

## Validation of AMSR



# Performance of AMSR in three field experiments SMEX02, SMEX03 and SMEX04

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University of South Carolina

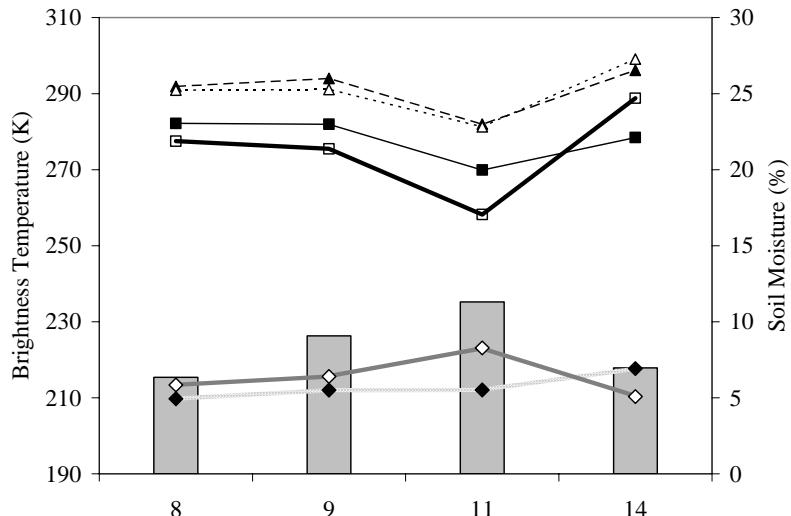
# In situ Sampling

- Gravimetric soil moisture
- Volumetric soil moisture
- Bulk density
- Soil roughness
- Soil/surface temperature
- Soil texture
- Vegetation water content
- Vegetation type

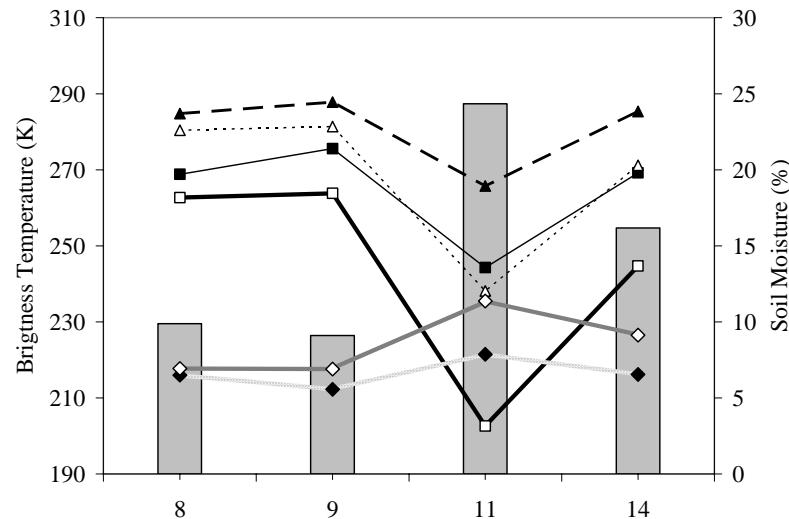


# Moisture and Vegetation Effects

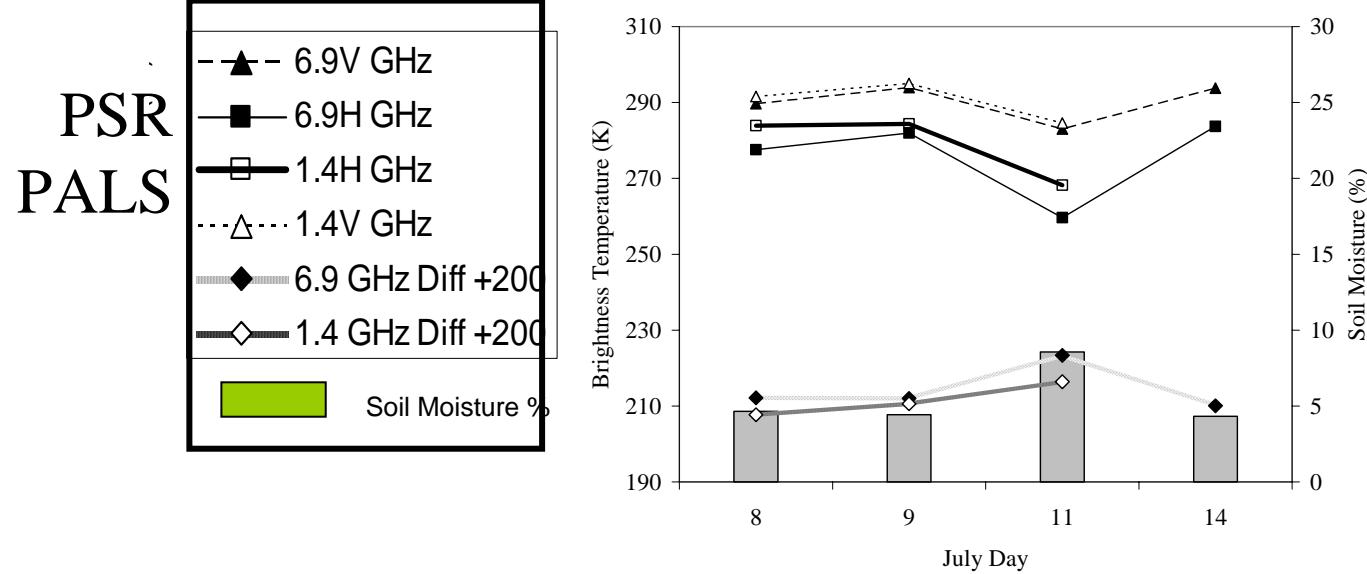
Bare Field

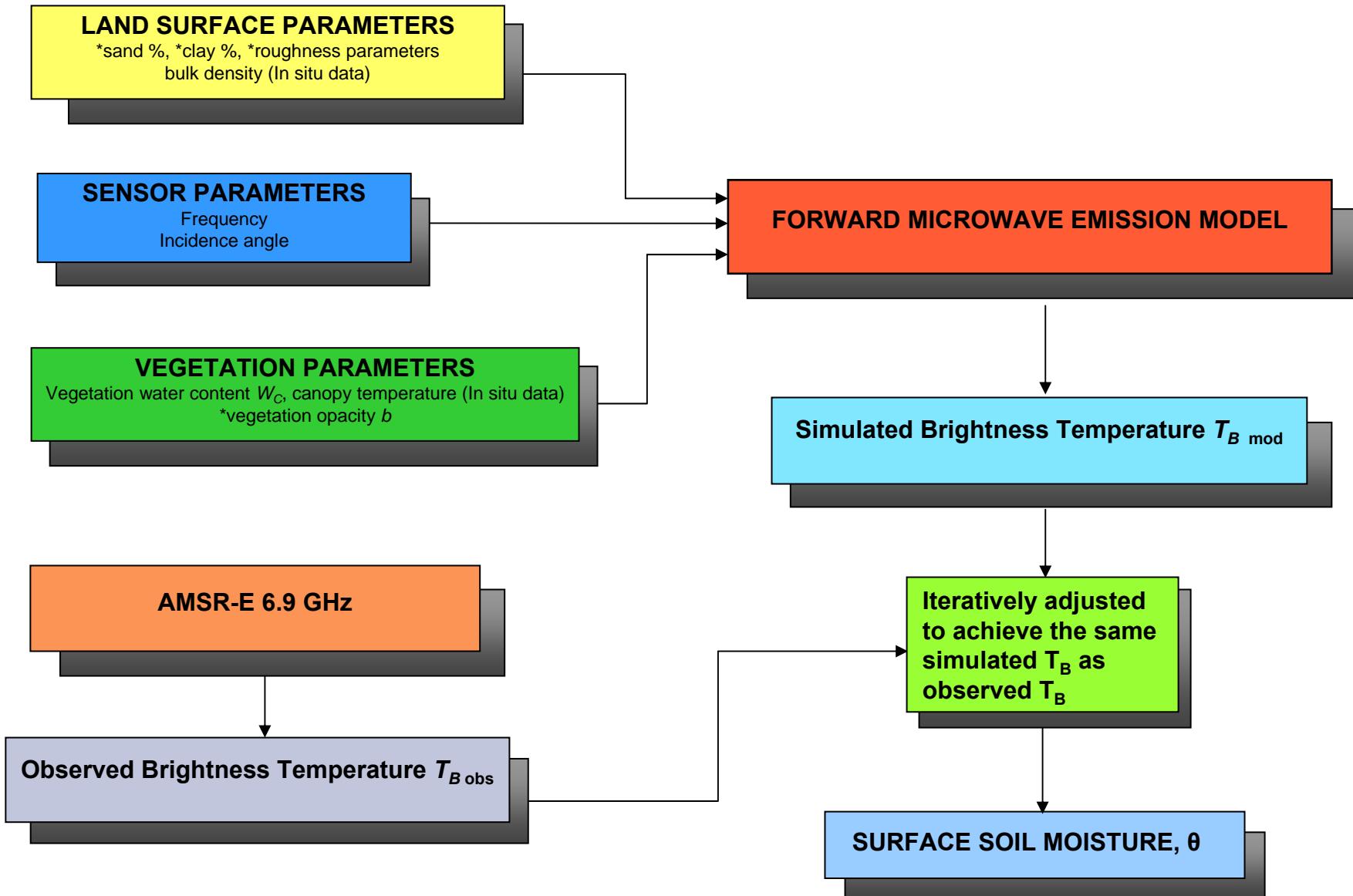


Wheat ( $0.36 \text{ Kg/m}^2$ )



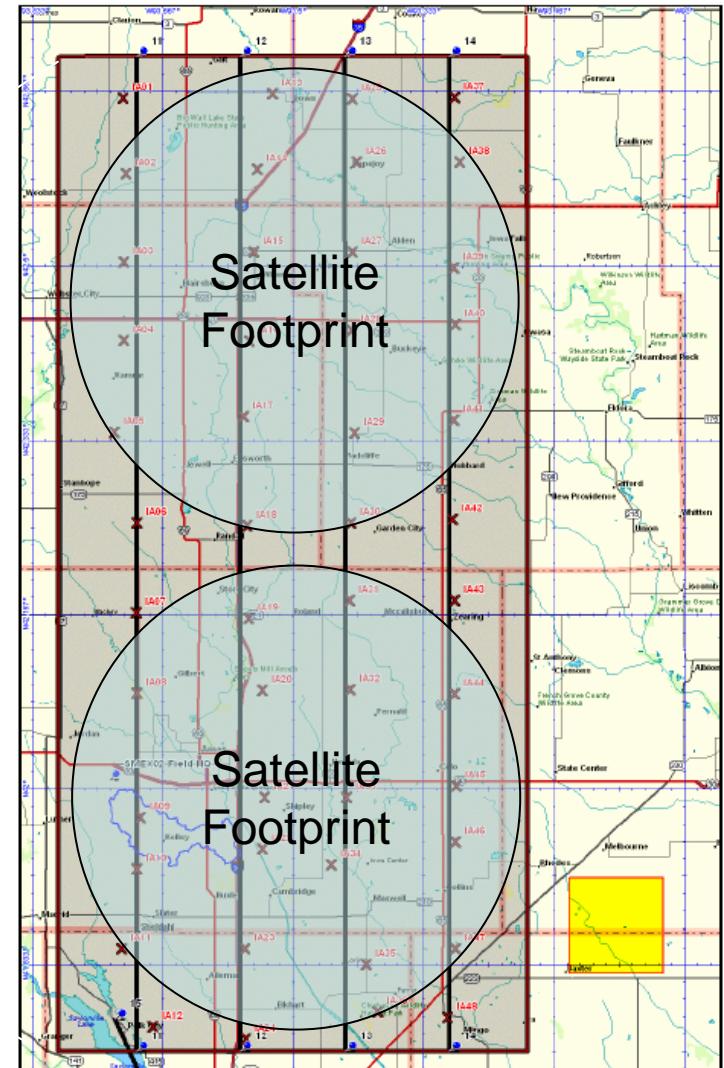
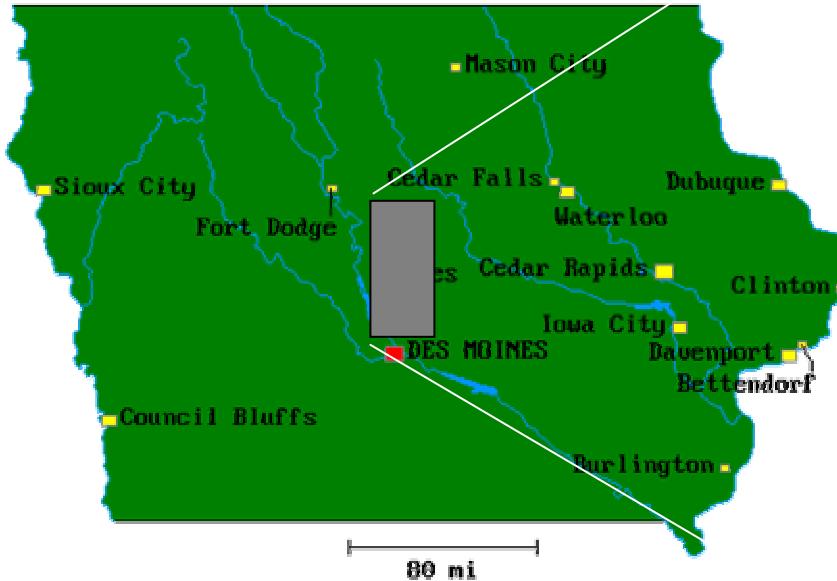
Corn ( $7.18 \text{ Kg/m}^2$ )





# SMEX02 Regional Study Area

Iowa...the Hawkeye State

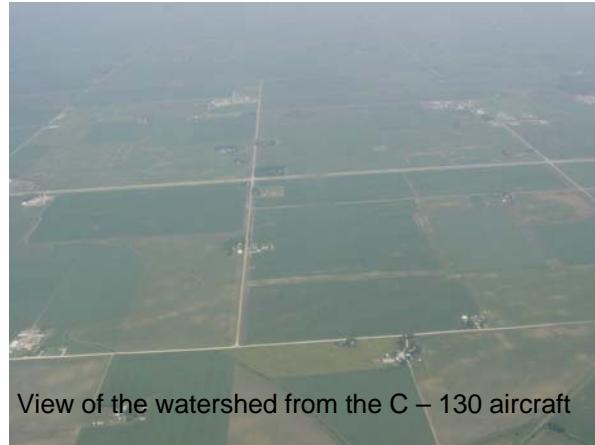


# **Soil Moisture Experiments 2002 (SMEX02)**

June 25<sup>th</sup> to July 12<sup>th</sup> 2002

Crop types: corn and soy

Major precipitation events



View of the watershed from the C – 130 aircraft



Corn fields grew from ~2 kg/m<sup>2</sup> to ~6 kg/m<sup>2</sup>

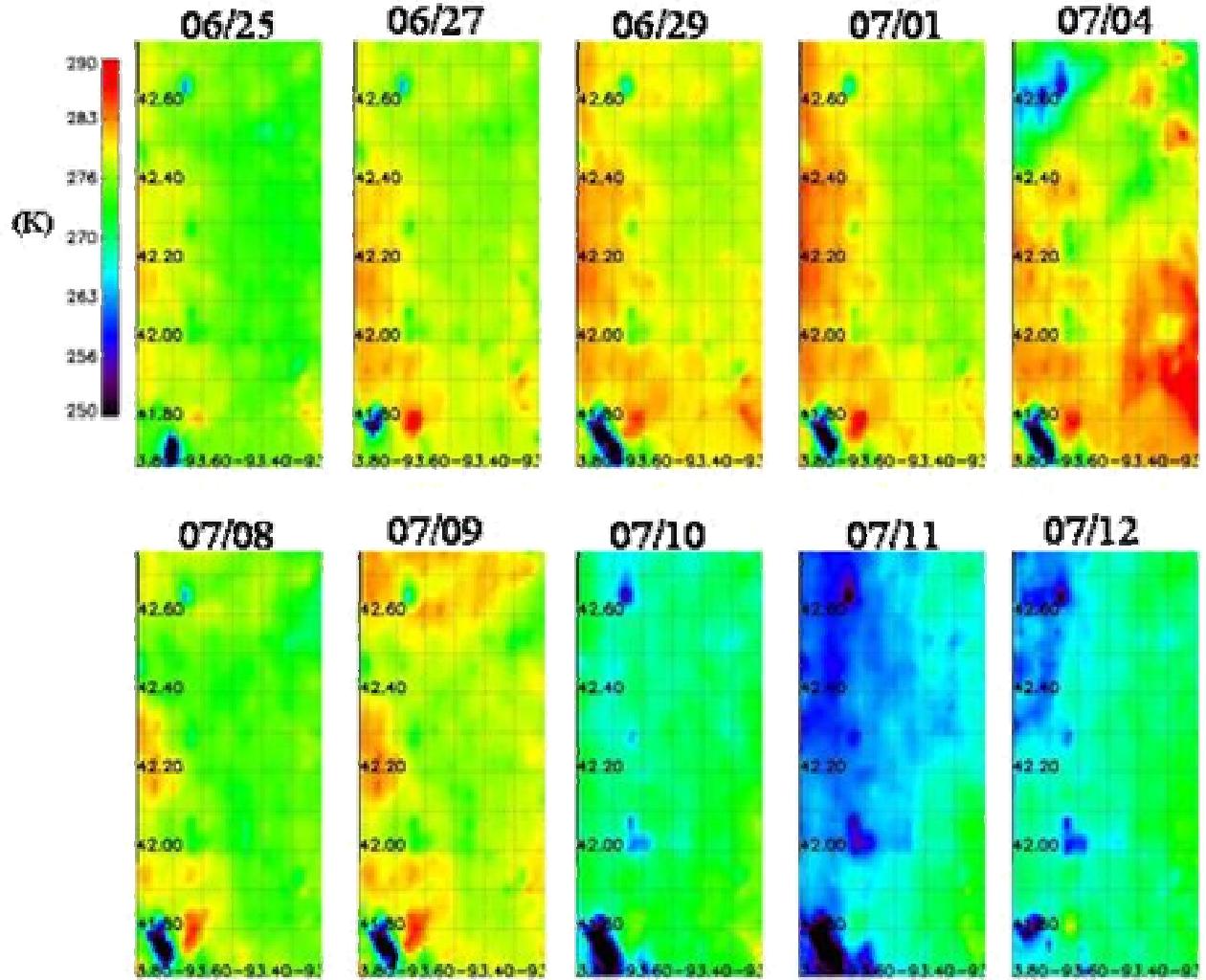


Soy fields grew from ~0 kg/m<sup>2</sup> to ~2 kg/m<sup>2</sup>

In situ data: gravimetric soil moisture, bulk density, soil roughness, soil temperature, soil texture, vegetation water content, vegetation type, vegetation temperature.

# Observed Aircraft Brightness Temperatures (PSR C/X 7.3 GHz)

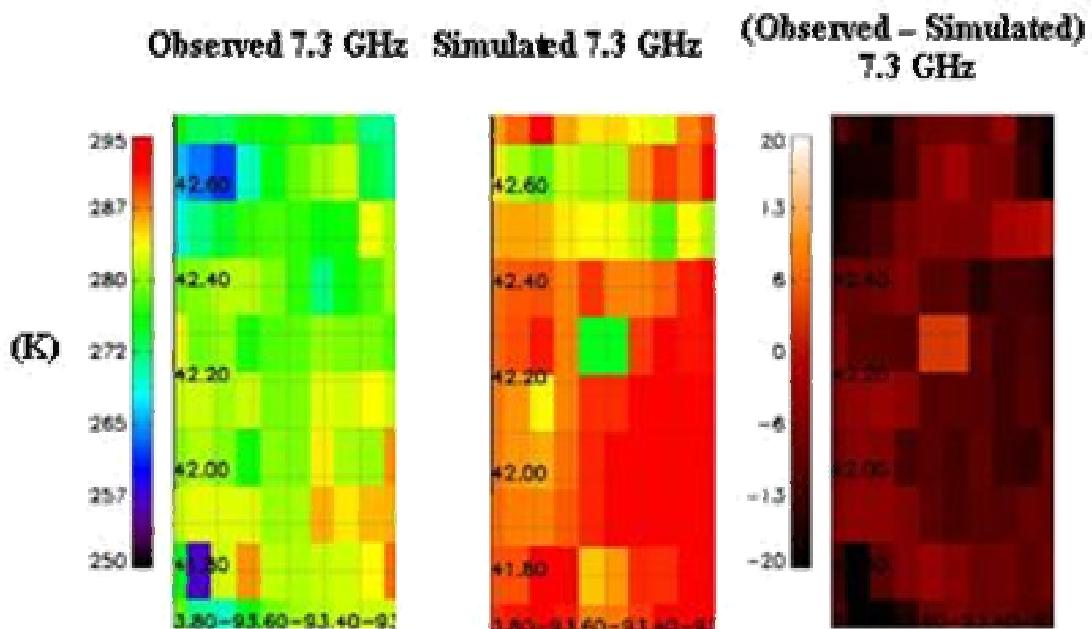
- Dry = warm (red)
- Wet = cold (blue)
- Heterogeneity
- Rain events



# Gridded Aircraft Results (PSR C/X 7.3 GHz)

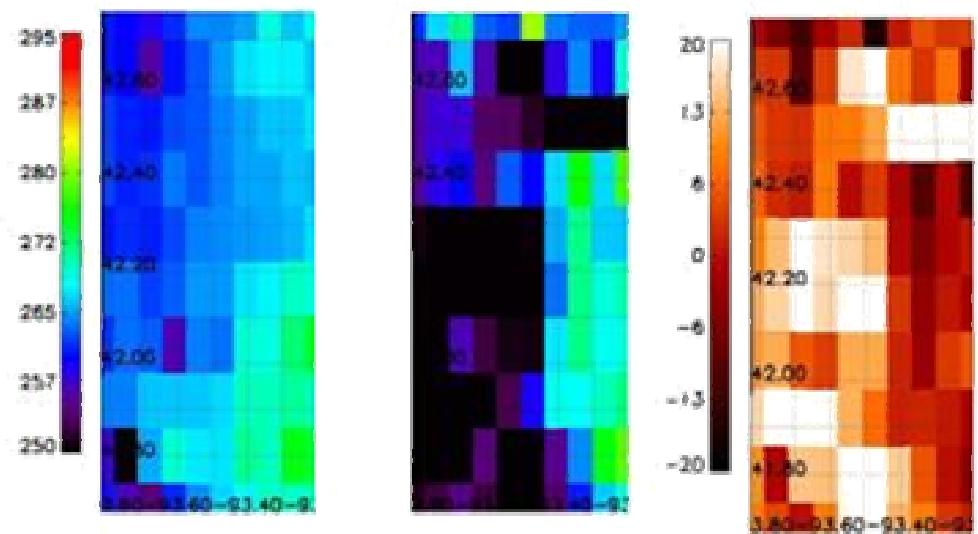
- 10 x 10 grid

July 4th



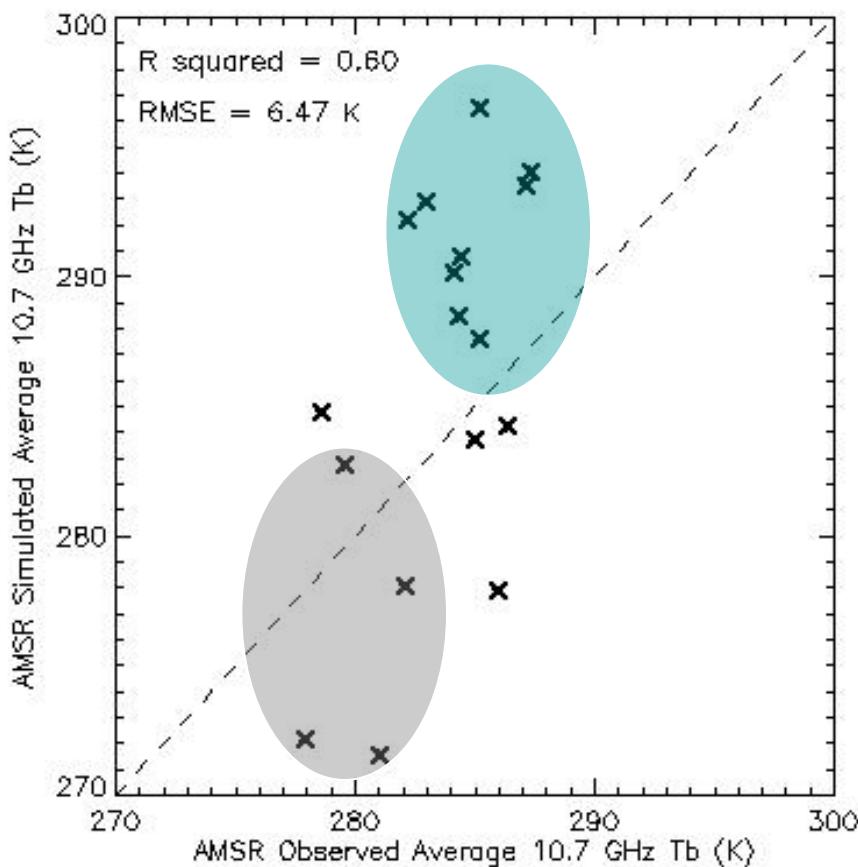
- Wetting Patterns Observed
- Heterogeneity Effects
- Vegetation influence

July 10th (K)

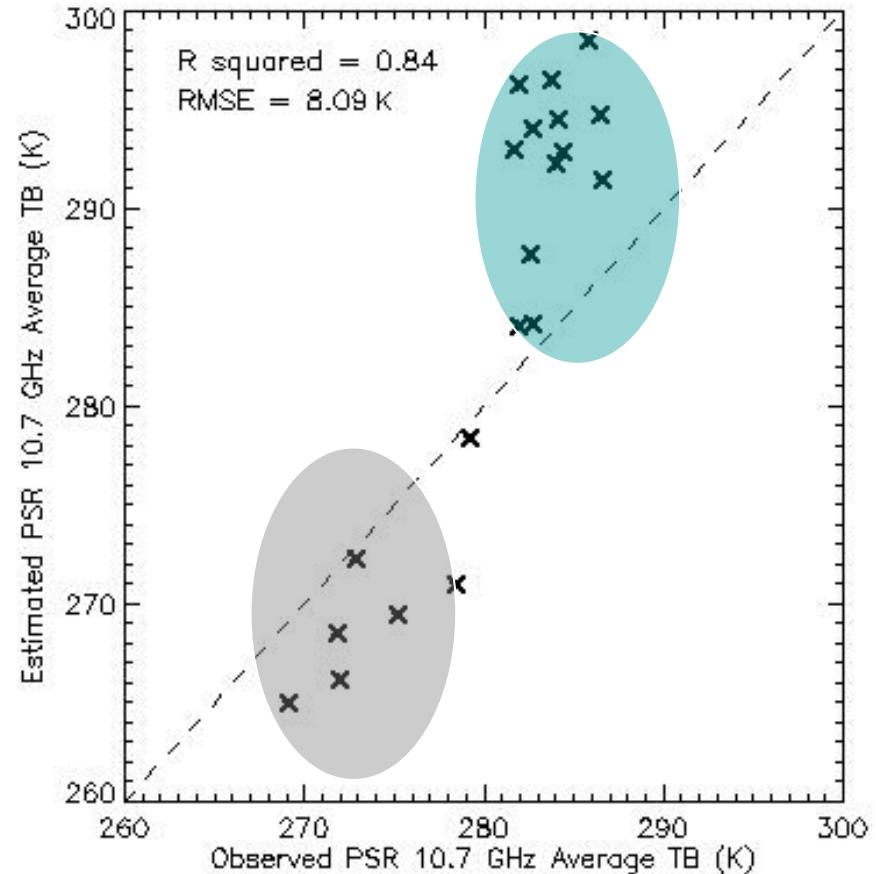


# Brightness Temperature Results

Satellite (AMSR 10.6 H GHz)



Aircraft (PSR/C 10.7 H GHz)

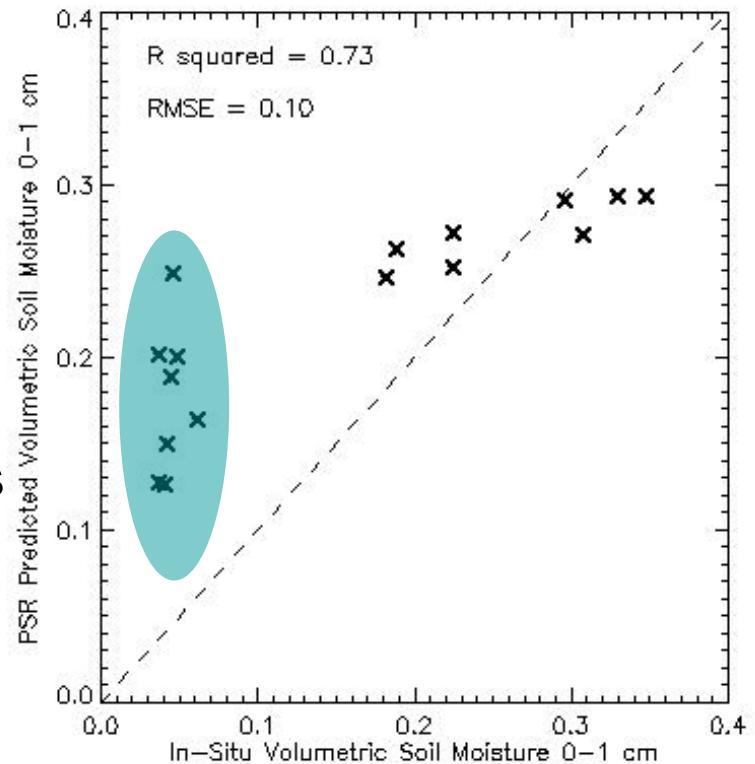


High soil moisture / Low vegetation

Low soil moisture / High vegetation

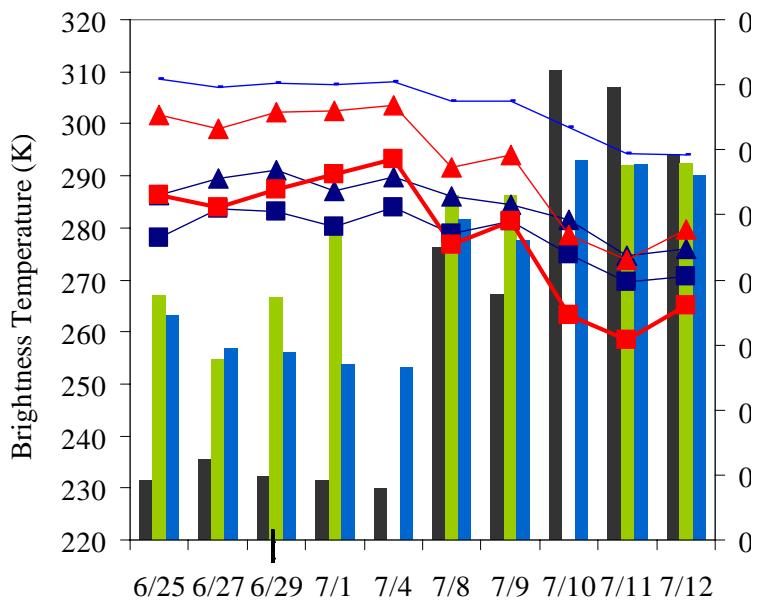
# Soil Moisture Retrieval Results

- Comparison using mean domain-scale
- Soil predictions better in the wetter regions
- Difficulty estimating low soil moisture values
- Vegetation influence?

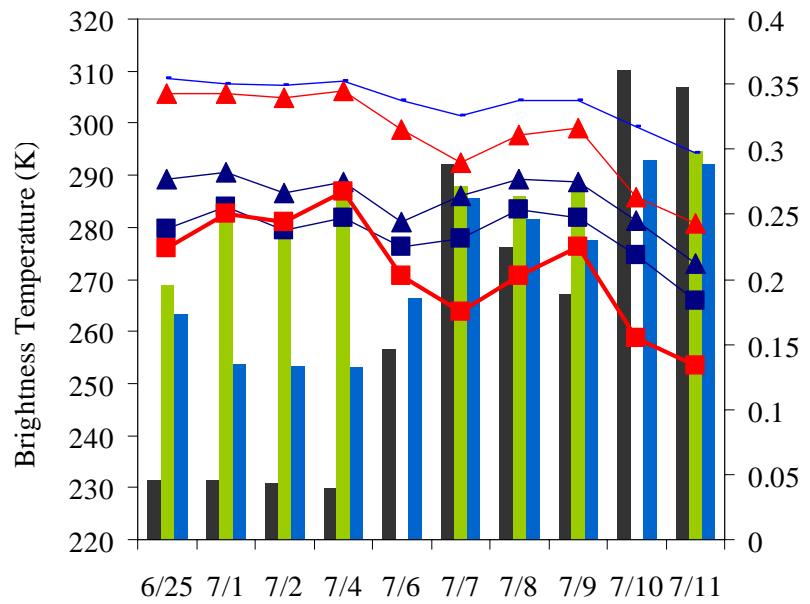


Estimated $m_v$	<i>in situ</i> $m_v$ 0-1 cm			<i>in situ</i> $m_v$ 0-6 cm		
	$R^2$	RMSE( $m^3 m^{-3}$ )	Bias ( $m^3 m^{-3}$ )	$R^2$	RMSE( $m^3 m^{-3}$ )	Bias ( $m^3 m^{-3}$ )
AMSR 10.7 GHz	0.436	0.127	-0.093	0.353	0.066	-0.048
PSR 10.7 GHz	0.711	0.099	-0.073	0.705	0.040	-0.028
PSR 7.3 GHz	0.738	0.102	-0.078	0.722	0.041	-0.033

# SMEX02 Time-Series



- Observed Soil Moisture (0-1cm)
- PSR Predicted Volumetric Soil Moisture
- Observed Volumetric Soil Moisture (0-6cm)
- Observed PSR 10.65H GHz TB
- Observed PSR 10.65V GHz TB
- Estimated 10.65H GHz TB
- Estimated 10.65V GHz TB
- Soil Temperature (5 cm)



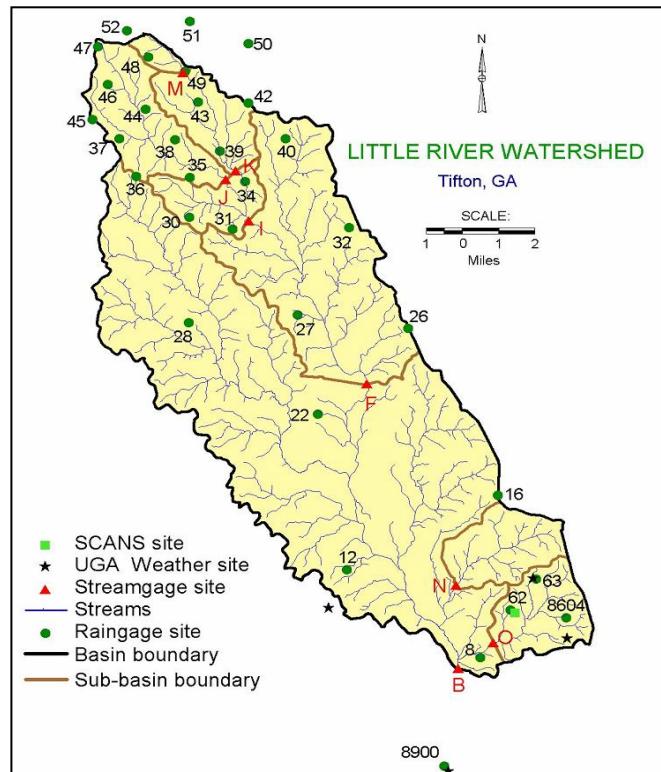
- Observed Soil Moisture (0-1cm)
- AMSR Predicted Volumetric Soil Moisture
- Observed Volumetric Soil Moisture (0-6cm)
- Observed AMSR 10.65H GHz TB
- Observed AMSR 10.65V GHz TB
- Estimated 10.65H GHz TB
- Estimated 10.65V GHz TB
- Soil Temperature (5 cm)

# SMEX03

## Study Area

- Soil Moisture Experiment: June 17 – July 21, 2003
- Little River Experimental Watershed
- Area of 3750 squared kilometers
- Humid climate
- Average rainfall ~ 1200 mm per year
- Vegetation cover types: forest (36%), pasture(18%), and agricultural crop surfaces (40%)
- Characteristic soil type: sandy loam
- Surface temperature and soil temperatures at 1cm, 5 cm, 10 cm
- Soil moisture at 0-1 cm, 0-3 cm, 3-6 cm
- Vegetation measurements at 12 sites

South Central Georgia

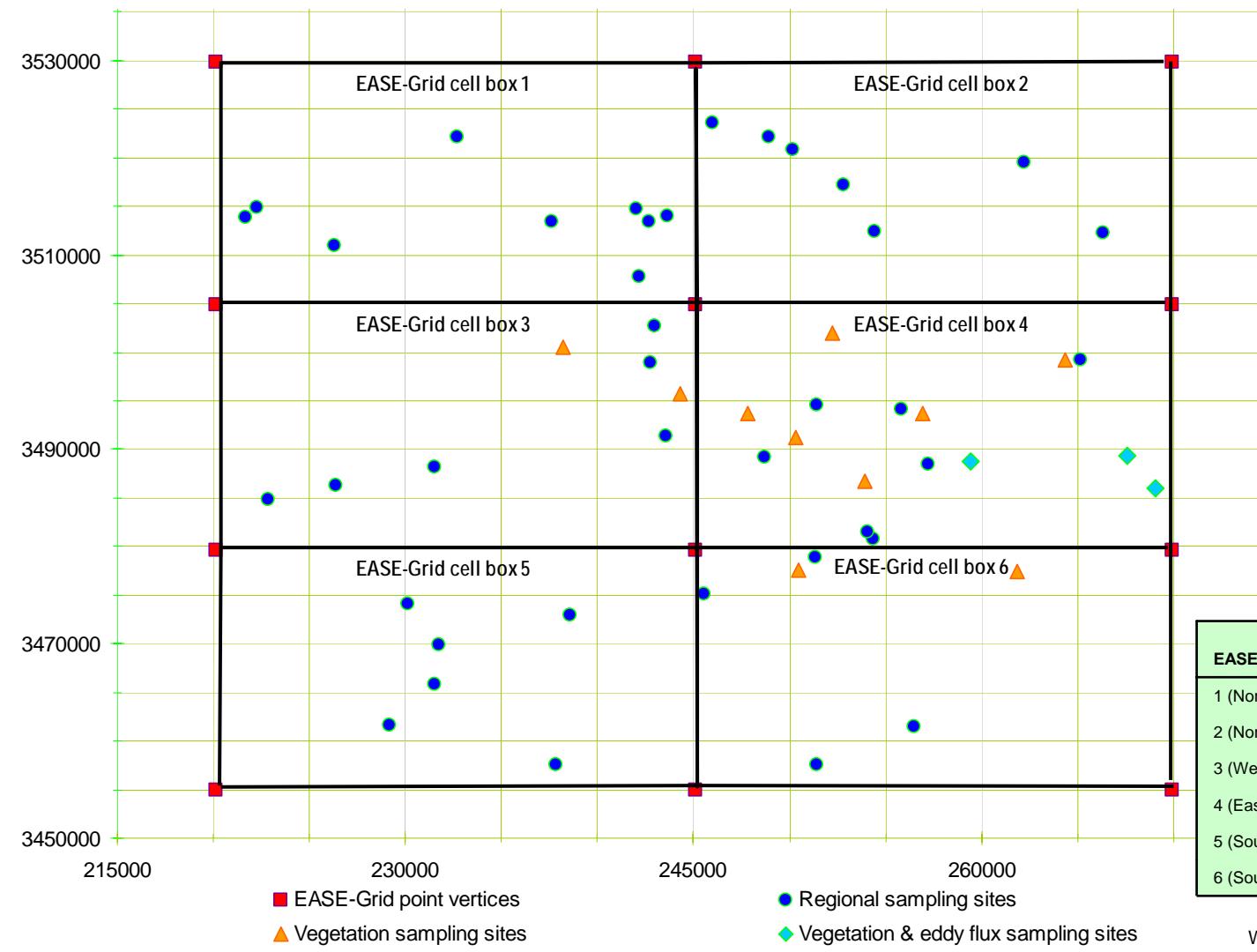


49 Regional Sampling Sites

# 49 Regional Sampling Sites

EASE-Grid point vertices

UTM Northing (m)	UTM Easting (m)
3530925.57	221138.25
3505461.96	220447.94
3480054.47	219763.61
3454714.19	219085.53
3530285.27	245770.22
3504824.21	245141.02
3479419.31	244517.27
3454081.65	243899.22
3529704.26	270399.84
3504245.51	269831.71
3478842.96	269268.51
3453507.68	268710.45

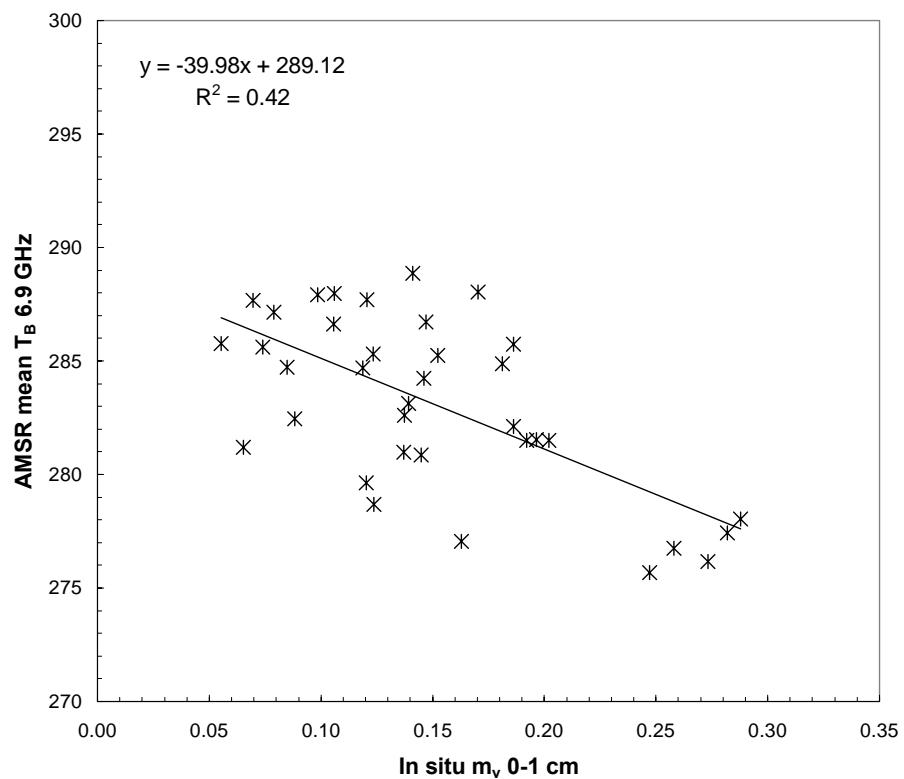


Land cover within each EASE-Grid cell box

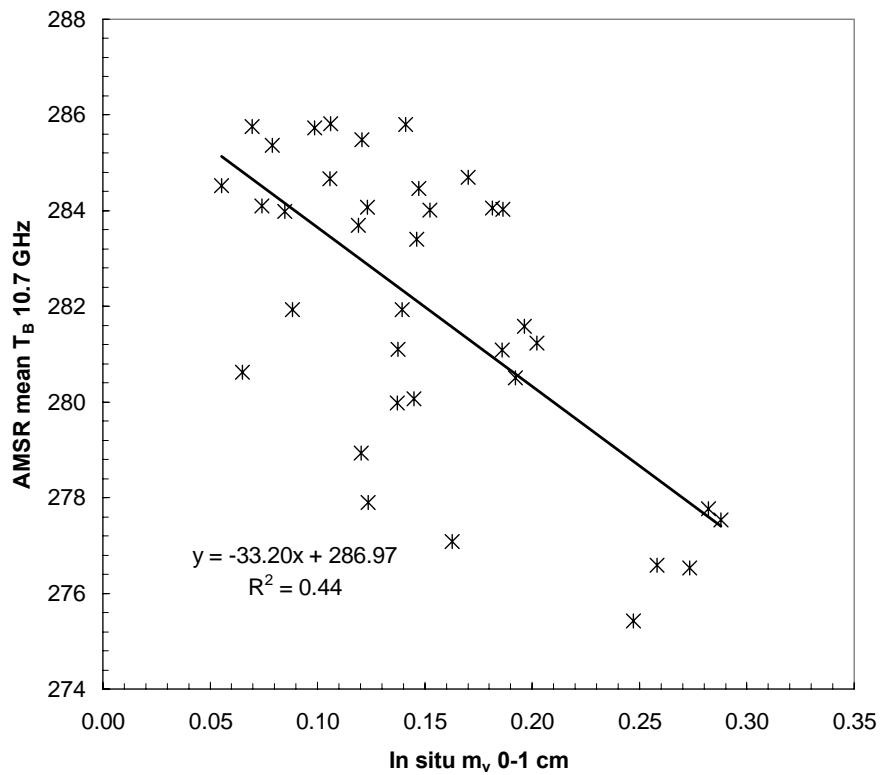
EASE-Grid Cell	Regional Sampling Sites	C	P	F
1 (North-east)	GA01-GA09	4	1	4
2 (North-west)	GA10-GA16	3	2	2
3 (West-central)	GA17-GA24	5	1	2
4 (East-central)	GA25-GA37	8	2	3
5 (South-west)	GA39-GA44	3	1	2
6 (South-east)	GA45-GA49	3	1	2

Where C refers to crop, P to pasture, and F to forest

## AMSR-E mean $T_B$ vs in situ 0-1 cm soil moisture

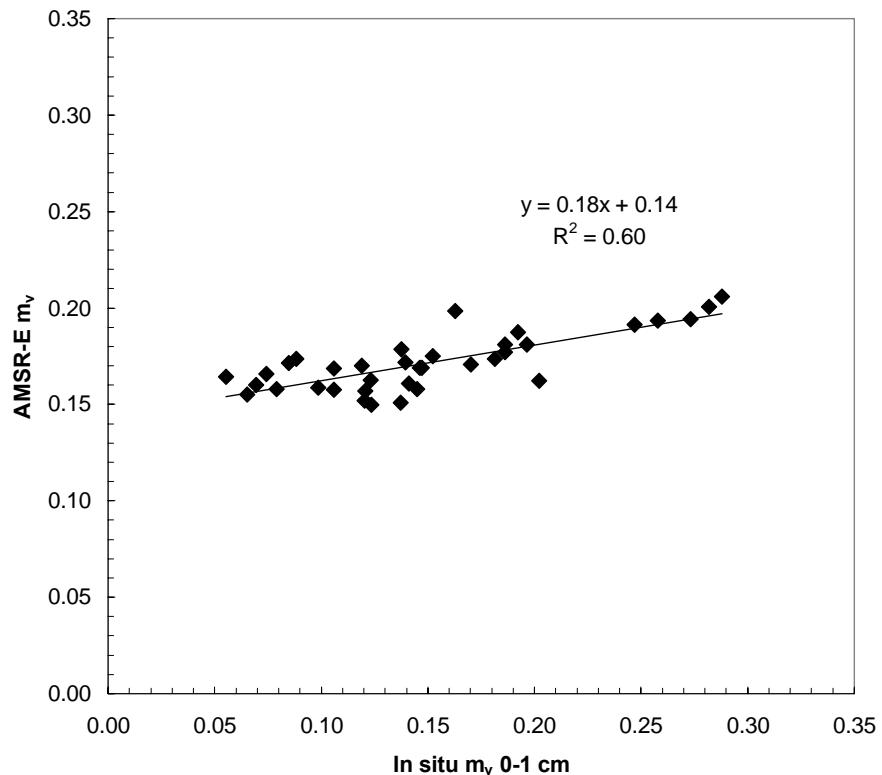


6.9 GHz (C-band)

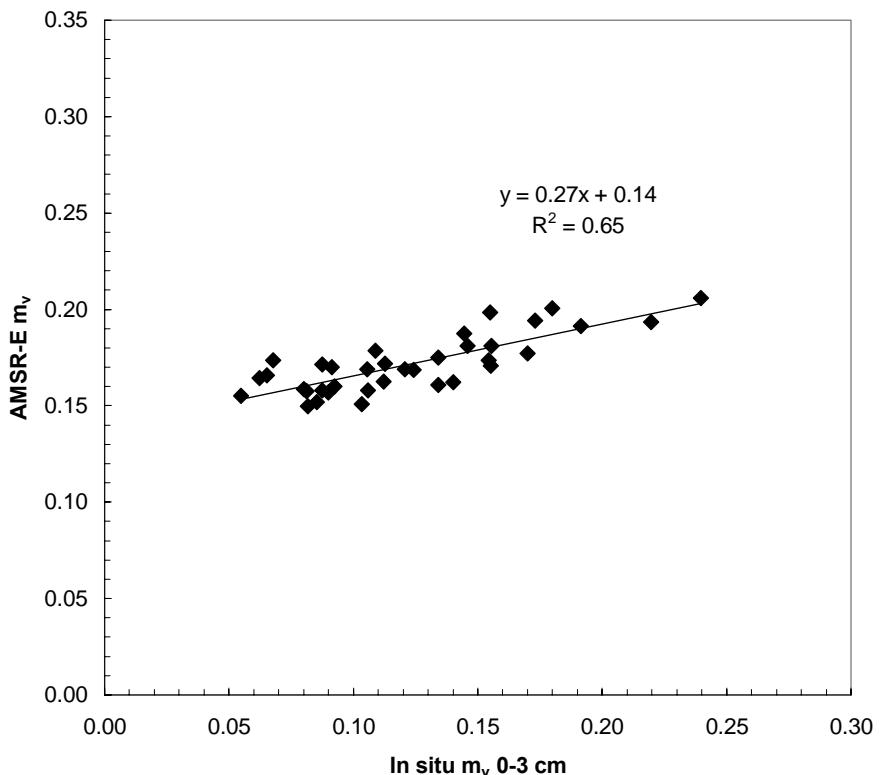


10.7 GHz (X-band)

## AMSR-E soil moisture product vs in situ soil moisture

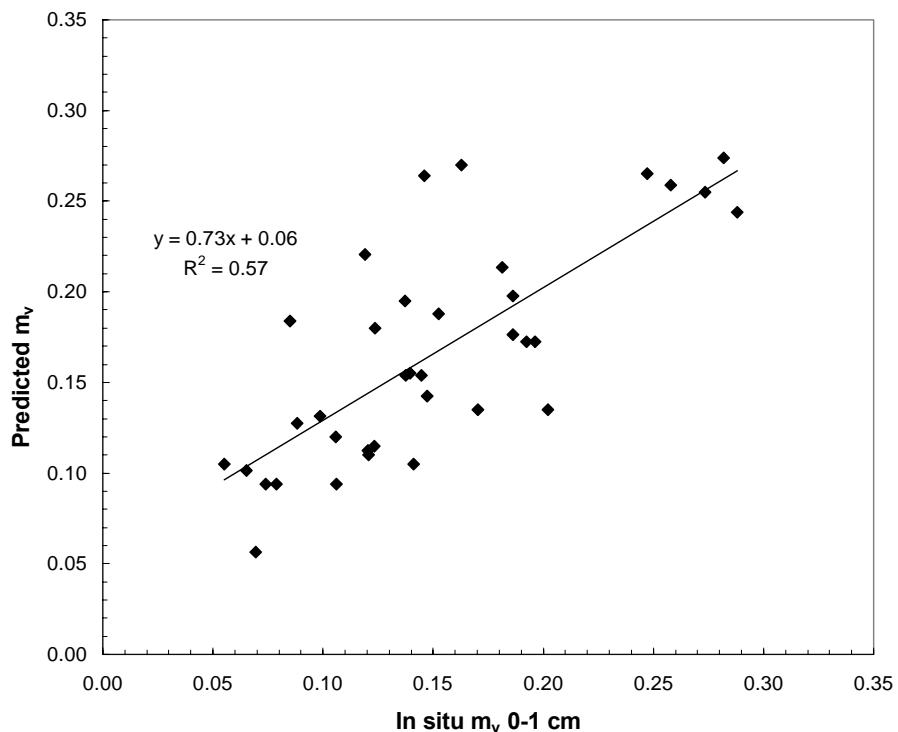


Mean  $m_v$  0-1 cm and  
AMSR-E  $m_v$ .

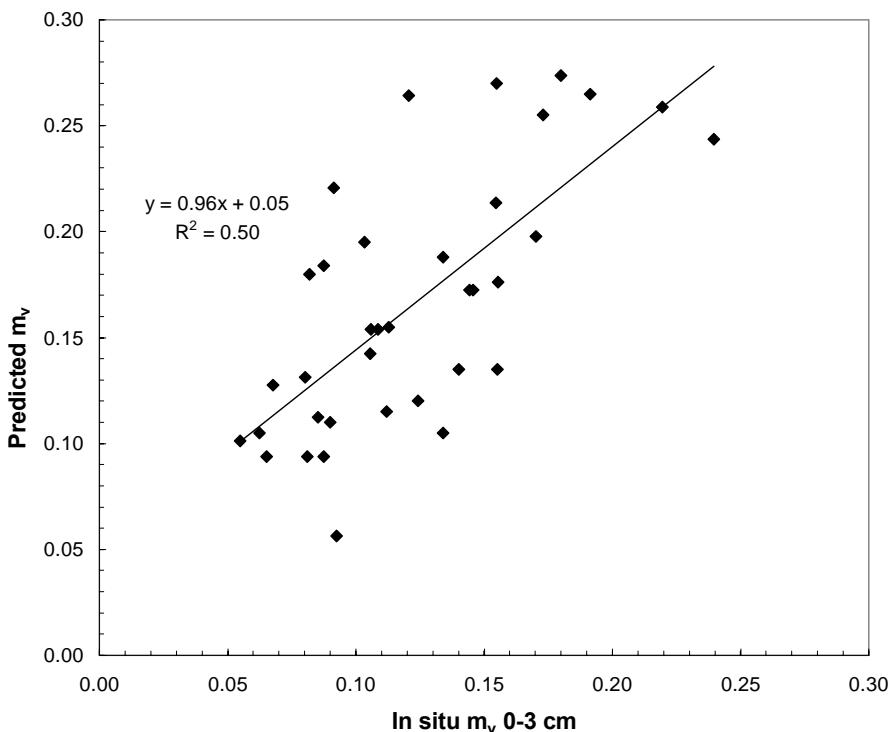


Mean  $m_v$  0-3 cm and  
AMSR-E  $m_v$ .

## Predicted soil moisture from AMSR C-band $T_B$

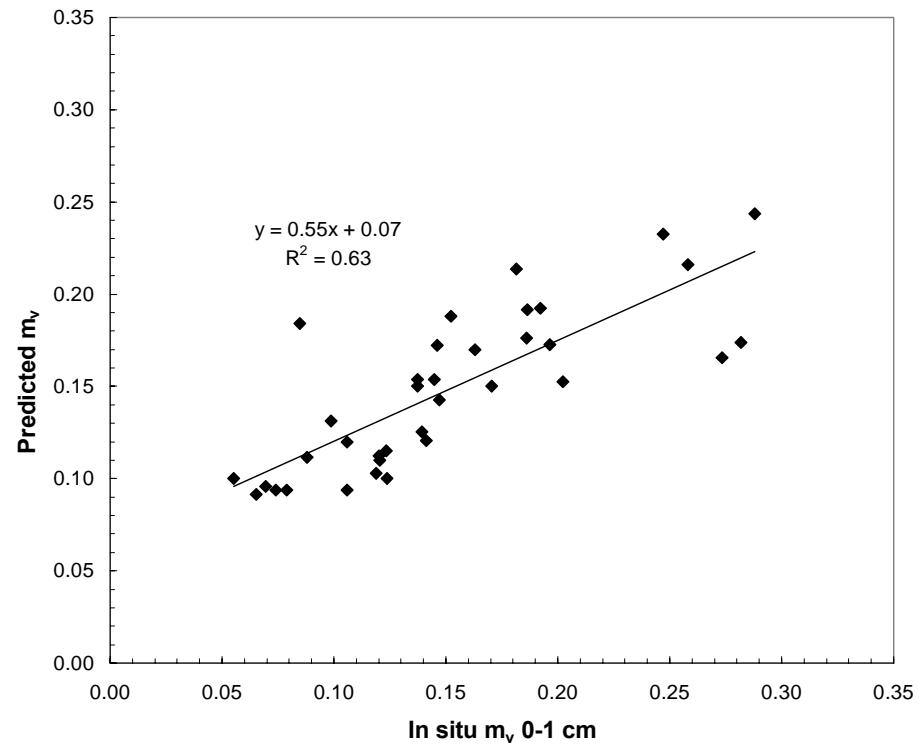


RMSE = 0.067

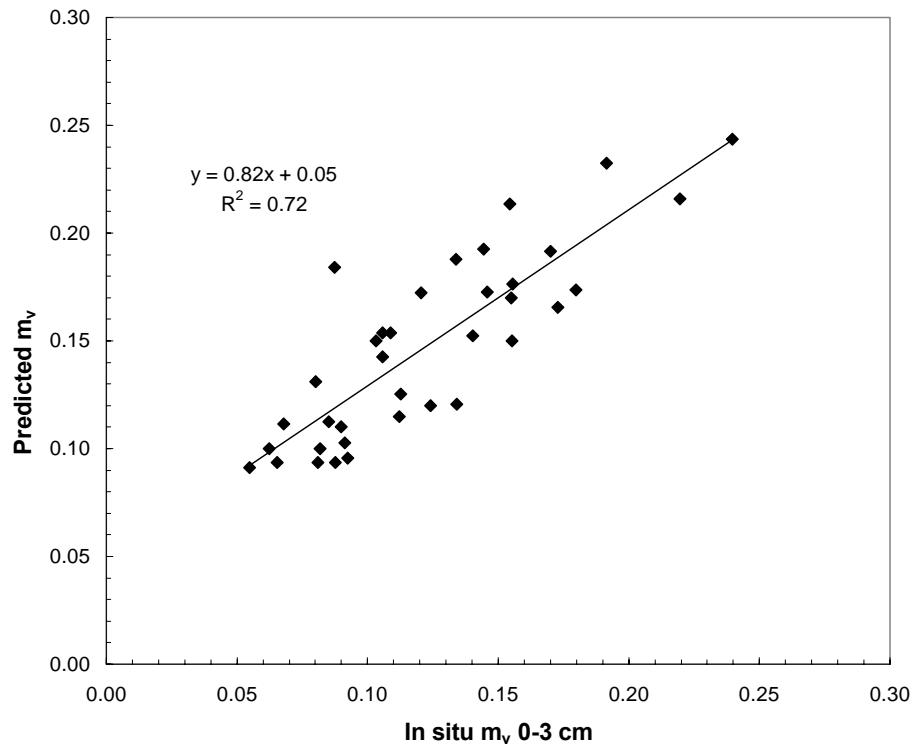


RMSE = 0.040

## Predicted soil moisture from AMSR X-band $T_B$



RMSE = 0.027



RMSE = 0.022

### AMSR Brightness Temperatures, TB H 10.7 GHz (X-band)

23 June, 2003

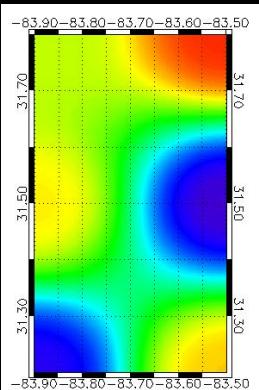
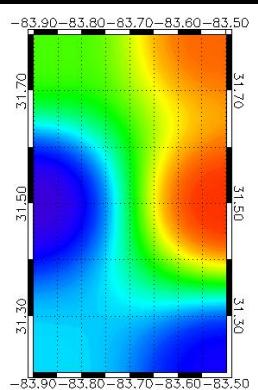
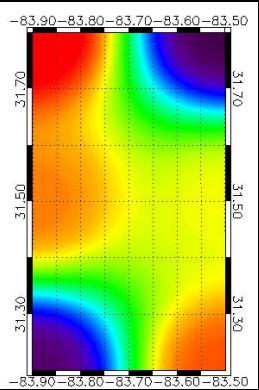
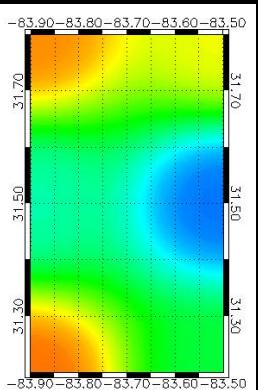
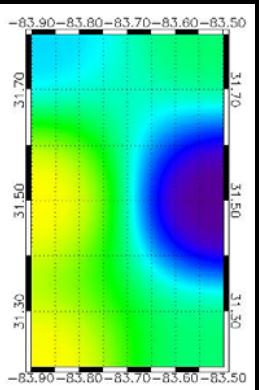
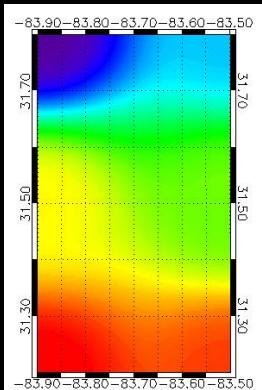
25 June, 2003

27 June, 2003

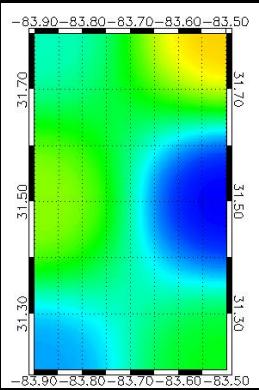
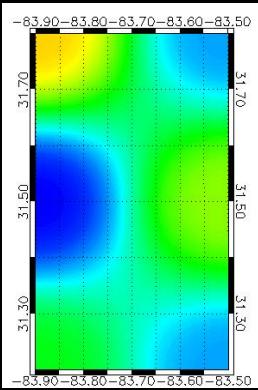
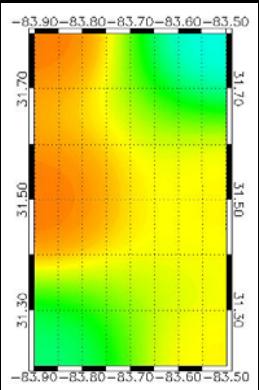
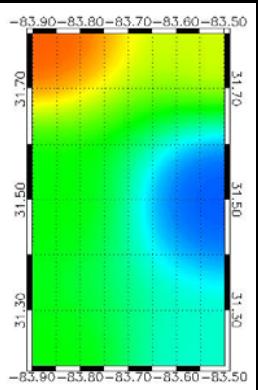
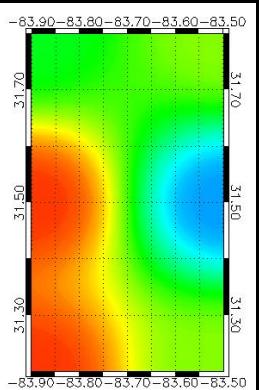
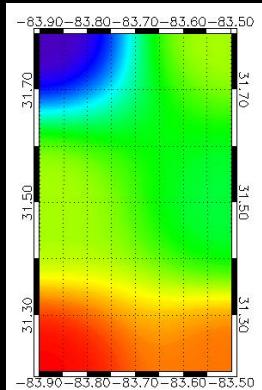
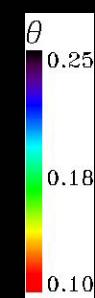
29 June, 2003

30 June, 2003

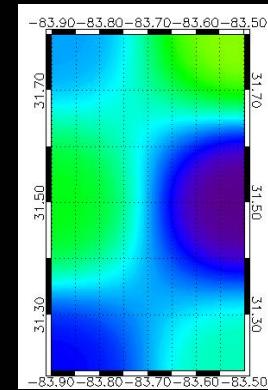
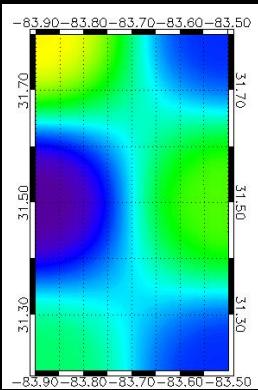
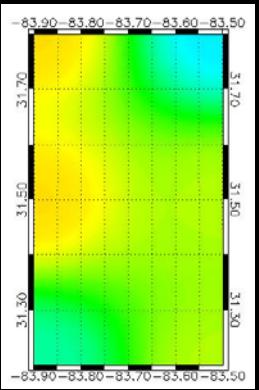
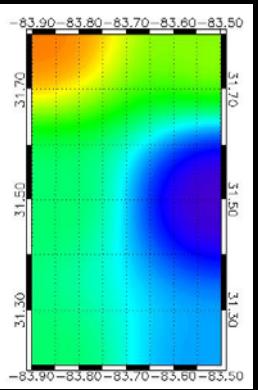
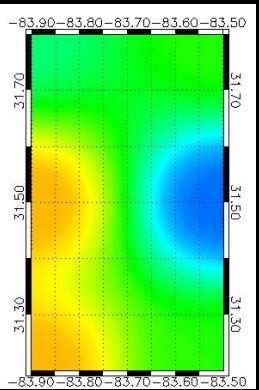
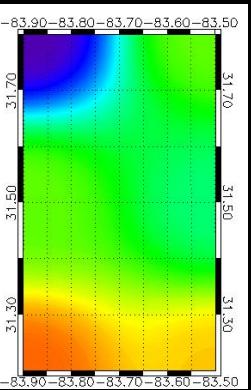
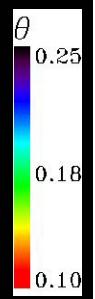
2 July, 2003



**Predicted volumetric soil moisture,  $\theta_v$  from RT model and in situ 0-1 cm soil temperature and soil moisture**



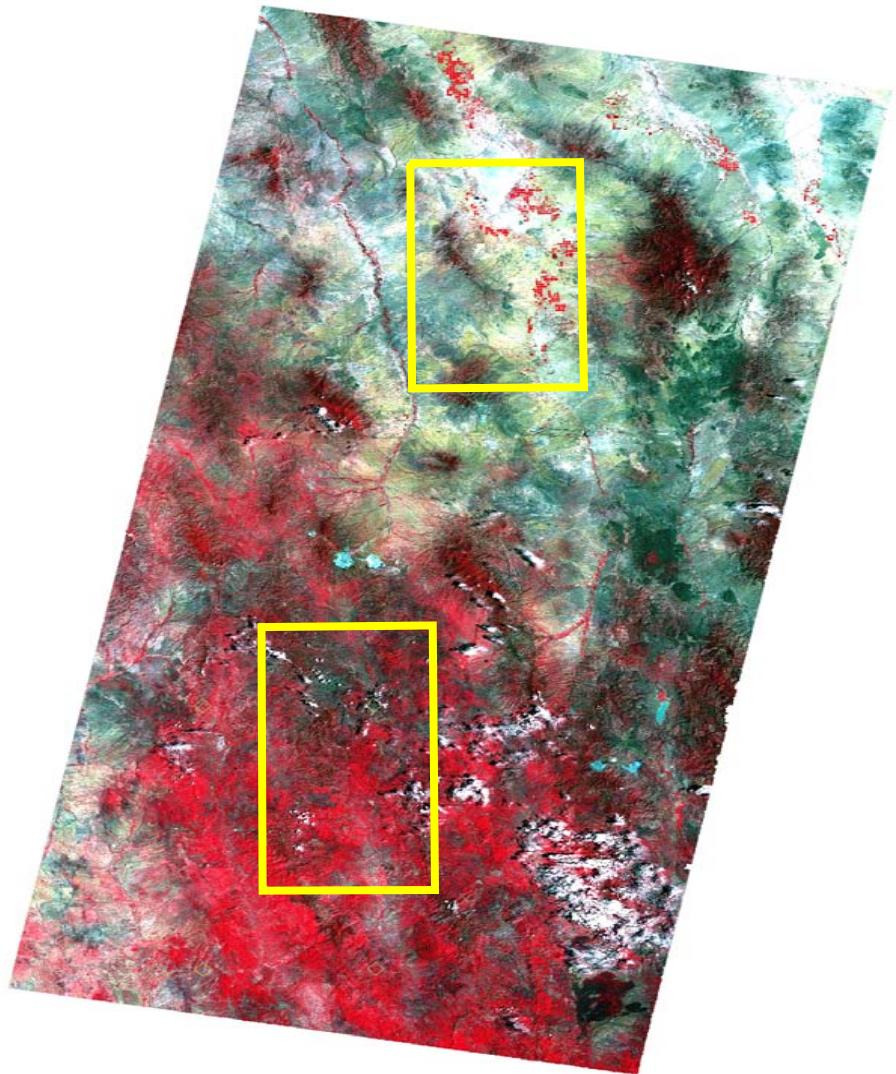
**Predicted volumetric soil moisture,  $\theta_v$  from RT model and in situ 0-3 cm soil temperature and soil moisture**



# Soil Moisture Experiment 2004 (SMEX04)

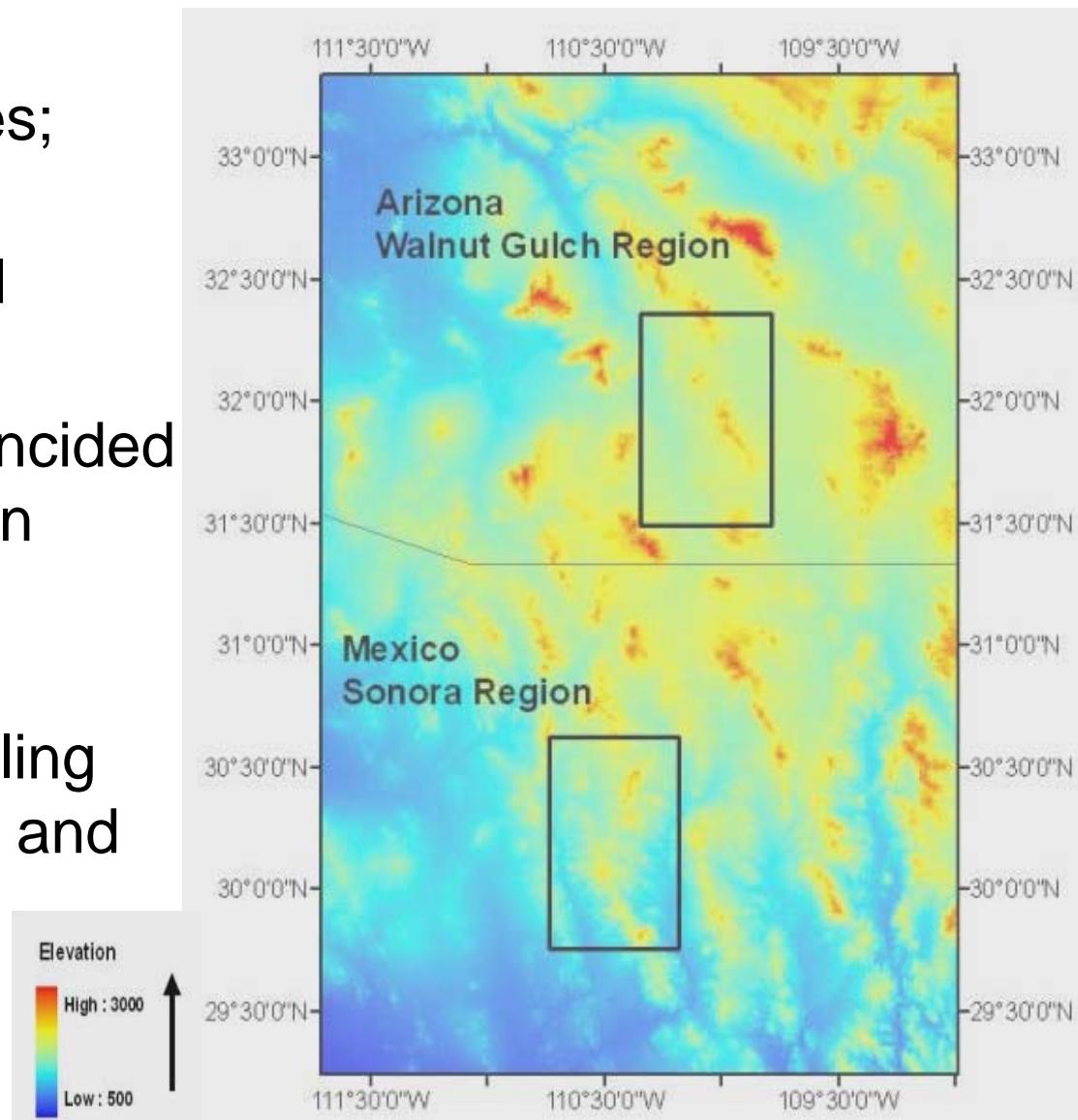
- Two regional study sites; Arizona and Sonora
- Diverse vegetation and topographic variations
- August 2- 27, 2004 coincided with the North American Monsoon Experiment (NAME)
- Intensive ground sampling concurrent with aircraft and Aqua AMSR<sub>sat</sub> EdSat TM

*Red- high vegetation*



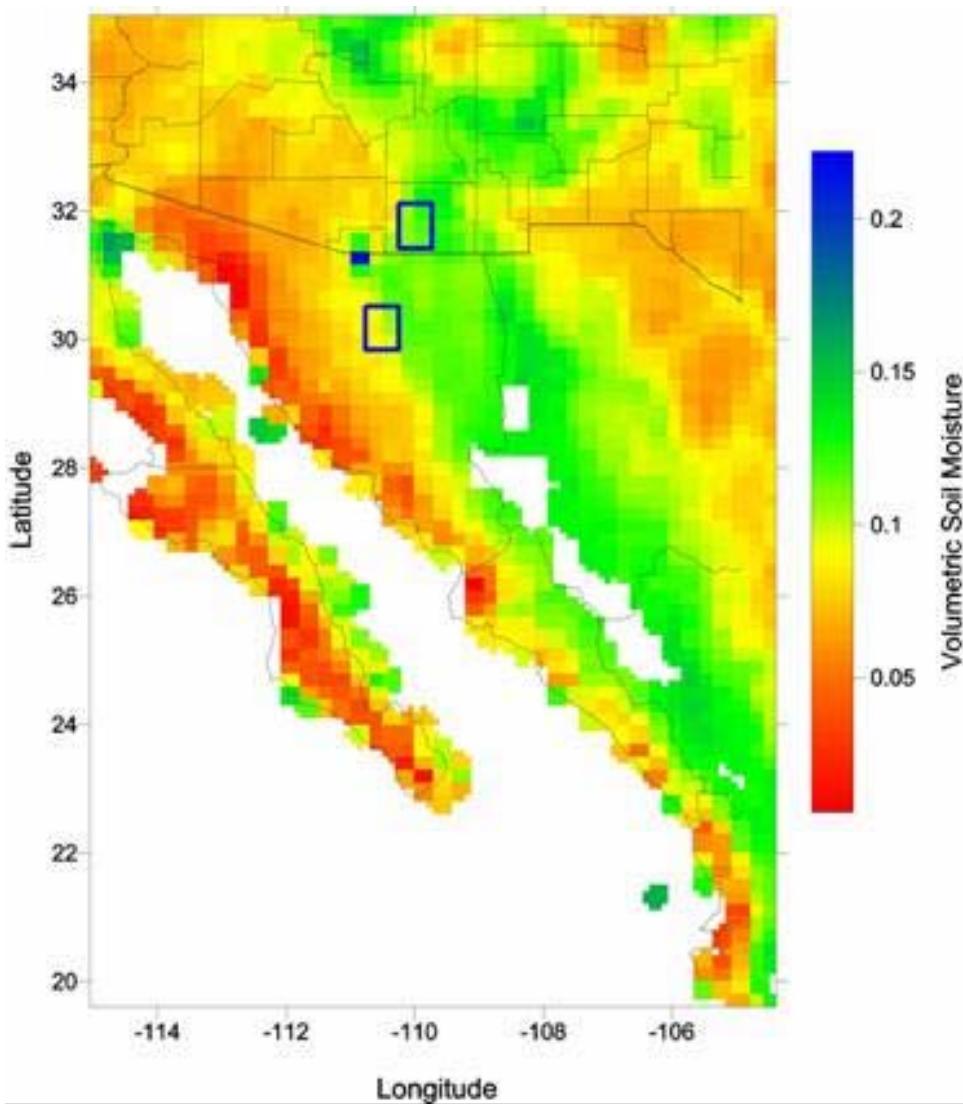
# Soil Moisture Experiment 2004 (SMEX04)

- Two regional study sites; Arizona and Sonora
- Diverse vegetation and topographic variations
- August 2- 27, 2004 coincided with the North American Monsoon Experiment (NAME)
- Intensive ground sampling concurrent with aircraft and Aqua AMSR-E



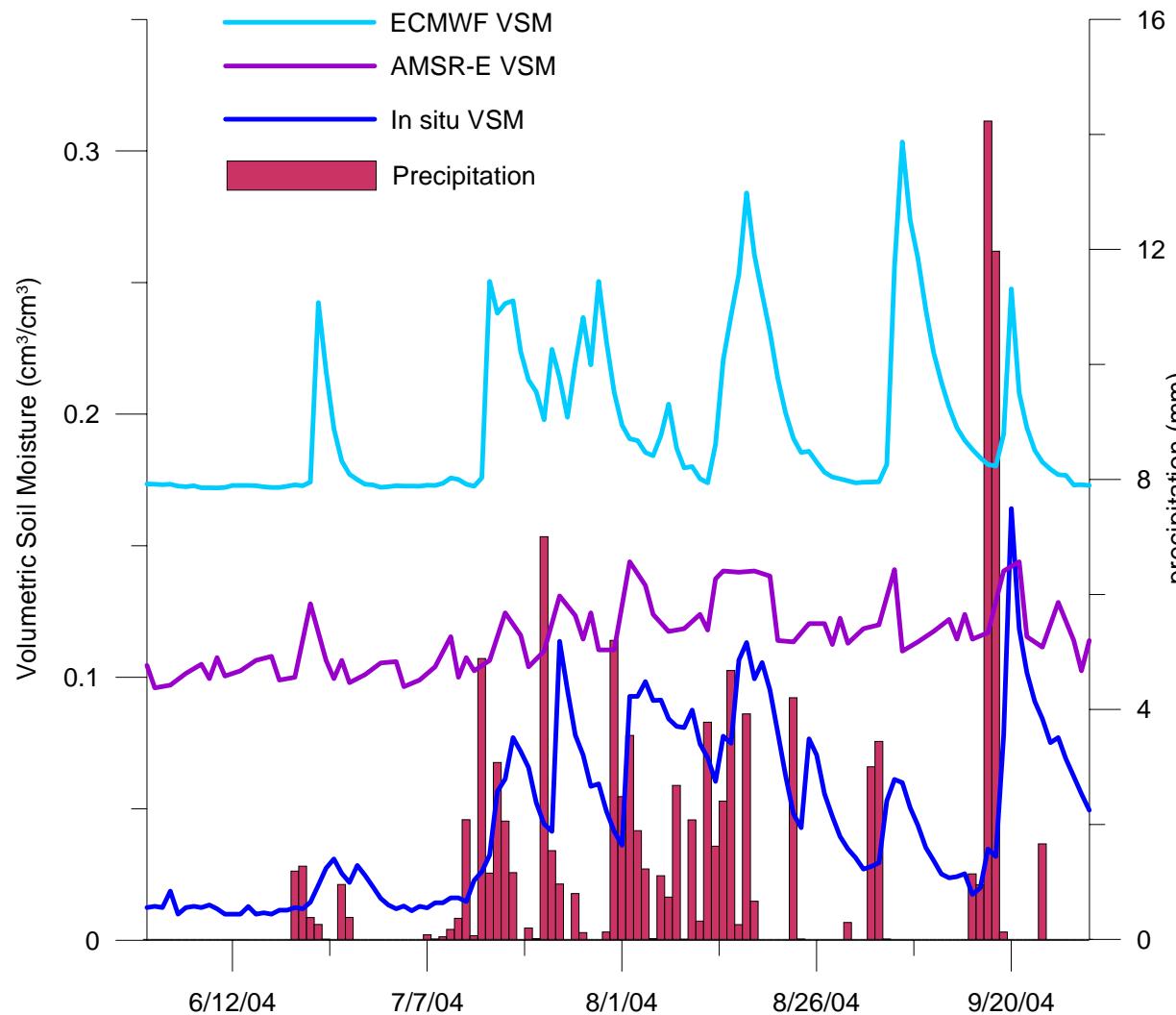
# Soil Moisture Estimation

- AMSR-E L3  
Global Standard Product
- Biased towards low values
- Accurate spatial patterns



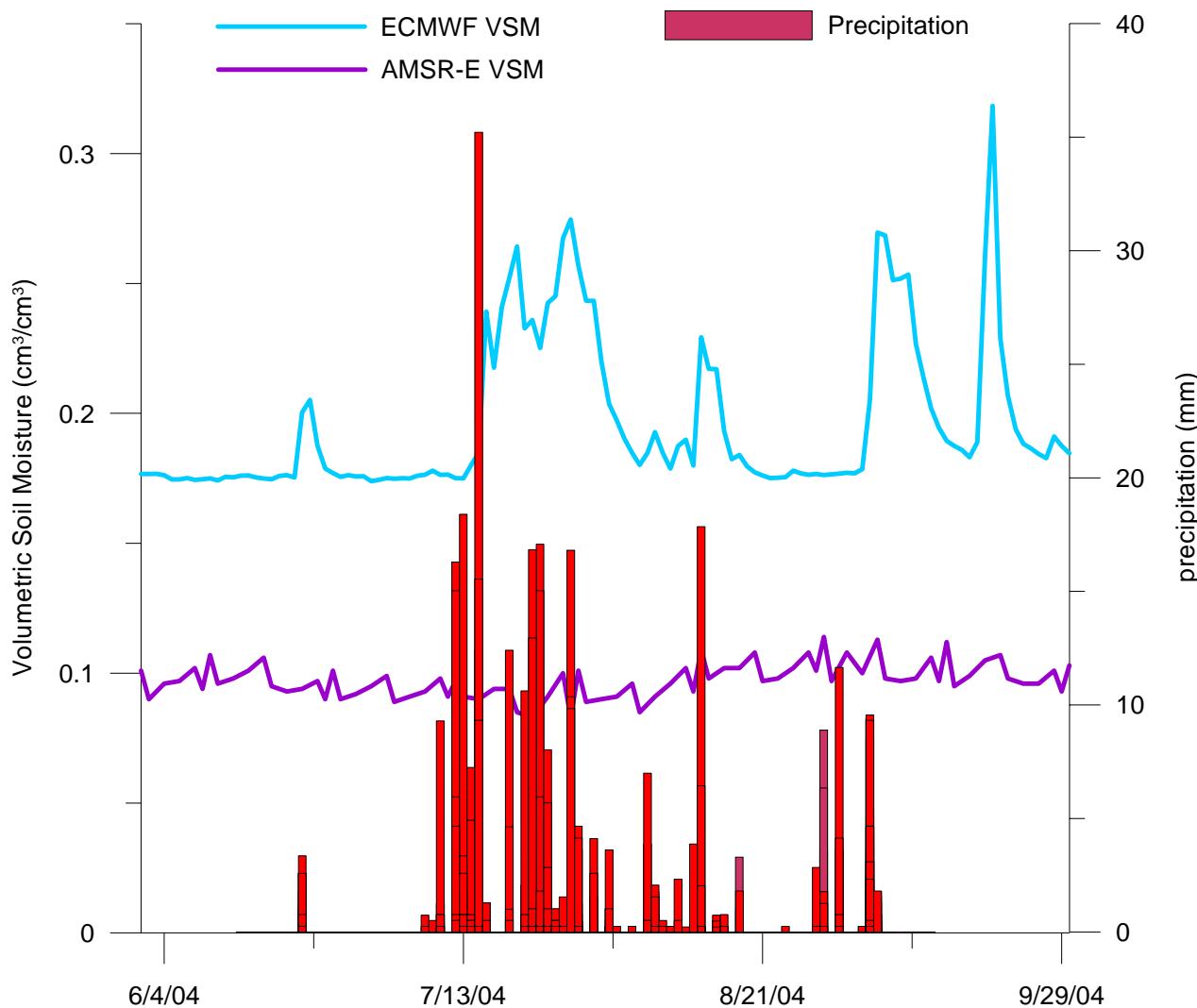
# AMSR-E Retrieval (Low Topography/Vegetation)

- Correlation with precipitation
- AMSR-E Accuracy (low precision)
- Dynamic range
  - AMSR-E; 0.05
  - in situ; 0.15
  - ECMWF; 0.23



# AMSR-E Retrieval (High Topography/Moderate Vegetation)

- ECMWF versus precipitation
- AMSR-E signal dominated by topography



# Final Thoughts

- The three field experiments offer different land surface cover and hydro-climate conditions to examine the validity of AMSR-E retrievals
- Use of the results to [a] modify the retrieval algorithm for soil moisture and [b] analysis for the “confidence” numbers for use in data assimilation procedures