

# Improvement of sea ice thickness measurement method using the shipborne Electro-Magnetic Inductive device

Kosuke Kawamura<sup>1</sup>, Kazutaka Tateyama<sup>2</sup>

<sup>1</sup> Graduate School of Engineering, Kitami Institute of Technology

<sup>2</sup> Kitami Institute of Technology

The Arctic sea ice extent has been rapidly decreasing since the late 1970s due to rising atmospheric and sea water temperatures associated with global warming, with the smallest sea ice extent ever recorded in September 2012. The salinity of seawater in the Arctic Basin is decreasing due to melting sea ice as well as increased freshwater supply from rivers (Krishfield et al., 2014).

This study estimates sea ice thickness using EM, since it has been reported that changes in seawater salinity affect the accuracy of EM (electromagnetic induction sensor) measurements. (Takahashi, 2016).

There is a marked conductivity difference between sea ice and seawater, and the EM method uses this difference to measure the apparent conductivity  $\sigma_a$  and estimate the distance ZE from the sensor to the sea ice bottom. (tateyama et al.2006)

In this study, data acquired during the Joint Ocean Ice Study (JOIS) 2010-2022, which takes place over one month out of 7-10 each year, are used in the analysis. The JOIS is conducted in the Beaufort Sea, Canada (Figure 1). Data used include total ice thickness obtained from EM and visual observations, GPS to determine observation locations, and electrical conductivity of navigated seawater. Then, based on the acquired data, we estimate it by 1D 3-layer model calculation (snow cover, sea ice, and sea water layer) using the numerical analysis program "PCLOOP".

Finally, we compare the total ice thickness (ZI). (Figure 3) The right side is before correction and the left side is after correction, and this result shows that the overall correction was small. This result was similar in other years as well.

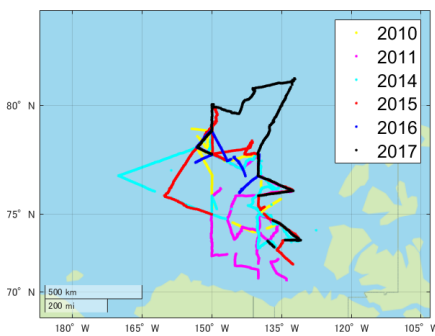


Figure 1. Passage during EM

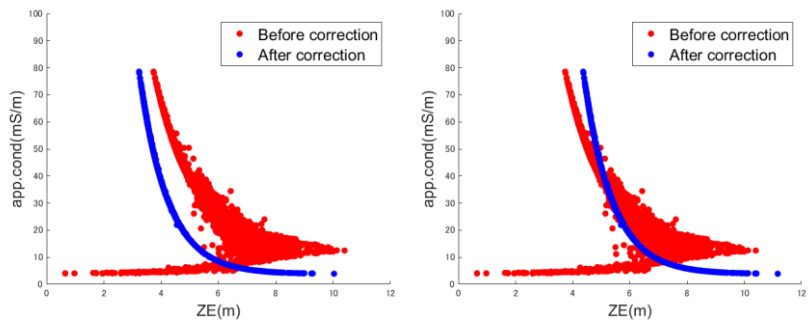


Figure 2. 2017's correction ZE

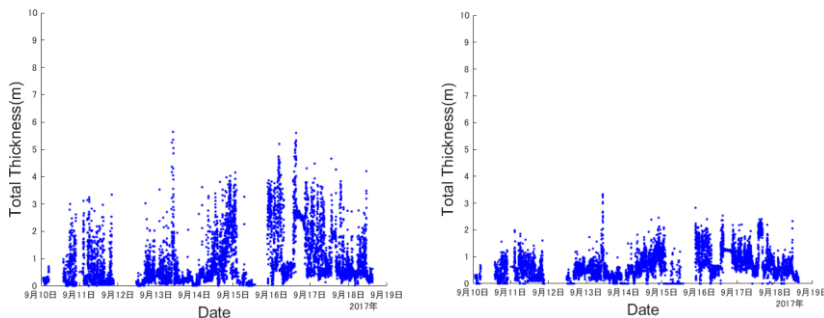


Figure 3. Before and after correction ZI

## References

- Krishfield, R. A. and 6 others (2014): Deterioration of perennial sea ice in the Beaufort Gyre from 2003 to 2012 and its impact on the oceanic freshwater cycle, *J. Geophys. Res. Oceans*, 119(2), 1271-1305,
- Takahashi, S.(2016).; Considering surface salinity by shipboard EM Sea Ice Thickness Measurement Method. Graduation thesis at Kitami Institute of Technology,43
- Tateyama, K. and 5 others (2006): Standardization of electromagnetic-induction measurements of sea-ice thickness in polar and subpolar seas. *Annals of Glaciology*, 44(1): 240-246