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Development of multi-sensor algorithm for enhancing the spatial and temporal resolution of Surface Soil Moisture

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Abstract

Surface soil moisture (SSM) is a crucial antecedent parameter for determination of various hydro-geomorphological conditions in the field of atmospheric and agricultural science. The available remotely sensed SSM datasets (AMSR-2, SMAP, SMOS) present with significantly degraded accuracy when compared to the in-situ measurements in heterogenous regions of India, as soil moisture retrievals through earth observation satellites are considerably sensitive to varying vegetation cover, biomass and surface roughness. A notable trade-off exists between the enhancement of spatial and temporal resolution. Advancements in methodological innovations must continually be sought to mitigate this trade-off, pushing the boundaries of what is achievable in both spatial and temporal dimensions. In the present study, we have utilized two distinct methodologies for the derivation of SSM product at a spatial resolution of 20 meters. The first approach involves the utilization of an enhanced Land Surface Temperature Product (LST) at a spatial resolution of 20 meters, in conjunction with Landsat-8 Normalized Difference Vegetation Index (NDVI) data to derive SM using the Soil Evaporative Efficiency Model. The second approach employs Sentinel-1 backscatter coefficients, specifically at VV polarization, coupled with MODIS Leaf Area Index (LAI). These datasets areintegrated within a modified water cloud model, facilitating the derivation of the SSM product. This methodology exploits the sensitivity of Sentinel-1 radar backscatter to surface moisture variations and complements this information with LAI, ensuring a robust characterization of soil moisture content. A single algorithm has been devised to harmoniously integrate the two approaches, thereby yielding the temporal resolution within the range of 2 to 5 days. In the algorithm, on instances where the data modeling from the former approach encounters limitations by virtue of the scarcity of input datasets, recourse is sought through the latter approach. Such a sequential approach ensures a comprehensive and adaptable analytical framework, allowing for an increased spatial as well as temporal resolution of

SSM datasets.