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Snow Processor for Sentinel Application Platform: underlying algorithm and its validation

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The Sentinel Application Platform (SNAP) architecture is ideal for Earth Observation processing and analysis (http://step.esa.int/main/toolboxes/snap/). In this work we develop a new Snow Processor and respective plugin for SNAP. We also describe physical principles behind the developed snow property retrieval technique based on the analysis of Ocean and Land Colour Instrument (OLCI) onboard Sentinel-3A/B measurements over fresh and polluted snow fields. Using OLCI spectral reflectance measurements in the range 400-1020nm, we derive such important snow properties as albedo (spectral and broadband), snow specific area, snow extent and snow grain size on the spatial grid of 300m. The algorithm also incorporates cloud screening and atmospheric correction procedures over bright snow surfaces.

The results of validation of the retrieved snow products using ground measurements performed in Antarctica and also on Greenland Ice Sheet are given. In particular, we have found that the spectral albedo is retrieved with accuracy of about 2-3% sufficient for climatic studies and also for other applications. The broadband albedo is retrieved with the accuracy of about 5% over fresh snow fields. The retrieved grain size based on the OLCI measurements at the wavelengths 865 and 1020nm has been compared with the snow grain size measurements performed on ground. The agreement is not such good as for albedo because of a priori assumptions implemented in the retrieval algorithm and also due to uncertainty in the grain size definition for irregularly shaped ice crystals in snow and its spatial variability. It is difficult to maintain the same standards of grain size measurements in the field. On the other hand, the derived optical snow grain size from OLCI measurements is obtained in the framework of the same theoretical formulation and consistent with derived albedo values. Therefore, it can be considered as an essential climate variable linked both to spectral and broadband snow albedos.

We also show the examples of snow albedo/grain size mapping over extended areas of Antarctica and Greenland using SNAP and OLCI measurements on board Sentinel-3A/B. The algorithm can be applied to upcoming OLCI Sentinel-3C/D measurements providing an opportunity for creation of long – term snow property records essential for climate change studies - especially in the Arctic region, where we face rapid environmental changes including reduction of snow/ice extent and, therefore, planetary albedo.