Applications of the Newly Improved Global MOD16 Evapotranspiration Algorithm at AmeriFlux Tower Site and Global Scale

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1. Methodology

The beta MOD16 ET algorithm developed by Mu et al. (2007) based on Cleugh et al. (2007) using the **Penman-Monteith equation** was improved to version 1.

$$LE = \frac{sA + \rho C_p (e_{sat} - e)}{s + \gamma(1 + R_s / R_a)}$$

2. Improvements

Major refinements include 1) the canopy and soil surfaces are divided into wet and dry surfaces. 2) The ET comprises daytime and nighttime parts. 3) The amount of soil heat flux is not neglected in version 1. 4) The methods to estimate stomatal conductance and aerodynamic resistance have been refined to account for some key dynamic processes.

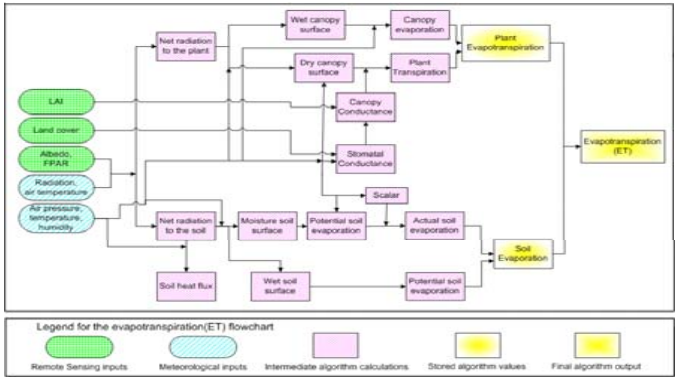

Fig. 1 The ET flowchart of the improved (version 1) MOD16 ET algorithm.

3. Validation of version 1 MOD16 ET Algorithm at Eddy Flux Towers

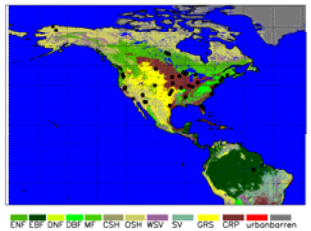

Fig. 2 Distribution of the 69 AmeriFlux eddy flux towers.

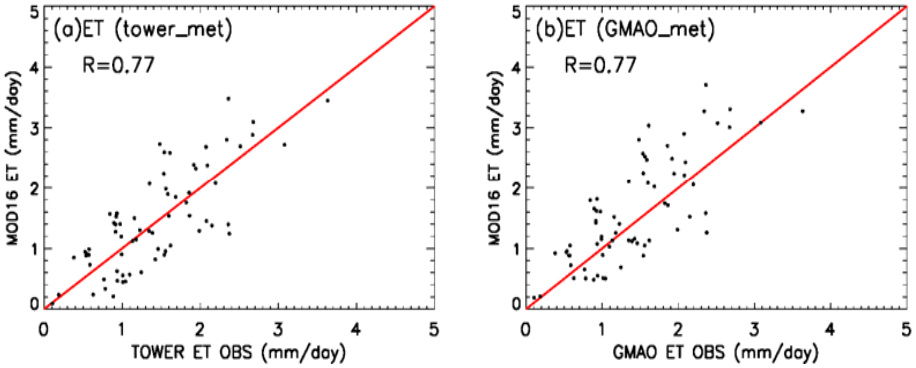

Fig. 3 Comparison of daily evapotranspiration (ET, mm/day) observations from the 69 flux tower sites and the ET estimates averaged over the MODIS 3x3 km cutout. These data were created using (a) tower-specific meteorology and (b) the global GMAO meteorology.

4. Validations at global watersheds

Annual precipitation was subtracted by stream flow to get the pseudo ET observations (ET OBS) for the watersheds. We assume that the soil water is at equilibrium in at least five years. The MOD16 ET estimates can explain 84% of the variations of the pseudo ET observations at the 234 watersheds.

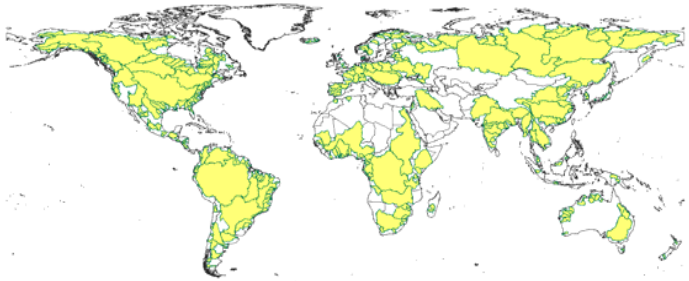

Fig. 4 Distribution of the 234 watersheds. Each watershed is filled with yellow color and green edge.

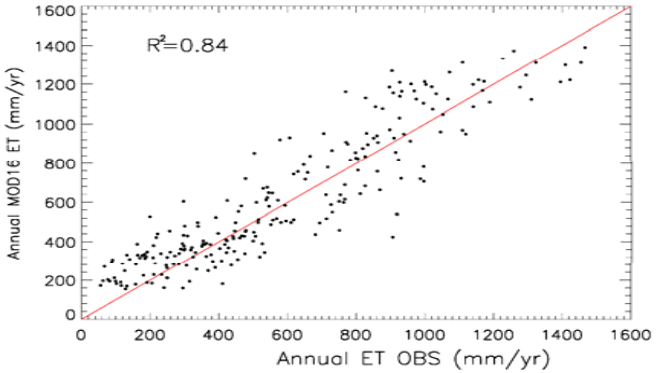

Fig 5. Comparison of annual pseudo ET observations (ET OBS) from the 234 watersheds and the ET estimates averaged over each watershed with version 1 MOD16 ET algorithm over at least five years during 2000-2006.

5. Global ET results

Version 1 MOD16 ET algorithm was applied globally over 2000-2006 with global GMAO reanalysis data. The 1km global ET was smoothed to 0.05-degree. The global mean annual ET is 581.7 mm/yr. Precipitation is not an input.

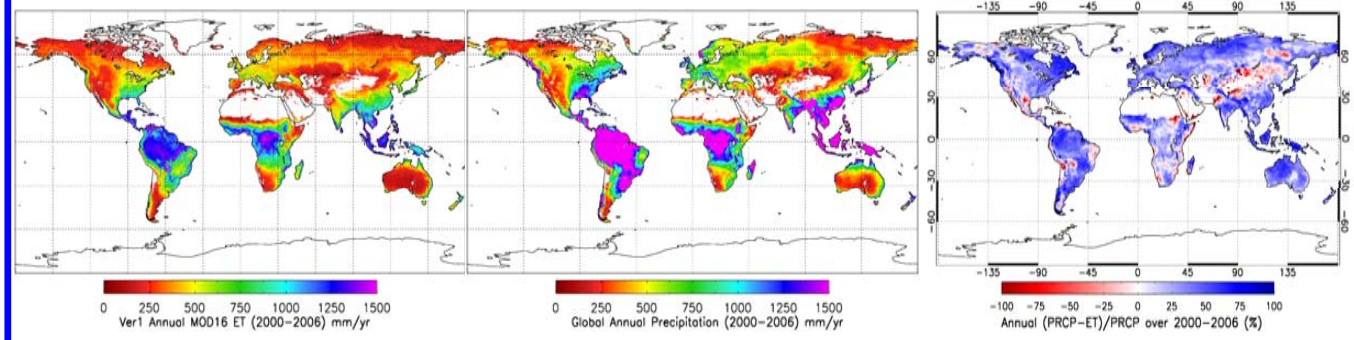

Fig. 6 (a) global annual ET (b) global annual precipitation over 2000-2006 and (c) the ratio of the difference between precipitation and ET to precipitation.

Reference

Cleugh, H. A., R. Leuning, Q. Mu, S. W. Running (2007) Regional evaporation estimates from flux tower and MODIS satellite data. Remote Sensing of Environment, 106, 285–304 (doi:10.1016/j.rse.2006.07.007).

Mu, Q., F.A. Heinsch, M. Zhao, S.W. Running (2007). Development of a global evapotranspiration algorithm based on MODIS and global meteorology data. Remote Sensing of Environment, 111, 519-536 (doi: 10.1016/j.rse.2007.04.015).

Mu, Q., M. Zhao, S.W. Running, Improvements and Evaluations of the MODIS Global Evapotranspiration Algorithm. (in preparation)