Journal of Arid Land, vol. 11(4): 495-512

Comparison of two remote sensing models for estimating evapotranspiration: algorithm evaluation and application in seasonally arid ecosystems in South Africa

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ABSTRACT:

Remote sensing tools are becoming increasingly important for providing spatial information on water use by different ecosystems. Despite significant advances in remote sensing based evapotranspiration (ET) models in recent years, important information gaps still exist on the accuracy of the models particularly in arid and semi-arid environments. In this study, we evaluated the Penman-Monteith based MOD16 and the modified Priestley-Taylor (PT-JPL) models at the daily time step against three measured ET datasets. We used data from two summer and one winter rainfall sites in South Africa. One site was dominated by native broad leaf and the other by fine leafed deciduous savanna tree species and C4 grasses. The third site was in the winter rainfall Cape region and had shrubby fynbos vegetation. Actual ET was measured using open-path eddy covariance systems at the summer rainfall sites while a surface energy balance system utilizing the large aperture boundary layer scintillometer was used in the Cape. Model performance varied between sites and between years with the worst estimates (R20.80 mm/d) observed during years with prolonged mid-summer dry spells in the summer rainfall areas. Sensitivity tests on MOD16 showed that the leaf area index, surface conductance and radiation budget parameters had the largest effect on simulated ET. MOD16 ET predictions were improved by: (1) reformulating the emissivity expressions in the net radiation equation; (2) incorporating representative surface conductance values; and (3) including a soil moisture stress function in the transpiration sub-model. Implementing these changes increased the accuracy of

MOD16 daily ET predictions at all sites. However, similar adjustments to the PT-JPL model yielded minimal improvements. We conclude that the MOD16 ET model has the potential to accurately predict water use in arid environments provided soil water stress and accurate biome-specific parameters are incorporated.