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Uncertainty analysis of the optical satellite data-derived snow products

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The behavior of the global snow cover can be effectively estimated using optical Earth Observation (EO) data, in particular during the end of the melting season. In addition to successful dry and continuous 100% (full) snow cover mapping, optical methods perform well over snowmelt regions with patchy wet snow. Long decadal scale time series of satellite data estimates on global Snow Extent (SE) or Fractional Snow Cover (FSC) and albedo are needed for constructing Climate Data Records (CDR). CDRs have a high relevance in climate research e.g. in climate monitoring including trend analysis and verification of climate models. Currently, the available optical satellite data records for hemispherical snow monitoring reach back for several decades, e.g. AVHRR (since ca 1980), ATSR (since ca 1990), AATSR and MODIS (since ca 2000). Also, the current VIIRS (since 2011) and the future Sentinel-3 both provide very potential data for global snow monitoring. It is fundamental to generate extensive CDRs with quality/estimation error information attached to each snow estimate, as the usefulness of the EO-based snow estimate is highly dependent on the quality of the interpretation.

The objective of this work is to establish and develop a methodology to determine a dynamic retrieval error estimate for the optical satellite-retrieved FSC. This is performed by applying an error propagation analysis for the consideration of the statistical error of FSC estimation. The procedure is demonstrated here by using the SCAmod algoritm, which is suited for global snow detection and able to perform well also in forested regions. Apart from determining the statistical (random) error, we outline the procedure for the evaluation of the systematic error (biases) of FSC products, both of which are essential for the generation of snow cover CDR. As we focus here on determining the statistical random error, it is crucial to know the variability of the different factors affecting the satellite-observations in various measurement conditions. These important error contributors in FSC retrieval with SCAmod are the variabilities in snow reflectance, forest transmissivity, forest reflectance (of an opaque canopy) and snow-free ground reflectance for different land cover classes. Based on the obtained results, it is possible to calculate the statistical error layers for different global FSC products and analyze the performance of the snow monitoring technique in various circumstances. This is highly relevant for the utilization of the CDRs for climate research purposes. We present the results and demonstrate the possibilities in global snow monitoring. Further work will clarify the behavior of the systematic errors by exploiting different ground truth reference datasets available.

Optical satellite data-derived information on FSC can be also used in combination with SWE estimates from passive microwave sensors, in order to provide combined information on global snow extent and snow mass with confidence limits. This is furthermore demonstrated here. The presented results are obtained within the ESA DUE GlobSnow project.