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Subsurface scattering effects in the ASCAT soil moisture product

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Microwave remote sensing has been recognized as an effective method for monitoring soil moisture, since the dielectric properties of a soil medium are strongly connected with the water content held within the soil. As a result, a positive relationship between backscatter measurements from active microwave instruments and soil moisture can be observed. However, it has been noticed that this behavior may change unexpectedly in case of very dry soils and the presence of strong subsurface scatterer. Such anomaly has been found in backscatter measurements from the Advanced Scatterometer (ASCAT) on-board the series of Metop satellites in arid and semi-arid regions. This unusual behavior was detected initially due to strong negative correlations in validation studies of the ASCAT soil moisture product, which is derived using the TU Wien change detection method. The current formulation of the TU Wien soil moisture retrieval algorithm is not able to model the impact of strong subsurface scattering effects, which leads to a wrong (wet) interpretation of dry soils.

In this study we analyze and evaluate a new method to account for subsurface scattering effects in the TU Wien soil moisture retrieval algorithm. The new approach assumes a negative relationship between backscatter and soil moisture in areas with temporal persistent subsurface scattering effects. More challenging are regions where subsurface scattering only occurs during dry periods, which requires to identify the transition between the alternating backscatter and soil moisture relationship first. In fact, this leads to a V-shaped function between backscatter and soil moisture and requires a reference soil moisture data set to determine the exact time period dominated by subsurface scattering.

The new ASCAT soil moisture product with a better interpretation of subsurface scattering from dry soils is globally validated against other remotely sensed soil moisture products (ESA CCI Passive) and soil moisture information from land surface models (Noah GLDAS). The results indicate that in areas with persistent subsurface scattering the assumed inverse relationship between backscatter and soil moisture compares well to other soil moisture products. Better results are also achieved in areas with a temporal dependency of subsurface scattering, but future work is needed to better characterize the exact time period when scattering mechanism start to mix and shift.