Comparison of MODIS derived evapotranspiration with LAS measurements at Changwu Agro-ecological Experimental station

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Significance of EvapoTranspiration (ET) linking the exchanges of both water and energy between land surface and atmosphere has been realized in disciplines of hydrology, meteorology and agriculture from a number of studies. Several approaches with varying complexities from simplified empirical regression method to physics based two-source models have been developed with remotely sensed data and ancillary surface measurements to estimate ET and Evaporative Fraction (EF, defined as the ratio of latent heat flux to surface available energy) over field and regional scales [1-2].

In this paper, a parameterization proposed by Jiang and Islam [3], which is based on the spatially contextual information of surface temperature (T_s) and vegetation index (VI) from remote sensing data, is applied to estimate regional ET and EF, namely T_s-VI triangle method. Notable advantages of T_s-VI triangle method over other commonly applied models to estimate regional ET and EF mainly include: 1) minimum input data are required, 2) no ground based measurements are needed, 3) absolute accuracy of T_s retrieved from remote sensing imagery is not indispensible, 4) estimation of EF is independent of R_n and G estimates, which allows one to evaluate this method directly without resort to surface energy balance equation. The parameterization of Jiang and Islam [3] is an extension of Priestley-Taylor equation, which can be expressed as:

$$LE = \phi[(R_n - G)\frac{\Delta}{\Delta + \gamma}]$$

Where LE is latent heat flux (ET in W/m^2), R_n is surface net radiation (W/m^2), G is soil heat flux (W/m^2), ϕ is a complex parameter that absorbs the effects of aerodynamic and canopy resistances (dimensionless), Δ is slope of saturated vapor pressure versus air temperature ($kP_a/°C$), γ is Psychrometric constant ($kP_a/°C$). Taking into account that an error of 1K in air

temperature only results in an error of 0.0127ϕ in EF [4], surface temperature derived from remotely sensed data will be used to replace air temperature in the estimation of parameter Δ [5]. Parameter ϕ is obtained by a two-step linear interpolation scheme [3]. Dry and wet edges in the T_s-VI triangle space are determined automatically using the iterative process developed by Tang et al. [5].

Surface net radiation, the sum of surface net shortwave and longwave radiation, is estimated using the algorithms with MODIS/TERRA products proposed by Tang et al. [6] and Tang and Li [7]. The scheme of Su [8] relating the ratio of G to R_n to fractions at bare soil and fully vegetated surface is used to estimate soil heat flux.

MODIS/Terra data used in this paper include Land surface temperature/emissivity (MOD11_L2), Surface reflectance (MOD09GA), Calibrated Radiances (MOD02), Geolocation (MOD03), Precipitable Water (MOD05_L2) products. Land surface temperature/emissivity (MOD11_L2) and Surface reflectance (MOD09GA) are downloaded from LPDAAC (Land Processes Distributed Active Archive Center, https://lpdaac.usgs.gov/). Calibrated Radiances (MOD02), Geolocation (MOD03) and Precipitable Water (MOD05_L2) products are retrieved from LAADS (Level 1 and Atmosphere Archive and Distribution System) Web, http://ladsweb.nascom.nasa.gov/).

The study area is located in the north of China. Latitude and longitude of the study area are respectively from 34˚ N to 37˚ N and from 106˚ E to 109˚ E. Instantaneous estimation of R_n and sensible heat flux as the residual of energy balance are validated with surface radiation and LAS (Large Aperture Scintillometer) measurements at Changwu Agro-ecological Experimental station collected during July to October 2009. It is shown that surface net radiation is generally overestimated with RMSD about 50 W/m^2. When surface available energy estimated is replaced by the surface measurements, reasonably good agreement between estimated and measured sensible heart flux from LAS has been observed with RMSD about 40 W/m^2.

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