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Improving Observations of Aggregate Snow Cover Properties on MOSAiC by Integrating Repeat Terrestrial Laser Scanning and In-Situ Data

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The spatial heterogeneity of the snow cover on Arctic sea ice impacts the coupled Ice-Ocean-Atmosphere system. This spatial heterogeneity manifests in both the spatial distribution of snow thickness and the material properties of that snow (e.g. density, specific surface area [SSA], thermal conductivity, salinity, etc). This presents a challenge for observing the aggregate snow cover properties. Most material properties can only be measured in-situ and it is logistically difficult to measure material properties at a large number of sites. Here, we address this challenge by integrating repeat Terrestrial Laser Scan (TLS) data and in-situ observations of snow properties on an area several hundred meters across. We used TLS to map the topography of this area at cm-scale vertical resolution on approximately a biweekly basis throughout the winter during MOSAiC. By comparing successive scans, we map the spatial extent of snow layers as they build up the snow cover. Concurrently, we made in-situ penetration resistance force measurements using a SnowMicroPen (SMP) to quantify the snow properties at sites within the measurement area. These weekly point measurements, with 3mm vertical resolution, provide details of the grain type, snow density and SSA stratigraphy. Combining the TLS and SMP observations enables us to extrapolate the layer-wise properties of the snow cover throughout the measurement area. We examine how consistent snow properties are within layers and use this information to quantify aggregate snow cover properties for the entire region. For example, by integrating SMP-derived density with TLS-derived layers we estimate aggregate change in snow mass for this region for selected periods of the winter.