Characteristics of evapotranspiration and its components in QYZ plantation: based on modified S-W model

Shen Jing
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Outline

- Motivation and objective
- Introduction to SW model
- Data and method
- Results and discussion
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Motivation and objective:

Evapotranspiration (ET) links water, energy and carbon cycles (Baldocchi *et al*., 1991;Hussey and Odum, 1992; Garatuza-Payan *et al*., 1998; Drexler *et al*., 2004; Gentine *et al*., 2007).

The accurate estimation of water loss by ET is very important for assessing water availability and requirements of terrestrial ecosystems.

Motivation and objective:

ET models	Advantages	Disadvantages
Single-layer big-leaf models	Simple parameterization	Unable to partition ET
Multi-layer big-leaf models	Accurate simulation	Complex parameterization
Ecological process-based models		
Remote sensing models	Regional representation , simple parameterization	Low temporal resolution
Two-layer big-leaf model (SW)	Relatively simple parameterization Enable to partition ET	---

Motivation and objective:

- to study the characteristics of ET and its components at QYZ site, based on modified SW model.

Introduction of modified SW model

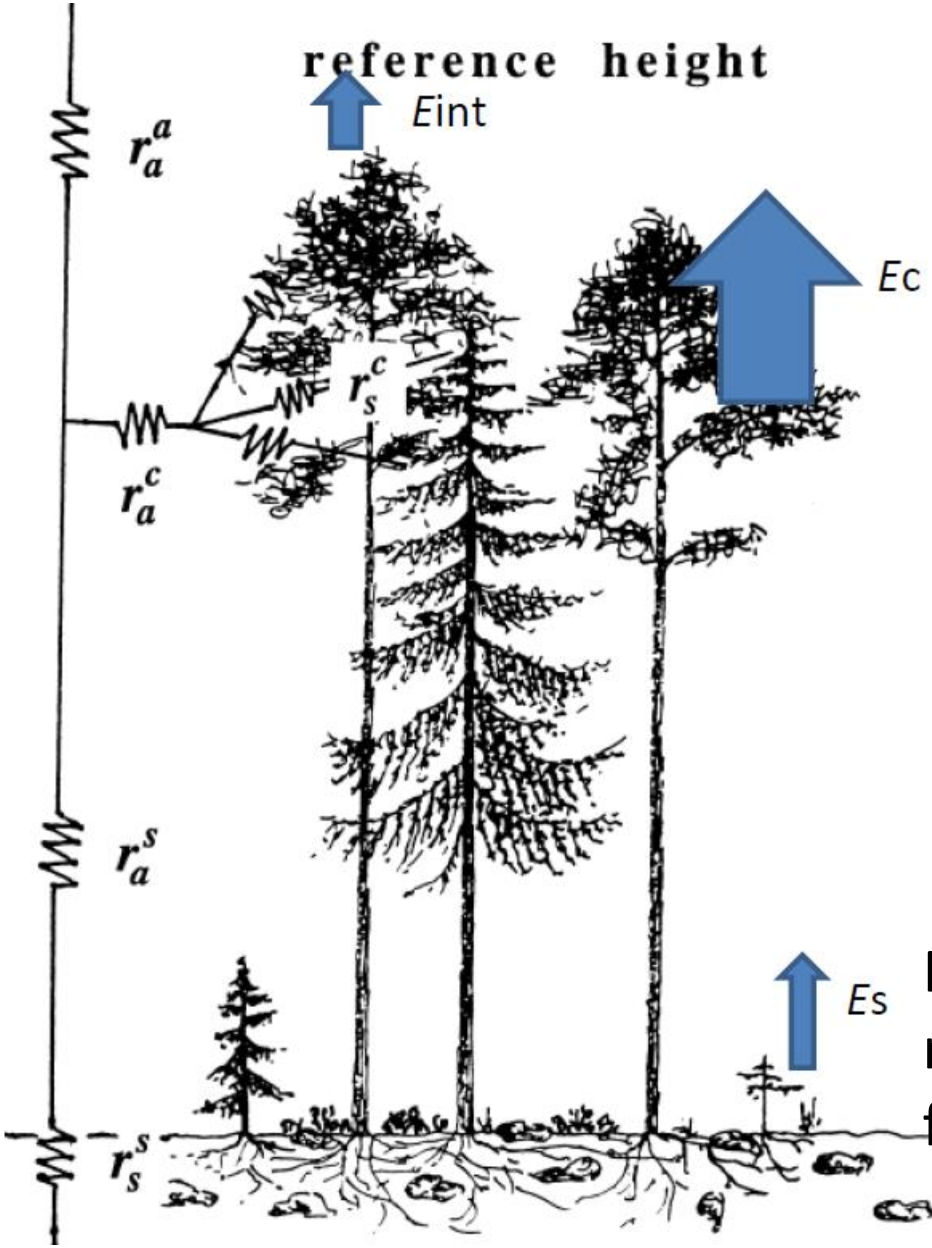

Figure 1. Scheme of the modified SW model, adapted from Iritz *et al.*, 1999.

Data and method

- Eddy covariance data: 30-min averaged CO_2 and H_2O flux data at QYZ site in 2011.
- Micrometeorological data: T_a, RH, u, R_n, G and so on.
- Satellite data: 16-day composite MODIS NDVI product MOD13A2.

$$LAI = \ln\left(1 - F_{canopy}\right) / 0.3$$ (Li *et al.*, 2006)

where

$$F_{canopy} = NDVI + 0.05$$ (Fisher *et al.*, 2008)

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Data and method

- 2D coordinate rotation and WPL correction.
- Despike when precipitation happened.
- Set the threshold of NEE to [-1 1] mg CO_2 m^{-2} s^{-1}.

$$NEE = F_c + F_s \quad \text{where} \quad F_s = \frac{\Delta c}{\Delta t} \bullet h$$

- Despike if the nighttime u* was less than 0.2 ms^{-1}(Liu *et al*., 2004; Yu *et al*., 2004; Zhang *et al*., 2006).
- Despike if beyond 1.96 times of the 5 points moving standard error.

Validated data: 84.9% in daytime and 14.4% at night.

Data and method

Short-time gap filling (less than 3 h) was done with linear interpolation.

Long-time gap filling was done with

$$R_d = R_{\mathrm{d},ref} e^{E_0\left(\frac{1}{T_{ref}-T_0} - \frac{1}{T_k-T_0}\right)}$$

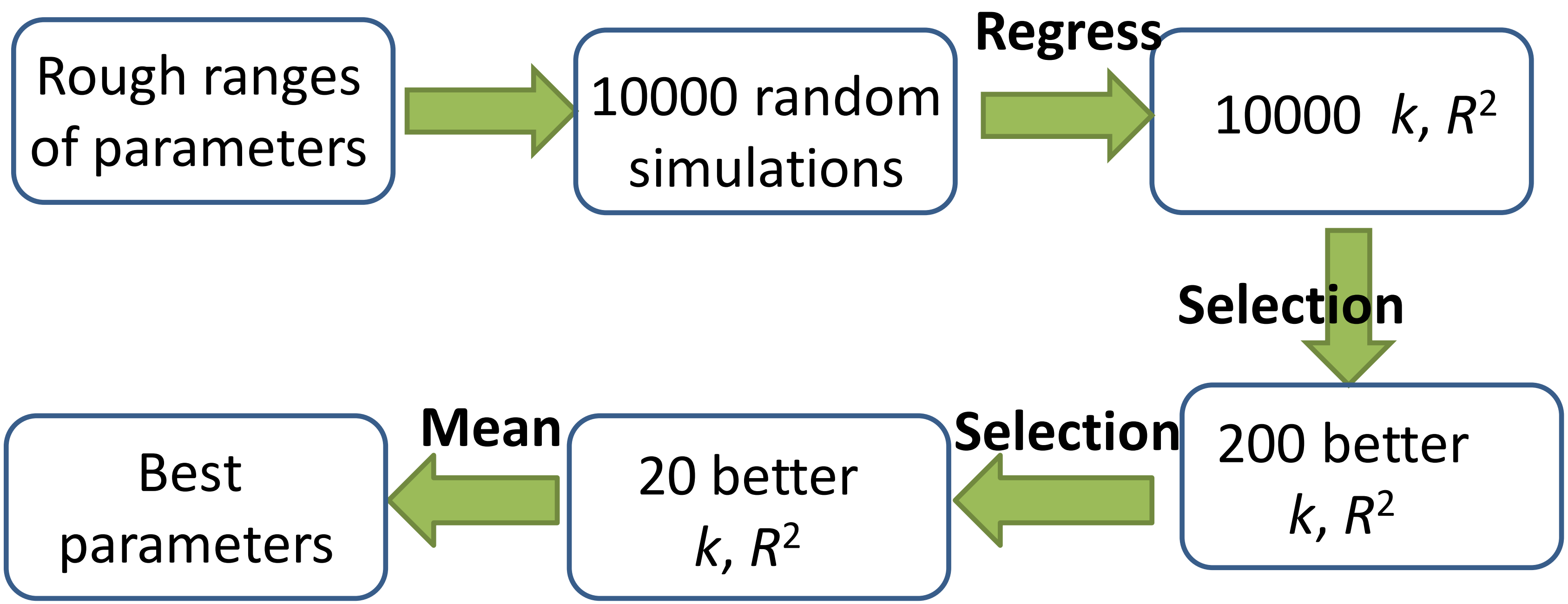
at night and

$$NEE = R_{\mathrm{d}} - \frac{\alpha Q_P P_{\max}}{\alpha Q_P + P_{\max}}$$

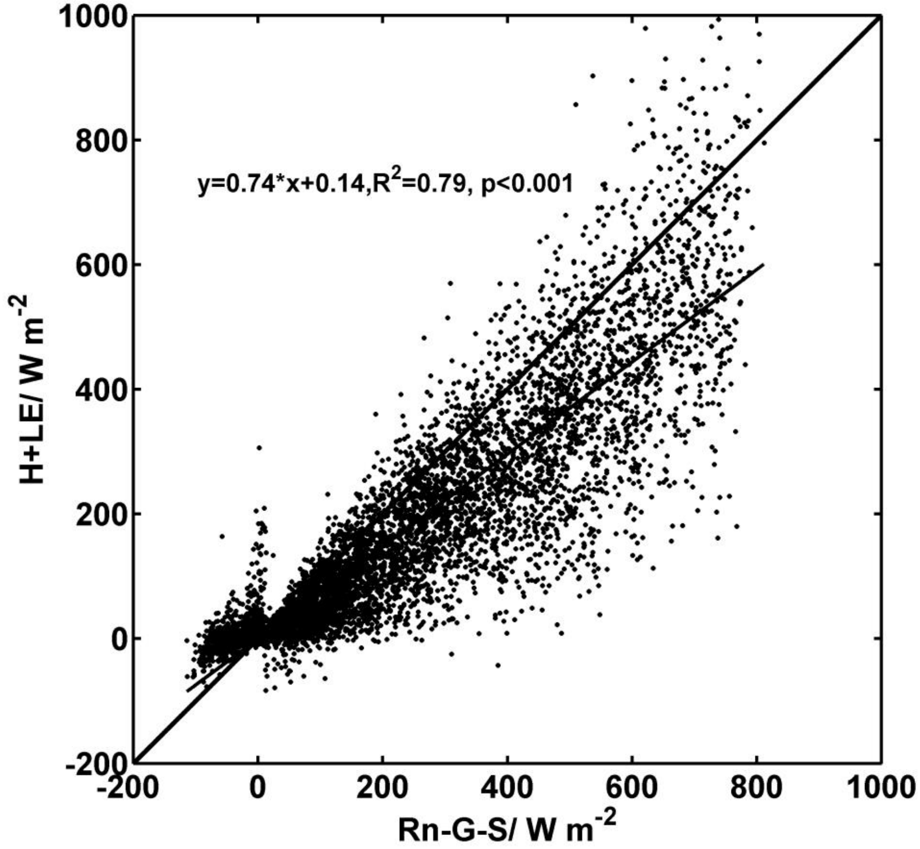
in daytime.

Data and method

Monte Carlo simulations was performed to estimate the key parameters in the model .



Results and discussion



$$S = S_H + S_E + S_P$$

$$S_H = \rho_a C_p z_r \Delta T_a / \Delta t,$$

$$S_E = \rho_a (C_p/\gamma) z_r \Delta e / \Delta t,$$

$$S_P = -F_c C, C = 0.469 \text{ J } \mu\text{mol}^{-1}.$$

(referring to Blanken *et al*., 1997)

Figure 2. Energy closure balance at QYZ site in 2011.

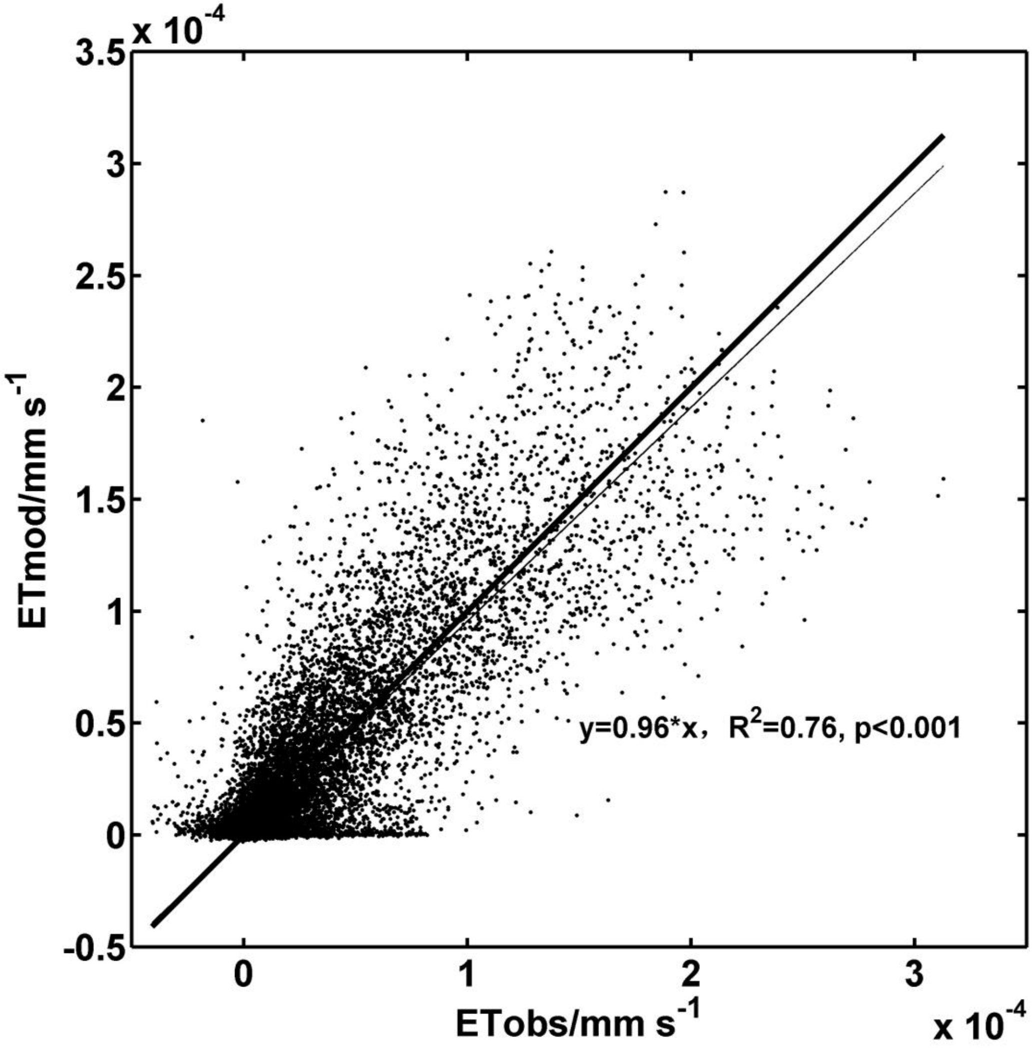


Figure 3. ET simulation at QYZ site on half-hour scale in 2011.

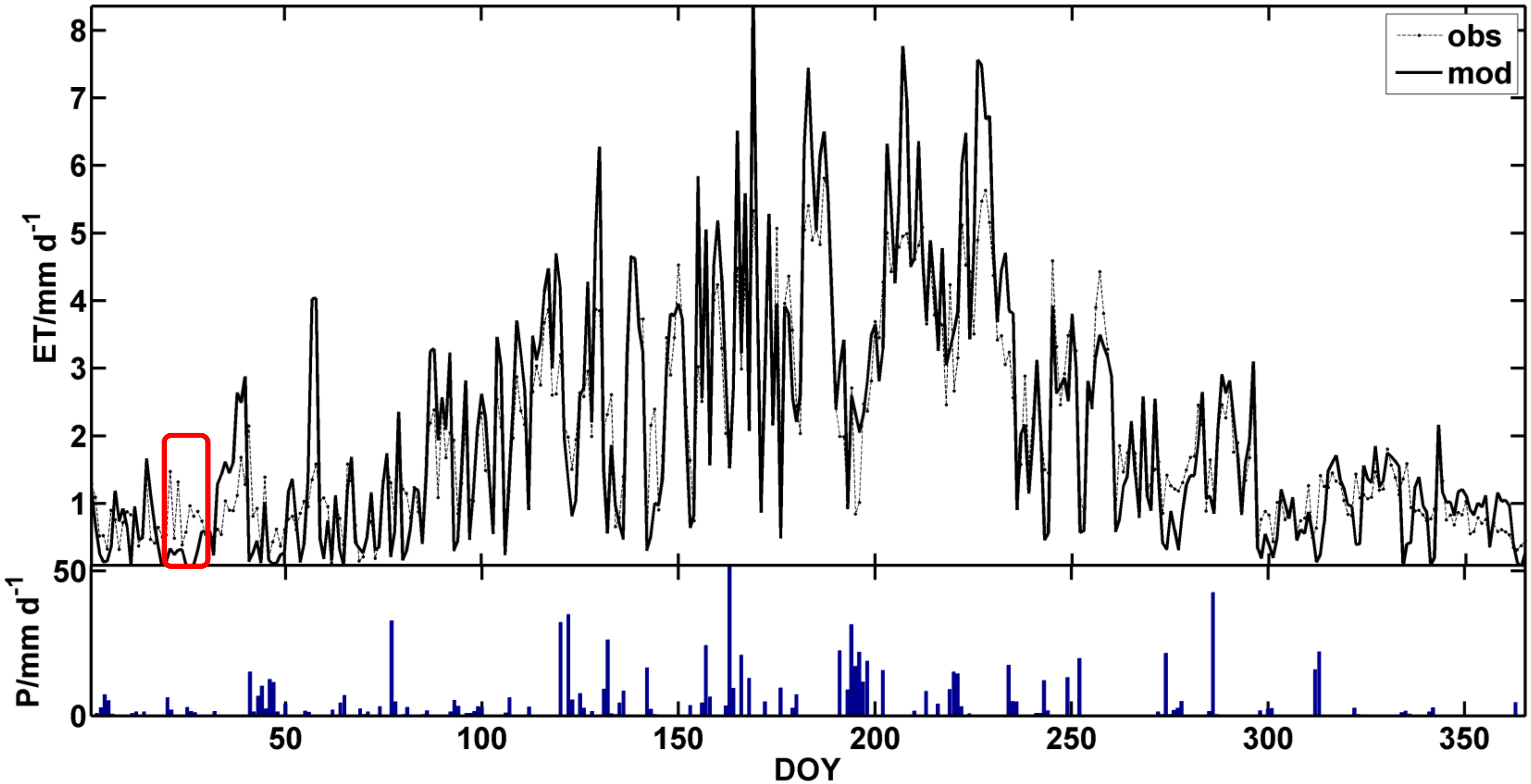


Figure 4. Time series of modelled (solid line) and observed(dash line) ET at QYZ in 2011.

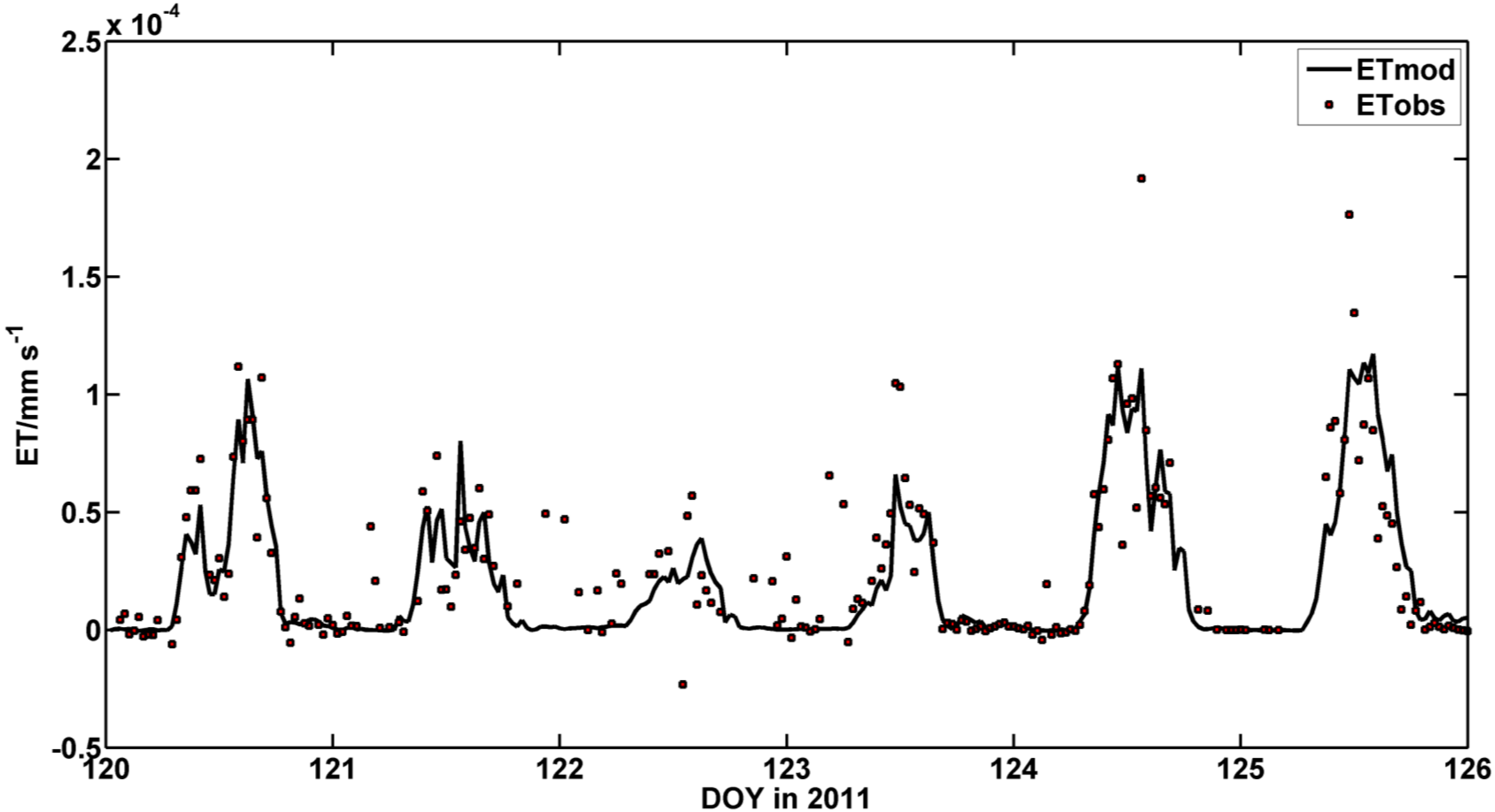


Figure 5. Time series of ET simulation at half-hour time scale in rainy days.

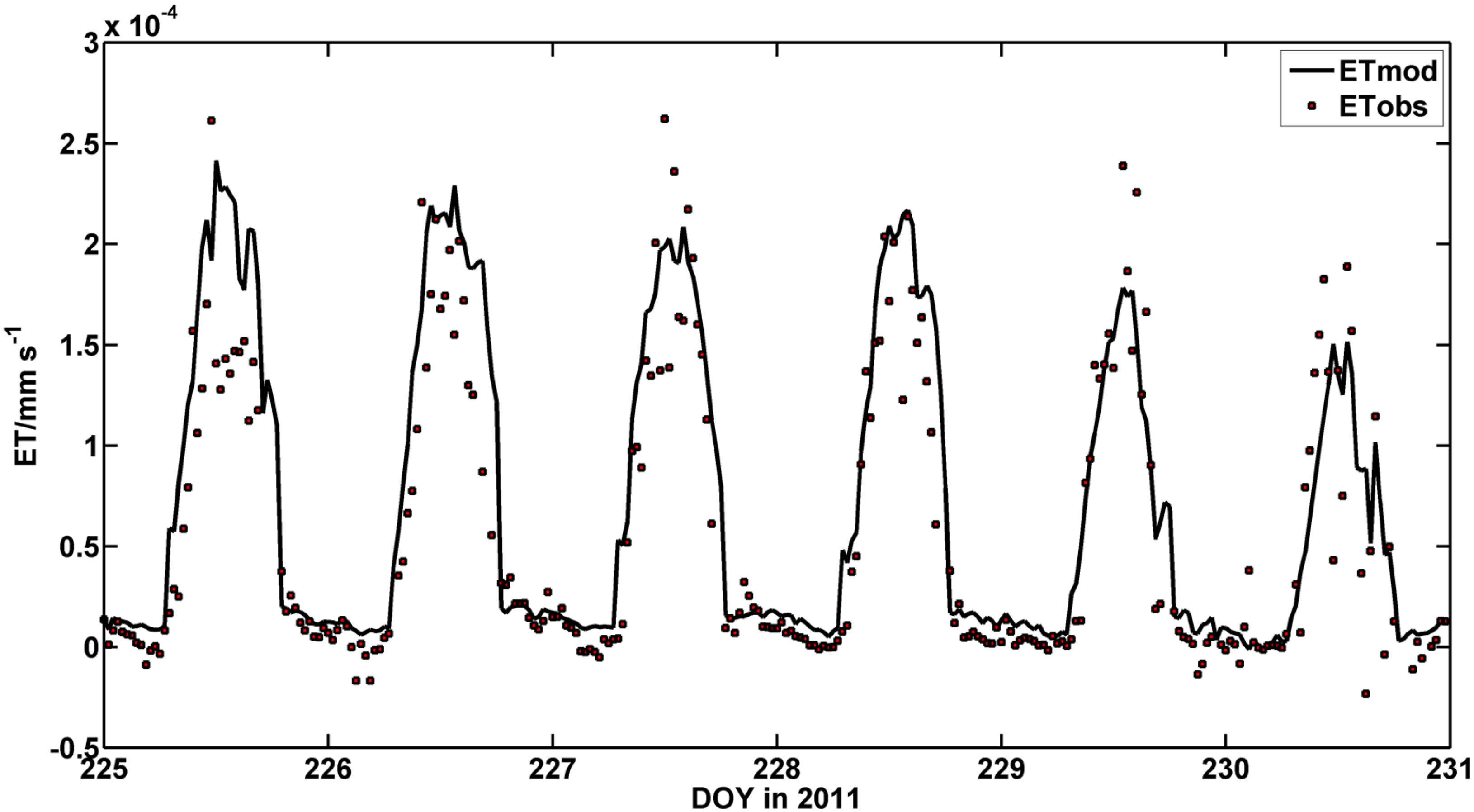


Figure 6. Time series of ET simulation at half-hour timescale in sunny days.

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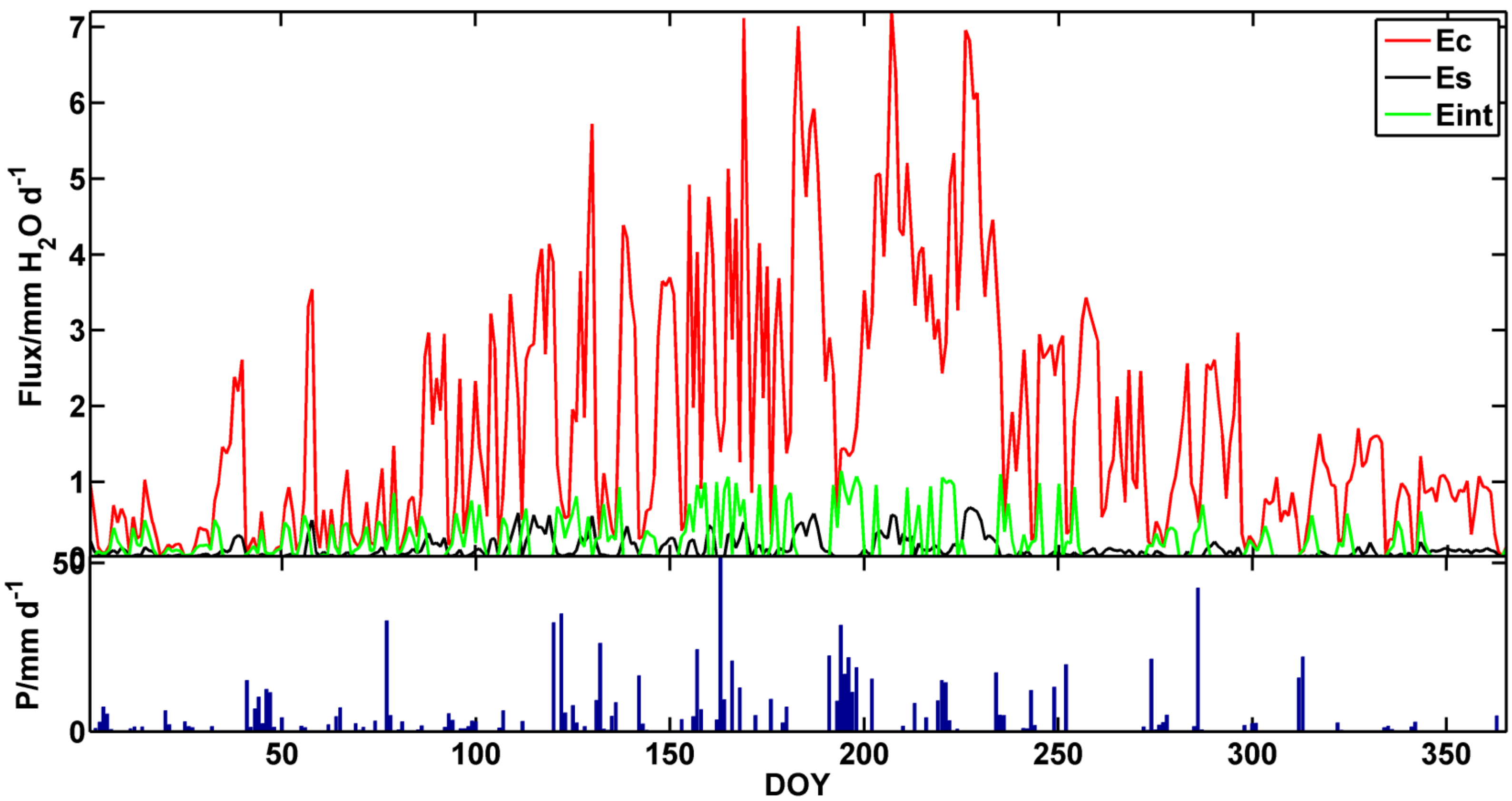

Figure 7. Time series of modelled components of ET.

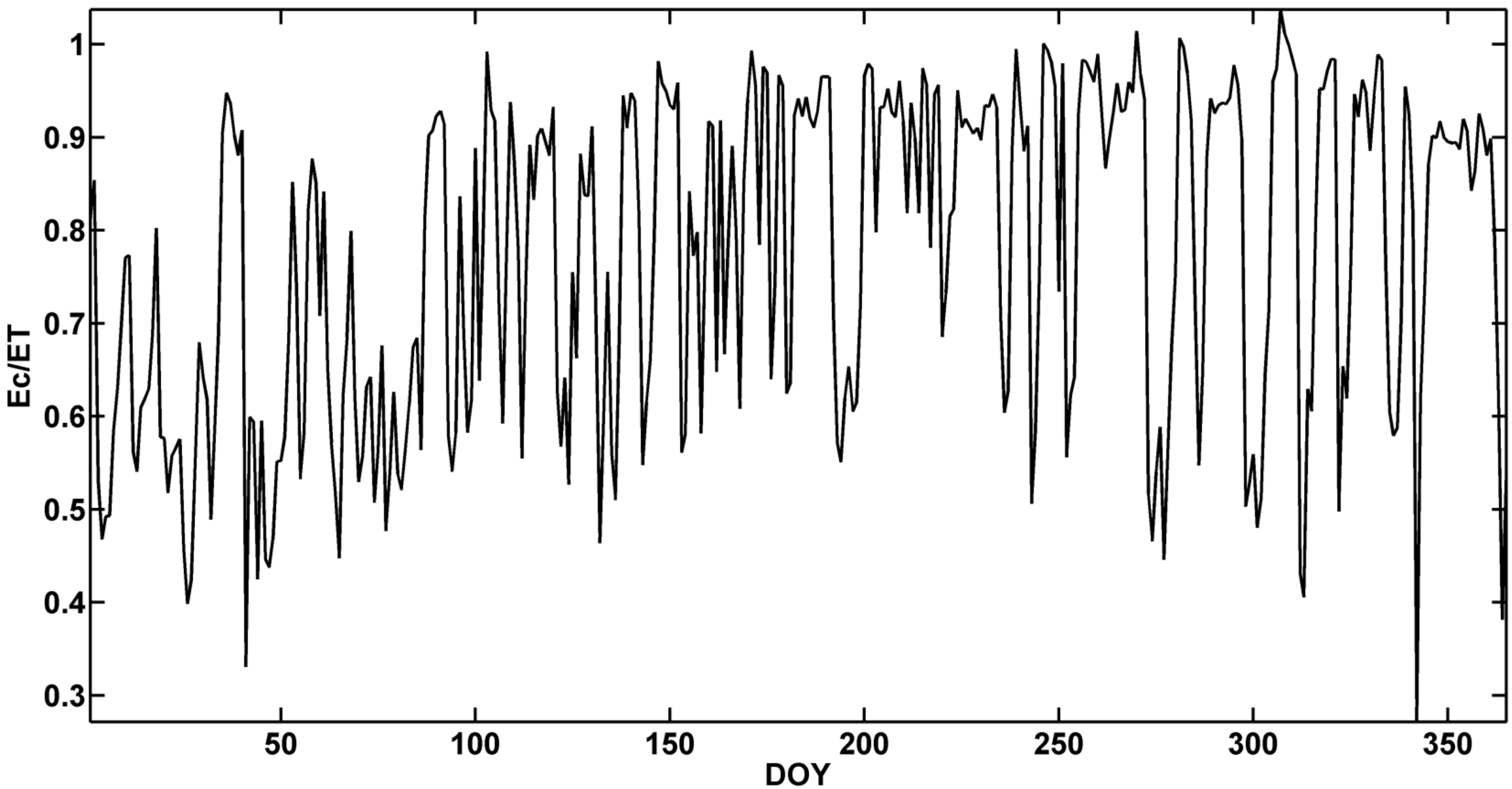

Figure 8. Time series of Ec/ET at QYZ in 2011.

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Table 1. Statistics of annual data in 2011.

P/mm	ET/mm	Ec/mm	Es/mm	Eint/mm
937.6	716.1/**750.0**	634.9	39.9	75.2
	0.76/**0.80**	**0.85**	0.05	0.10

Table 2. Ec/ET from published papers.

Site description	Year	Ec/ET	Reference
Upland oak-dominated broadleaf forest, Oak Ridge, TN	1998-1999	0.42-0.46	Wilson *et al.* (2001)
Duke Forest Ameriflux Hardwood site, Orange County, North Carolina	2002-2005	~0.72	Stoy *et al.*(2006)
		0.53-0.58	Oishi *et al.* (2008)
Agdal olive (*Olea europaea* L.) orchard in Marrakech, Morocco	2002	0.69-1.00	Williams *et al.* (2004)
Sicilian olive grove, Italy	2009-2010	0.57-0.90	Cammalleri *et al.*(2013)
QYZ	2003-2008	0.63-0.68	Wei et al. (2012)

Summary

- The energy closure at QYZ in 2011 was comparable to other studies.
- Es increased rapidly after precipitation and lasted about 8-10 days.
- Ec/ET was influenced by precipitation and was about 0.85 at annual timescale in this study.
- Eint/ET was about 10%.

Next work

How to explain the difference of Ec/ET between mine and others?

Thanks!

Any advice are welcome.