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Fusing multi-sensor microwave vegetation optical depth products into long-term data records

Leander Moesinger (1), Wouter Dorigo (1), Matthias Forkel (1), Richard de Jeu (2), Robin van der Schalie (2), Tracy Scanlon (1), and Irene Teubner (1)

(1) Department of Geodesy and Geoinformation, Vienna University of Technology, Austria, (2) VanderSat B.V., Haarlem, The Netherlands

Since the late 1970s, spaceborne microwave sensors have been providing measurements of radiation emitted by the Earth's surface. From these measurements it is possible to derive vegetation optical depth (VOD), a model-based indicator related to vegetation density and its relative water content. Because of its high temporal resolution, VOD can be used to monitor short- to long-term changes in vegetation. Studying long-term VOD trends and dynamics is generally hampered by the relatively short time span covered by the individual microwave sensors. This can potentially be overcome by merging multiple VOD products into a single climate data record. However, combining multiple sensors into a single product is challenging because systematic differences between input products, e.g. biases, different temporal and spatial resolutions and coverage, need to be overcome.

Here, we present a new series of long-term VOD products, which combine multiple VOD datasets obtained by the Land Parameter Retrieval Model from different sensors (SSMI, TMI, AMSRE, Windsat, and AMSR2). We produced separate VOD products for microwave observations in different spectral bands, namely Ku-band (period 1987-2018), X-band (1997-2018), and C-band (2002-2018). Superior to previous merged VOD products, our multi-band VOD products preserve the unique characteristics of each frequency with respect to the structural elements of the canopy. The approach to merge the single-sensor VOD products closely follows that of the ESA CCI Soil Moisture products [1,2]: First, the datasets are co-calibrated via cumulative distribution function matching using AMSR-E as scaling reference. We apply a new matching technique that scales outliers more robustly. We validate this method using the Kolmogorov-Smirnov test which shows that the bias correction performs well and is globally consistent. Since we use in most cases only temporally overlapping observations, trends are generally preserved. Second, we merge the datasets by taking the arithmetic mean between temporally overlapping observations of the scaled data. Using an autocorrelation analysis, we are able to show that the merged datasets have less noise than the input datasets.

Our presentation will give an overview of the methodology, including an assessment of the CDF-matching methodology and the effect of averaging multiple sensors. Further we will show the temporal and spatial coverage of the final product and a comparison of seasonal to long-term VOD dynamics with MODIS LAI. Finally, we will discuss challenges of VOD merging methodologies and potential improvements.

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