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Use of Sentinels to aid the global monitoring of snow cover

Jouni Pulliainen (1), Miia Salminen (1), Kari Luojus (1), Sari Metsämäki (2), Juha Lemmetyinen (1), Matias Takala (1), Juval Cohen (1), and Kristine Böttcher (2)

(1) Finnish Meteorological Institute, Helsinki, Finland (Jouni.Pulliainen@fmi.fi), (2) Finnish Environment Institute, Helsinki, Finland

Earth observation instruments onboard Sentinel satellites provide a unique opportunity for the monitoring and investigation of global snow processes. The issue of the possible decay of seasonal snow cover is highly relevant for climate research. In addition to water cycle, the extent and amount of snow affects to surface albedo, and indirectly to carbon cycling. The latter issue includes snow-induced changes in permafrost regions (active layer characteristics), as well as the effect of snow (melt) to vegetation growth and soil respiration.

Recent advances in ESA DUE GlobSnow project have shown that by combining data from optical satellite sensors and passive microwave instruments advanced Climate Data Records (CDR) on seasonal snow cover can be produced, extending to time periods of over 30 years. The combined snow cover products provide information both on Snow Extent (SE) and Snow Water Equivalent (SWE) on a daily basis. The applicable instruments providing historical data for CDR generation include such microwave radiometers as SMMR, AMSR and SSMI/I, and such optical sensors as AVHRR, AATSR and VIIRS. Sentinel 3, especially its SLSTR instrument, is a prominent tool for expanding the snow CDR for forthcoming years.

The developed global snow cover monitoring methodology, demonstrated and discussed here, derives the SWE information from passive microwave data (accompanied with in situ observations of snow depth at synoptic weather stations). The snow extent and fractional snow cover (FSC) on ground is derived from optical satellite data, in order to accurately map the continental line of seasonal snow cover, and to map regions of ephemeral snow cover. An advanced feature in the developed methodology is the provision of uncertainty information on snow cover characteristics associated with each individual satellite data footprint on ground and moment of time.

In addition to assisting the generation and extension of the global snow cover CDR, Sentinel missions provide data that enable the improvement of snow monitoring algorithms for hydrological and NWP applications. On the other hand, Sentinel observations can be applied to enhance snow processes considerations in hydrological, climate and weather prediction models. In general, synergistic techniques that apply data from different sensors (active-passive, optical-microwave, moderate-coarse resolution) are feasible to numerous cryospheric research and end-use applications. For example, MSI of Sentinel 2 and Sentinel 1 SAR can be synergistically used to provide information on snow melt at the scale of sub-drainage basins for hydrological river discharge forecasting independently on cloud conditions. The snow melt monitoring information has also been shown to be relevant for the mapping of the start of the growing season at the conifer forests of the boreal forest zone, which is highly relevant for the global mapping of annual carbon balance.