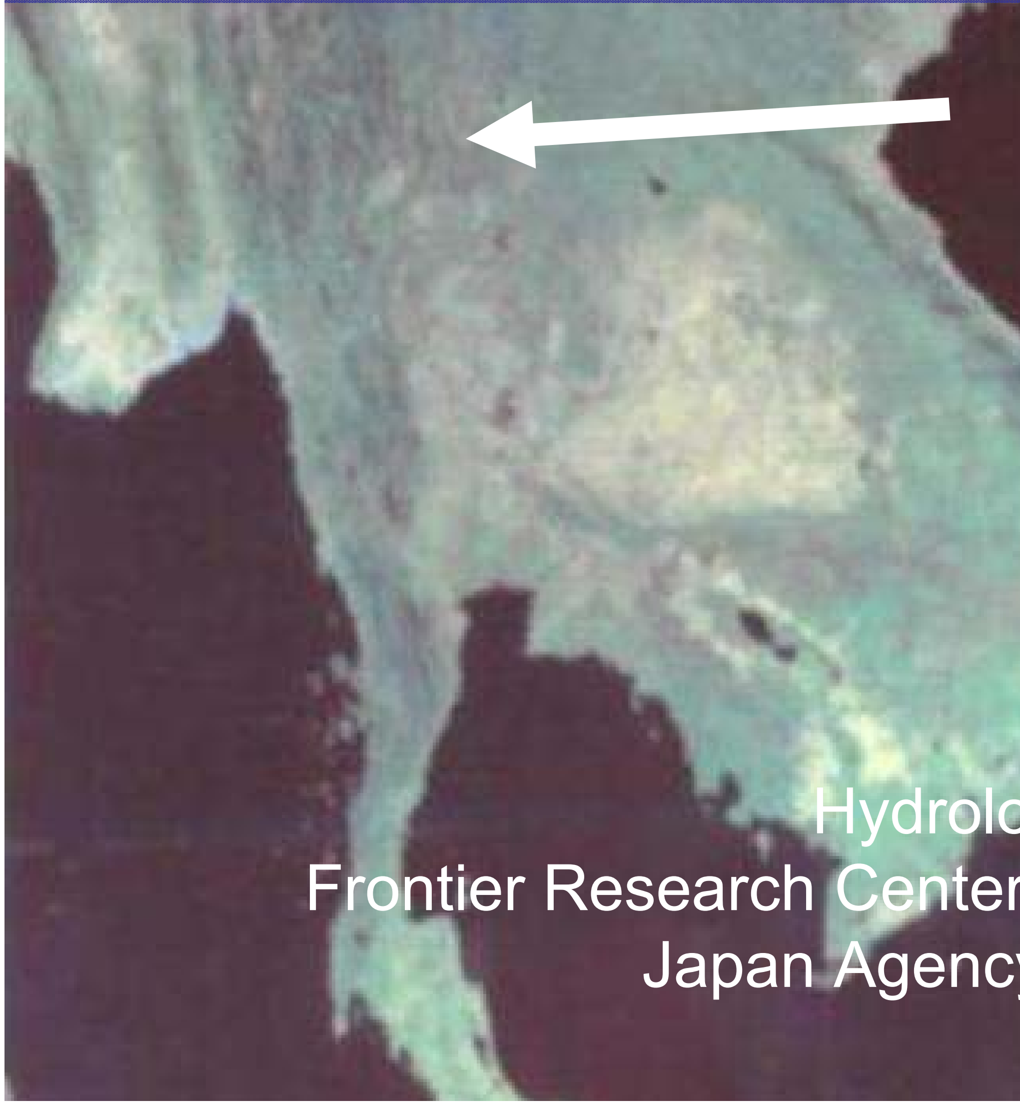
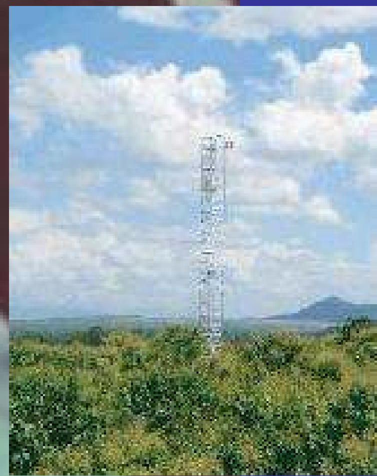
Impact of variations in leaf area index on evapotranspiration in a dry tropical region





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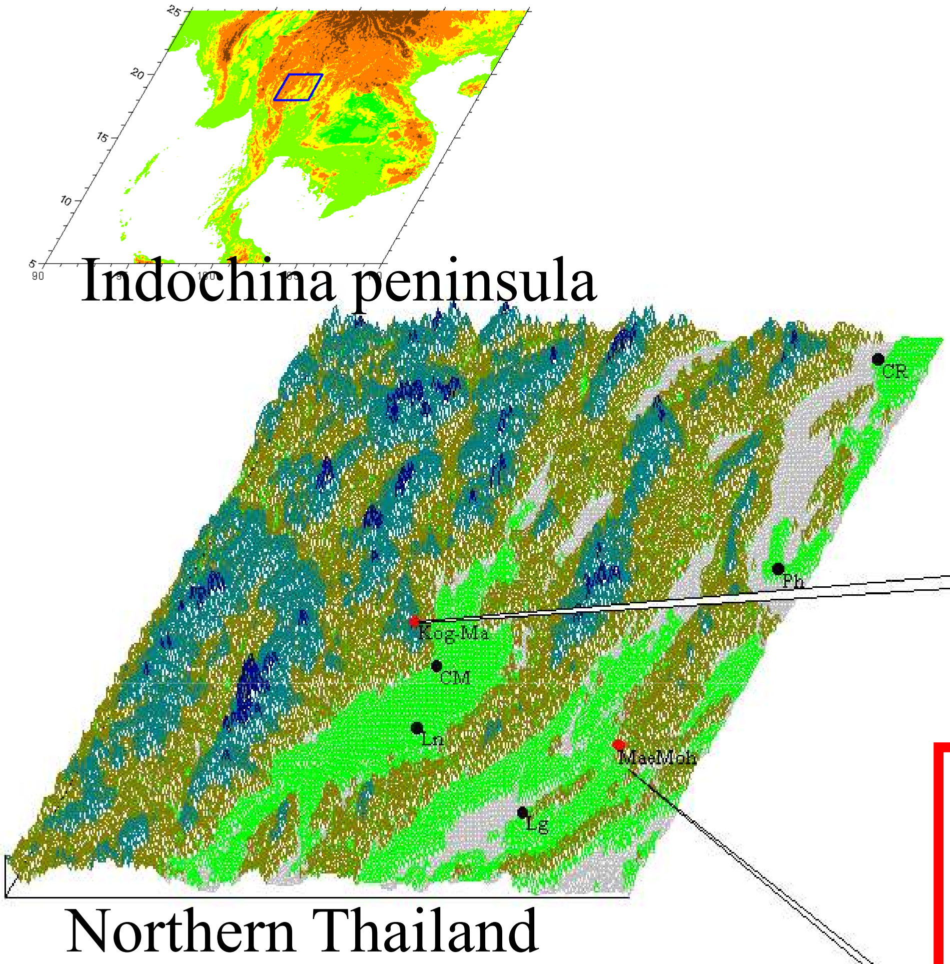
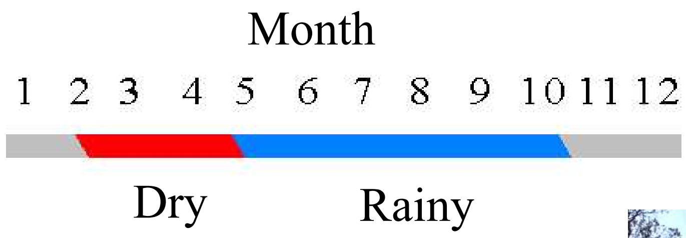


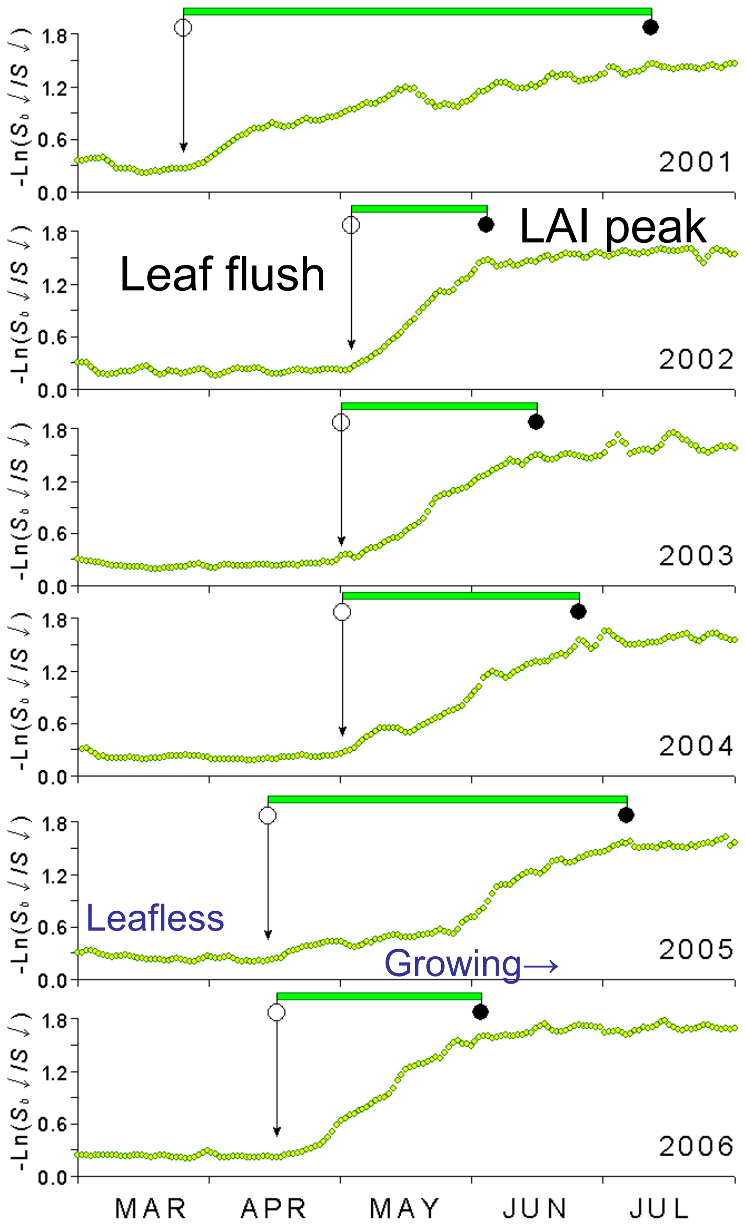


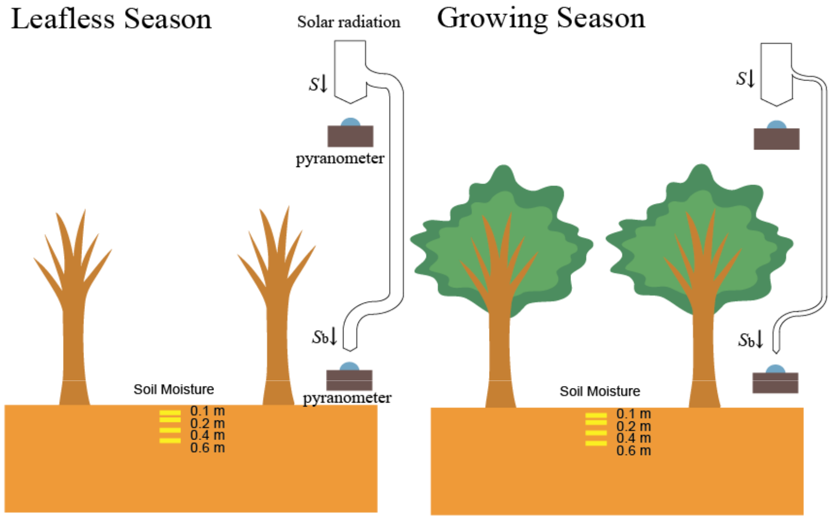
Evergreen forest

Deciduous forests: Teak Plantation

Background

Background Variation in Leaf flush & the subsequent growth





- $-Ln(S_b\downarrow / S\downarrow)$, was used as an indicator of temporal changes in leaf area index

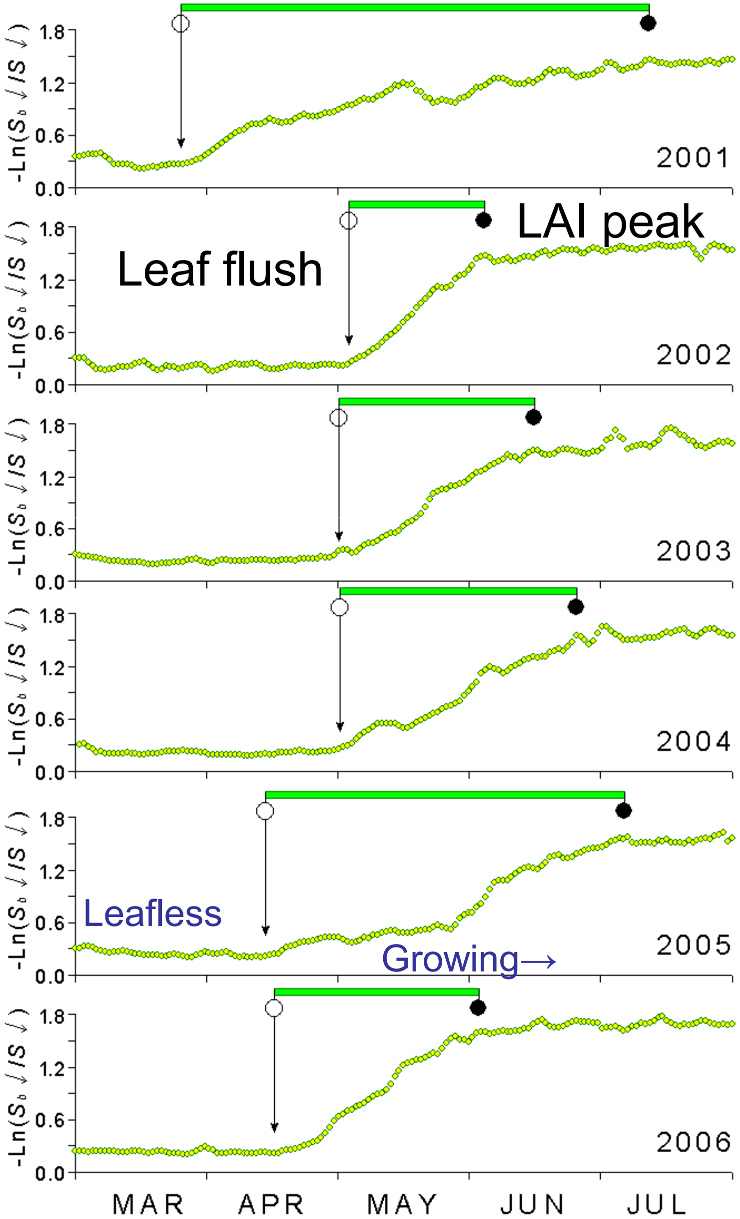
  $-Ln(S_b\downarrow / S\downarrow)$: the values in leafless seasons < in growing seasons

Measurement of radiation above and below the canopy

Timing of leaf flush and the subsequent growth are different.

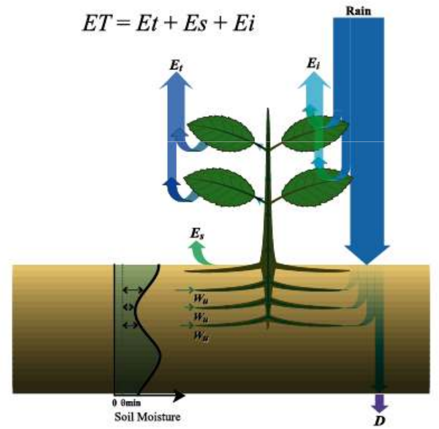
Background

Allocation of water budget



→ Growing LAI →

Impact?



Et: transpiration
Ei: canopy interception
Es: soil evaporation

Water budget in vegetation.

Water budget in a forest

These variations are likely to influence the allocation of water budget (evapotranspiration).

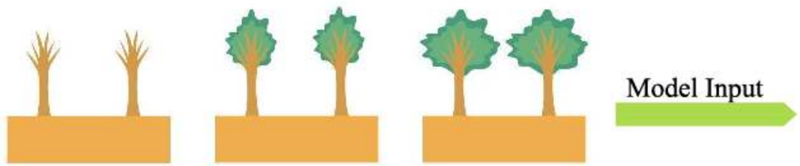
Study Aim

●The importance of changes in LAI on Et, Es & Ei was investigated from MAR to JUL, using numerical simulations.

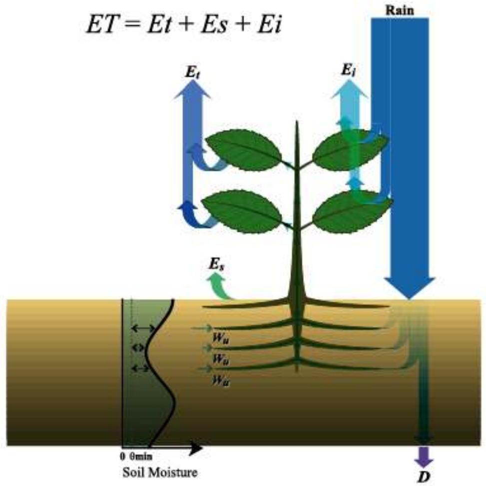
● Two seasonal changes were given.

One Scenario is based on the measurement, and the other scenario is going to be shown later.

→ Growing LAI →



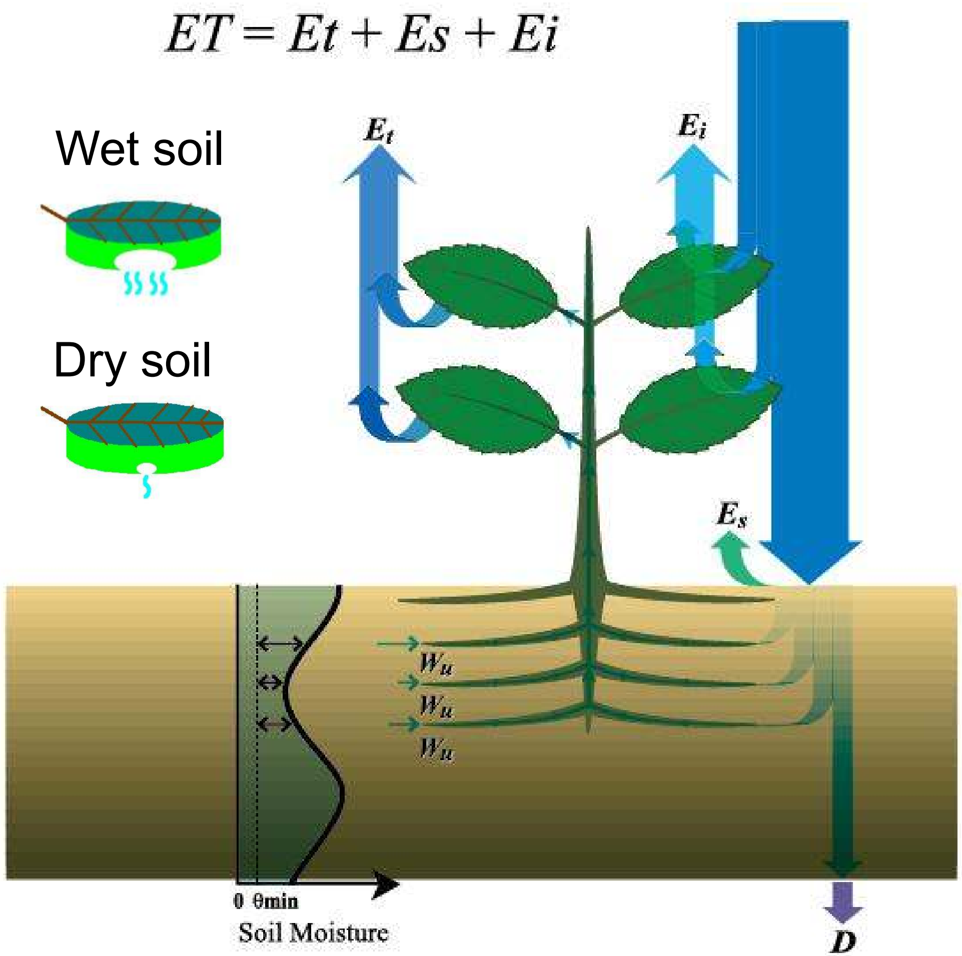
How different?



Et: transpiration
Ei: canopy interception
Es: soil evaporation

Water budget in vegetation.

A Multilayer Model for Evapotranspiration



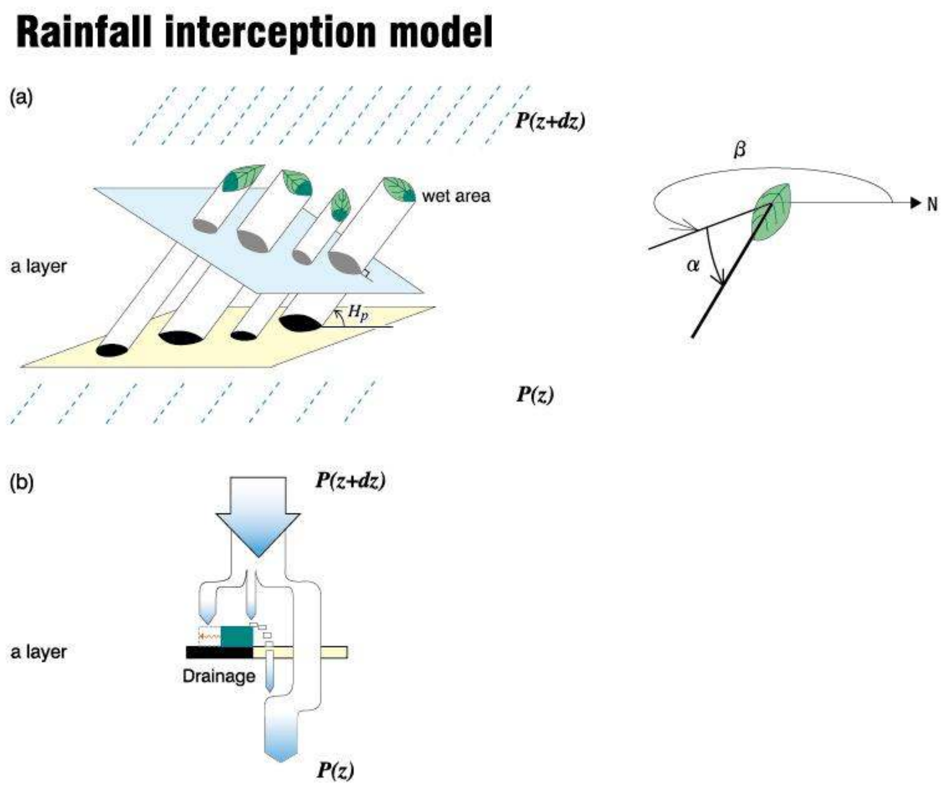
Sub-models/processes

1) Atmospheric diffusion (Wilson & Show, 1971)
2) Radiation transfer model (Tanaka, 2002)
3) Rainfall interception model (Tanaka, 2002)
4) CO_2, water vapor, and heat on wet leaf surfaces (Tanaka, 2002) Important in rainy season
5) Liquid water and heat exchanges in soil layers (Kondo & Xu, 1997)
6) **Water uptake (Tanaka et al., 2004)**
7) **Effect of soil water content on stomatal closure (Tanaka et al., 2004)**

Important in dry season

These processes are important in a dry tropical region

A Multilayer Model for Evapotranspiration



1) atmospheric diffusion (Wilson & Show, 1971)
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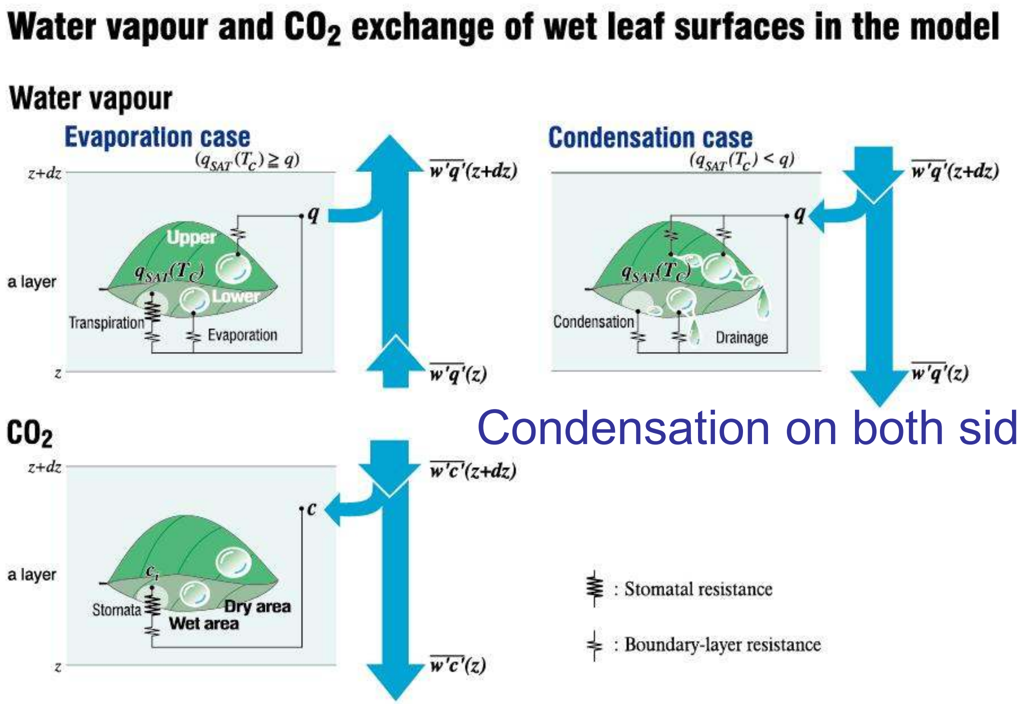
The processes are important in rainy seasons

A Multilayer Model for Evapotranspiration



Condensation on both sides

CO2 exchange on dry bottom side

1) atmospheric diffusion (Wilson & Show, 1971)
2) Radiation transfer model (Tanaka, 2002)
3) Rainfall interception model (Tanaka, 2002)
4) CO_2, water vapor, and heat on wet leaf surfaces (Tanaka, 2002)
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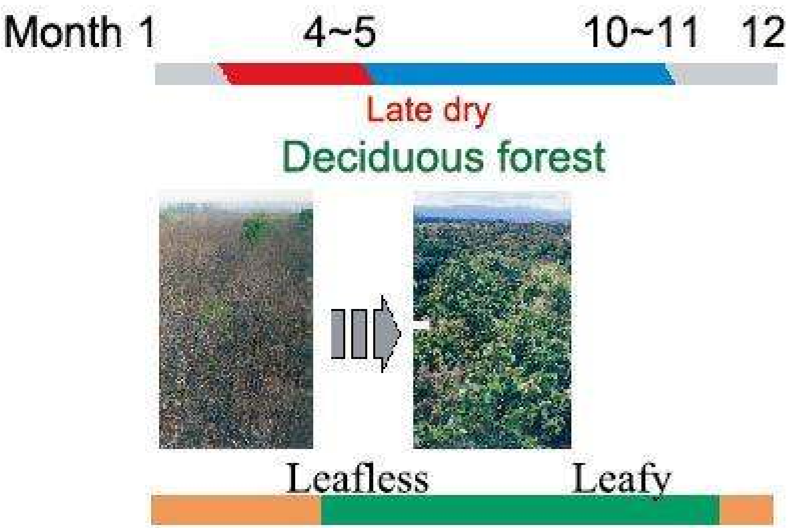
The processes are important in rainy seasons

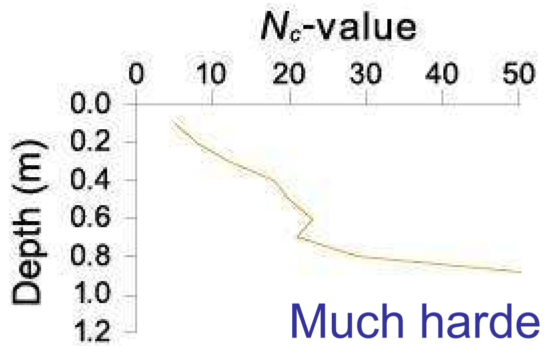
Site and hydro-meteorology



The even-aged teak stand (Tectona grandis, L. F.), which is widely distributed in Indochina and India as a commercial production, was planted in 1968.

A mean canopy height was 17.2.
Rooting depth seems to be <1m .

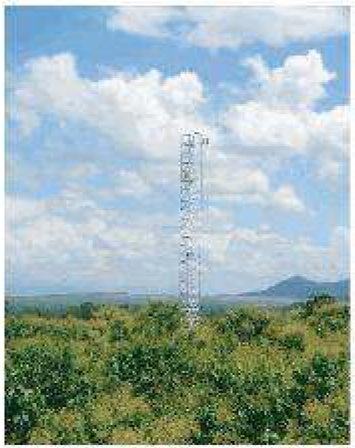
Used as model input



Much harder at <1m

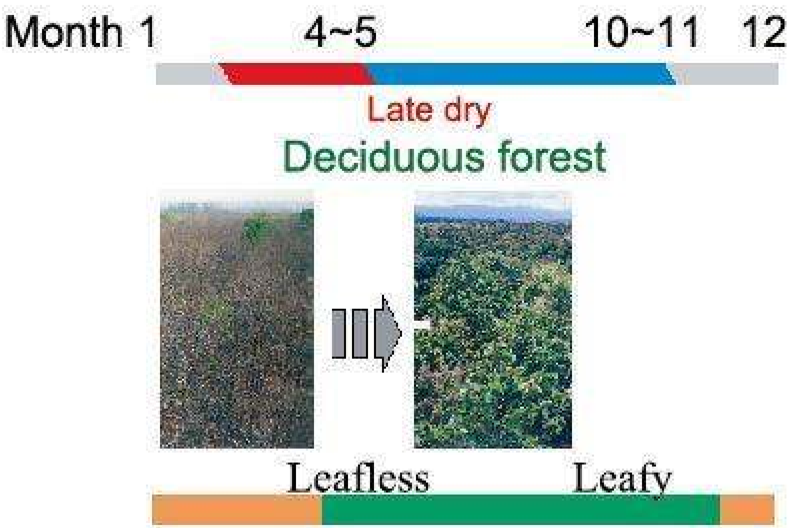
The strength of soil

Leafless Season



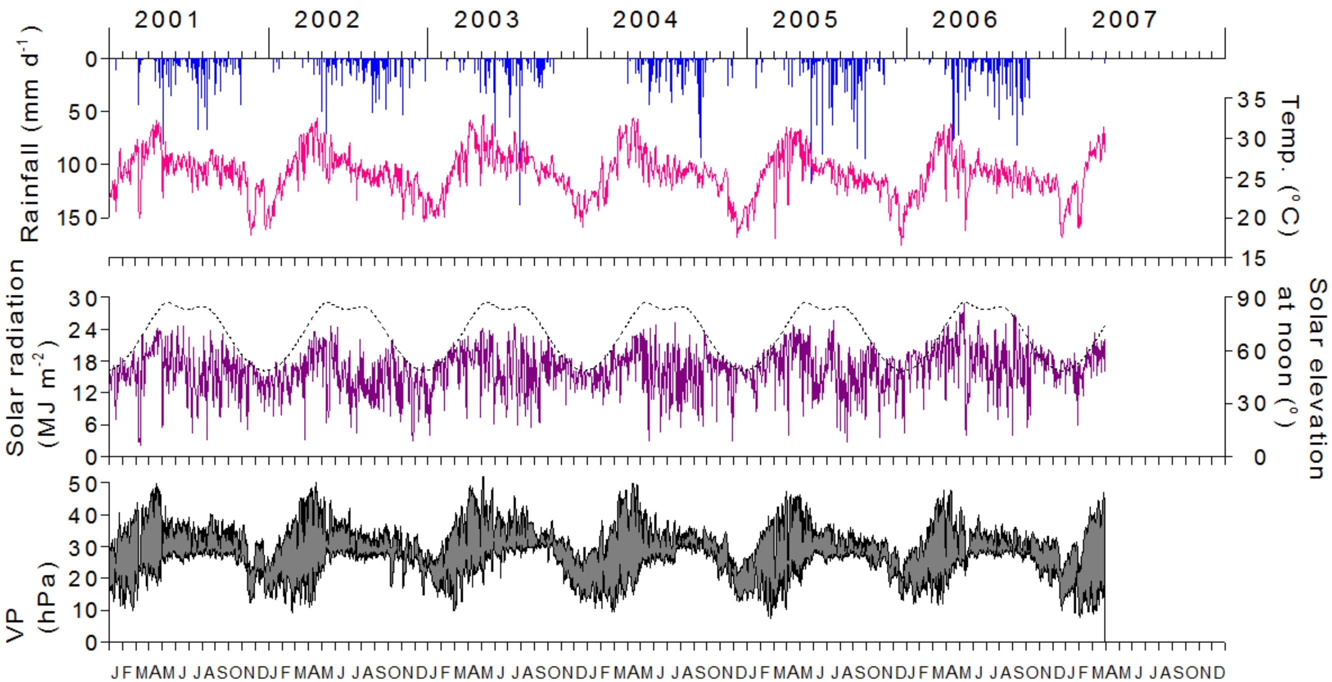
Growing Season

Site and hydro-meteorology



These hydro-meteorological variables were input data.

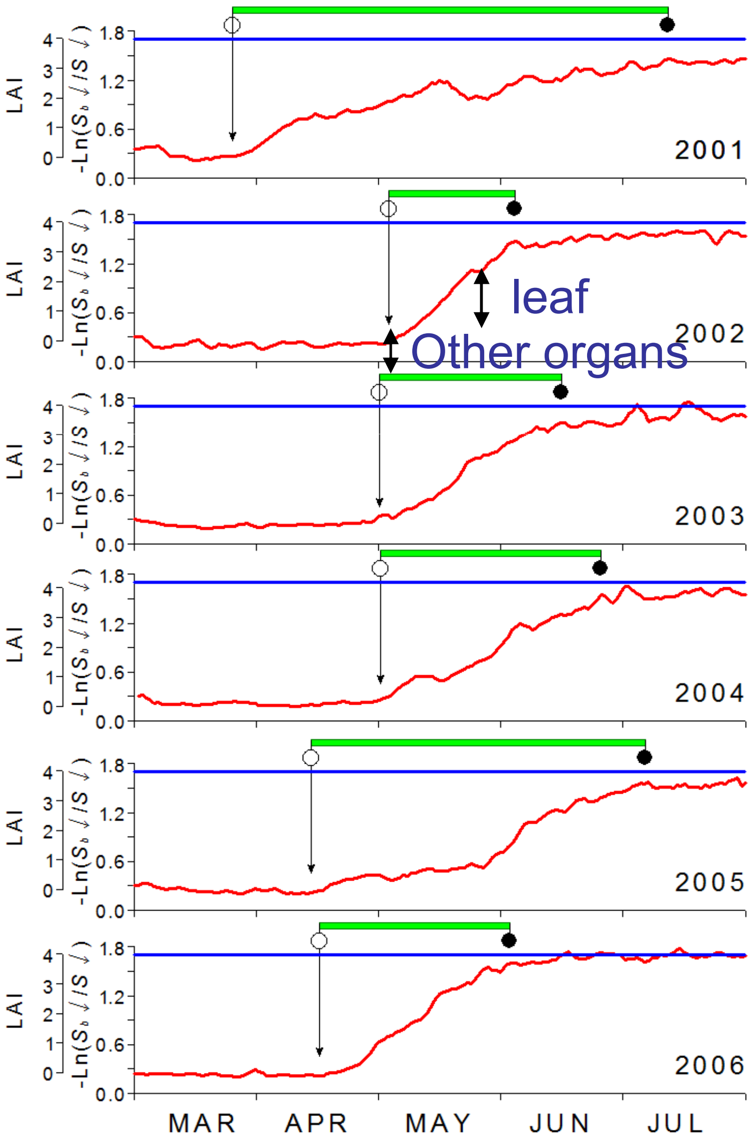
But output of ET will be shown from Mar. to Jul. in every years.

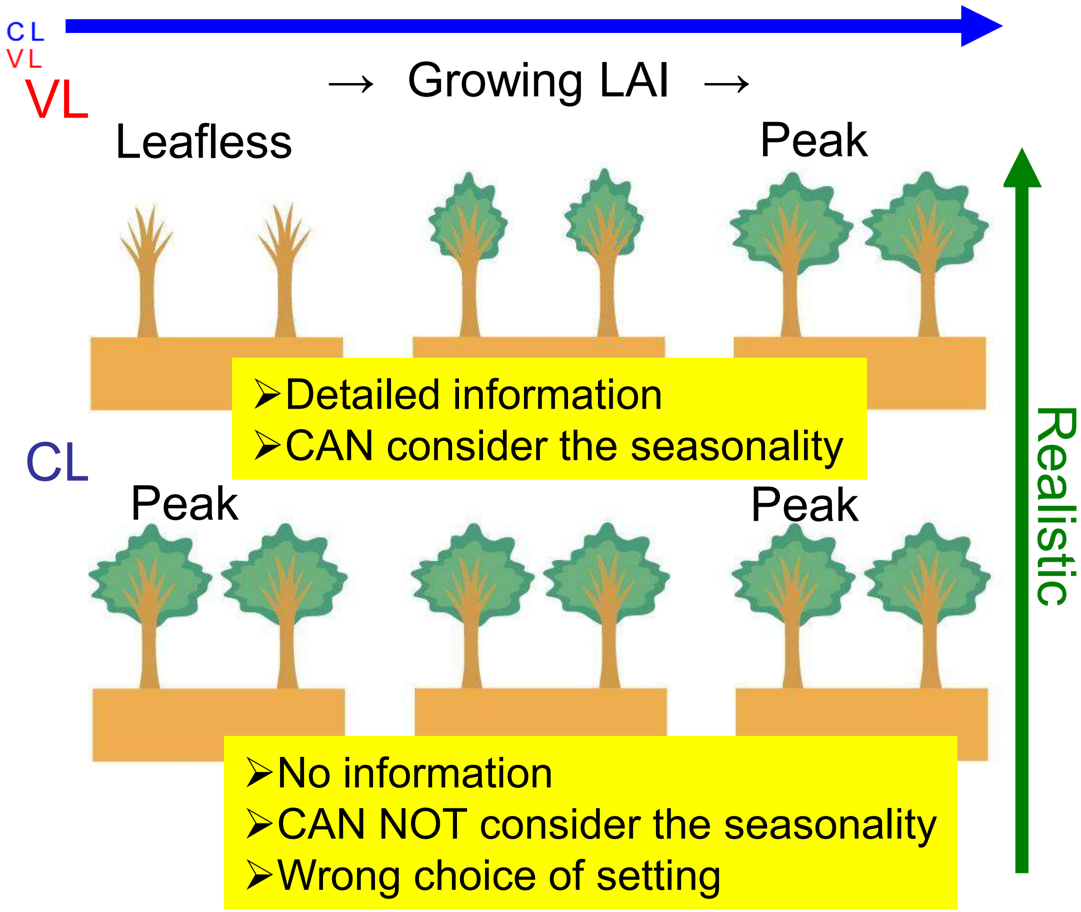


Three seasons

Two seasonal changes

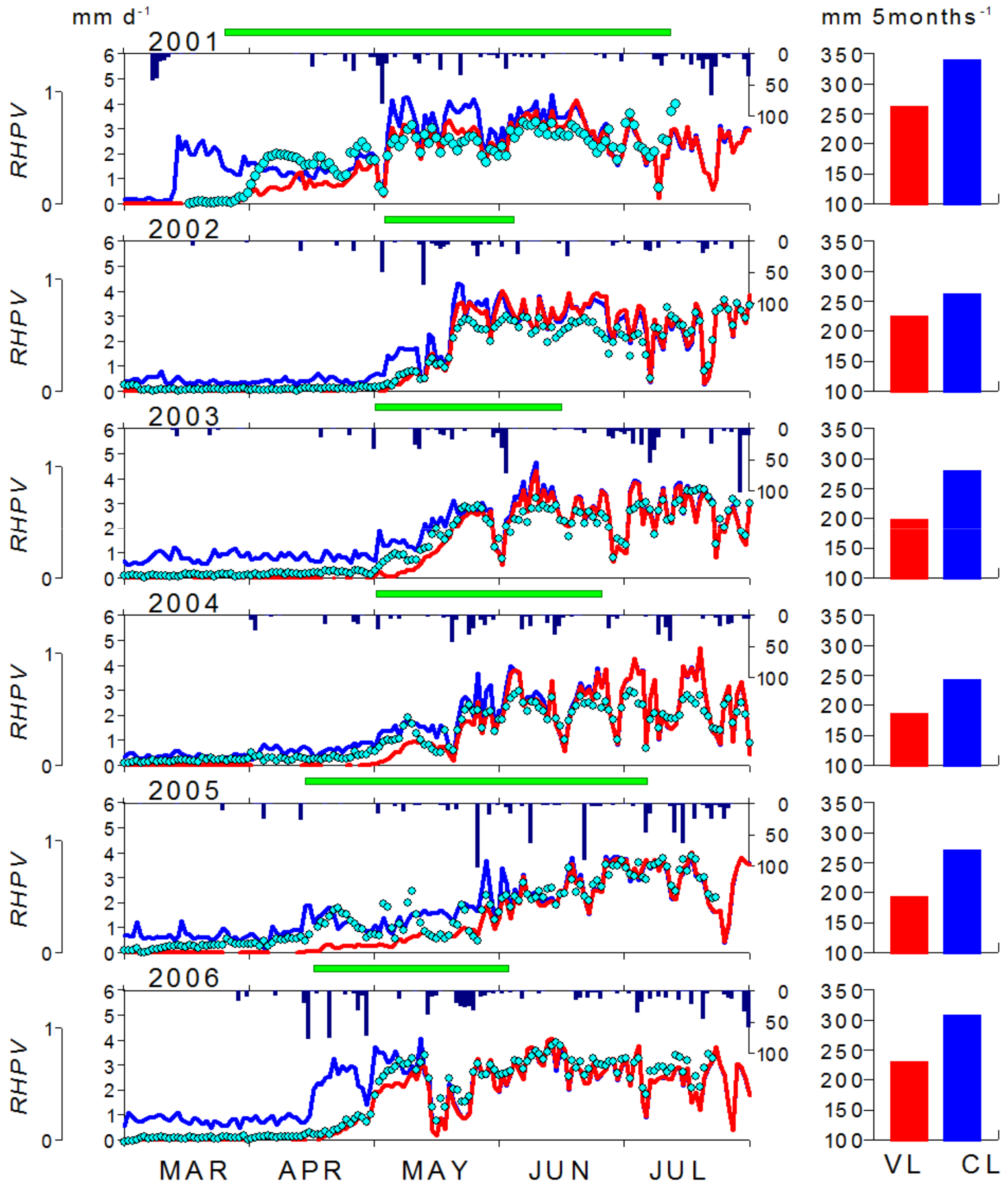
in the study

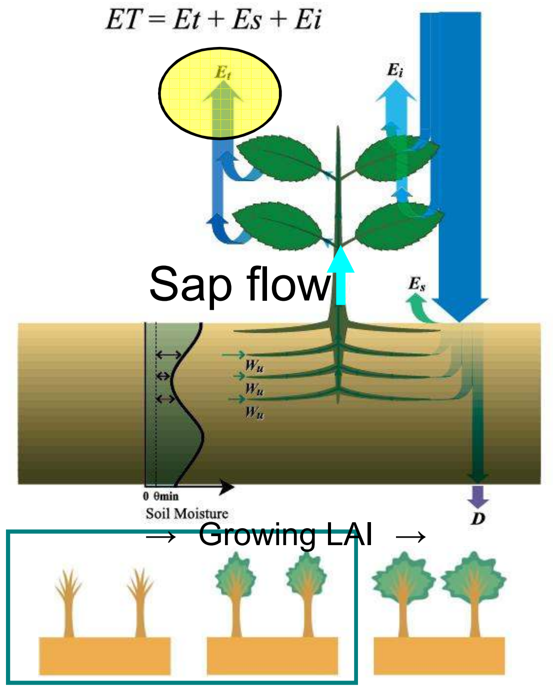




The scenario of CL (the extreme case) was chosen to emphasize the impact of growing process on evapotranspiration.

Simulation results of *Et*





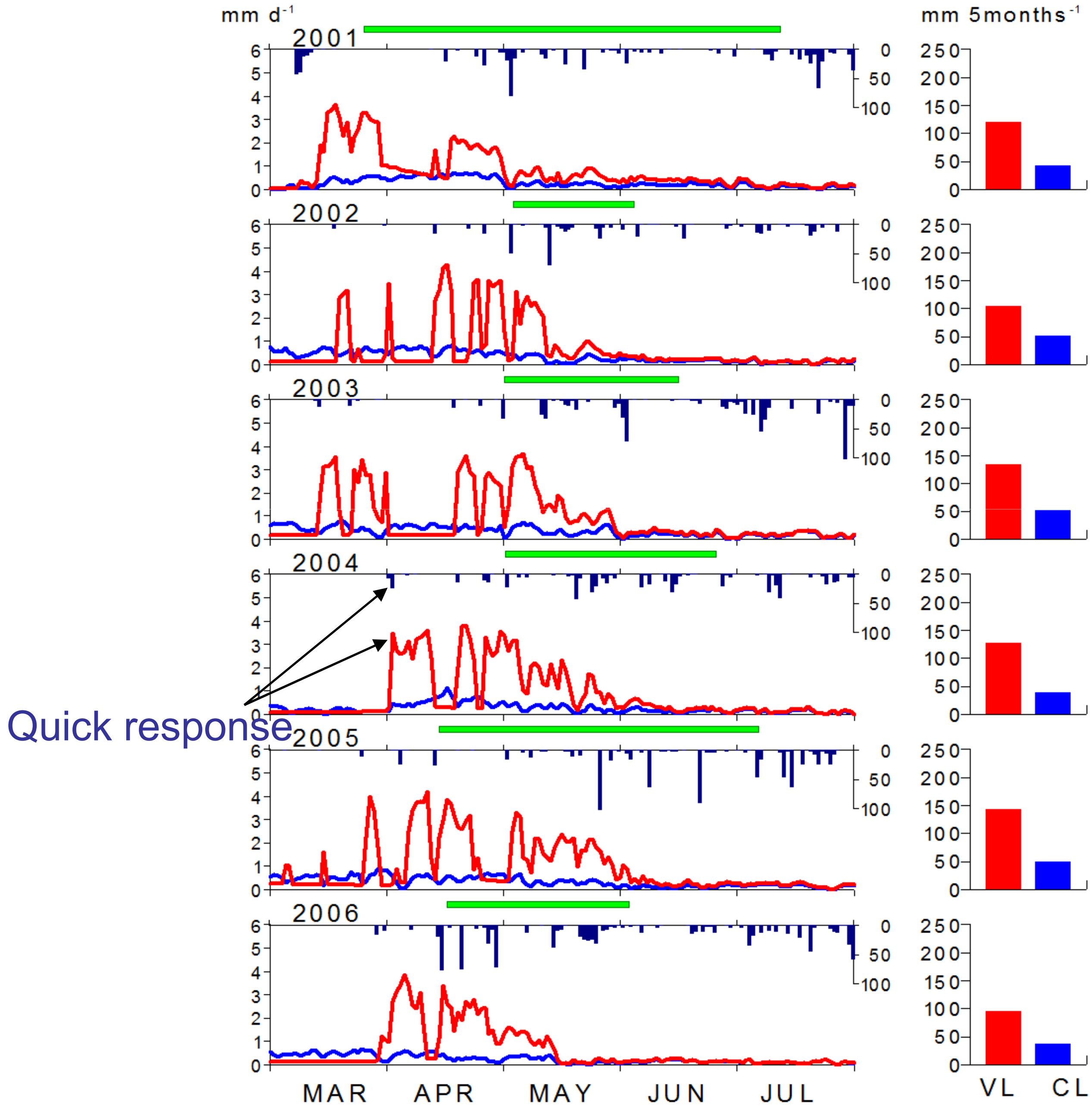
Important for Et.

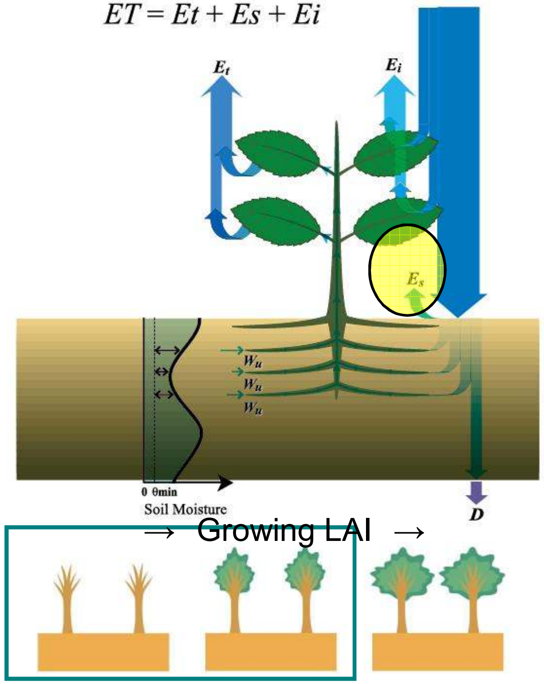
Et with VL agreed with the measurement of sap flow.

At Leafless and small LAI, *Et* with CL is larger.

The difference of accumulate was values42±16mm/5ms

Simulation results of *Es*



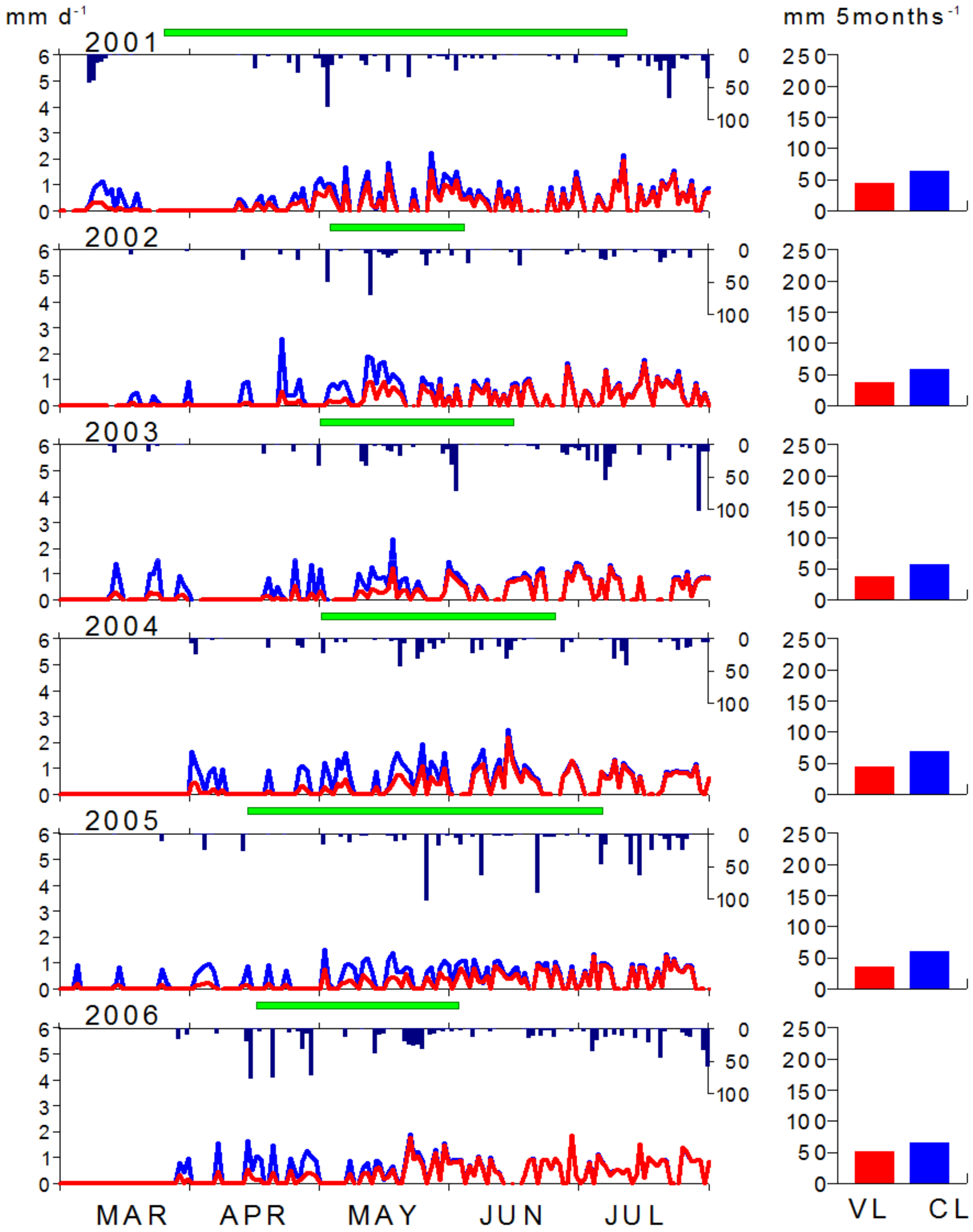


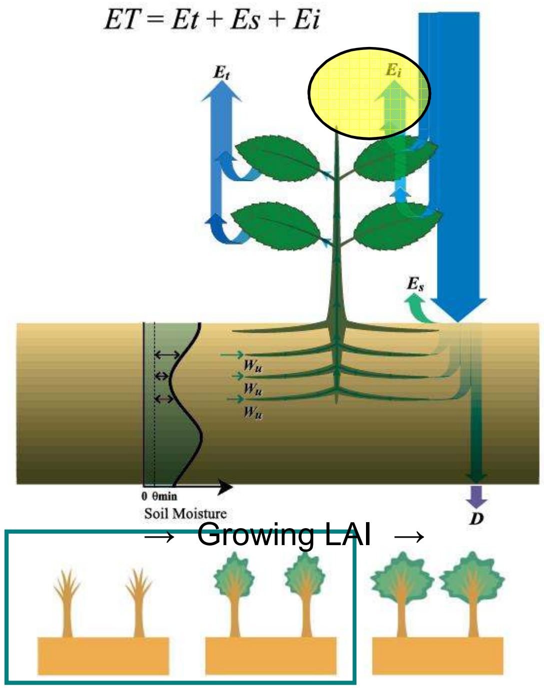
Important for Es.

At Leafless and small LAI,
Ei with VL is larger.

The difference of accumulation was 44±14mm/5months

Simulation results of *Ei*





Important for Ei.

At Leafless and small LAI, *Ei* with CL is larger.

The difference of accumulation was 14±3mm/5months

Smaller effect in Ei

Summary

- Two numerical experiments with different seasonal patterns of LAI (i.e., with and without the seasonality) were carried out.

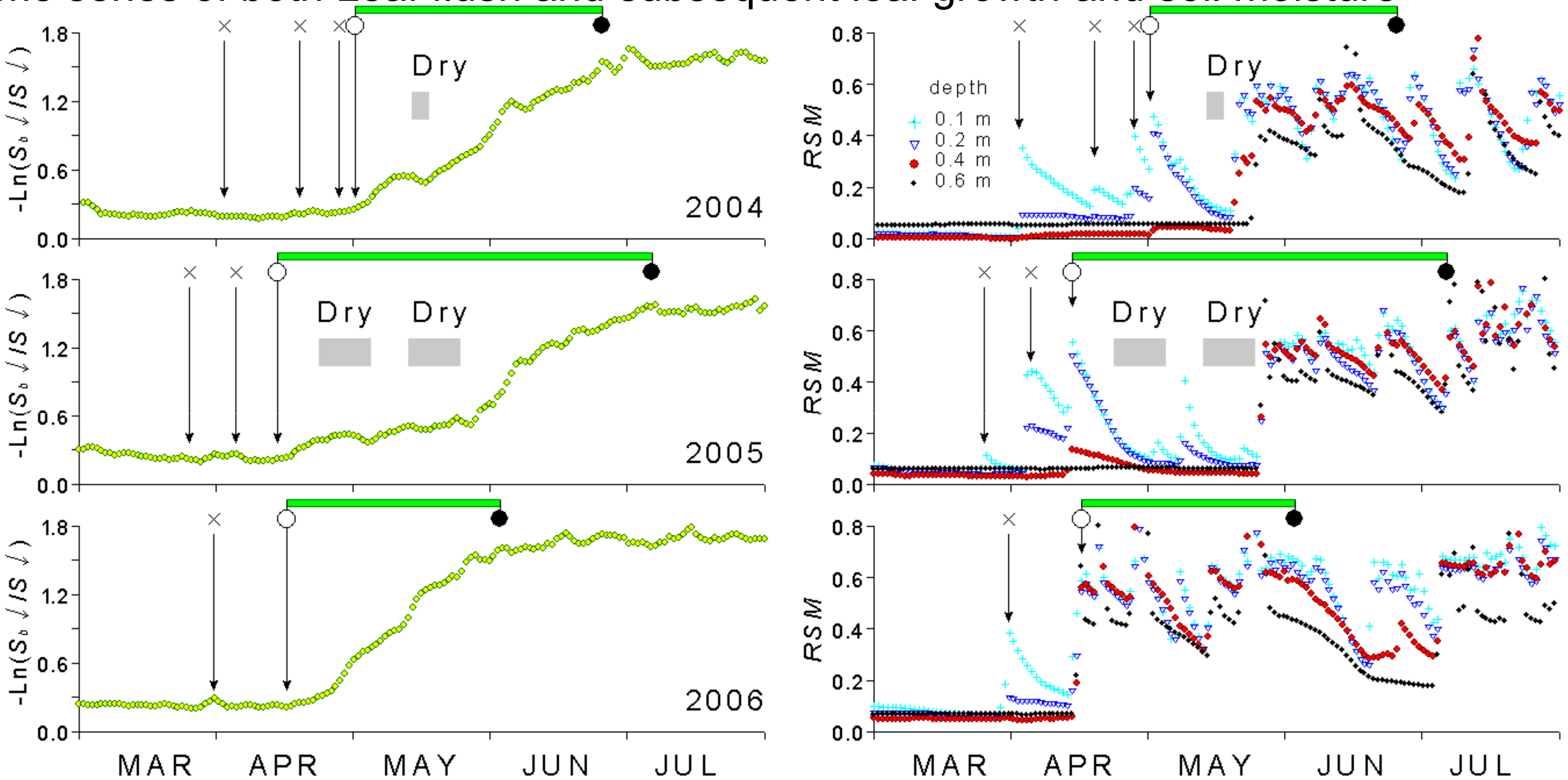
- The constant LAI increased transpiration (*Et*) at small LAI, particularly immediately after leaf flush.
- The constant LAI reduced soil evaporation (*Es*) during dry seasons and increased canopy interception (*Ei*) during growing LAI.

Hereby, the importance of LAI was shown.

Future work

Mechanism of leaf flush and growth

Time series of both Leaf flush and subsequent leaf growth and soil moisture



1.Leaf flush is affected by soil moisture content.

2.Periods of soil drought after leaf flush inhibited leaf expansion, resulting in prolongation of the interval between leaf flush and peak LAI

Dynamics can be predicted!