Geophysical Research Abstracts
Vol. 18, EGU2016-9538, 2016
EGU General Assembly 2016

Small scale variability of snow properties on Antarctic sea ice

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Snow on sea ice plays an important role in air-ice-sea interactions, as snow accumulation may for example increase the albedo. Snow is also able to smooth the ice surface, thereby reducing the surface roughness, while at the same time it may generate new roughness elements by interactions with the wind. Snow density is a key property in many processes, for example by influencing the thermal conductivity of the snow layer, radiative transfer inside the snow as well as the effects of aerodynamic forcing on the snowpack. By comparing snow density and grain size from snow pits and snow micro penetrometer (SMP) measurements, highly resolved density and grain size profiles were acquired during two subsequent cruises of the RV Polarstern in the Weddell Sea, Antarctica, between June and October 2013. During the first cruise, SMP measurements were done along two approximately 40 m transects with a horizontal resolution of approximately 30 cm. During the second cruise, one transect was made with approximately 7.5 m resolution over a distance of 500 m. Average snow densities are about 300 kg/m^3, but the analysis also reveals a high spatial variability in snow density on sea ice in both horizontal and vertical direction, ranging from roughly 180 to 360 kg/m^3. This variability is expressed by coherent snow structures over several meters. On the first cruise, the measurements were accompanied by terrestrial laser scanning (TLS) on an area of 50x50 m^2. The comparison with the TLS data indicates that the spatial variability is exhibiting similar spatial patterns as deviations in surface topology. This suggests a strong influence from surface processes, for example wind, on the temporal development of density or grain size profiles. The fundamental relationship between variations in snow properties, surface roughness and changes therein as investigated in this study is interpreted with respect to large-scale ice movement and the mass balance.