Geophysical Research Abstracts
Vol. 21, EGU2019-15273, 2019
EGU General Assembly 2019

Surface soil moisture retrieval using optical/thermal infrared remote sensing data

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Surface soil moisture (SSM) plays significant roles in various scientific fields, including agriculture, hydrology, meteorology and ecology. However, the spatial resolutions of microwave SSM products are too coarse for regional applications. Most current optical/thermal infrared SSM retrieval models cannot directly estimate the quantitative volumetric soil water content without establishing empirical relationships between ground-based SSM measurements and satellite-derived proxies of SSM. Therefore, in this study, SSM is estimated directly from 5-km-resolution Chinese geostationary meteorological satellite FY-2E data based on an elliptical-new SSM retrieval model developed from the synergistic use of diurnal cycles of land surface temperature (LST) and net surface shortwave radiation (NSSR). The elliptical-original model was constructed for bare soil and did not consider the impacts of different fractional vegetation cover (FVC) conditions. To optimize the elliptical-original model for regional-scale SSM estimates, it is improved in this study by considering the influence of FVC, which is based on a dimidiate pixel model and a moderate resolution imaging spectroradiometer (MODIS) normalized difference vegetation index (NDVI) product. A preliminary validation of the model is conducted based on ground measurements from the counties of Maqu, Luqu and Ruoergai in the source area of the Yellow River. A correlation coefficient (R) of 0.620, a root mean square error (RMSE) of 0.146 m^3/m^3 and bias of 0.038 m^3/m^3 were obtained when comparing the in-situ measurements with the FY-2E-derived SSM using the elliptical-original model. In contrast, the FY-2E-derived SSM using the elliptical-new model exhibited greater consistency with the ground measurements, as evidenced by an R of 0.845, an RMSE of 0.064 m^3/m^3 and a bias of 0.017 m^3/m^3. To provide accurate SSM estimates, high-accuracy FVC, LST and NSSR data are required. To complement the point-scale validation conducted here, cross comparisons with other existing SSM products will be conducted in future studies.