Modeling timeseries of microwave brightness temperature at Dome-C, Antarctica.

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Introduction

Studies investigating the Antarctic climate change using observations from meteorological stations are limited by the sparsity of the stations (~120 met station to cover 14.10 km²). Space-borne microwave radiometers are attractive tools as they offer the opportunity to map spatial variations of surface temperature from 1979 to nowadays. However, the microwave observations are not simply related to the surface temperature, emissivity which depends on snowpack characteristics is an important factor.

In previous studies, grain size and shape were estimated in the field by visual inspection with an optical lens, Macelloni 2007. Contrary to density and temperature, grain size is difficult to measure, especially because grains are delicate to separate without breaking them. Furthermore, accurate grain size is crucial to model accurate emissivities.

This poster aims at modeling brightness temperature (Tb) 1) with a grain size estimation by a Bayesian approach and 2) with a new snow micro-structure measurement, NIR photography.

Observations

✓ Snow temperatures were measured every hour down to 21 m.
✓ Snow density was measured in a snowpit and on a ice core.
✓ Passive microwave observations were acquired daily by AMSR-E (Advanced Microwave Scanning Radiometer - Earth Observing System). Two channels are used: 19 and 37 Ghz at Vertical polarization.

Future work

• Investigate the penetration depth estimation.
• Validate the snow grain-size profile predicted by CROCUS over Antarctica.
• Adopt an approach based on physical modeling, which consists in a coupled snow evolution / emission model, like CROCUS-MEMLS.

Microwave Emission Model of Layered Snowpacks (MEMLS)

MEMLS is a thermal microwave emission model based on a multilayer radiative transfer scheme. MEMLS includes scattering by stratification because the snowpack could be consisting of several snow layers. Primary parameters required for each layer are: snow temperature T, snow density ρ, correlation length l, emissivity which depends on snowpack characteristics.

Results

1) In the same way as estimated correlation length (previous section), the measured SSA profile yields a similar increase of the correlation length in the top 3 m (= green line).
2) With correlation length computed from NIR photography, the lowest RMSE (2,38 K) is predicted with α = 2,08. In theory, for a random scatterer α =3, Debye, 1957.

With Near Infra-Red Photography

Specific Surface Area (SSA) is the ratio between surface area of snow grain and its volume. It is considered an essential micro-structural parameter for the characterization of snow. Photography in the NIR spectrum is sensitive to the SSA, Matzl 2006.

1) Snow reflectance is calculated from calibrated NIR photographs of snow-pit wall.
2) A calibration curve reflectance - SSA is defined with stereological measurements.
3) Reflectance profile is convert to SSA profile, and finally in correlation length profile (= red curve).

References