Land flux Analysis Team

Long-term heat, vapor and carbon dioxide fluxes observation for impact assessment on the interaction between land and atmosphere under the climate change and the land use change

Amnat Chidthaisong (KMUTT)
Chaiwat Ekkawatpanit (KMUTT)
Nittaya Cha-un (KMUTT)
Korakod Nusit (NU)
Warangluck Sonklin (NU)
Suban Phonkasi (NU)
Montri Sanwangsri (PU)
Panya POLSON (RID)
Vanisa SURAPIPITH (PCD)
Daisuke KOMORI (IIS/UT)
Tomohito YAMADA (Hokkaido)
Wonsik KIM (NIAES)

IMPAC-T

Integrated study on Hydro-Meteorological Prediction and Adaptation to Climate Change in Thailand

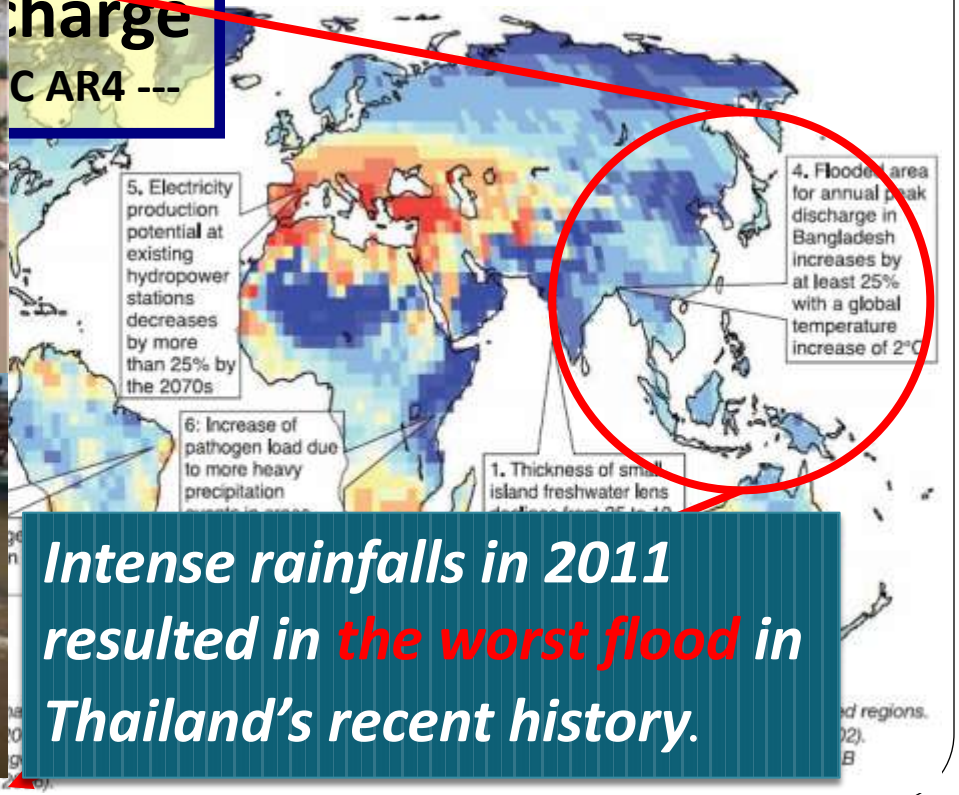
2009-2014

Why is the flux observation needed ?

IPCC AR4 noted that changes in precipitation and temperature lead to changes in water resources in some dry regions at mid-latitudes and in the dry tropics, due to changes in rainfall and evapotranspiration (IPCC, 2007).

Changes
---Ensemble M

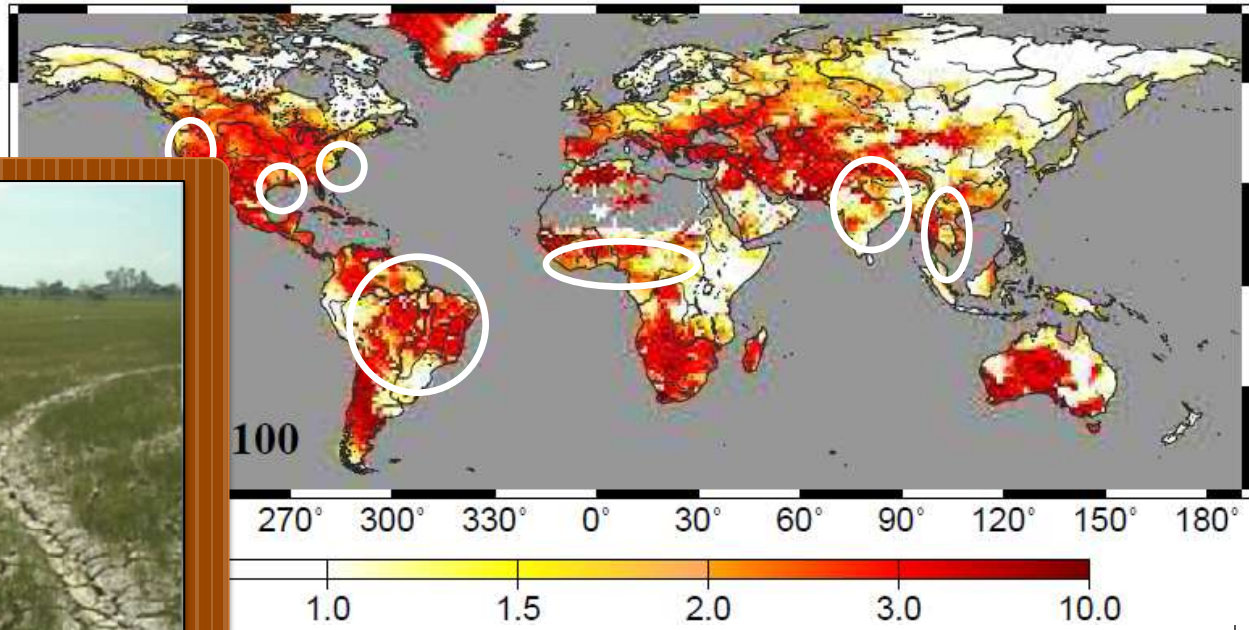
charge
C AR4 ---

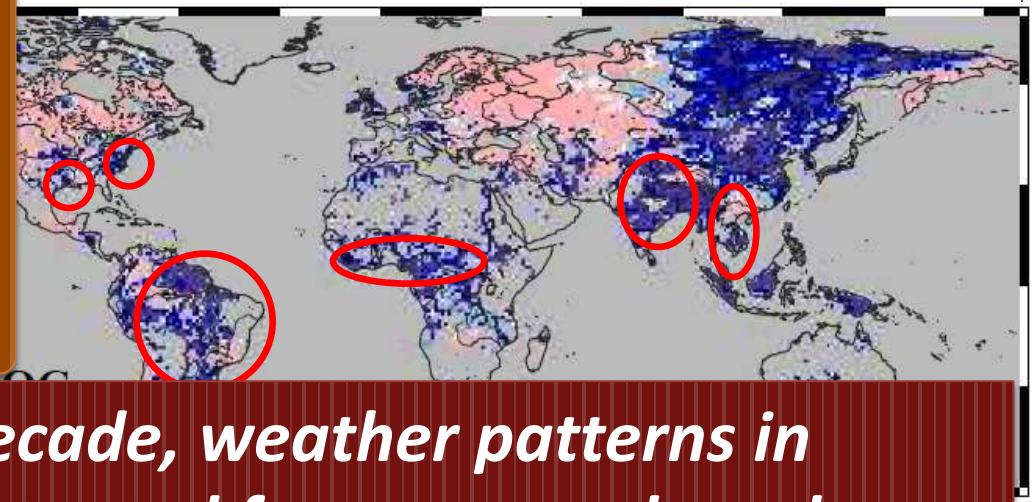


Intense rainfalls in 2011 resulted in the worst flood in Thailand's recent history.

Extreme event

In 2008, the population suffers from severe drought, million people in 71 provinces were affected by water shortages.

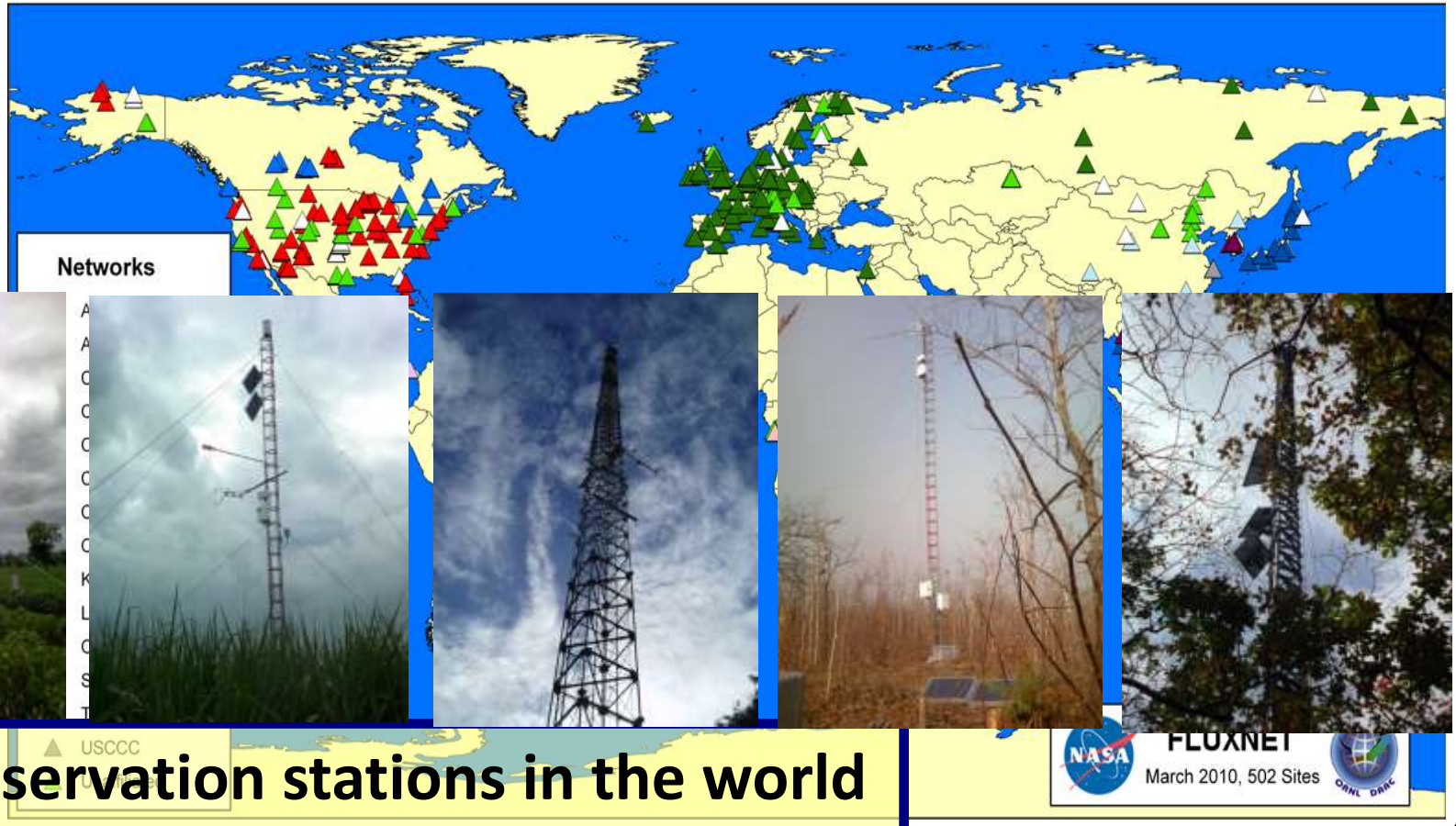




During the past decade, weather patterns in Thailand have fluctuated from severe droughts and floods

Why is the flux observation needed ?

Under the scientific issues of global climate change, monitoring sensible and latent heat flux (H and lE) and CO_2 flux (Fc) are required over the worldwide to investigate the effect of global climate change to the interaction between biosphere and atmosphere and to assess the characteristics of trace gases and energy/water exchange by ecosystems and their climatic responses (Raupach, 2005).



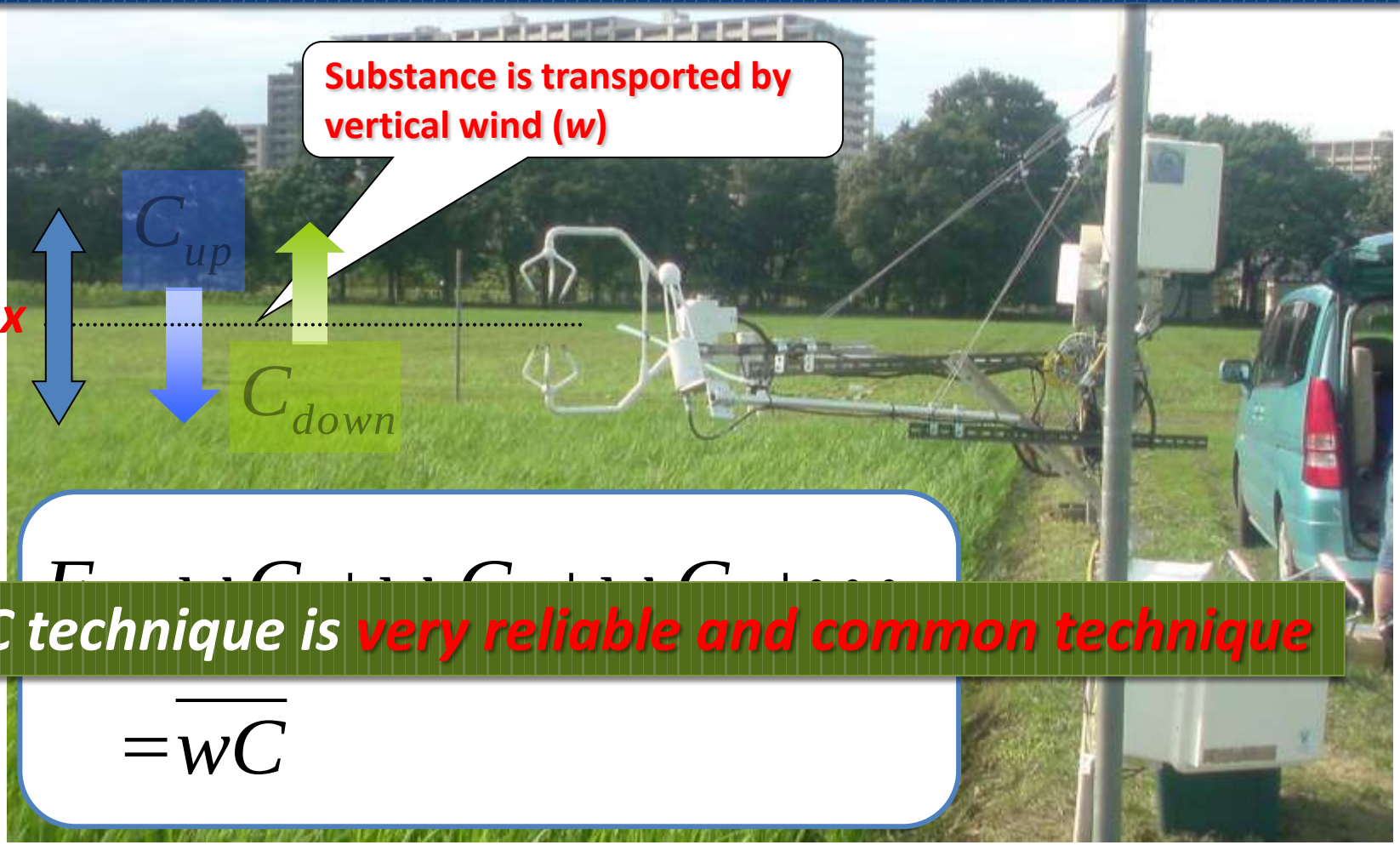
Flux observation stations in the world

Background

- How can the flux be observed ? -

How can the flux be observed ?

The eddy covariance (EC) technique, a micrometeorological flux measurement method, widely used for H, lE, and F_C between the biosphere and atmosphere.



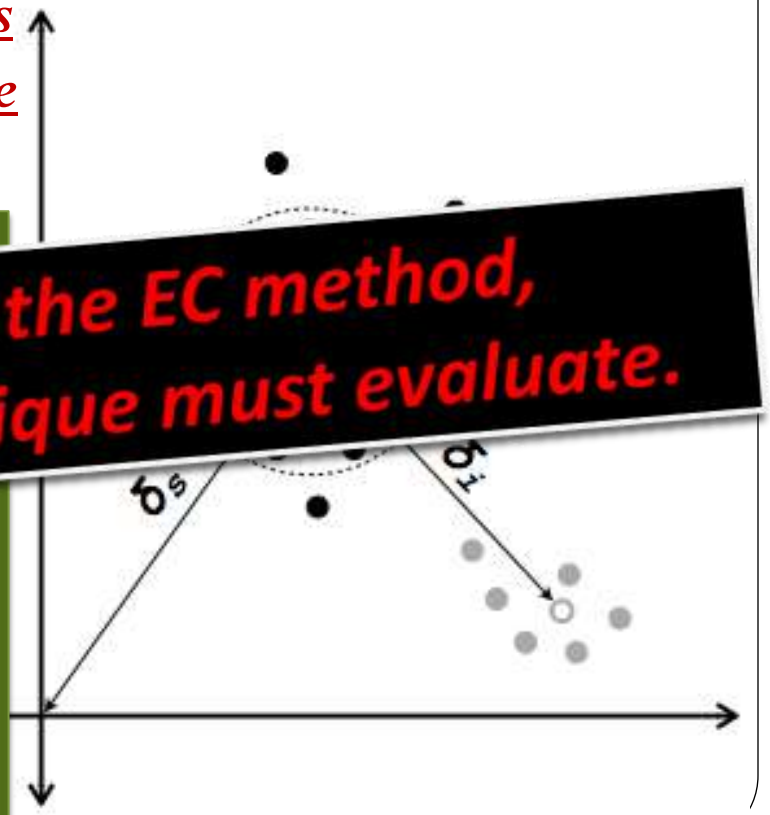
However, not all the measured flux data may be of sufficient quality to provide a quantitative view of those fluxes because few sites meet all the assumptions of flux measurement, such as homogeneous land cover, flat terrain, and proper atmospheric conditions (Foken and Wichura, 1996; Baldocchi, 2003).

In statistical analysis of sampling data, the uncertainty (δ) coming from fluctuations during the measurement of a quantity can be summarized as followings;

- **Randomness (δ_r)** is primarily relev[illegible]

To understand the reliability of the EC method, the uncertainty in the EC technique must evaluate.

- **Illegitimate (δ_i)** to surface heterogeneity and atmospheric stationarity caused by instrumental uncertainties or statistical fluctuations



Objective

1) Development of a method of quality check for turbulent fluxes by the uncertainty analysis.

2) Evaluation of measured fluxes, and research on the characteristic of fluxes on studied site.

3.1) Impact assessment on the interaction between land and atmosphere under the climate change and the land use change.

3.2) Investigation of the dry dipterocarp ecosystem using a hydrological model, and its sensitivity of extreme climate variables such as drought (under hot and cold temperature).

Research plan

1) **Installation of several eddy covariance Flux observation systems** to representative vegetations in Thailand where are agricultural fields (paddy, sugarcane, etc.) and forest for measuring flux.

2) **Development on quality check technique for measured fluxes** by the uncertainty analysis by comparing with current technique.

3) **Development of quasi-real time monitoring system** for flux observation.

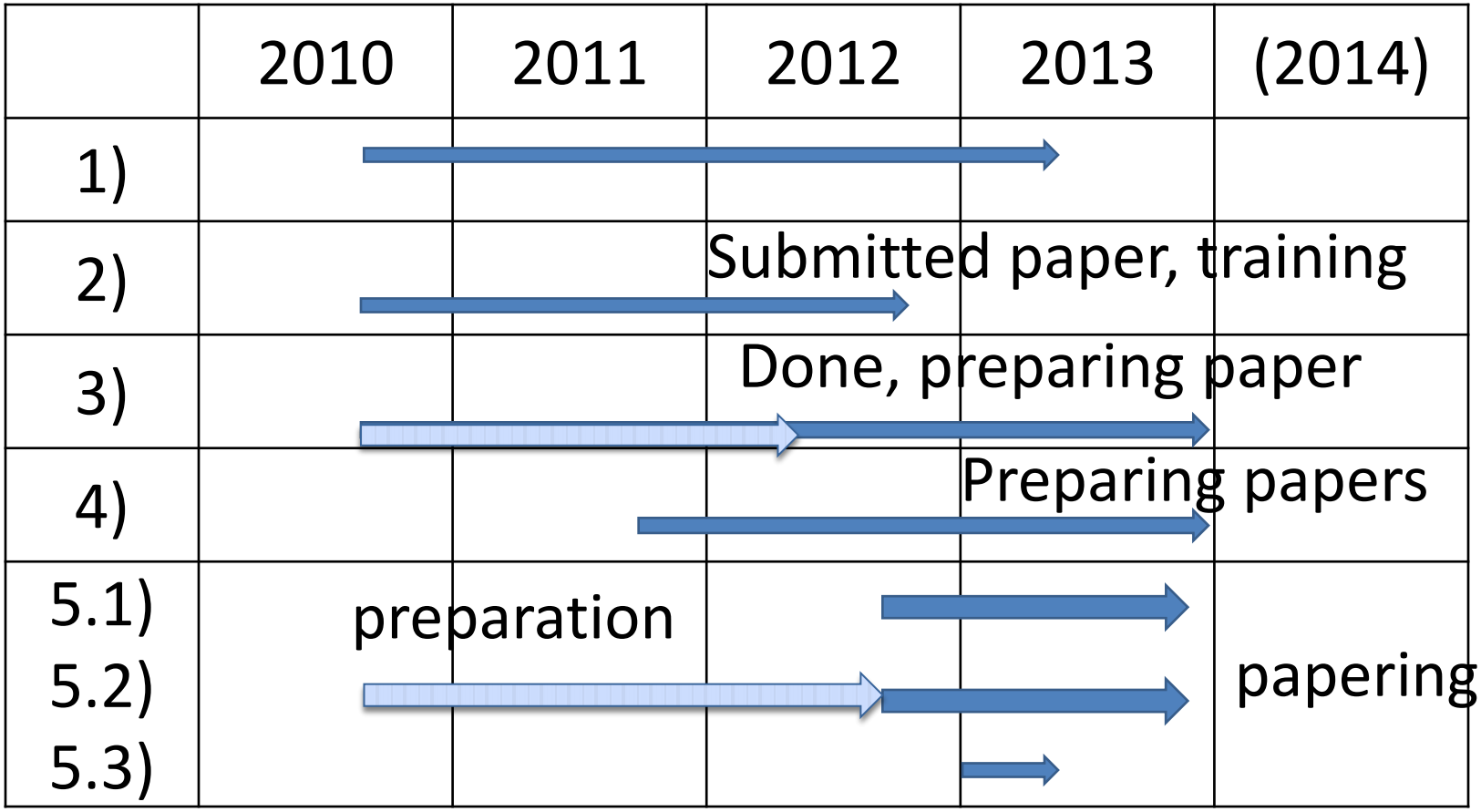
4) **Evaluation of measured fluxes, and research on the characteristic of fluxes on studied site**.

5.1) Comparing the data measured at TAK tower where fluxes have been measured during 10 yrs under the condition on the land use change, and research on **understanding the interaction between land and atmosphere under the land use change**.

5.2) Simulating dry dipterocarp ecosystem *lE* using a hydrological model, and investigating **its sensitivity of extreme climate variables such as drought** .

5.3) Preparing flux data and forcing data for hydrological models.

Research plan



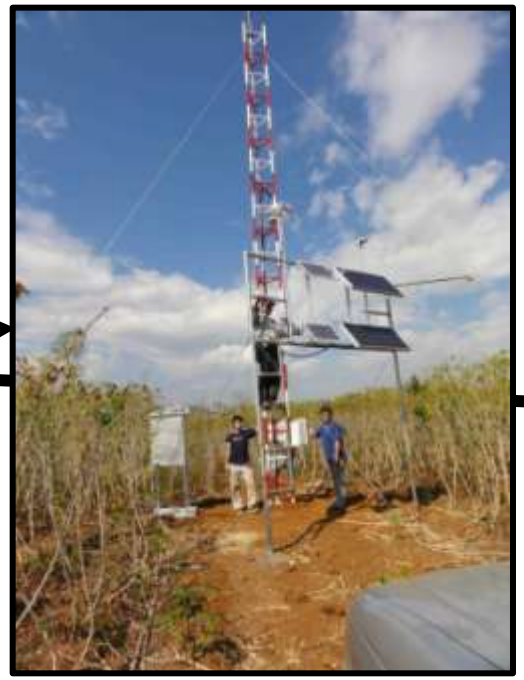
Main activities:

1) Turbulent data measured at DTT, PRT, STT, CTT, DRT.

2) FLUXPRO, a program of automatic quality check for turbulent fluxes

Flux observation

Phayao forest flux tower



Tak flux tower

Cassava field flux tower

– Rainfed Paddy field flux tower

& Dry Dipterocarp forest FT

Sugarcane field flux tower

Picture from ThaiFlux network: P. Kasemsap, 2006

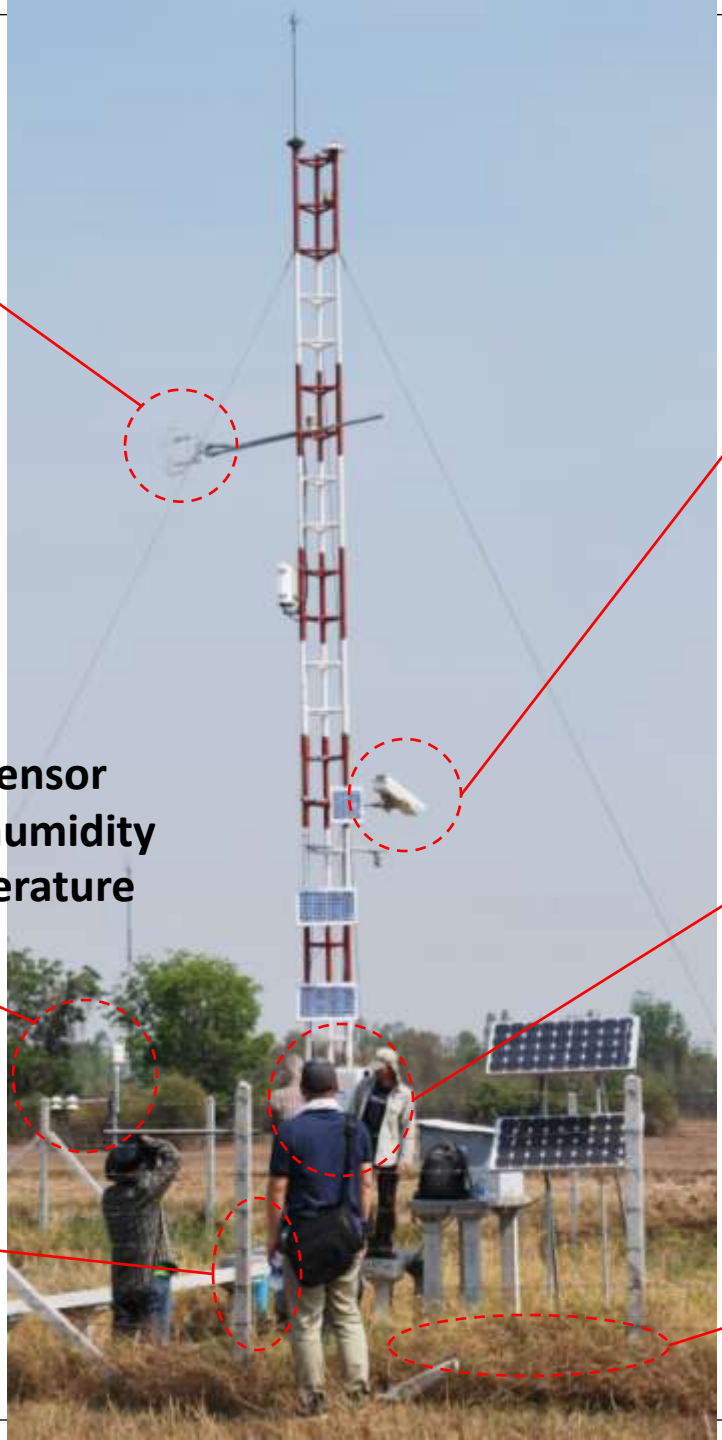
Rain-fed paddy Flux observation

EC105 → CO_2/H_2O vapor
CSAT3 → anemometer

Net radiation
Short-long wave
In & Out

-Rainfall sensor
-relative humidity
-Air temperature

-water temperature
-water level

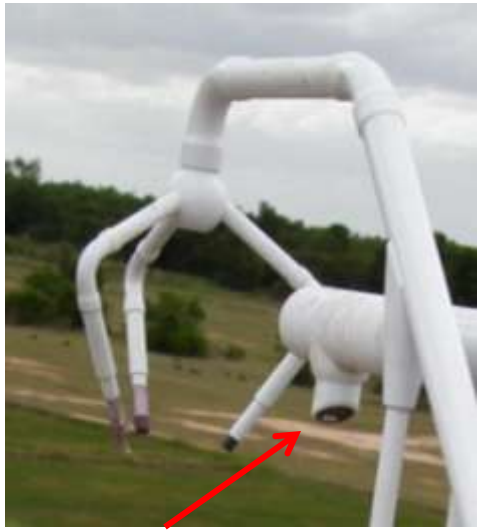


- Camera → rice plant growth
-Infrared sensor

CR1000 Data logger

Soil moisture 2.5, 15, 60 cm

Bird problem & protection

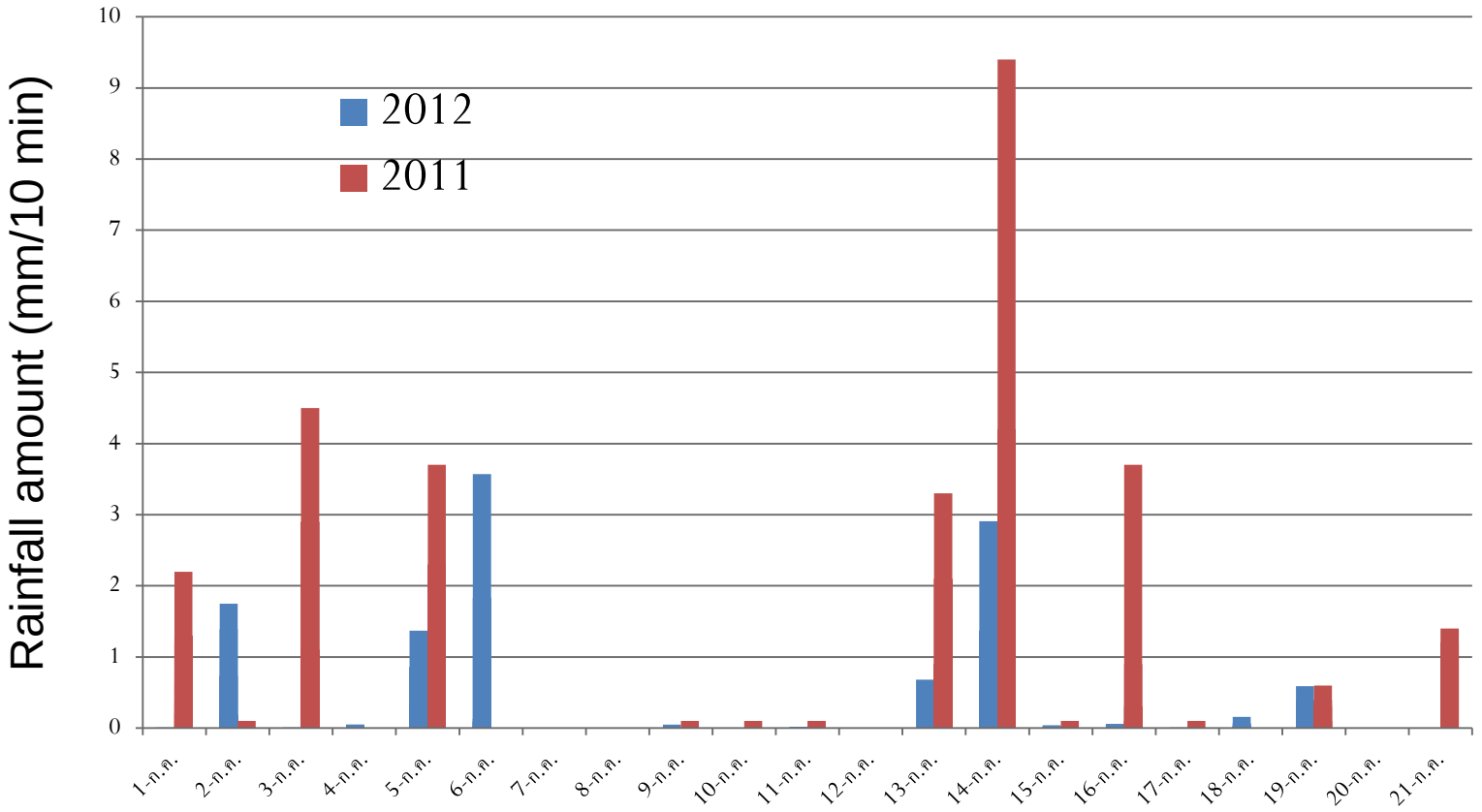


Sugarcane field Flux observation


Jan 12, 2013

Condition of the sugarcane field

- In this season (2012), the sugarcane field is relatively dryer than last year. Therefore, the growth is slower. (Below plot for July)



Cassava field Flux observation

Installation finished in January, 2012

System	Observation items
Eddy covariance flux system Sampling rate: 10 Hz Observation height: 7 m	1) 3 dimensional wind speed 2) H2O/CO2 concentration 3) Air pressure 4) Sonic temperature
Weather observation system Sampling rate: 1 sec Recording rate: 10 min Observation height: 2 m	1) Upward/downward short-/long- wave radiation 2) Photosynthesis active radiation 3) Air temperature 4) Humidity 5) Wind speed & direction 6) Rainfall 7) Digital picture
Soil observation system Sampling rate: 1 sec Recording rate: 10 min	1) Soil moisture @2.5, 15, 60cm 2) Soil temperature 3) Submerge water level 4) Surface temperature

Field survey on Forest Flux observation

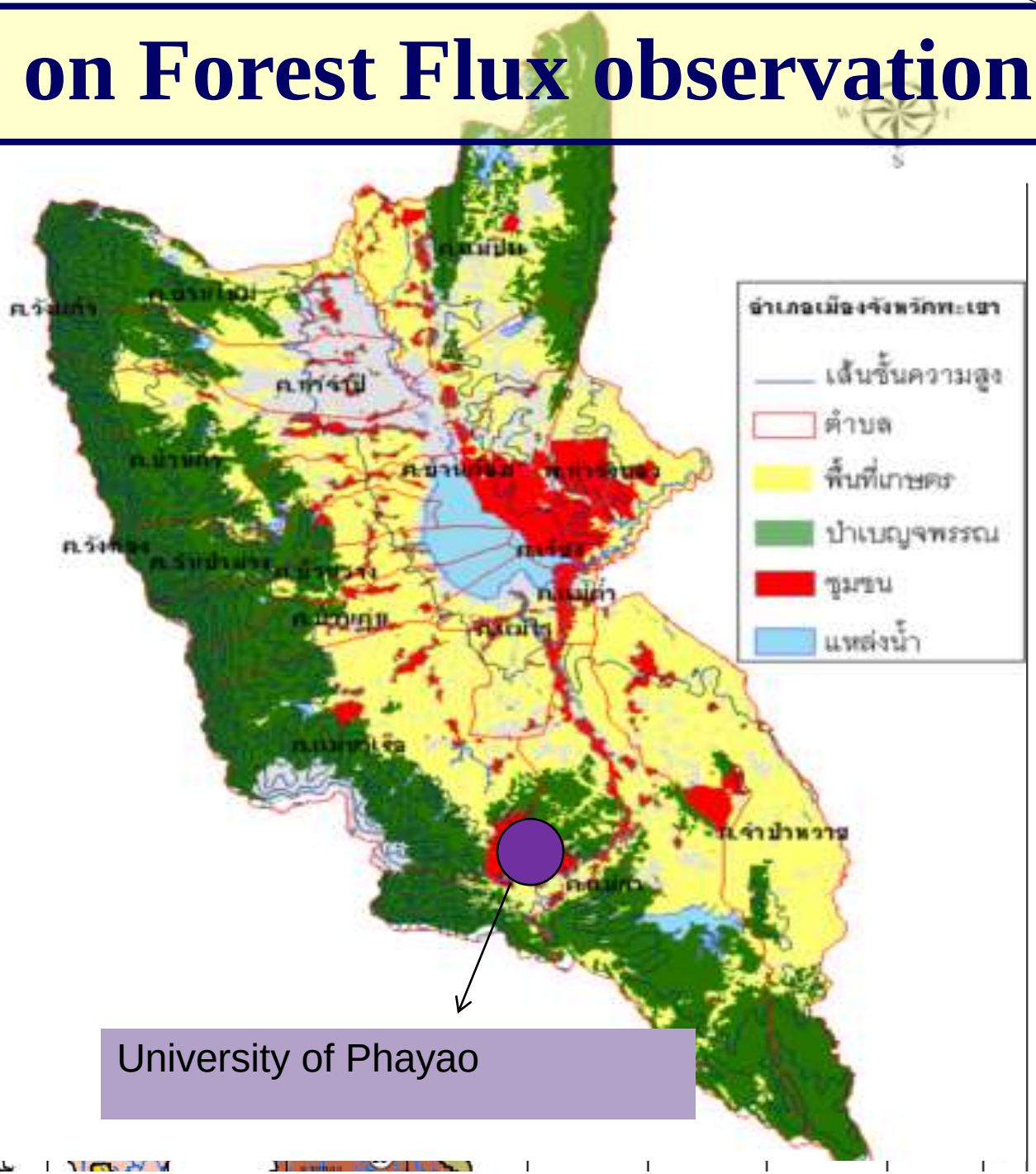
River basin

Crops area

Urban area

Forest area

Swamp and lake area



University of Phayao

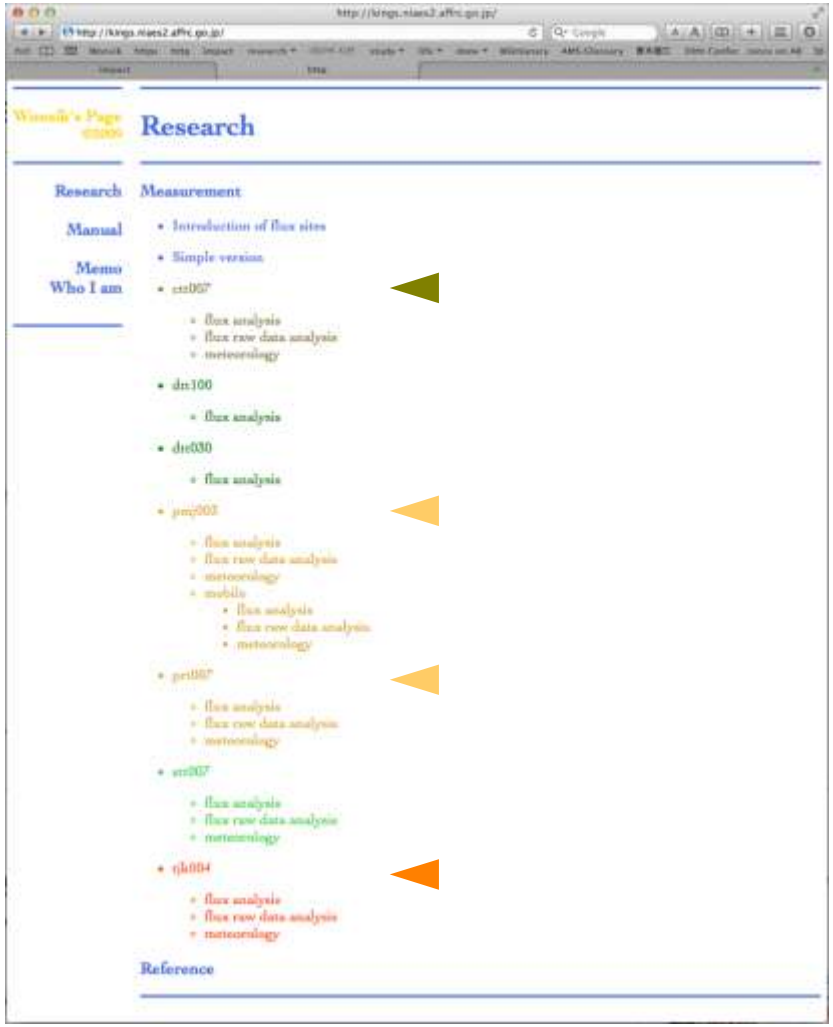
The forest site for setup new tower

Quasi real-time monitoring system

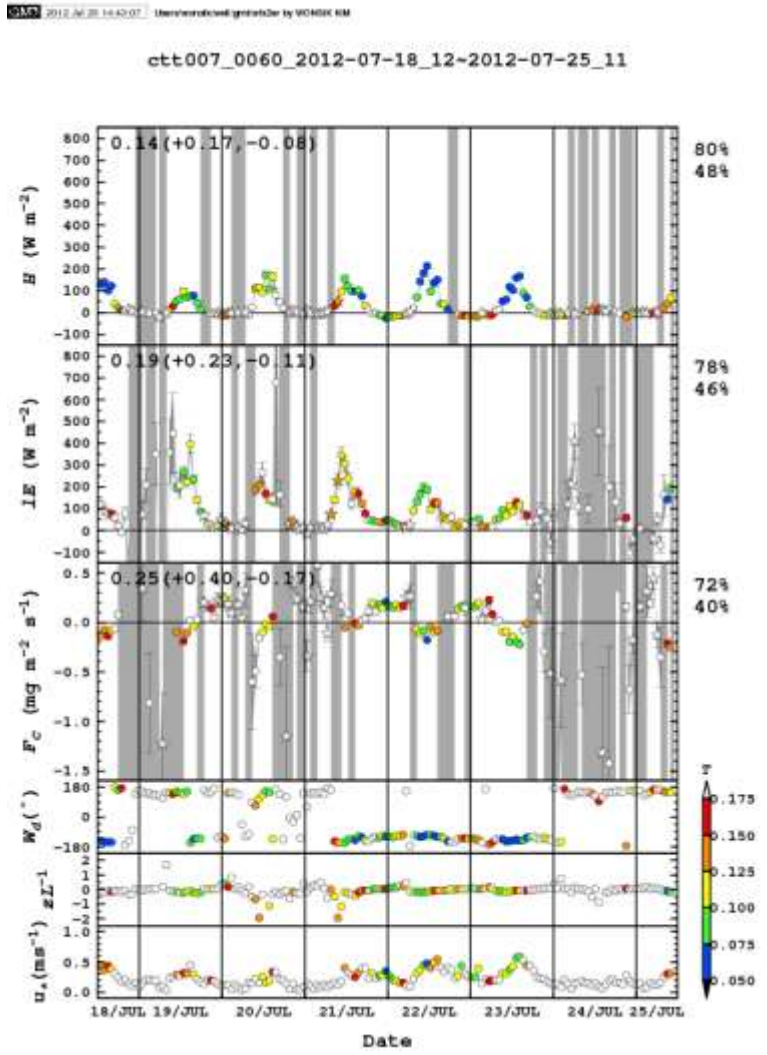
http://matthew.niaes.affrc.go.jp/~wonsik/

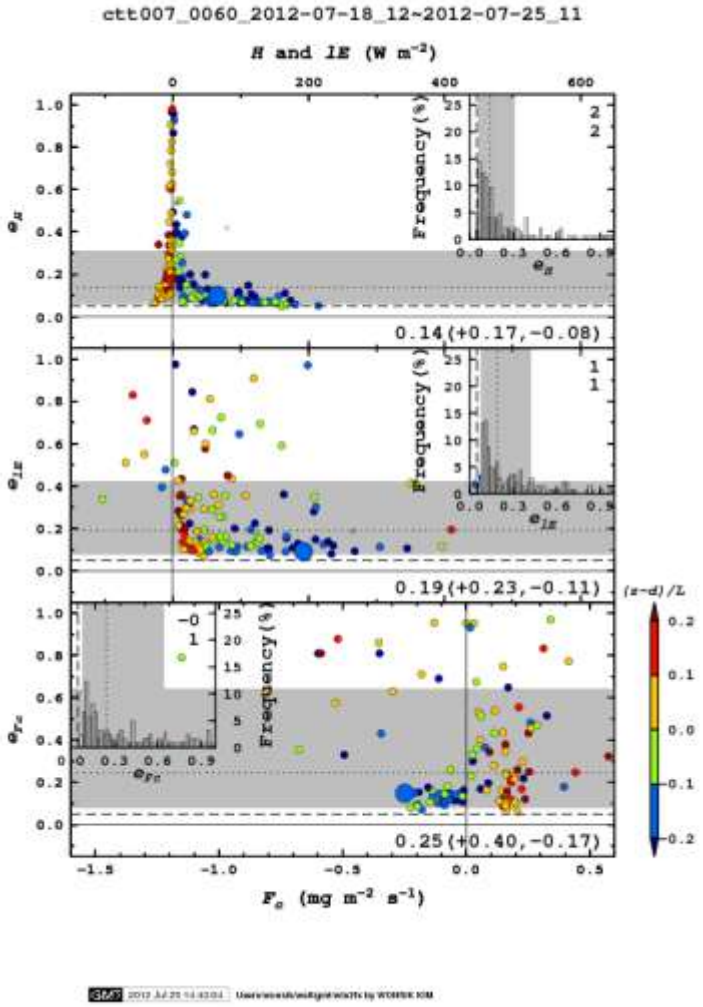
FluxPro Function

- Site ID: abc000
  - a: vegetation type
  - b: city name
  - c: country name
  - 000: measurement height for flux
- Flux Analysis
- Flux raw data analysis
- Micrometeorological analysis



Weekly fluxes and those tolerances

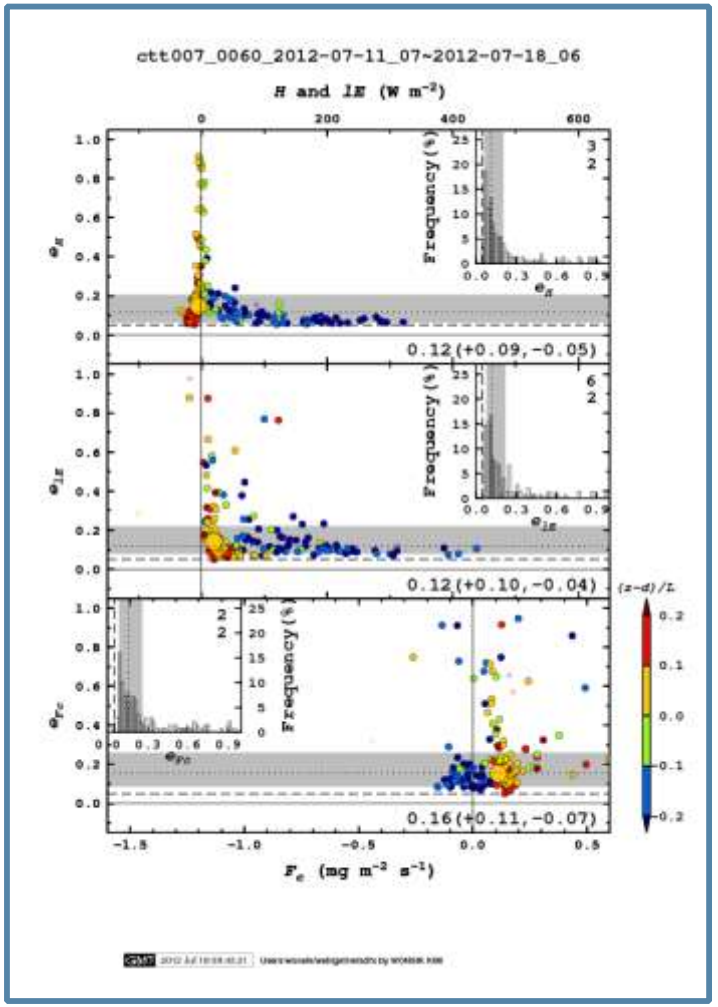




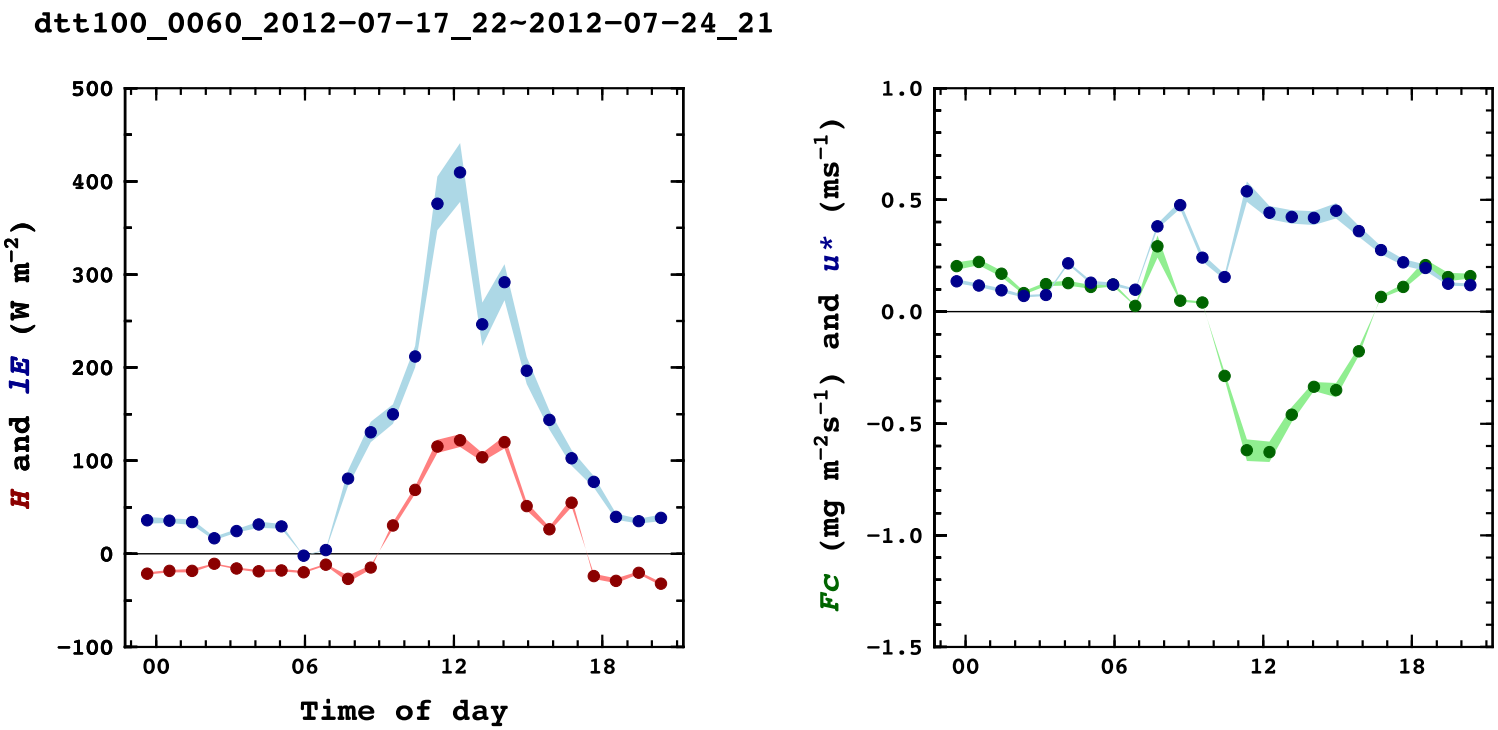
Relative Random Error

$$e = \frac{\sigma}{|\mu|} = \frac{\sqrt{E[(X-\mu)^2]}}{|E[X]|}$$

$$T = E[e] = \mathrm{Median}[e]$$



Weekly mean daily trends of fluxes



H: 1.42±0.58 MJ $m^{-2}day^{-1}$

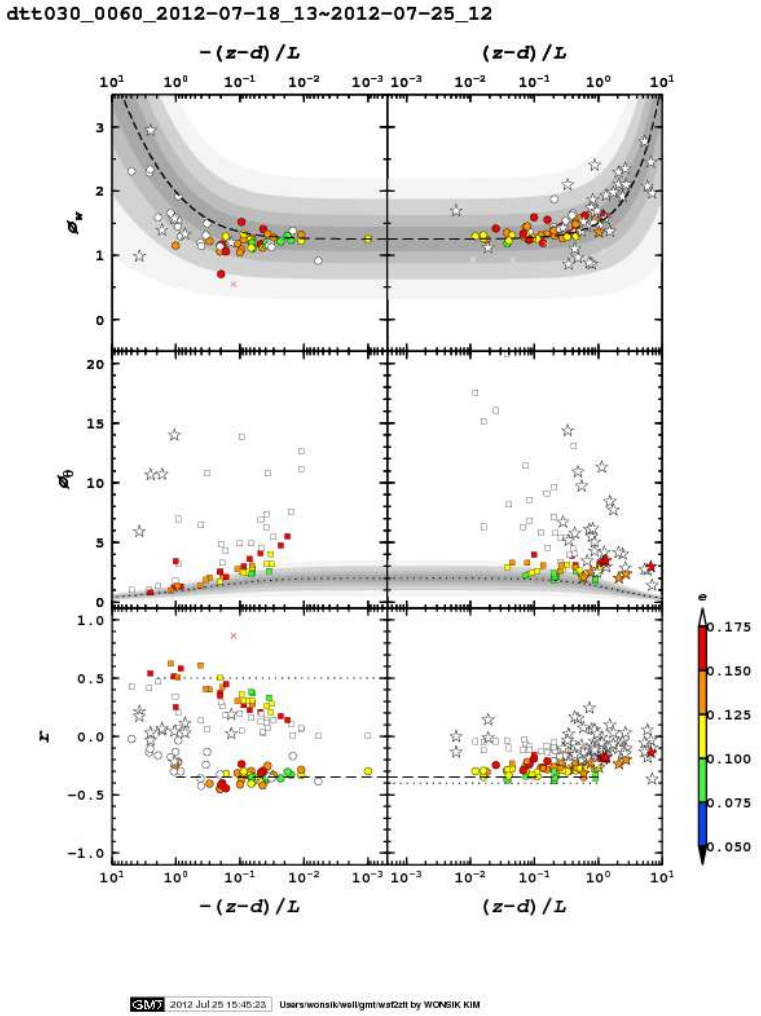
lE: 9.87±4.22 MJ $m^{-2}day^{-1}$

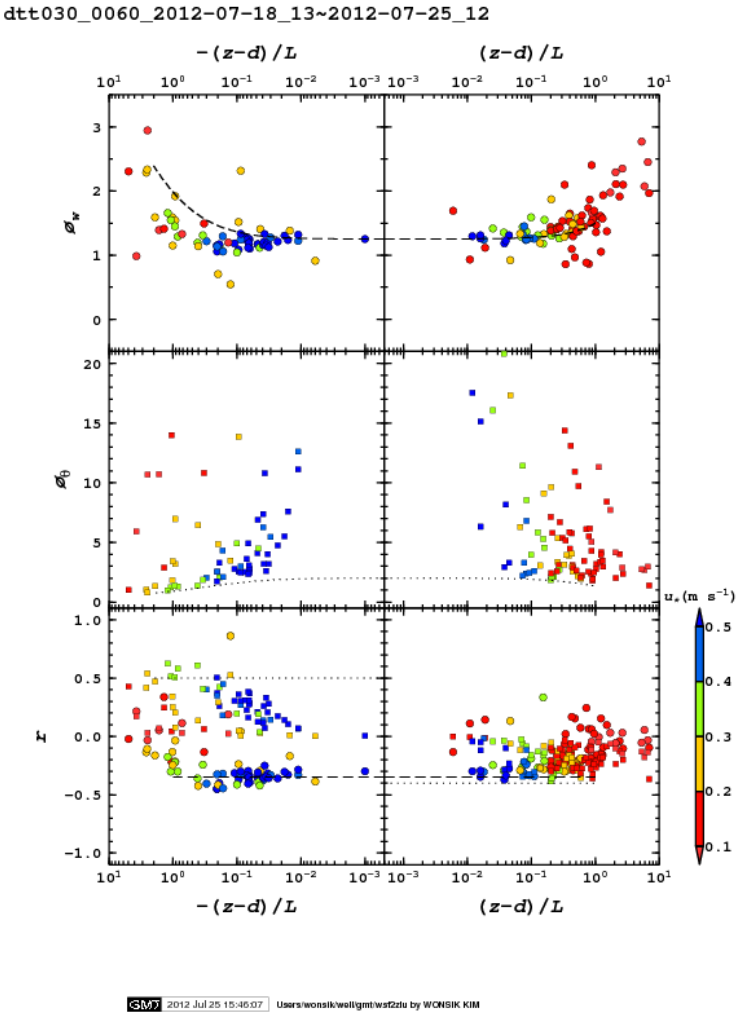
lE: 3.95±1.69 mm day^{-1}

Fc: −2.12±−0.96 g $m^{-2}day^{-1}$

Fc: −0.05±−0.02 mol $m^{-2}day^{-1}$

Relationship between similarity and stability





Flux raw data analysis

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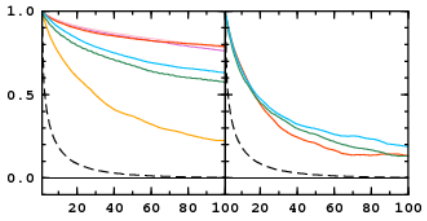

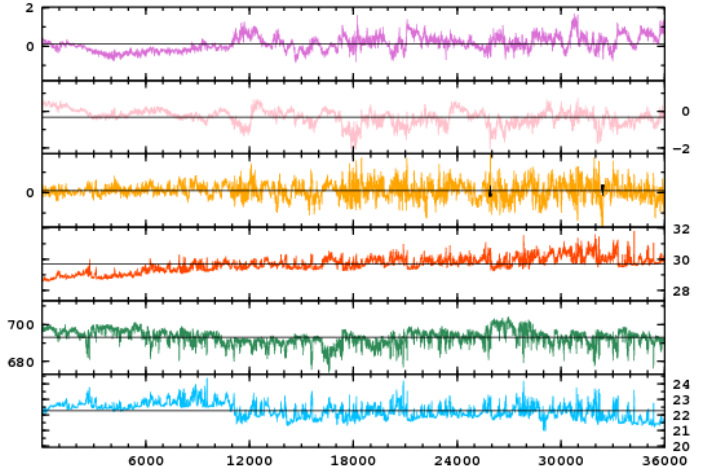

results	:	ux	vy	wz	ts	ca	ea	pr	
mean	:	0.13	-0.31	0.05	29.67	692.85	22.26	100.33	
std	:	0.38	0.40	0.18	0.47	3.98	0.47	0.04	
number of error spikes:		0	0	0	0	0	0	total:	0
number of sigma spikes:		0	0	9	0	0	0	total:	9
totoal spikes:		0.00	0.00	0.03	0.00	0.00	0.00	%	5.0

20707::H:17.663 0.337 lE:115.983 0.125 Fc:-0.172 0.176 Tau:0.036 0.177
20707::phi:5.358 2.979 1.842 1.104 r:0.169 -0.304 0.492 -0.376
20707::wd:67.057,as:-0.108,us:0.177 mo:-0.030 -0.007

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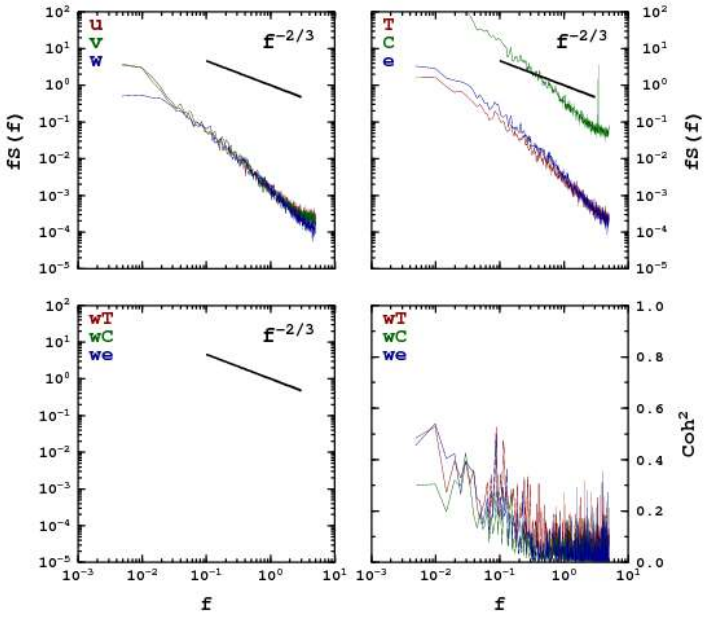

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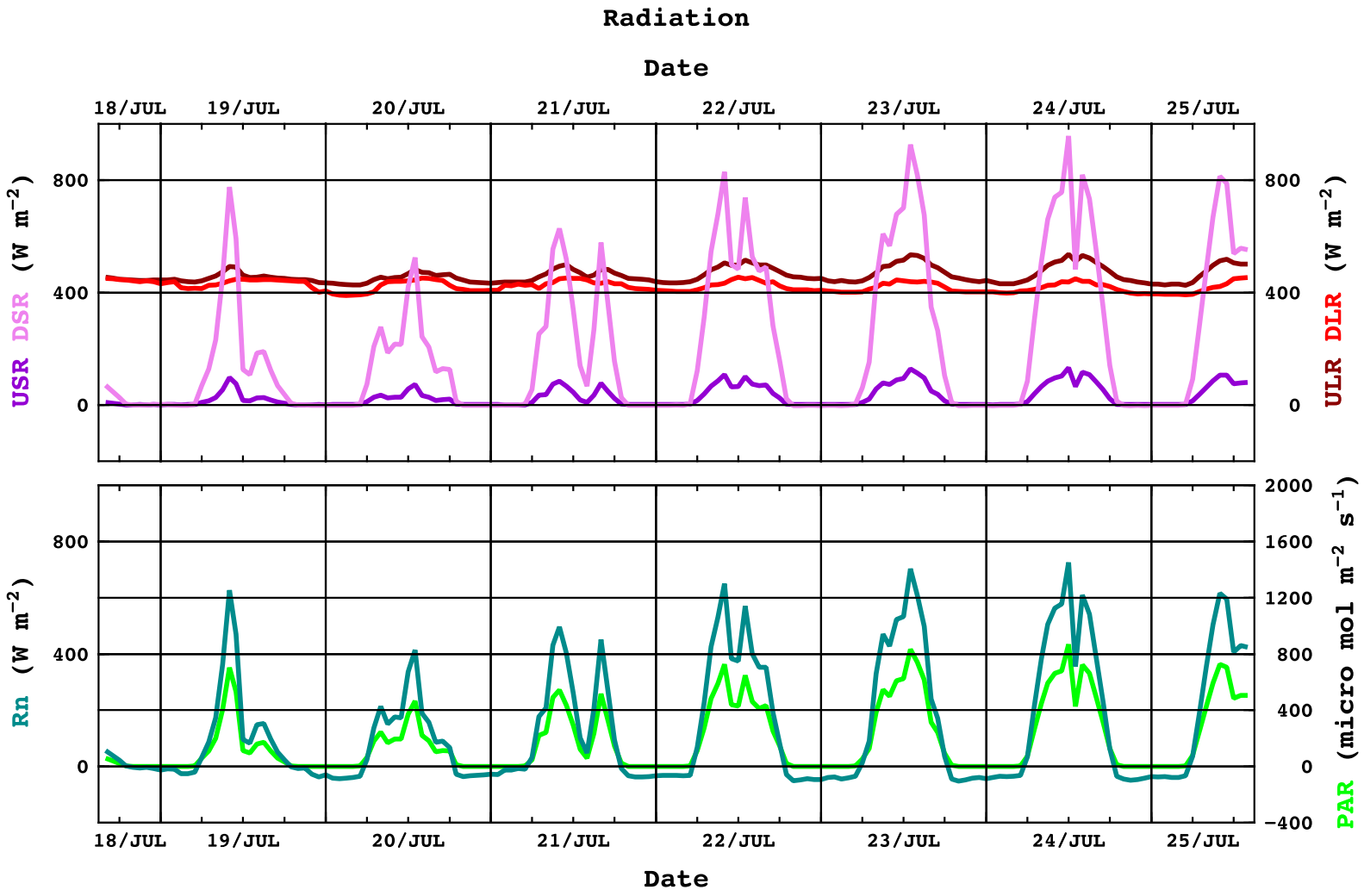
Weekly trends of radiation components



Weekly trends of meteorological components