Multi-sensor Wide-area Level-3 Radar Backscatter Time Series

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Abstract

Whereas the community of earth observation specialists that deal with optical sensors such as MODIS, Landsat, Sentinel-2, and Sentinel-3 are generally familiar with composite products, as these are indispensable for analysis of cloud-cleared land cover, the radar community has no comparable widely-used composite product sets. Due to the availability of cloud-cleaning processes and associated level 3 products, wide area multi-spectral reflectance images are often processed at scale in time series, e.g. using the Google-Earth-Engine for phenological studies. Until now, no level 3 radar backscatter time series products have been available, due to the difficulty of combining data acquired in different geometries from different tracks (e.g. ascending vs. descending). The free availability of well calibrated Sentinel-1 data obtained using a regular pattern of acquisitions is enabling for the first time the calculation of level 3 backscatter products. In addition to this reliable data stream, a further pre-requisite for advancing to level 3 has been the availability of robust geometric and radiometric terrain corrections. We present examples of multi-track multi-temporal combinations that enable wide-area seamless analysis.

After briefly reviewing the principles of geometric and radiometric terrain correction and their associated GTC and RTC products, we show the additional steps necessary to build regularly updated level 3 products for a moving time-window. Given a set of RTC products acquired using multiple tracks within a given time-window, we apply local resolution weighting to produce a single composite image representative of the window. Each observation is weighted by its local resolution (i.e. the reciprocal of the local illuminated area). Given that no large changes took place within the time-window, this generally produces a composite without any stark edges caused by inconsistent backscatter signatures.

The compositing technique is open to data from multiple sensors if all are well calibrated both geometrically and radiometrically. For a site in Canada’s Arctic, we show sample composite products generated with Sentinel-1A/B alone, Radarsat alone, and combined including data from both Sentinel and Radarsat. We will include Radarsat Constellation Mission data if available, and otherwise show a combination of Sentinel-1 and Radarsat-2 datasets. The temporal resolution can be shortened towards a single day if data from multiple missions are integrated together. We illustrate how the determination of melt-onset dates over a wide region is improved given multi-mission data integration.

Keywords - Analysis Ready Data (ARD)