



Water Cycle and Agricultural Activities during the Post-Monsoon Season in the Stung Sangker River Basin and Wider Area in the Western Cambodia

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SAFE prototyping in Cambodia

- **Approved in May 2009** as a new SAFE prototype activity
- Focusing on
 - Water cycle : particularly drought
 - Its impacts on agricultural water : primary occupation of 2/3 people
- Objectives:
To provide usable information for the agricultural activities in the western Cambodia by improving understanding of the mechanisms and various phenomena behind the unique post-monsoon water cycle, that benefits the prevailing rain-fed rice production in that area.

Rainfall & agricultural activities during the post-monsoon season

Sangker River Basin

Tonle Sap Lake

→ most productive area in the agricultural activities

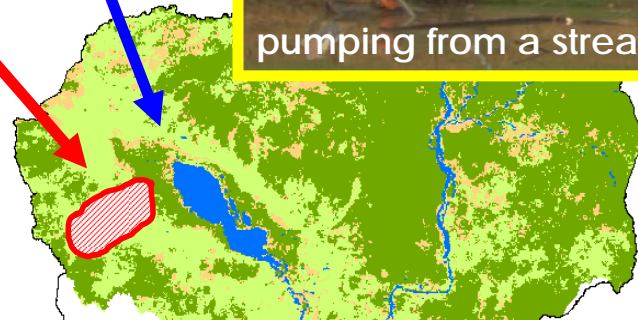
"Cambodian rice bowl"

✓ raining season agric. Lands and stream flows

✓ dry-season agriculture



pumping from a stream

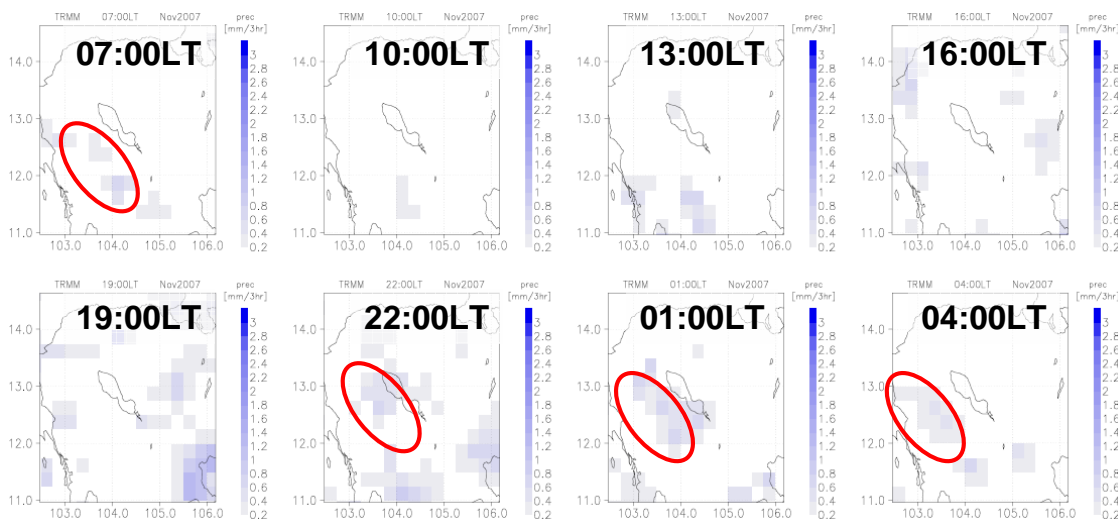


~ Target phenomenon ~

relationship between Water Resource (rainfall, stream flow, etc.) & Agric. Activities in the western Cambodia

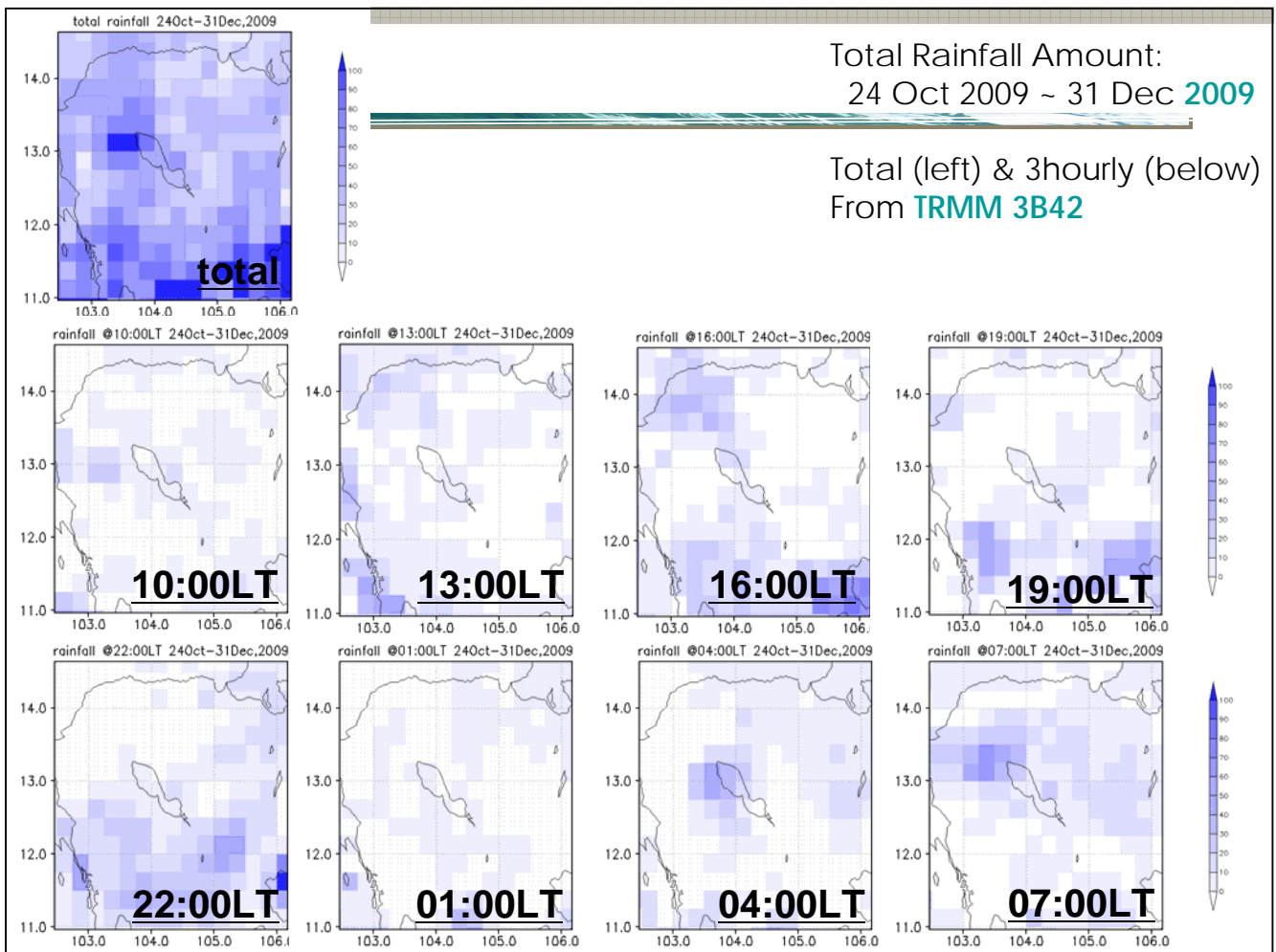
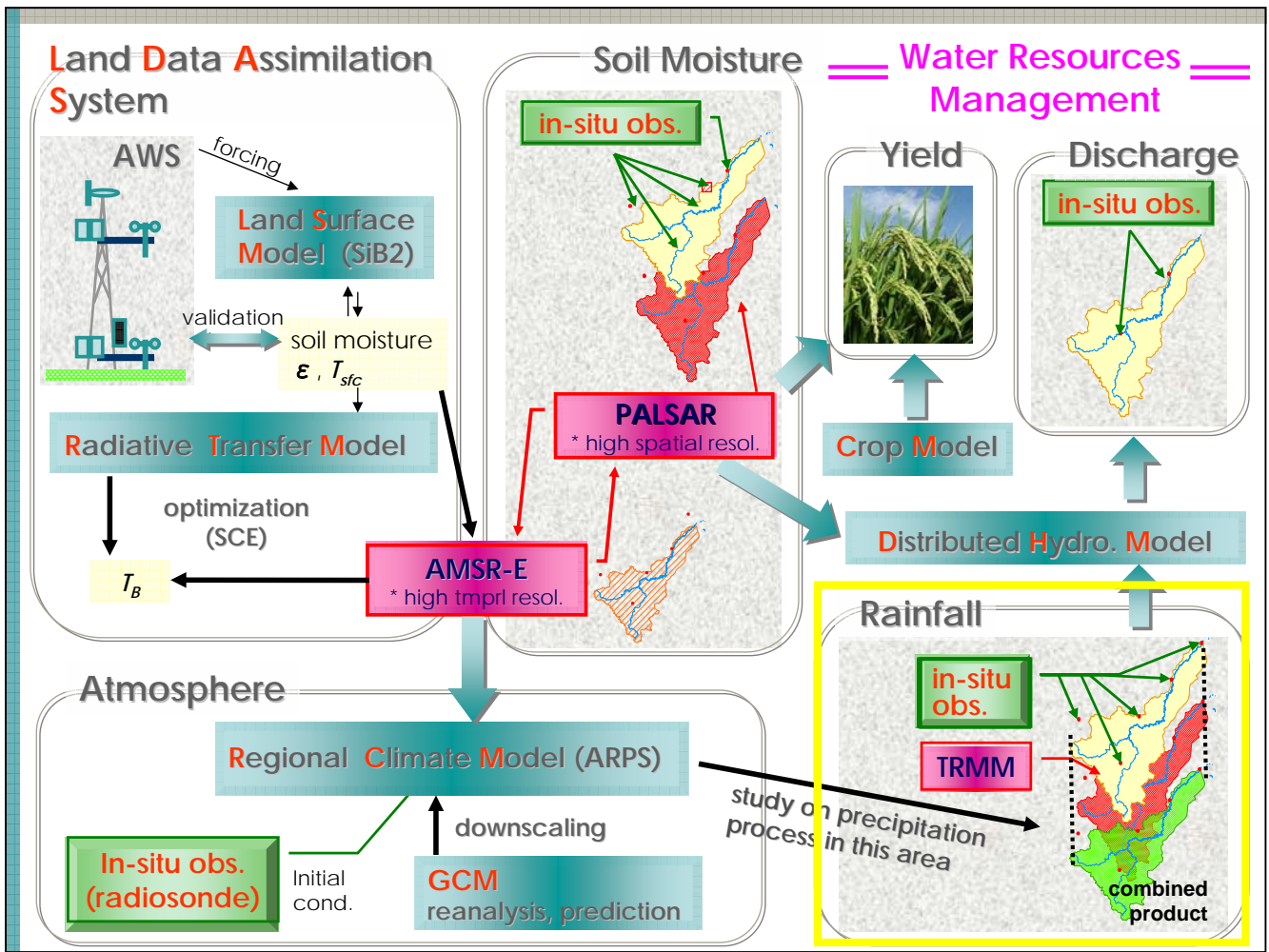
Rainfall after the Rainy Season

Post-monsoon rainfall from TRMM in 2007

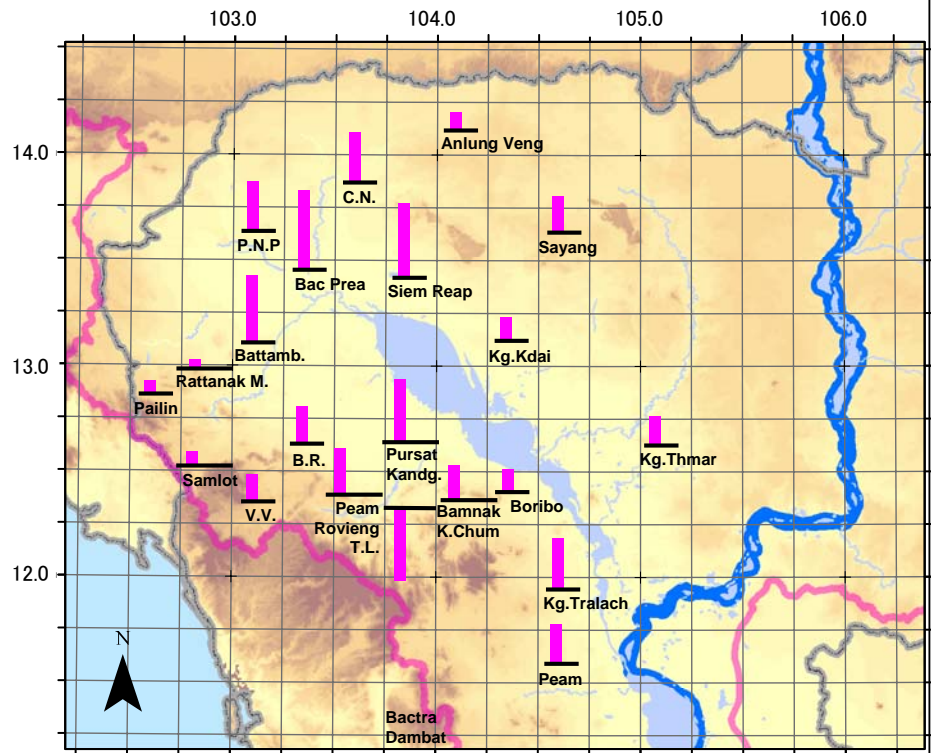
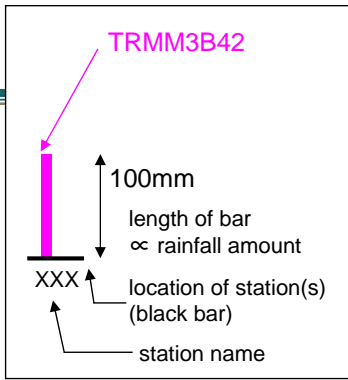


~ Hypothesis ~

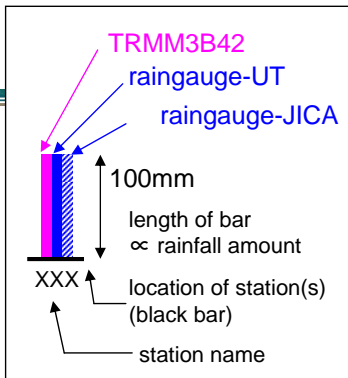
During the post-monsoon season, night time precipitation is dominant in the western side of the Tonle Sap Lake, and that supports the productive agricultural activities during the dry season in this area.



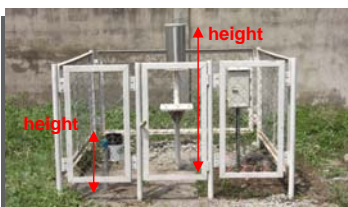
Total Rainfall Amount:
24 Oct 2009 ~ 31 Dec 2009



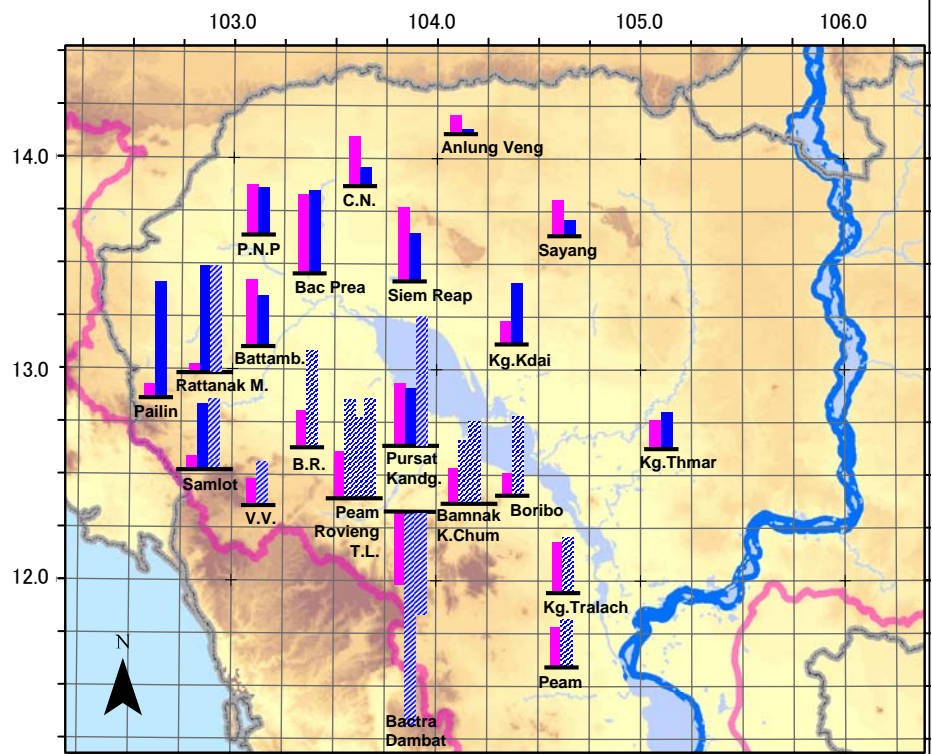
Total Rainfall Amount:
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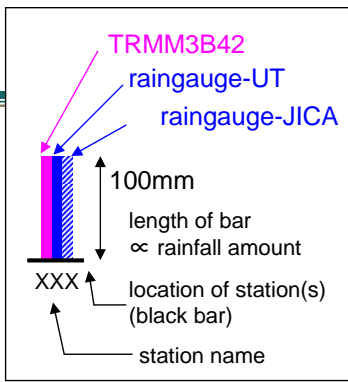
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installed on	Sep-Oct. 2009	2003- 2006
height	0.50m	1.50m



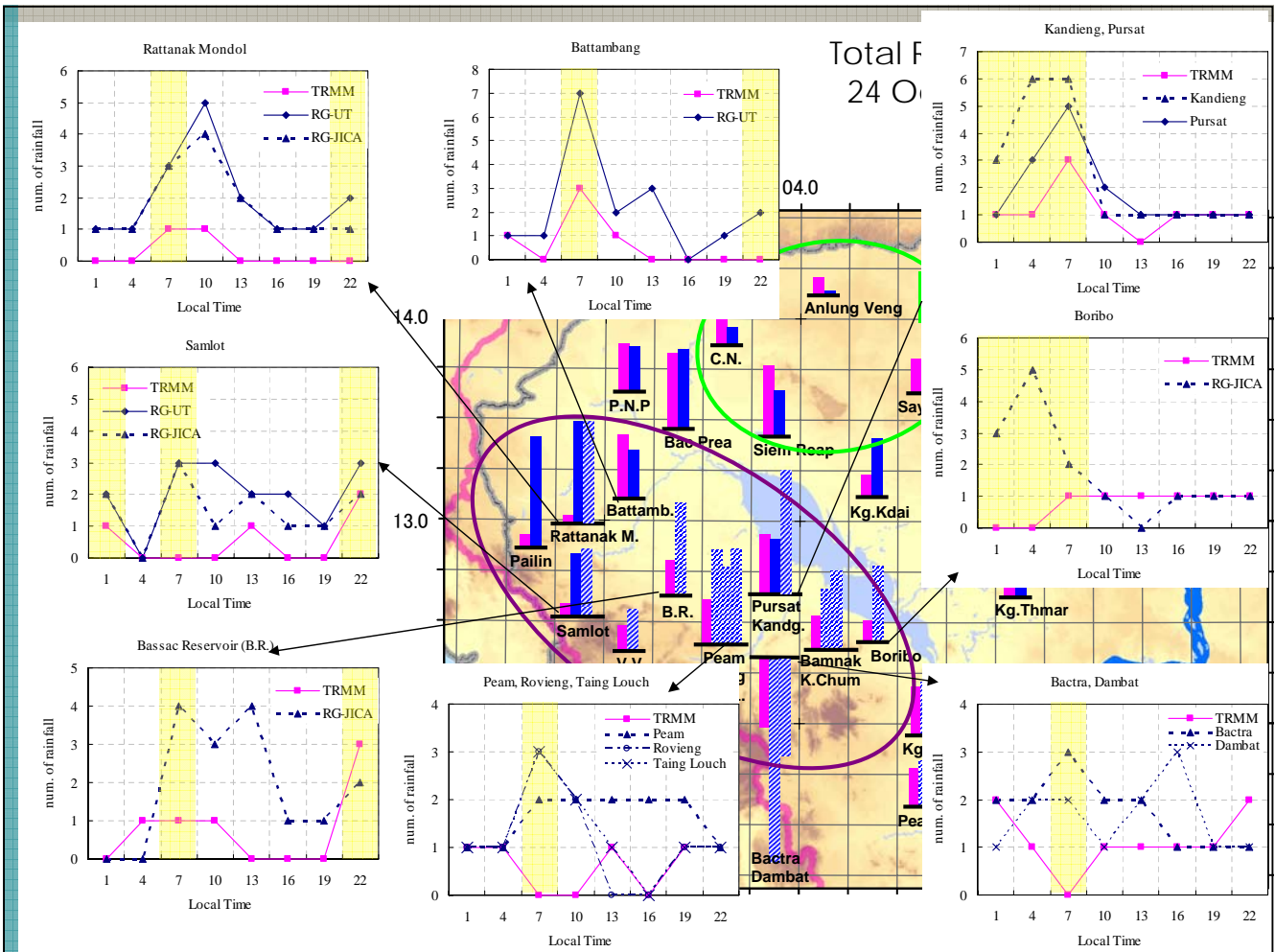
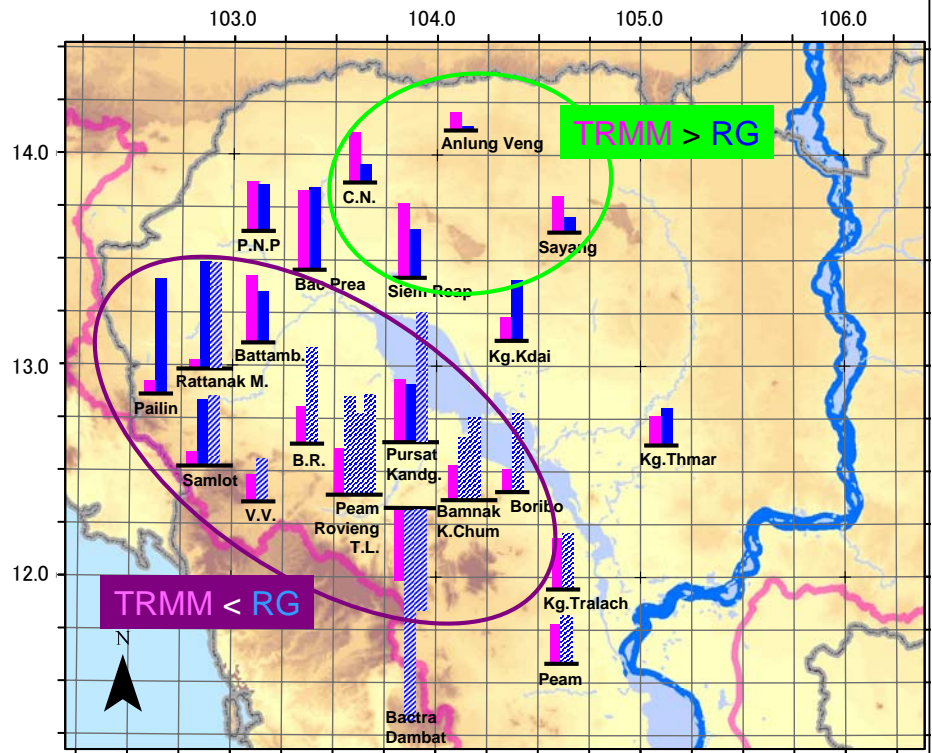
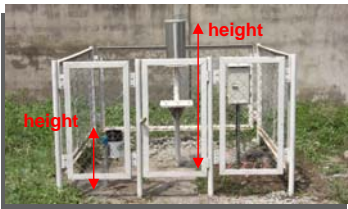
RG-UT RG-JICA

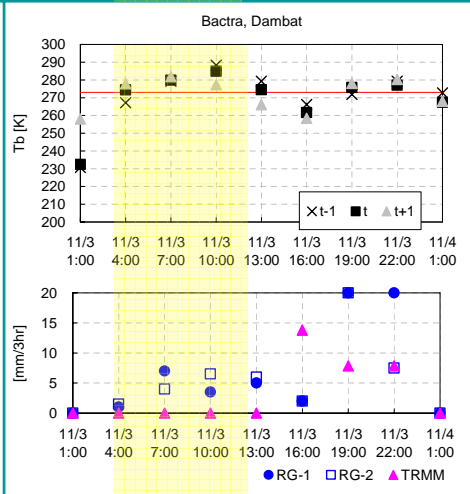
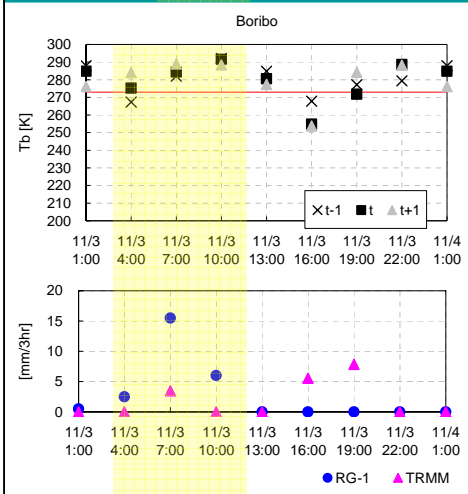
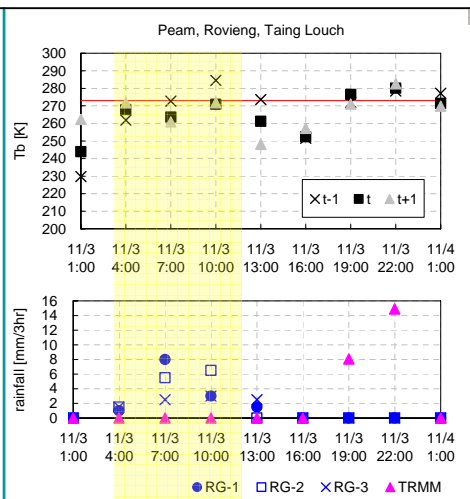
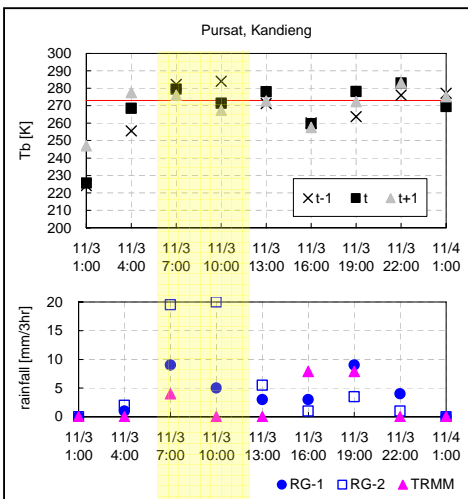


Total Rainfall Amount:
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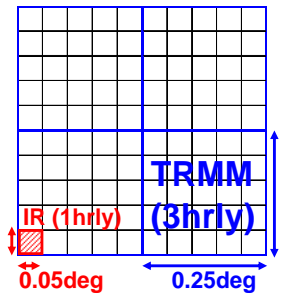
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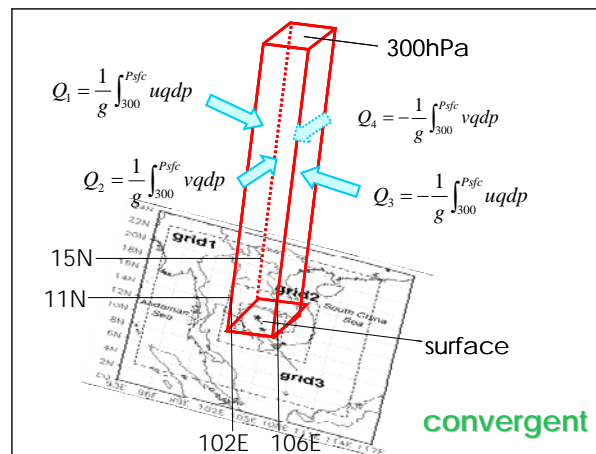
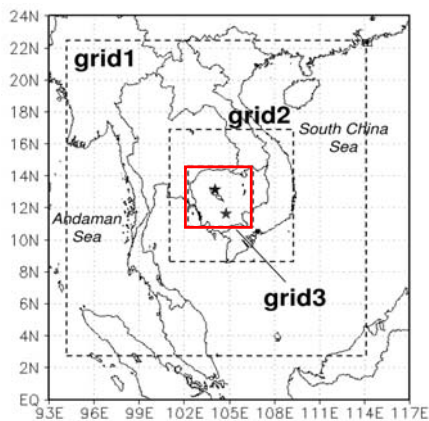
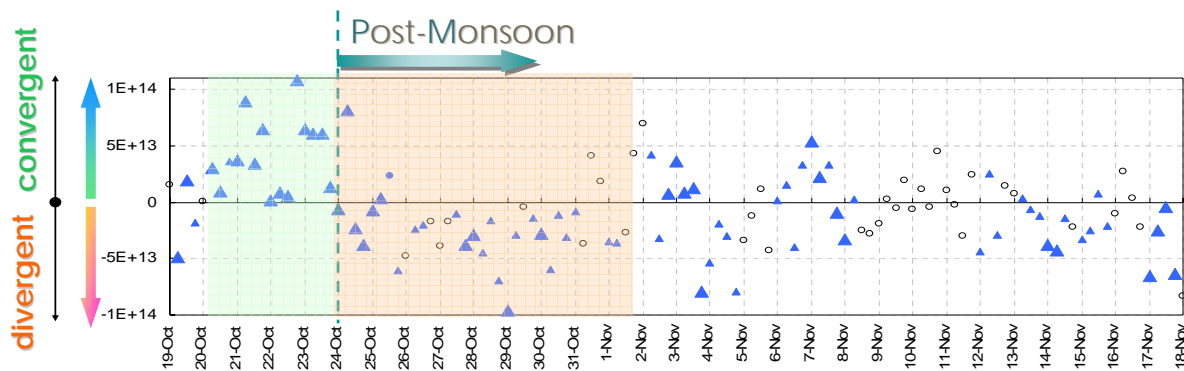
Rainfall & Cloud-Top temperature

T_B from MTSAT-IR1

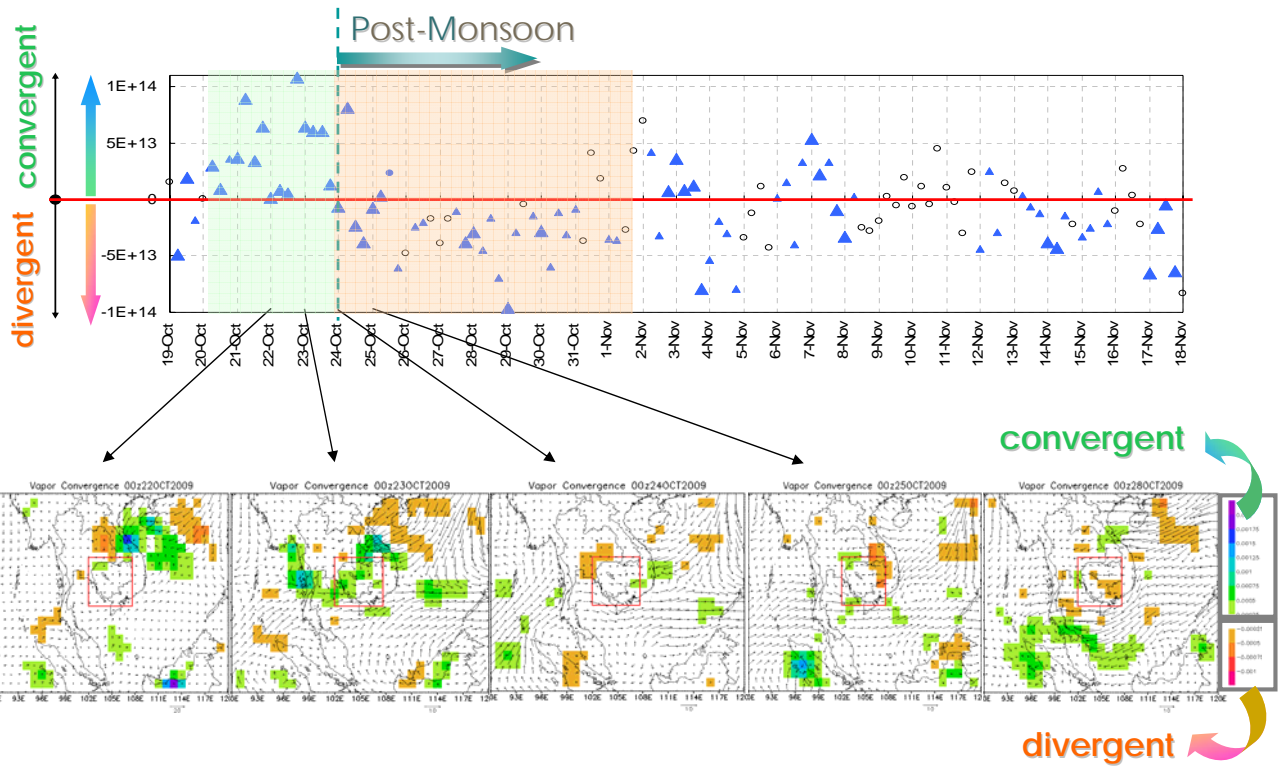


Rainfall from low-level clouds
 → Due to its unique rainfall system?

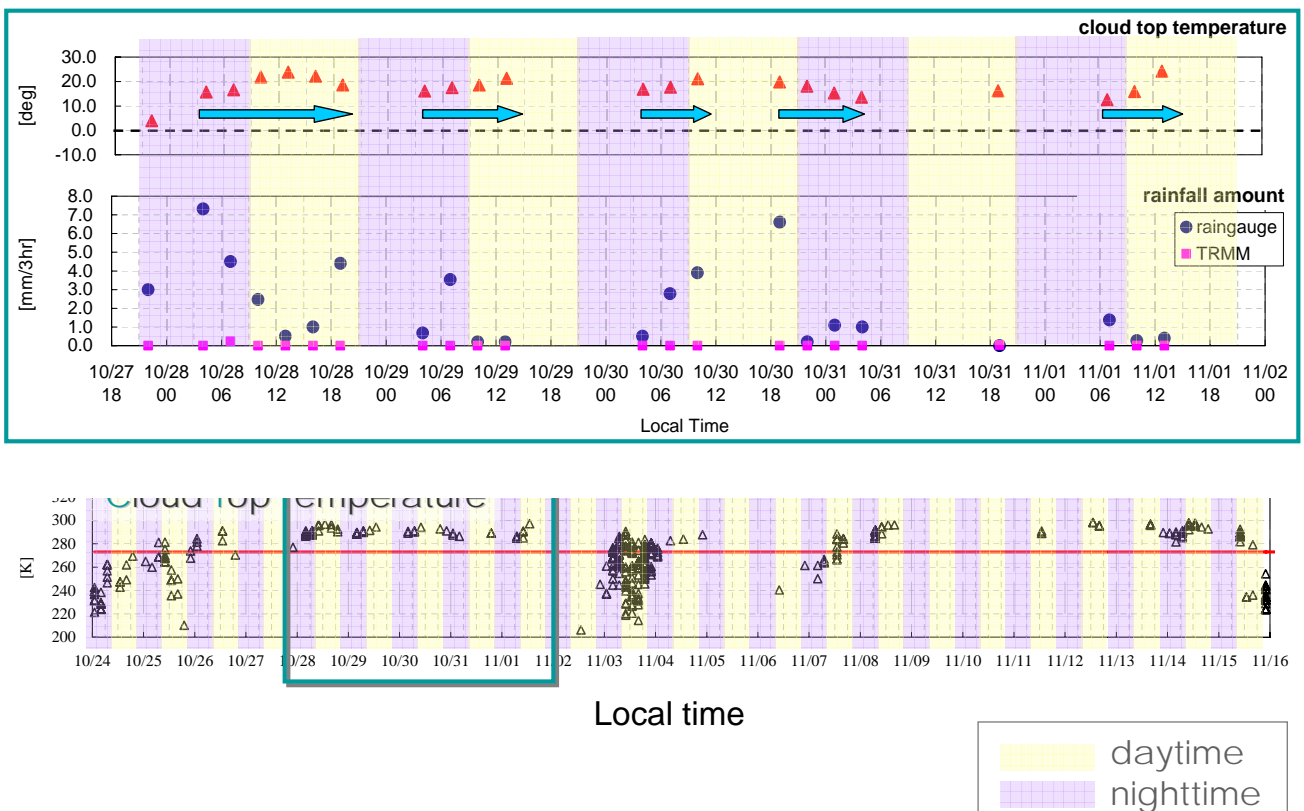
Vertical Integration of Water Vapor Convergence



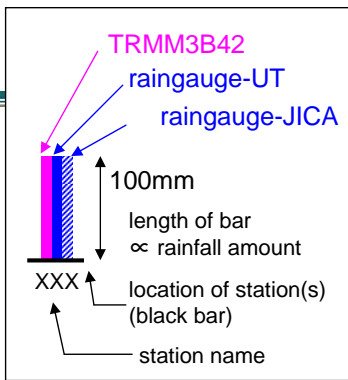
Vertical Integration of Water Vapor Convergence



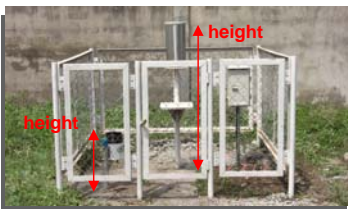
Post-Monsoon Conditions in 2009



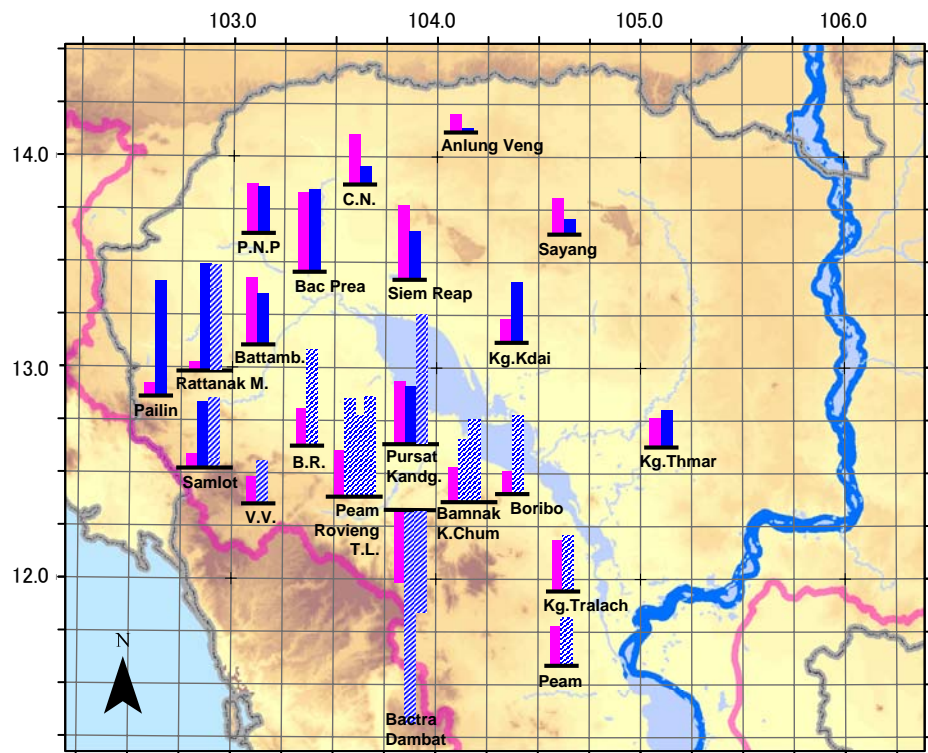
Total Rainfall Amount:
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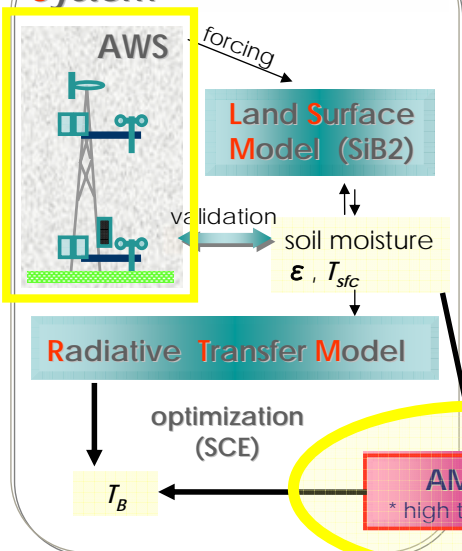
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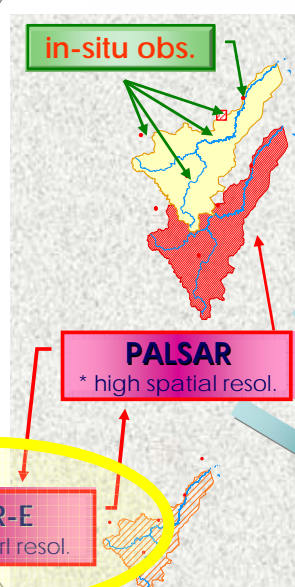
RG-UT RG-JICA



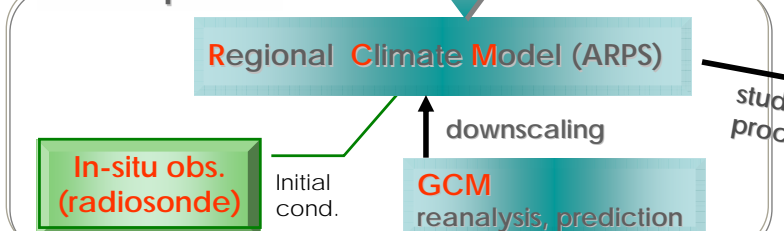
Land Data Assimilation System



Soil Moisture



Atmosphere



★ available on **high temporal resolution**

⇒ can be used **as the input to RCM**

★ algorithm is under development by using the **LDAS system & AWS obs.**

* problem1: validation

⇒ **low spatial resolution**

⇒ heterogeneity within a footprint makes it difficult to validate the algorithm with the point-scale in-situ obs.

⇒ **Heterogeneity will be checked by using PALSAR**

* Problem2: algorithm

⇒ **lake surface** would be included within a footprint, though current LDAS system assumes land-surface ⇒ percentage of lake area will be derived by PALSAR

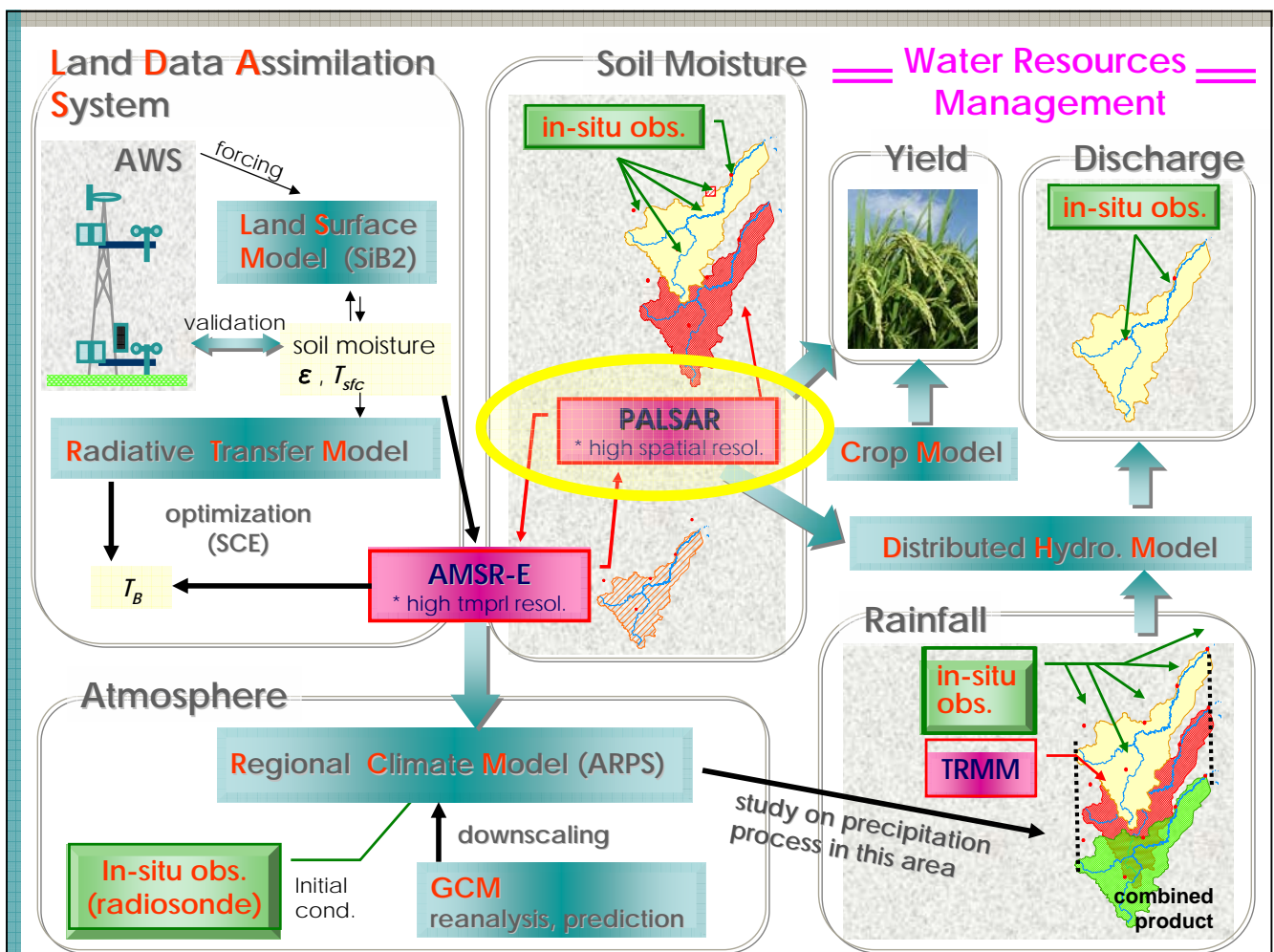
Result Application to Pursat Station

LDASUT.AIEM Period: 2009 Nov. 01 – 2010 Jan. 31 (dry season)

1. The estimated soil moisture is not good agreement of observed soil moisture.
2. The estimated soil moisture value is jumping each assimilation process (when AMSR-E data available).



It seems that this is because the existence of water surface area in the AMSR-E footprint (6.9GHz and 18GHz).



Soil Moisture Estimation by PALSAR

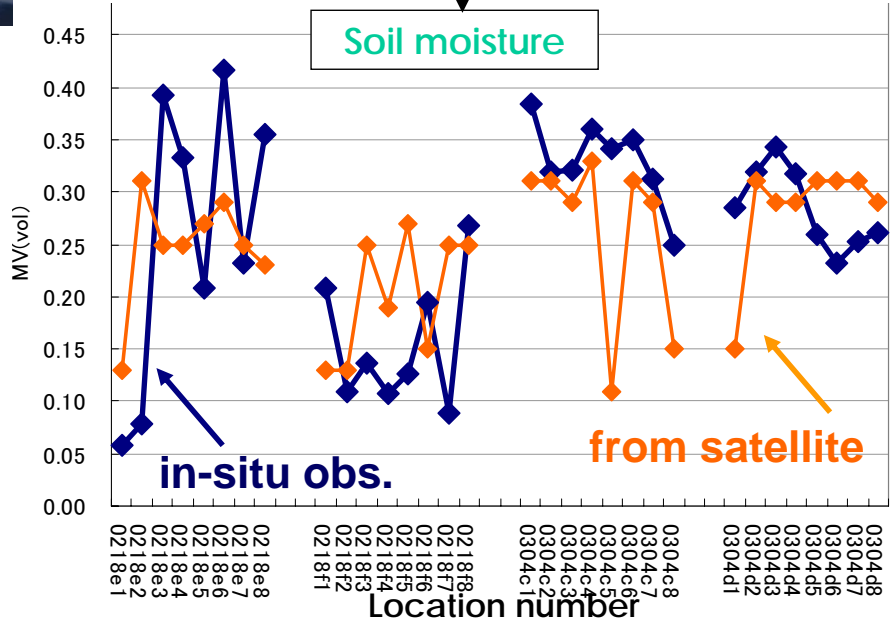


Algorithm under development !!

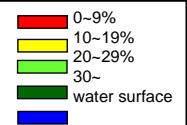
4 polarization data (HH, HV, VH, VV)

Look up table

Soil moisture



Soil Moisture Distribution by PALSAR

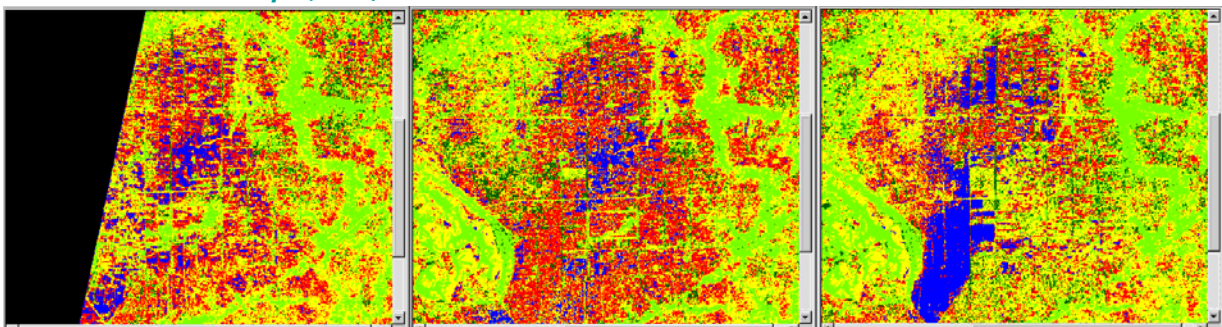


18th Feb. 2010

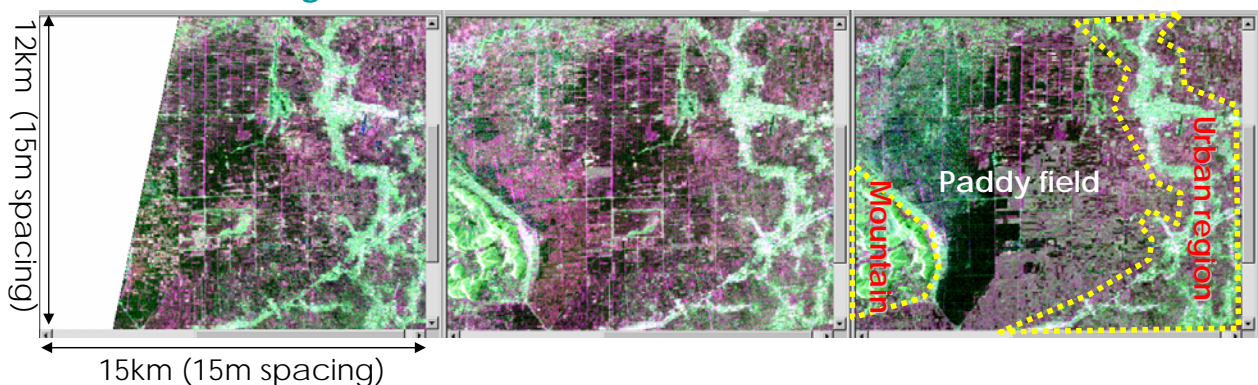
4th Mar. 2010

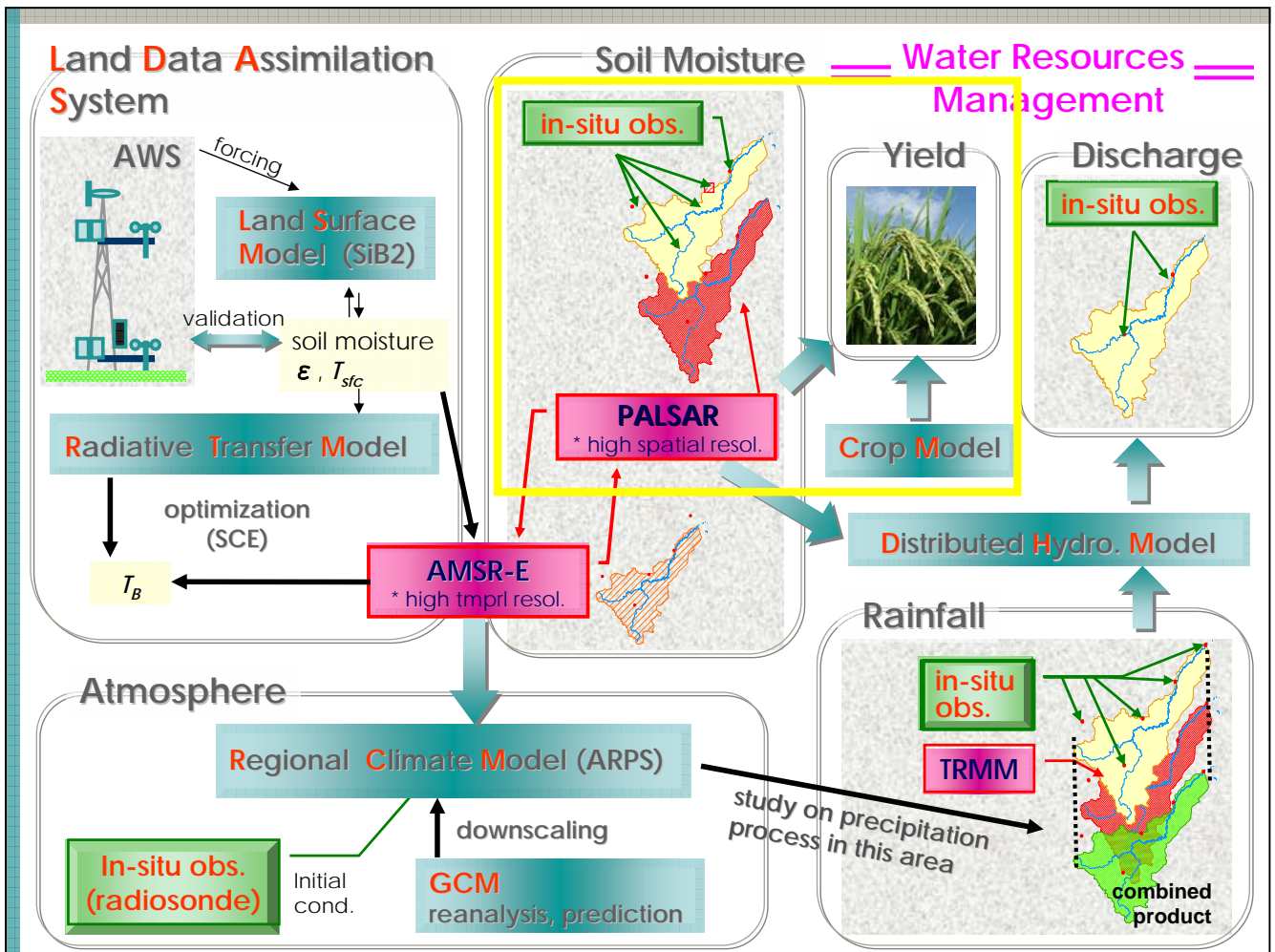
19th Apr. 2010

● *Soil moisture map (trial)*

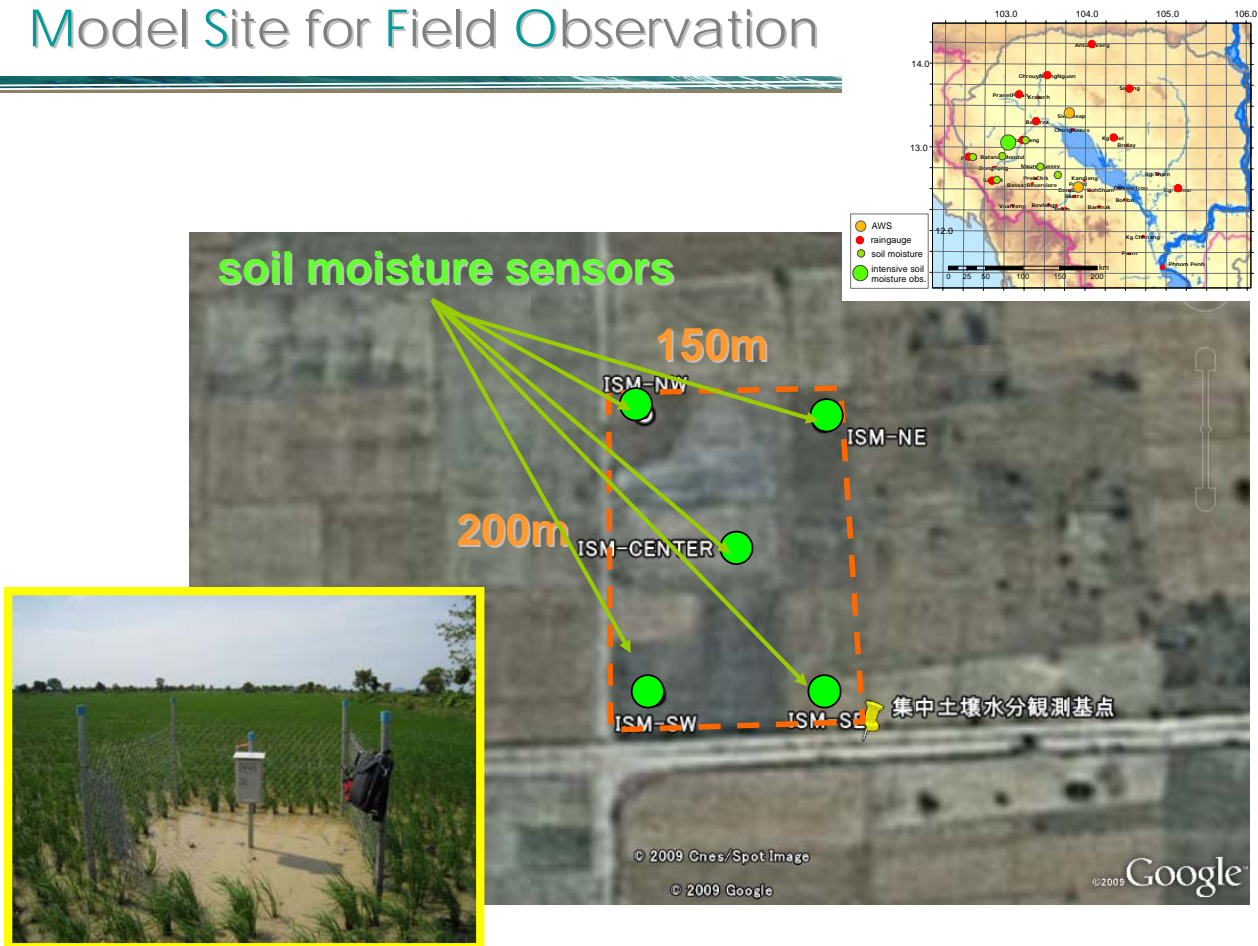


● *PALSAR raw image*

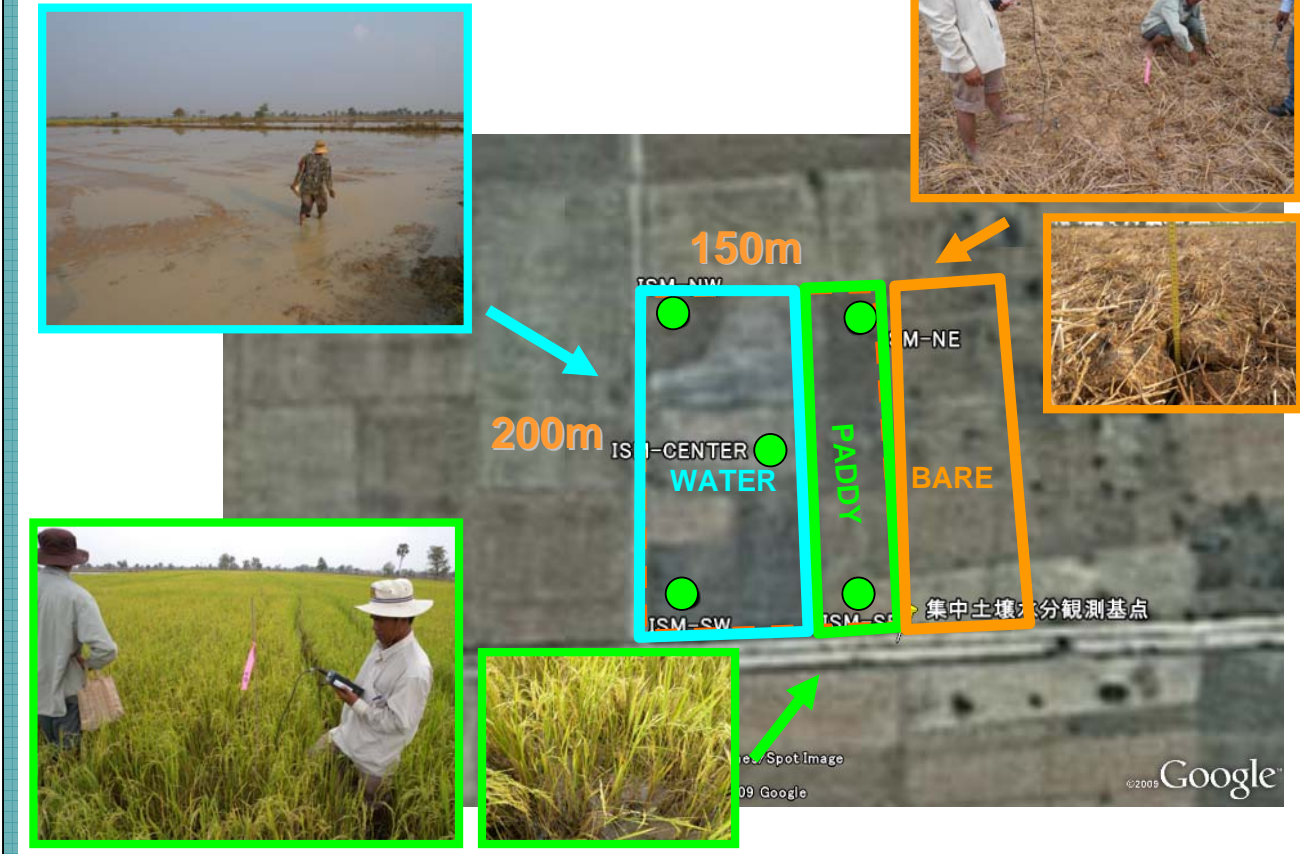




Model Site for Field Observation



Model Site for Field Observation



Field Investigation of Agricultural Activities

EAST

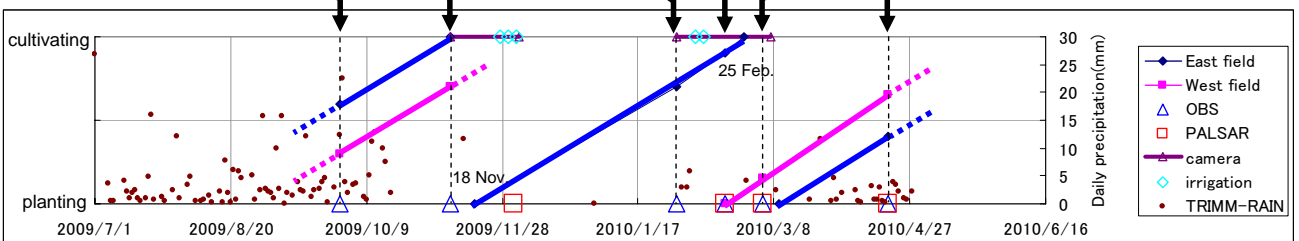


WEST

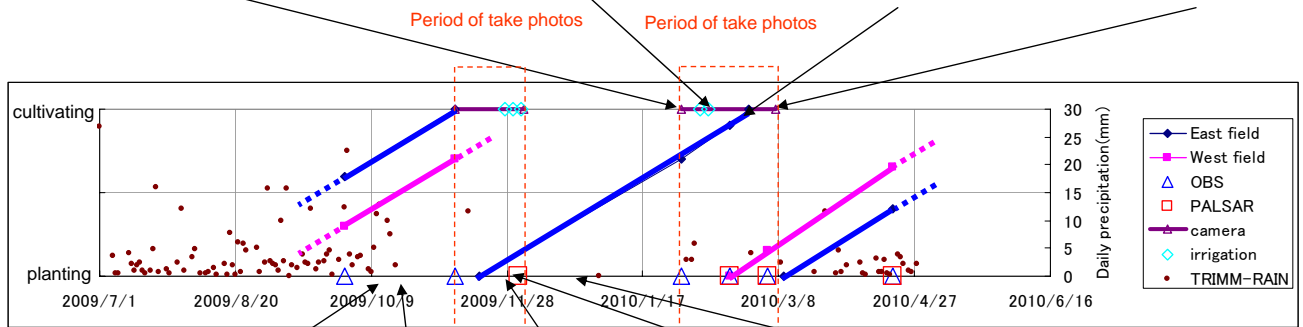


29 Sep 9 Nov 31 Jan 18 Feb 4 Mar 19 Apr

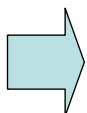
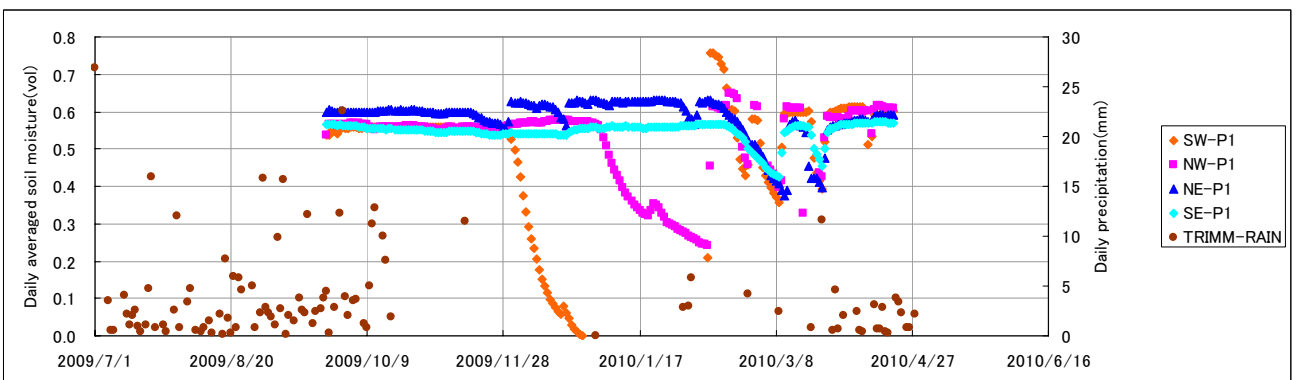
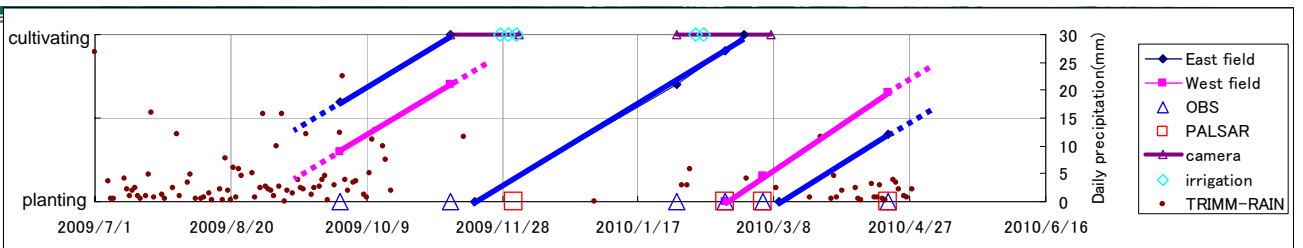
Field Obs.



Monitoring with Auto-Digital Field Cameras



Agricultural activities, Soil Moisture, Rainfall



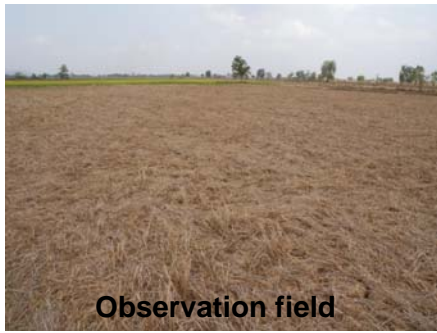
The soil moisture is kept high level by irrigation without rain.
Consequently, if enough water are supplied the farmers repeat farmir



The key is allocation of limited water in dry season

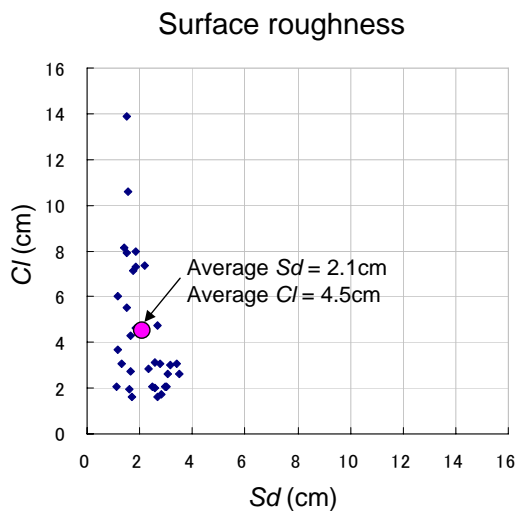
Observation field

- We conducted a field observation synchronized with PALSAR PLR mode.
 - Venue: a part of large paddy field located in a suburb of Battambang, Cambodia.
 - Date: 18th February, 2010
- The field condition was bare and dried surface after cultivate.

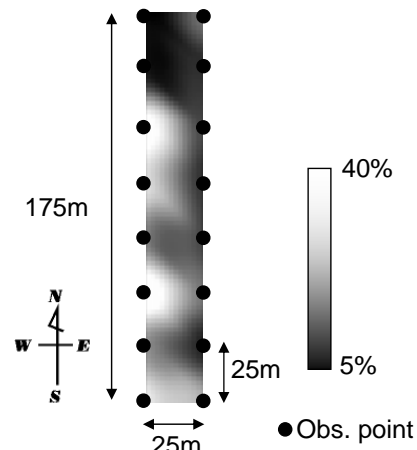


Field observation

- Field size: east-west 50m, north-south 200m.
- Collected items
 - Volume fraction of soil moisture : M_v (vol.)
 - Standard deviation of surface height: S_d (cm)
 - Surface correlation length: C_l (cm)
- Observed at 16 points with 25m intervals.



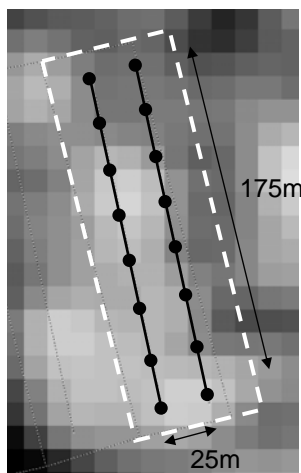
Soil moisture distribution (spatially interpolated by 16 data)



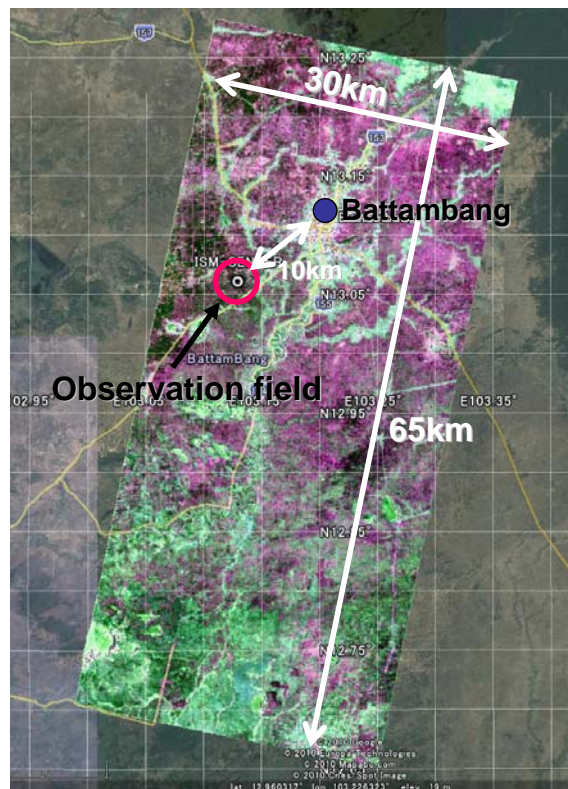
PALSAR data

Summary of analyzed PALSAR data

Mode	PLR
Obs. date	18 th Feb., 2010
Local time	10:30 (Descending)
Polarization	HH + HV + VH VV
Resolution	12.5 m



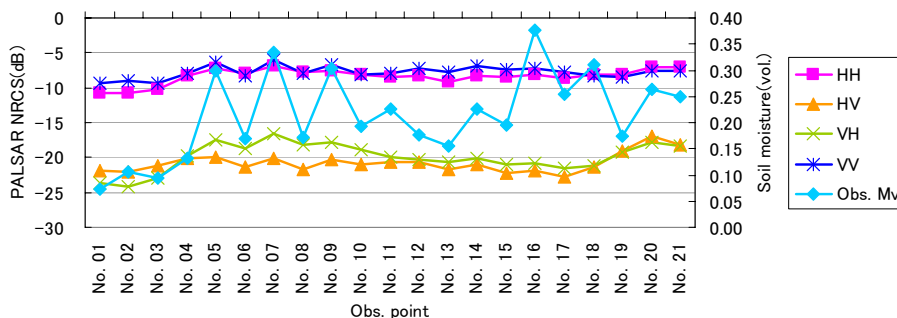
Distribution of PALSAR σ^0_{HH} within observation field



Composite PALSAR image (R:G:B=VV:VH:HH)

The relationship between parameters and PALSAR σ^0

- The variation of observed soil moisture and PALSAR σ^0 .



- We conducted the simulation which generate σ^0 from field observation data, and compared with PALSAR σ^0 for identifying Sv and D.

$$\begin{aligned} \text{Obs. } \sigma^0_{HH} &\text{ vs. Sim. } \sigma^0_{HH} = f(Mv, Sd, Cl, Sv, D) \\ \text{Obs. } \sigma^0_{VH} &\text{ vs. Sim. } \sigma^0_{VH} = f(Mv, Sd, Cl, Sv, D) \\ \text{Obs. } \sigma^0_{VV} &\text{ vs. Sim. } \sigma^0_{VV} = f(Mv, Sd, Cl, Sv, D) \end{aligned}$$

Mv: Volume fraction of soil moisture (vol.)
 Sd: Standard deviation of surface height (cm)
 Cl: Surface correlation length (cm)
 Sv: Volume fraction of soil particles (vol.)
 D: Soil particle diameter (cm)

where *Mv*, *Sd*, *Cl* are field data, *Sv*, *d* are variable.

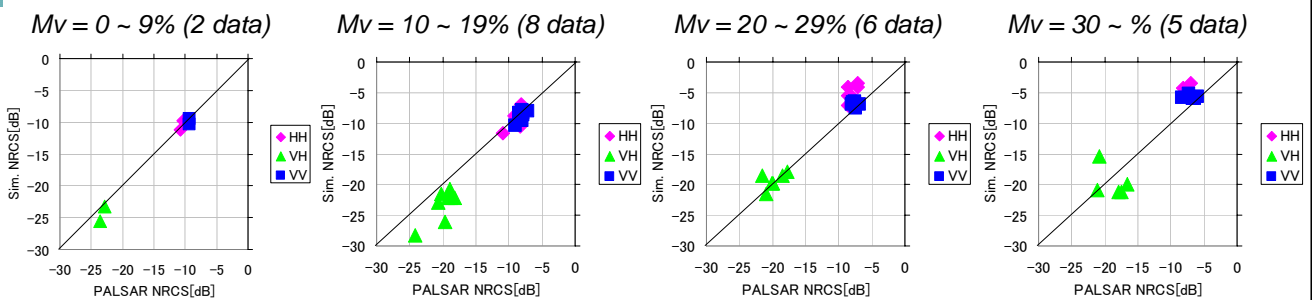
- *Mv* = average value from the spatially interpolated distribution within 1 pixel of PLASAR.
- *Sd* = 2.1cm : average value of 18 observation point.
- *Cl* = 4.5cm : average value of 18 observation point.

The relationship between parameters and PALSAR σ^0

- By dividing the soil moisture into four categories, optimized sets of S_v and D were obtained.

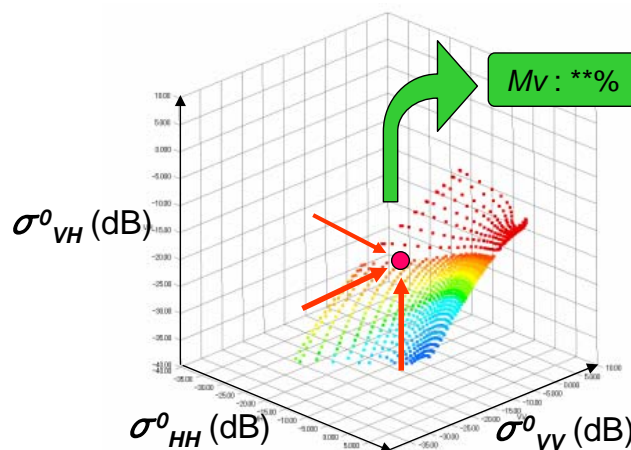
Setting of both S_v and D

M_v (%)	S_v (vol.)	D (cm)
0 ~ 9	0.6	1.4
10 ~ 19	0.2	1.0
20 ~ 29	0.2	0.9
30 ~	0.2	0.6



The look up table for soil moisture estimation

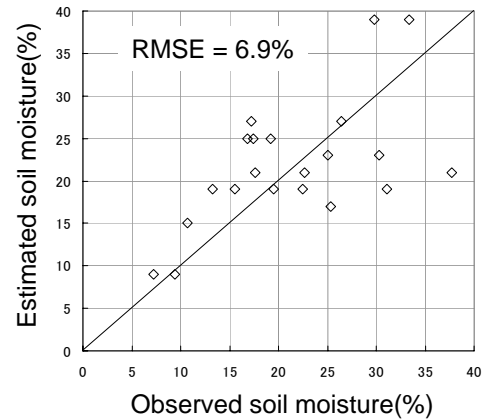
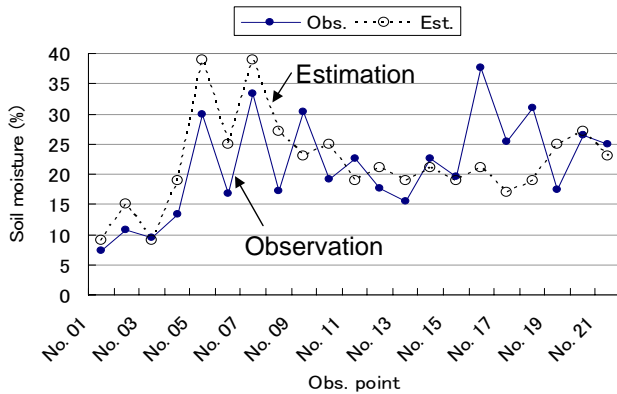
- A look-up table was obtained from the forward model by introducing the calibrated values of S_v and D for each soil moisture category.
- By introducing the observed σ^0 and getting the nearest point value from the look-up table, we can estimate soil moisture and surface roughness parameters.



Virtual image of the look up table.

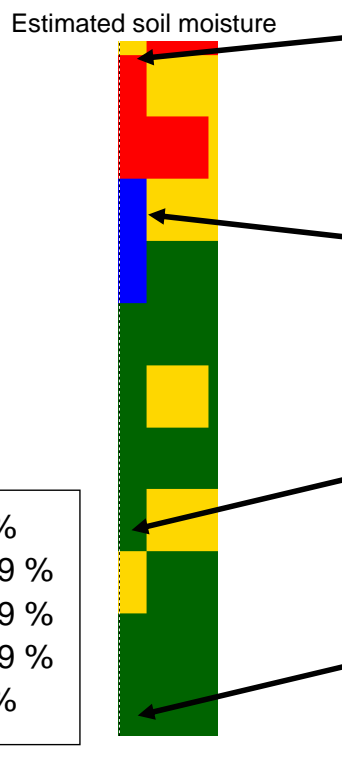
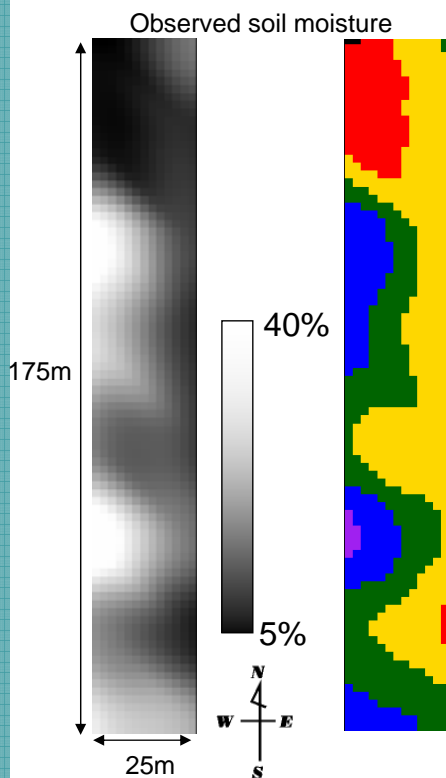
Result of soil moisture estimation

- The sensitivity of the PALSAR σ^0 at no. 16, 17, and 18 were very weak. As the result, there are large errors at these points.
- Except these estimated values, the results of the algorithm show the good agreement with the observed.



Comparison between observed and estimated MV

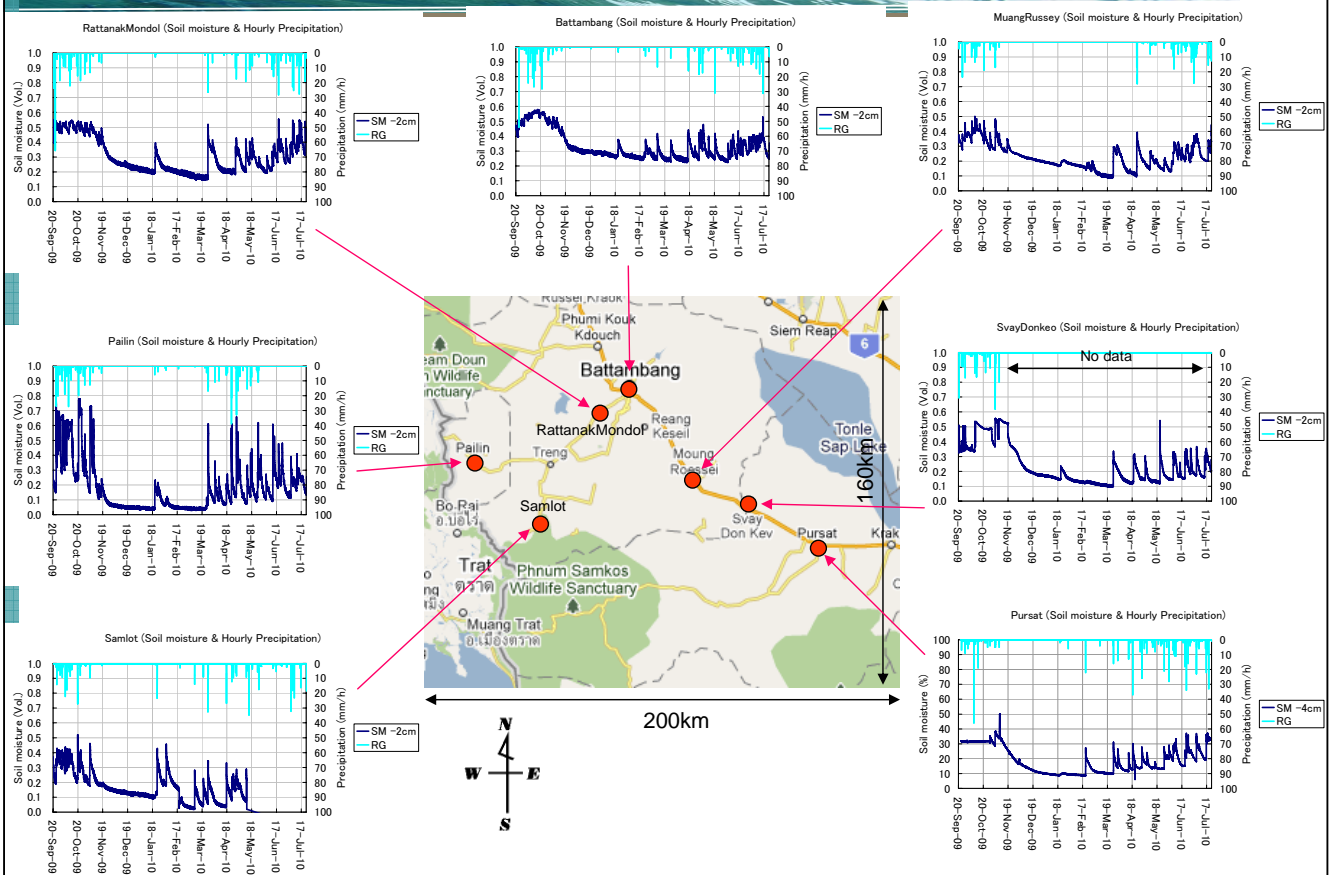
Spatial distribution

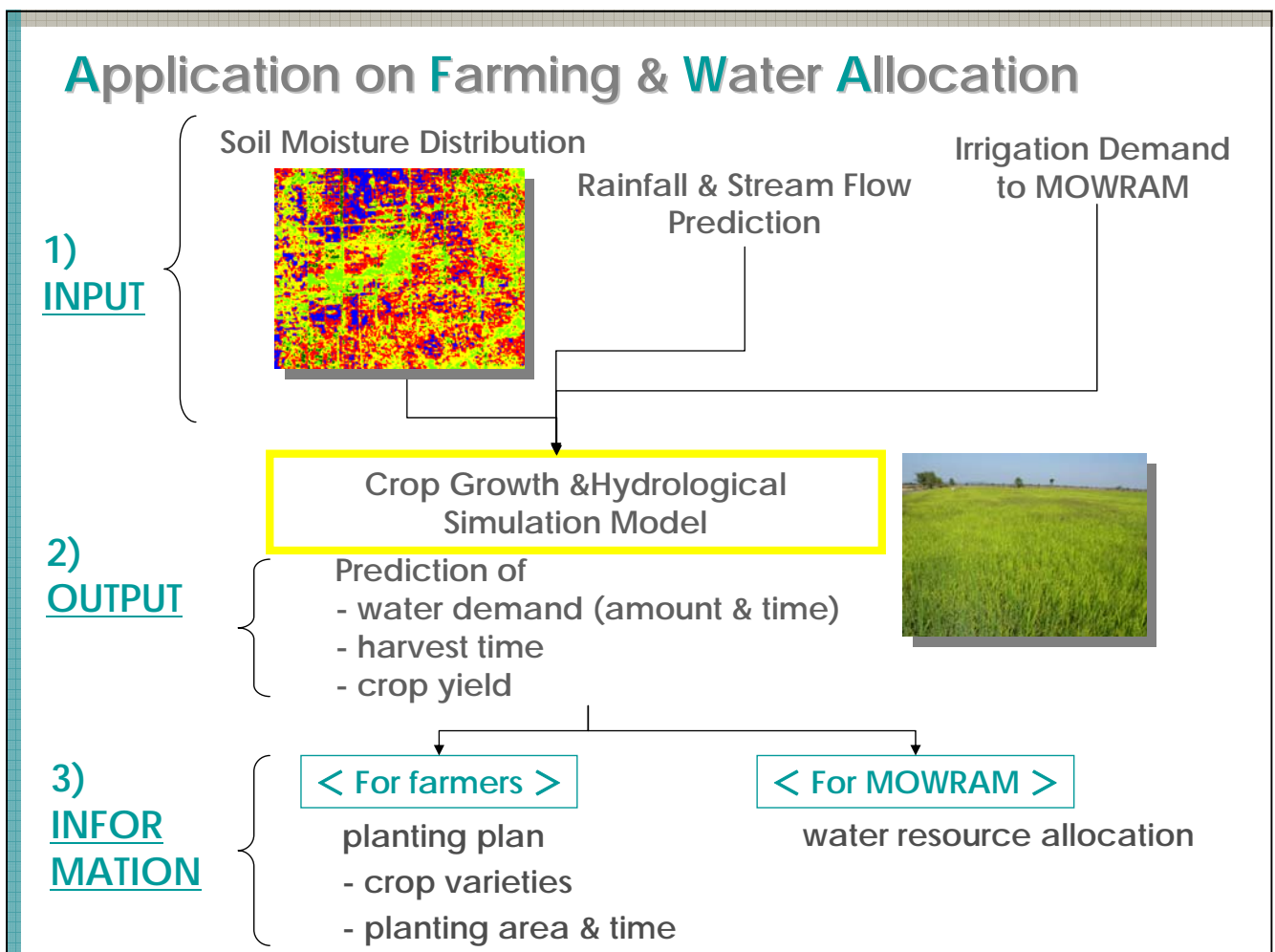
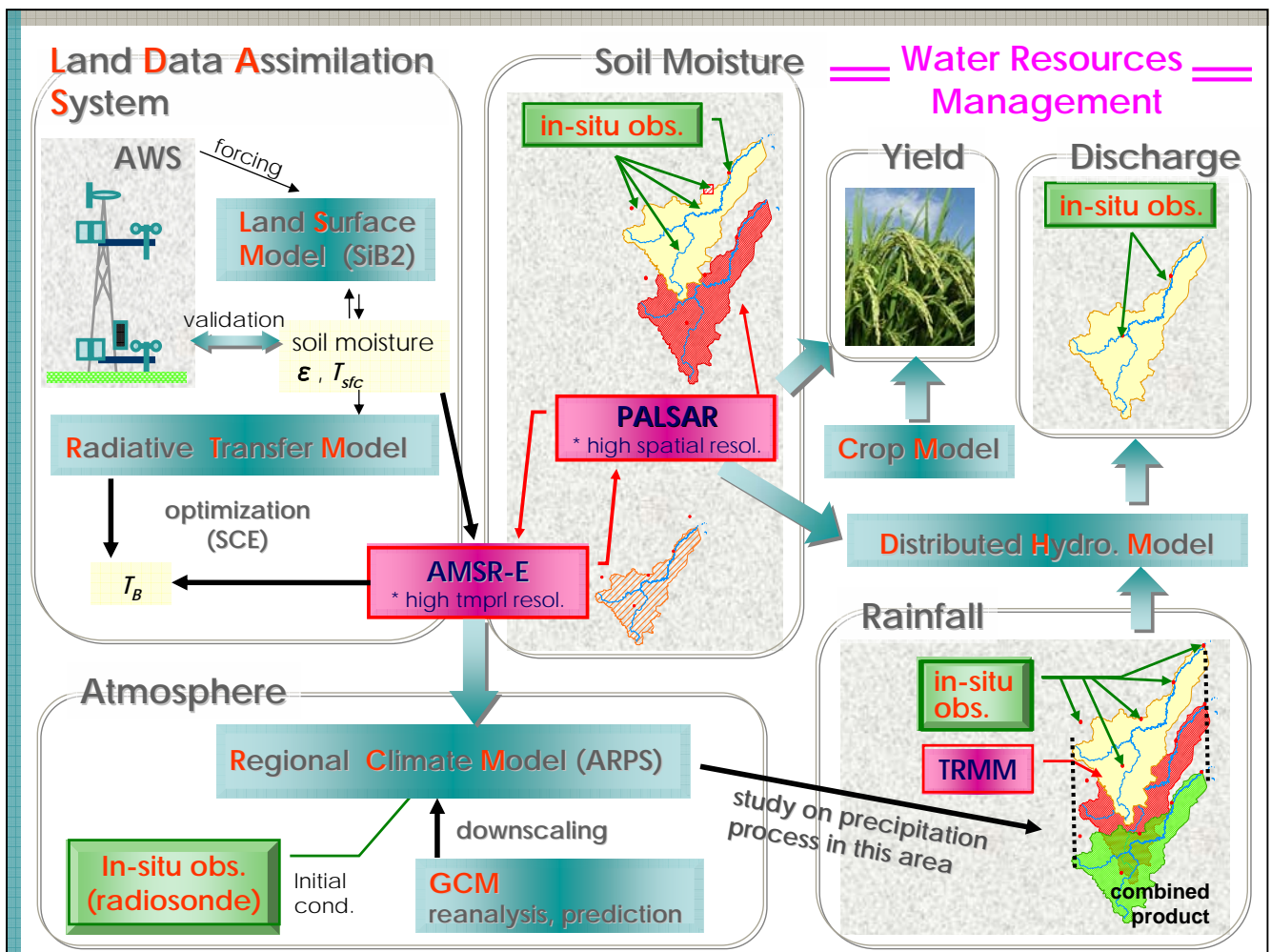


Conclusions

- In this study, we developed the multi-polarization SAR algorithm for soil moisture estimation in a paddy field in Cambodia.
- The algorithm show the good performance in the estimation of soil moisture.
- Following the first step of the algorithm development, we need to
 - clarify the sources of errors.
 - check the applicability of the sets of parameters.
 - investigate the effects of the rice plant growth on the microwave radiative transfer.
 - classify the land cover in advance.

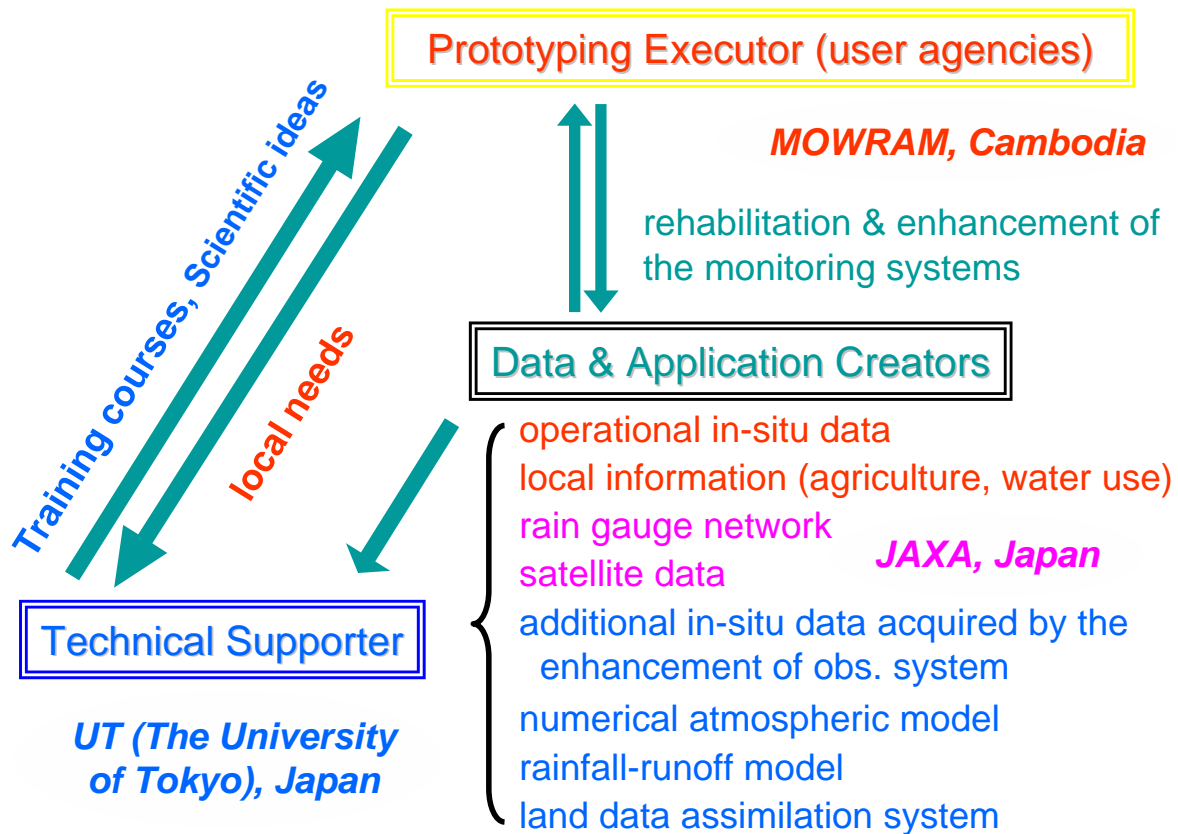
Surface Soil Moisture and Hourly Precipitation from 20th Sep., 2009 to 23rd Jul., 2010





Project Team & Relationship among Participants

+ Cooperation with other projects



Next Steps

- (1) **Expansion of the Observation Network & Data Integration Functions**
 - 1) maintenance the existent in-situ network
 - 2) intensive observation of radiosonde, paddy/lake fluxes, isotope, etc.
 - 3) integration of in-situ & satellite data
 - 4) data collection for long-term Hydro-Met data.
- (2) **Test Offering of Monitoring & Prediction Outputs to MOWRAM**
 - 1) 7-10day rainfall
 - 2) Soil moisture distribution by PALSAR
- (3) **Development and Application of Advanced Models**
 - 3) Regional Climate Models
 - 4) Coupled Land-Atmosphere Data Assimilation Model
 - 5) Seasonal (3 months) prediction model
- (4) **Better Understanding of Water Cycle Processes**
 - 1) Interaction of Land-Atmosphere interaction
 - 2) Tracing of "water" through land, lake, & atmosphere, by using isotope
 - 3) Effect of the different lake area and land conditions between the post-monsoon & pre-monsoon seasons.
 - 4) Impact of climate change
- (5) **Contribution to Agriculture: Test Offering of Information to support**
 - 1) rain-fed agricultural land ; and 2) irrigated agricultural land



Thank you very much
for your supports and cooperation

