Global Remote Sensing of Daily Evapotranspiration based on Surface Energy Balance Method

Key Points:

- Underestimation of sensible heat or overestimation of latent heat (evapotranspiration) in SEBS is due to its overestimation of kB^{-1}.
- Vertical variation of foliage density, foliage shielding, and foliage drag/heat transfer were used to build a column canopy-air turbulent transfer model.
- The column model accurately simulate heat flux for seven canopy covers by considering momentum and heat transfer efficiency in vertical canopy layers.
- A remote sensing energy balance (EB) model is integrated with the column canopy-air turbulent exchange parameterization method.
- The EB model can estimate daily ET for all weather conditions

Abstract

A global daily evapotranspiration (ET) product without spatial-temporal gaps covering the period 2000-2017 is produced using a recent developed energy balance (EB) model and MODIS satellite data. The EB model is driven by instantaneous remote sensing land surface temperature and daily meteorological data.

Two novel gap-filling methods for estimating daily ET during cloudy days are applied. The performance of the daily ET data is evaluated at 238 flux sites measurements representative of a broad range of biomes and climates at the global scale. The gap-filling EB method reproduce observed daily ET with an reasonable accuracy of ~5% errors.

We find a mean bias (MB) of 0.04 mm/day in ET estimates, while the RMSE is 1.56 (±0.25) mm/day. By using the combination of thermal and optical remote sensing-based inputs and reanalysis forcing, This work provides a daily ET at 5 km resolution without spatial-temporal gaps for the global land area.

The ET data is freely open on the web:
http://en.tpedatabase.cn/portal/MetaDataInfo.jsp?MetaDataId=249454

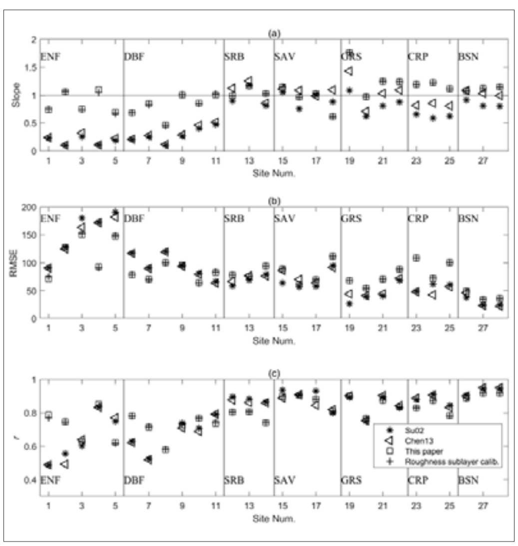

Figure 1. A method for estimating roughness length from remote sensing technique is developed in this study. The performance of the roughness length scheme described in Chen et al. (2013), SEBS (Su 2002) and this work was examined by comparing simulated H to measured ones at 28 flux tower stations (ENF: needle forest, DBF: broadleaf forest, SRB: shrub, SAV: savanna, GRA: grassland, CRP: cropland, and BSN: sparsely vegetated land). The energy balance model structure was adjusted from one foliage layer to a multi-foliage layer, which provides the possibilities to include the impact of vertical variations in foliage leaf area density, foliage shelter factor and foliage heat transfer coefficient. The linear fitting slope (a), RMSE(b), r (c) were derived from H observation and simulation with four schemes.

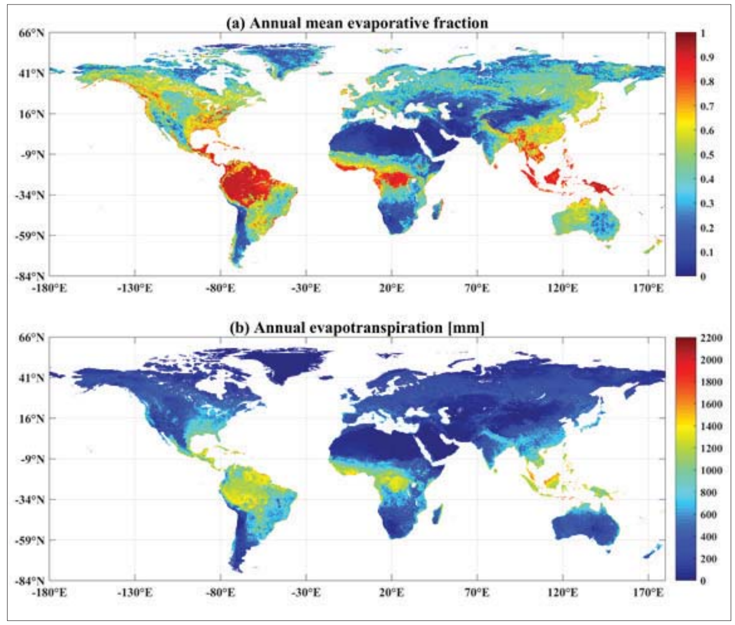

Figure 2 Annual mean evaporative fraction (a) and annual evapotranspiration (b) over global landmass produced by MODIS satellite data and the energy balance model.

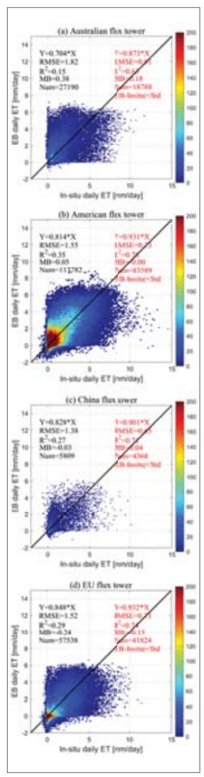

Figure 3 Scatter density of EB daily ET estimation against in-situ daily ET observation. Red text in each figure shows the results from data selected with |EB-Insitu|< one standard deviation.

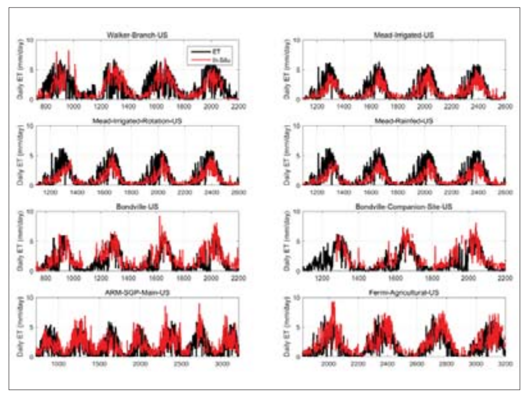

Figure 4 Time series of daily ET simulation and in-situ observations at 8 US flux sites, Label x-axis gives day numbers since 1st January 2001.

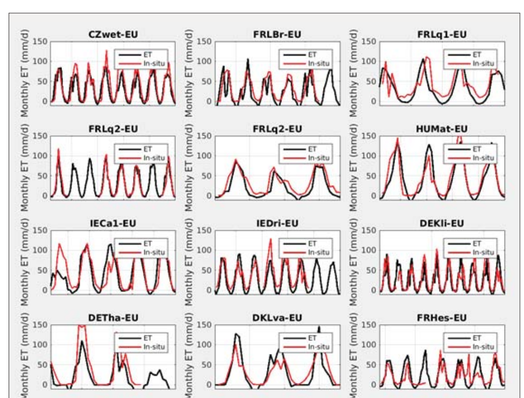

Figure 5 Monthly ET (accumulated from daily ET) against in-situ observations at 12 European flux tower sites

For more information

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