Snow SSA retrieval from Sentinel 3 OLCI Instrument over the Greenland Ice Sheet

Retrieving snow physical characteristics from the Greenland Ice Sheet surface snow and assessing the accuracy of the satellite retrieved data compared to ground-truth data.

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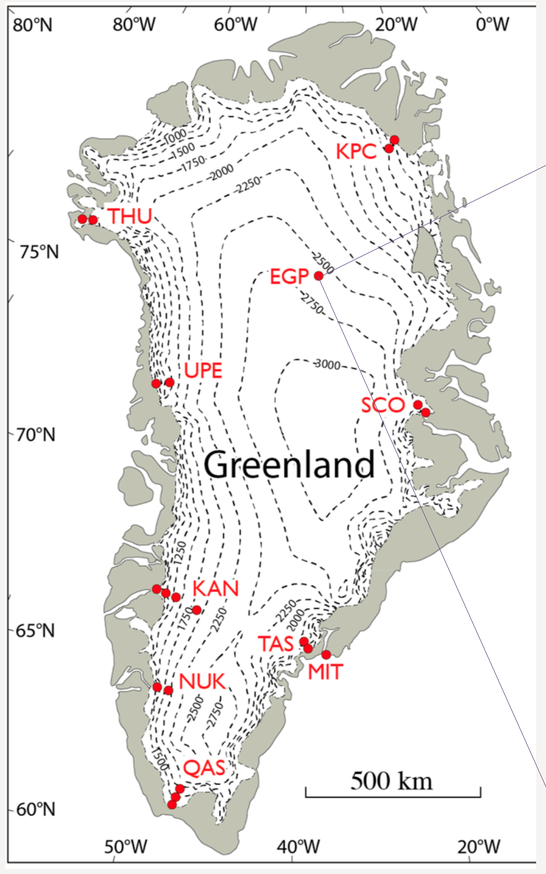
Motivation

Measurements of snow characteristics are vital for calculating surface energy fluxes over snow covered regions. Albedo varies as a response to changing grain diameter and grain shape of the surface snow. The snow specific surface area (SSA) is measurement which can combine these two features.

Aim = continue the work done by Kokhanovsky et al. (2019) into developing an accurate remote sensing technique to extract micro-structural information about surface snow.



Source: Kokhanovsky et al., 2019

SSA = *the surface area of the snow crystals that is exposed to the air.*

Methods

Sentinel-3 OLCI L1 imagery (300m spatial resolution) was downloaded for summer 2019 (28/05/19 – (04/07/2019) covering the north east region of the Greenland Ice Sheet.

The images from ~midday were used in order to match the time of field data retrieval

The S3 Snow processing flow was used as displayed to the right.

EastGRIP Site

75.63°N, 35.99°W

SNAP SICE visualization of SSA, The left image is the variation in SSA over the chosen area, and the right is the Rayleigh corrected image.

Processing Flow:

OLCI L1 Image

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Rayleigh Correction
- Bands 1,5,6,10,11, 17 and 21 used.

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IdePix OLCI
- Pixel Classification
- Determines cloud cover from snow/ice

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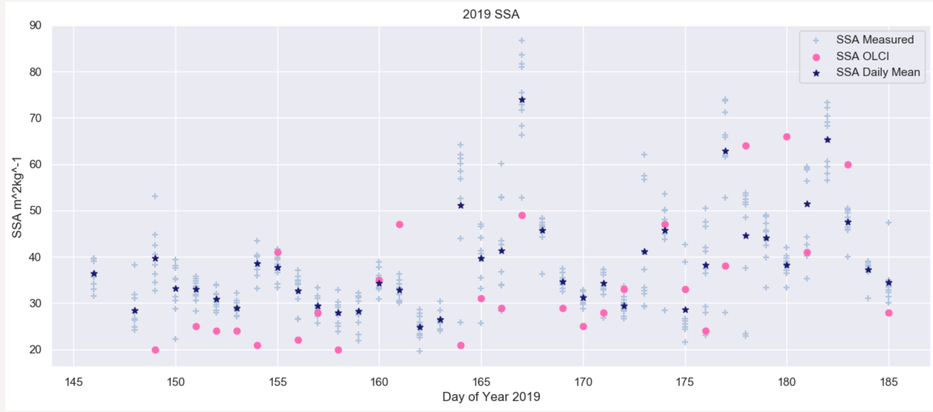
SICE Snow Properties Processor
OLCI L1 Radiance + Rayleigh Corrected + IdePix

Considerations

- Effect of ice flow (~60m per year)
- Automatic snow-cloud classification uncertainty
- Multiple days experience cloud cover and therefore data was irretrievable.

Field Data

- 100m transect with samples taken every 10m in the morning of everyday.
- This gave 10 samples over the transect per day
- IceCube device calculating SSA based on reflection



Results

The graph below shows how the OLCI derived SSA compares to the field data.

The dark blue point represent the average daily measurement from field data.

The days with highest values and deviation in SSA are seen on the days with lots of spatial variation. Possibly due to wind blown fresh precipitation.

R^2 value shows a very low correlation between the OLCI measured value of SSA and the ground truth data.

OLCI 300m pixels result in an average over the whole area and therefore are unable to pick up anomalous wind-blown regions.

Conclusions

The results indicate that satellite imagery from Sentinel 3 can be used for SSA measurements. This conclusion can be drawn given the highly variable nature of SSA within a small area due to wind redistribution, thus causing large variation in the ground truth data which result in a very low r^2 value between observed and remotely sensed measurements. The results agree largely with those retrieved by Kokhanovsky et al. (2019) where both SSA measurements correlate less above $35 m^2 kg^{-1}$.

REFERENCES

Danne, O., Brockmann, C. and Kokhanovsky, A. (2020) SEOM S3 for Snow / SICE User Manual.

Kokhanovsky et al. (2019). 'Retrieval of Snow Properties from the Sentinel-3 Ocean and Land Colour Instrument', *Remote Sensing*, **11(2280)**, pp. 1-43.

Unpublished SSA data. Collected for the EastGRIP Surface Programme 2019

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