Hydrology Contributing to Water Resources Management under Climate Change

Requirements to Hydrology

- Connectivity with Global Models
  - physical down-scaling
  - integrated hydrological models with self-running capability
- Transferability under Climate Variability
  - model parameter estimation
  - initial and boundary conditions
  - forcing
- Leading to Public Awareness and Effective Actions
  - data integration for getting comprehensive knowledge
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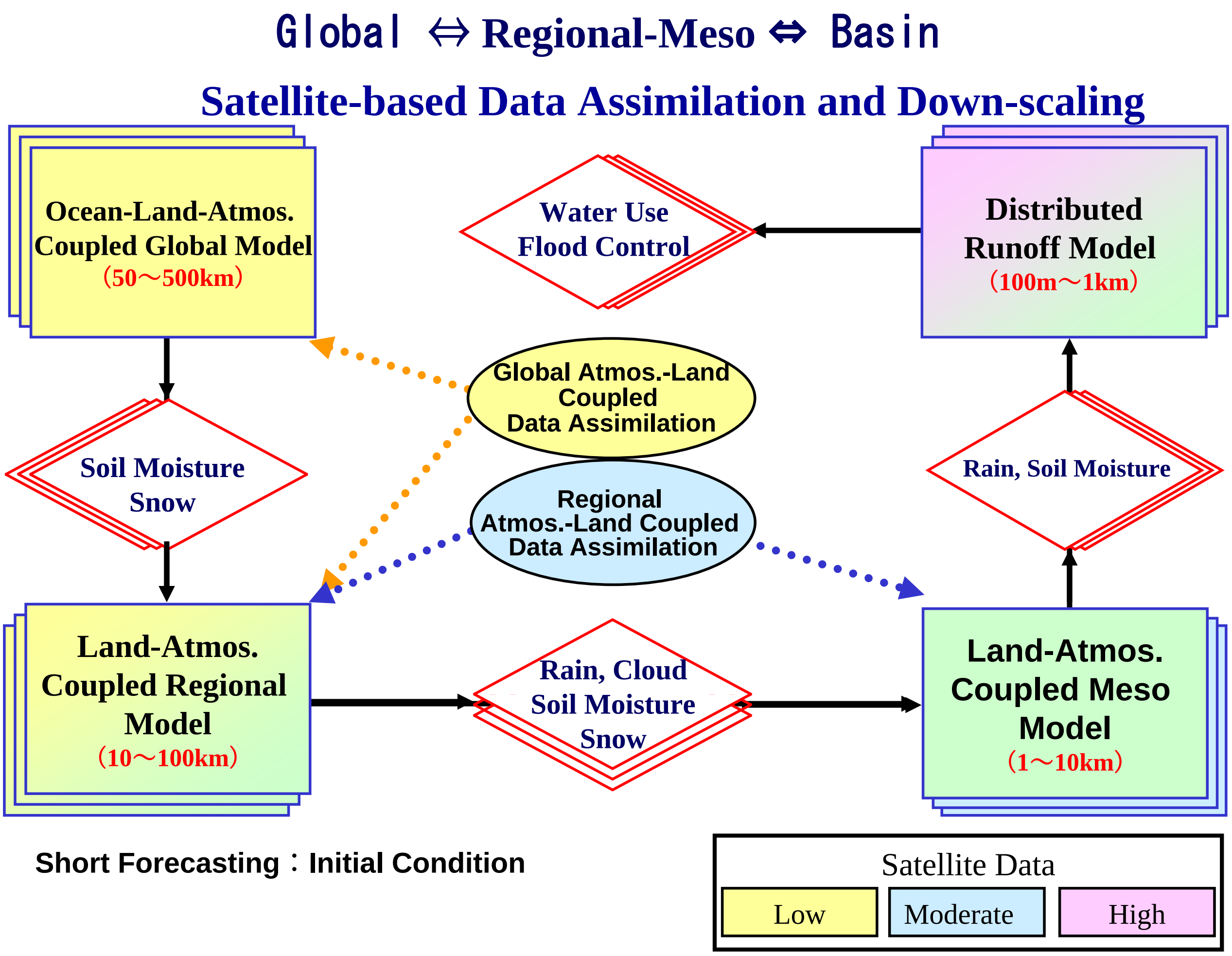
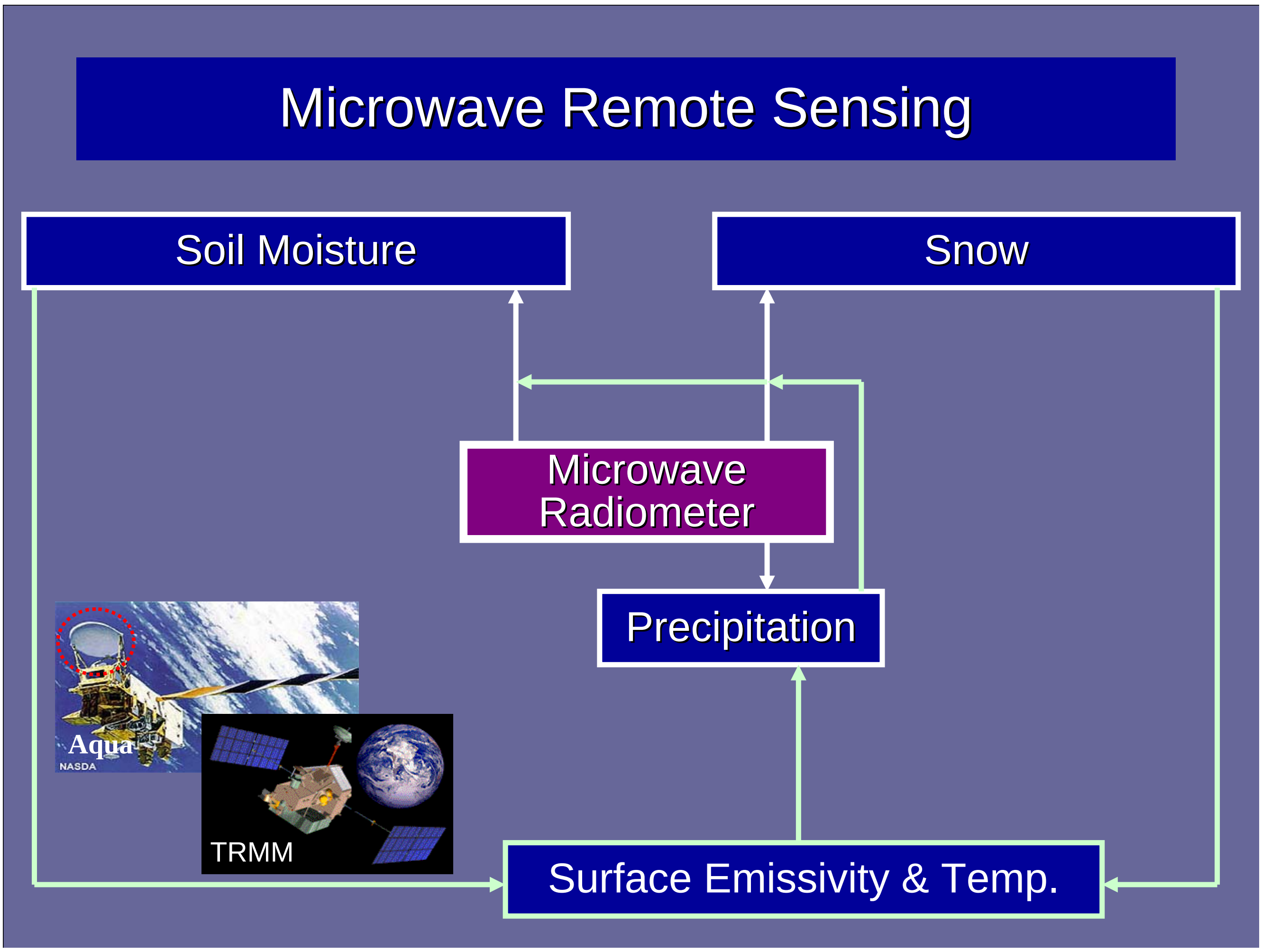
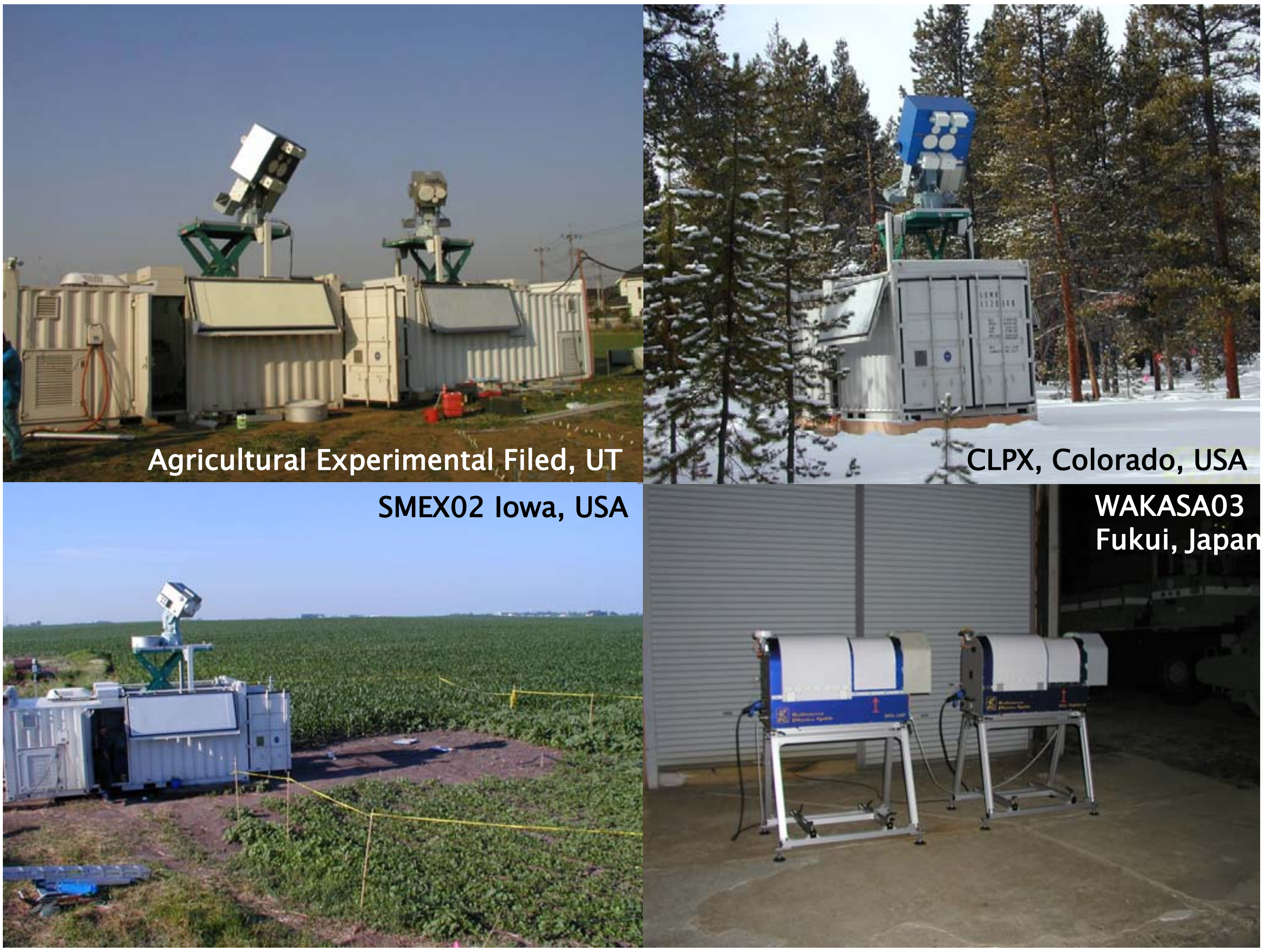
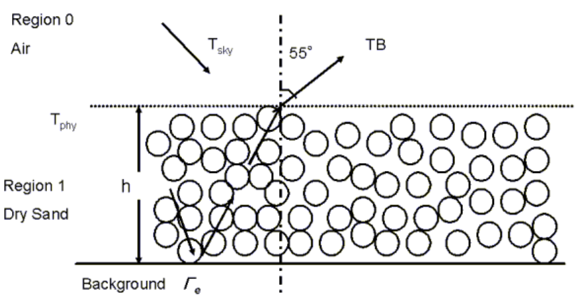

Global ⇔ Regional-Meso ⇔ Basin
Satellite-based Data Assimilation and Down-scaling
Ocean-Land-Atmos. Coupled Global Model (50～500km)
Water Use Flood Control
Distributed Runoff Model (100m～1km)
Global Atmos.-Land Coupled Data Assimilation
Soil Moisture Snow
Regional Atmos.-Land Coupled Data Assimilation
Rain, Soil Moisture
Land-Atmos. Coupled Regional Model (10～100km)
Rain, Cloud Soil Moisture Snow
Land-Atmos. Coupled Meso Model (1～10km)
Short Forecasting：Initial Condition
Satellite Data
Low
Moderate
High

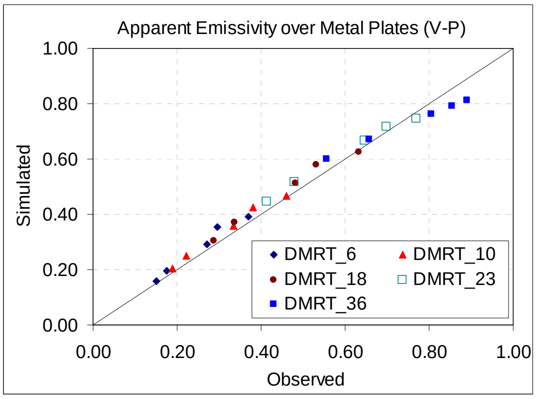

Microwave Remote Sensing
Soil Moisture
Snow
Microwave Radiometer
Precipitation
Aqua
NASDA
TRMM
Surface Emissivity & Temp.

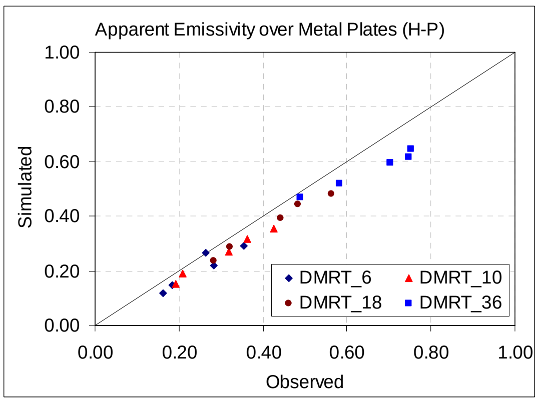


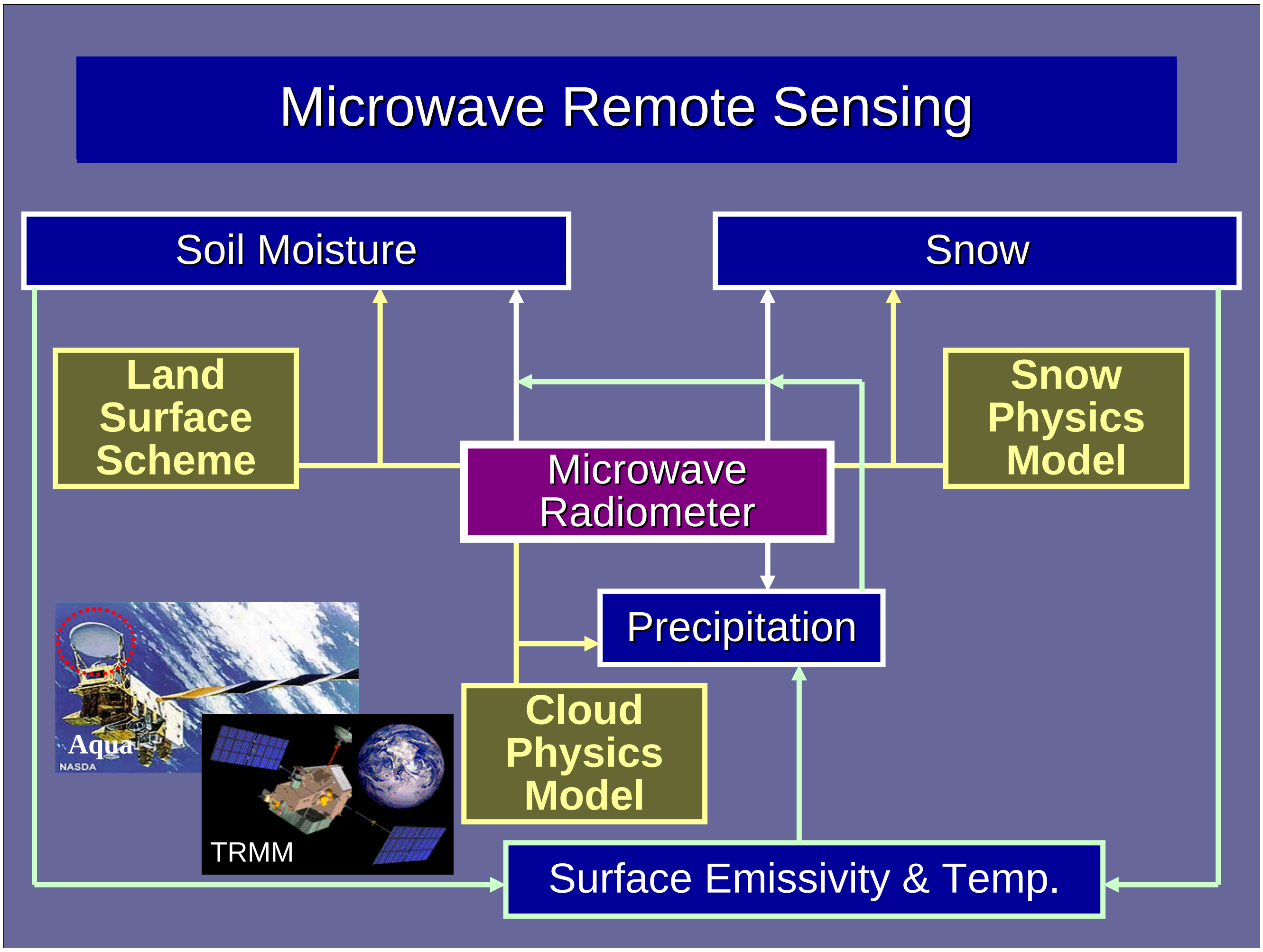
GBHM Experiments



Kuria & Koike, 2007



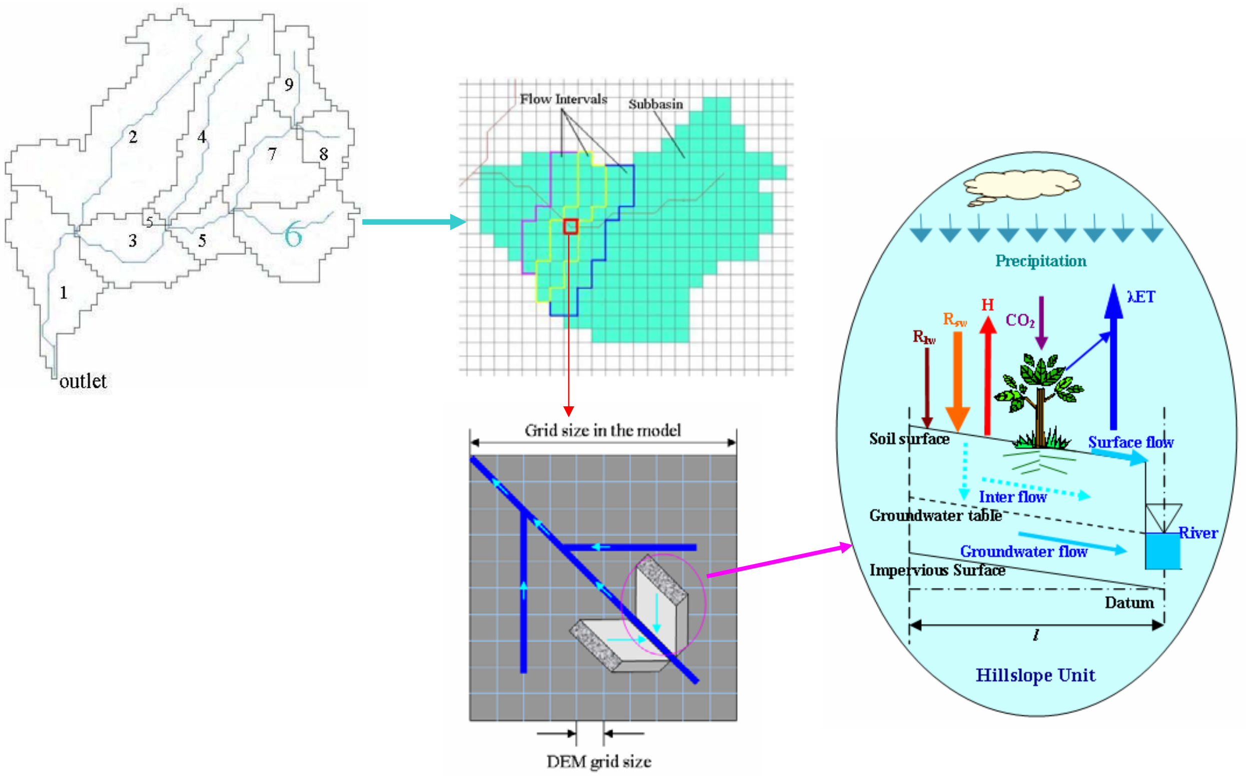




Wang, Koike et al. 2009

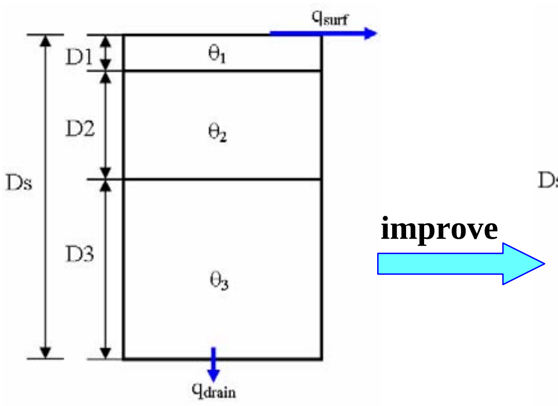
WEB-DHM

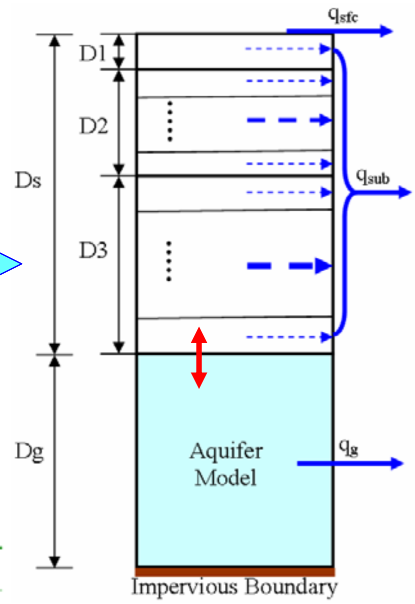
(Water and Energy Budget-based Distributed Hydrological Model)



Improvements over 1-D LSM

(a) SiB2 (b) WEB-DHM





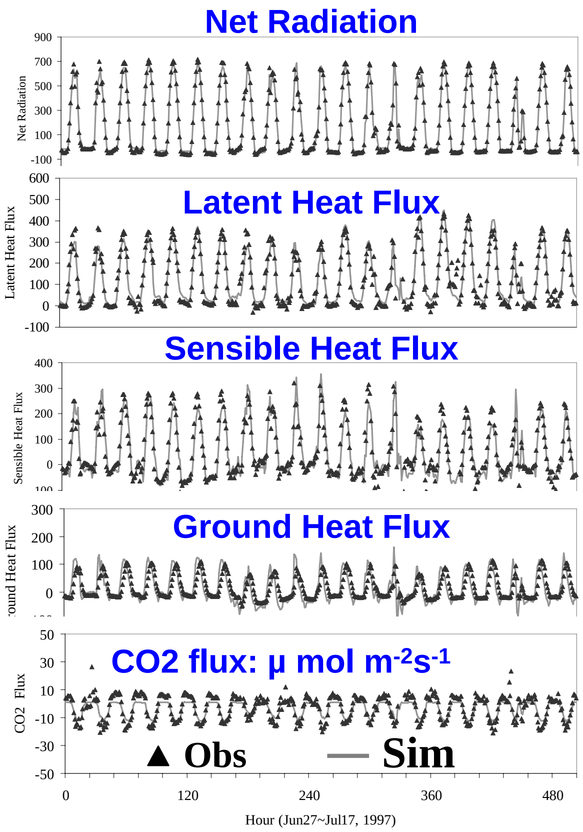
Soil Hydraulic Function

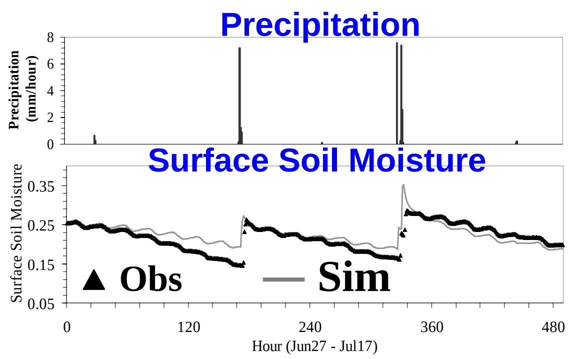
Table 1. Soil hydraulic functions used in SiB2 and HydroSiB2

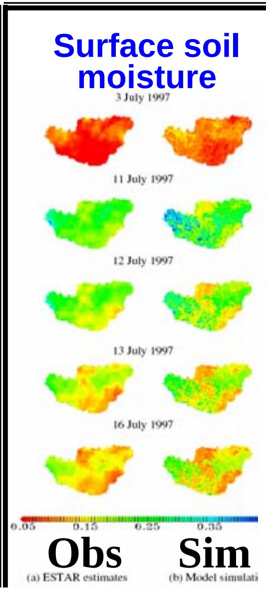
Source	$\psi(\theta)$	$K(\theta)/K_s$	
Campbell (1974)	$\psi_s\left(\dfrac{\theta}{\theta_s}\right)^{-b}$	$\left(\dfrac{\theta}{\theta_s}\right)^{2b+3}$	SiB2
van Genuchten (1980)	$\dfrac{1}{\alpha}\left[(S)^{-1/m}-1\right]^{\frac{1}{n}}$	$S^{1/2}\left[1-\left(1-S^{1/m}\right)^m\right]^2$	WEB-DHM

Model Evaluations with SGP97&SGP99 Observations

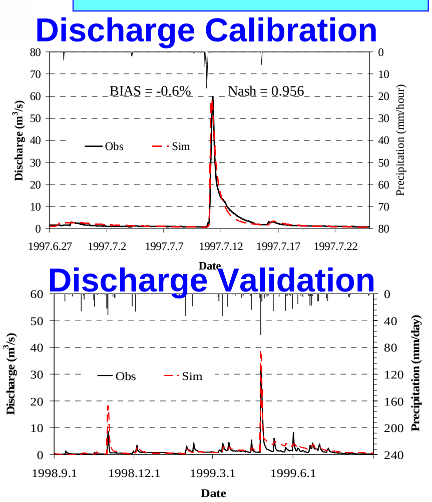
NOAA flux site



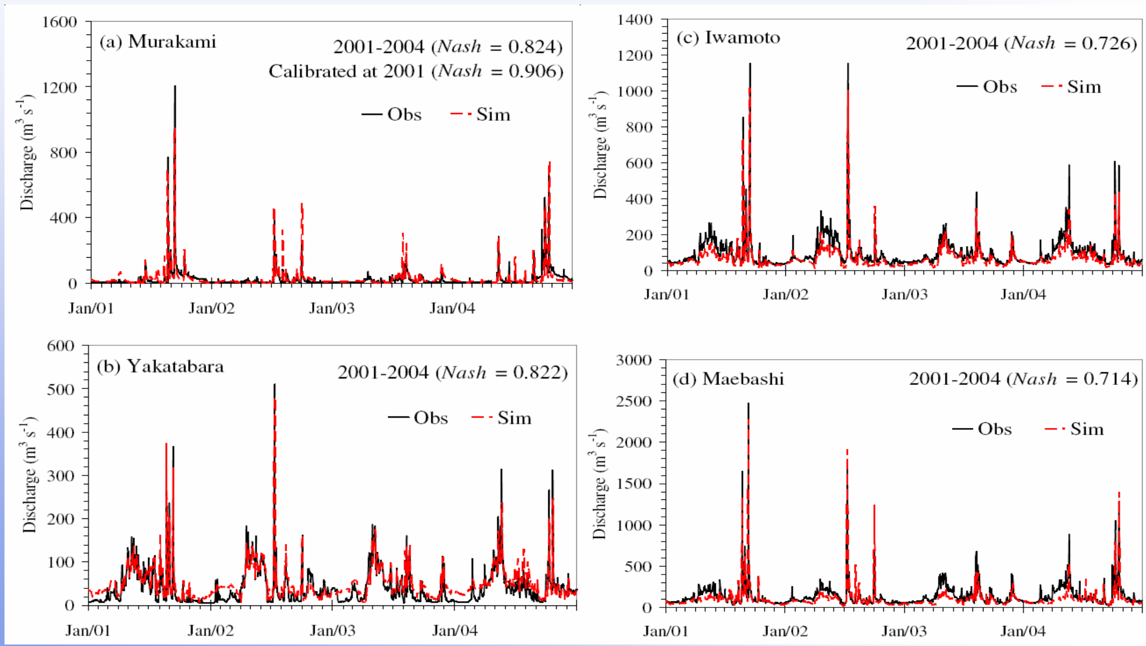




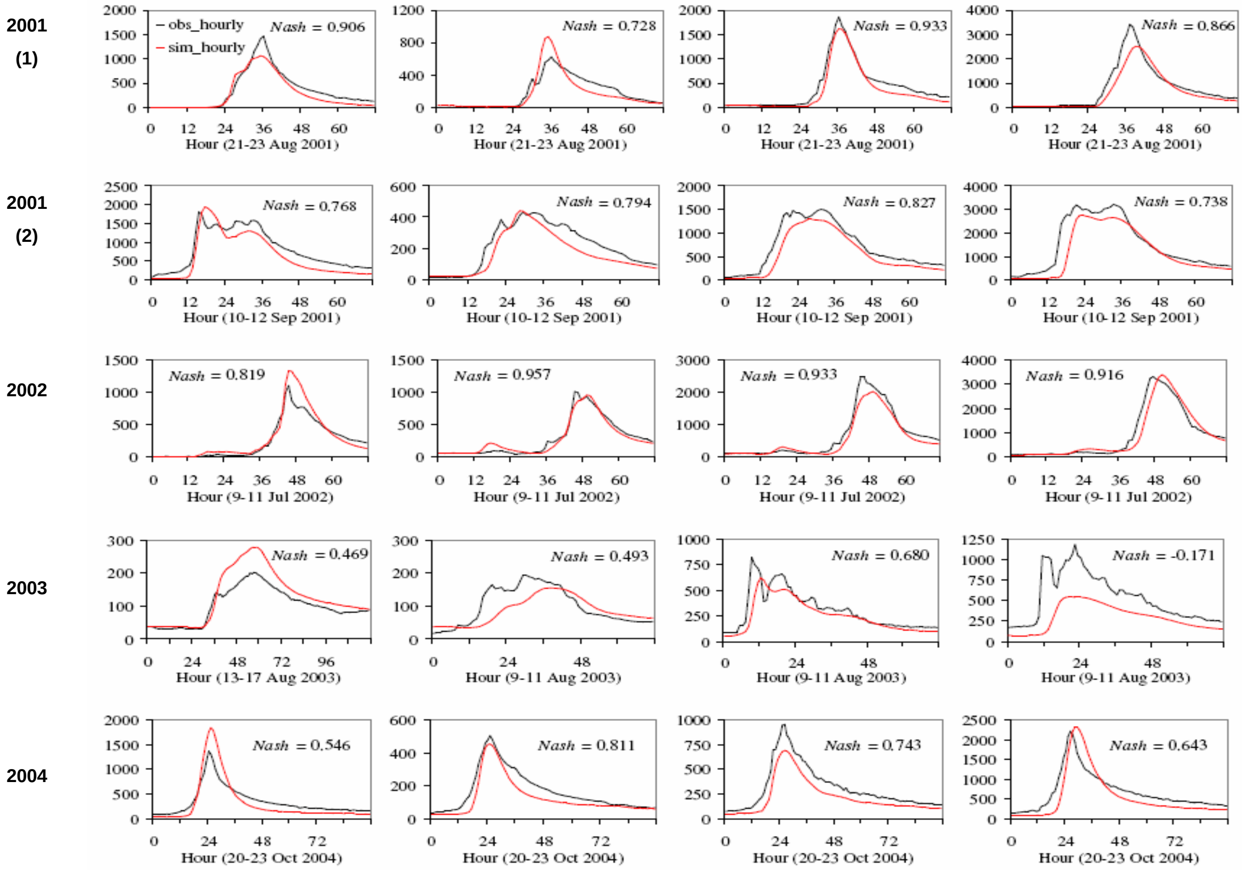
Basin-scale



Calibration and validation with discharges at main stream gauges

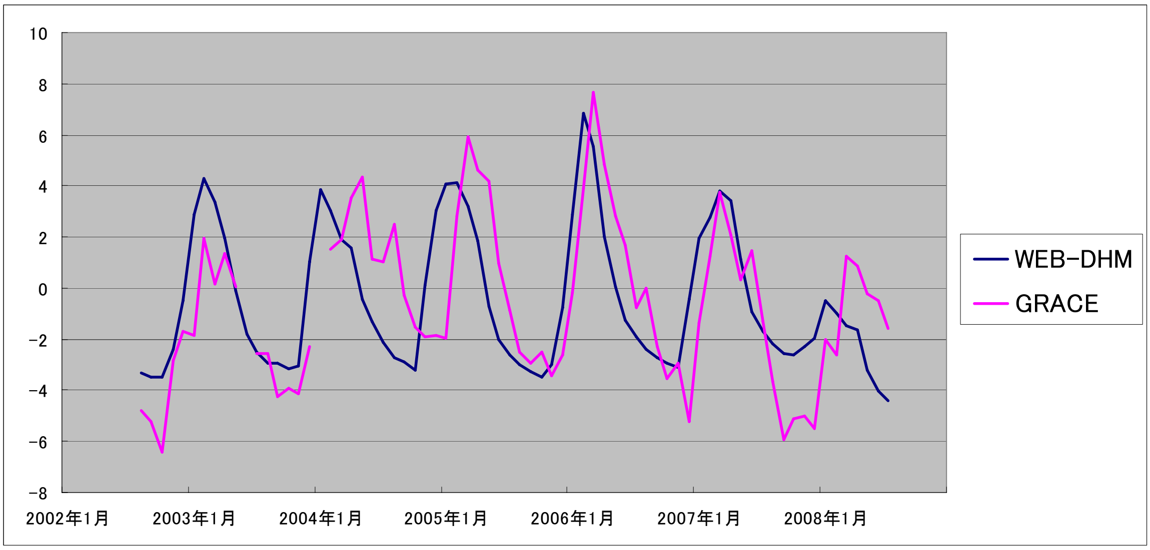


Annual Largest Flood Peaks



(a) Murakami **(b) Yakatabara** **(c) Iwamoto** **(d) Maebashi**

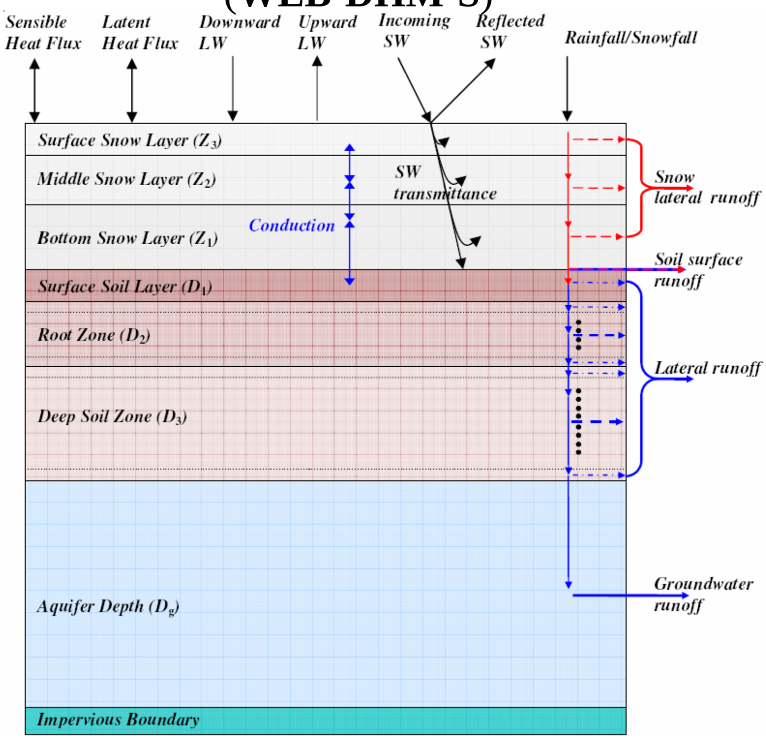
Model Simulation – Multi-Satellites Product (Ground Water in Semi-Arid Region)



Improving the snow physics of WEB-DHM

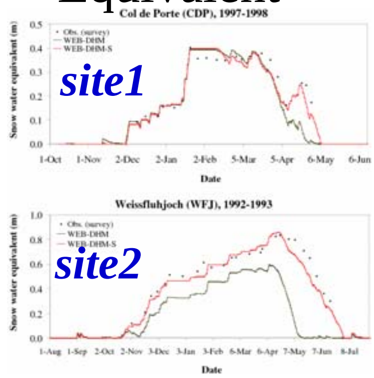
A three-layer snow model is added

(WEB-DHM-S)

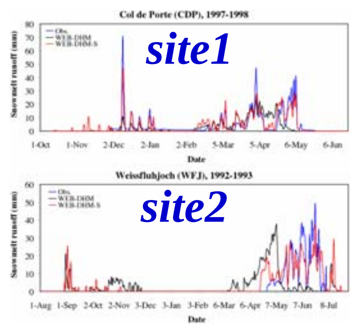


Shrestha, Wang, Koike et al., 2010

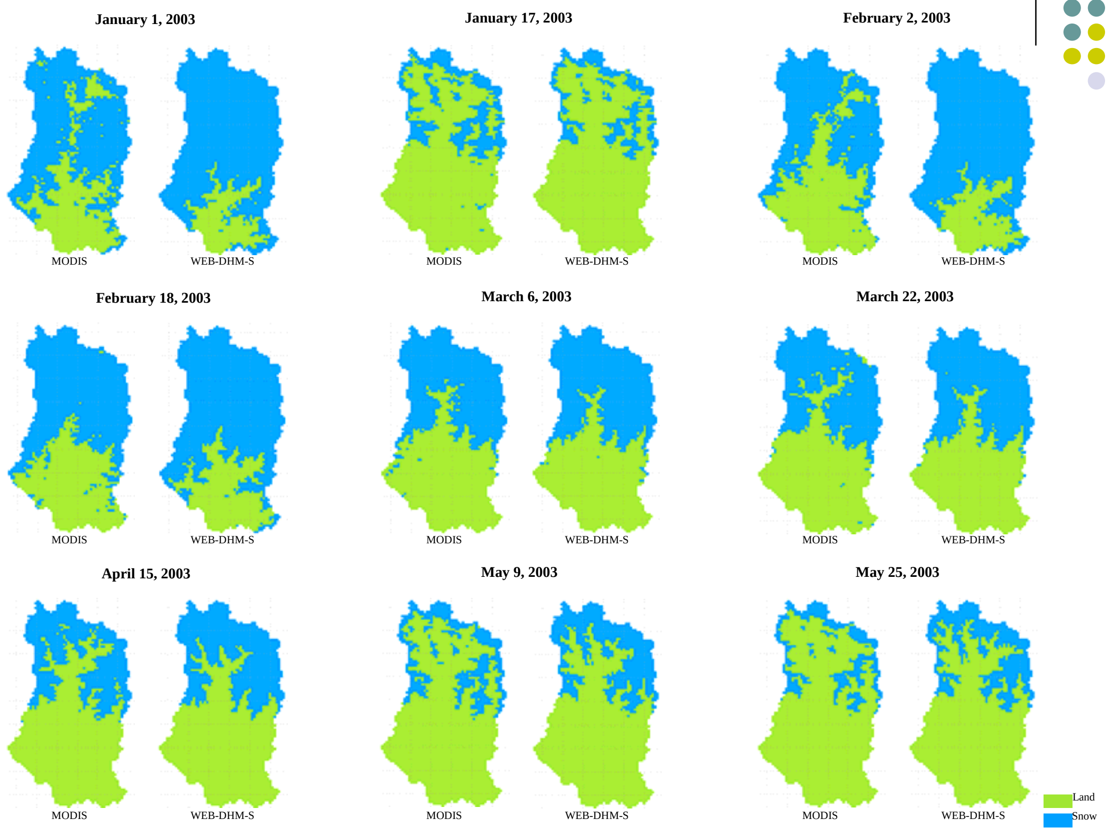
Snow Water Equivalent



Snowmelt Runoff



Comparison with MODIS snow cover product



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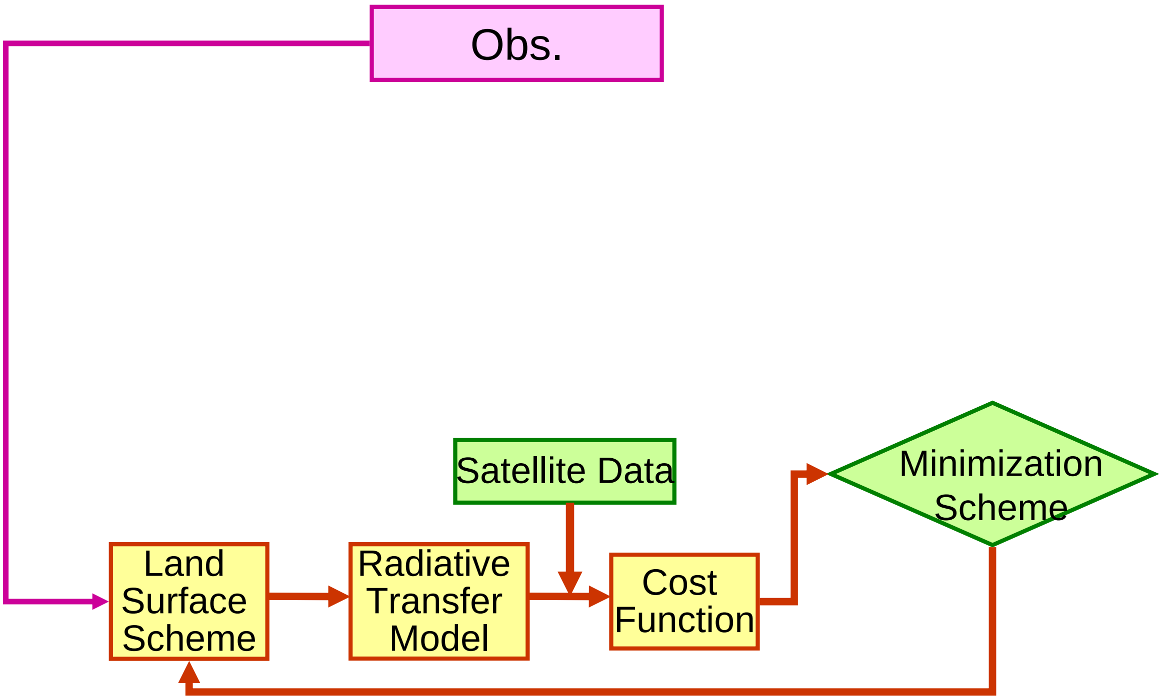
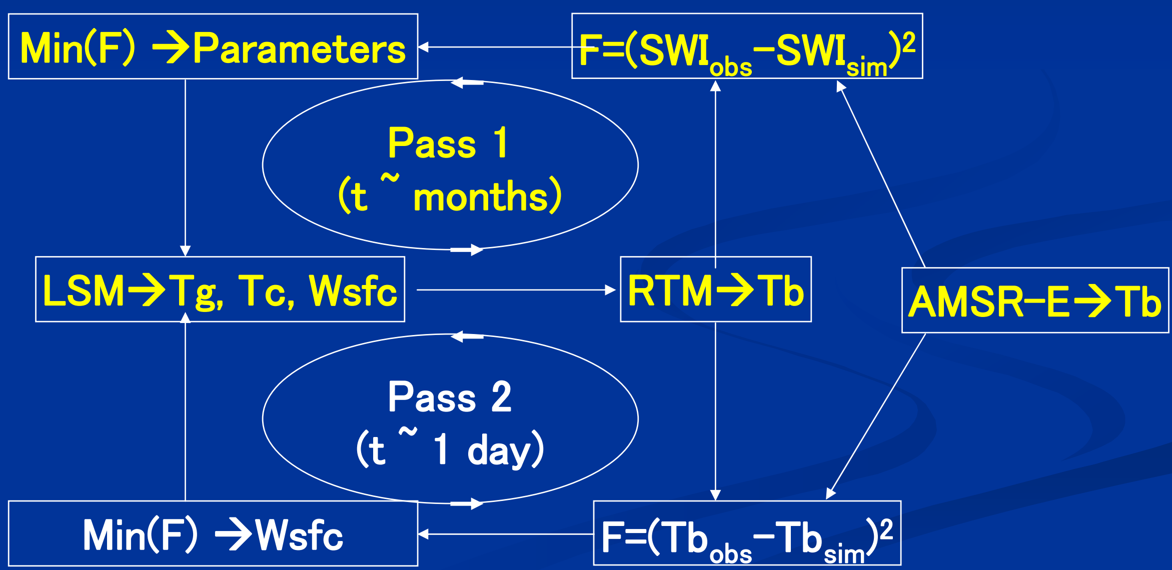


LDAS

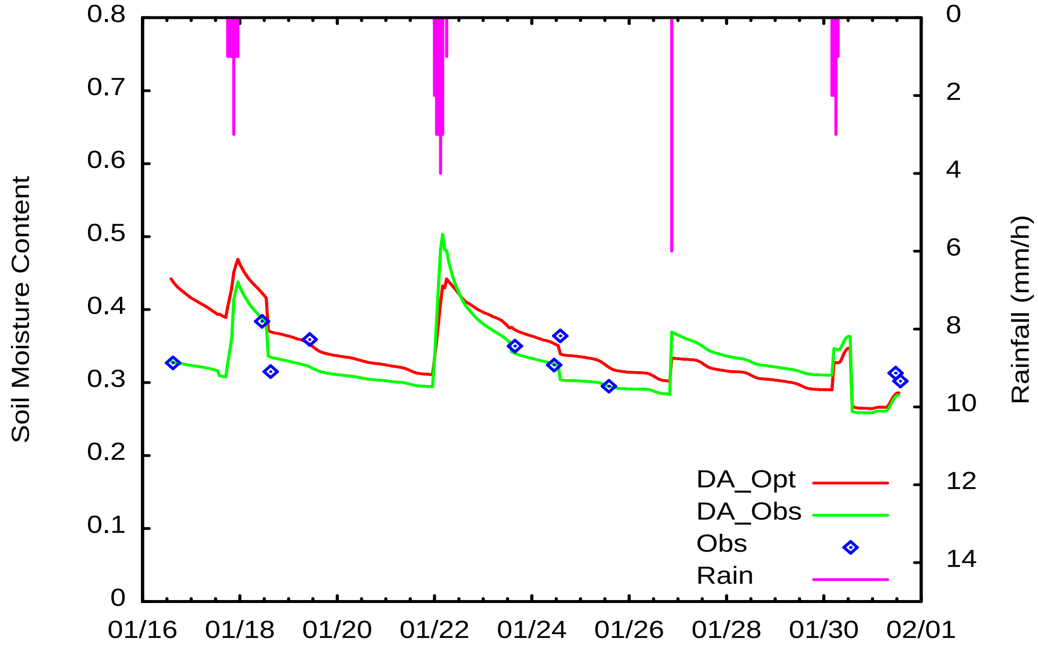
LDAS-UT Algorithm

- Dual-pass technique



(Yang et al,2007)

Parameter Optimization in Tanashi Exp.-- without vegetation effect



Good estimation of soil moisture

Lu & Koike, 2008

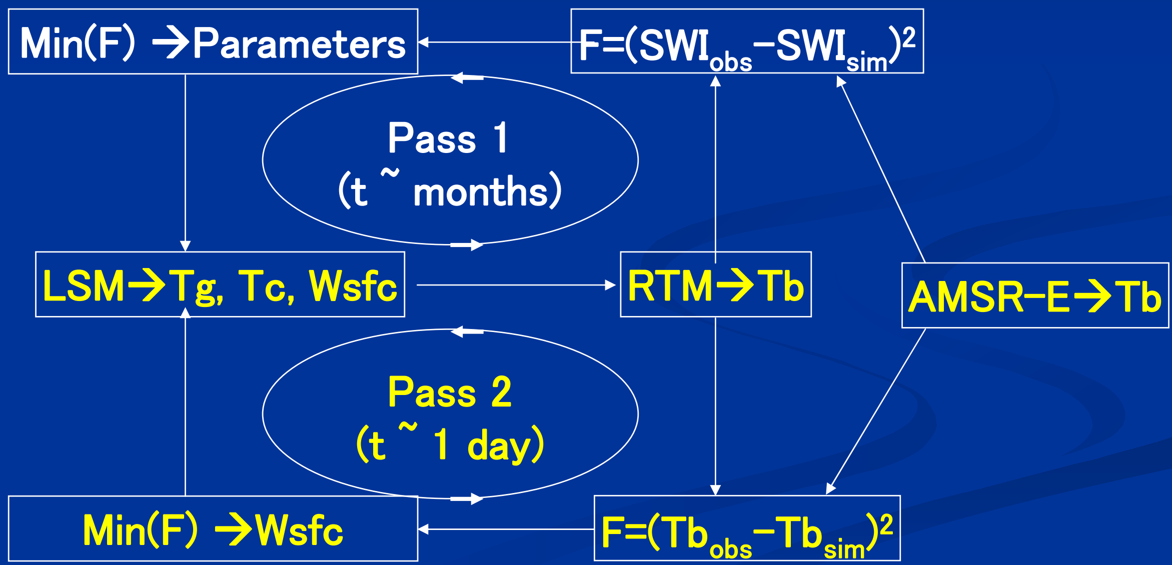
Optimized Parameters

	Optimized	Observed
SAND (%)	28.3	26
CLAY (%)	34.9	43
Porosity	0.587	0.725
rms h (cm)	0.513	1.01
l (cm)	0.478	1.16
www1	0.45	0.327

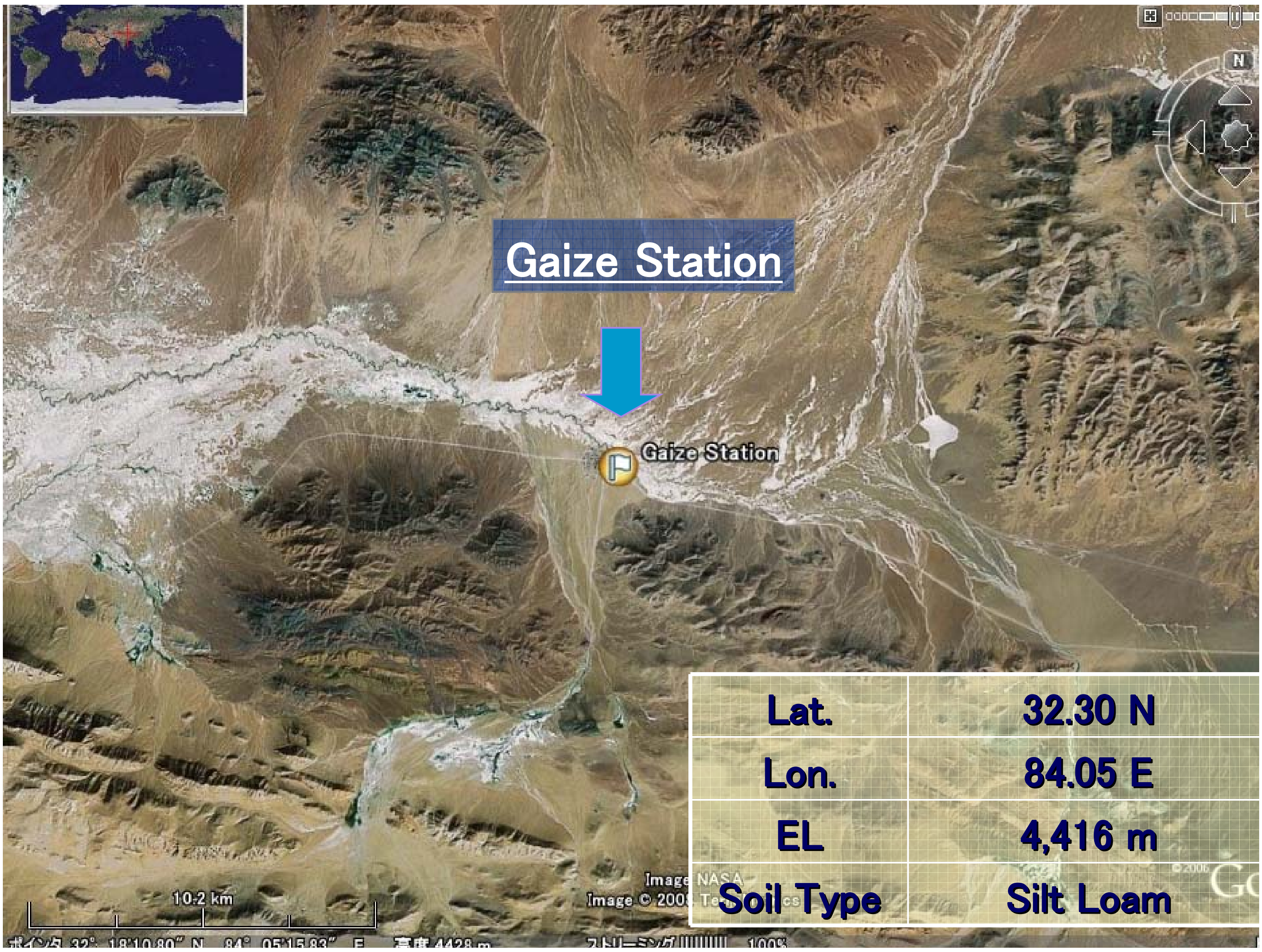
Lu & Koike, 2008

LDAS-UT Algorithm

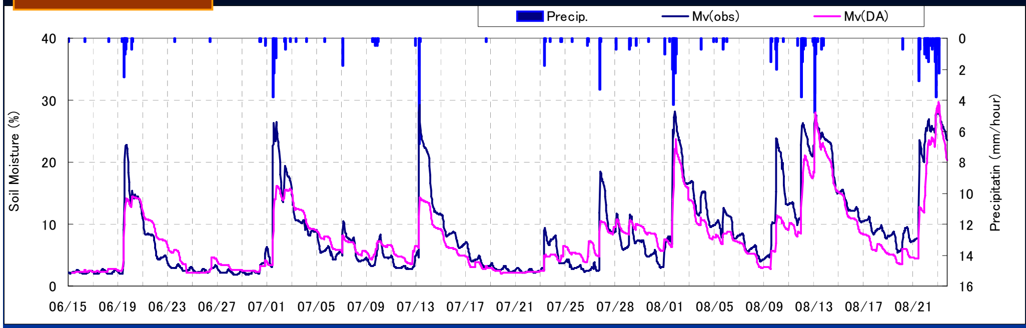
- Dual-pass technique

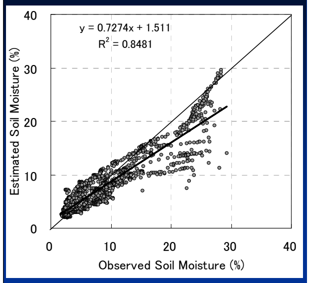


(Yang et al,2007)

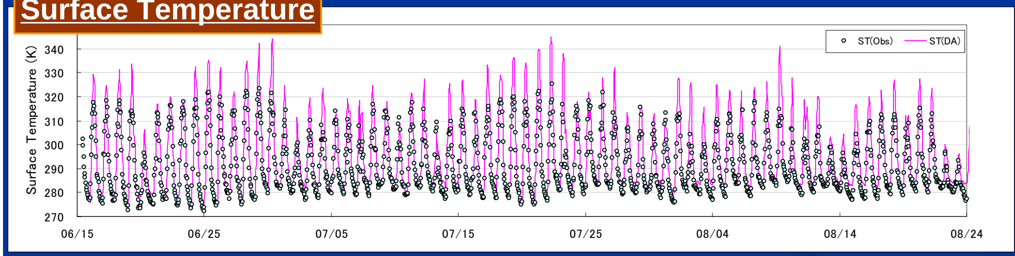


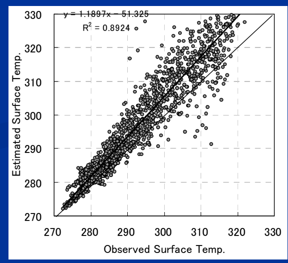
Soil moisture





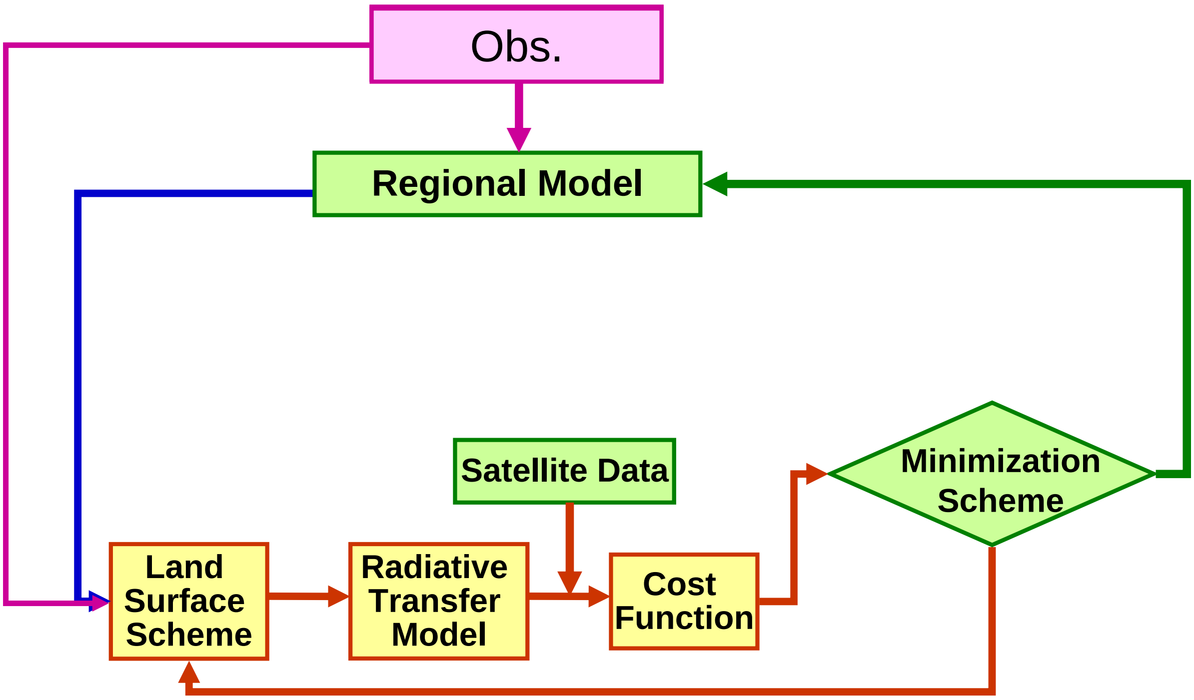
Surface Temperature





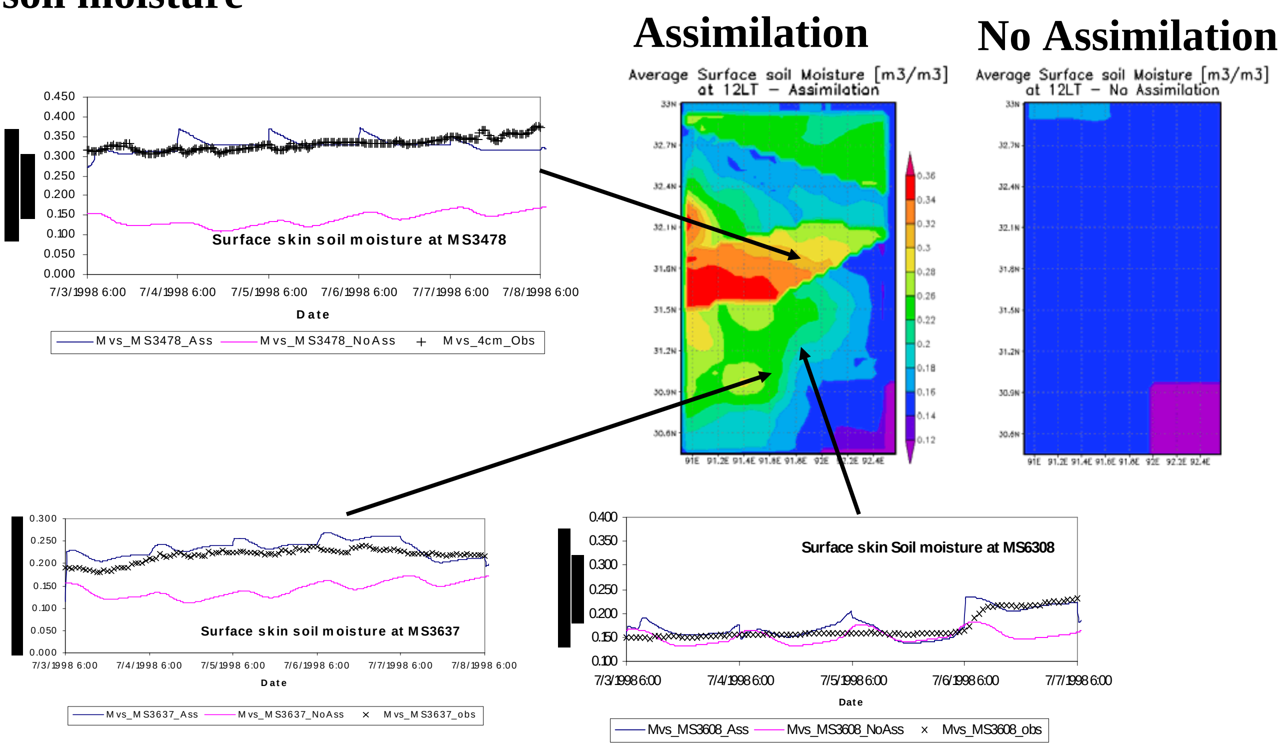
Introducing DMRT

Tamagawa & Koike, 2008



LDAS-A

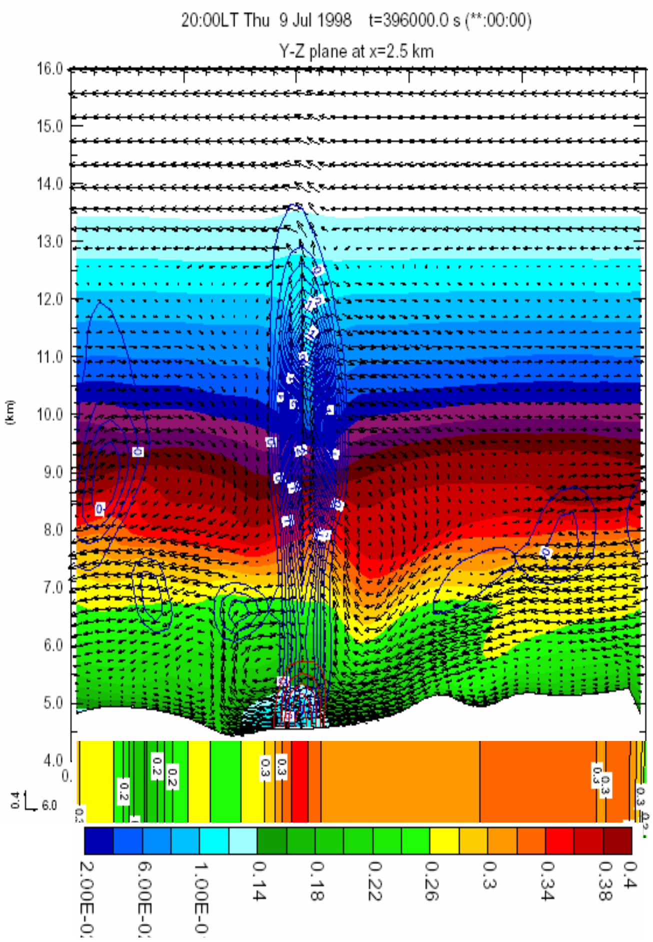
soil moisture



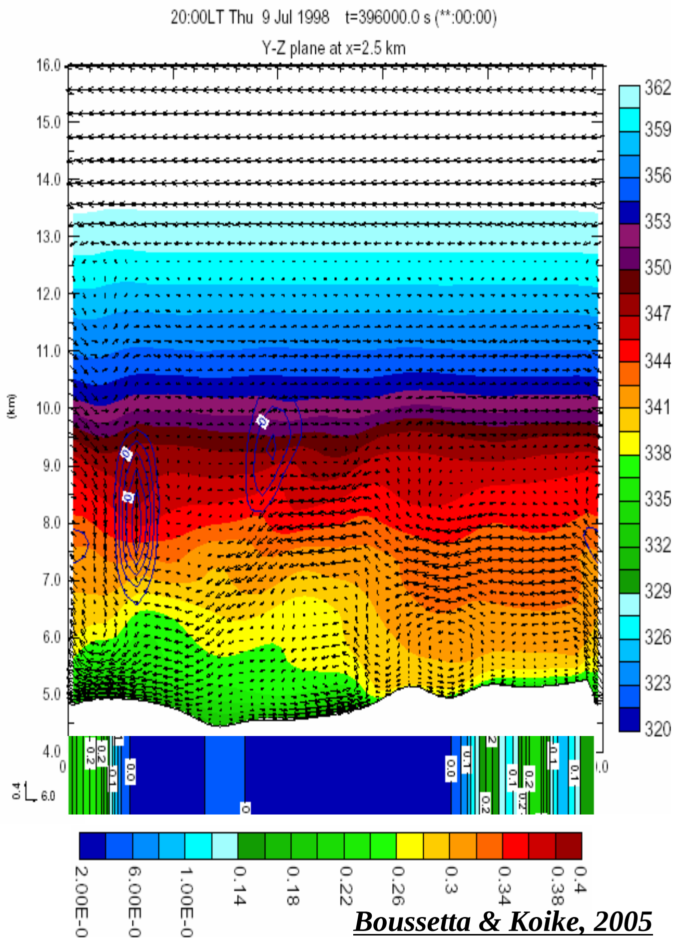
25

Boussetta & Koike, 2007

陸面データ同化ー大気結合モデル



陸面データ同化結合なし



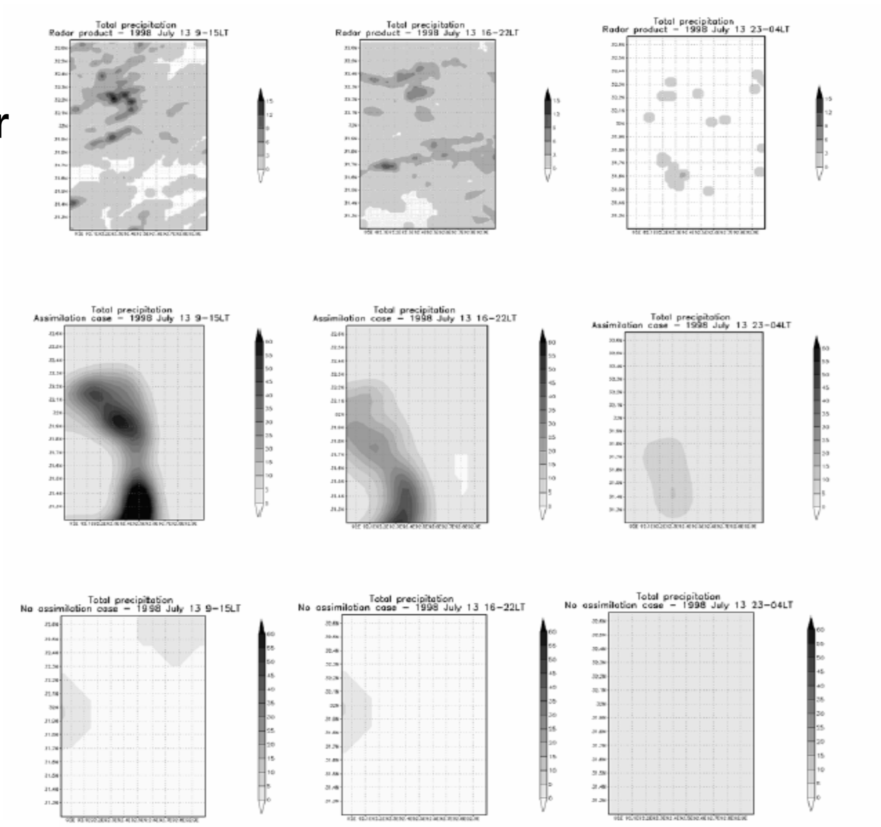
Boussetta & Koike, 2005

Diurnal Cycle Of Precipitation in the Tibetan Plateau

In-situ 3D Doppler Radar

With LDAS

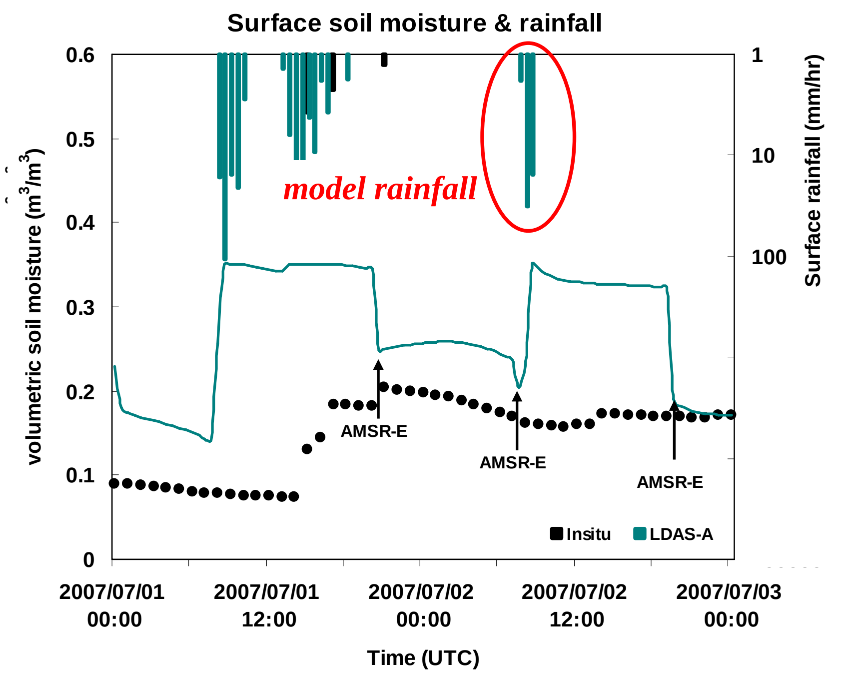
Without LDAS



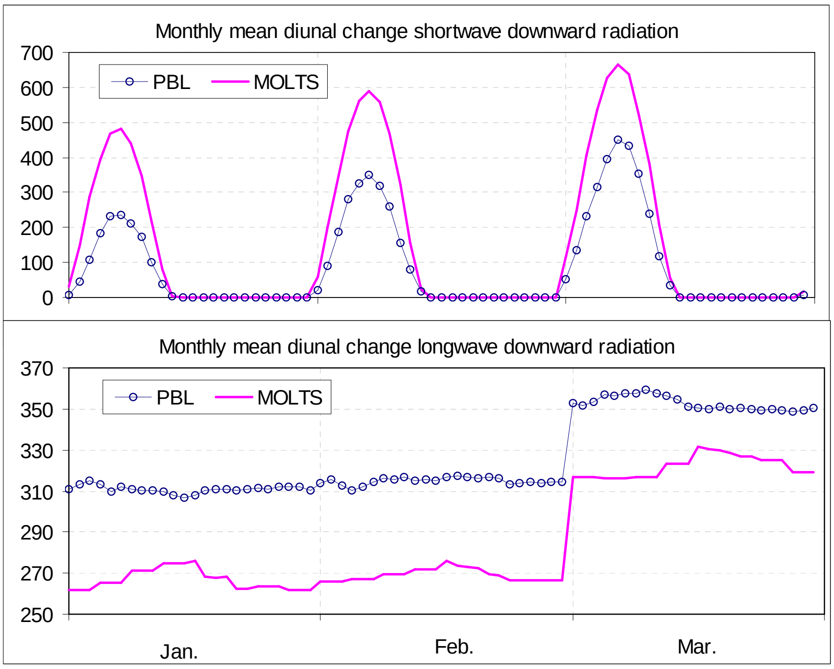
Boussetta & Koike, 2008

9-15 **16-22** **23-04**

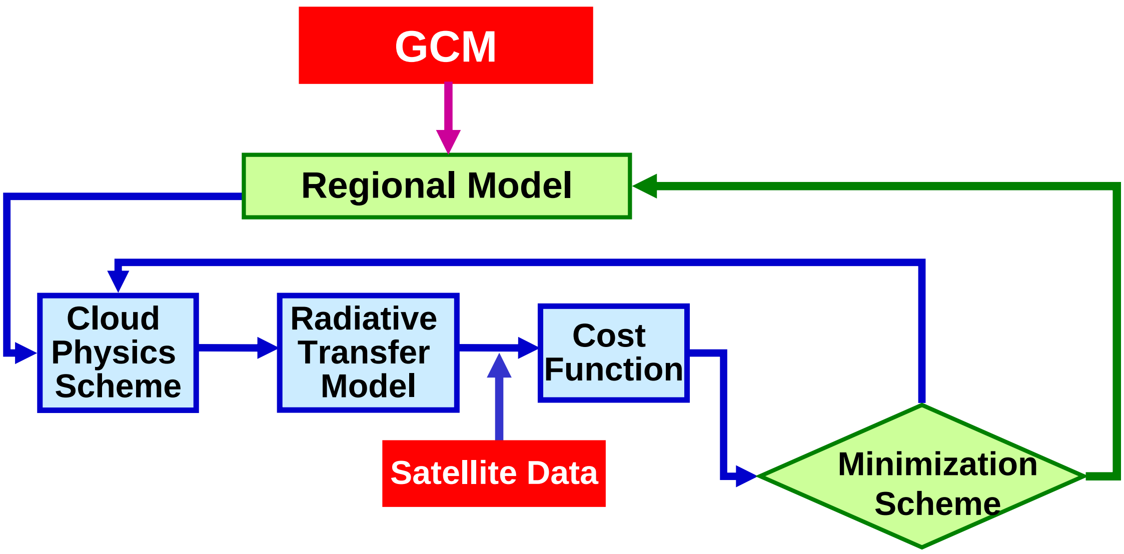
Impacts of Errors in Model Rainfall on the Soil Moisture



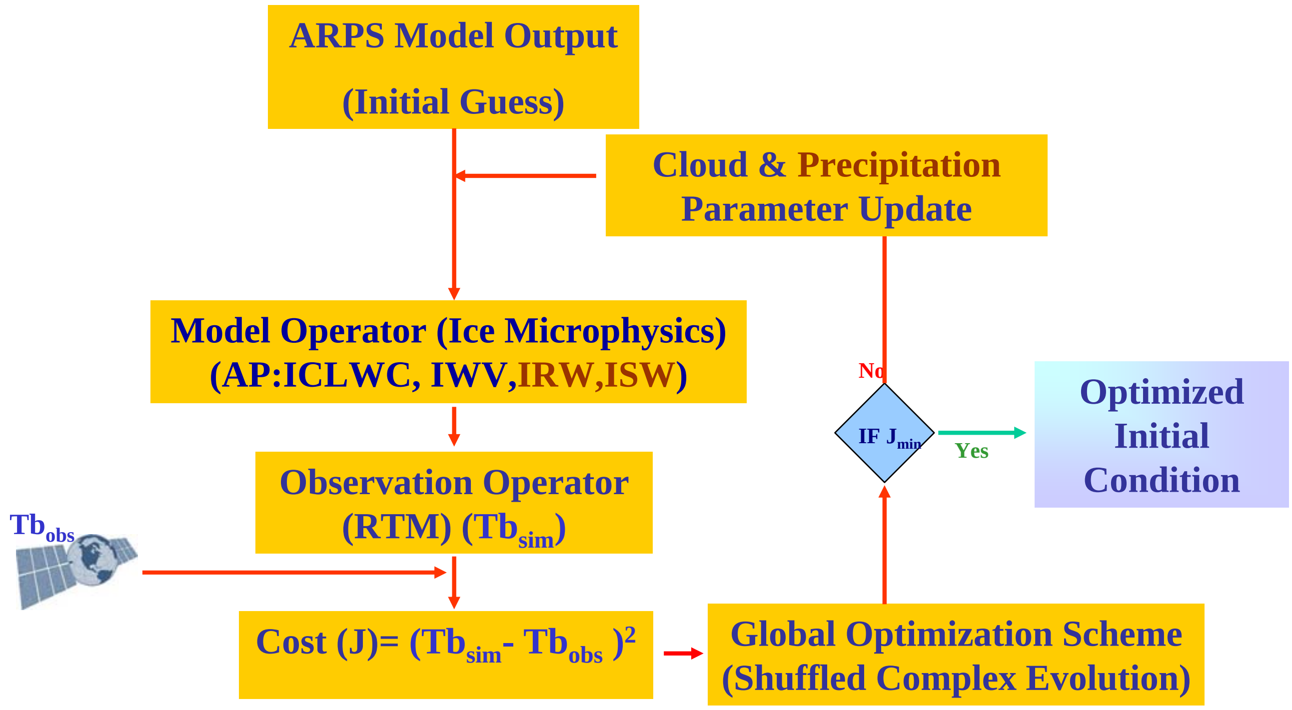
Impact of Model Errors in Radiation



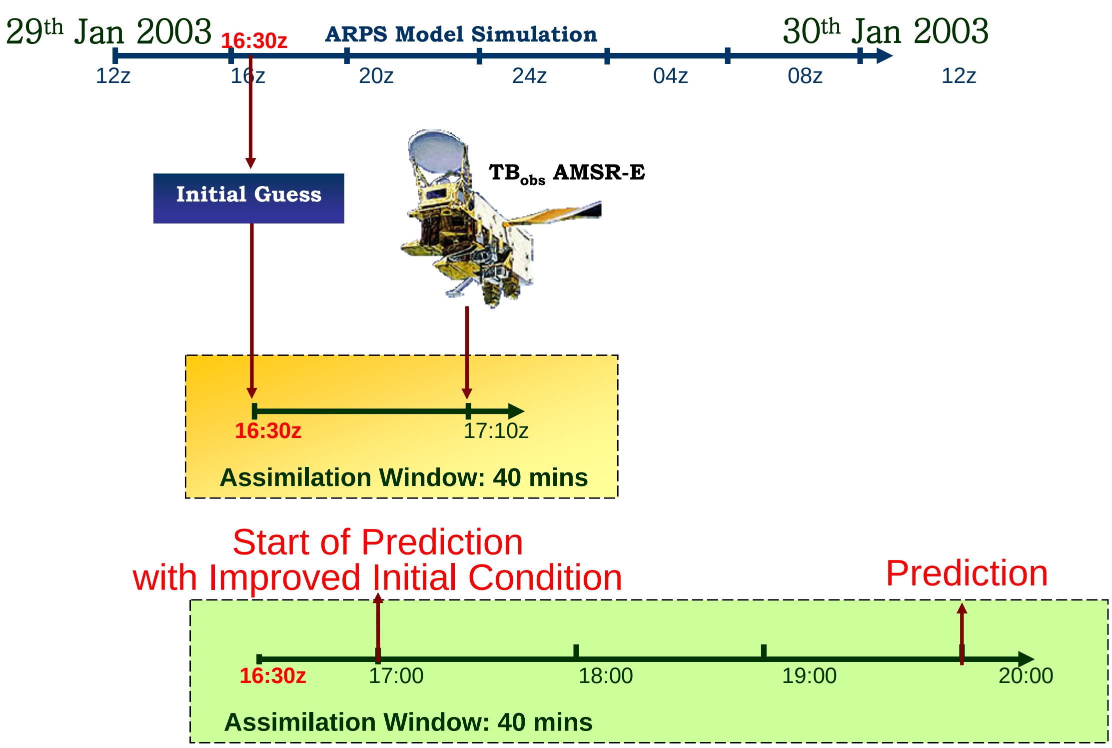
Lu & Koike, 2008



CMDAS Framework



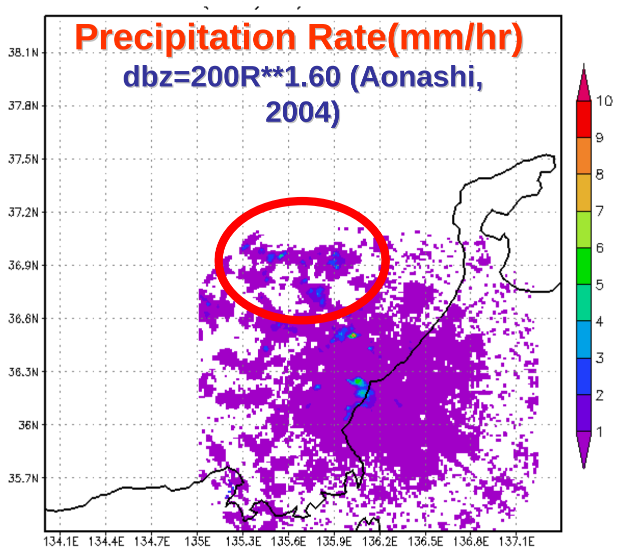
Mirza & Koike, 2008



Mirza & Koike, 2008

Precipitation Rate(mm/hr)

dbz=200R**1.60 (Aonashi, 2004)



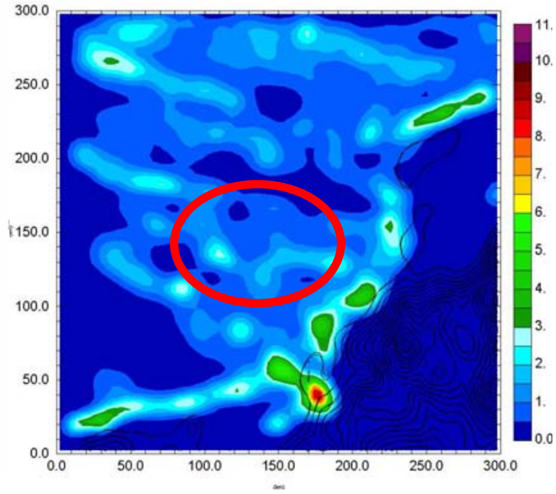
29th Jan, 17:00z

Initial condition

with assimilation

with no assimilation

C M D A S



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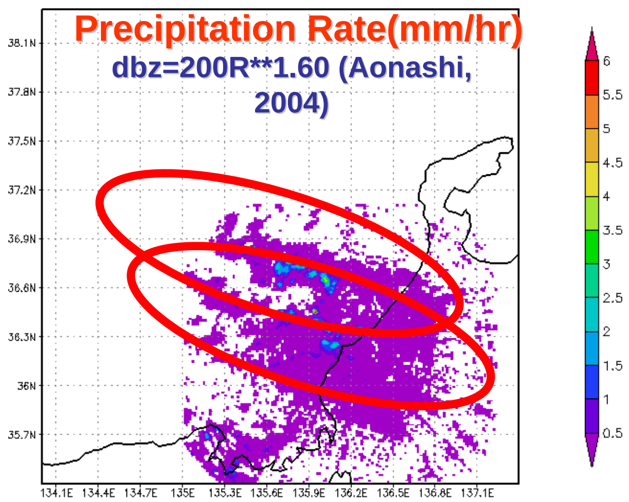


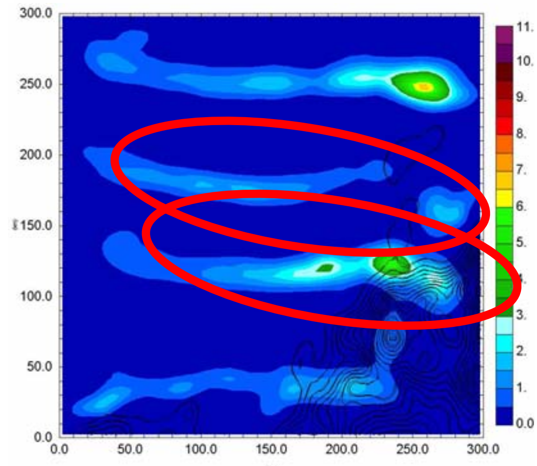
29th Jan, 20:00z

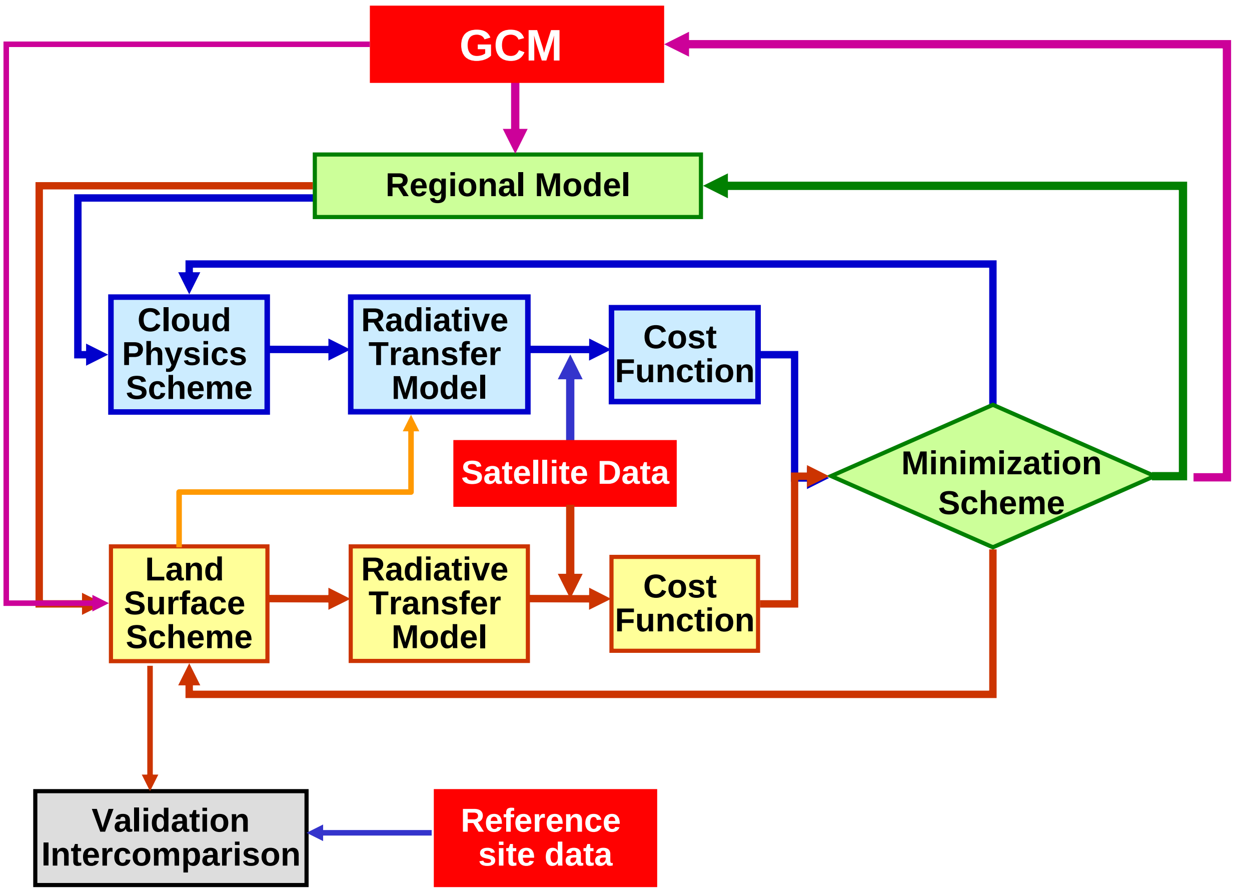
3hour prediction

with assimilation

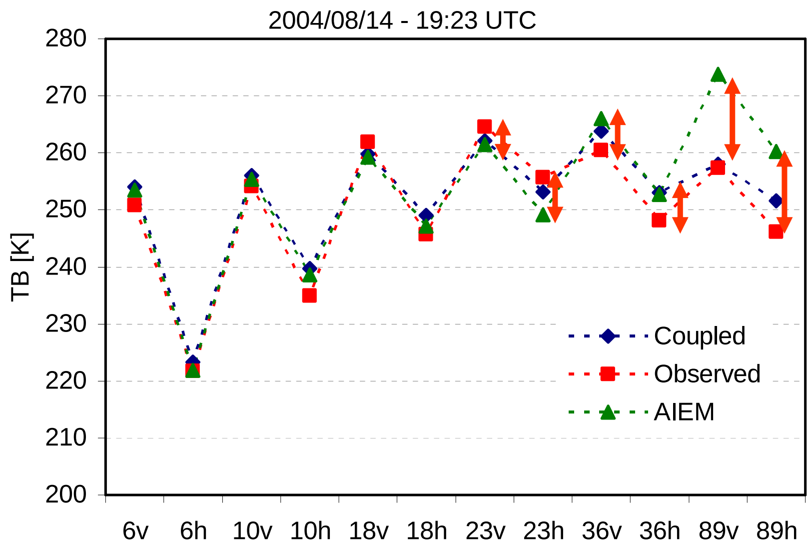
with no assimilation

C M D A S

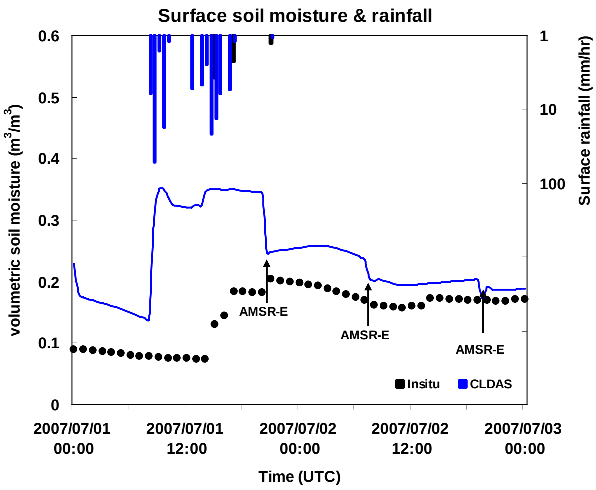


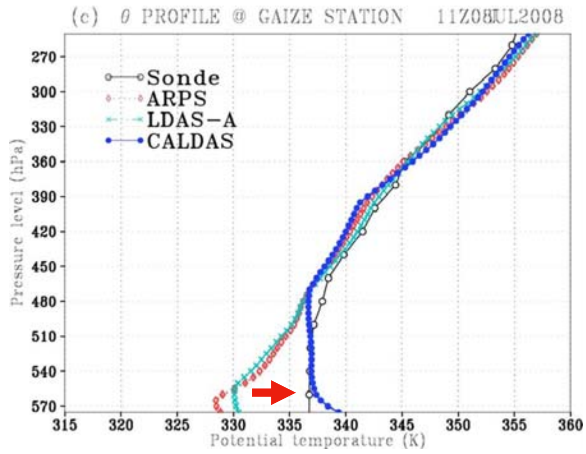


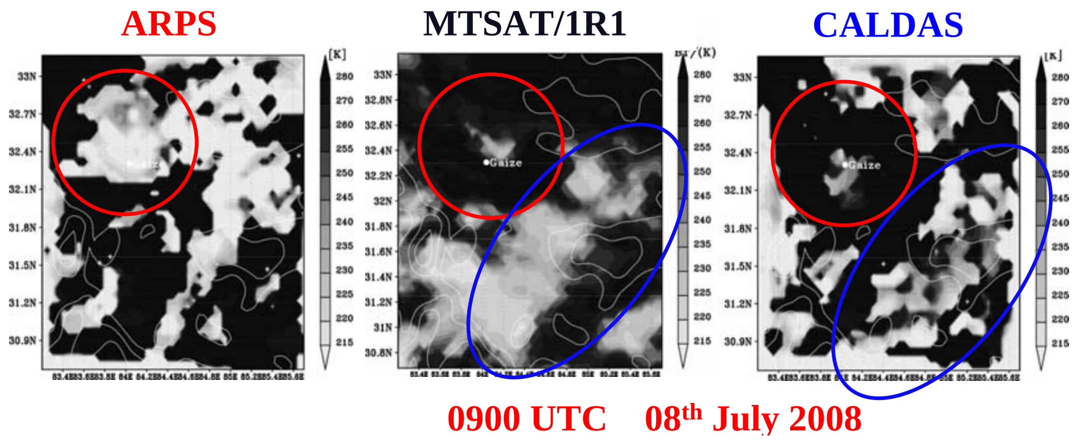
Coupled Soil Atmosphere RTM



By coupling AIEM with atmosphere RTM we get better agreement. For wetter cases AIEM is sufficient.







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Resilience

We must build the capacity of society to demonstrate resilience in the face of changing climate.

Actions

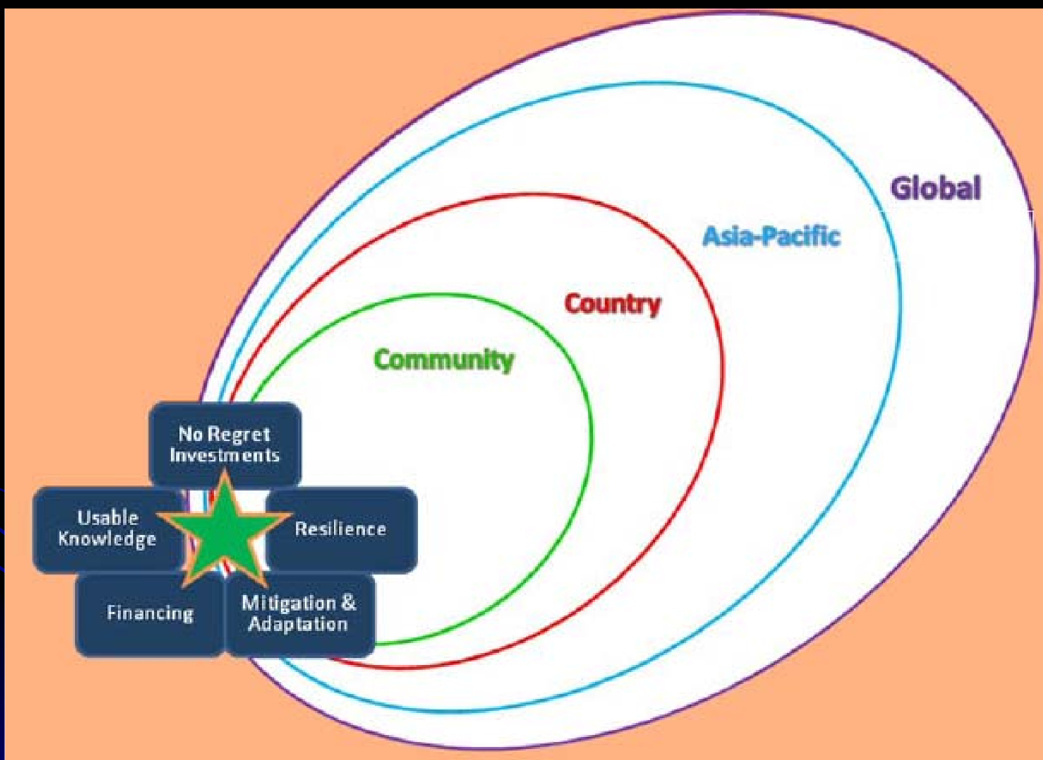
✓Strengthen the adaptation capacities of water managers, communities, scientists, and of society as a whole.

✓Improve community-based water risk management capacities.

** recovery capability*
invulnerability

- *Sharing more confirmed information*
- *Risk assessment and management*
- *Strategic selection of options and implementation*
- *Networking*

Multi-scale Resilience



Thank you!