Can grain size modeled with SNOWPACK be used with HUT snow emission model?

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Finnish Meteorological Institute uses HUT snow emission model in the operational GlobSnow snow water equivalent (SWE) algorithm to retrieve SWE maps from passive microwave satellite data. Currently the algorithm calculates snow grain size for the stations where snow depth data is available by minimizing error between brightness temperatures measured by satellites and predicted by HUT snow emission model. An interpolated grain size field is then used in the retrieval of SWE for the northern hemisphere.

Our goal is to investigate, whether grain size predicted by physical snow model SNOWPACK could be used with HUT snow emission model, and would the use of a priori snow data from SNOWPACK increase accuracy of retrieved SWE.

Our material includes time series of four winters of automatic meteorological and snow measurements (to drive SNOWPACK and HUT snow emission model), manual snow pit data and observations of traditional and optical grain size (to validate SNOWPACK), and tower-based microwave radiometer measurements (to validate HUT snow emission model).

Results

- Use automatic measurements of meteorological, radiation, snow, and soil parameters as input to HUT snow emission model to simulate brightness temperature of snow-covered ground
- Minimize error between HUT model results and microwave radiometer measurements by using grain size in HUT model
- Use the same automatic measurements to simulate snow evolution with SNOWPACK
- Compare the best-fit grain size from HUT model with SNOWPACK results and manual field measurements

Data

- Main measurement area is an opening surrounded by sparse pine forest
- All snow measurements are within 20 m of each other
- Snow measurements outside of radiometer footprint
- Meteorological and radiation data measured at a weather station at 500 m distance
- Measurements during four winters, 2009-2013

Models

SNOWPACK

- 1-D finite element method
- Calculates evolution of snowpack from meteorological and radiation measurements
- Outputs profiles of snow parameters
- Developed at WSL Institute for Snow and Avalanche Research (SLF), Switzerland

HUT snow emission model

- Semi-empirical model
- Calculates brightness temperature of a snow-covered ground

Conclusions

- SNOWPACK optical grain size (D_{o,SP}) can be used with HUT snow emission model.
- Scaling factor = 1
- SNOWPACK traditional grain size (D_{o,SP}) also usable with scaling factor = 0.78