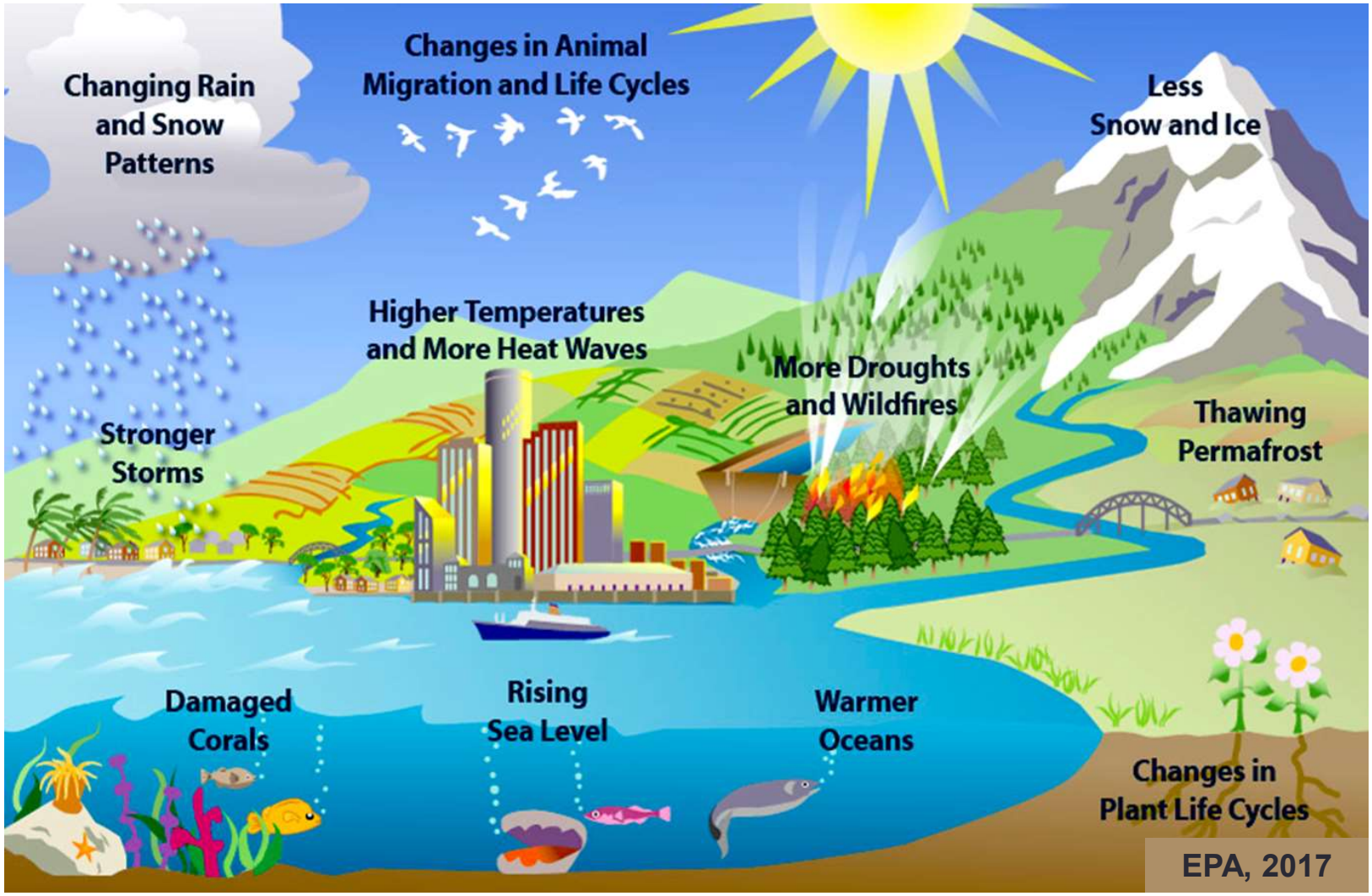
Determination of Evapotranspiration and crop coefficients of Rubber Plantation in Thailand

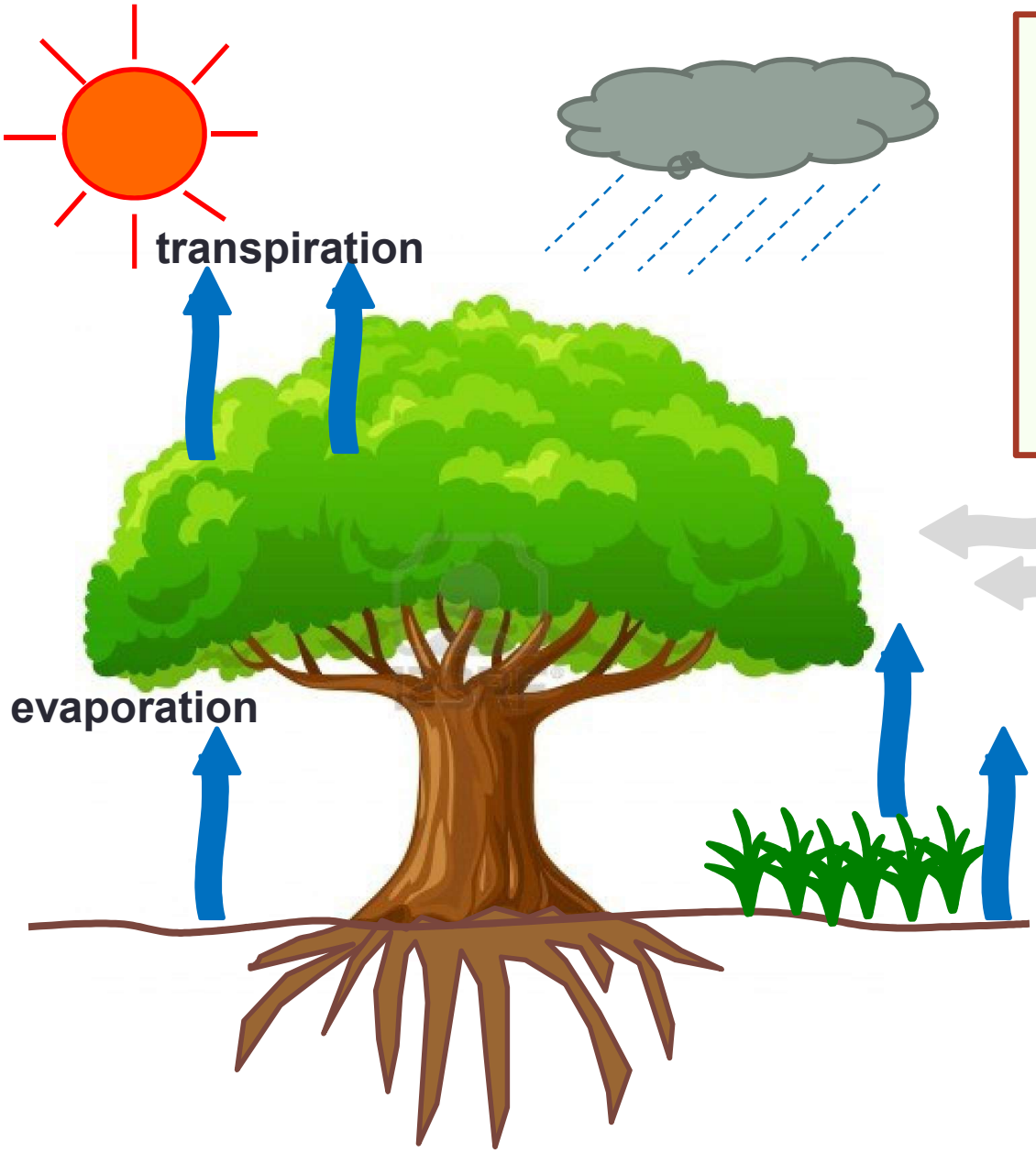
Nongpat Chaichana, Chompunut Chayawat, Jate Sathornkich, Jessada Phattaralerphong, Duangrat Satakhun, Poonpipope Kasemsap, Phiippe Thaler, Frederic Gay, Pisamai Chantuma

Kasetsart University, THAILAND

What climate change effects are we already seeing?



Introduction



Evapotranspiration

↓

Evaporation

+

Transpiration

Factors

- Weather parameter
- Management and environment condition
- Crop factors

Introduction

Estimating Evapotranspiration

Indirect methods
: Penman equation
Direct method
: Eddy Covariance (EC)

$$ET = Kc \times ET_0$$

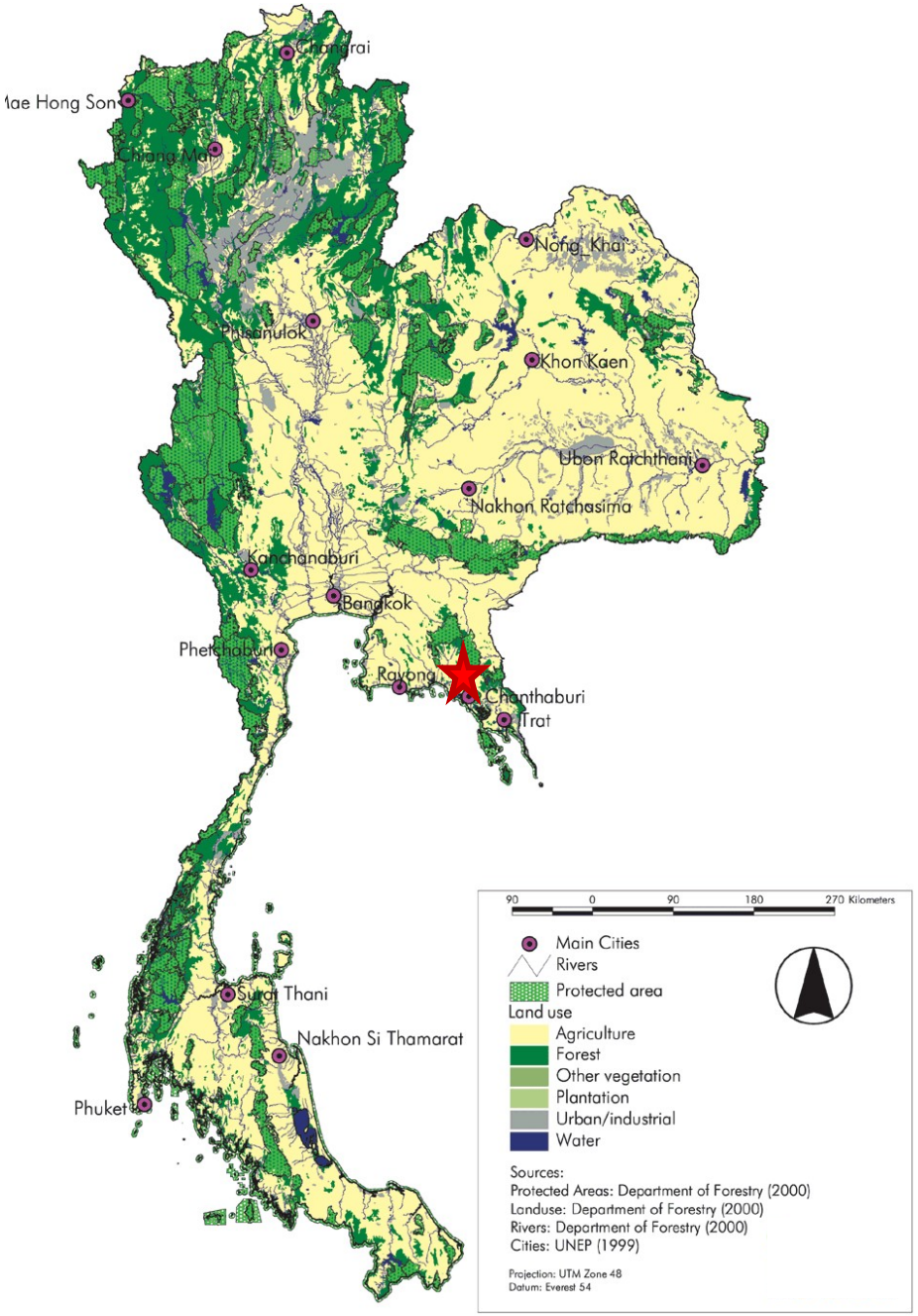
- ET : crop evapotranspiration
- ET_0 : reference evapotranspiration
- Kc : crop coefficient
- Unit : mm/unit time

" Some of the technique to measure ET are only valid under specific climatic and agronomic conditions and cannot be applied under conditions different from those under which they were originally developed"

Objective

- Evaluating the evapotranspiration (ET) and crop coefficient (Kc) values of the rubber plantation using the Eddy Covariance technique (EC)
- Comparing the Kc values obtained by the FAO-56 Penman-Monteith

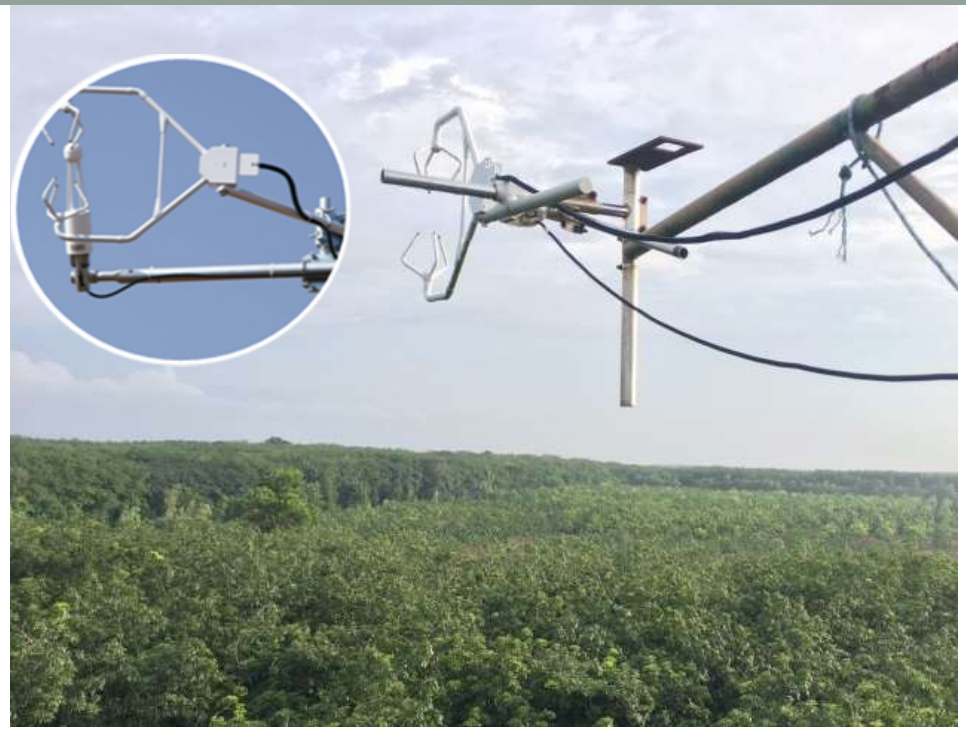
Material and Method



Experimental site

- 2013 - 2015
- 19-21 years old rubber plantation (RRIM 600)
- Chachoengsao Rubber Research Station, Thailand
- Long. 101°28´5.53´´E
- Rain fed agriculture
- Growing distance 2.5 x 7 m
- Tapping: started 2005

Material and Method



- Tower height 25 meter
- Eddy Covariance system
  - 3D Sonic Anemometer
  - Gas Analyzer
  - Frequency 20 Hz
  - Data processing by Edire software package

Material and Method

Micrometeorological data

- Net Radiation
- Rain fall
- Wind speed and wind direction
- Air temperature and Relative Humidity
- Soil temperature and soil water content

Physiological data

- Leaf Area Index (LAI)
- Plant growth

Results

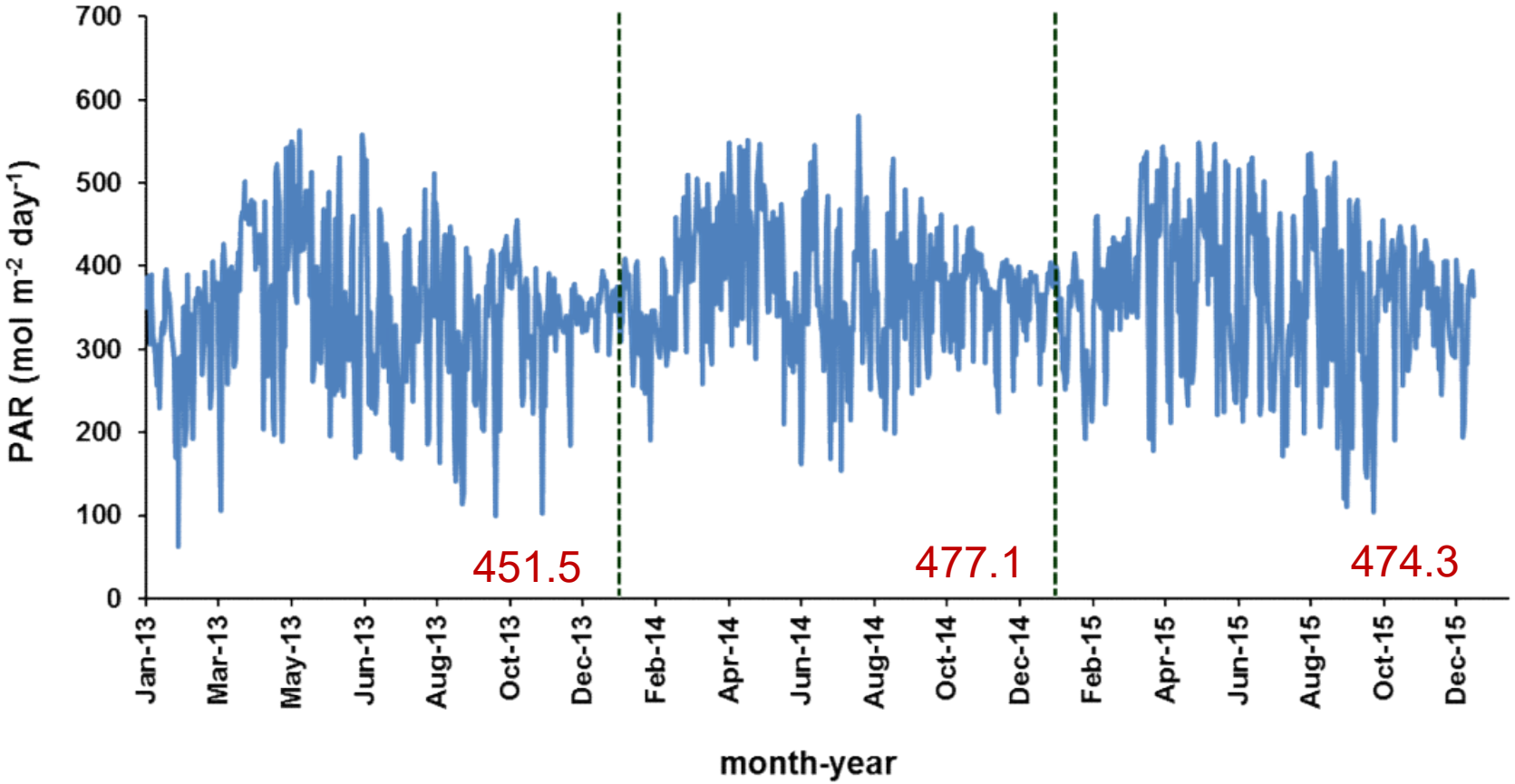


Fig. 1 The Photosynthetically active radiation (PAR) in 2013 – 2015

Results

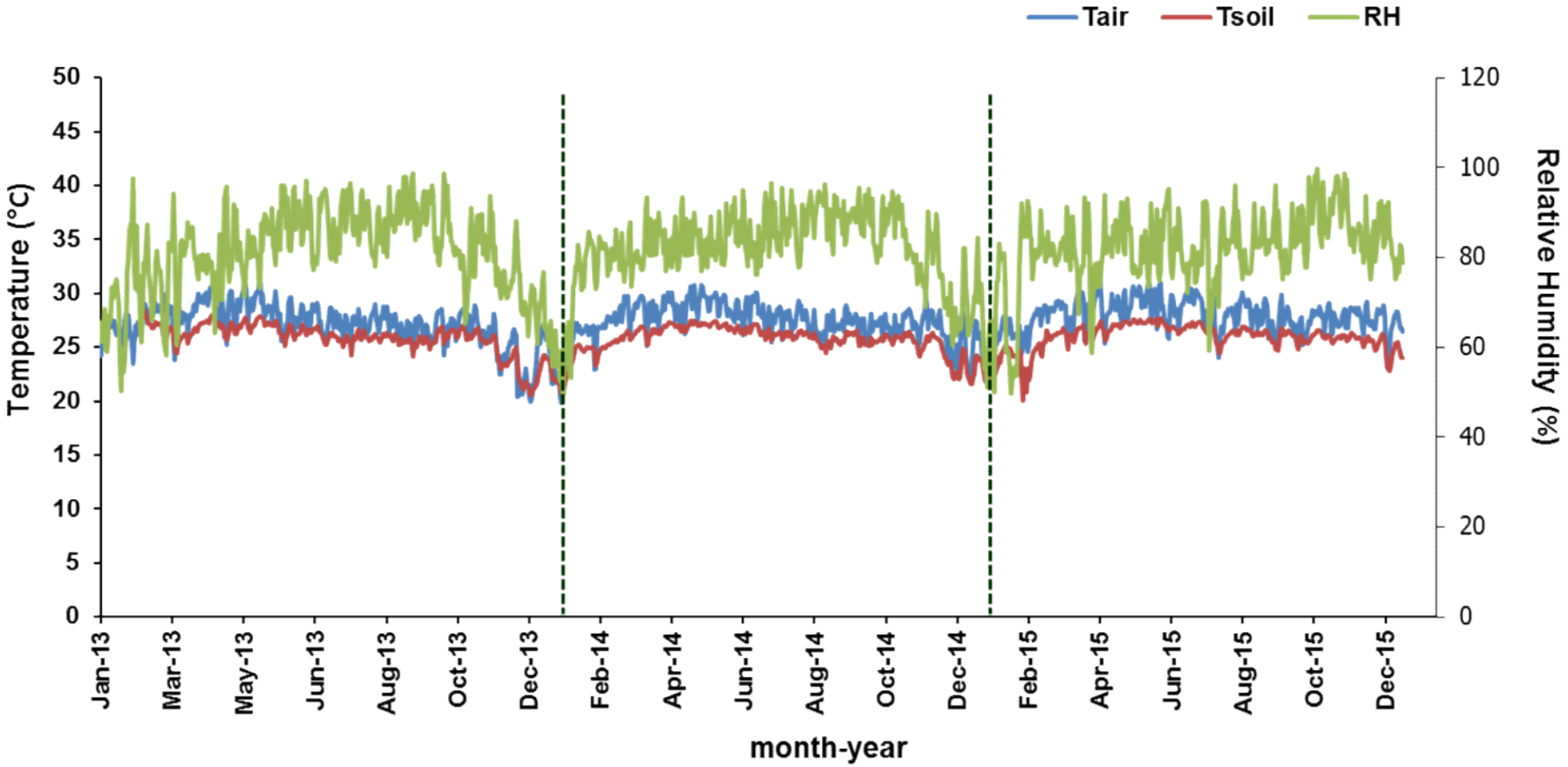


Fig. 2 The daily average of air temperature (Ta), soil temperature (Ts) and relative humidity (RH) in 2013 – 2015

Results

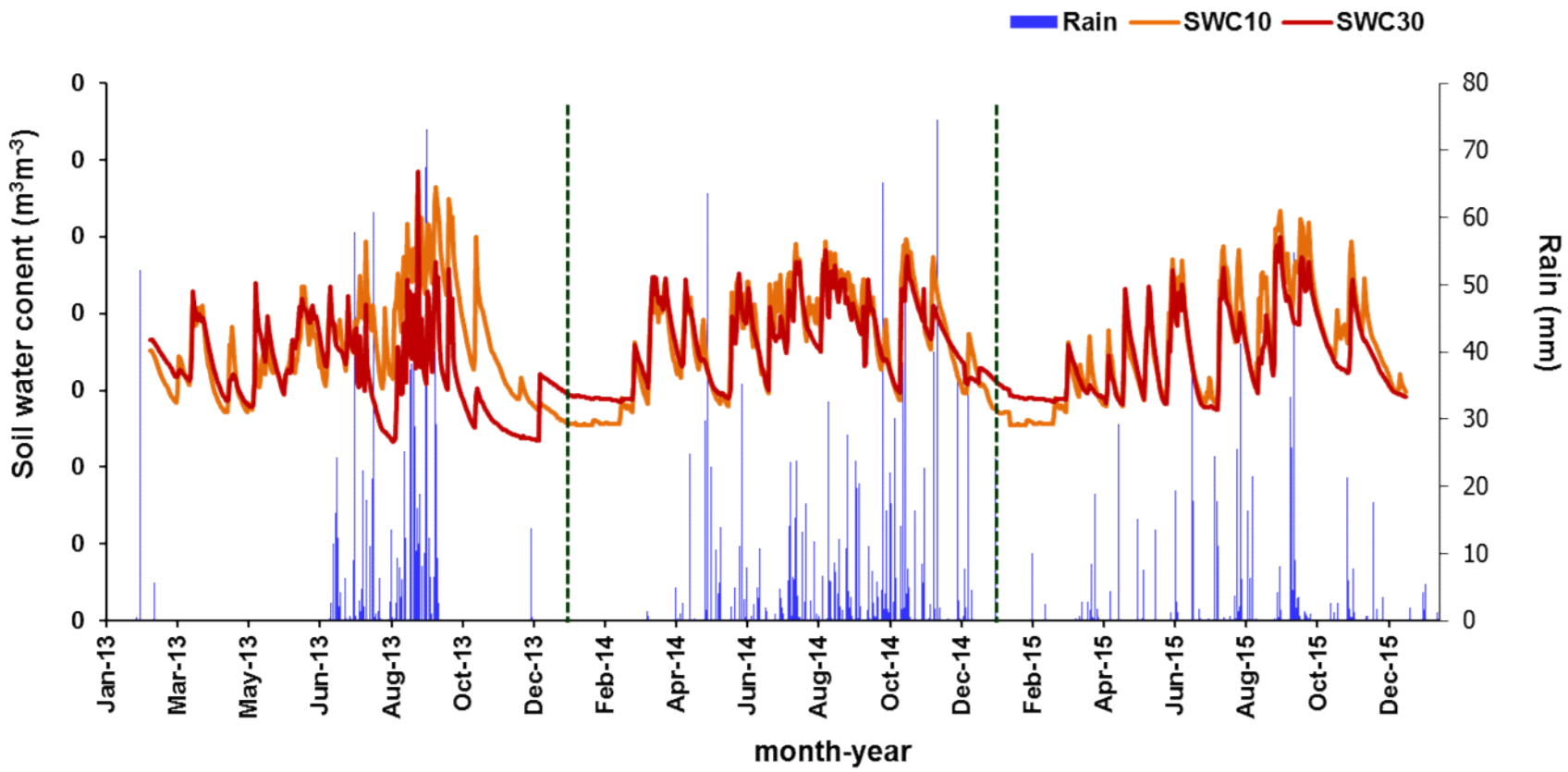


Fig. 3 The daily average of soil water content (SWC) at 30 and 50 cm depth and the amount of rain in 2013 – 2015

Results

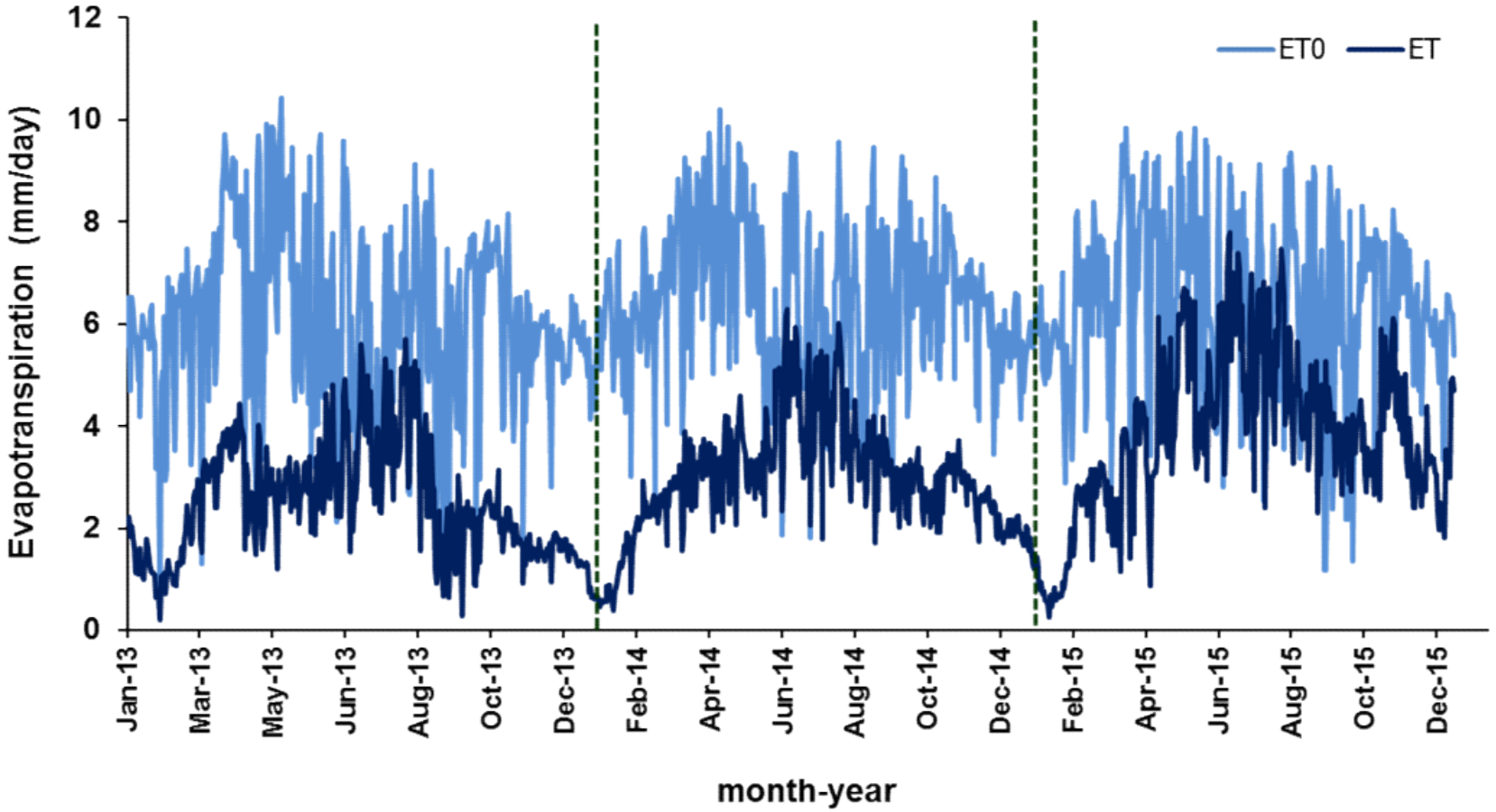


Fig. 4 The daily average of evatranspiration and reference evatranspiration in 2013 – 2015

Daily average of evapotranspiration (mm/day)

	2013	2014	2015
ET average	**2.6**	**2.3**	**3.7**

Results

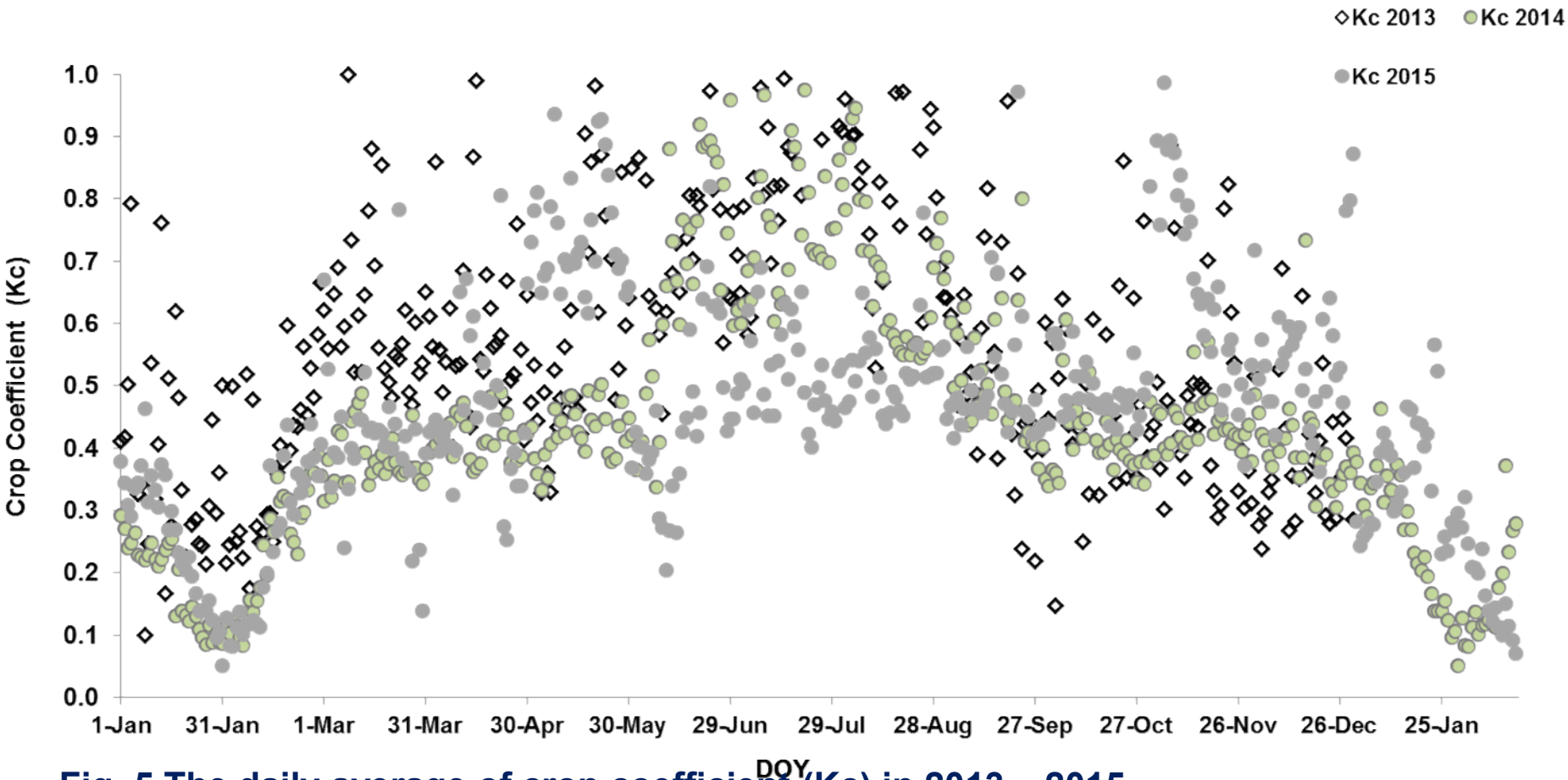


Fig. 5 The daily average of crop coefficient (Kc) in 2013 – 2015

Daily average of crop coefficient

	2013	2014	2015
Kc average	**0.39**	**0.35**	**0.35**

Results

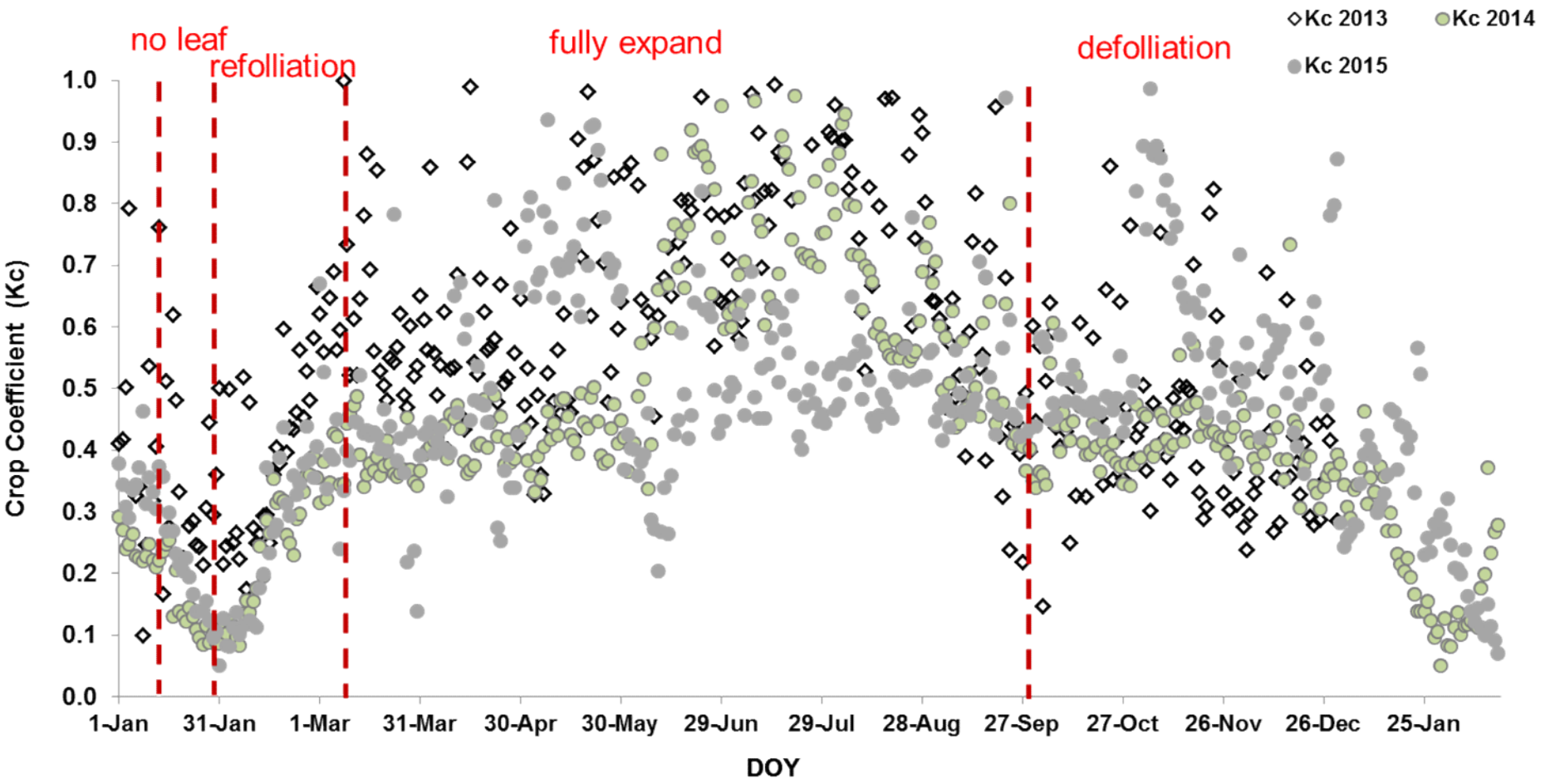


Fig. 5 The daily average of crop coefficient (Kc) in 2013 – 2015

Results

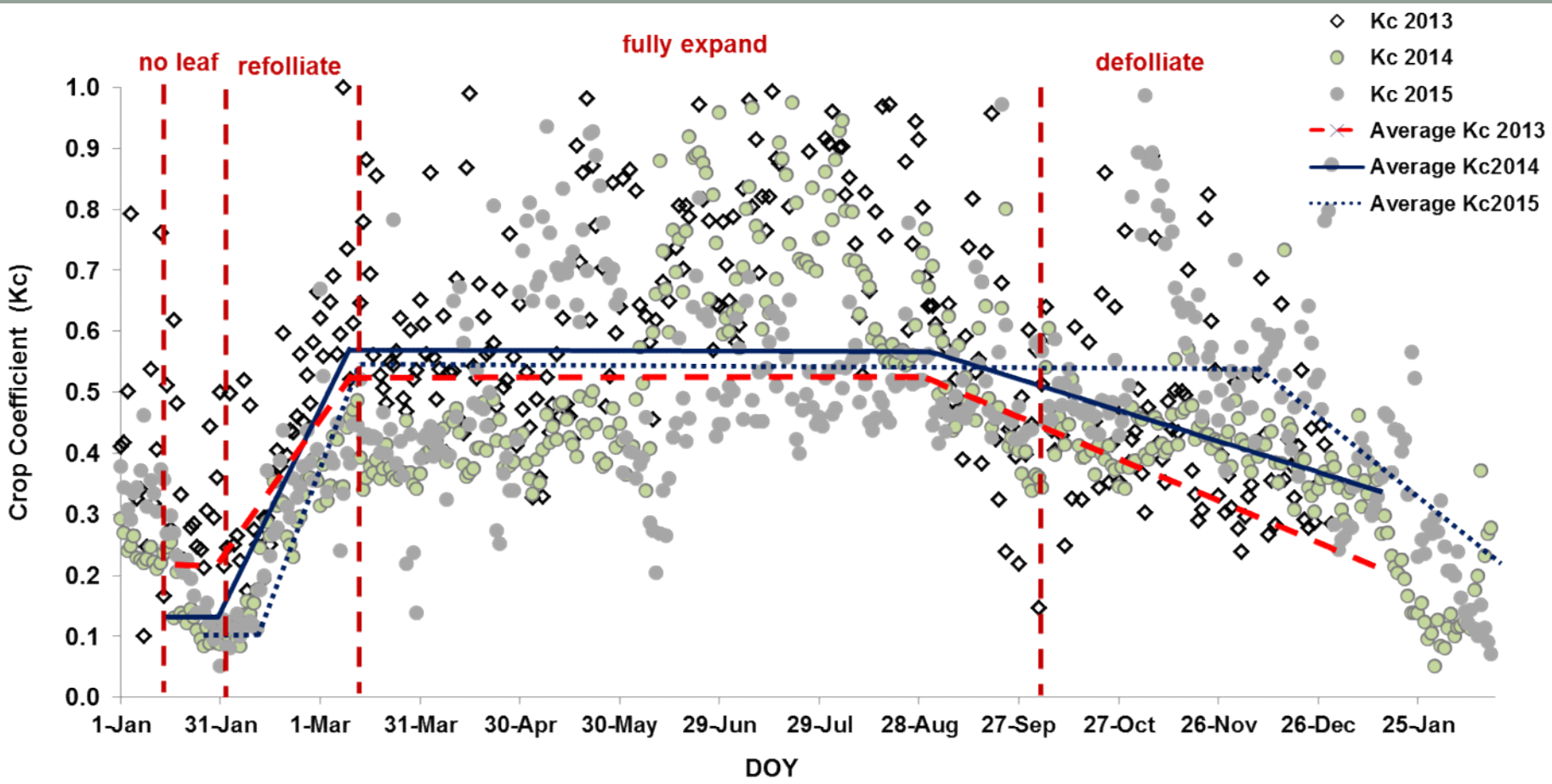


Fig. 5 The daily average of crop coefficient (Kc) in 2013 – 2015

Daily average of crop coefficient in each growing stage

	2013	2014	2015
No leaf	0.23	0.13	0.11
Refoliation	0.34	0.27	0.36
Fully expanded	0.54	0.57	0.54
Defoliation	0.45	0.42	0.38

Results

The average of crop coefficient in each growing stage from CRRC and FAO-56

Growth phase	Duration (days)	Kc average CRRC	Kc average FAO	%difference
No leaf	15	0.16	0.85	56.4
Refoliation	36	0.32		
Fully expanded	205	0.55	0.9	38.9
Defoliation	125	0.42	0.9	53.3

In FAO, Kc value relates to evapotranspiration of a disease free crop, under optimum soil water and fertility conditions. (Somjate et al., 2012) . Kc strongly controlled by variations in available energy and leaf area (Thomas, W et al., 2016)

Results

The average of crop coefficient

Kc Average	min	max	Annual rain	
CRRC 2013	0.08	0.98	1,316	Jan/Jul
CRRC 2014	0.09	1.65	1,282	Jan/July
CRRC 2015	0.05	1.18	1,161	Jan/Nov
Maha Sarakham (10 months)	0.24	1.8	596	Min in dry season, maximum in rainy

Somjate et al., 2012

Results

The regression analysis of evapotranspiration

Growth stage	Rn	Rg	PAR	Tair	RH	VPD
No leaf	0.19**	0.12**	0.04**	-0.07ns	0.02ns	-0.29**
Refoliation	0.60**	0.61**	0.60**	-0.20**	0.03ns	-0.27**
Fully expanded leaf	0.72ns	0.73**	0.61**	-0.27**	-0.03**	-0.26**
Defoliation	0.69**	0.65**	0.69**	-0.25**	0.02ns	-0.33**

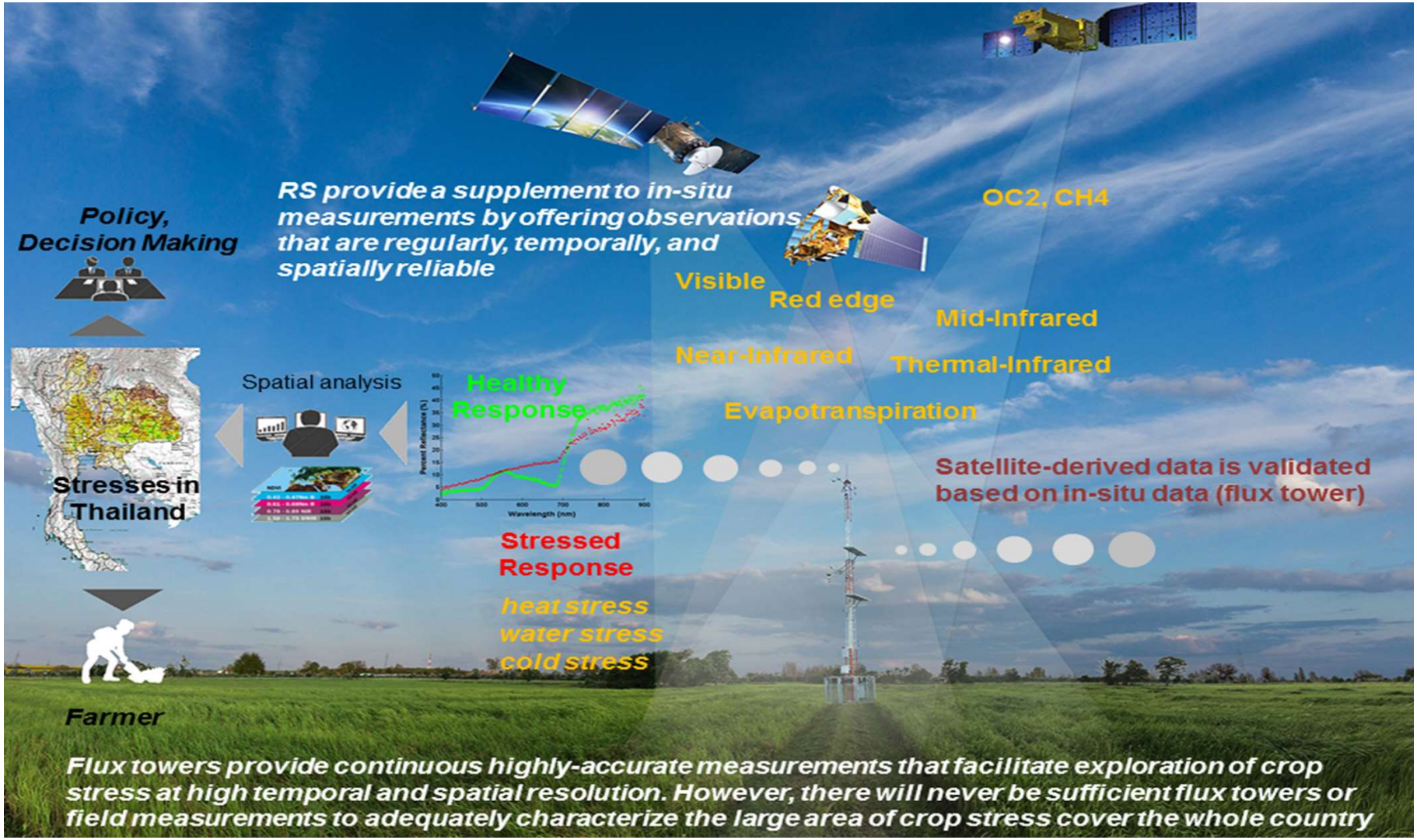
(Chompunut et al., 2016)

The magnitude and distribution of NEE and ET were controlled by seasonal changes in solar radiation, and growth stages of rubber

Conclusions

- The mean ET of 2013 – 2015 over rubber plantation were 2.6, 2.9 and 3.6 $mmday^{-1.}$. The seasonal trend of ET was largely controlled by phenology.
- The lowest value of Kc January which are in the dry season and the no the event of rain. The highest value of Kc in 2013 and 2014 in July which are in the rainy season and the Kc values in 2015 in Nov with the rainy period.
- Divide the growing period into four general growth stages including no leaf, refolliate, fully expand and defolliate.
- Can compare with the FAO method as the same pattern but can not compare in Kc values.
- The variation of Kc values was controlled by seasonal changes in rainy event and growth stages of rubber.

Future plan



Apply the remote sensing data to estimate the regional distribution of the instantaneous carbon flux and ET using the combination of MODIS observations and ground-based data by eddy covariance measurements to validate the results.