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Quasi in-situ snow and sea ice interface microstructure measured by micro-computed tomography

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The sea ice / snow interface in the high Arctic can no longer be thought of as simply black and white, but more complex than previously estimated. Our understanding of this interface is crucial for remote sensing, snow, brine and ice mass distribution, thermal conductivity and therefore ice growth and ice melt. To better understand the snow microstructure, we installed a micro-computed tomograph (micro-CT) in a cold laboratory on board Polarstern and measured a full annual cycle of the Arctic snow cover during the MOSAiC expedition. We discovered two large uncertainties when looking at the boundary between sea ice and snow boundary during the year.

1) Large temperature gradients of 100 K m^{-1} (compared to Alps (20 K m^{-1}) specific to the high Arctic cause extreme metamorphism within the snowpack. This transports ice grains from the salty first year sea ice (FYI), across the interface up into the snowpack, producing snow with brine pockets on FYI. 10-30% of snow grains on FYI are affected by vapour migration from the sea ice, and can now be thought of as a mix of ocean and atmospheric sourced particles, which can be distinguished by oxygen isotope analysis. Brine in the snow structure has large implications for remote sensing backscatter and possibly mass balance.

2) Multi-year ice (MYI) also has large uncertainties, because the interface has a hard impenetrable layer- because of the porous summer ice surface, known as the surface scattering layer (SSL) after refreezing. In summer, this SSL is thought of as an ocean water snow layer, with a density of <500 kg m^{-3}. After refreezing in autumn, this layer produces a dense, icy 2-10 cm deep layer at the snow/ice interface and occasionally occupies up to 50% of the snow profile on MYI in winter.. This layer, which has previously not been observed, may, depending on the state of metamorphism and hardness,influence snow water equivalent and snow depth measurements.

This study uses a combination of micro-Computed Tomography measurements to determine geometrical snow properties combined with oxygen isotope analysis to understand the ice origin (atmospheric or marine). We aim to better understand processes at the snow/ice interface on Arctic sea ice and as a result, the infiltration of brine into snow on FYI.