New satellite concepts for measuring snow mass

* Juha LEMMETYINEN¹, Chris DERKSEN², Giuseppe PARRELLA³, Giovanni MACELLONI⁴, Helmut ROTT⁵, Andreas WIESMANN⁶, Kimmo RAUTIAINEN⁷, Kari LUOJUS¹, Irena HAJNSEK³, Thomas NAGLER⁵, Marco BROGIONI⁴, Christian MÄTZLER⁶ and Michael KERN⁷.

1. Finnish Meteorological Institute, Erik Palménin aukio 1, 00560 Helsinki, Finland. juha.lemmetyinen@fmi.fi
2. Environment and Climate Change Canada, 4905 Dufferin Street, Toronto, Ontario, M3H 5T4, Canada.
3. German Aerospace Centre DLR, Muenchnerstr. 20, 82234 Wessling, Germany.
4. Institute of Applied Physics « Nello Carrara », Via Madonna del Piano, 10 50019 Sesto Fiorentino (FI), Italy.
5. ENVEO IT GmbH, ICT Technologiepark, Technikerstr. 21a, Innsbruck 6020, Austria.
7. European Space Research and Technology Centre, Keplerlaan 1, 2201 AZ Noordwijk, the Netherlands.

* Corresponding Author

ABSTRACT

There is a long-stranding need of reliable space-borne observations on snow mass, as current satellite sensors and data products are largely unable to meet requirements presented in particular by numerical prediction and watershed management. Namely, state-of-the-art method relying on passive microwave observations [1] suffer from the inherent coarse resolution of sensors and retrieval ambiguities, restricting the usability of retrieved products in e.g. heterogeneous terrain such as mountain watersheds. CoReH2O (Cold Regions Hydrology High-resolution Observatory), a candidate for ESA’s 7th Earth Explorer [2], aimed to address some of the observational gaps by providing information on SWE, as well as snow accumulation over glaciers, at a resolution ranging from 200 to 500 meters and a revisit time between 3 and 15 days. The sensor envisaged for CoReH2O was a dual polarization, dual frequency Synthetic Aperture Radar (SAR). However, CoReH2O was finally not selected for further development beyond Phase A. With the non-selection of CoReH2O, the snow science community has begun investigating alternate options for global snow mass retrieval. Dedicated mission concept studies have been launched e.g. at the European Space Agency (ESA) and the Canadian Space Agency (CSA), outlining possibilities for future space sensors focusing on retrieval of snow mass and other characteristics of the terrestrial cryosphere.

We provide recent feedback from these ongoing studies, including the scientific justification for improved snow mass retrieval, capabilities of present Earth Observing systems, and different technological options for to address a range of geophysical observation needs. We outline the main investigated mission concepts and sensor options which have the potential to address observational requirements. The investigated concepts include several options exploiting active microwave observations, ranging from multi-frequency scatterometry to concepts exploiting single- and multiple pass InSAR techniques. The drawbacks and benefits of the alternate concepts are discussed in terms of spatial and temporal coverage, spatial resolutions, technological maturity, scientific maturity (retrieval skill) as well as the potential of different concepts for retrieving secondary geophysical parameters, such as sea ice characteristics.
