# Application of Community Land Model to Semi-arid Mongolian Grassland

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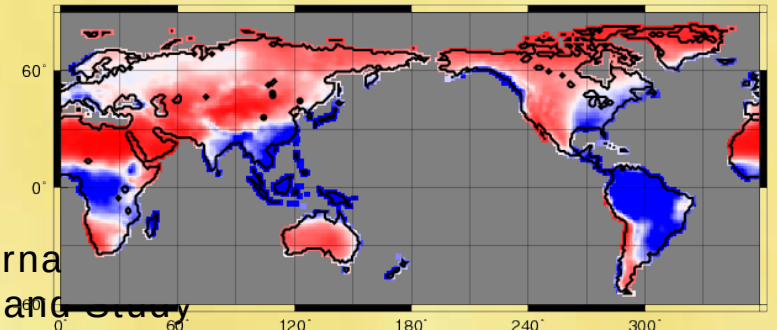
# Background: Dryland Hydrometeorology

- Small amount of Precipitation(P)
  - large fraction of evaporation(E) in P
  - small amount of P-E (available water resources)
- Large variability of P, P-E
  - at the scale of interannual & interseasonal
  - linked with vulnerability of natural and social systems
- Key issues:
  - Are these reproducable (simulatable) with models?



# Goals:

- To evaluate applicability of land surface models (LSMs) to Asian drylands,

  in order to answer the questions

  - What is key phenomena for the landsurface simulation?
  - What is key parameters of the model ?
  - Is it possible to “scale-up” observations using LSMs?

Obser

# Radiative Dryness Index (by Budyko)

$$RDI = Rn / \ell P$$

how much energy is available to evaporate all of precipitation ?

0-1 : tropics, forest in mid-latitude, 2-3 : semi arid, 3< : arid

computed from GLDAS products

Tongyu

sparse grassland

Lanzhou

KBU

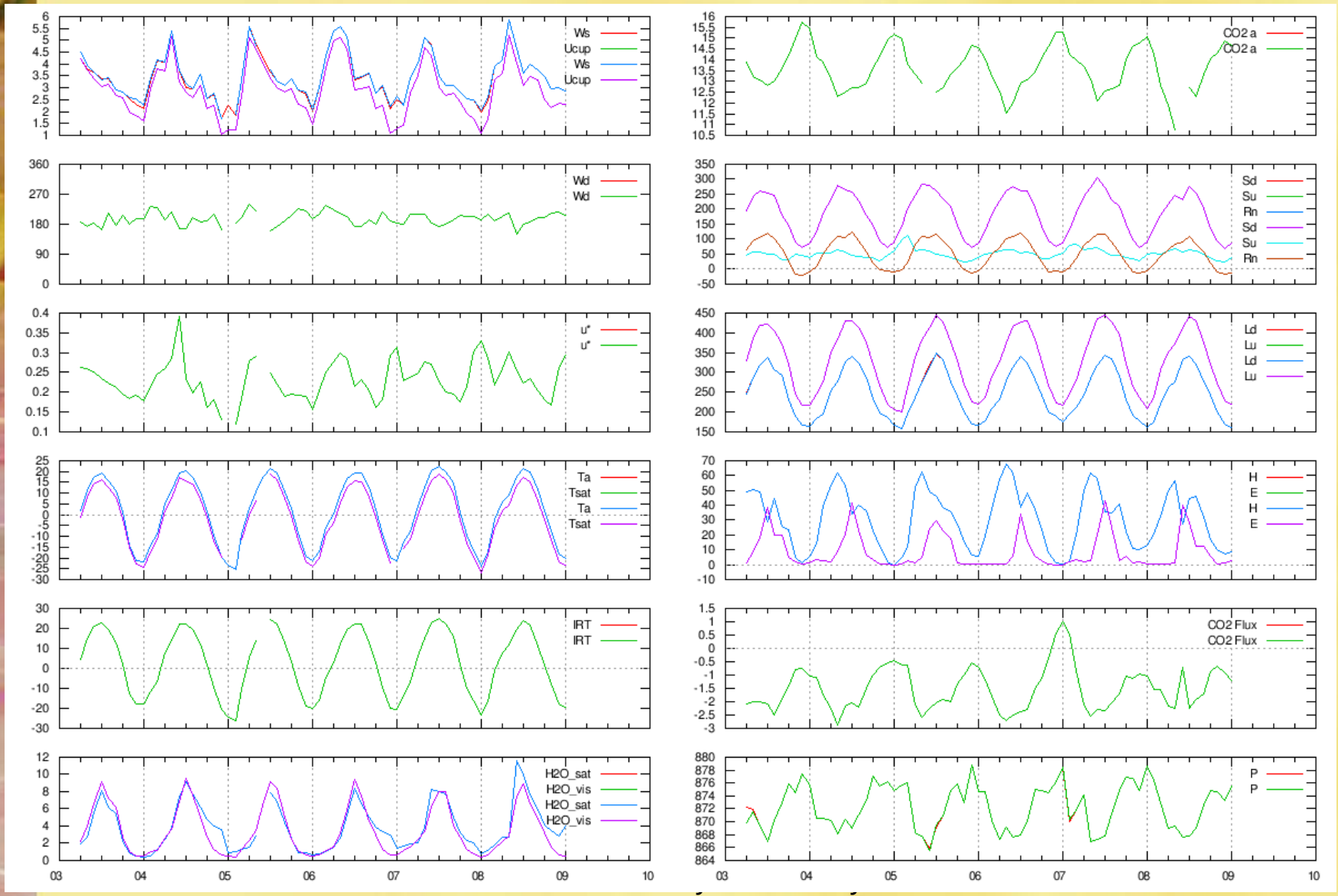
RDI (Radiative Dryness Index)

computed from GLDAS products

# Observations & Data processing

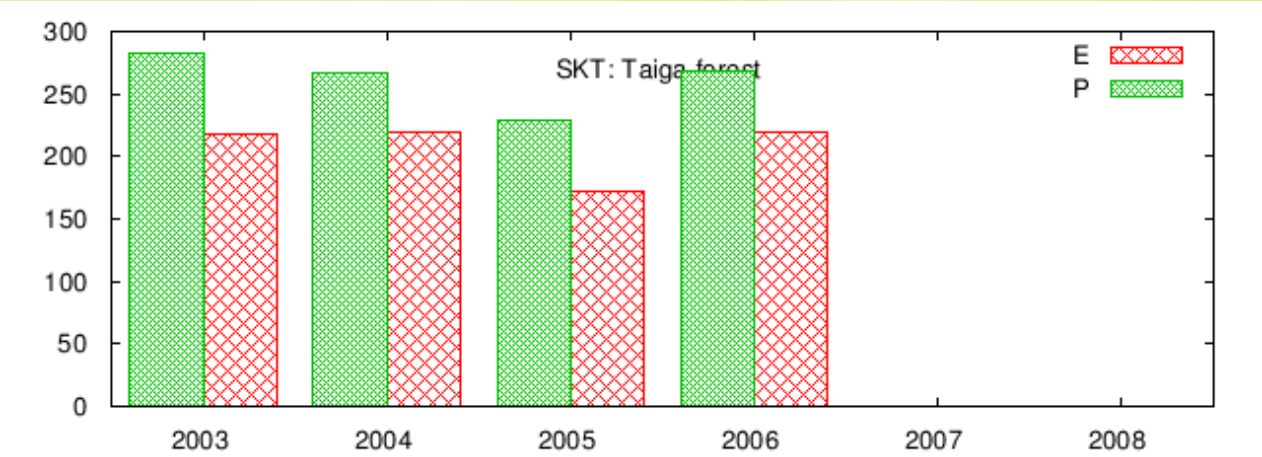
- Eddy-correlation based systems
- Observatios Started on 2003.03
- Quality control & Gap-filling: following AsiaFlux

# Observational results

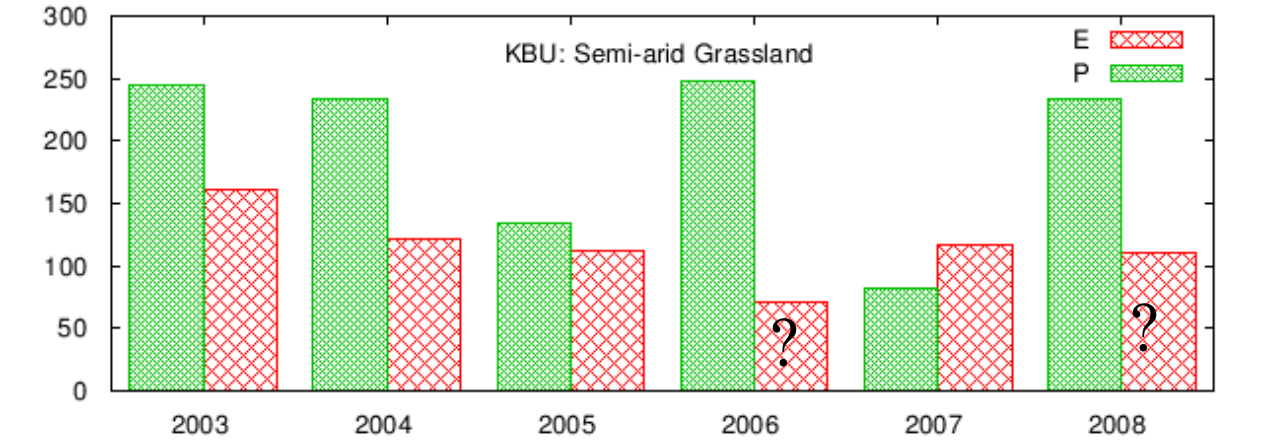


# Observational results: annual water budget

Forest




Grassland



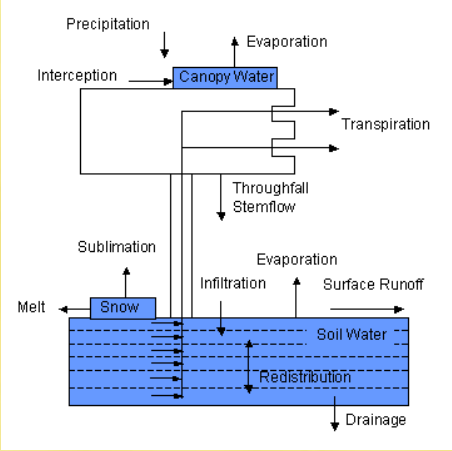

Larger interannual variations of precipitation & evaporation at grassland

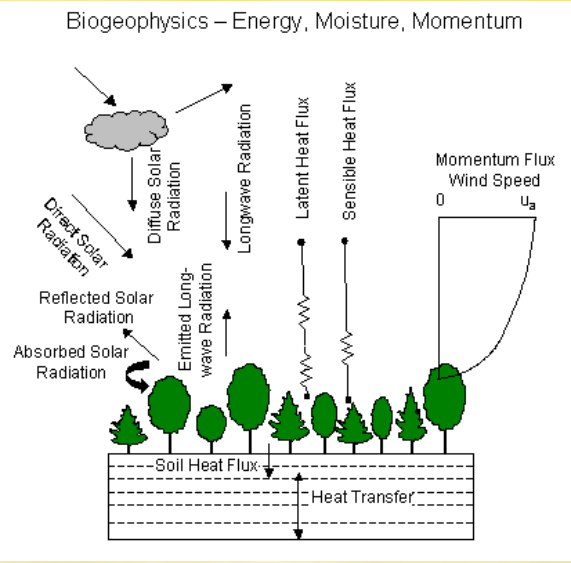
# Application of Land Surface Model (CLM3)

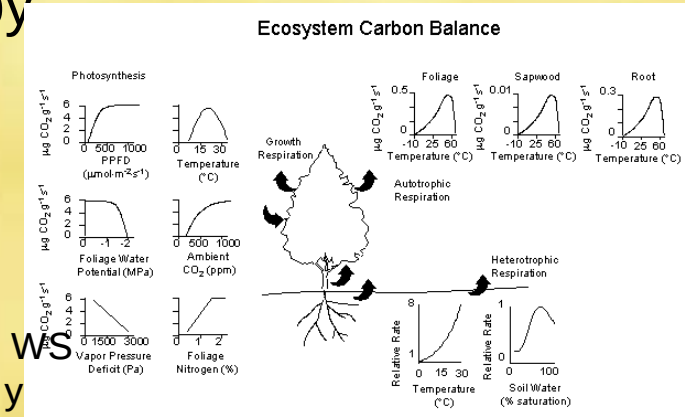
- Community Land Model ver.3 (CLM3)
  - landsurface model of NCAR-CCSM(GCM)
  - synthesized model of multiple
    - LSM by Bonan
    - BATS
    - LSM of Institute of Atmospheric Physics (IAP94)

# CLM3: processes

- land surface fluxes
  - transpiration: conductance-type
  - $CO_2$: func(PAR, enzyme, etc )
- soil & snow processes
  - 10 layers, Rechard's eqn
- Hydrology
  - discharge, infiltration
- Radiation
  - radiation transfer model within canopy
- Othres (not used here)
  - dynamic vegetation, bVOC
  - biogeochemistry

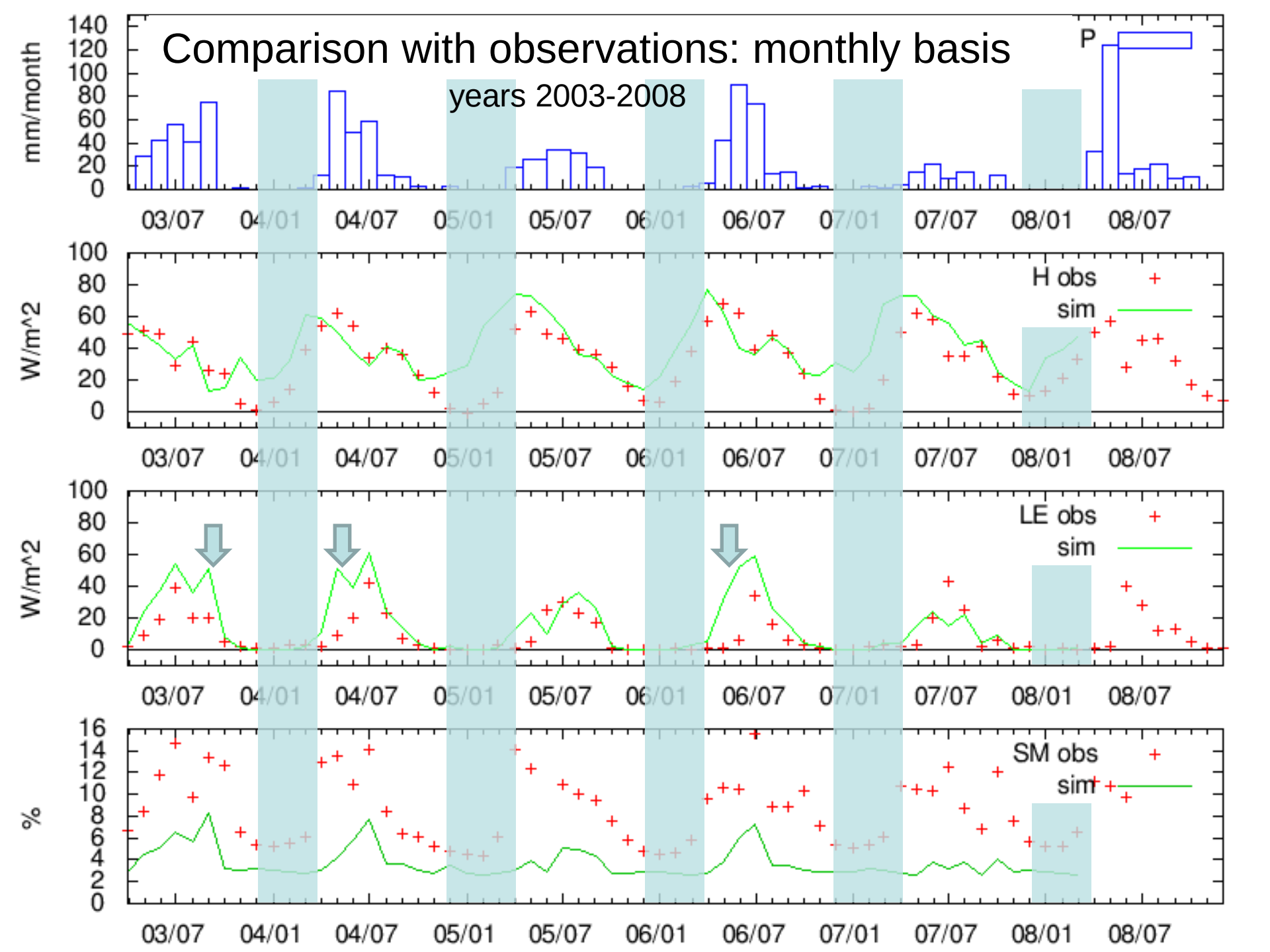


# CLM3: specifications & Inputs

- Specifications of computation
  - Period: 2003. 4 – 2008.4 (5 years)
  - Location: KBU (grassland)
  - Vegetation: C3 grassland 100%
- Data inputs
  - using insitu observations as much as possible
    - atmospheric forcing: insitu observation (T, q , u, Sd)
    - soil characteristics (color, compound etc): observed
    - vegetation (LAI, SAI, height, etc): observed
    - micrometeorological (z0, d0, etc): observed
  - others: use references (Bonan, et al, 2002)


Comparison with observations: monthly basis
years 2003-2008
P
mm/month
H obs
sim
W/m^2
LE obs
sim
W/m^2
SM obs
sim
%
03/07
04/01
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05/01
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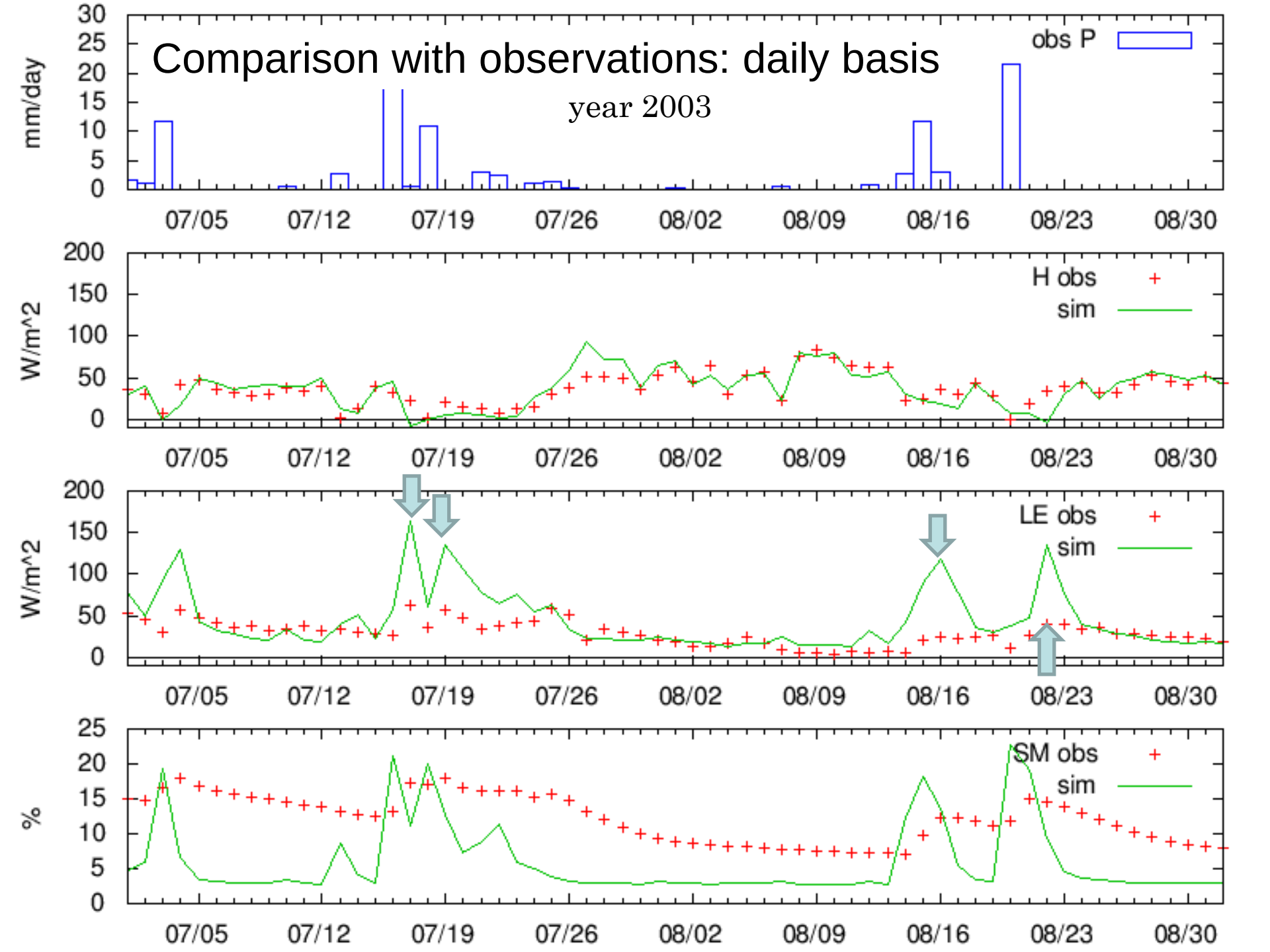
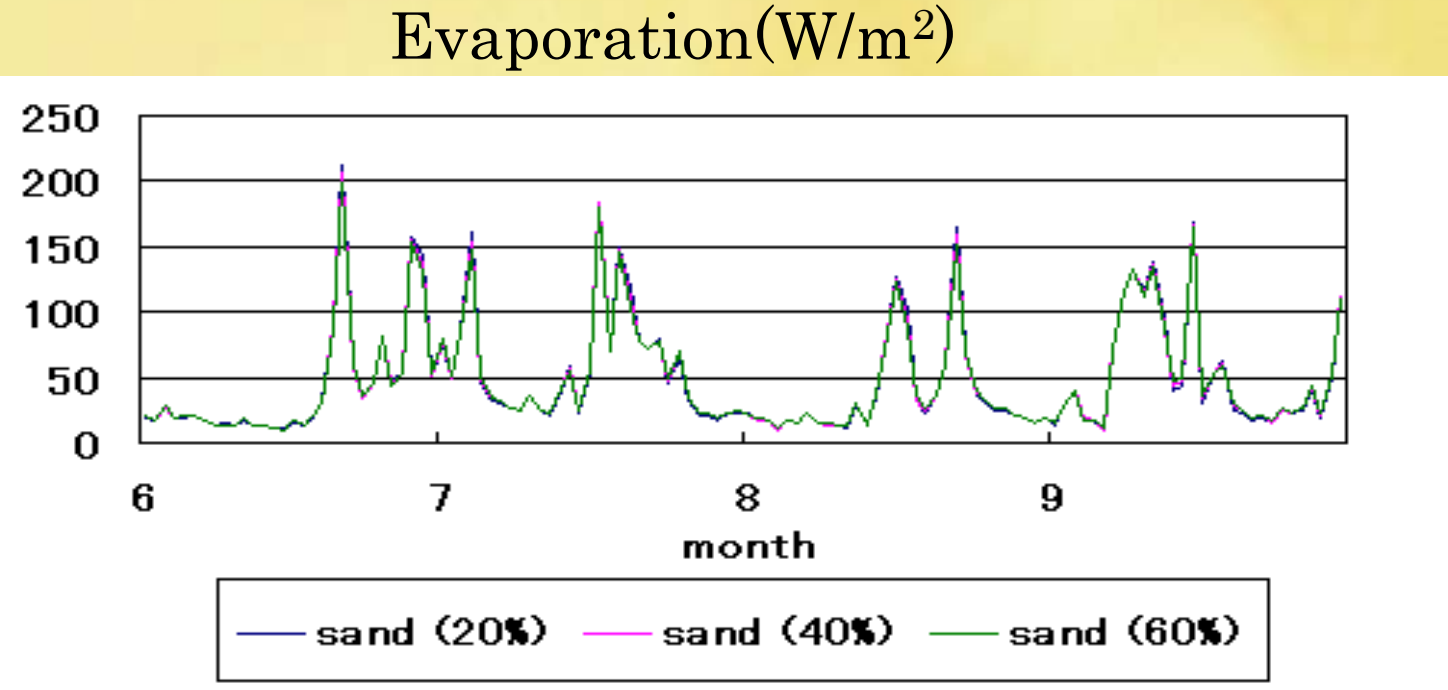

Comparison with observations: daily basis
year 2003
mm/day
obs P
W/m^2
H obs
sim
W/m^2
LE obs
sim
%
SM obs
sim
07/05
07/12
07/19
07/26
08/02
08/09
08/16
08/23
08/30

# Sensitivity analyses

- Objectives
  - to seek key parameters & phenomena in simulating landsurface processes
- Parameters in question
  - Soil properties
  - LAI

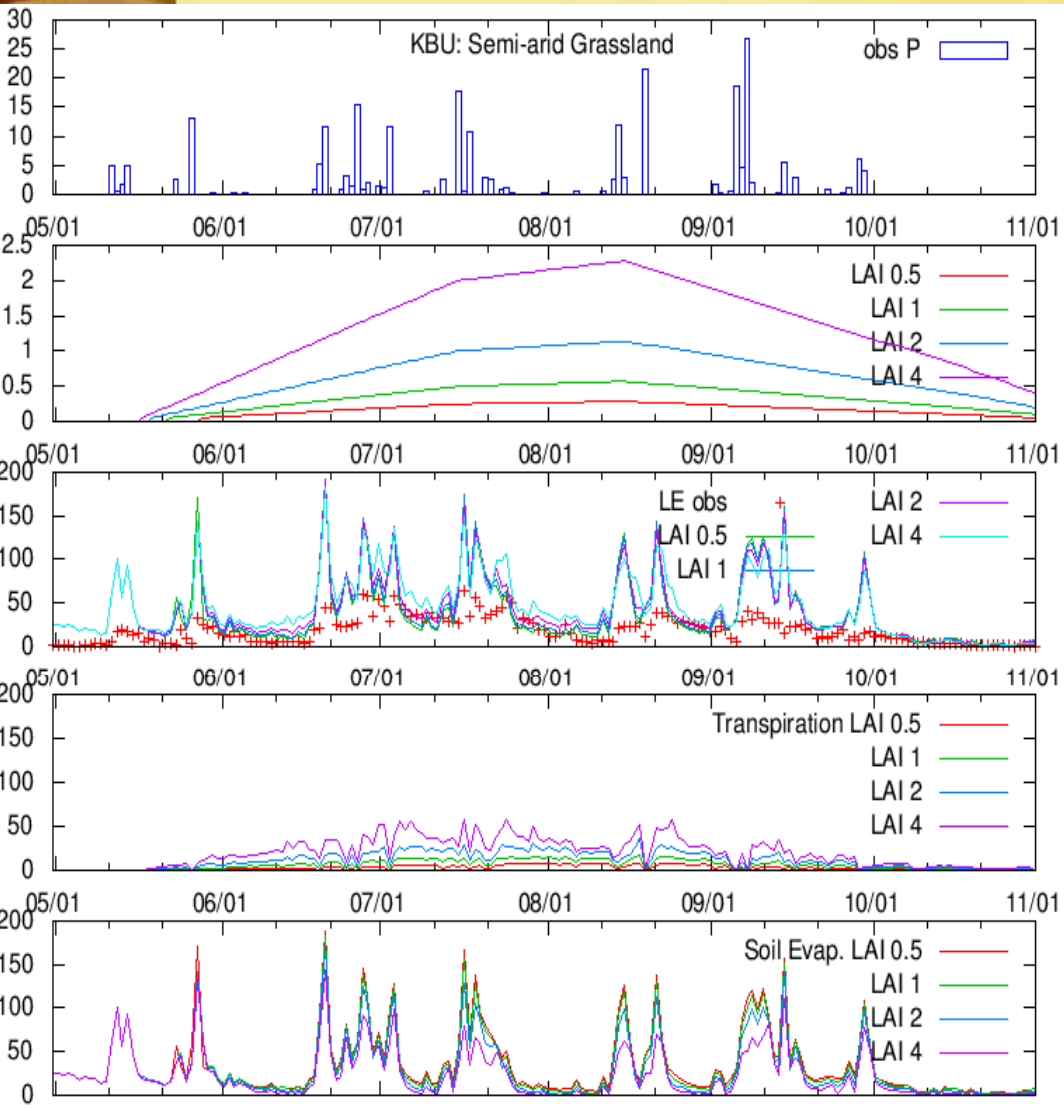
# Sensitivity test 1
# soil properties

- soil properties
  - fraction of sand: 74%(observed) -> 20, 40, 60%




  - almost negligible sensitivities to soil properties

# Sensitivity test 2
# LAI




- sensitivity to LAI
  - obs x 2, x4, x 0.5
  - considerable sensitivity
  - why?
    - soil is dry
    - soil moisture flux is not significant
    - soil evaporation depends on LAI

# Conclusions (tentative)

- CLM applicability
  - Reproduces H relatively well
  - Overestimates E right after precipitation events.
    - soil evaporation schemes?
    - dead liter?
- Sensitivity tests
  - small sensitivity to soil properties
  - relatively larger sensitivities to LAI
    - even at sparse grassland

- Observation continues since March, 2003

KBU & SKT is registered as

- CEOP reference sites
- AsiaFlux sites

data is available through their database