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Soil Moisture Retrieval Using Multi-Channel Passive Microwave Measurements through Improved Radiative Transfer Modeling

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Accurate retrieval of soil moisture from satellites is always a huge challenge. A soil moisture retrieval product is being produced at Princeton University for last several years from various passive microwave sensors (e. g. Advanced Microwave Scanning Radiometer – Earth Observing System (AMSR-E), TRMM Microwave Imager (TMI)) by inverting a single-channel single-polarization (10.65 GHz Horizontal polarization) radiatve transfer model, the Land Surface Microwave Emission Model (LSMEM). The inversion is done using the bisection method to find the soil moisture value (within the range of 0$\sim$50% vol/vol) that best predicts the satellite brightness temperature. It is noticed that soil moisture values within the above range often fail to produce brightness temperatures that match satellite observations and consequently the retrieval produces incorrect soil moisture at 0% or 50% vol/vol. Therefore, the model has gone though a number of improvements. First, a microwave algorithm was implemented to calculate the required input surface temperature from 37 GHz vertical polarization brightness temperature data. Second, the vegetation water content (VWC) climatology dataset was also replaced with monthly varying vegetation optical depth (VOD) datasets based on multiple passive microwave channels. Finally, the quartz content of soil (representative of sand percentage) and surface roughness parameters were calibrated to match the forward model predicted and the satellite observed brightness temperatures. These improvements were tested globally. The improved model parameterization and calibration resulted in significant reduction of the bias in the predicted brightness temperature, with significantly improved retrieved soil moisture values. The improvement is clearly evident all over the continents, but most prominently over the Sahara desert and other thinly vegetated surfaces. Microwave based rainfall, active snow, thick vegetation and RFI flags are used in the post-processing stage to mask out the soil moisture values over those regions. All the required variables for the model input and post-processing are based on microwave brightness temperature data and all the passive microwave sensors carry all those brightness temperature channels. Therefore, this soil moisture retrieval system is dependent on a single microwave sensor and can be used in operational mode.