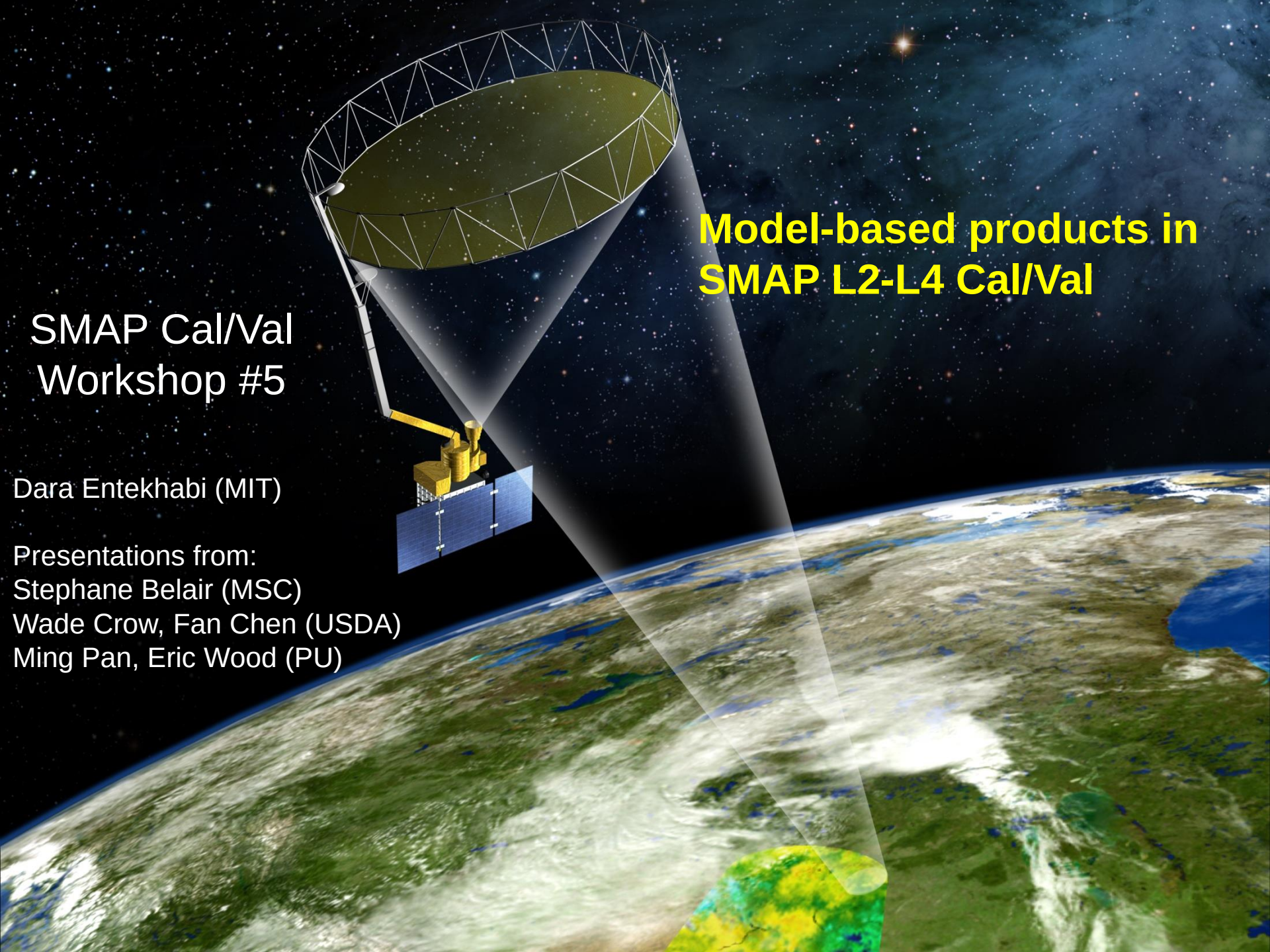


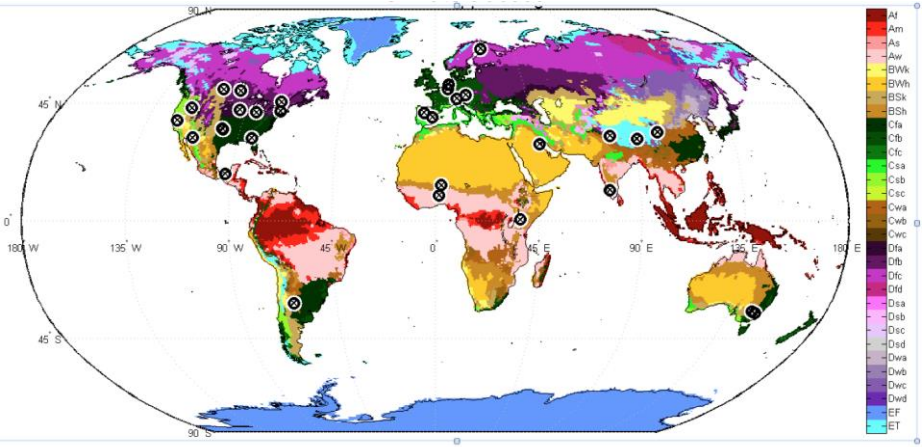
Model-based products in SMAP L2-L4 Cal/Val

SMAP Cal/Val Workshop #5

Dara Entekhabi (MIT)

Presentations from:
Stephane Belair (MSC)
Wade Crow, Fan Chen (USDA)
Ming Pan, Eric Wood (PU)

The Need



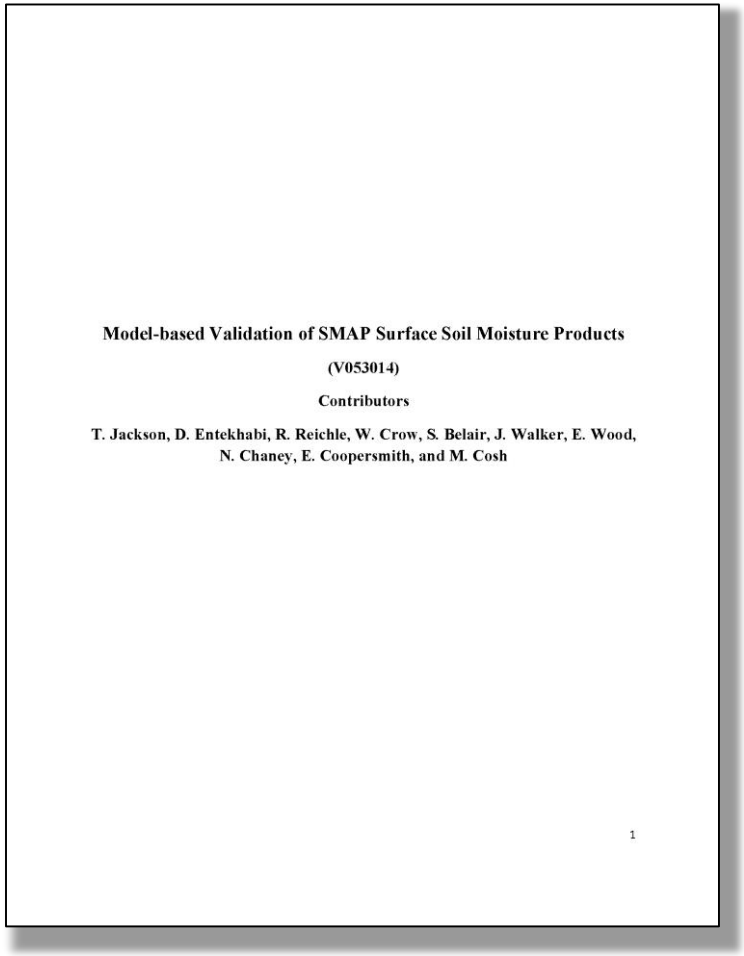
1. Need evaluation over wider range of climate and vegetation conditions

2. Need bound on representativeness error of in situ measurements

Model can, in the absence of soil moisture measurements, project other available observations (e.g. precipitation, land use classification, topography) on the soil moisture variable

KG Class	KG 1st	KG 2nd	KG 3rd	Number of Sites
Af	Tropical	Rainforest		
Am		Monsoon		
Aw		Savannah		
BWh	Arid	Desert	Hot	1
BWk			Cold	
BSh		Steppe	Hot	
BSk			Cold	3
Csa	Temperate	Dry Summer	Hot Summer	1
Csb			Warm Summer	1
Csc			Cold Summer	
Cwa		Dry Winter	Hot Summer	1
Cwb			Warm Summer	
Cwc			Cold Summer	
Cfa		Without Dry Season	Hot Summer	3
Cfb			Warm Summer	4
Cfc			Cold Summer	
Dsa	Cold	Dry Summer	Hot Summer	
Dsb			Warm Summer	
Dsc			Cold Summer	
Dsd			Very Cold Summer	
Dwa		Dry Winter	Hot Summer	
Dwb			Warm Summer	
Dwc			Cold Summer	
Dwd			Very Cold Summer	
Dfa		Without Dry Season	Hot Summer	2
Dfb			Warm Summer	2
Dfc			Cold Summer	1
Dfd			Very Cold Summer	
ET	Polar	Tundra		
EF		Frost		

White-paper on use of models in SMAP Cal/Val



Model-based Validation of SMAP Surface Soil Moisture Products

(V053014)

Contributors

T. Jackson, D. Entekhabi, R. Reichle, W. Crow, S. Belair, J. Walker, E. Wood, N. Chaney, E. Coopersmith, and M. Cosh

1

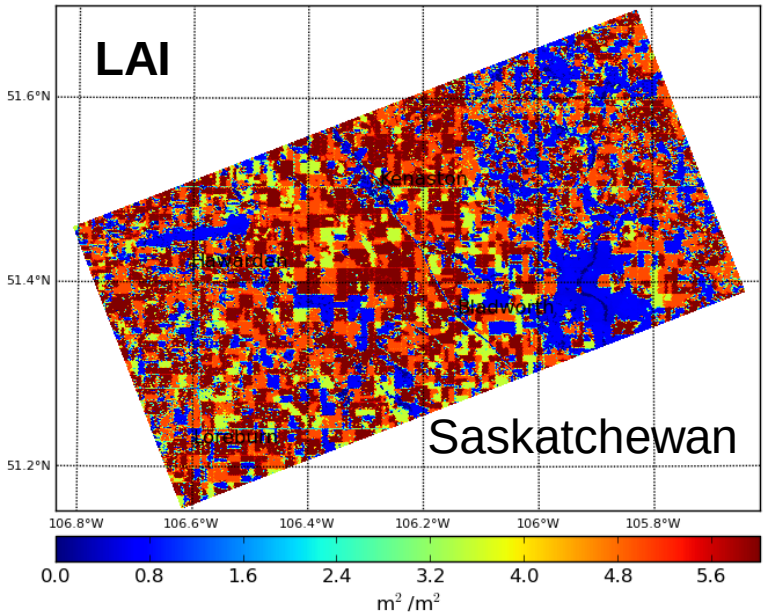
The following four surface soil moisture validation activities can benefit from using model products:

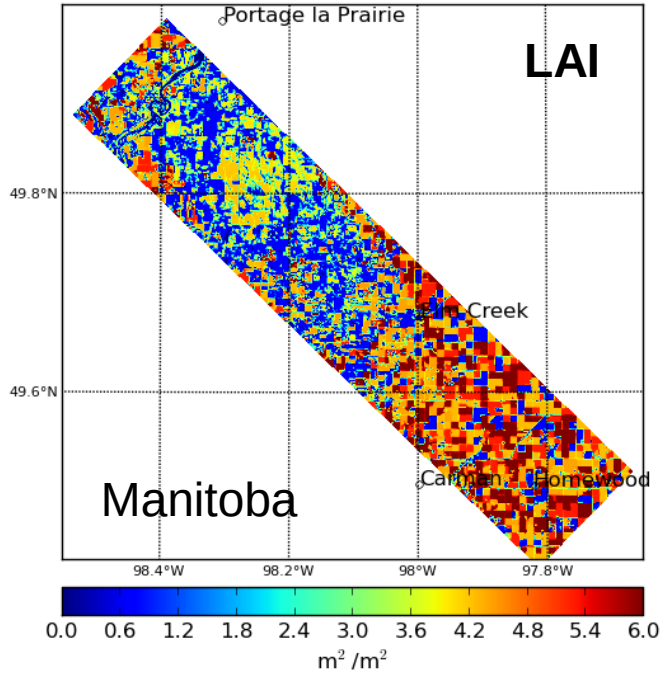
1. Direct Evaluation of SMAP Products on a Global Basis
2. Direct Evaluation of Core and Supplemental In Situ Sites
3. Scaling In Situ Point Samples to SMAP Grid Cells
4. Triple Co-Location (TC)

Stephane Belair (MSC)

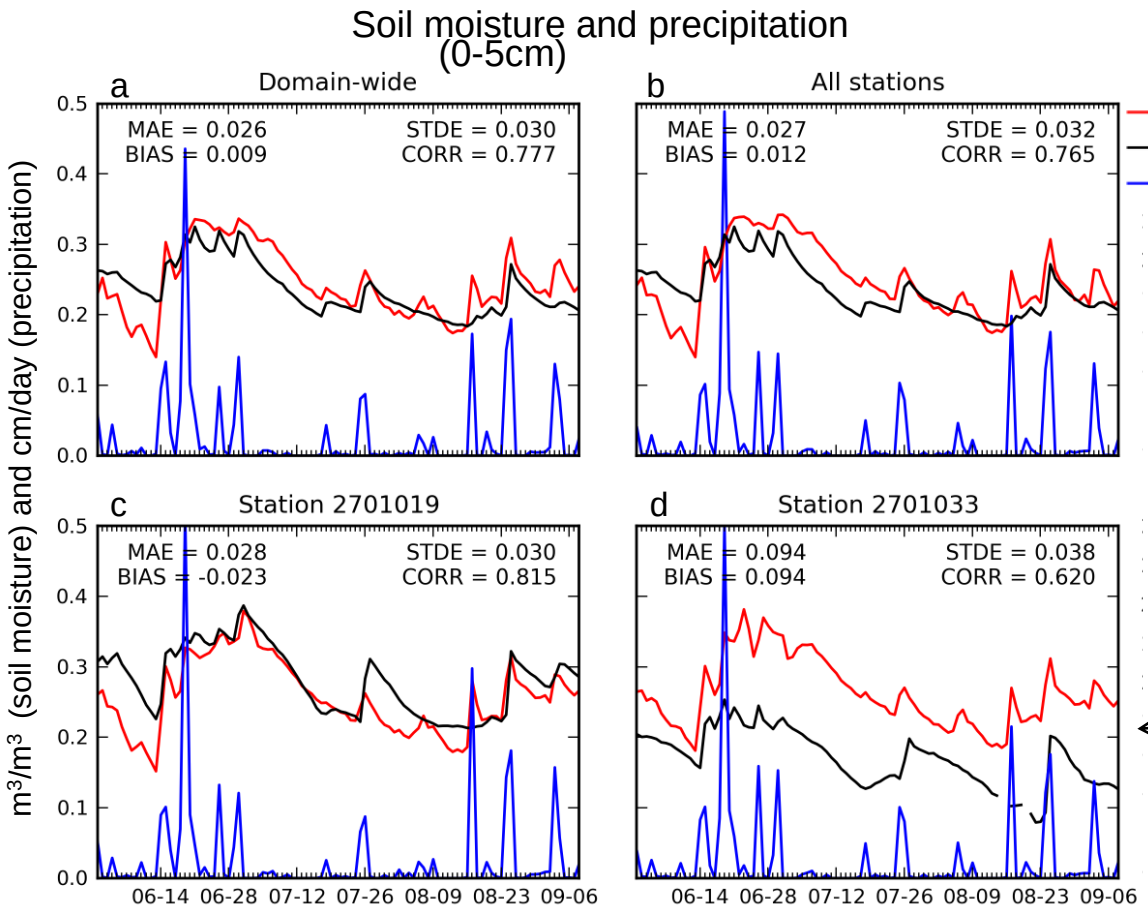
Motivation for 100-m Modeling

- First… direct comparison against SMAP soil moisture products based on spatial averaging
- Second… extra dataset for SMAP cal-val (e.g., for triple colocation)
- Thus, the main objective is to represent soil moisture as well as its spatial and temporal variability with the highest accuracy possible over 2 domains in Canada





Brightwater Creek network - SK



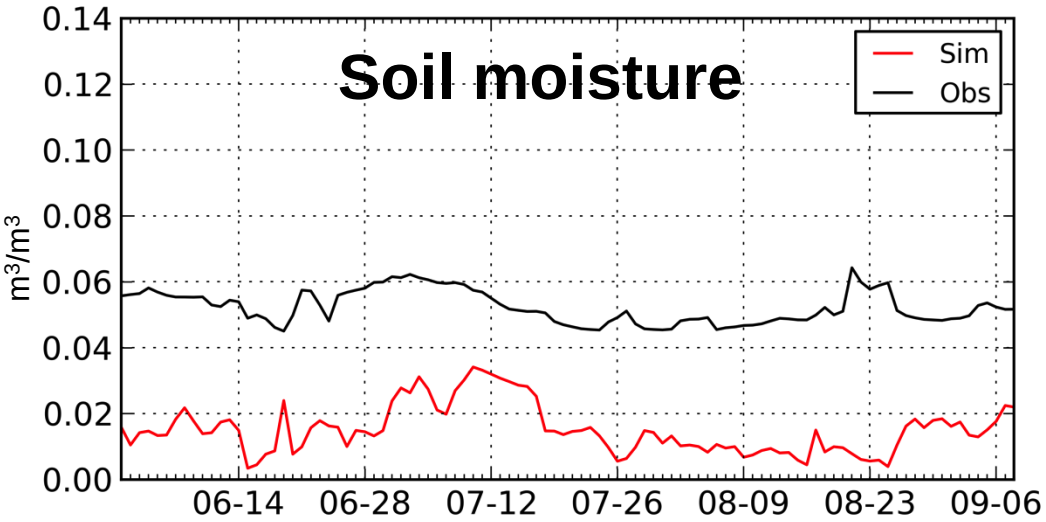
Best →

← Worst

(Garnaud et al. 2015)

Brightwater Creek network - SK

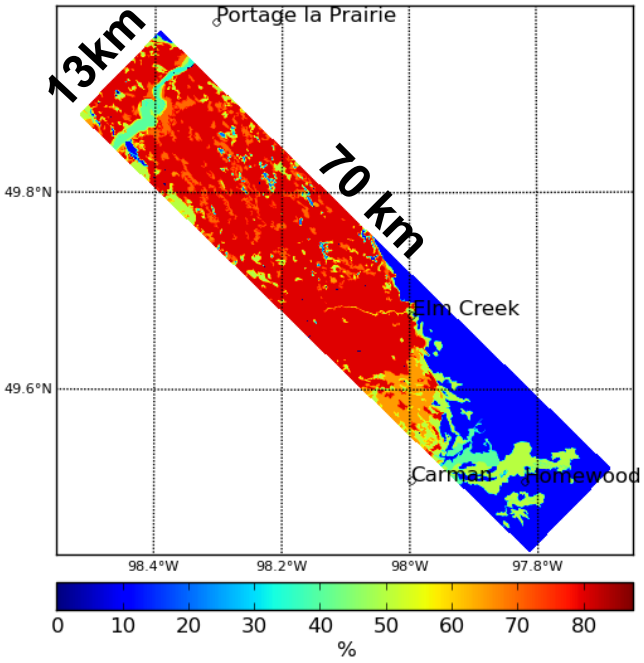
- Standard deviation (spatial variability) in time of simulated data at grid points corresponding to obs



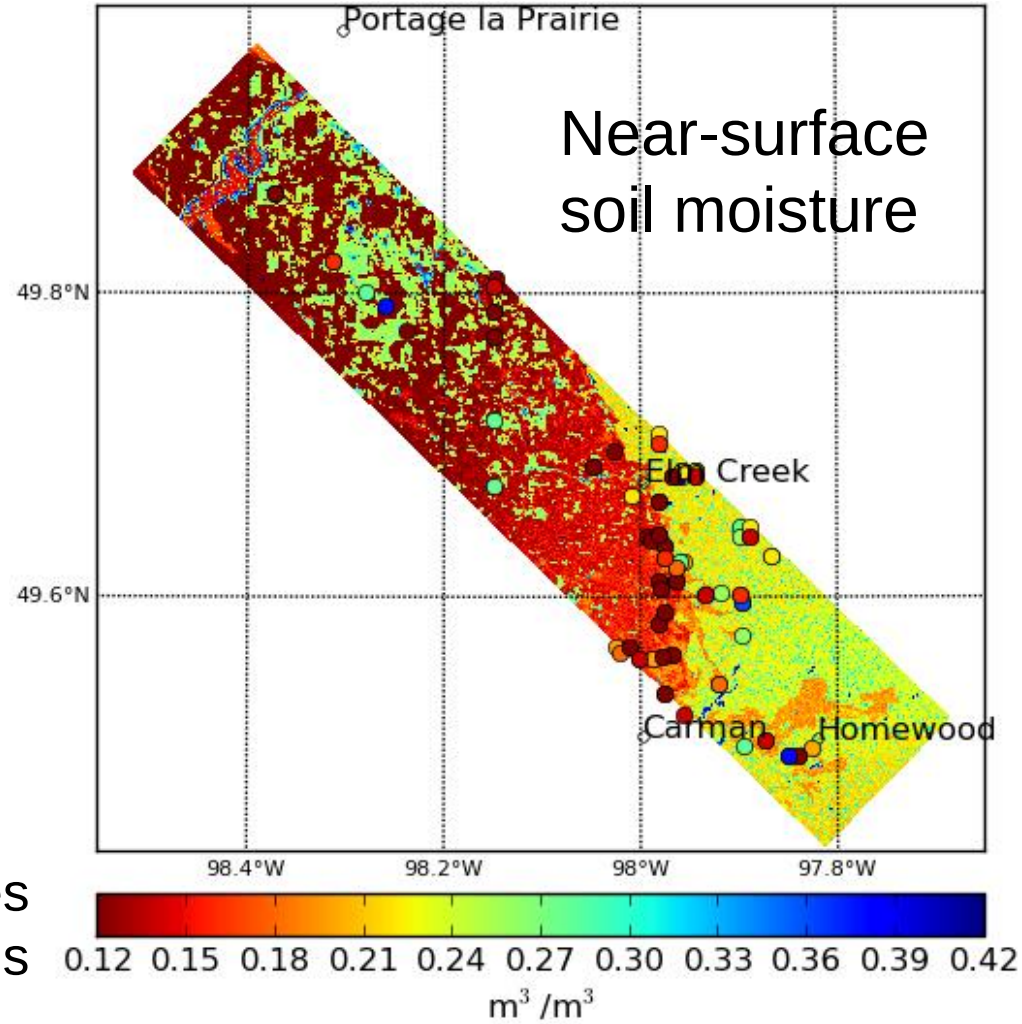
(Garnaud et al. 2015)

- Spatial variability severely underestimated compared to obs
- Possible causes: uniform soil texture, fixed plant growing cycle, fine-scale orography, forcing data (15-km resolution)

SMAPVEX12 - Manitoba



Soil texture (sand percentage)

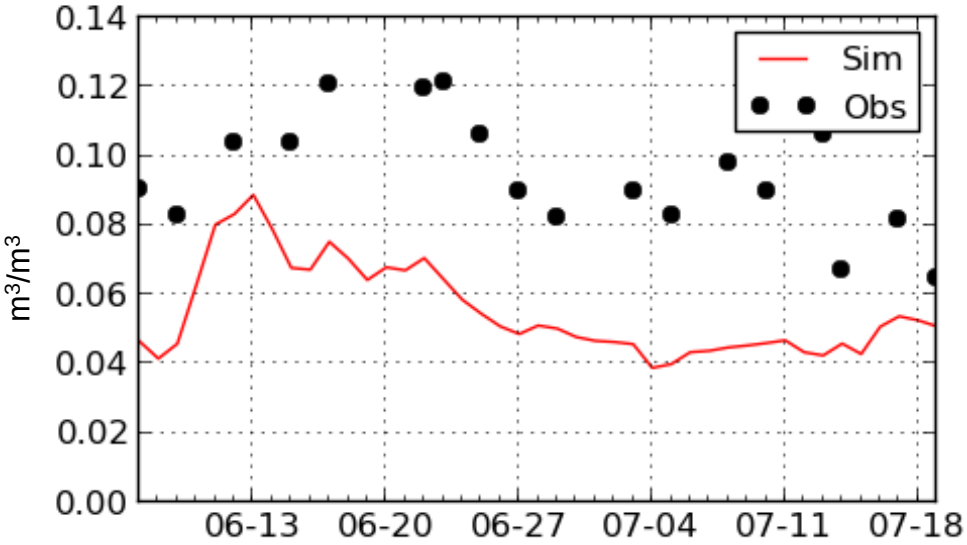


July 5th 2012, filled circles represent observations

SMAPVEX12 - Manitoba

- Improvement in spatial variability of soil moisture

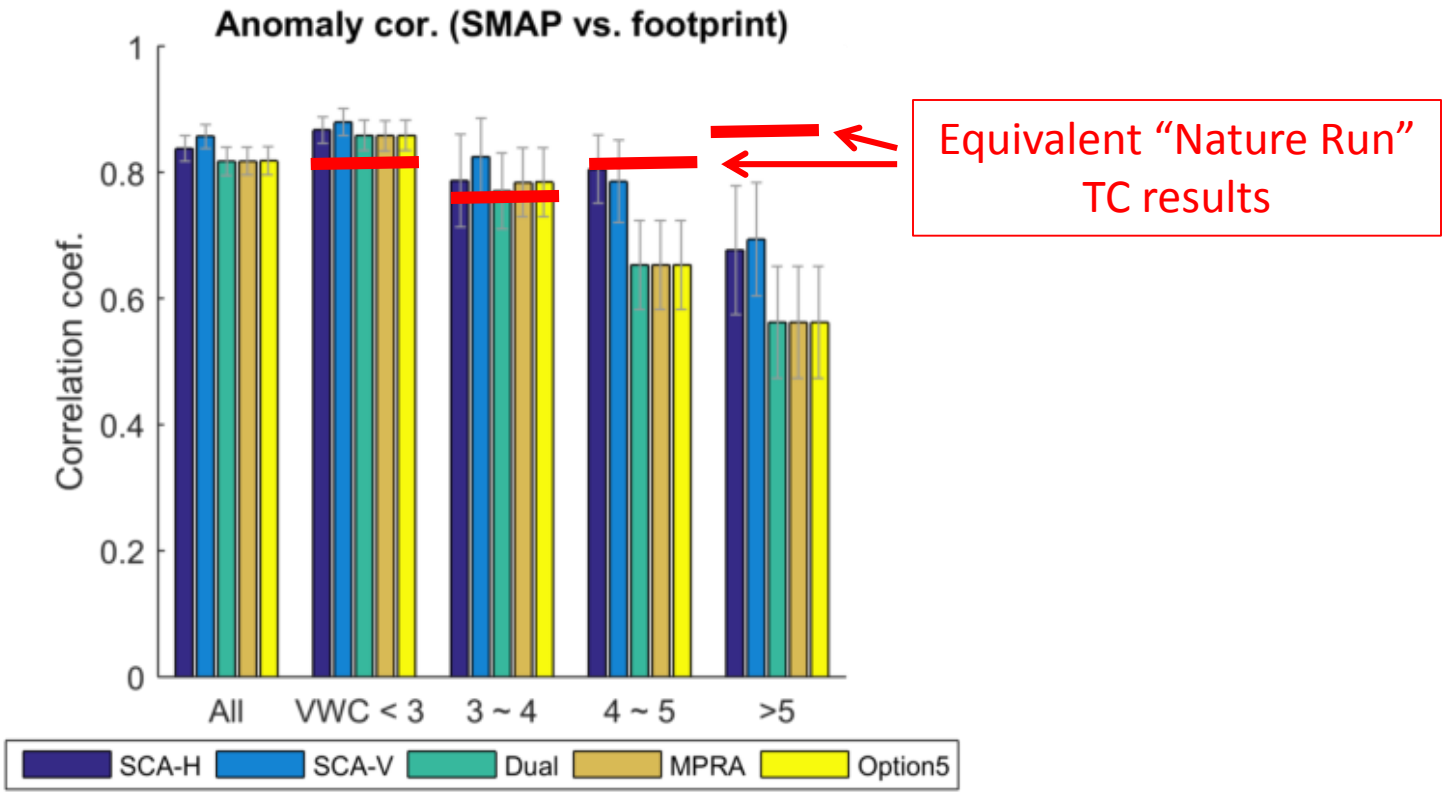
  (mostly related to soil texture and vegetation)



- Further improvements could be made:
  - Forcings of higher resolution (precip and radiation)
  - Lateral hydrological flows
- Questions regarding how useful these high-resolution model will be in the context of SMAP

Wade Crow and Fan Chen (USDA)

SMAP L2_P versus GMAO Nature Run Results

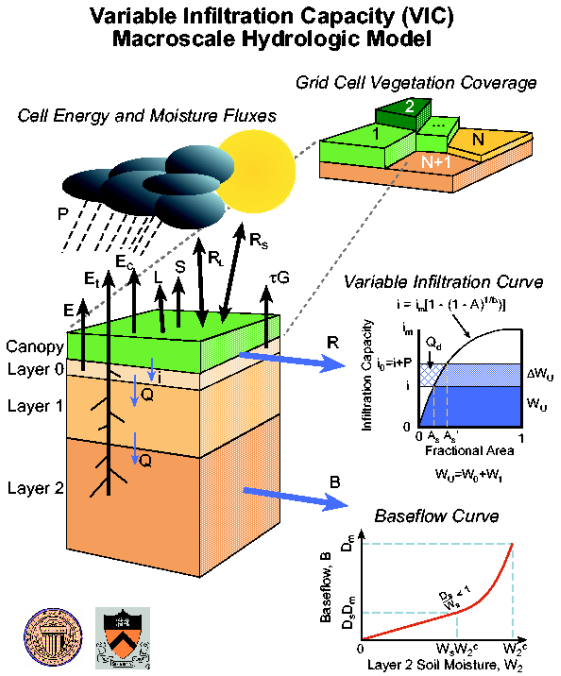


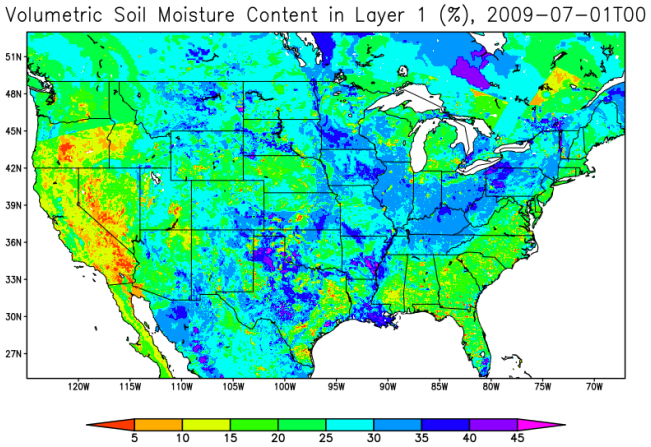
Based on TC results at CONUS USDA SCAN and NOAA CRN sparse network site locations.

Upshot: The GMAO Nature Run is performing well over CONUS. Not quite as good as SMAP L2_P retrievals over low/moderate vegetation, but clearly better for VWC > 5 kg/m^2.

Ming Pan, Nat Chaney, and Eric Wood (Princeton)

VIC 3km Near Real-Time Simulation over CONUS





Main Specs

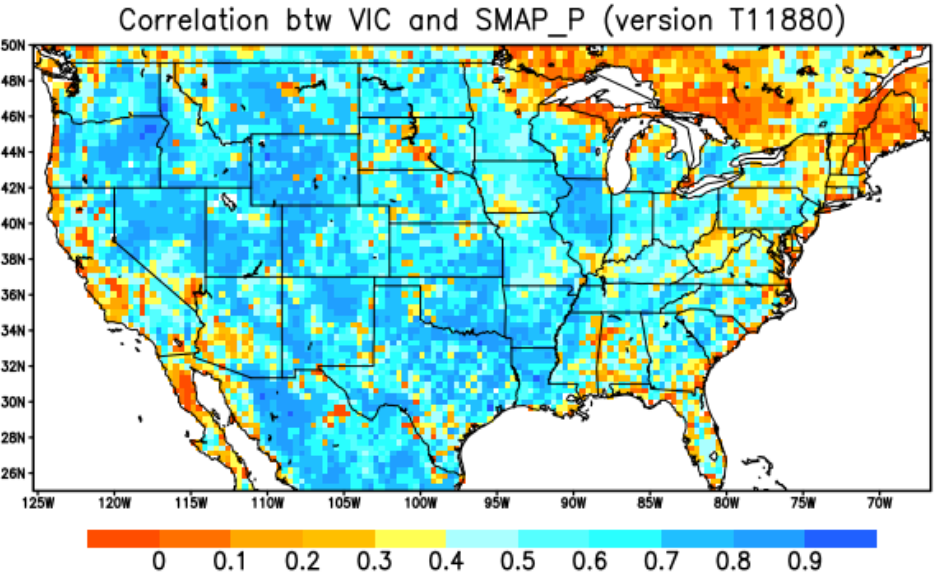
- Variable Infiltration Capacity (VIC) model
- 4km pixels resampled to SMAP 3km EASE grid
- Hourly time step, available ~4 days behind real time
- Retrospective simulation from Oct 1, 2002
- Rainfall from Stage IV radar/gauge merged product
- Solar radiation from GOES Surface and Insolation Products (GSIP)
- Other meteorological forcing fields from NLDAS-2
- 8 outputs archived @ JPL: soil moisture content in 3 layers, soil temperature in 3 layers, land surface temperature, and rainfall (more @ Princeton Univ)
- NetCDF-4 packaged with CF standard

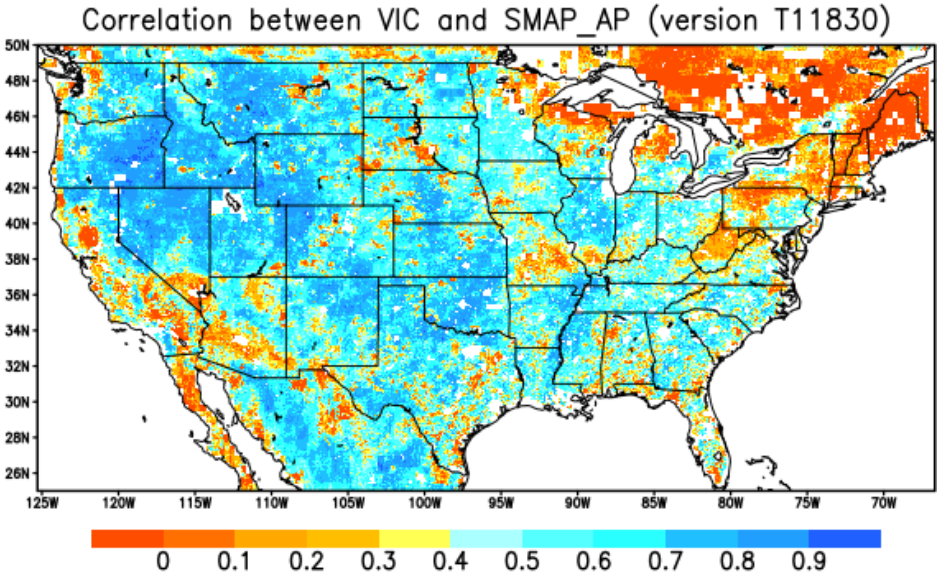
VIC 3km Near Real-Time Simulation over CONUS

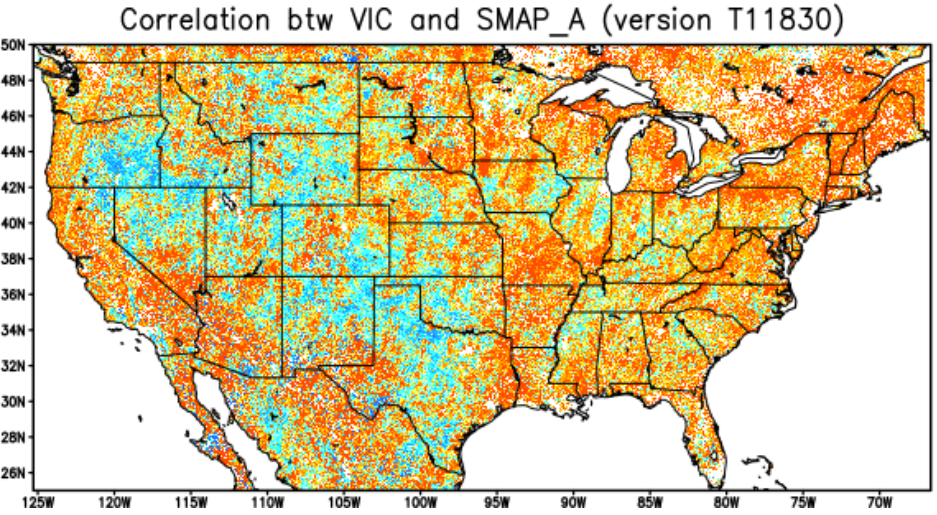
Input Meteorological Forcing Fields

Forcing Field	Source	Resolution	Lag Time	Processing
Precipitation	Stage IV (radar/gauge)	4 km	~1 day	
Shortwave Radiation	GSIP (GOES satellite)	0.125º	2-3 hours	Solar angle based time shift, bilinear interpolation
Longwave Radiation	NLDAS-2 (analysis)	0.125º	3-4 days	Elevation based interpolation
2m Air Temperature	NLDAS-2 (analysis)	0.125º	3-4 days	Elevation based interpolation
Specific Humidity	NLDAS-2 (analysis)	0.125º	3-4 days	Elevation based interpolation
Surface Pressure	NLDAS-2 (analysis)	0.125º	3-4 days	Elevation based interpolation
10 Wind Speed	NLDAS-2 (analysis)	0.125º	3-4 days	Bilinear interpolation

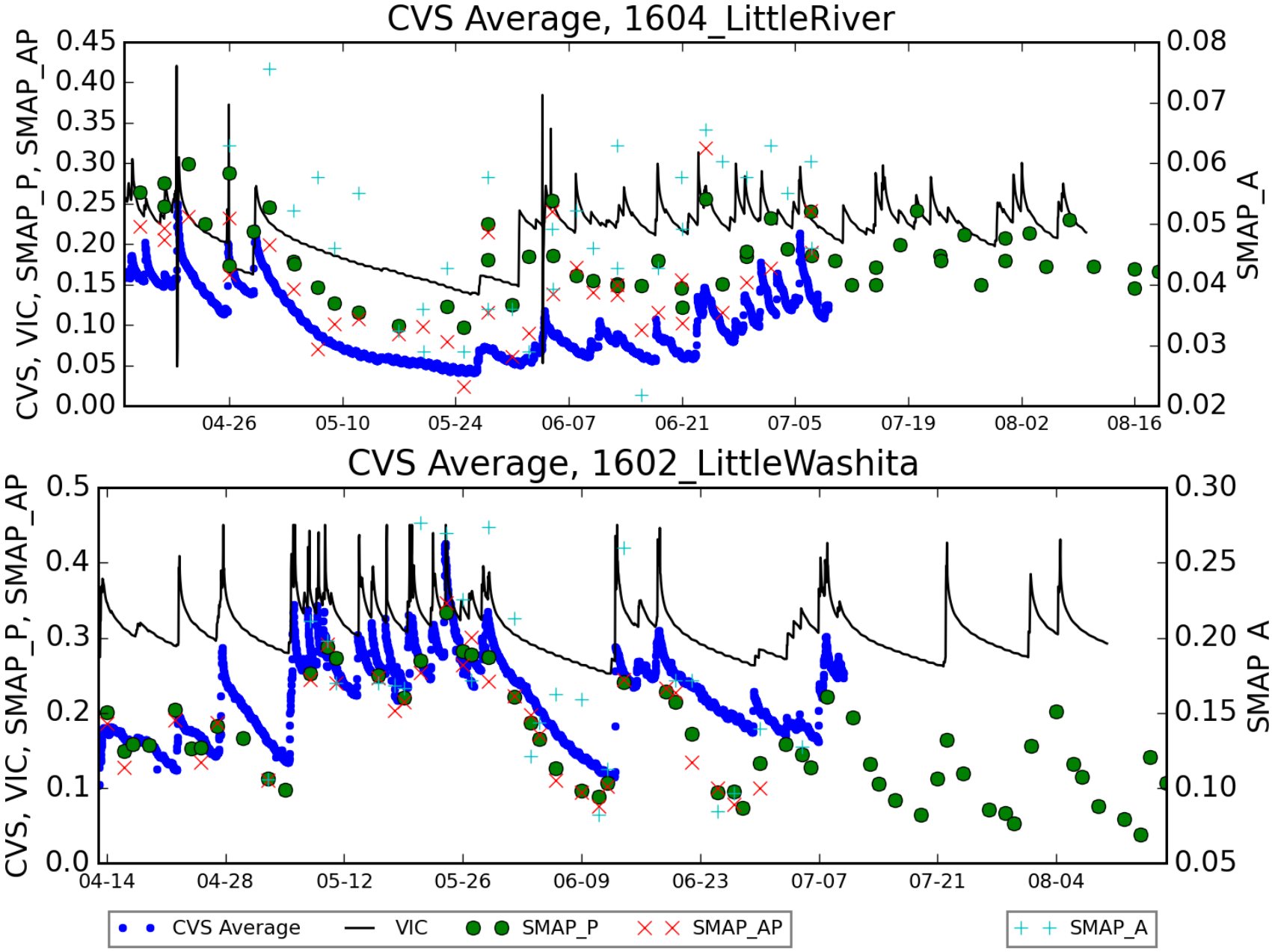
Comparisons over CONUS







Comparisons over CONUS



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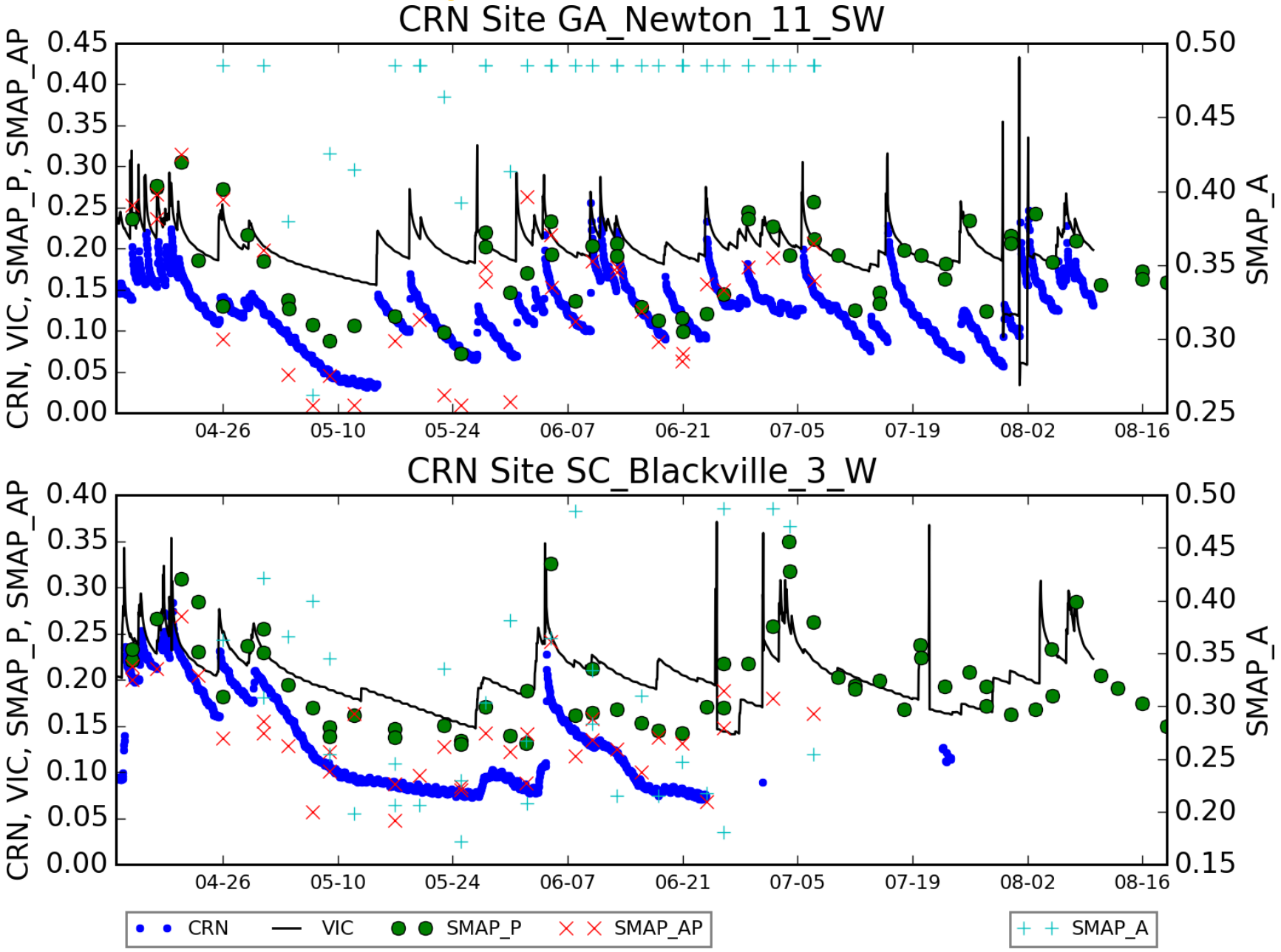
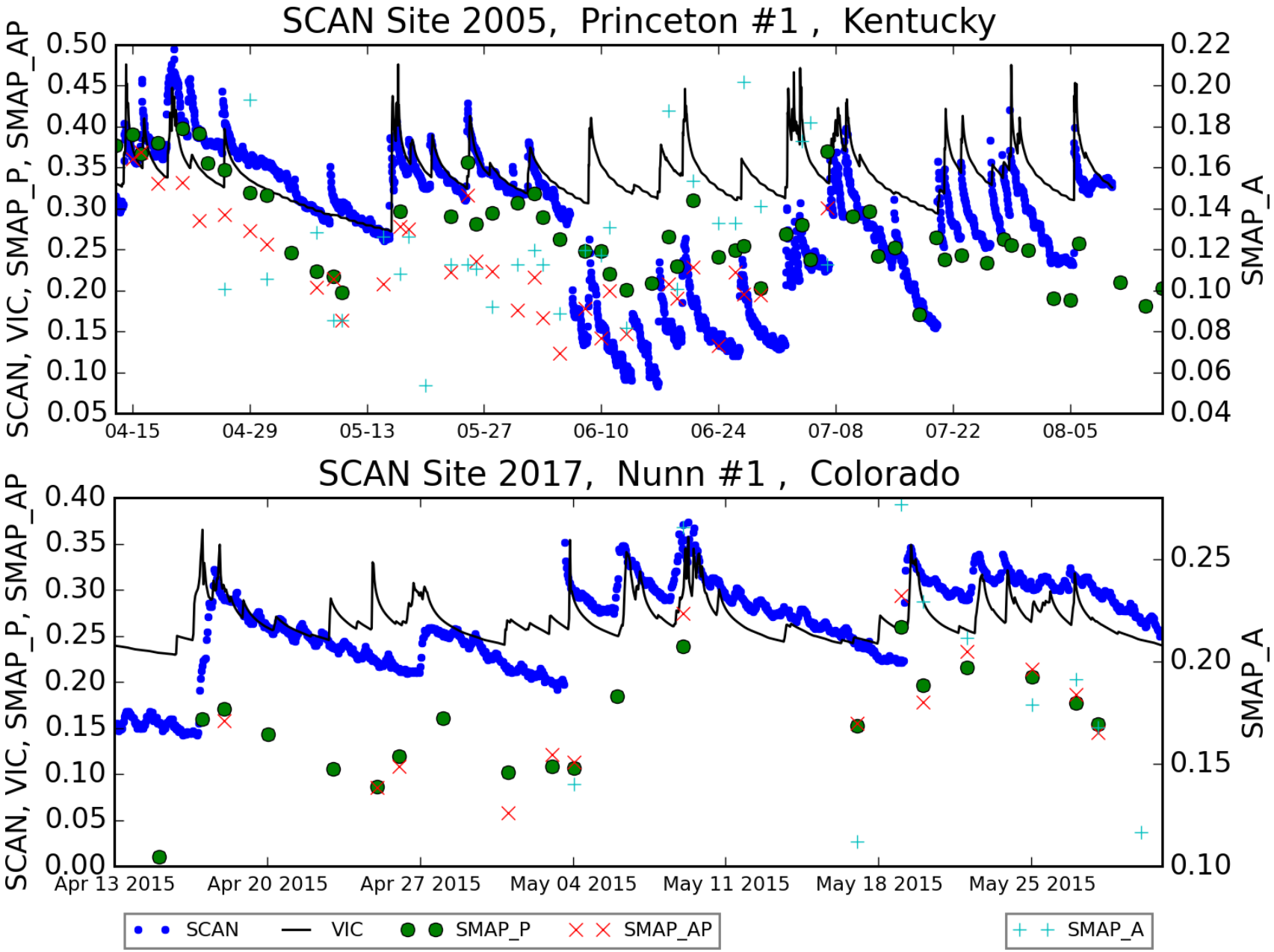


Comparisons over CONUS



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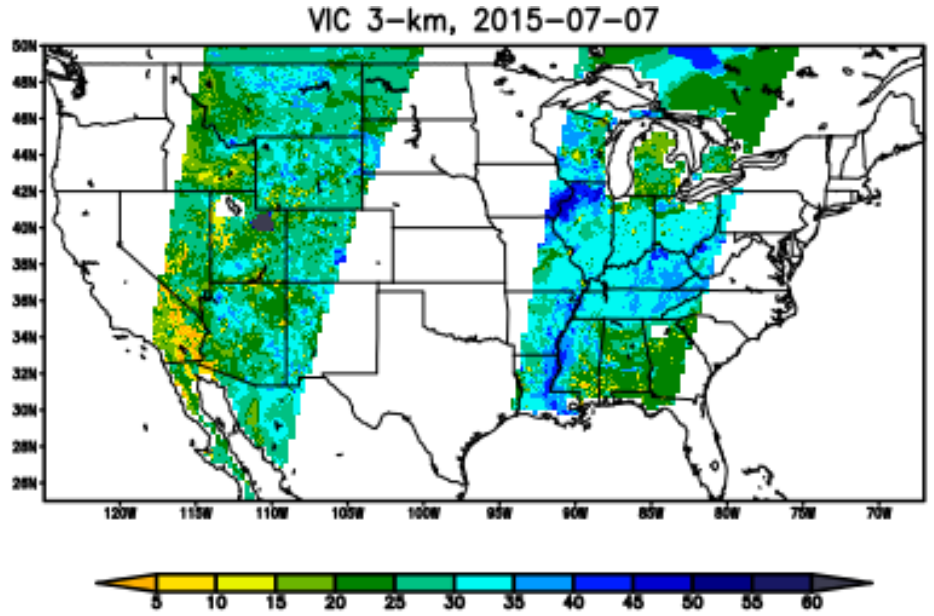
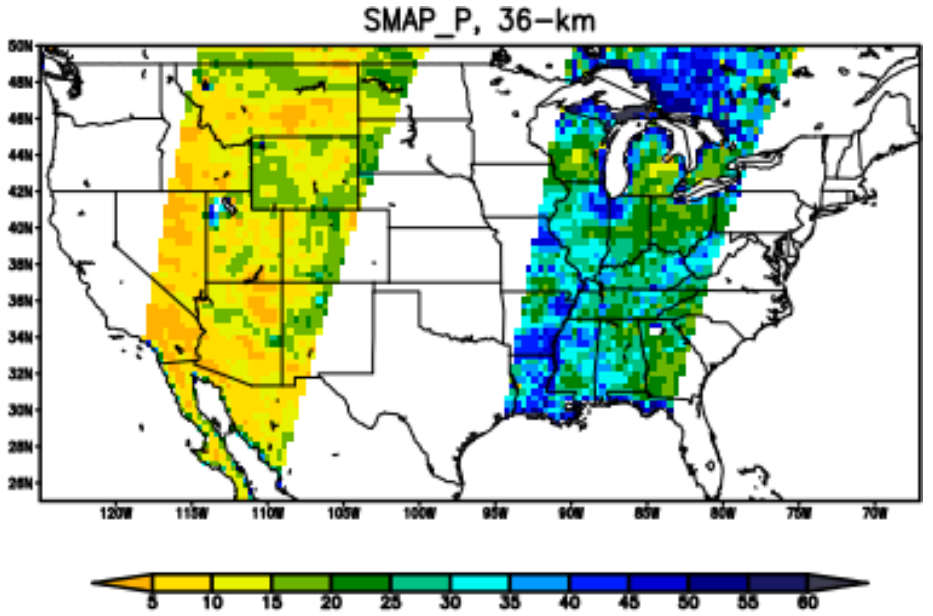
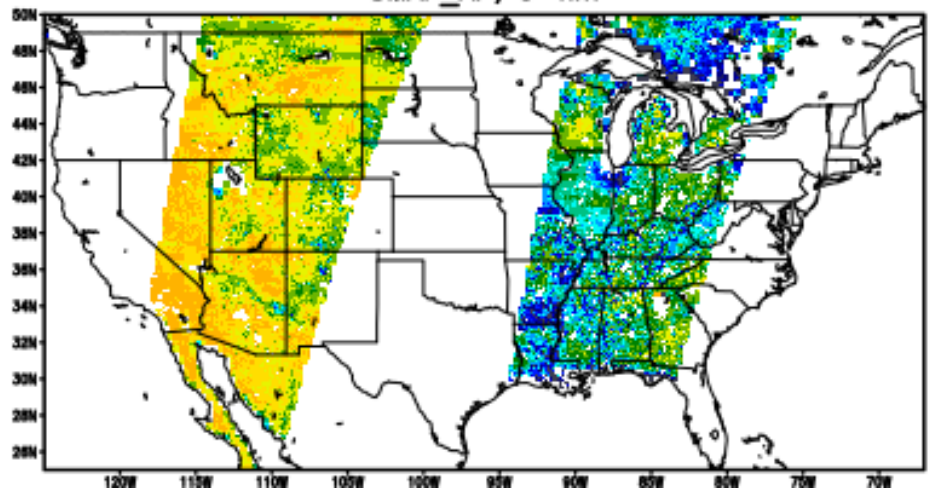
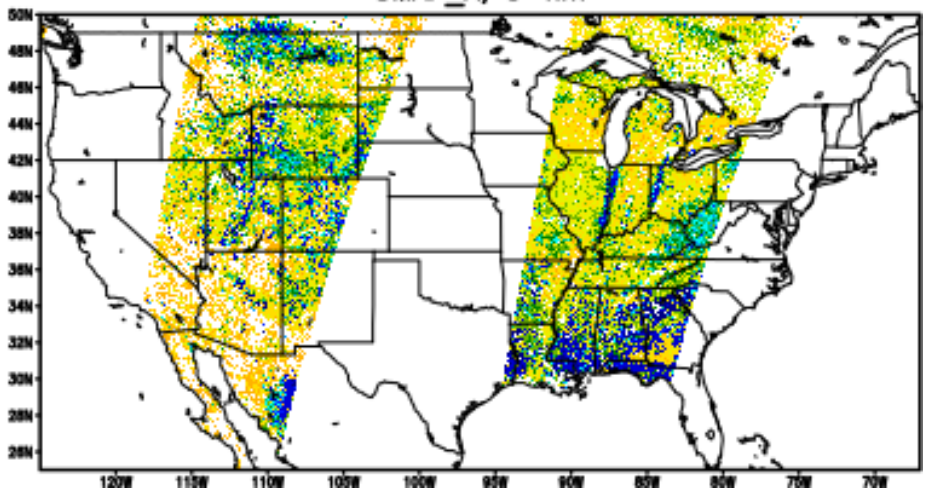








Backups

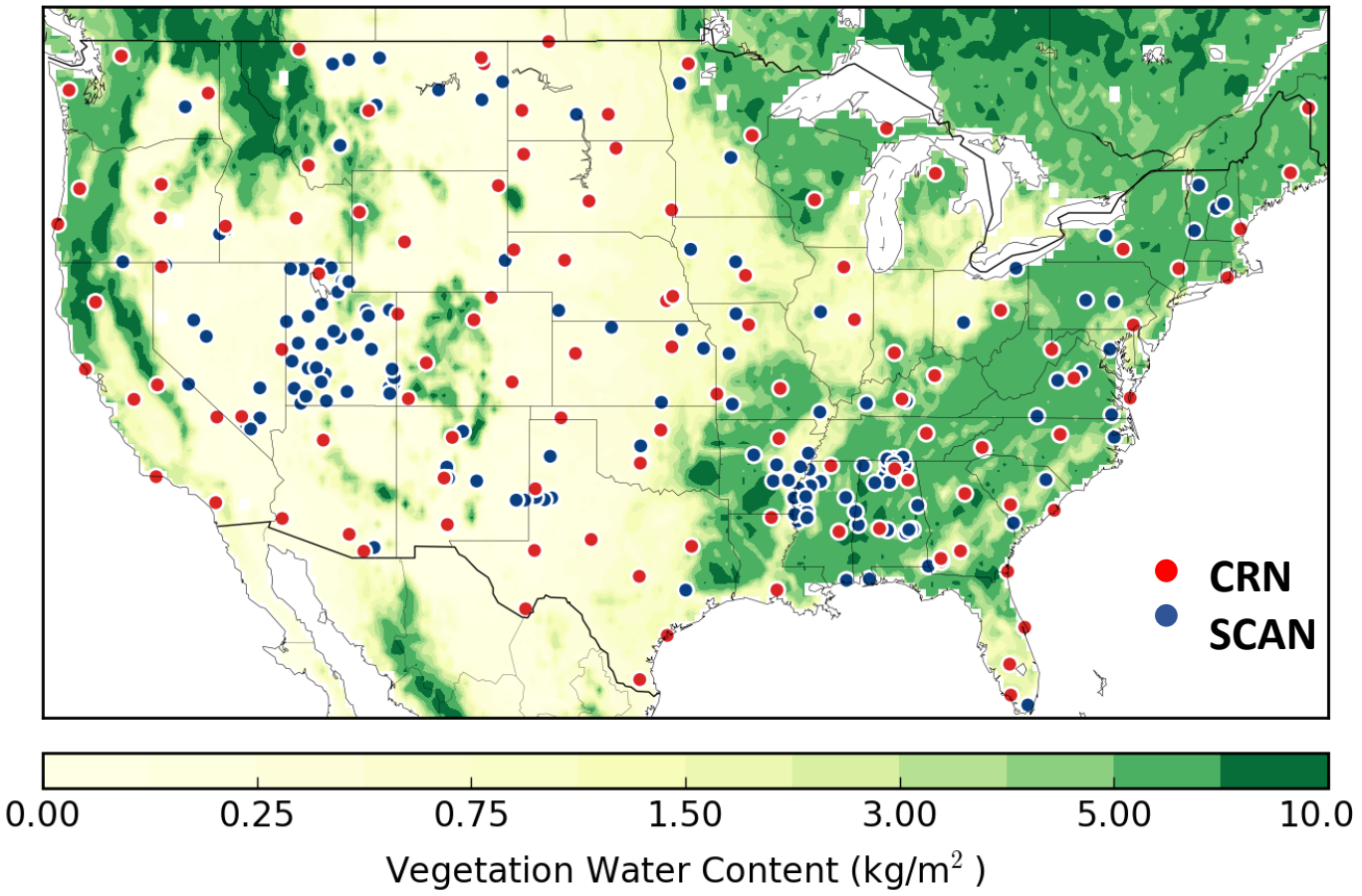
Comparisons over CONUS

Point comparisons are made over two networks:

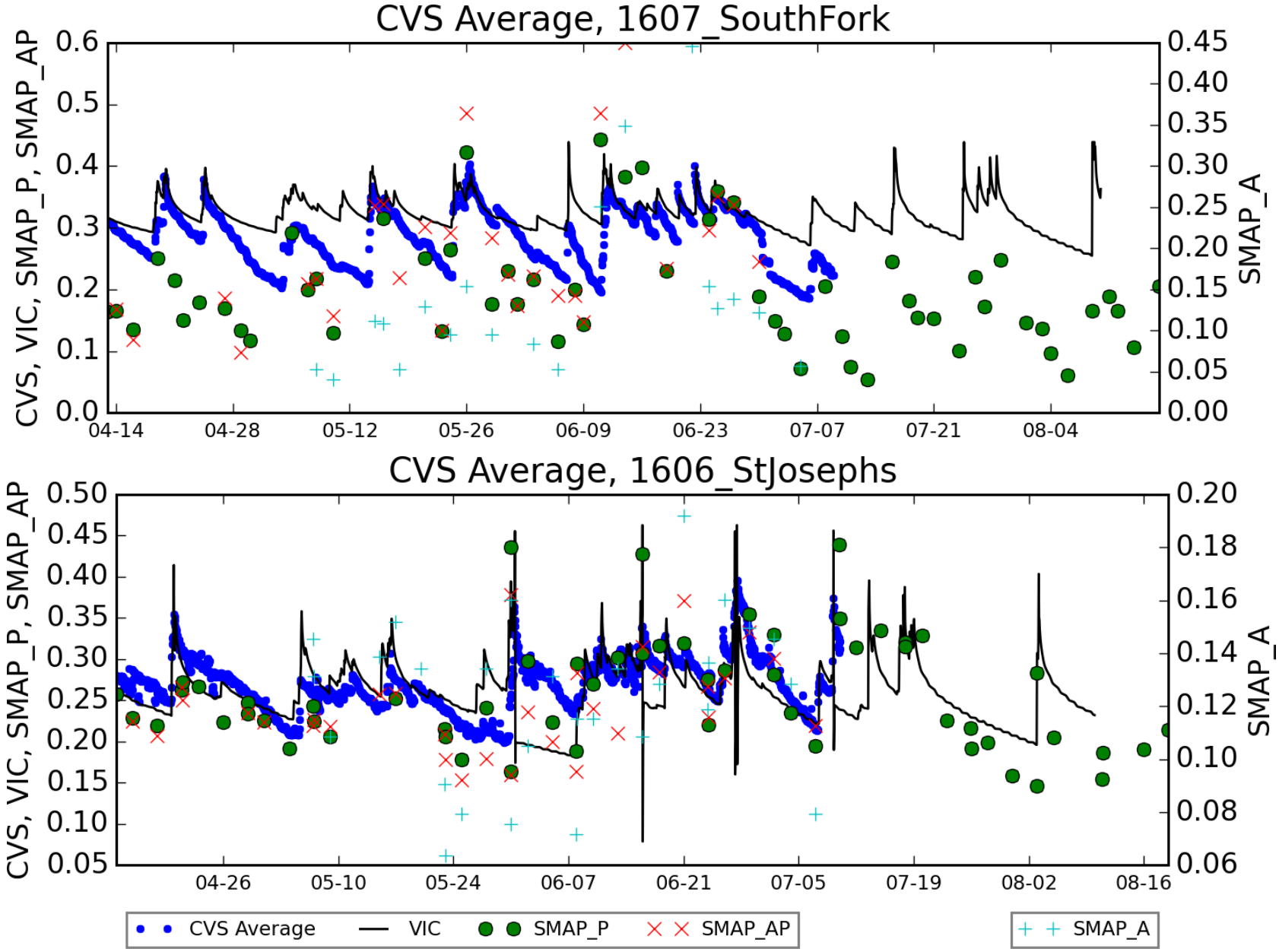
- Soil Climate Analysis Network (SCAN)
- U. S. Climate Reference Network (CRN)

All-station average comparisons made over 8 Core Validation Sites (CVS):

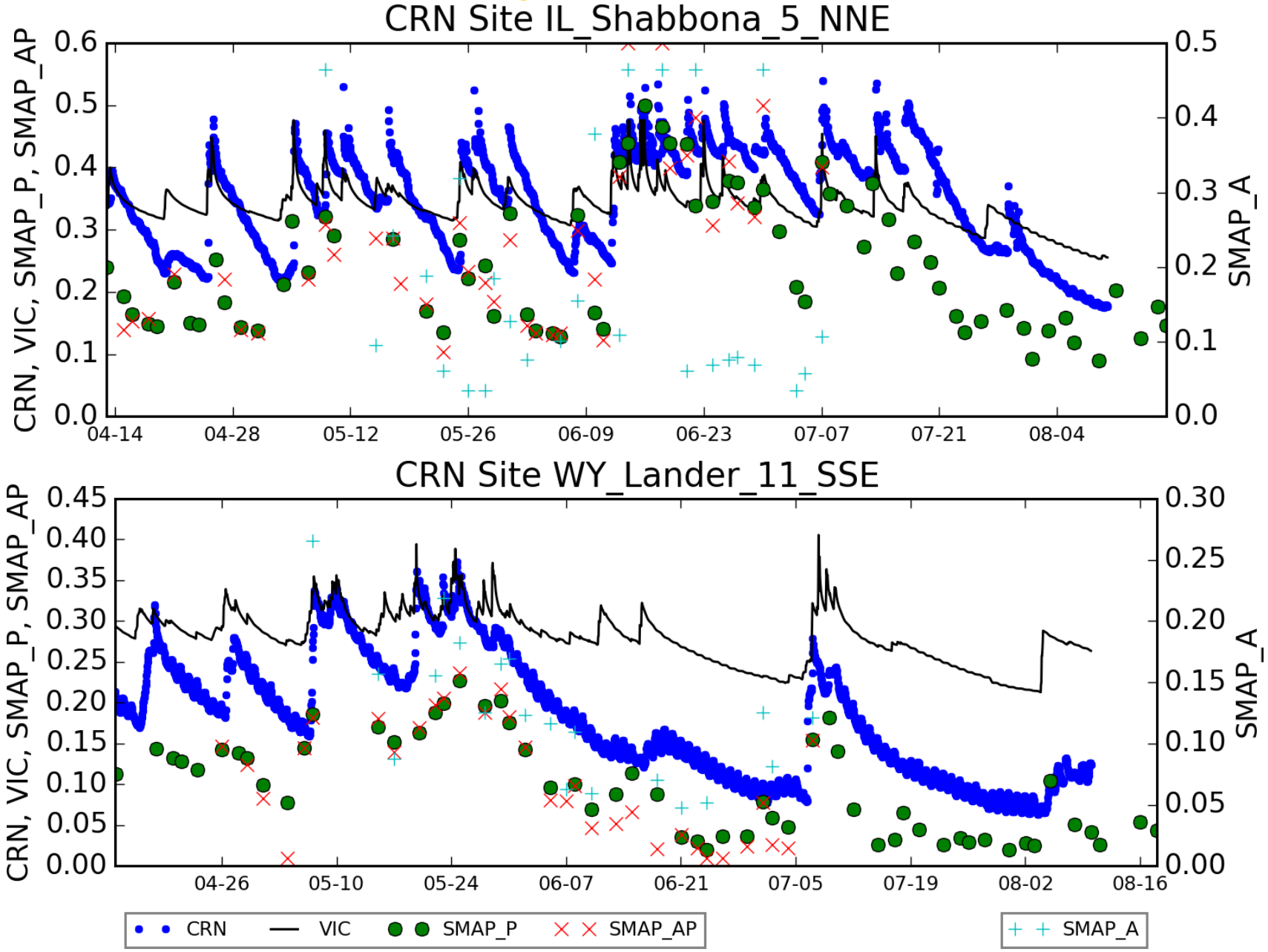
Walnut Gulch, Little River, Little Washita, Fort Cobb, South Fork, St Joseph and UT Austin.



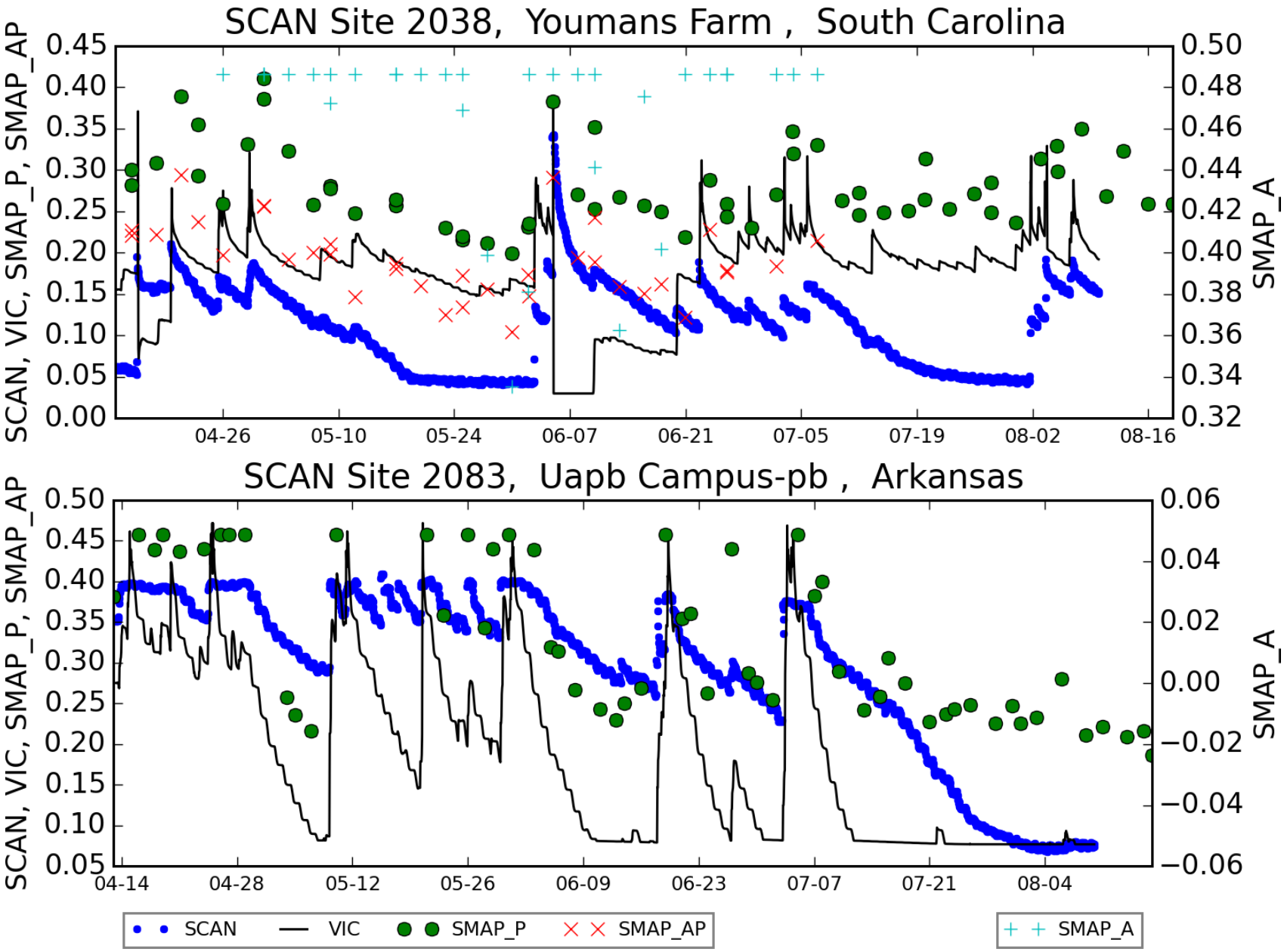
Comparisons over CONUS



Initial Comparisons over CONUS



Comparisons over CONUS



Comparisons over CONUS