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# Validation of diurnal thaw and refreeze patterns of the snow surface from satellite and field data from the Lena Delta

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Snowmelt plays an important role for hydrology in northern latitudes. Its spatial and temporal dynamics are determined by atmospheric processes. The temporal dynamics can be observed on the ground for single locations. Spatial patterns can be identified by satellite sensors especially microwave instruments. The combined analyse enhances not only the understanding of remotely sensed datasets over at high latitudes but also promotes model applications on various scales.

Backscatter measurements obtained with Ku-band scatterometer provide information on the dielectric properties changes of the snow surface. Such data are available from Seawinds/QuikScat scatterometer with approximately 12.5 km footprints. Pan-Arctic time series for the snowmelt period are available since 2000. The high revisit intervals provide several acquisitions per day which allows the investigation of diurnal differences during spring snowmelt. The snow surface is frozen in the morning and may melt during the day before it refreezes again over night. The backscatter difference of such events varies throughout the snowmelt period. The current diurnal difference approach considers long term noise and was developed by use of ground data from the southern Taiga. Verification within tundra regions and especially areas with a high percentage of open water bodies was still lacking.

Long term automated ground measurements for advanced interpretation of data from active microwave sensors are available from the Lena Delta. Ground data are collected at a long term monitoring station in the central Lena River Delta since 1998. The research site is located on the island of Samoylov, in the zone of continuous permafrost and is characterized by wet polygonal tundra. The snow cover is thin, varying between only a few centimetres on the polygonal rims to up to 50 cm in the polygonal troughs. Automated weather and soil data collection includes air temperature and humidity, radiation components, wind, snow depth and distribution, soil temperatures and moisture. A comparison between scatterometer and meteorological datasets is performed in detail for the year 2007. It includes onset and end of snowmelt with field data on snow depth, spatial variability and snow physical characteristics.

The period with significant diurnal thaw and refreeze lasted 33 days in 2007 according to the scatterometer data. Two additional consecutive days of diurnal thaw and refreeze have been determined already at the beginning of May 2007. This corresponds to days with air temperature above freezing, the TDR measurements of the entire snow profile, however, show only a slight increase for those days. The depletion of the snow cover started eight days later. This onset can be precisely captured with QuikScat. The end of diurnal thaw and refreeze corresponded to the first disappearance of snow cover. Although the footprint (12.5 km diameter) is much larger than Samoylov island and more than 50% is characterized by lakes and the surrounding Lena River, a correct determination of snow melt date was possible and the approach has thus been applied for all available years with Quikscat data. The onset of thaw varied between the $7^{th}$ of May and $22^{nd}$ of May for 2000 – 2007. Earlier first short snow surface thaw periods occurred only in 2002, 2005 and 2007 (2-3 days length). The mean day of year (DOY) for onset of snowmelt was 136 ($15^{th}$/$16^{th}$ of May)and the mean end day was 159 ($7^{th}$/$8^{th}$ of June). The average duration of thaw was 23 days with 13 days with significant diurnal thaw and refreeze.

Such exact determination of melt period supports hydrological modelling as well as regionalisation of ecosystem flux measurements. This validation study adds to the understanding of the microwave backscatter variation and results encourage application over much larger regions such as entire Siberia. The high accuracy also allows for trend analyses.