Snow Depth on Sea Ice Record from 1955-2019 in the Canadian Arctic and Development Plans for Multi-Satellite Snow Depth Retrieval

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ABSTRACT

Using *in situ* snow depth measurements at 11 Canadian study sites from the period 1955-2019, we study the intra-annual and decadal trends in snow accumulation on landfast sea ice and on terrestrial ground within the Canadian Arctic. Ice chart data acquired via the Canadian Ice Service are used to establish sea ice break-up and freeze-up dates and assess their impact on snow depth evolution. We find that on-ice and on-land snow accumulation in autumn differ due to the lag between the freeze-up and the first snow of the season. Once sea ice consolidates, on-ice and on-land snow depth become positively correlated in winter ($p < 0.05$). The mean seasonal rate of snow accumulation on sea ice from September to April is 3.2 ± 0.6 cm per month across the Canadian Arctic. Snow depth on terrestrial land is generally higher than on sea ice in the southern Canadian Arctic by up to 20 to 30 cm; but snow depth on sea ice tends to exceed that on land in the northern Canadian Arctic from winter to spring. Results have been submitted for publication in a peer-reviewed journal (in print).

As a follow-up study, a machine learning (ML) algorithm is being developed to estimate winter snow depth on landfast sea ice in the Canadian Arctic using measurements from satellite altimeters (ICESat-2 and CryoSat-2) and radar scatterometers (Sentinel-1 and RADARSAT-CM), under the first-order assumption that rougher sea ice, which is signified by higher SAR backscatter, would entrap thicker snow. Preliminary results indicate some correspondence between the altimetric surface heights and SAR backscatter coefficient (sigma-nought). Our proposed approach can provide greater spatial and temporal coverages for snow depth estimates on Arctic landfast sea ice. A field campaign is planned in April 2022 to sample snow on sea ice at near-coincident CRYO2ICE tracks to provide validation datasets.

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