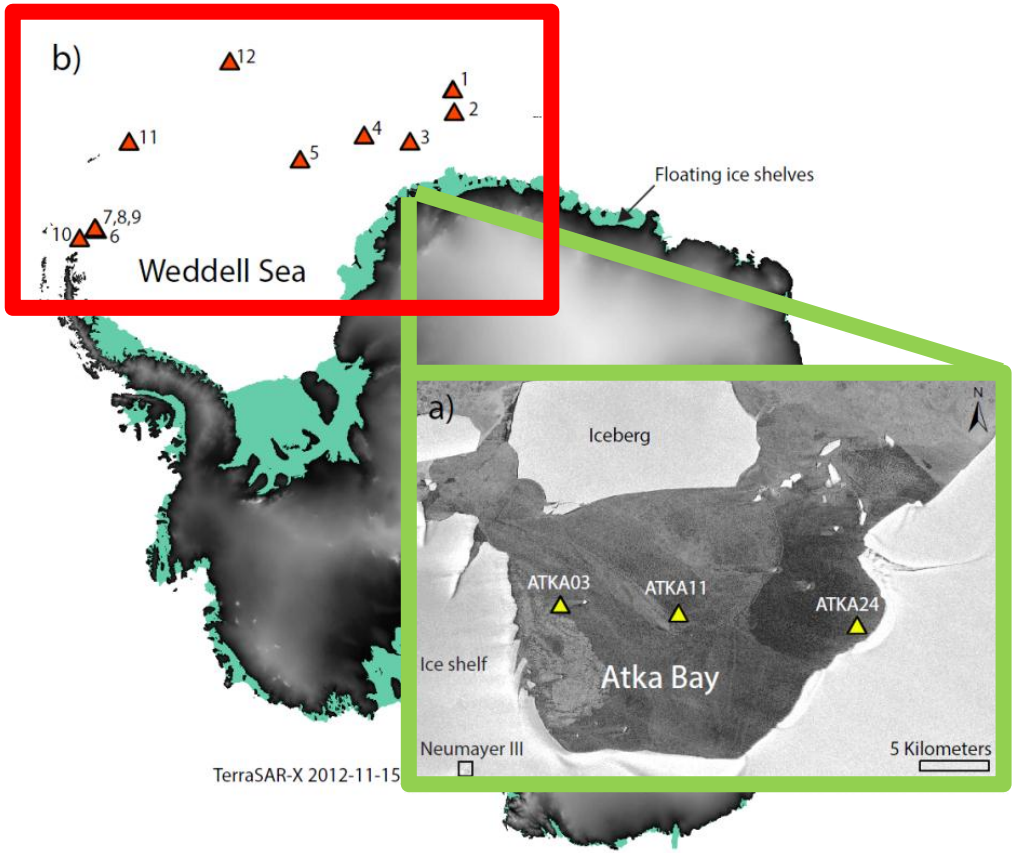
Sub-ice platelet layer

- Result of ocean-ice shelf interactions
- Contributes to heat and mass balance of adjacent sea ice
- Unique ice habitat
- Modifies sea-ice freeboard

→ Determination of platelet-layer volume without drilling

- Absolute EM calibration
- Platelet-layer conductivity and ice-volume fraction

Study sites



a)

Atka Bay

- Sea ice
- Sub-ice platelet layer
- Seawater

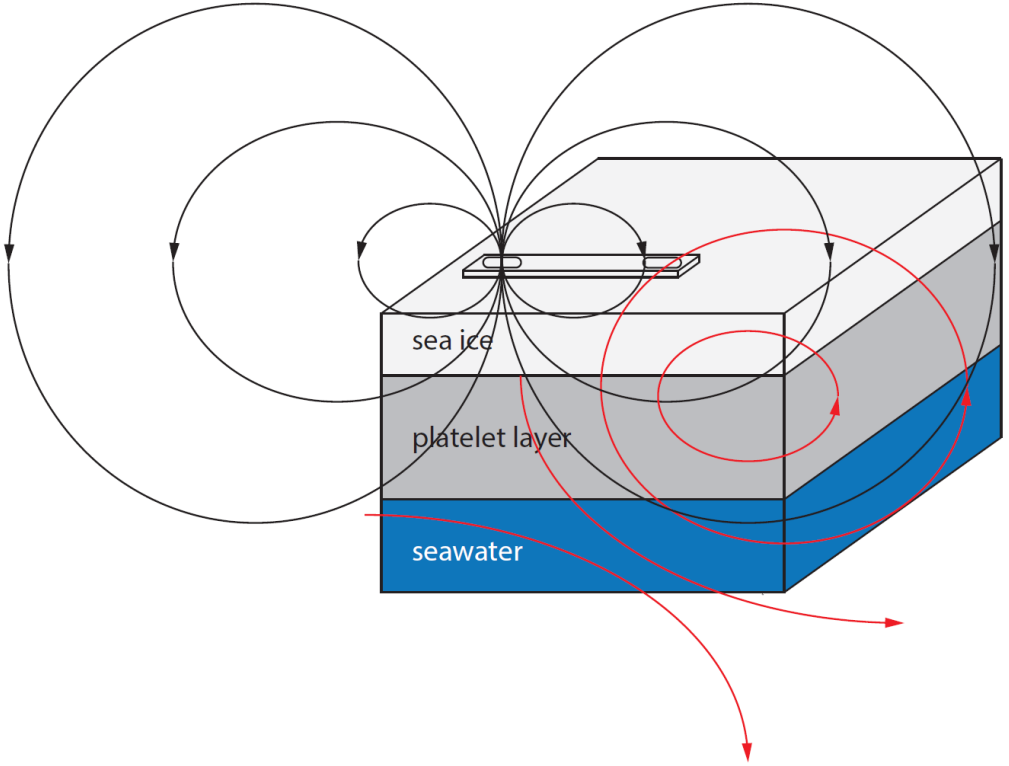
b)

Weddell Sea

- Sea ice
- Seawater

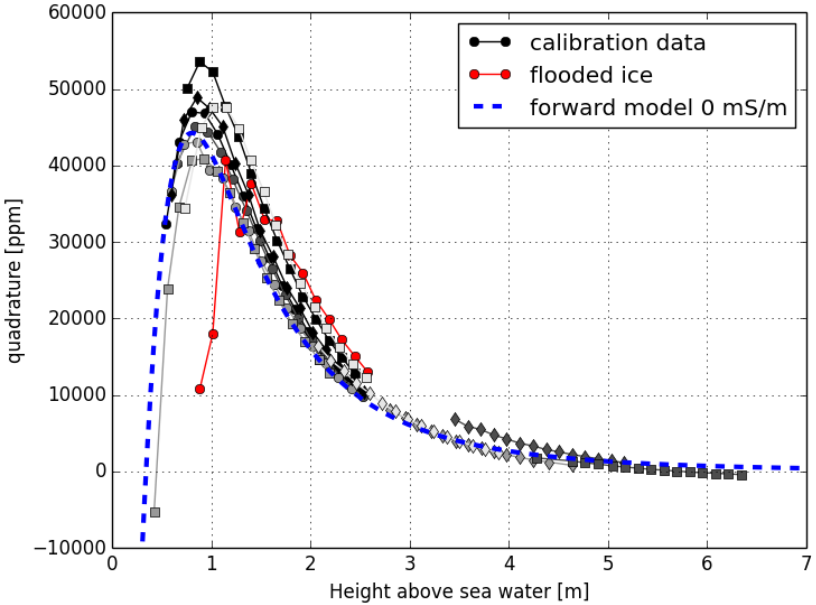
Calibration and uncertainties

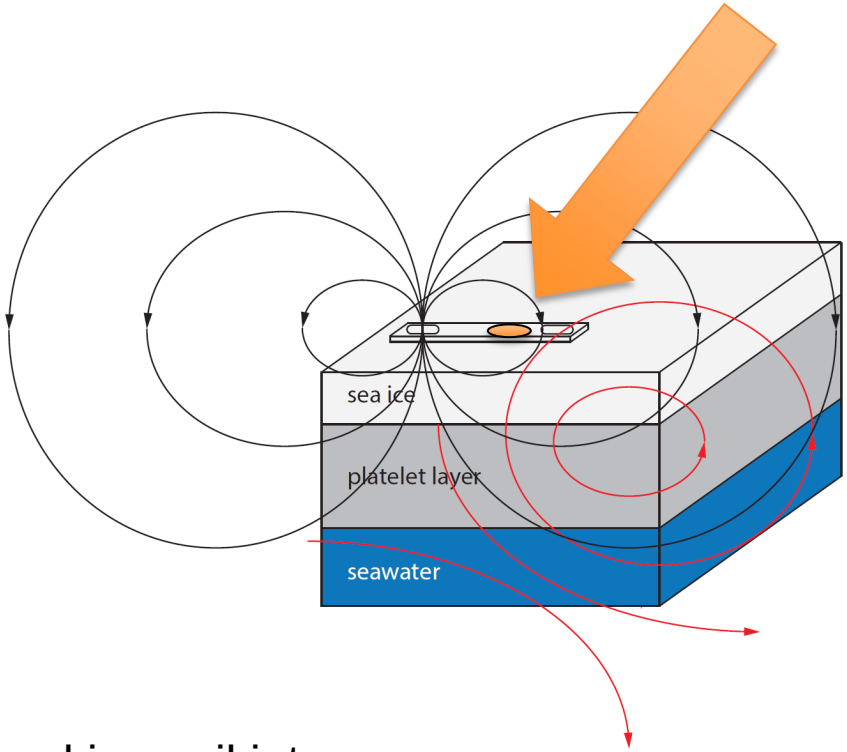
- GEM-2, Geophex Ltd
- 1530 Hz - 93090 Hz
- Inphase and Quadrature



Calibration and uncertainties

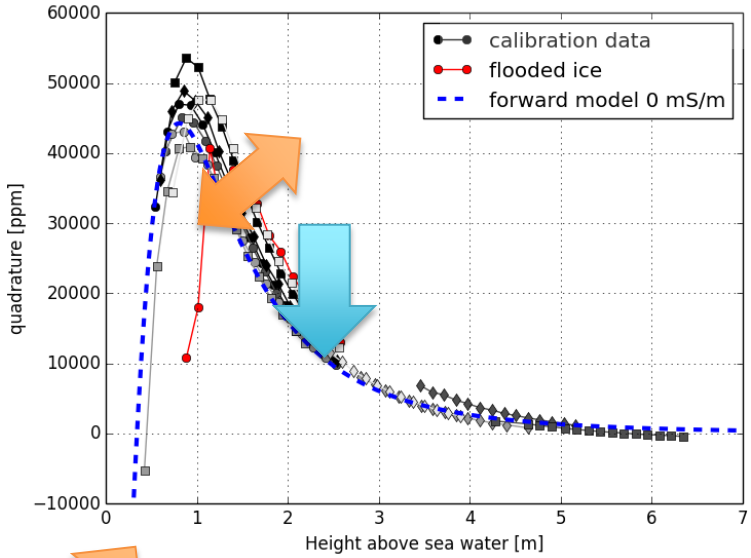
Raw data, Quadrature, 63030 Hz





→ Including theoretical response of bucking coil into the forward model of Anderson, 1979

Calibration and uncertainties



General **offset** to the forward model due to imprecise calibration of individual frequencies.

→ **Calibration coefficients**

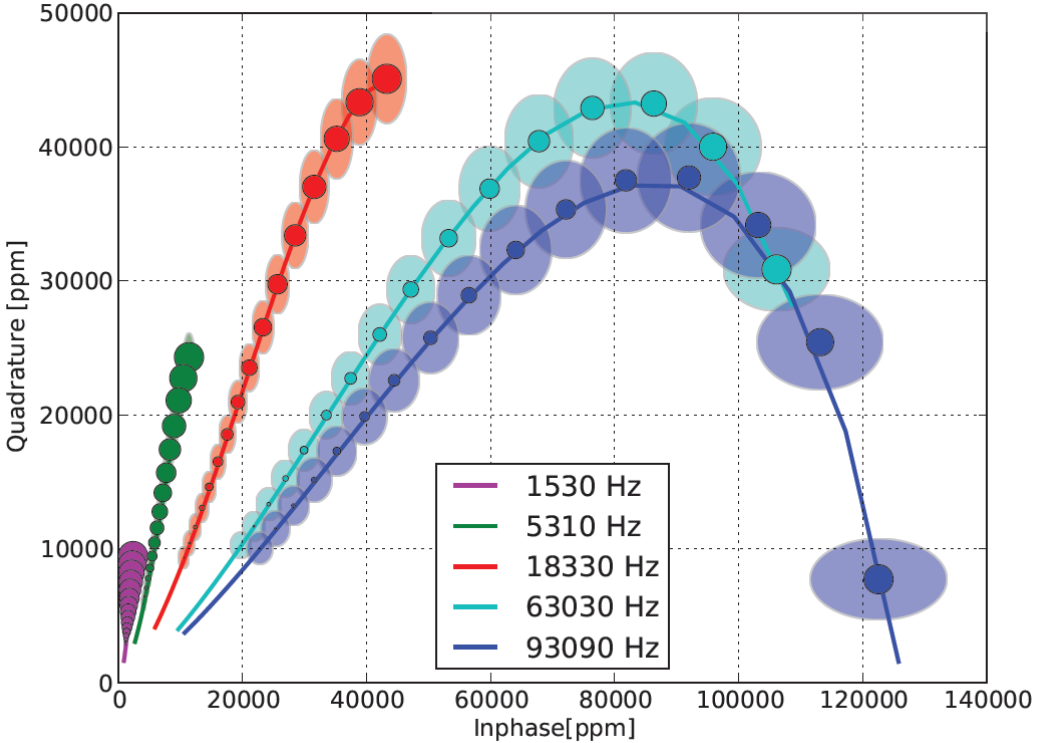
→ **Averaged calibration coefficients for data correction**

Inter-variability between different calibrations

- Temperature
- Sea-ice conductivity
- Sea-ice thickness

→ **Uncertainties**

Calibration and uncertainties



- **Field data: Inphase, Quadrature**
  5 Frequencies, 0-2 m

- **Uncertainty ellipses**:
  Gaussian law of error propagation
  - Standard deviation of calibration coefficients
  - Noise of Inphase, Quadrature

- **Forward models**

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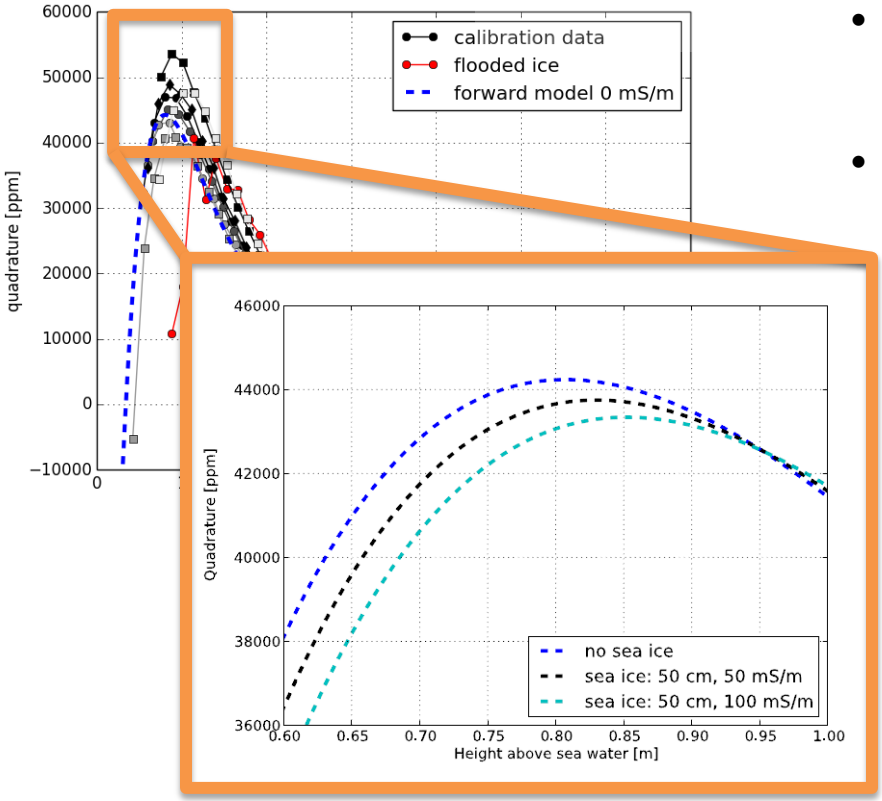
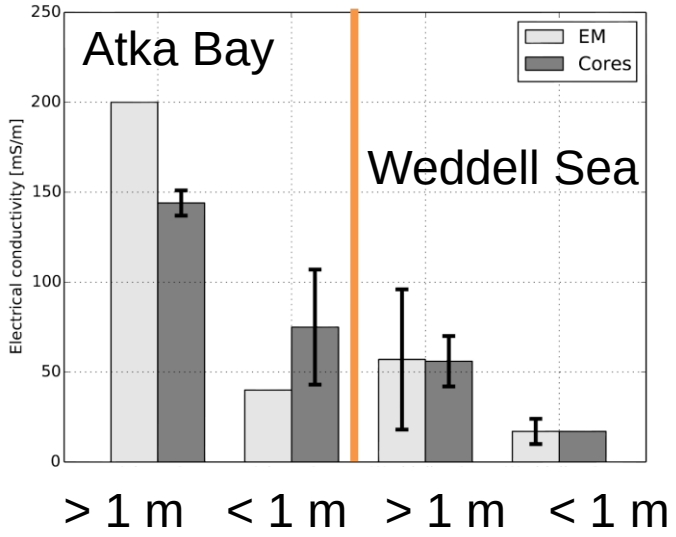
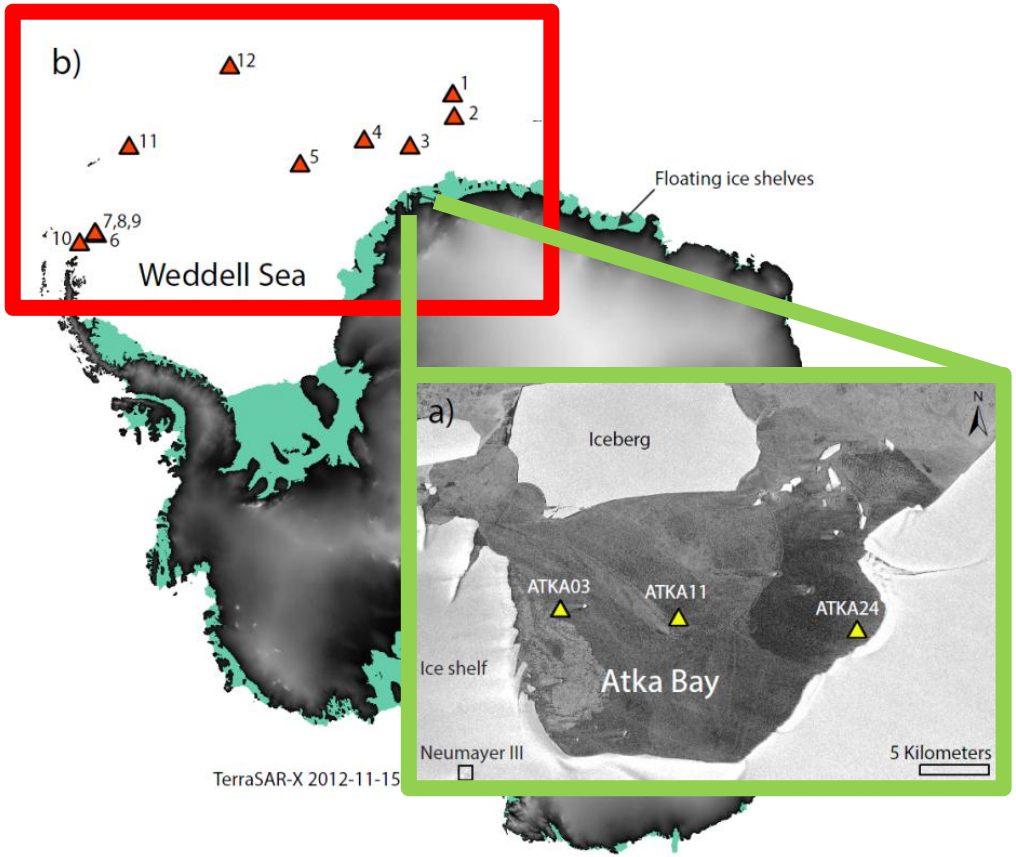
Sea-ice conductivity



- Quadrature components of 63030 and 93090 Hz are sensitive to sea-ice conductivity
- In same range as data from drilled sea-ice cores



Study sites



Calibration coefficients, uncertainties

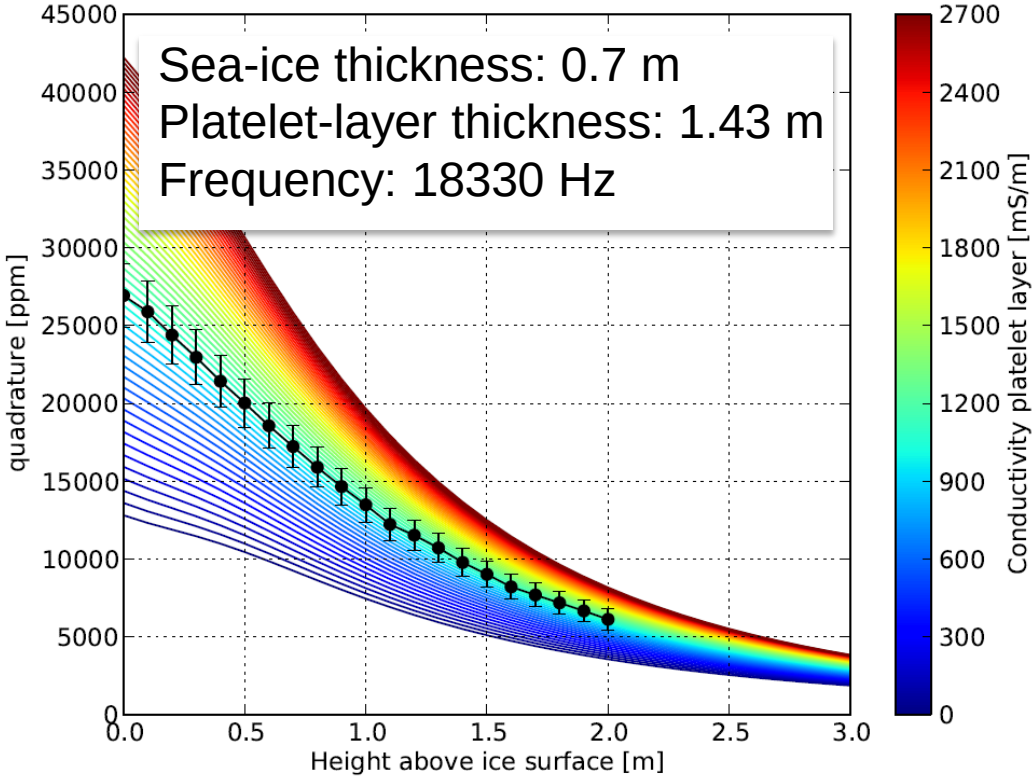
Weddell Sea

- Sea ice
- Seawater

Atka Bay

- Sea ice
- Sub-ice platelet layer
- Seawater

Bulk platelet-layer conductivity



- Comparison of calibration data to forward model of Anderson, 1979
- Resulting bulk platelet-layer conductivity of

1154 ± 271 mS/m

Ice-volume fraction (1 - Φ)

Archie‘s law

$$\rho = \rho_b (\Phi)^m$$

ρ	Bulk platelet-layer conductivity (1154 mS/m)
ρ_b	Conductivity of seawater between ice platelets (2690 mS/m)
Φ	Porosity
m	Cementation factor (1.5-2.5)

→ Resulting **ice-volume fraction of 0.29 - 0.43**

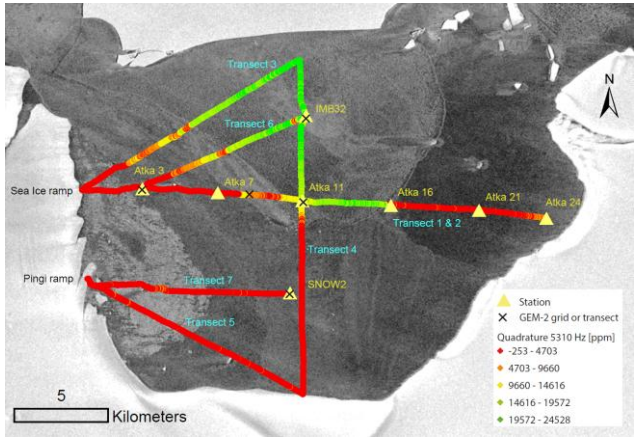
Summary

- **Absolute calibration** of GEM-2 with uncertainty estimations
- **Sea-ice conductivity** estimation with high- frequency quadrature components (63030 Hz and 93090 Hz)
- **Platelet-layer conductivity** estimation by comparing calibration data to forward models
- **Ice-volume fraction** estimation by using Archie‘s law

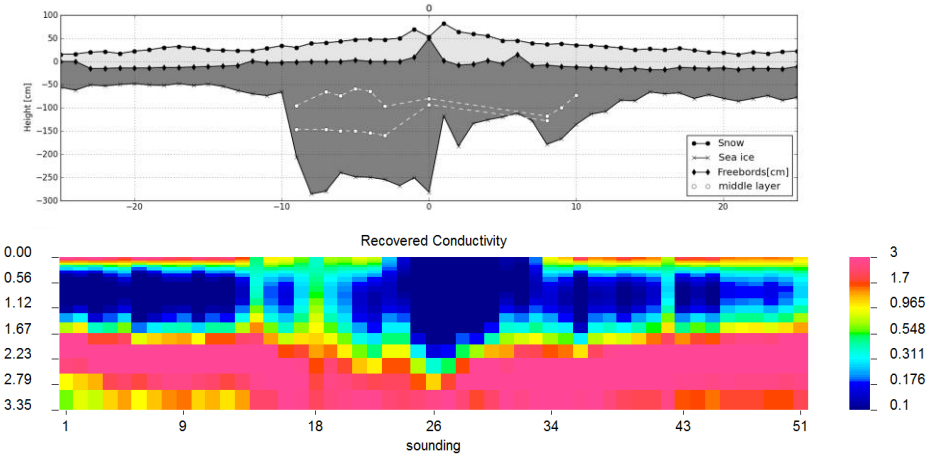
Outlook

Inclusion of bucking coil bias in the em1dfm inversion code (from UBC)

- Platelet-layer thickness and conductivity at Atka Bay



- Internal properties of pressure ridges



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