8. Preparation for Implementation Plan for Climate Change: 12:15-12:30, 6 Oct 2010

Hydrological modeling and applications for improved Integrated Water Resources Management

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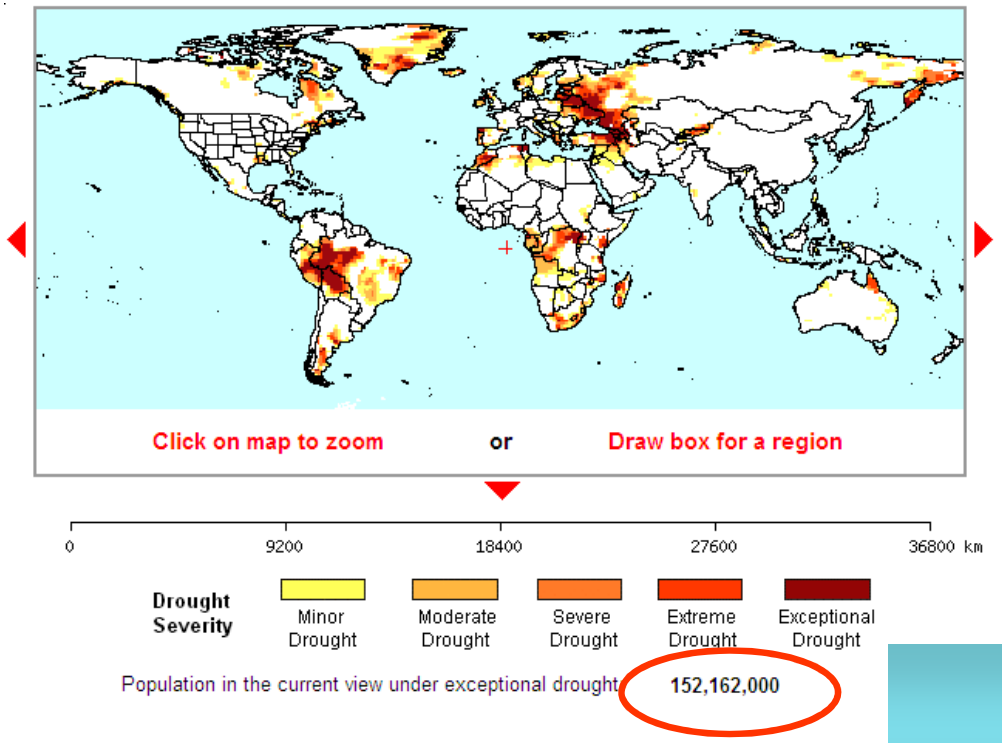
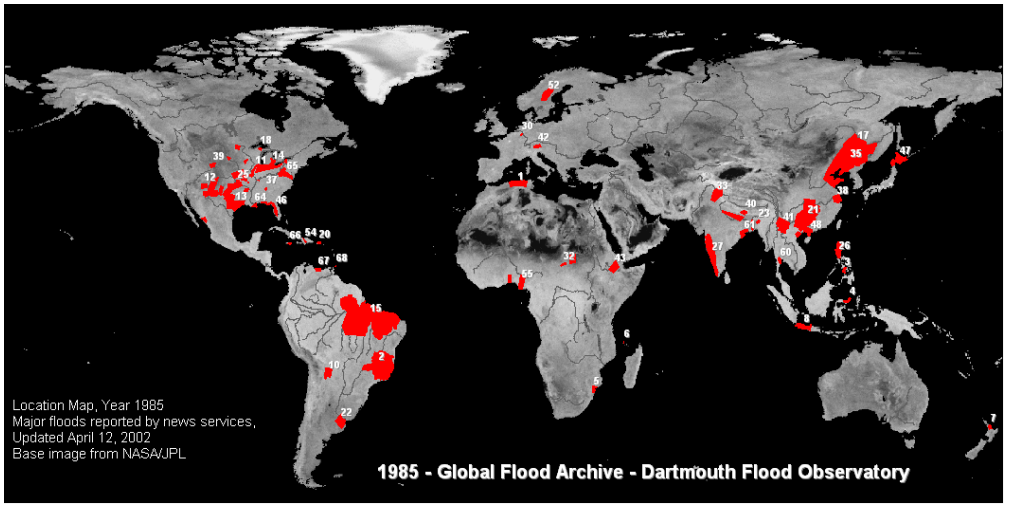
Global Drought (September 2010)

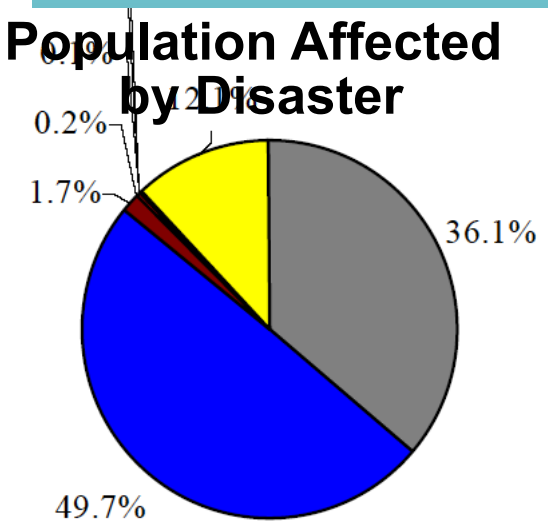


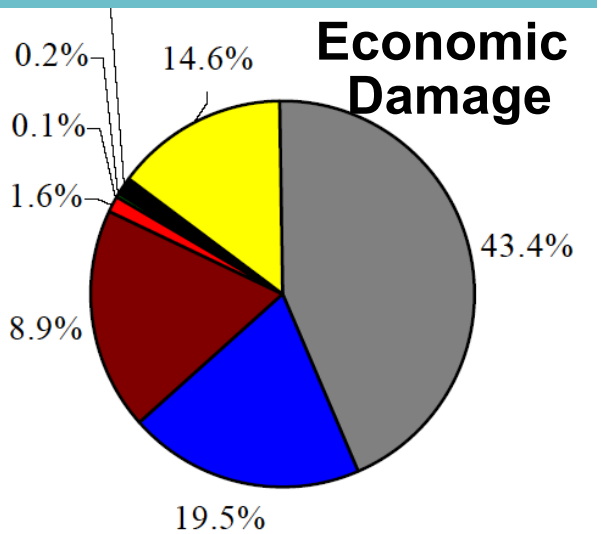
Global Flood Events (1985-2006)



Damage by Natural Disasters around the World in Last 28 Years

- Drought
- Floods
- Earthquake
- Extreme-temperature
- Slide
- Volcano
- Wild-fire
- Windstorm

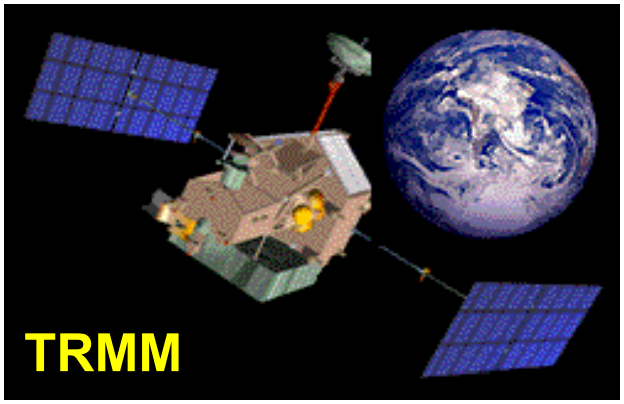




Overall Strategy

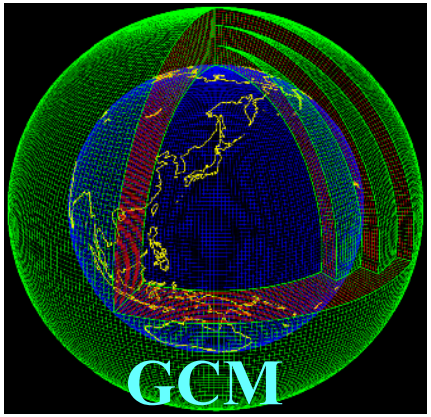
Observation

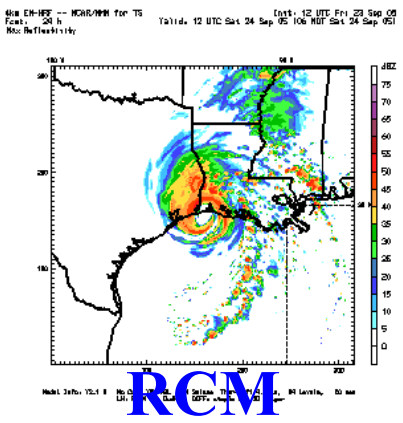
Satellite

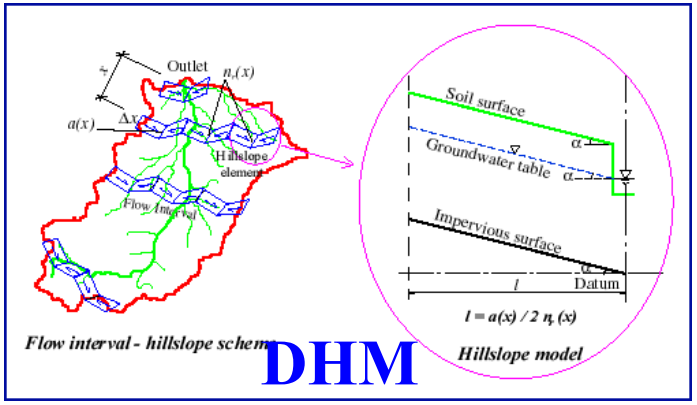


In-situ

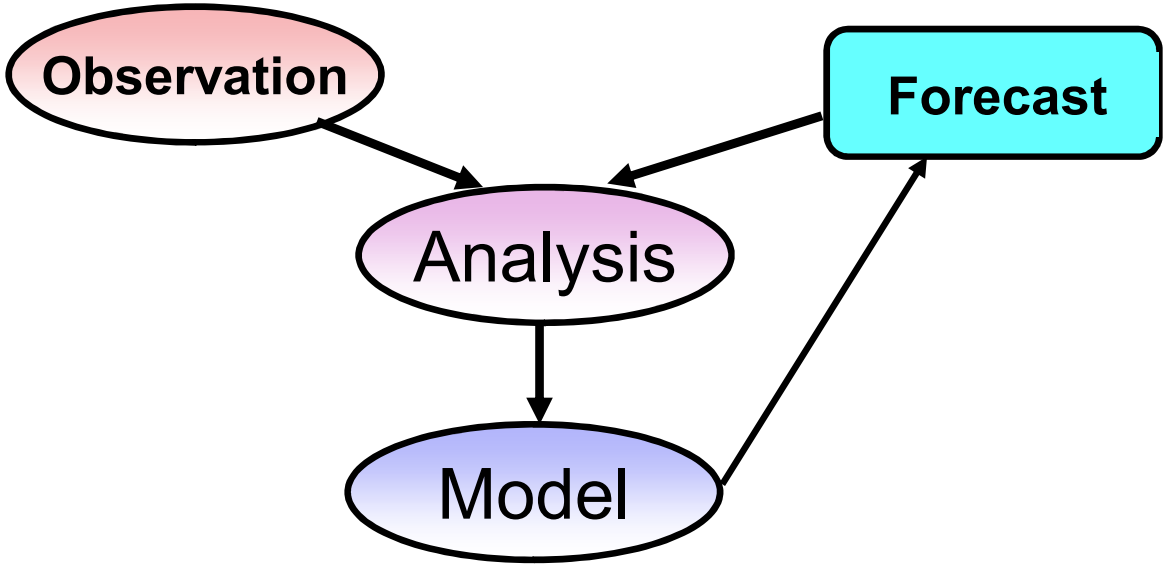
Modeling





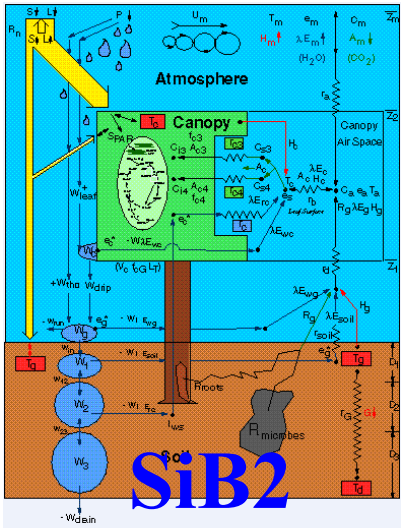


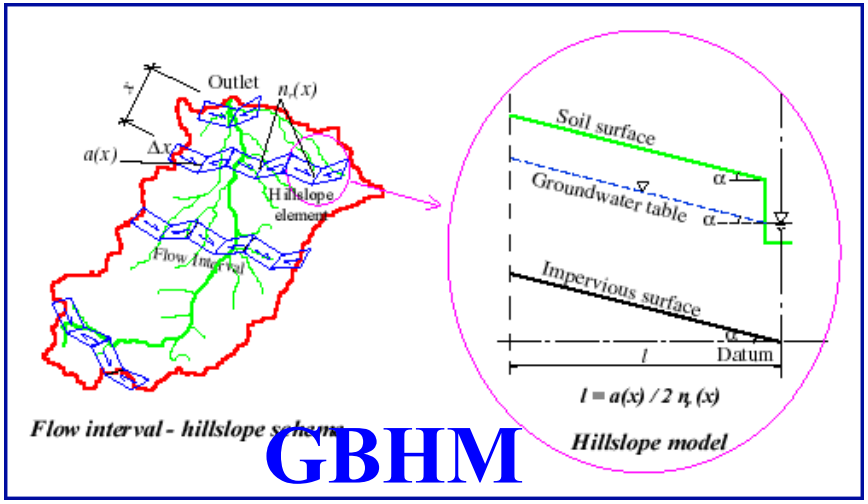
Data Assimilation



Land Surface Models Distributed Hydrological Models

Representative





Merit

- ➢Well formulate 1-D water and energy fluxes in SVAT system;
- ➢Prediction of photosynthesis and respiration.

Couple

- ➢Distributed representation of the spatial variation;
- ➢Slope-driven runoff generation and River Routing;
- ➢Groundwater dynamics.

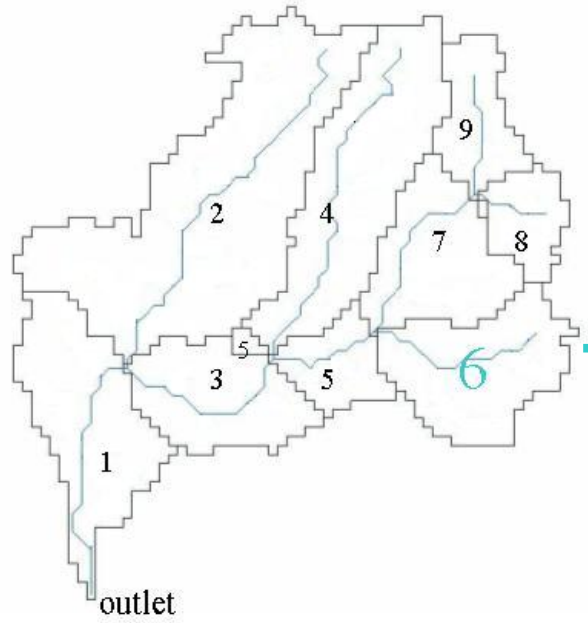
WEB-DHM

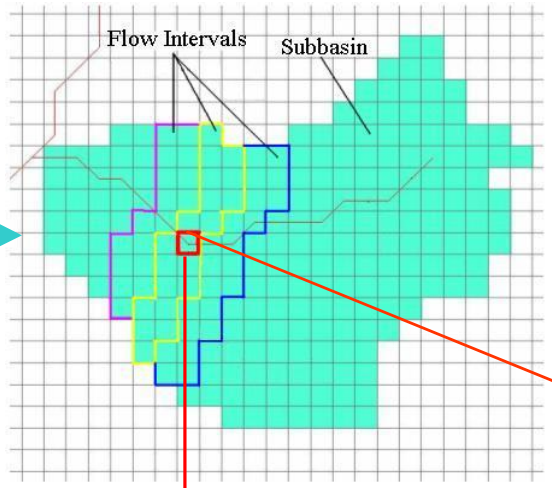
Water and Energy Budget-based Distributed Hydrological Model

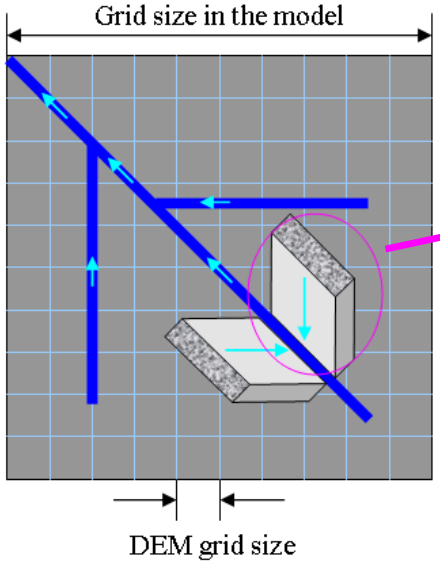
WEB-DHM

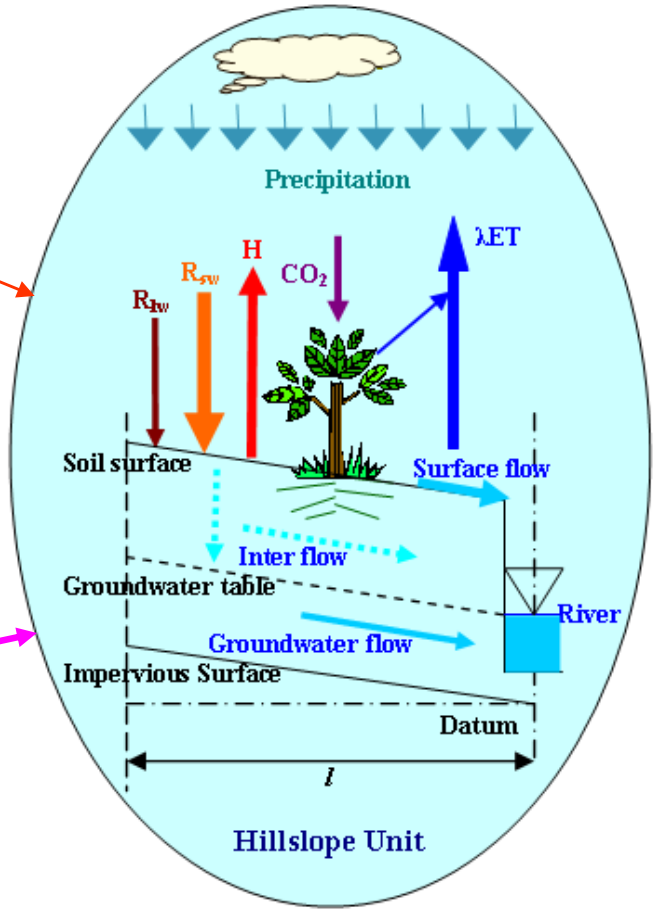
Wang, 2007, PhD thesis

(Water and Energy Budget-based Distributed Hydrological Model)







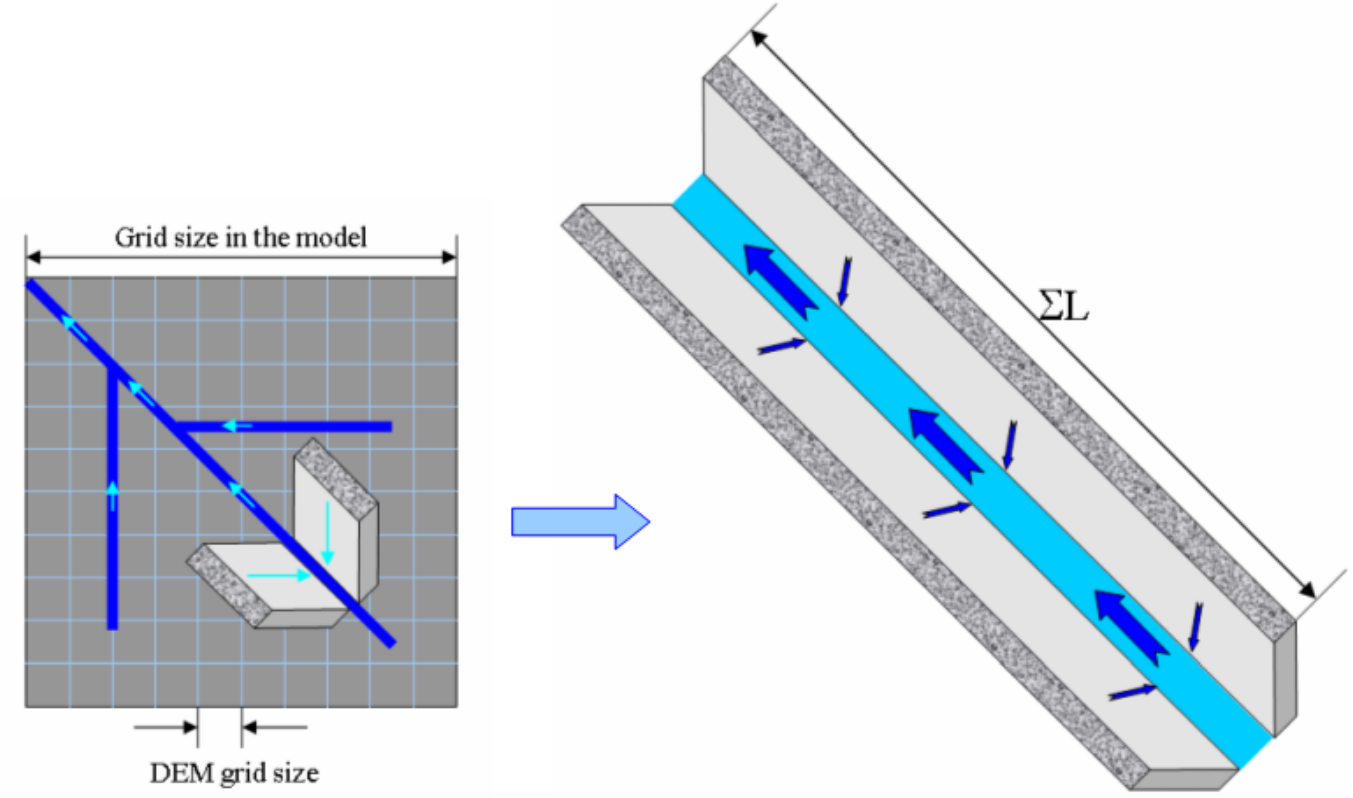


Sub-grid Scheme

Slope length and angle are preprocessed from fine DEM

Incorporating sub-grid topography, but with high efficiency

Simplification of a big model grid to a long hillslope element



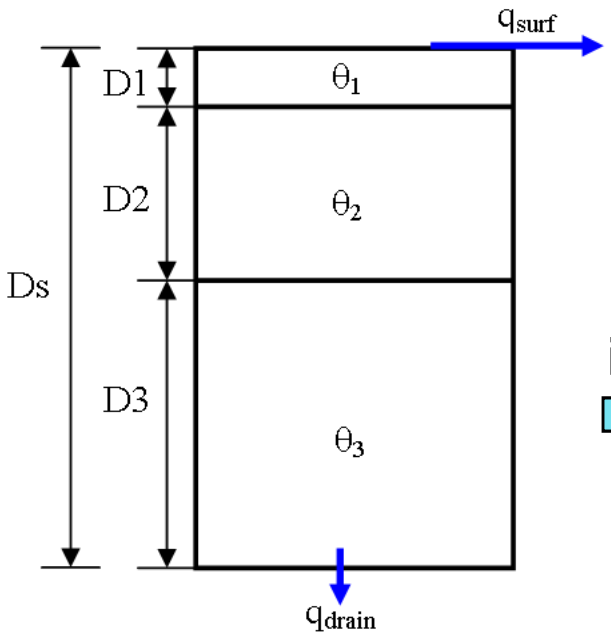
(a) Big grid with DEM-derived streams (total length = ΣL).

(b) Hillslope element with one virtual stream (length = ΣL).

Applicability of WEB-DHM to large river basins.

Improvements of WEB-DHM over SiB2

(a) SiB2



improve

(b) WEB-DHM

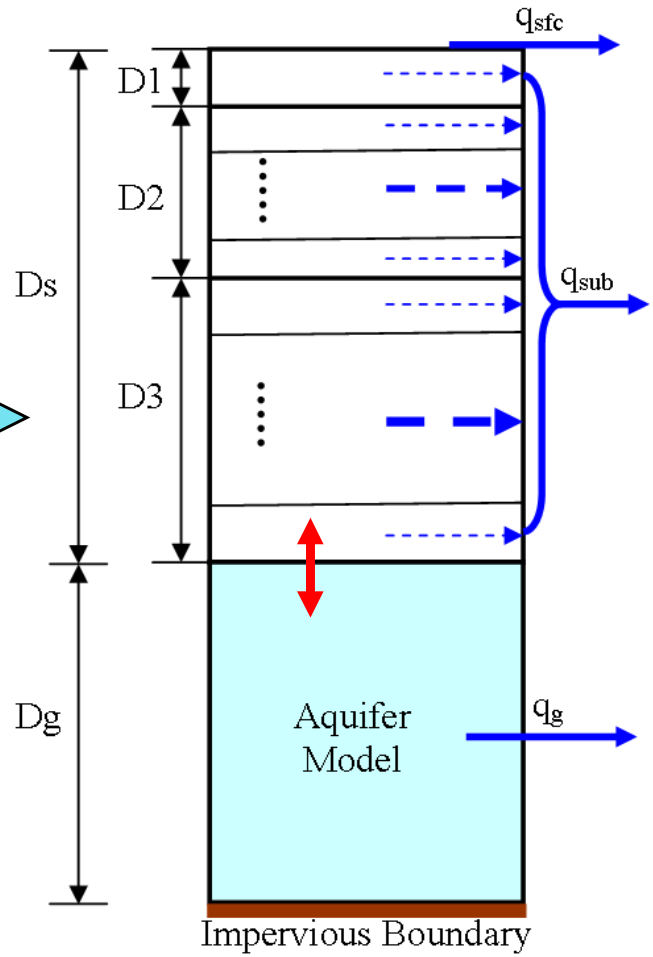


Table 1. Soil hydraulic functions used in SiB2 and HydroSiB2

Source	$\psi(\theta)$	$K(\theta)/K_s$
Campbell (1974)	$\psi_s\left(\frac{\theta}{\theta_s}\right)^{-b}$	$\left(\frac{\theta}{\theta_s}\right)^{2b+3}$
van Genuchten (1980)	$\frac{1}{\alpha}\left[(s)^{-1/m}-1\right]^{\frac{1}{n}}$	$s^{1/2}\left[1-\left(1-s^{-1/m}\right)^{m}\right]^{2}$

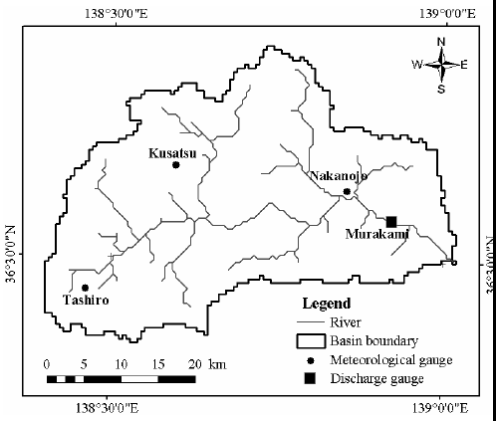
SiB2

WEB-DHM $\begin{cases} n = 1/b + 1 \\ \alpha = -1.0/(100 * \psi_{sat}) \end{cases}$

Rawls et al.(1992), Braun and Schadler (2005)

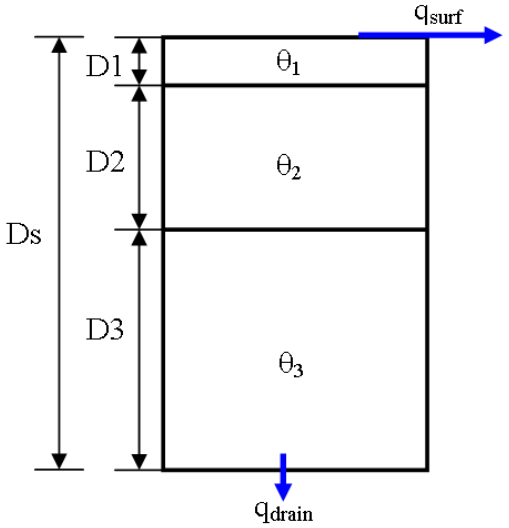
Both with sub-grid topography

Agatsuma Basin

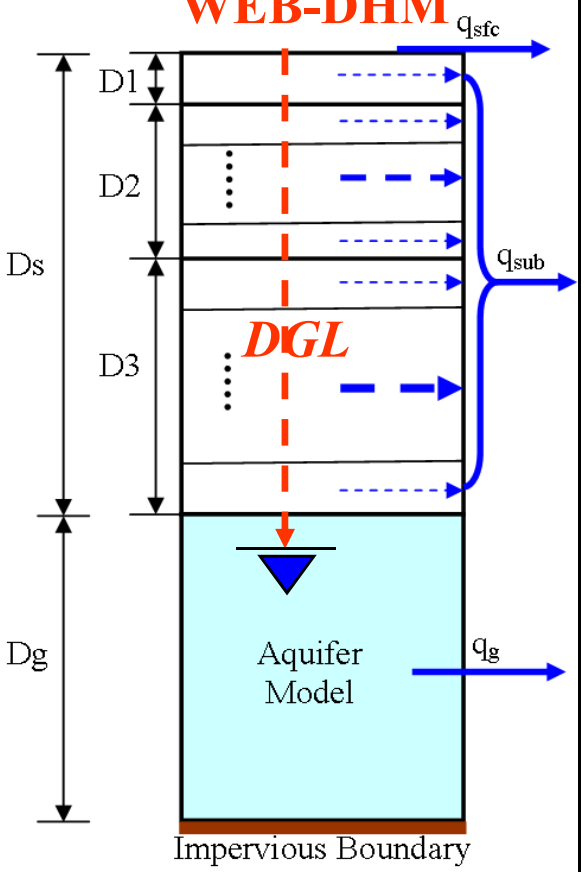


Basin-averaged model outputs

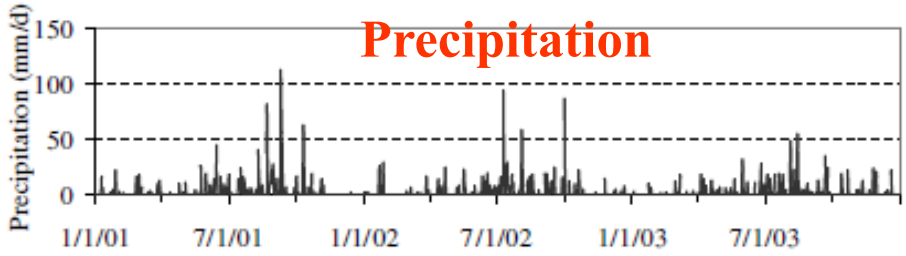
SiB2



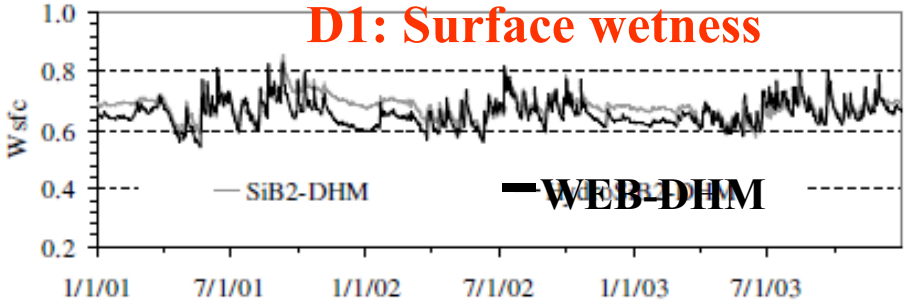
WEB-DHM



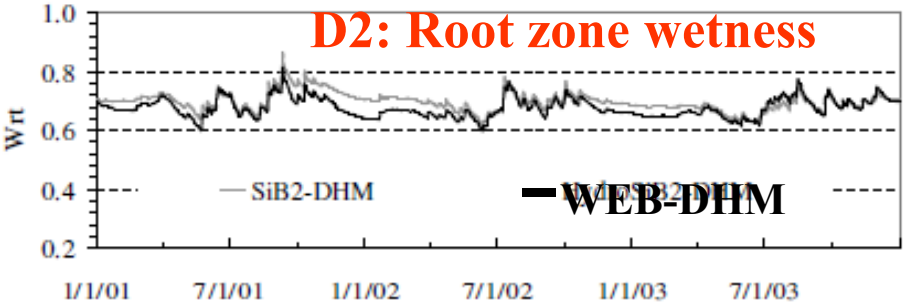
Precipitation



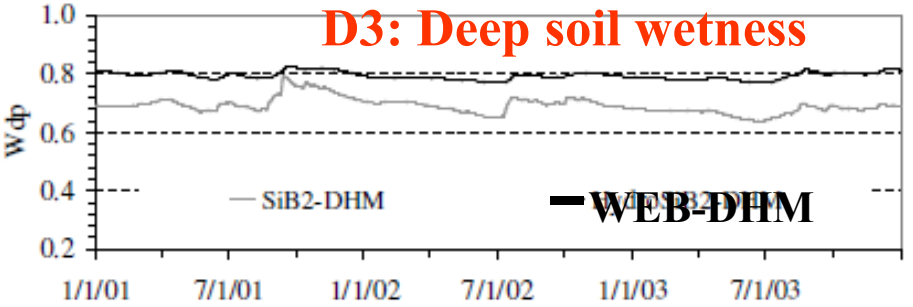
D1: Surface wetness



D2: Root zone wetness



D3: Deep soil wetness

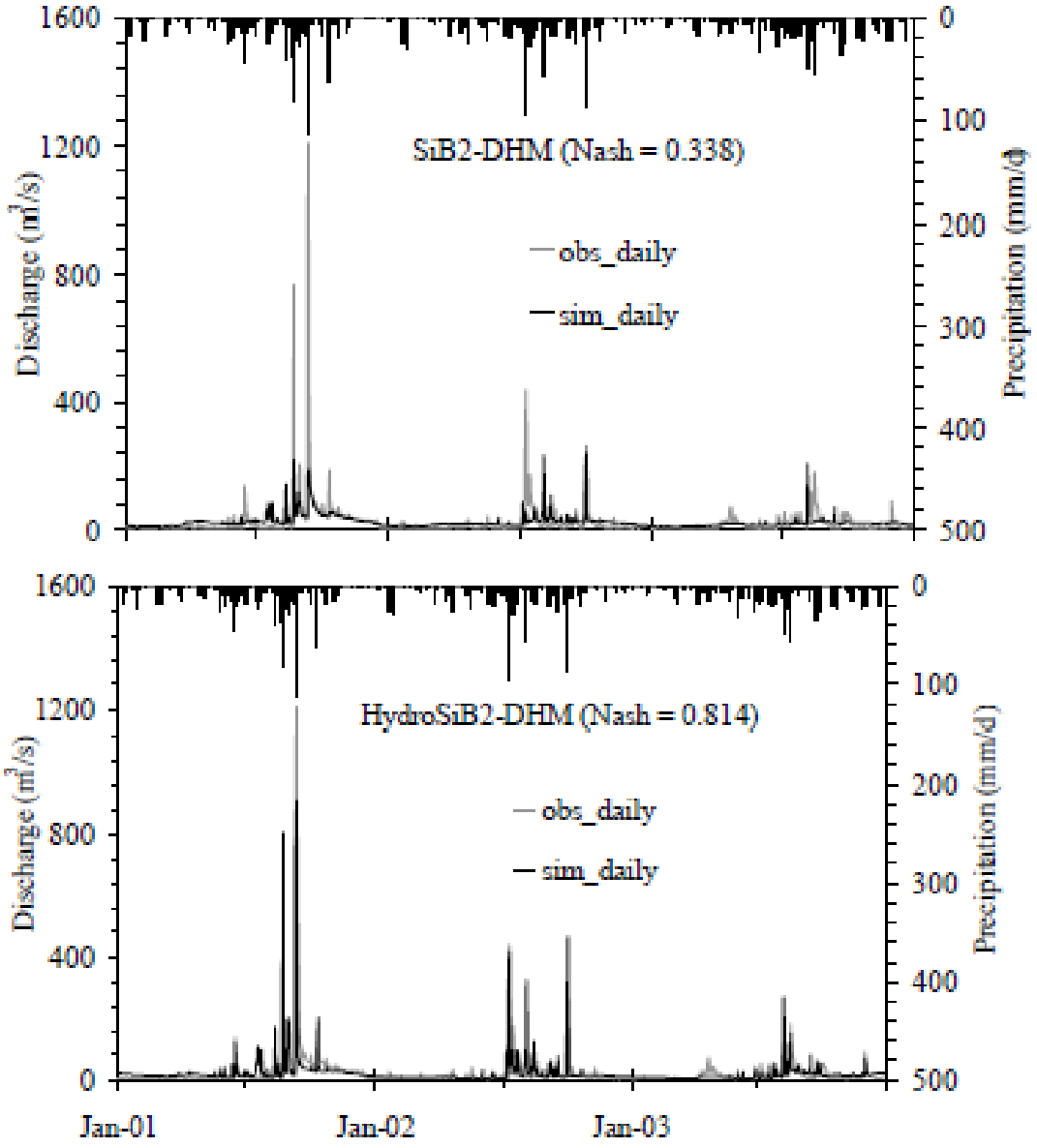


Comparison of daily streamflows at Murakami

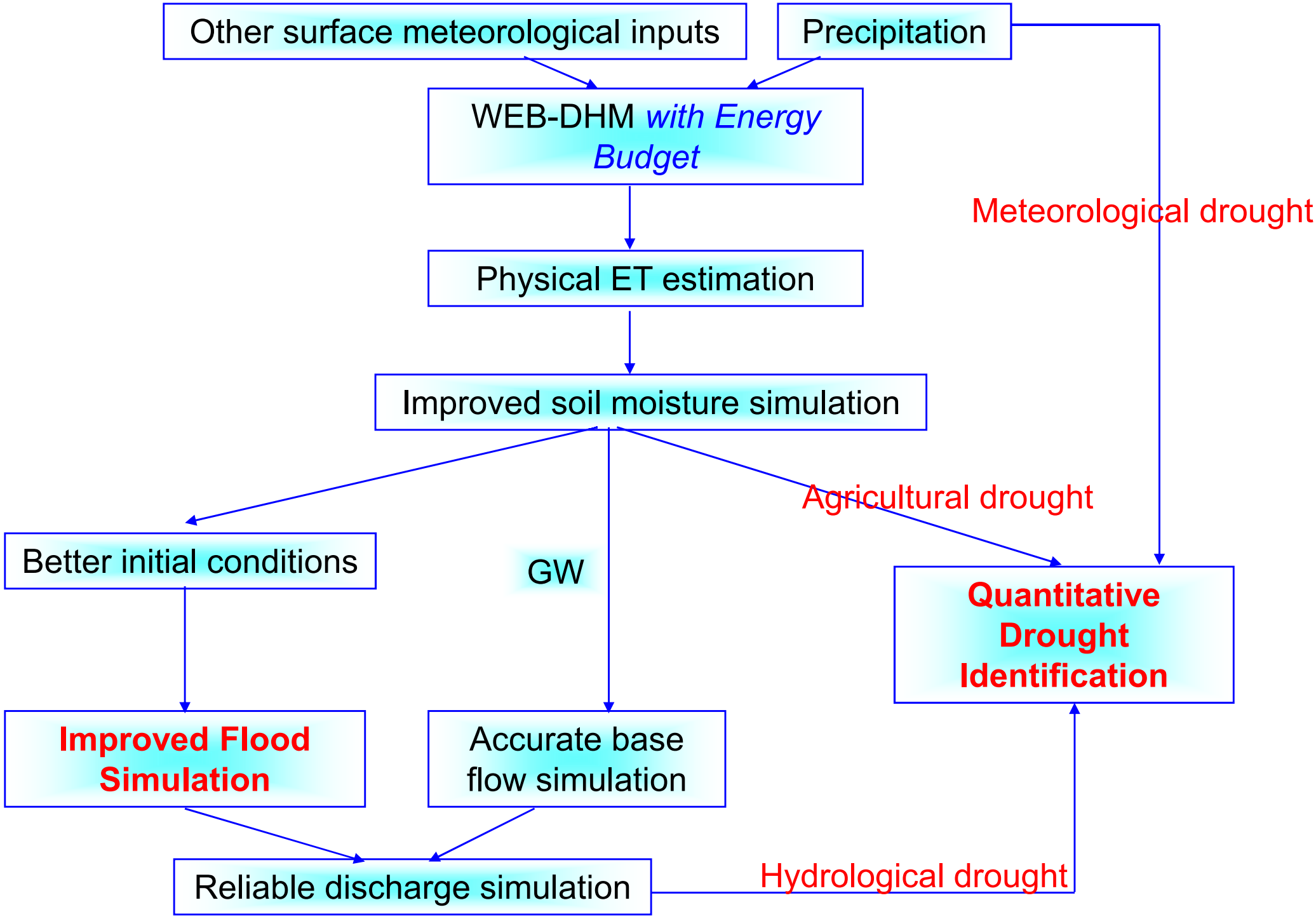
both considering sub-grid topography

SiB2

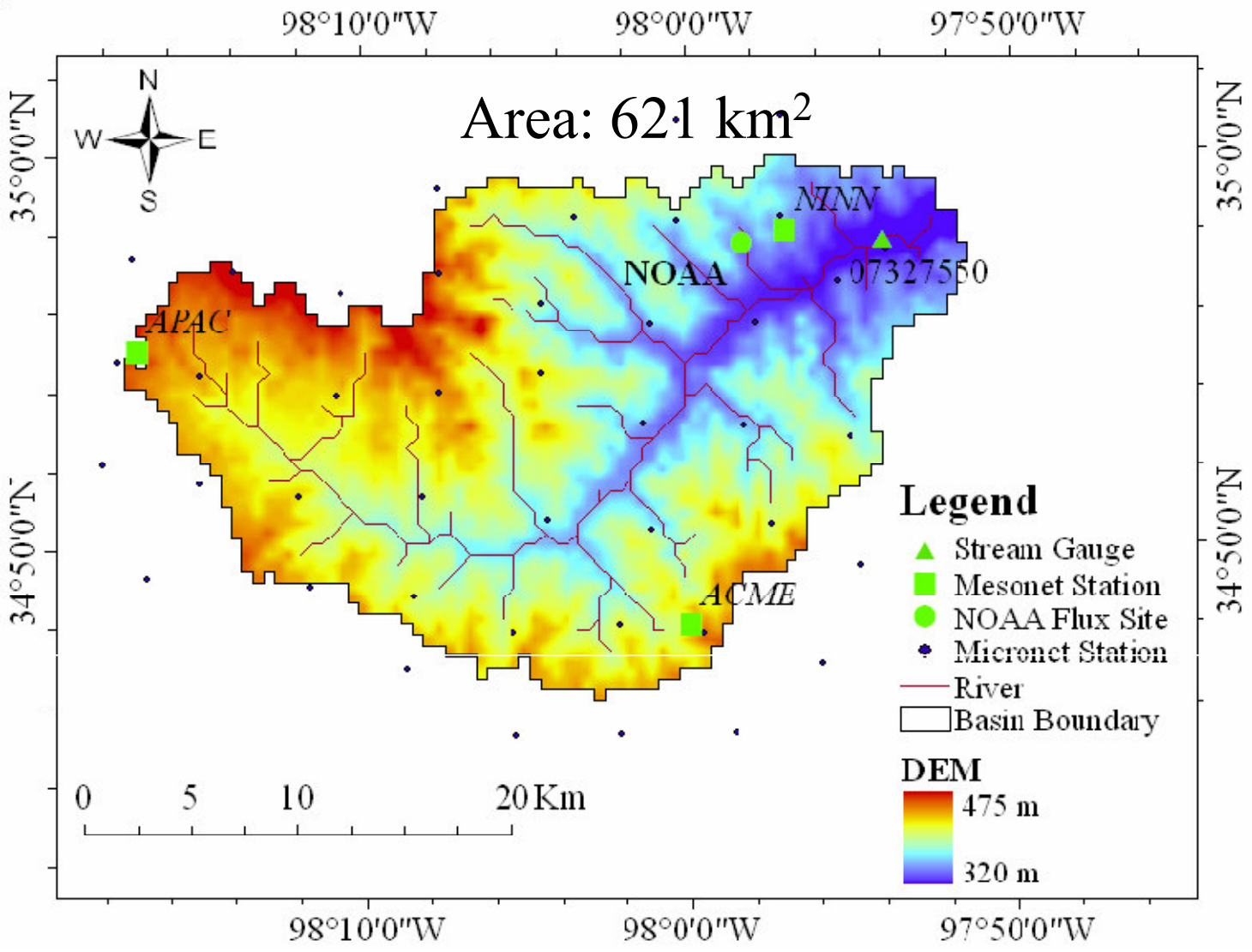
WEB-DHM



WEB-DHM is a solution for flood and drought



Little Washita Basin, USA

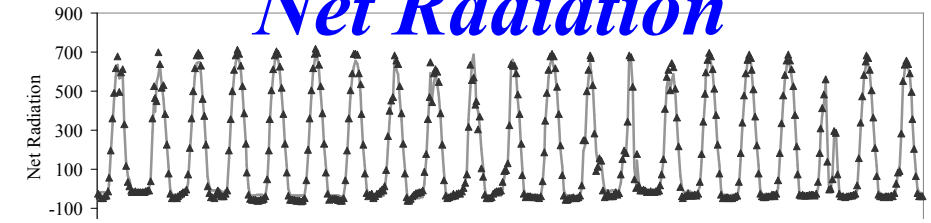


Hourly simulation with 500 m grid size

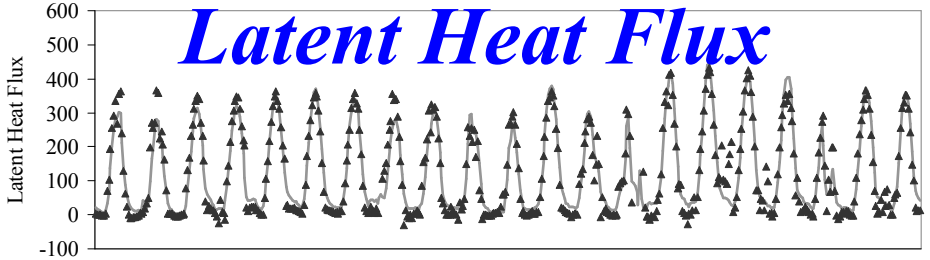
Model Evaluations with SGP97&SGP99 Observations

NOAA flux site

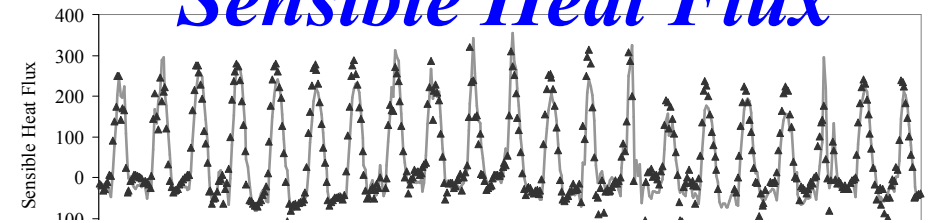
Net Radiation



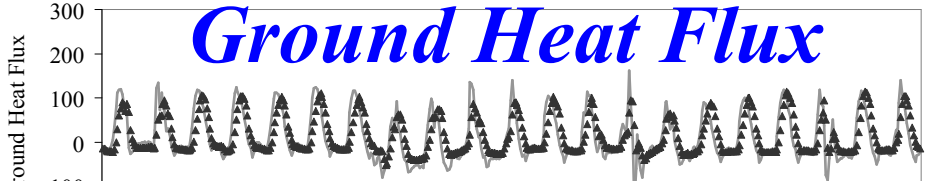
Latent Heat Flux



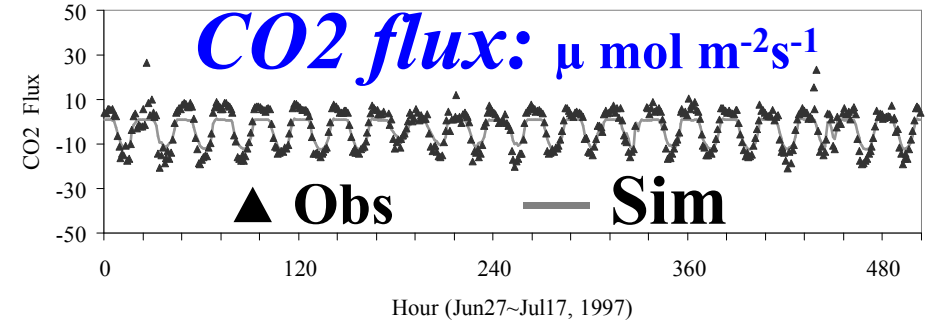
Sensible Heat Flux



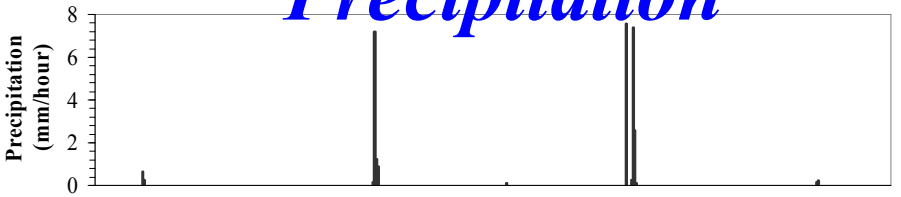
Ground Heat Flux



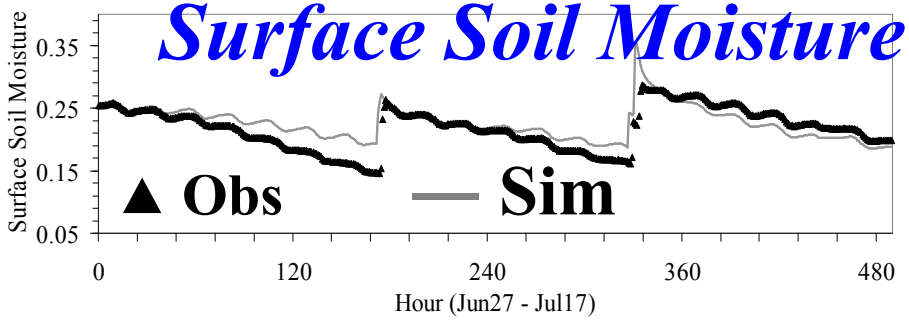
CO2 flux: μ mol m^{-2}s^{-1}



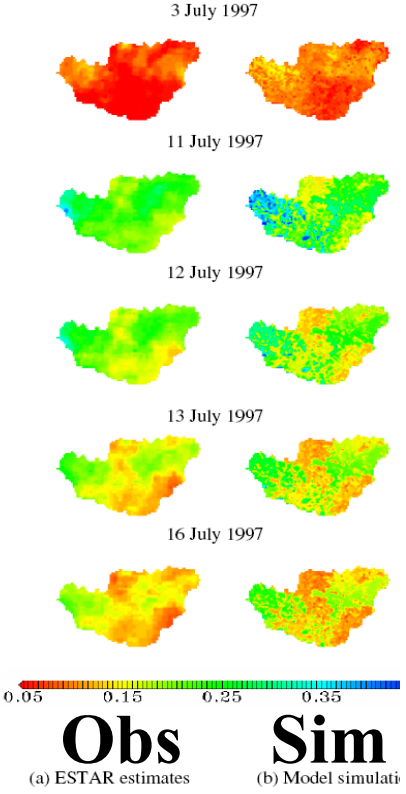
Precipitation



Surface Soil Moisture

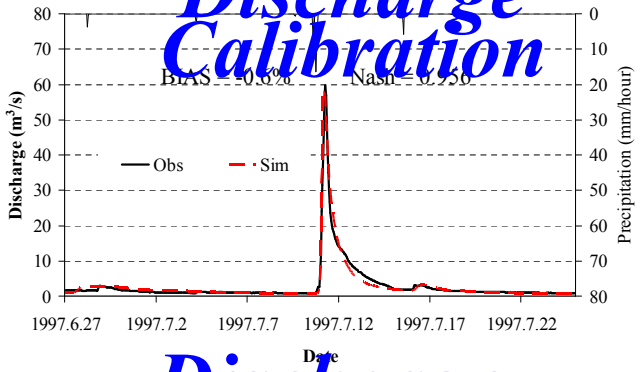


Surface soil moisture

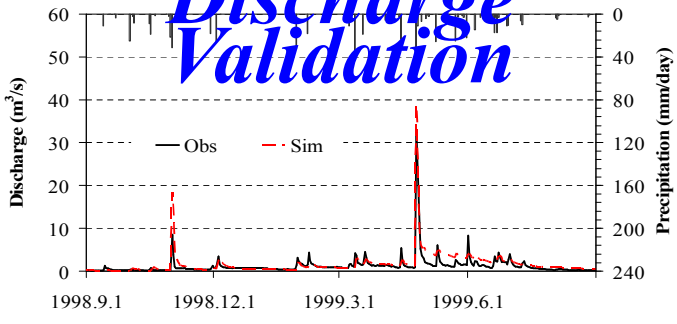


Basin-scale

Discharge Calibration

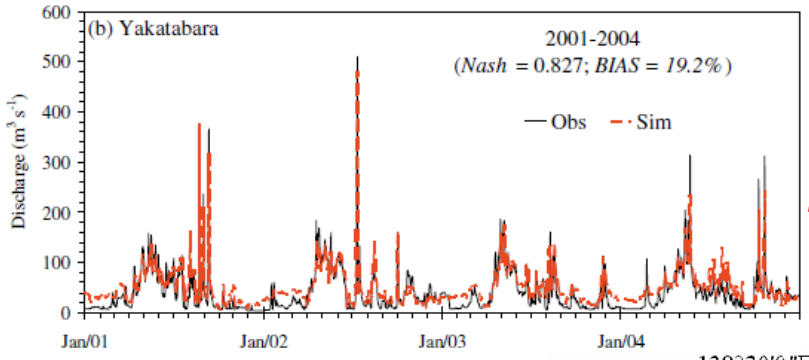


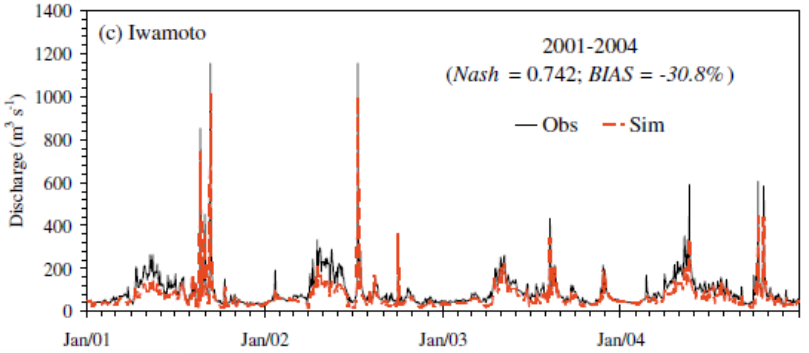
Discharge Validation



The upper Tone River Basin, Japan

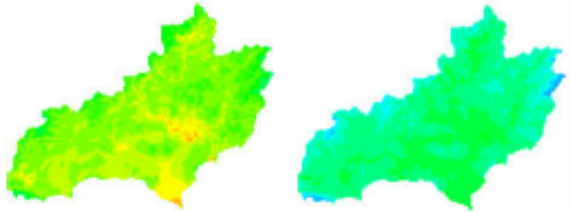
2001-2004



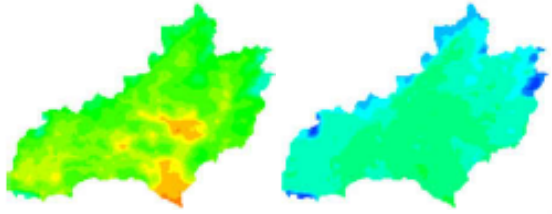


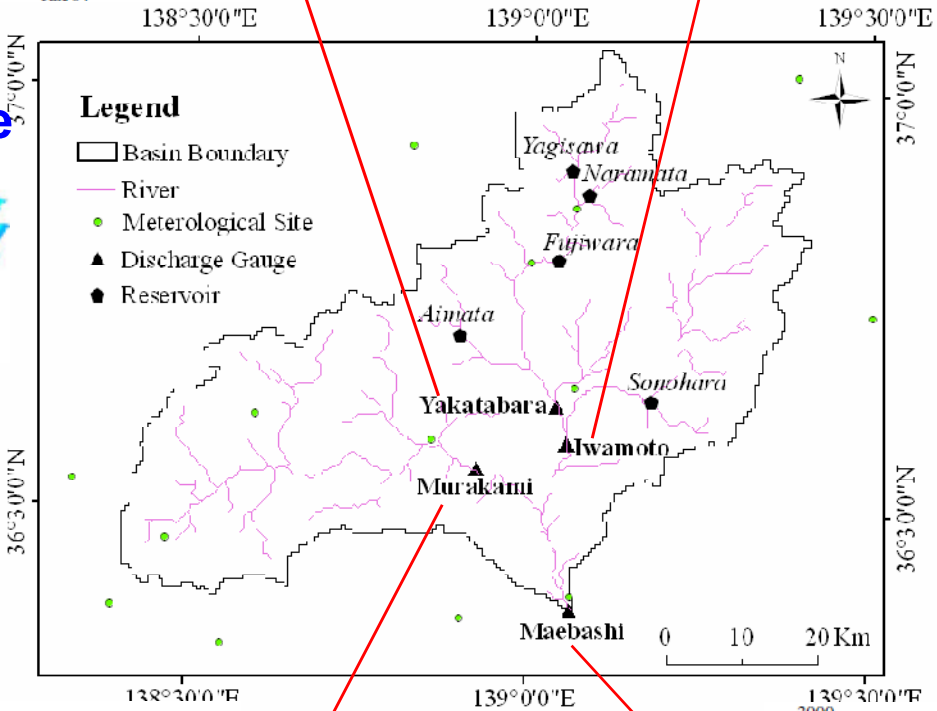
Simulated LST

Daytime nighttime

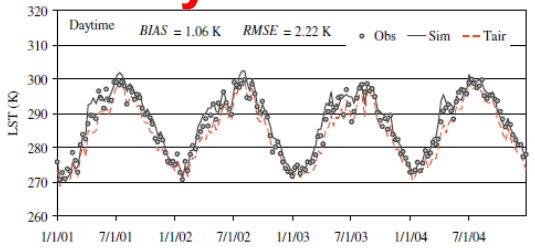


MODIS LST

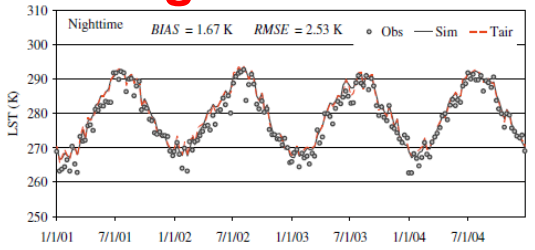


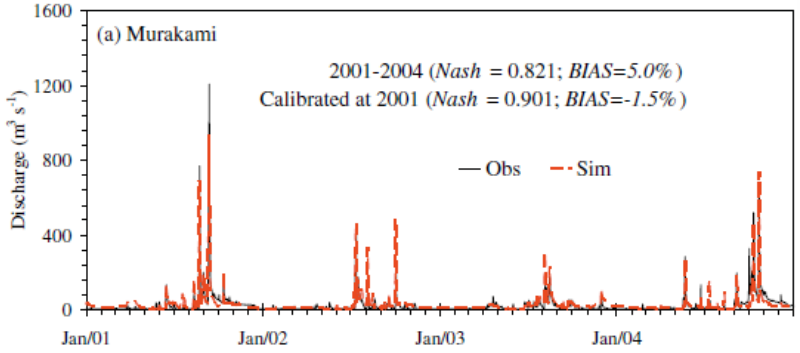


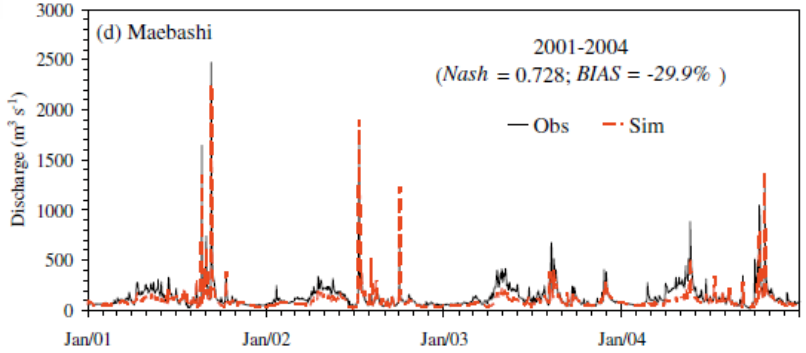
Daytime LST



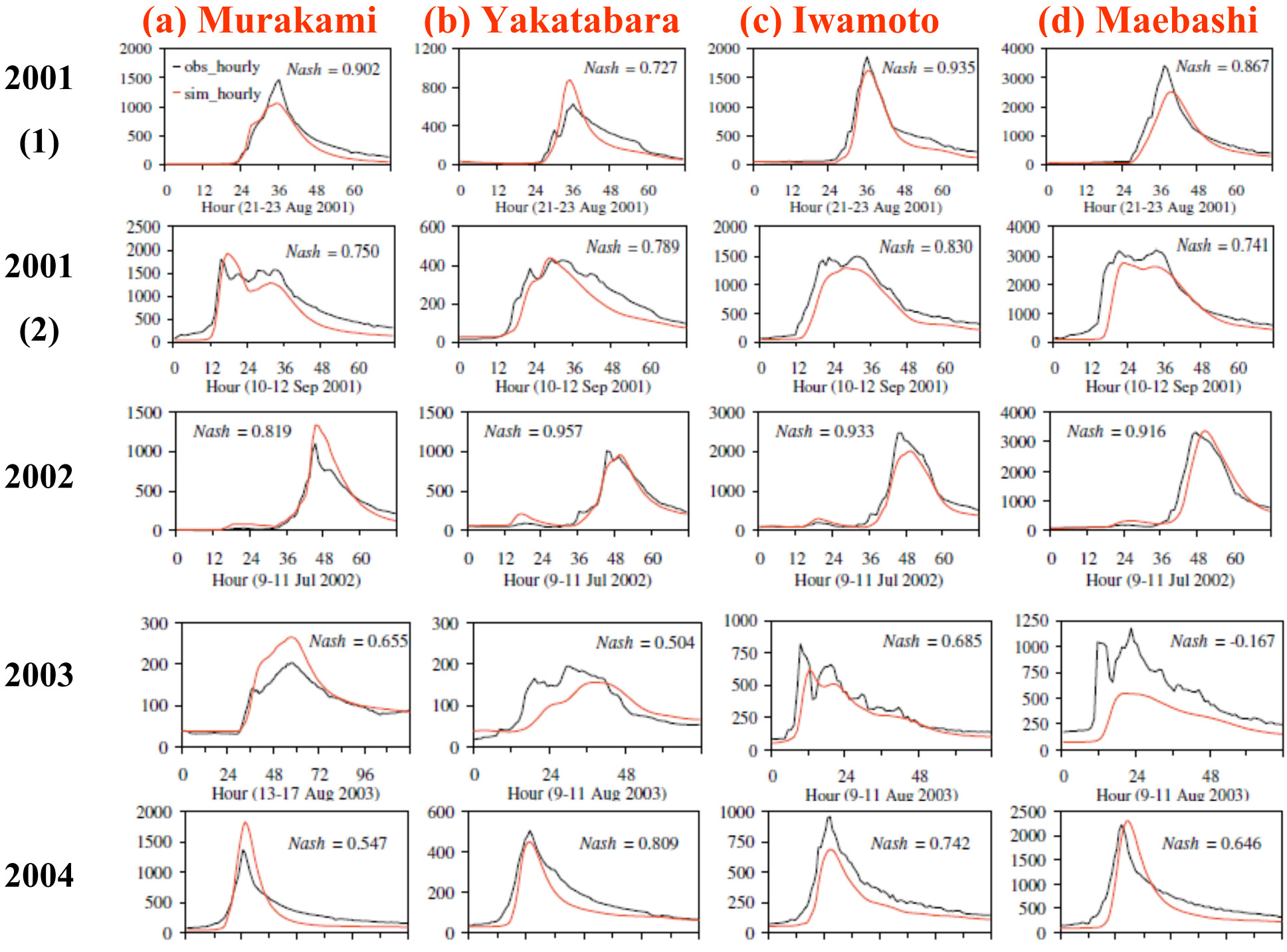
Nighttime LST







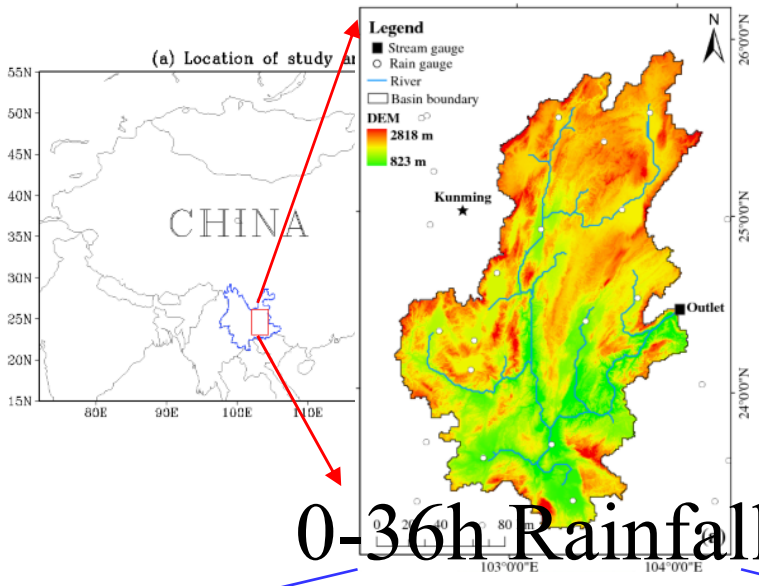
Hourly Annual Largest Flood Peak



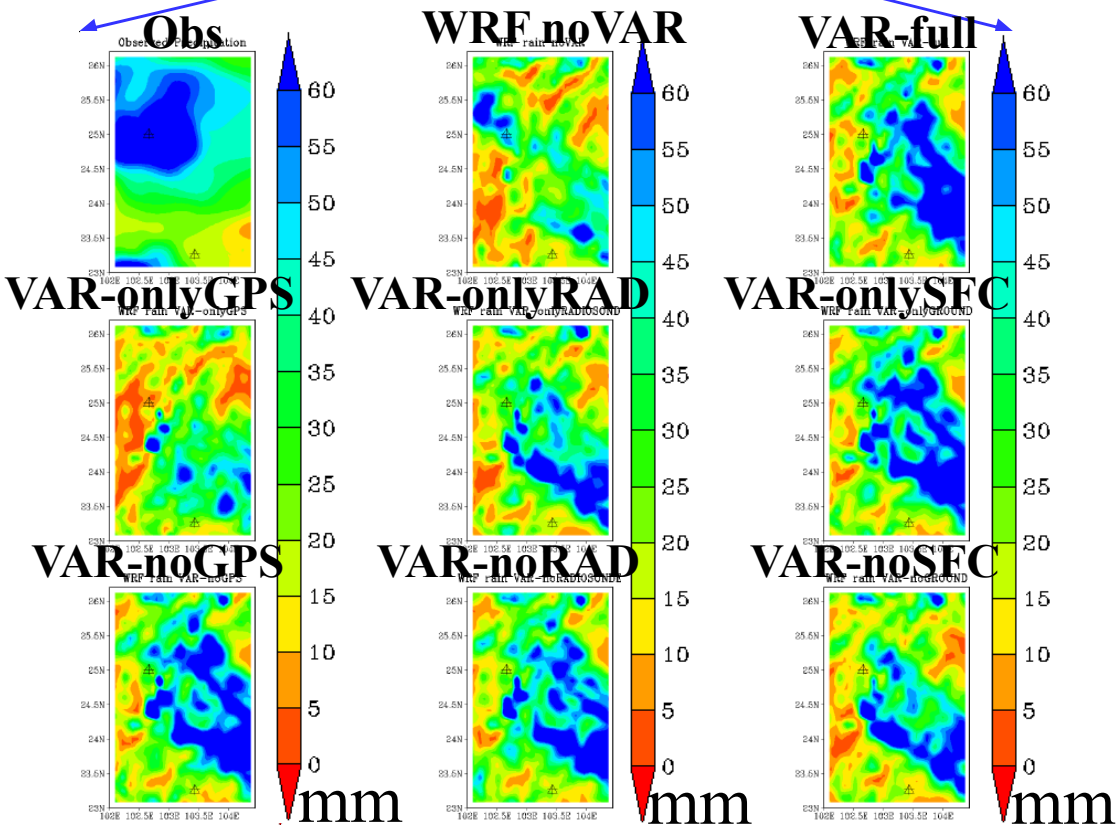
Japan-China cooperative JICA Project: Technical support in China

41 engineers from China Institute of Water Resources and Hydropower Research, China Meteorological Administration and its provincial branches, Institute of Tibetan Plateau/CAS, & Nanjing University

The 0-36h real-time flood forecasting, Nanpan River

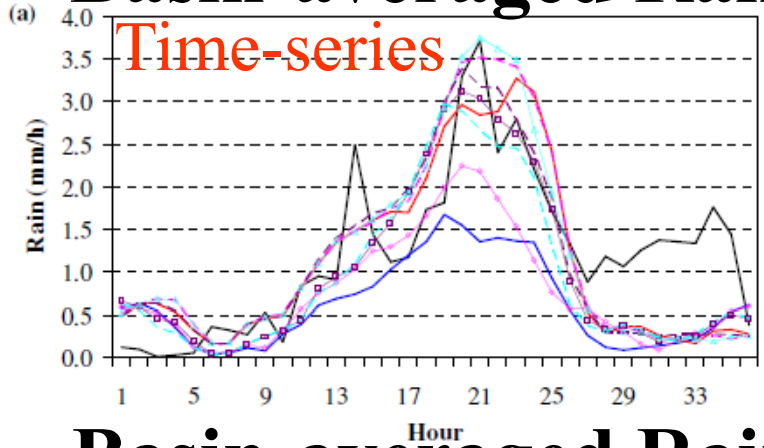


0-36h Rainfall



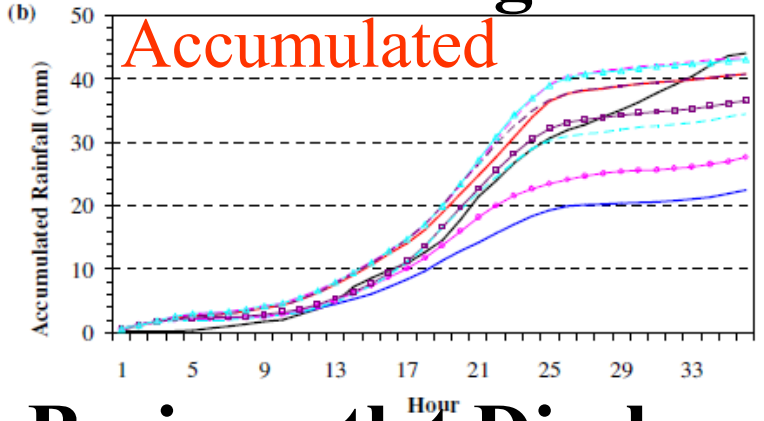
Basin-averaged Rain

Time-series

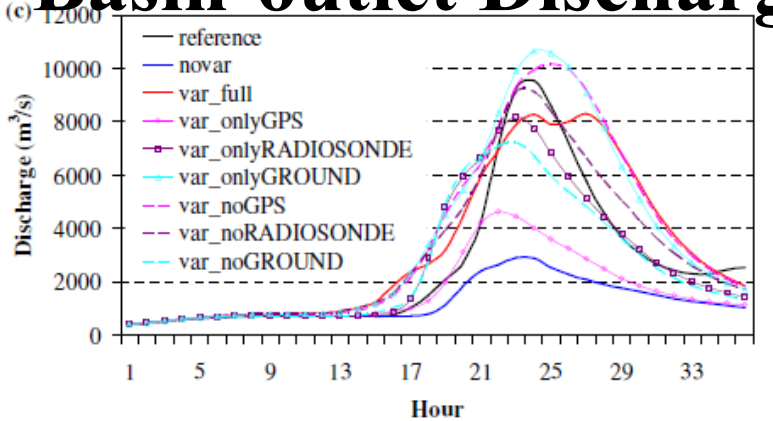


Basin-averaged Rain

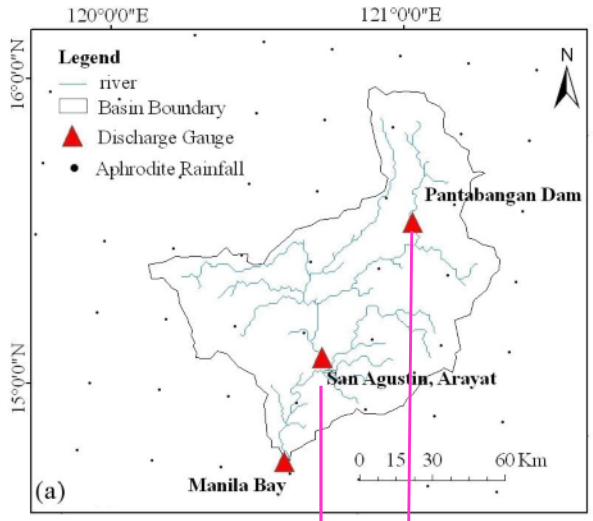
Accumulated

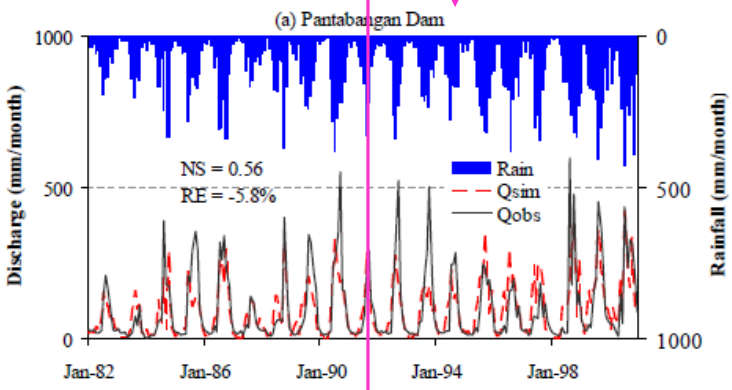


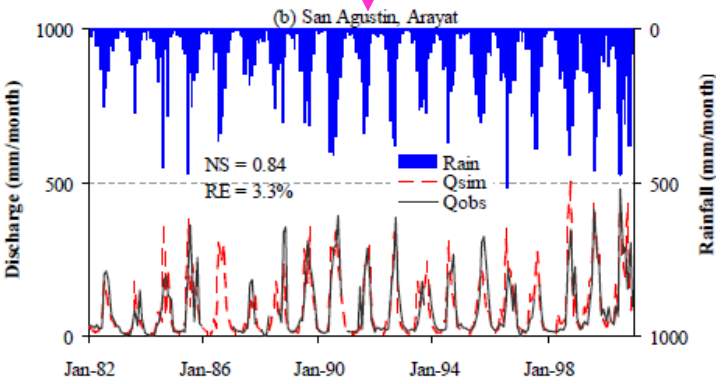
Basin-outlet Discharge



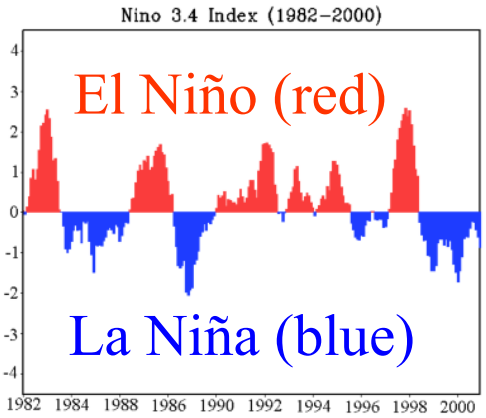
Drought study in Pampangga River Basin, Philippines





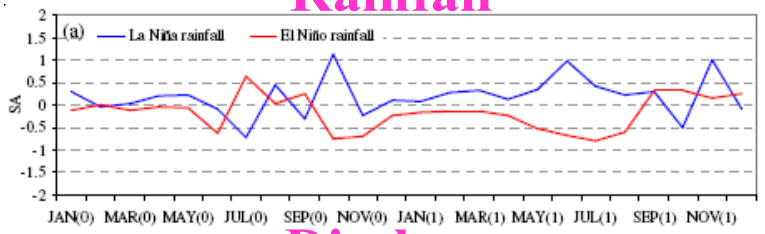


ENSO influence

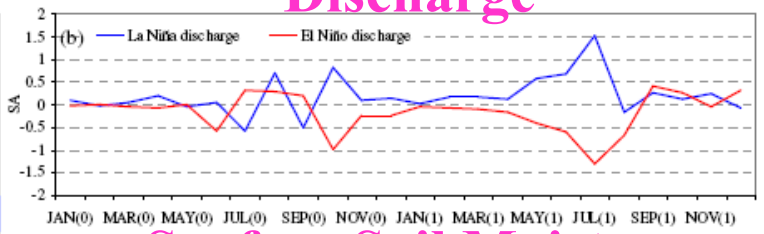


Standardized Anomaly Index

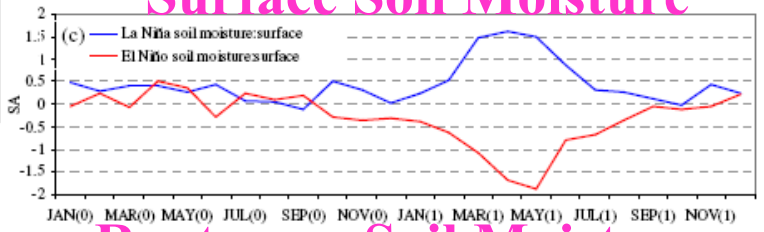
Rainfall



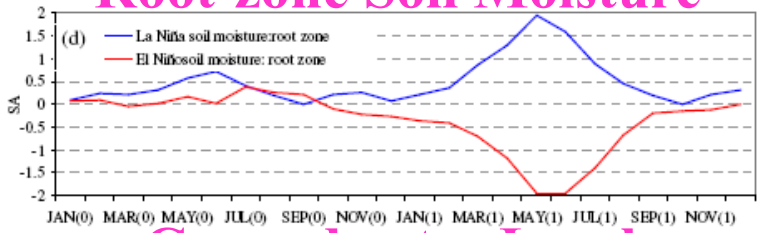
Discharge



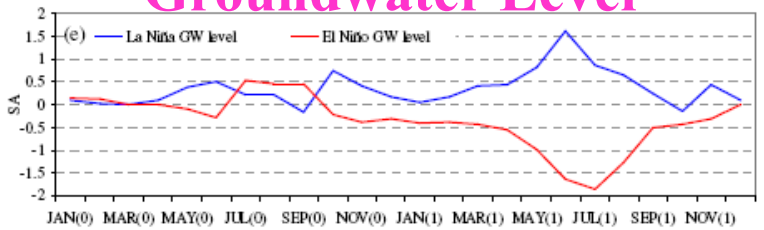
Surface Soil Moisture



Root-zone Soil Moisture

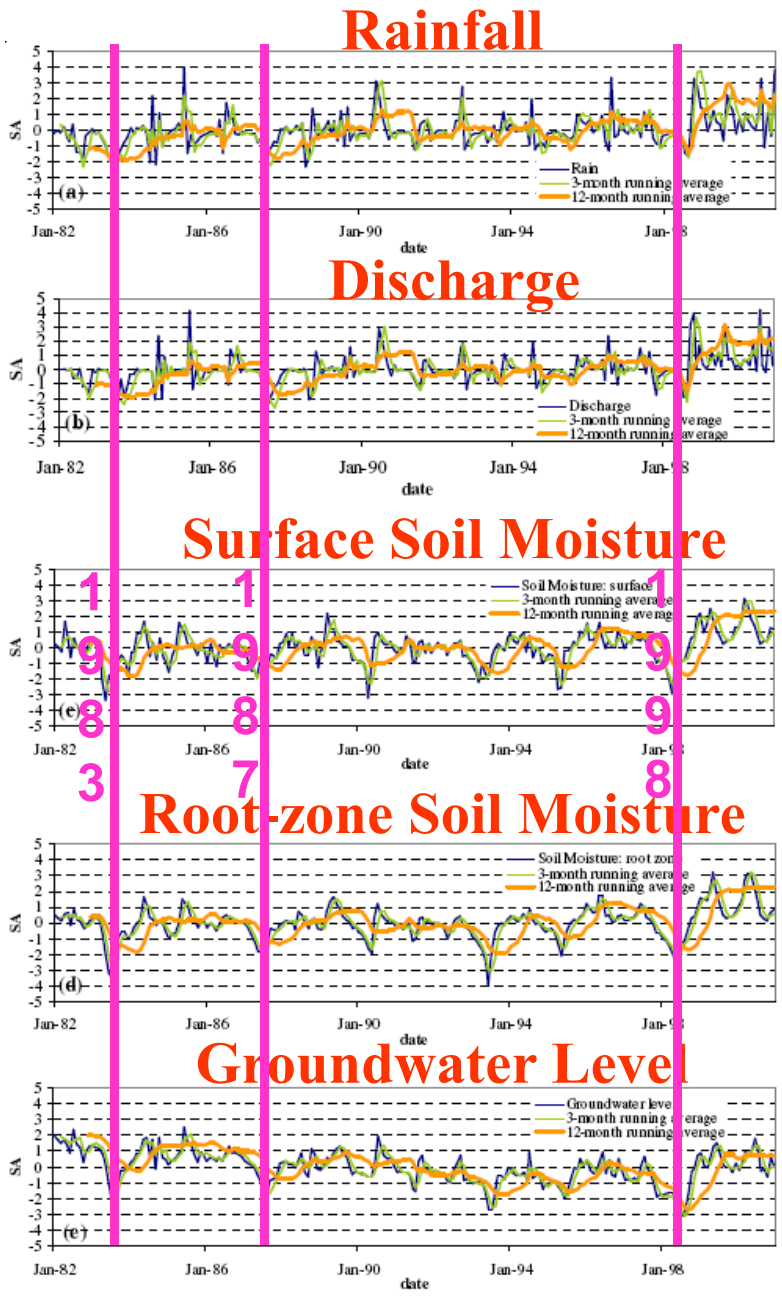


Groundwater Level



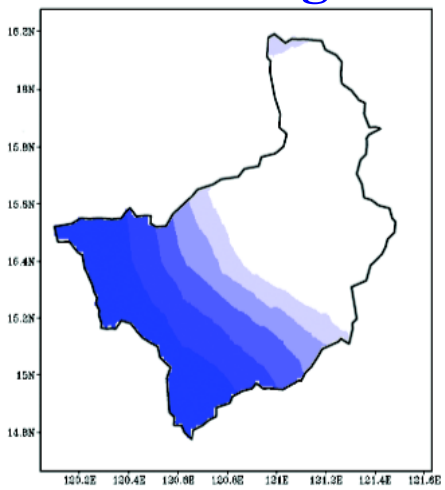
Drought identification, Pampangga River Basin, Philippines

Standardized Anomaly Index (SA)

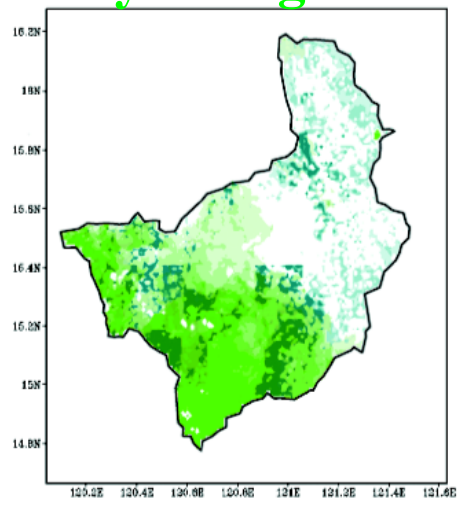


Drought-prone areas (*Aug 1998*)

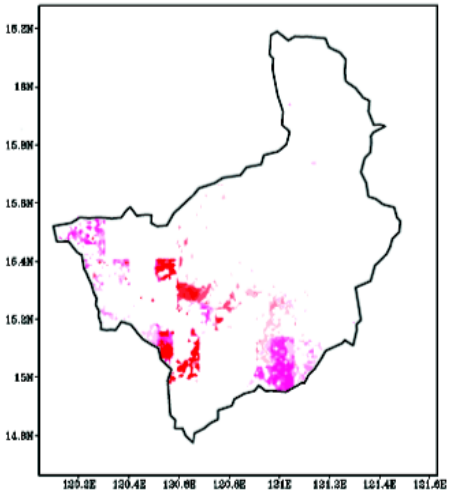
Meteorological



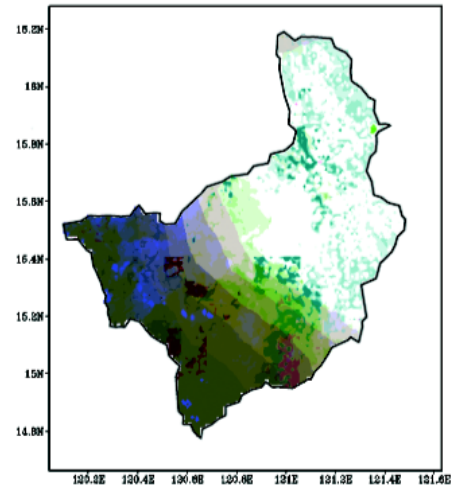
Hydrological



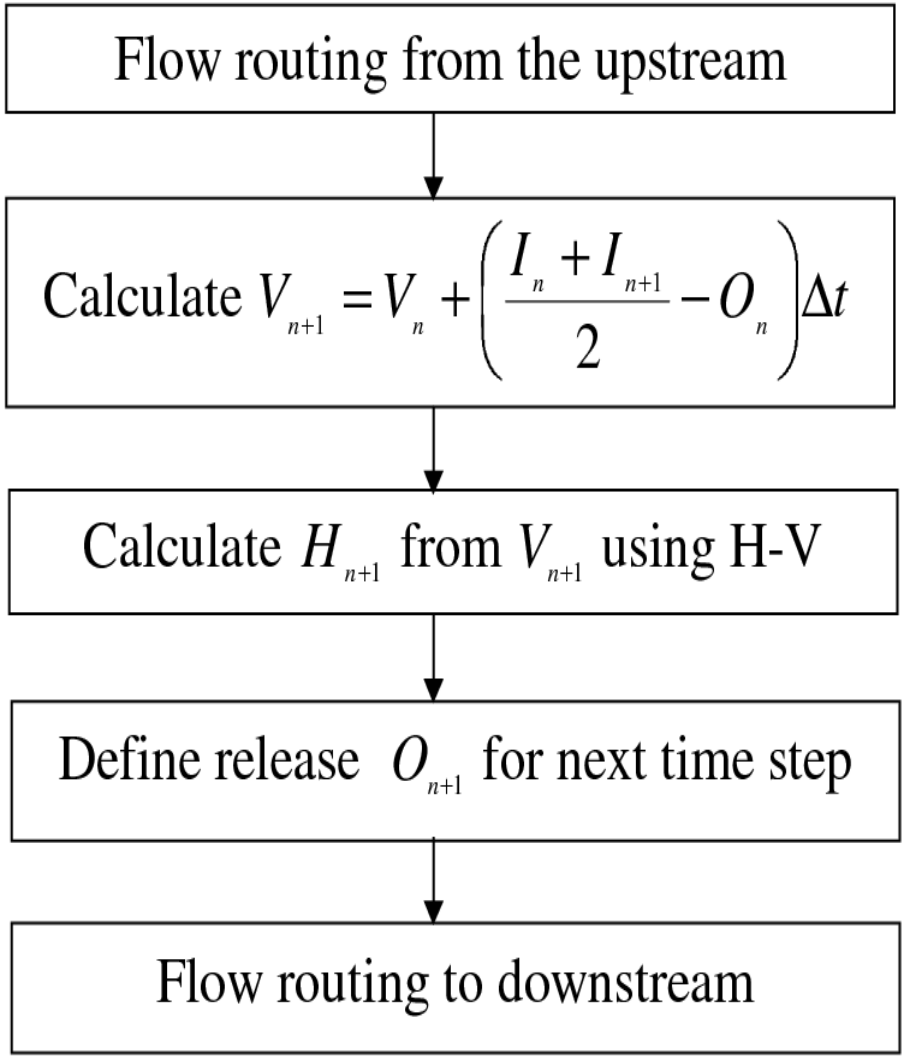
Agricultural



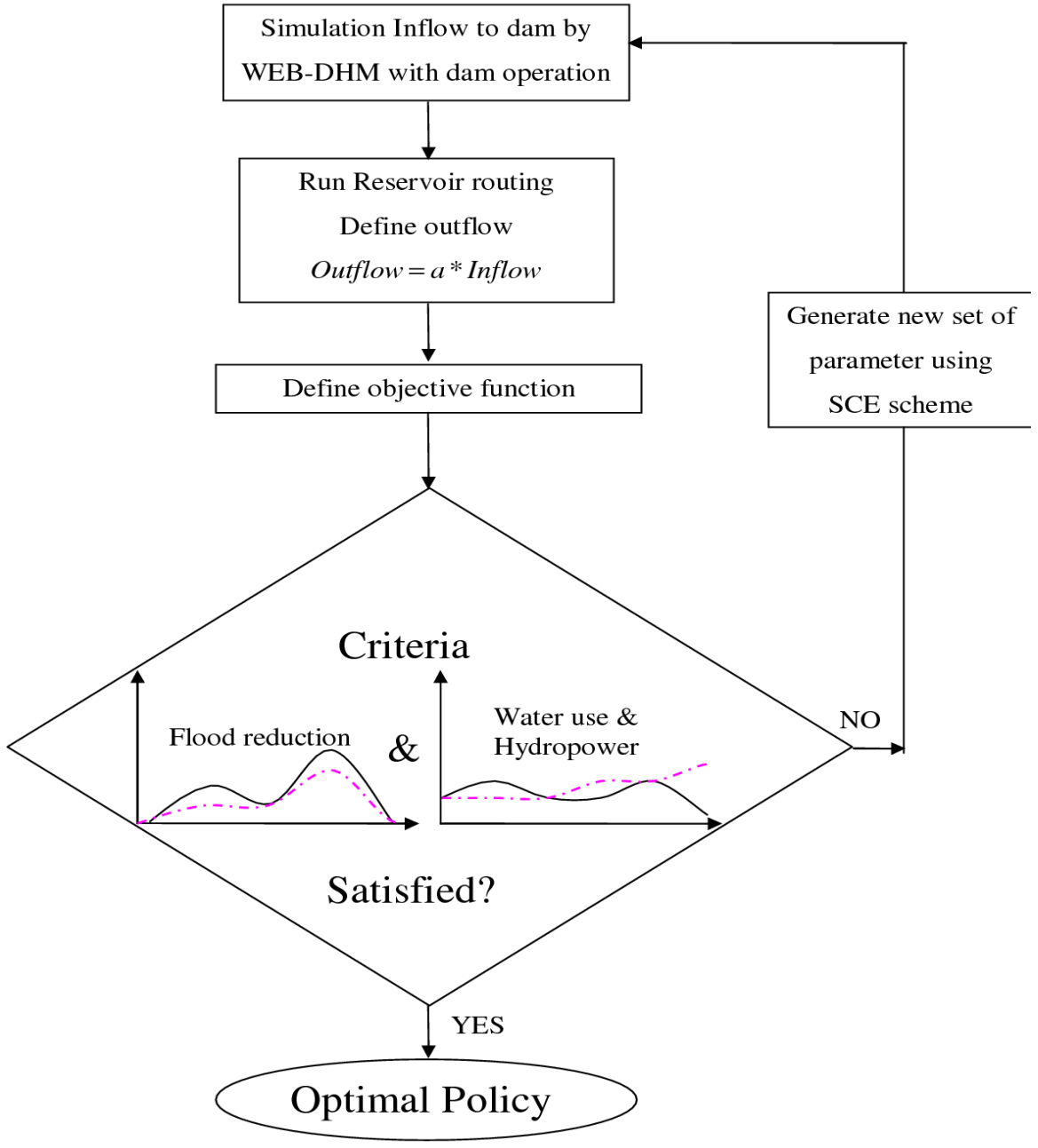
Combined



WEB-DHM coupled with SCE for improved reservoir operation in Red River Basin, Vietnam

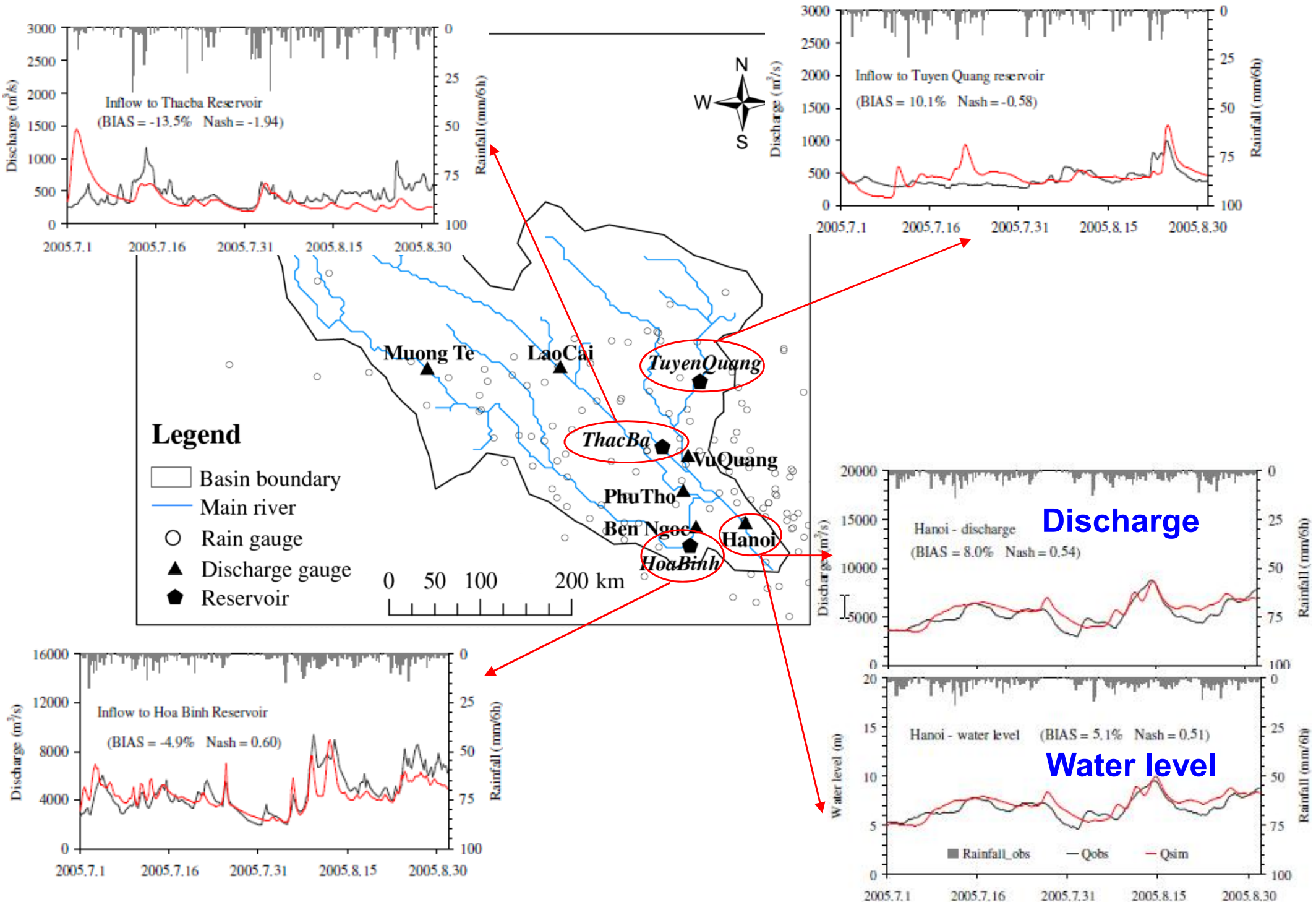


Add a reservoir module



Couple with SCE for optimization

The Red River Basin, Vietnam



The Red River Basin: 160,000 km^2

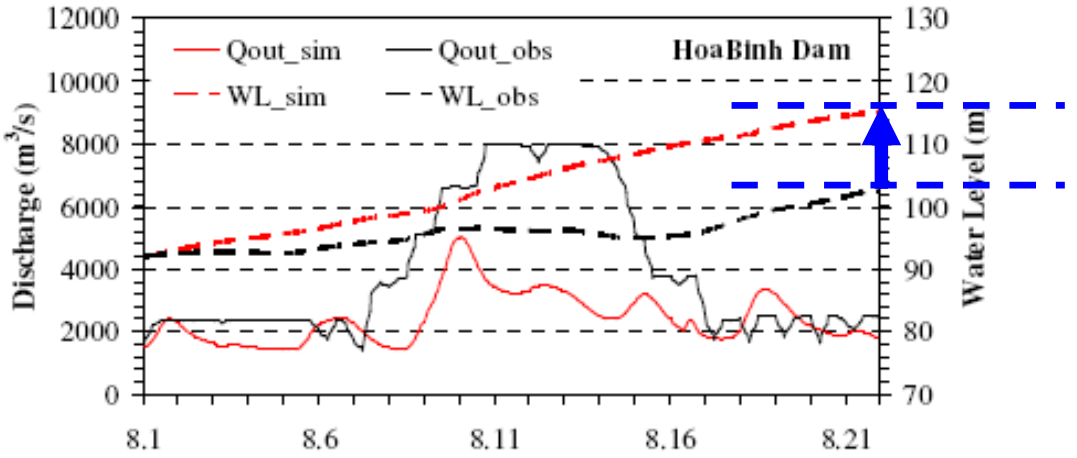
Lead-time dam operation system

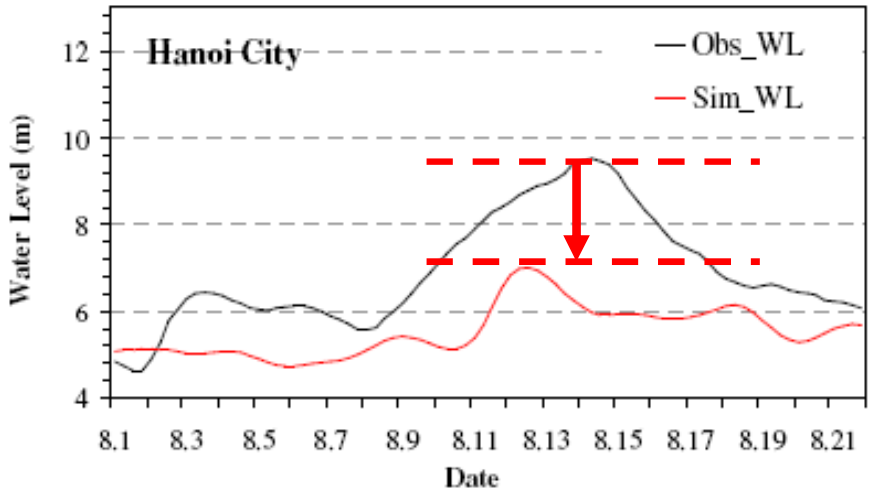
$$MinimizeF = w_1\left(\sum_{t=1}^{T}\frac{1}{T}\left(H_{ds\_sim}-H_{ds\_opt}\right)^2\right)+w_2\left(\sum_{t=1}^{T}\frac{1}{T}\left(R_{dam\_sim}-R_{\max}\right)^2\right)$$

Lead-time optimization: JMA-GPV forecasts

Operation: the corrected GSMaP rainfall with gauge data

Flood Control (FC)／Water Use (WU) can be changed:
w1 : w2 ＝FC : WU



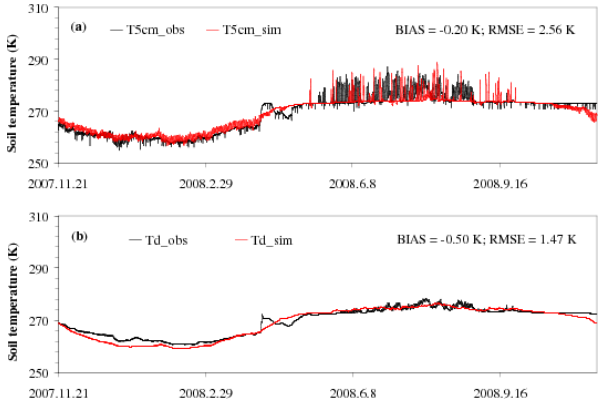


2005

Frozen Soil Parameterization in WEB-DHM

Point-scale frozen dynamics

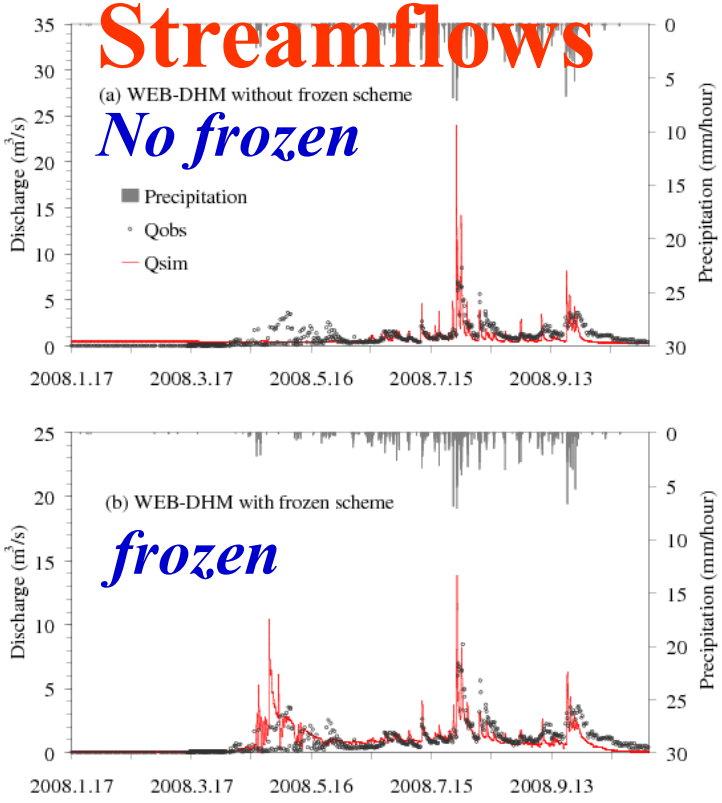
Soil Temperature



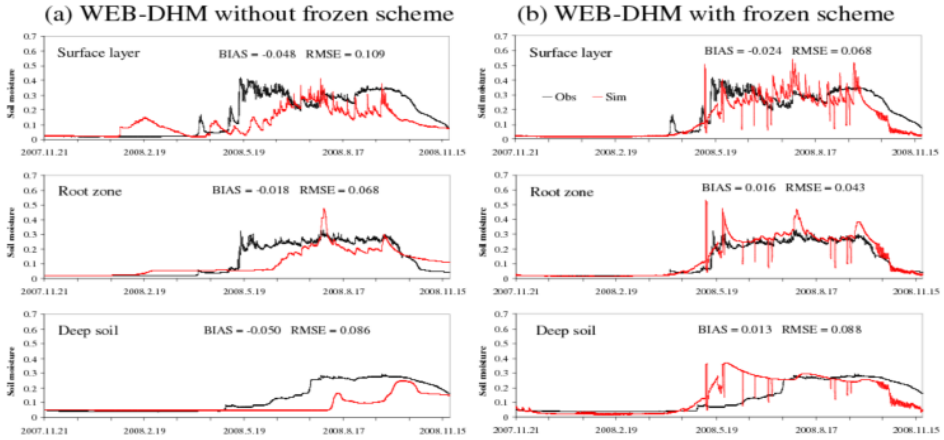
$$\theta_{\mathrm{liq},j} = a(T_f - T_{\mathrm{soil},j})^b$$

& modifications for soil hydraulic and thermal properties

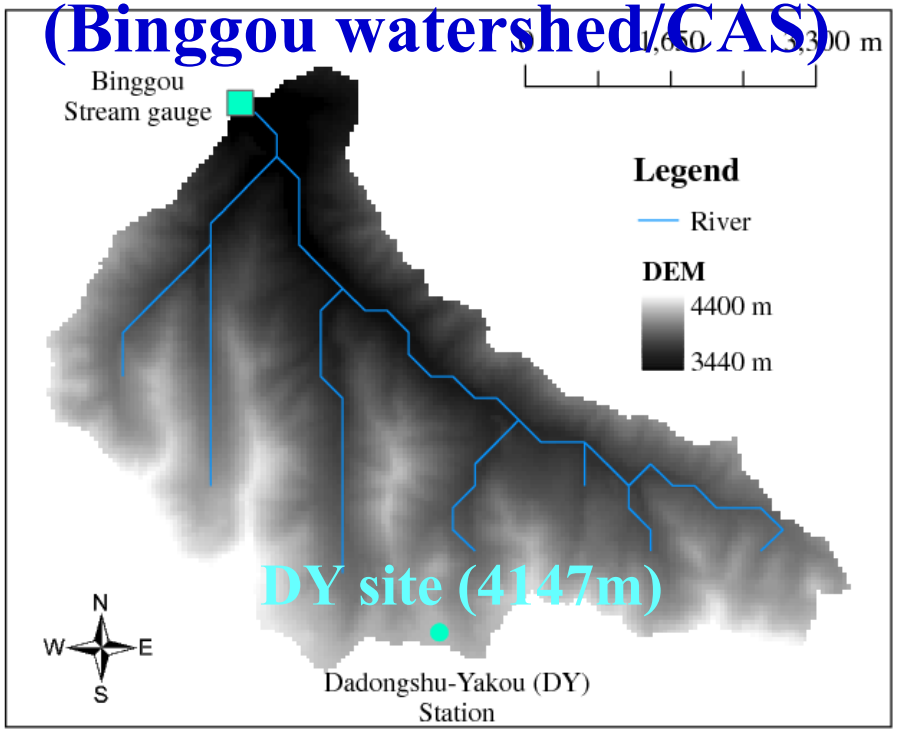
Streamflows



Soil moisture profile



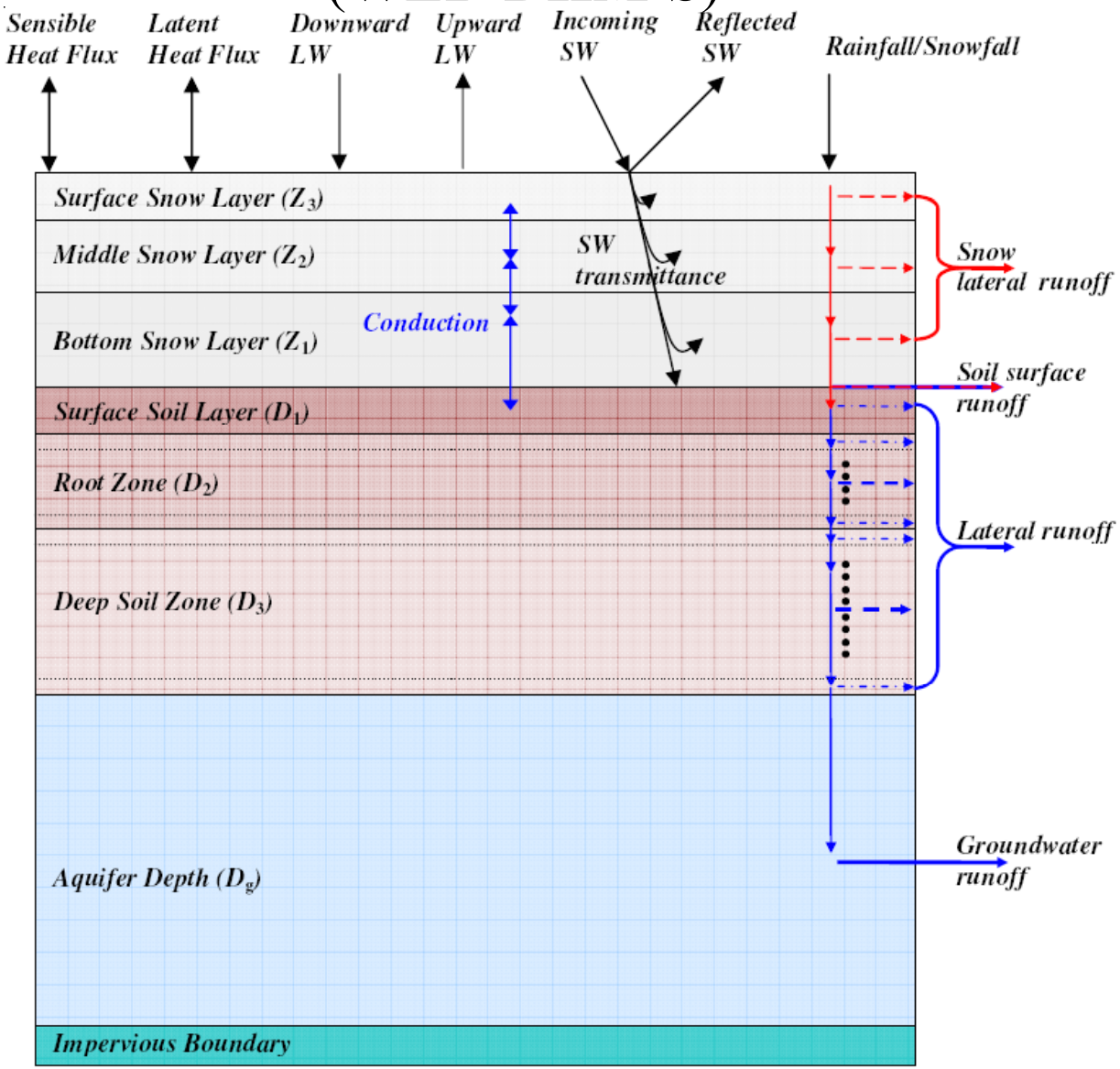
(Binggou watershed/CAS)



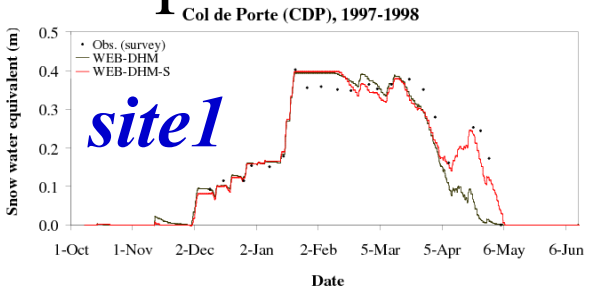
Improving the snow physics of WEB-DHM

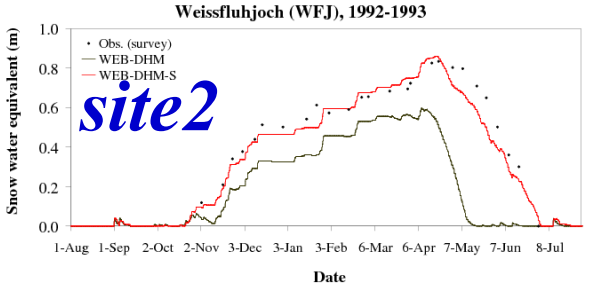
A three-layer snow model is added

(WEB-DHM-S)

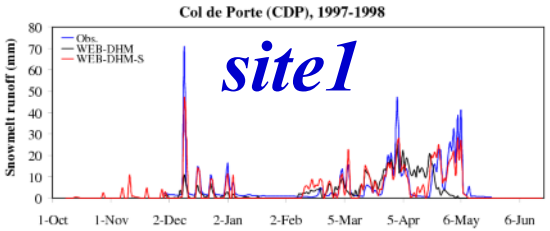


Snow Water Equivalent





Snowmelt Runoff



Thank you for your attention!

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