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Derivation of soil moisture sensing depth from microwave satellite sensors

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Soil moisture retrievals from low frequency passive microwave satellite sensors (e.g. ESAs current Soil Moisture Ocean Salinity mission (SMOS)) are assumed to estimate spatially explicit soil moisture content of the first centimeters. However, the exact microwave sensing depth and the dynamic nature of the sensing depth at satellite grid scale is still to a large degree unknown. A more reliable estimation of the sensing depth would greatly improve the utility of microwave soil moisture retrievals. Validation activities could be fine-tuned, algorithms could be improved, and modeling applications could match observations to more optimal model depth. In addition to all this, soil moisture sensing depth information is essential for the development of a consistent fundamental soil moisture climate data record.

With the availability of multiple polar orbiting satellites with multi-frequency microwave radiometers it has now become possible to study the microwave sensing depth as it manifests itself at observational scales. The approach uses the differences in timing between the diurnal temperature cycle (DTC) of microwave observations and thermal infrared observations as a basis to calculate the sensing depth. Using an intercalibrated multi sensor microwave data set and geostationary thermal infrared observations this approach is used to evaluate sensing depth at several microwave frequencies relevant for soil moisture retrieval. Field data in combination with an integrated thermodynamic hydrological microwave model are then used to develop guidelines for a dynamic sensing depth algorithm. The key advantage of this approach is its global applicability, providing timely and consistent information on sensing depth for different satellite soil moisture datasets.