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The Cryosphere Discussions

Interactive comment on "Airborne mapping of the sub-ice platelet layer under fast ice in McMurdo Sound, Antarctica" *by* Christian Haas et al.

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Summary

This manuscript presents a comprehensive analysis of airborne electromagnetic (AEM) survey data over sea ice in the McMurdo Sound including a semi-empirical approach for measuring the both the thickness of the consolidated sea ice and the depth of the sub-ice platelet layer (SIPL) below it. Typically, the presence of a SIPL complicates the AEM-based measurement of ice thickness since it effectively introduces another independent variable that affects the observed apparent conductivity upon which the ice thickness measurement is based. However, using a forward modelling approach, the authors demonstrate that the quadrature (Q) component of the induced AEM signal

is less sensitive to the presence of a SIPL than the in-phase (I) component.

On this basis, the authors determine that the SIPL thickness can be estimated from the difference in the apparent thicknesses determined from the I- and Q-components. And using drill-hole observations of the thickness of both consolidated ice and the SIPL measured at discrete points beneath AEM surveys, they show that the thickness of the SIPL in McMurdo is approximately 0.4 times the difference between the I- and Q-derived apparent thickness measurements. This factor of 0.4 is related to the effective conductivity of the SIPL, which is determined in part by the solid fraction of ice within the SIPL. Using this calibrated relationship, the manuscript presents measurements of SIPL thickness from 5 years of AEM surveys in McMurdo Sound. The data show a persistent, interannual pattern of enhanced SIPL thickness in two locations, indicating the likely outflow path of ice shelf water (ISW) from beneath the McMurdo Ice Shelf. The production and pathways of ISW are closely tied to basal melt processes and the authors conclude by noting the value of AEM surveying for mapping and monitoring SIPL thickness and ISW flow in other remote regions of the Antarctic coast.

This is a well written paper and easy to read paper summarizing several years of work that has culiminated in a greater understanding of platelet distribution in McMurdo Sound that has implications for ISW formation and basal melt. At the same time, the technique used could applied with great value in other locations. I have only one general comment, that I think should be fairly straightforward to address. Otherwise, I look forward to seeing this paper published.

General Comments

Limited discussion on variability in consolidated in thickness

My only major comment relates to the observation that the data presented represent a very narrow range of consolidated ice thicknesses, h_i. Figure 5a indicates the ratio $h_{(a,Q)}/h_i$ increases as h_i decreases, which leaves me wondering how reliable the SIPL thickness estimates would be in the presence of greater spatial or temporal variability

in h_i. It is unfortunate that only few measurements were made in thicker multiyear ice, but the inclusion of a brief discussion about how they compare with the AEM measurements might still be helpful. The authors might also consider how the sensitivity to SIPL thickness would be affected over thin ice, earlier in the year, which could be relevant for studying intra-annual SIPL variability

Minor Comments

Line 175-176: I recommend introducing the concept of apparent thickness at the beginning of this paragraph and the symbol h_a should be defined before it first used.

Line 176: I don't think the parentheses around "or Q" are necessary

Line 400: If the approximate values of the dimensions a,b,c, and d are really important to this discussion, then I feel the reader should be given some further explanation without need to refer to the paper by Jones 2012b. At the least, the text should provide units for the stated values.

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