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Snow water equivalent processing system for northern hemisphere

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Information on snow cover is important, for example, in investigating hydrological, climatological, and greenhouse gas processes (such as CO2 and CH4). Spaceborne passive microwave data are suitable for the retrieval of snow information because of a wide swath, all-weather imaging capabilities, multi-frequency response to the presence of snow on land, and a continuous time series that are available for over 30 years. Typically, passive microwave derived SWE estimates contain high uncertainties at the hemispheric scale both in terms of systematic and random error. In this work an assimilation algorithm by Pulliainen (2006) has been used. It weighs passive microwave data combined with a semi-empirical radiative transfer model, and prior snow information from ground measurements. Assimilation technique diminishes the typical shortcomings of spaceborne microwave radiometer data derived SWE products. The resulting SWE dataset is available via web service at www.globsnow.info.

The SWE algorithm works as follows. Synoptic weather station observations are obtained from European Centre for Medium-Range Weather Forecasts (ECMWF) and processed through Finnish Meteorological Institute (FMI) real time database. The values are filtered for non suitable data and interpolated using kriging interpolation. Thus, Snow Depth (SD) background field and variance estimate are obtained. Spaceborne radiometer data is acquired either through National Snow and Ice Data Center (NSIDC) or National Aeronautics and Space Administration (NASA). The data is either already in Equal-Area Scalable Earth Grid (EASE-grid) or gridded to EASE. Snow grain size is estimated using radiometer data and interpolated SD-values for the whole area under investigation.

In the next step, the SWE and SWE variance time series are obtained through weighing different data sources. A winter-long cumulative dry snow mask is used to correctly track down the southern border of snowfall in the autumn. Daily snow clearance masks are derived from the microwave data using the algorithm described in Takala et al. (2009). Data on snow clearance is used to track the southern limit of snow melt in the spring. The assimilated SWE and SWE variance values are obtained through simple rules involving cumulative dry snow mask and snow clearance mask.
The difference between assimilated SWE product and kriging interpolated SWE field were analyzed. Difference images together with station locations show the adaptive nature of the algorithm. In areas with sparse synoptic network the algorithm puts more often emphasis on the spaceborne derived data than the ground based observations. Scatterplot of independent ground truth data (INTAS-SCCONE) vs. SWE estimates together with density show that the results are well in agreement and the majority of SWE observations reside in the range of 0-150 mm.

The SWE time series of northern hemisphere covering 30 years together with NRT processing has been implemented first time with this level of spatial accuracy and
sensitivity of SWE estimates.