

The background of the slide is a composite image. It features a view of Earth from space, showing a curved horizon with green land, blue oceans, and white clouds. In the upper left, the SMAP (Soil Moisture Active Passive) satellite is depicted. It has a large, circular, gold-colored antenna dish with a white support structure. Below the dish is the satellite's main body, which includes solar panels and other instruments. A wide, white, cone-shaped beam of radiation extends from the dish towards the Earth's surface, where it illuminates a small, circular area of land. This area is highlighted with a color-coded map showing green and yellow, representing soil moisture data. The sky is dark with numerous stars.

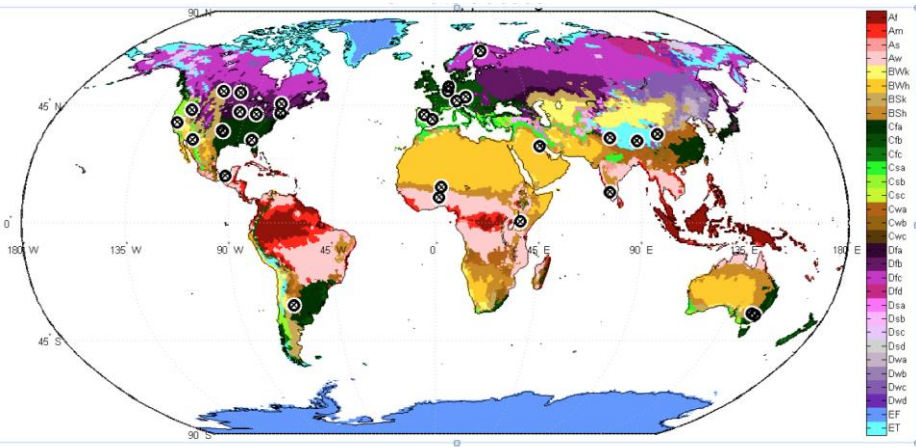
SMAP Cal/Val Workshop #5

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

Dara Entekhabi (MIT)

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

The Need



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

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

Model-based Validation of SMAP Surface Soil Moisture Products

(V053014)

Contributors

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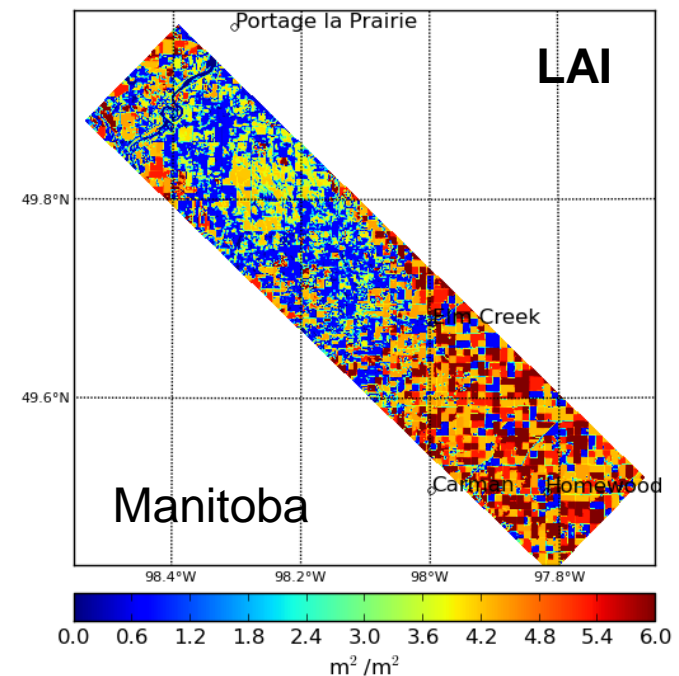
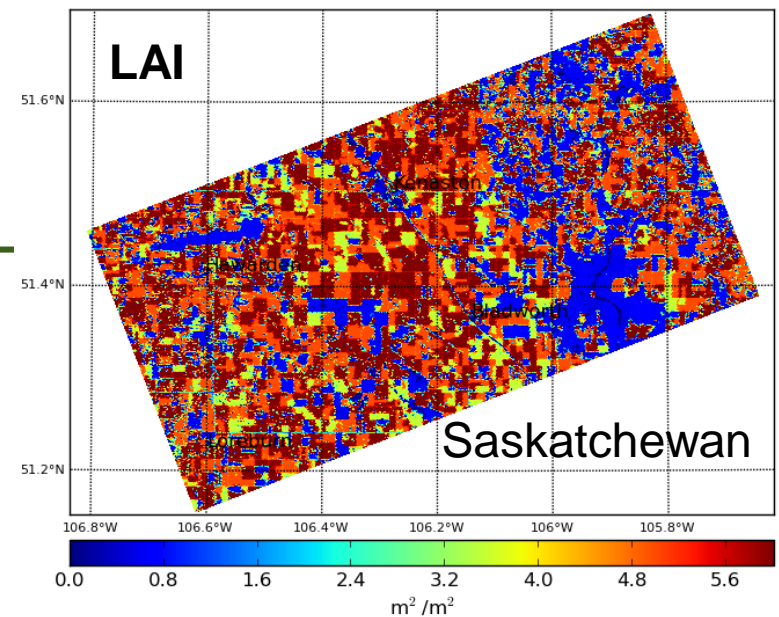
The following four surface soil moisture validation activities can benefit from using model products:

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)

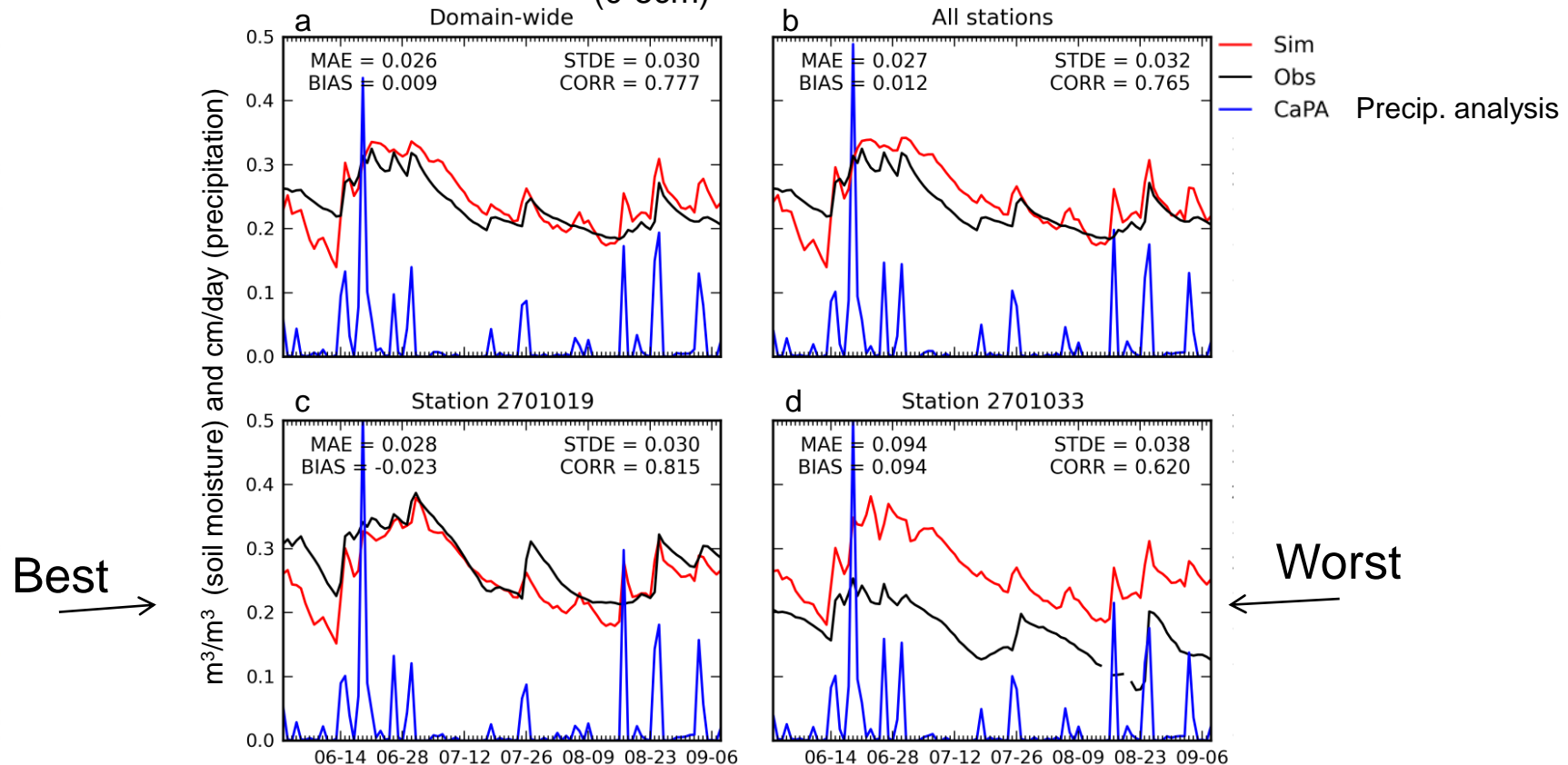
Motivation for 100-m Modeling

- First... direct comparison against SMAP soil moisture products based on spatial averaging
- Second... extra dataset for SMAP cal-val (e.g., for triple collocation)
- 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

Soil moisture and precipitation (0-5cm)



(Garnaud et al. 2015)

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Environnement
Canada

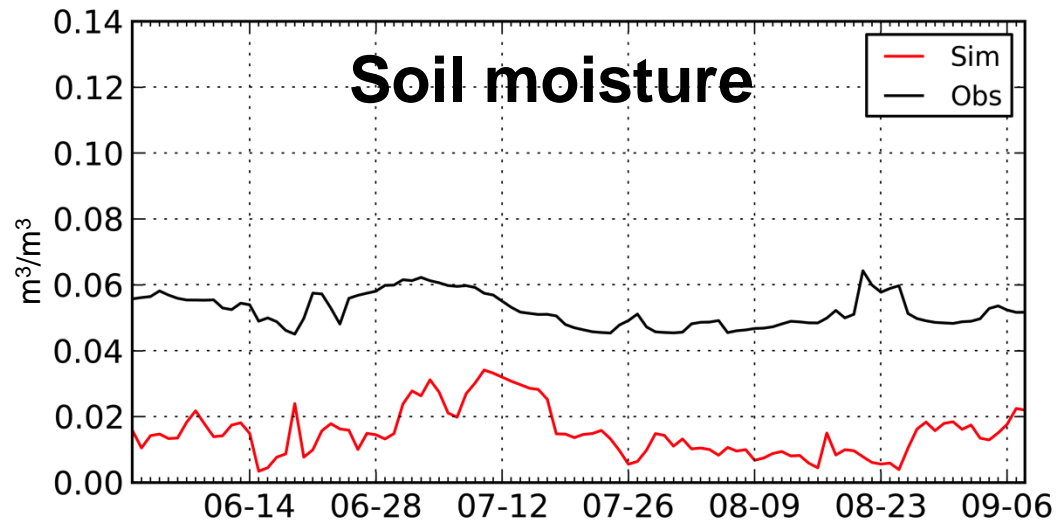
Environment
Canada



Canada

Brightwater Creek network - SK

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

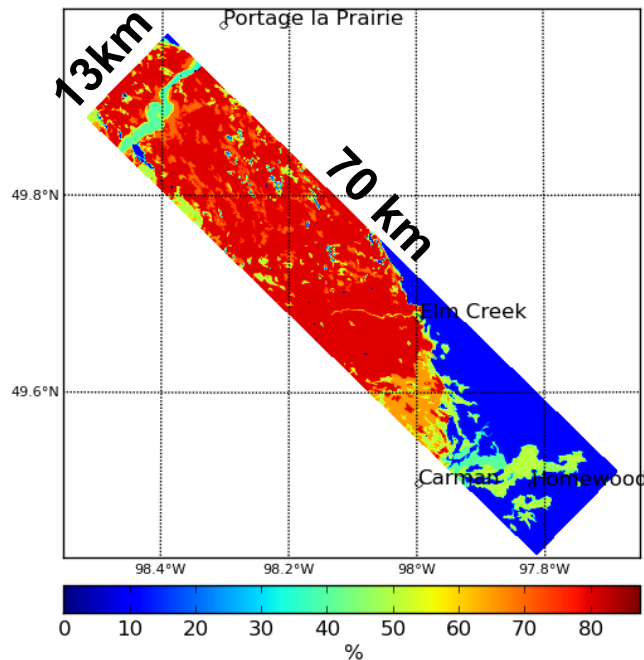


(Garnaud et al. 2015)

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

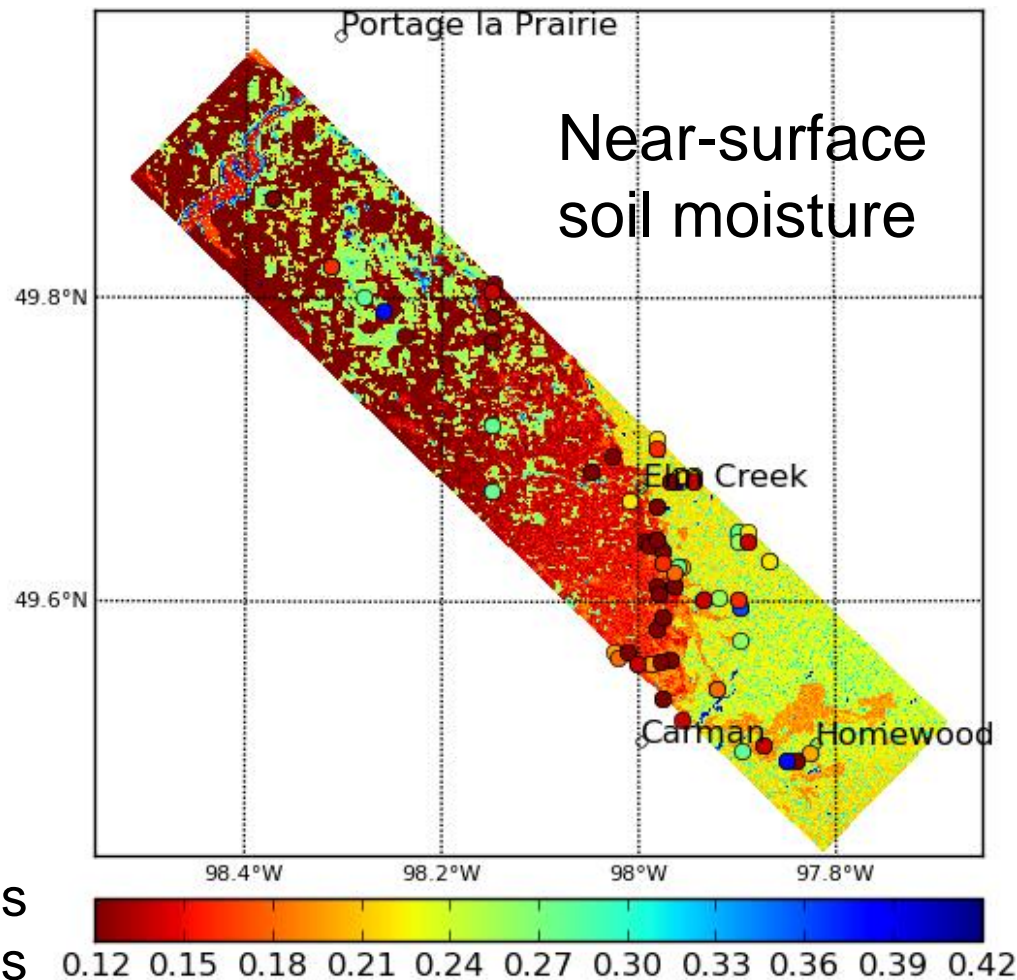


SMAPVEX12 - Manitoba



Soil texture (sand percentage)

July 5th 2012, filled circles represent observations



Environnement
Canada

Environment
Canada

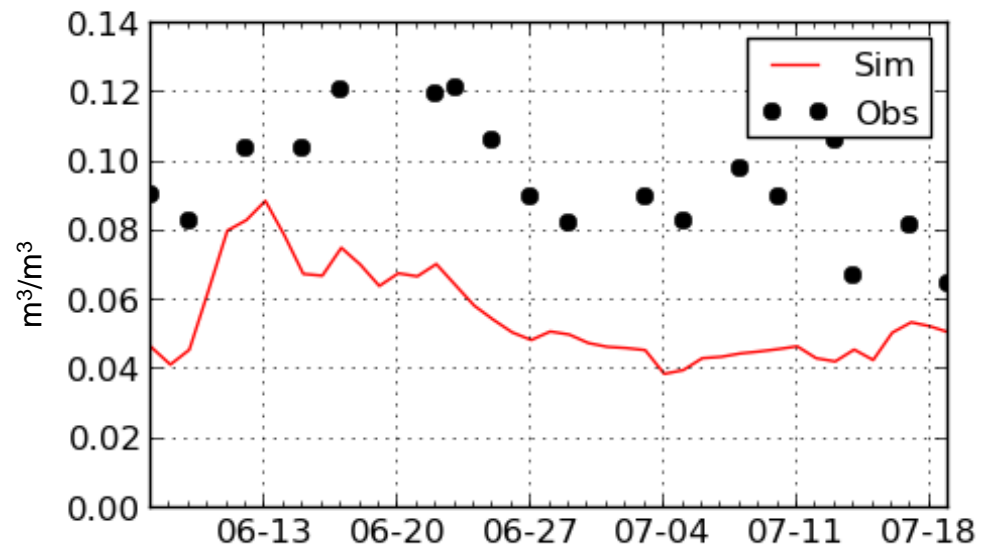
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Canada

SMAPVEX12 - Manitoba

- Improvement in spatial variability of soil moisture (mostly related to soil texture and vegetation)

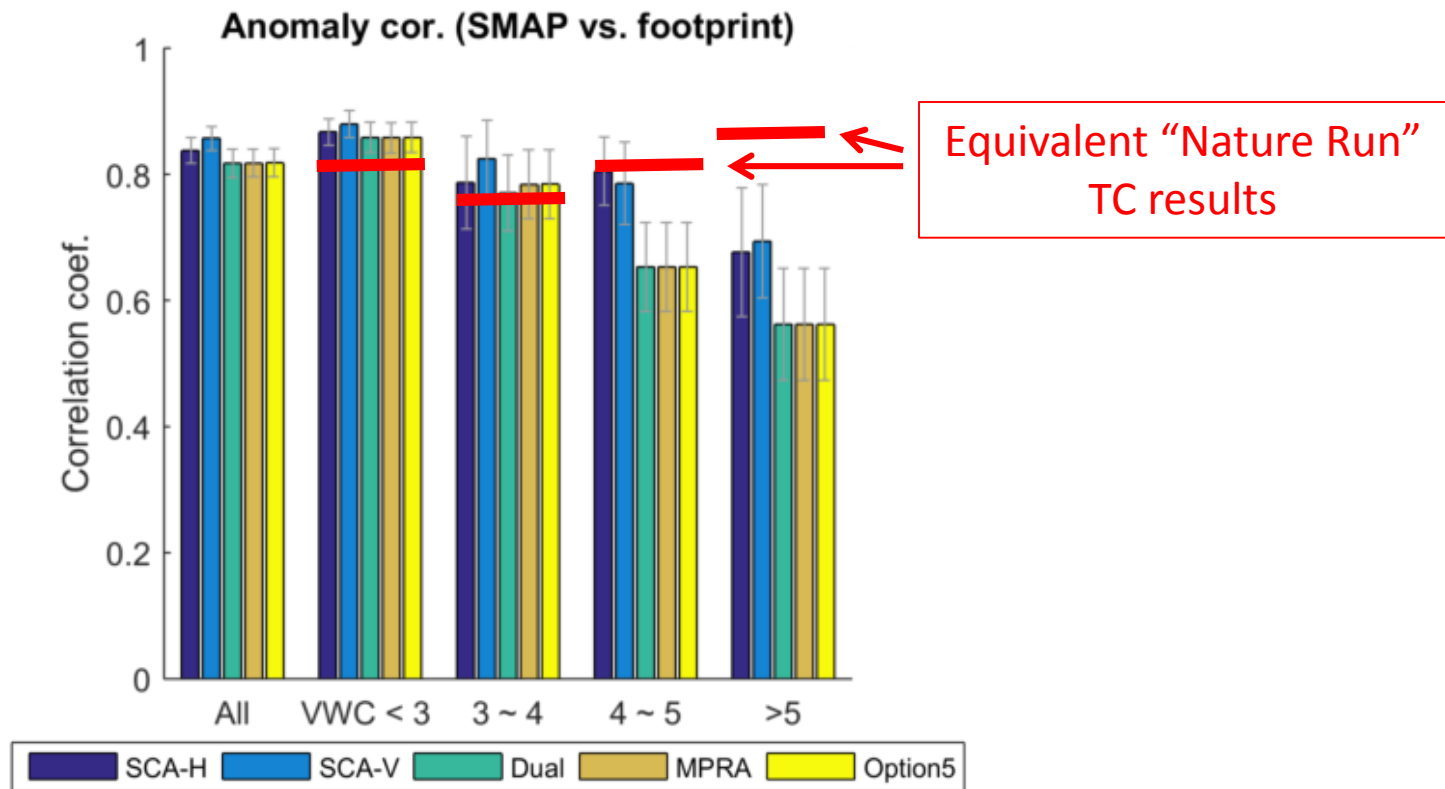


- Further improvements could be made:
 - Forcings of higher resolution (precip and radiation)
 - Lateral hydrological flows
- Questions regarding how useful these high-resolution model will be in the context of SMAP



Wade Crow and Fan Chen (USDA)

SMAP L2 P versus GMAO Nature Run Results

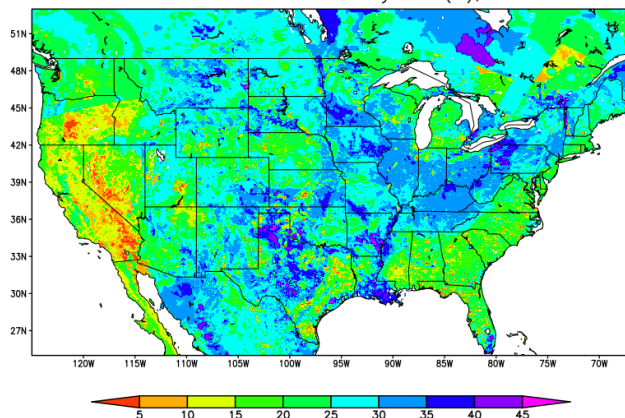
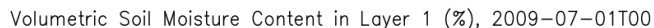


Based on TC results at CONUS USDA SCAN and NOAA CRN sparse network site locations.

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/m².

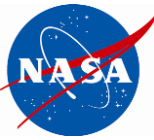
Ming Pan, Nat Chaney, and Eric Wood (Princeton)

Variable Infiltration Capacity (VIC) Macroscale Hydrologic Model



- 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

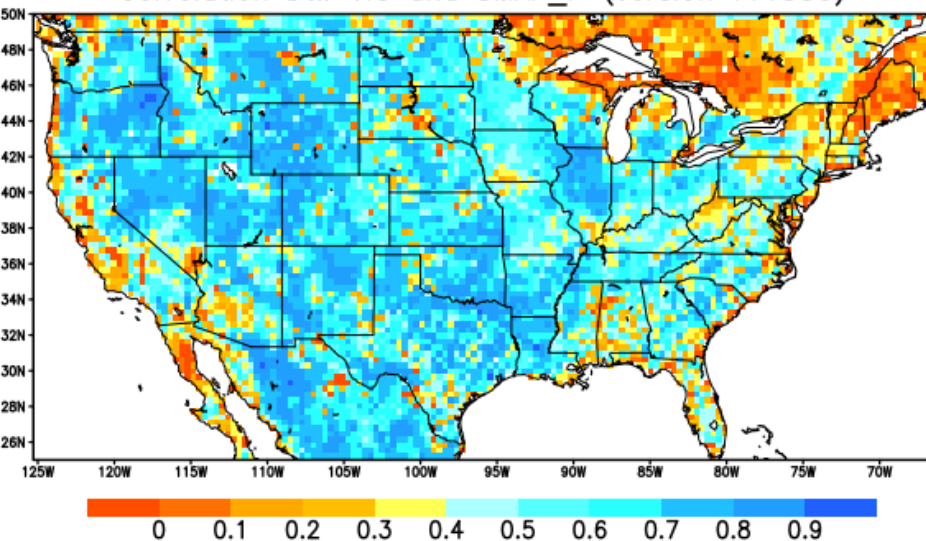


Input Meteorological Forcing Fields

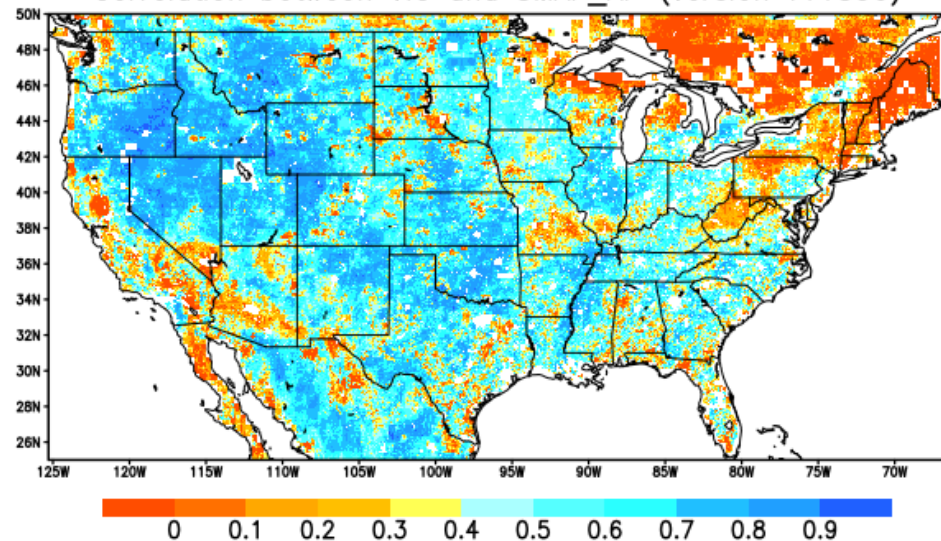
Forcing Field	Source	Resolution	Lag Time	Processing
Precipitation	Stage IV (radar/gauge)	4 km	~1 day	
Shortwave Radiation	GSIP (GOES satellite)	0.125°	2-3 hours	Solar angle based time shift, bilinear interpolation
Longwave Radiation	NLDAS-2 (analysis)	0.125°	3-4 days	Elevation based interpolation
2m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

Comparisons over CONUS

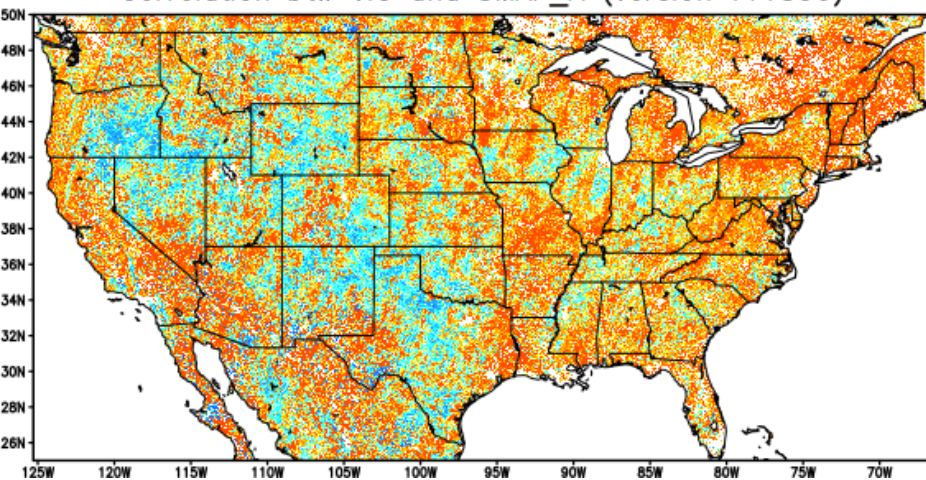
Correlation btw VIC and SMAP_P (version T11880)



Correlation between VIC and SMAP_AP (version T11830)

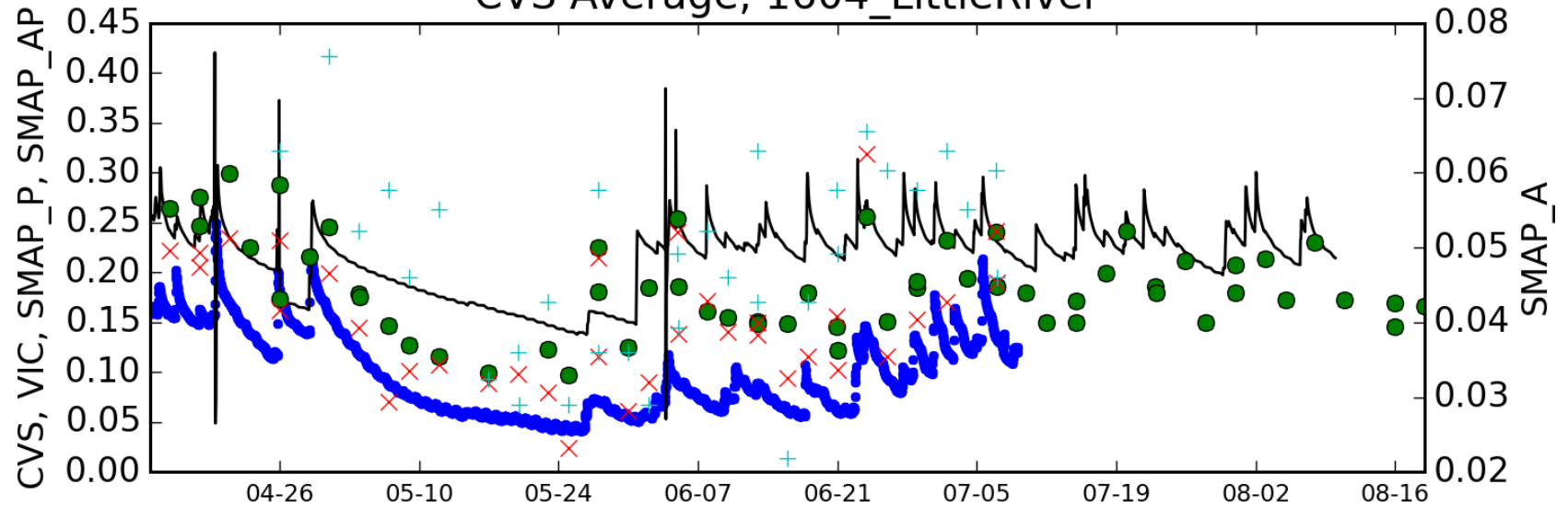


Correlation btw VIC and SMAP_A (version T11830)

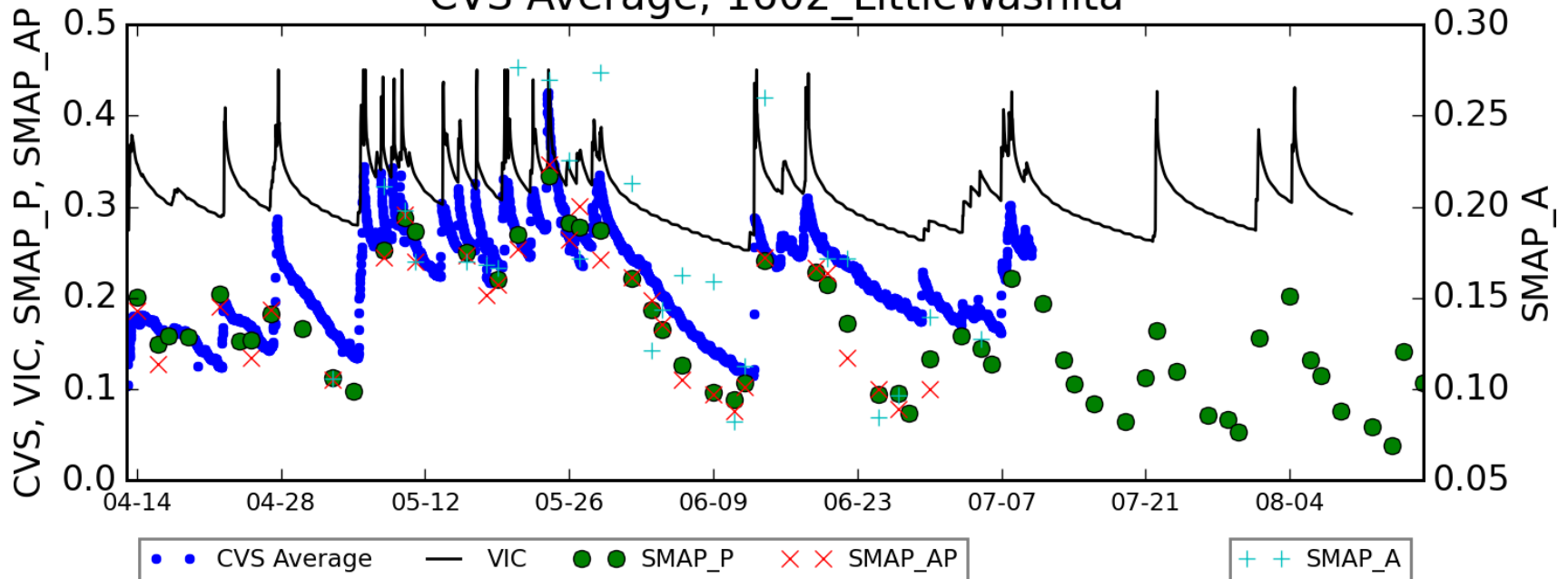


Comparisons over CONUS

CVS Average, 1604_LittleRiver

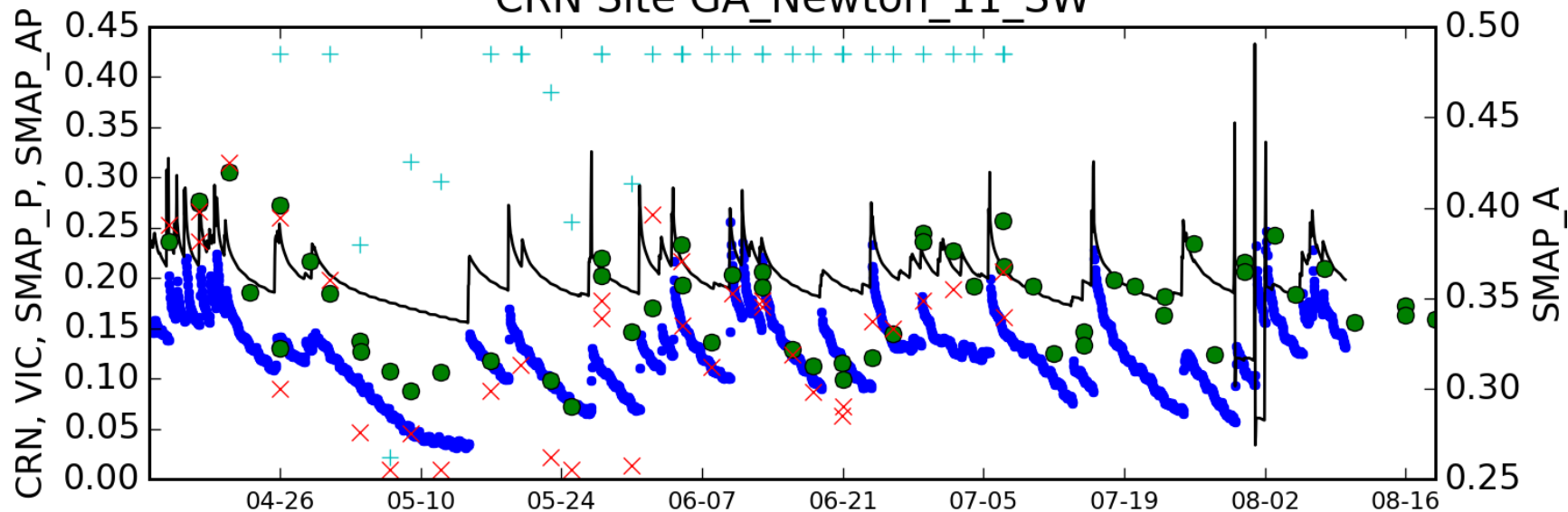


CVS Average, 1602_LittleWashita

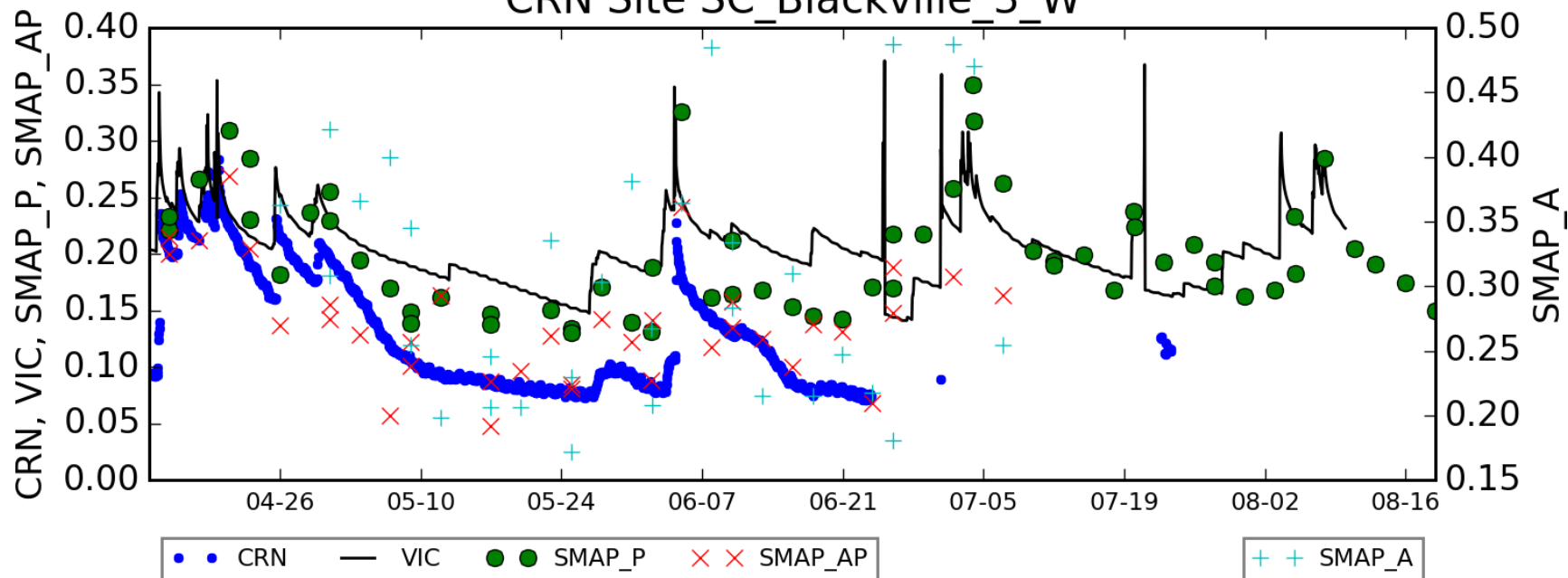


Comparisons over CONUS

CRN Site GA_Newton_11_SW

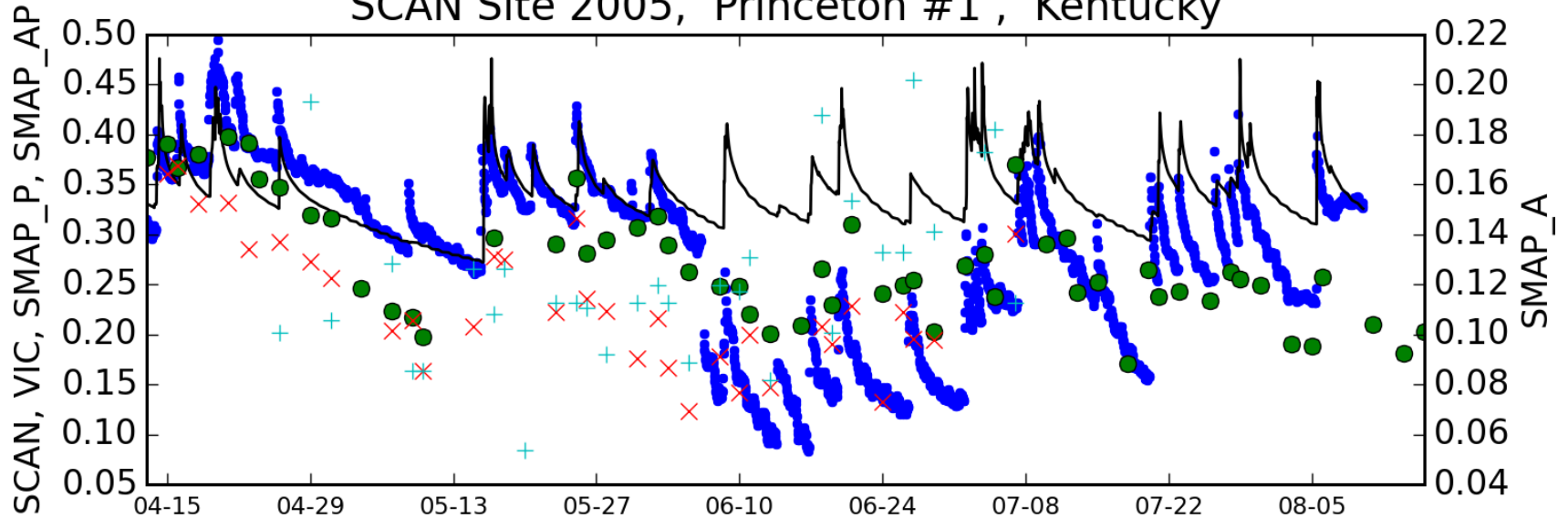


CRN Site SC_Blackville_3_W

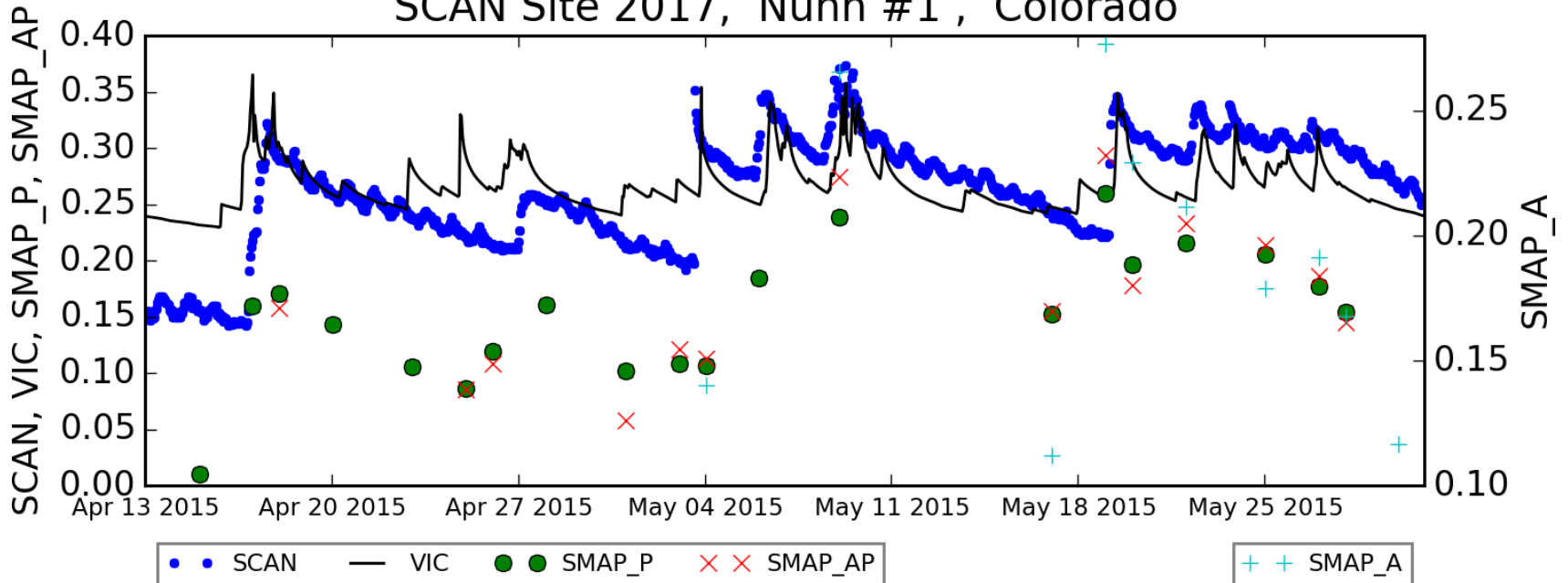


Comparisons over CONUS

SCAN Site 2005, Princeton #1 , Kentucky

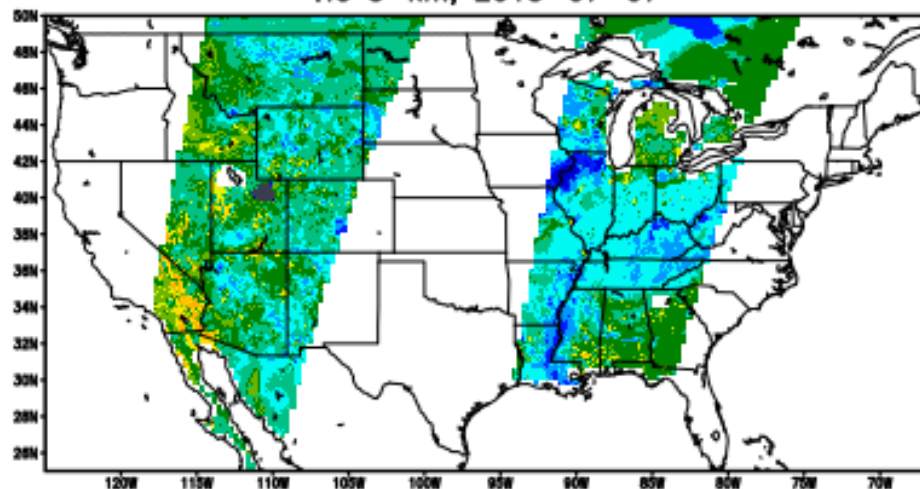


SCAN Site 2017, Nunn #1 , Colorado

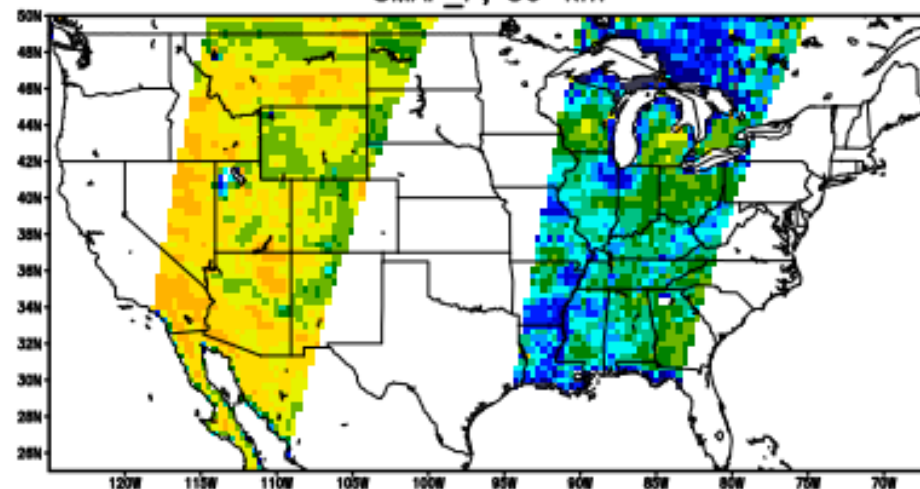


Comparisons over CONUS

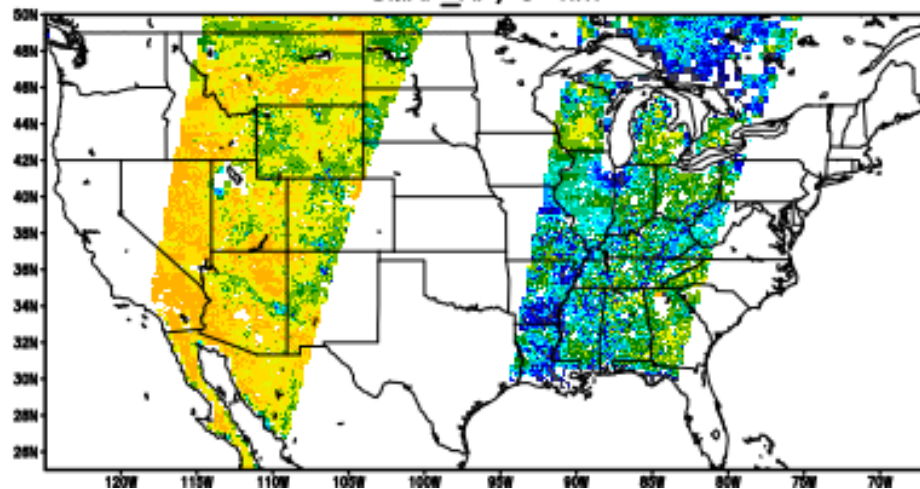
VIC 3-km, 2015-07-07



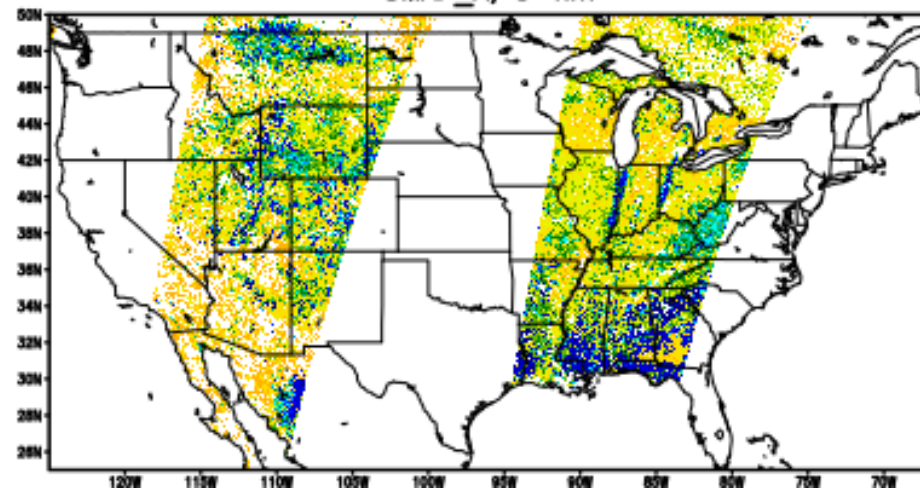
SMAP_P, 36-km



SMAP_AP, 9-km



SMAP_A, 3-km



Backups

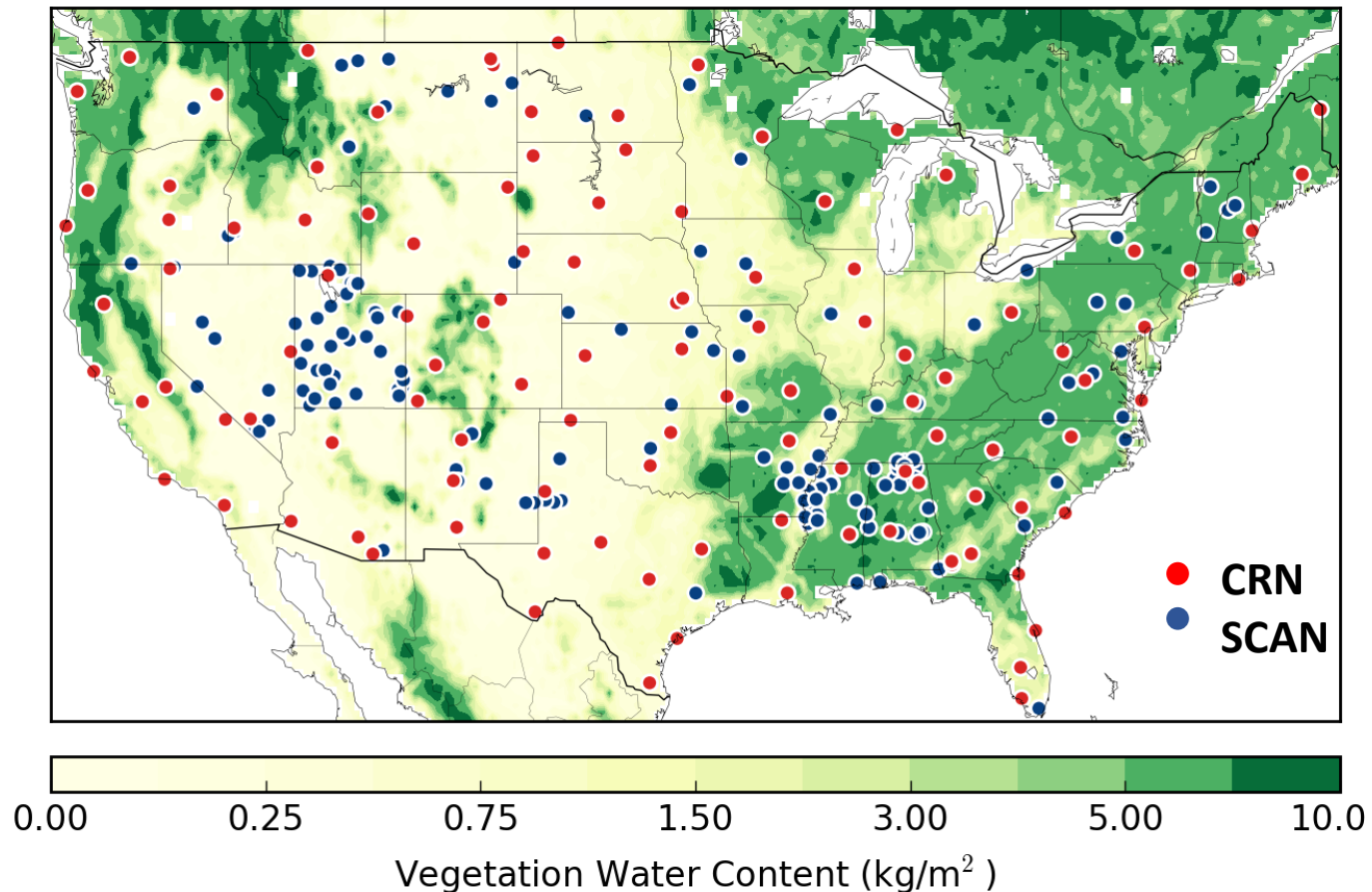
Comparisons over CONUS

Point comparisons are made over two networks:

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

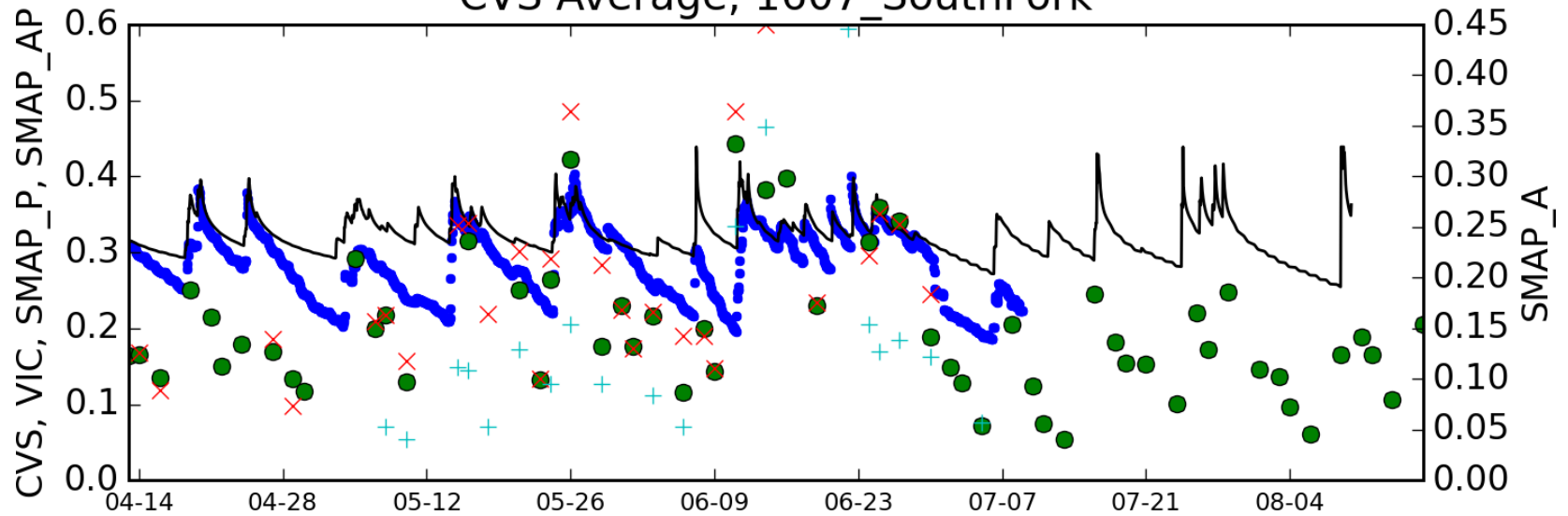
All-station average comparisons made over 8 Core Validation Sites (CVS):

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

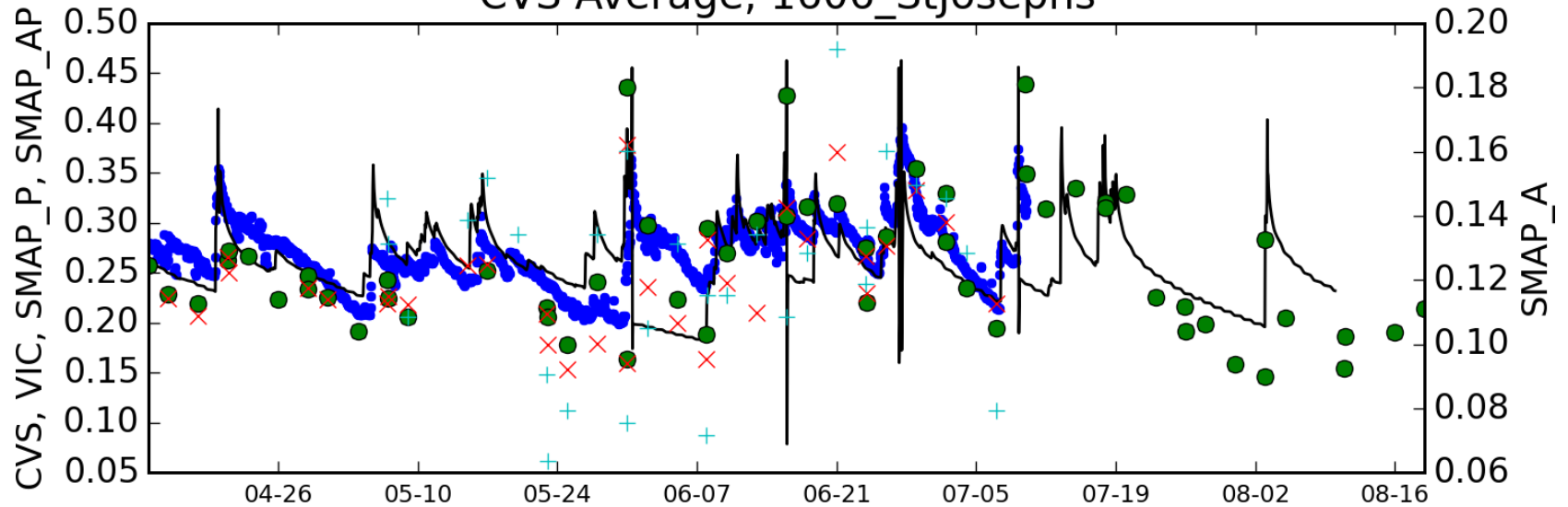


Comparisons over CONUS

CVS Average, 1607_SouthFork



CVS Average, 1606_StJosephs

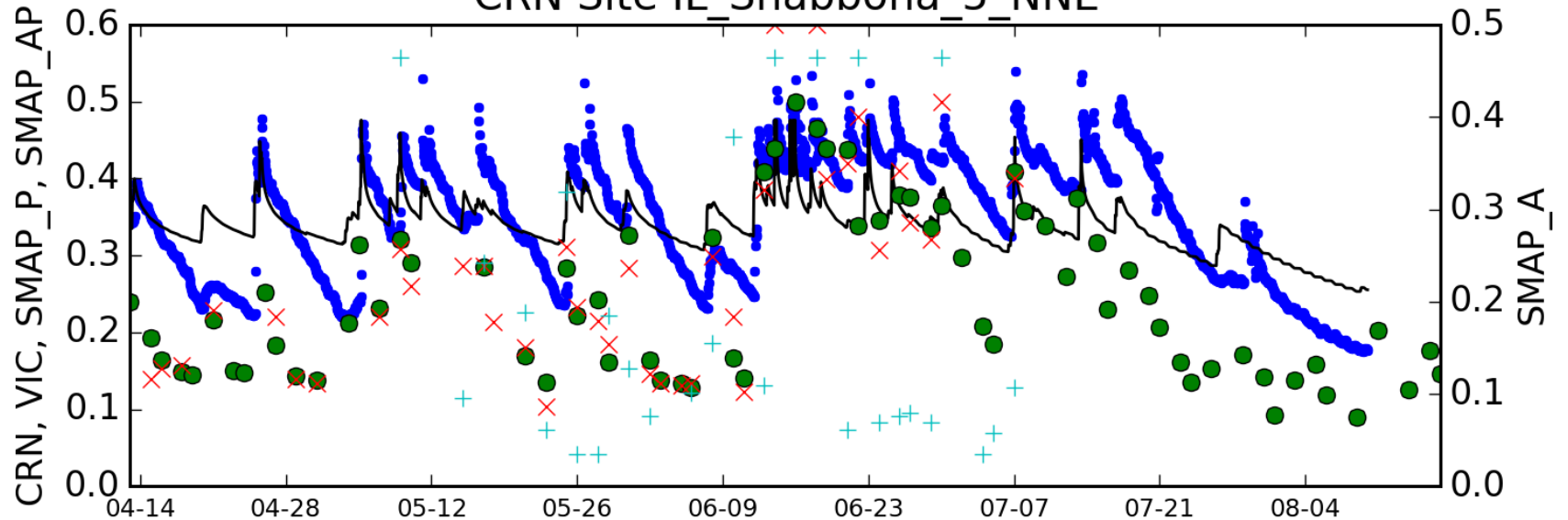


● CVS Average — VIC ● SMAP_P × SMAP_AP

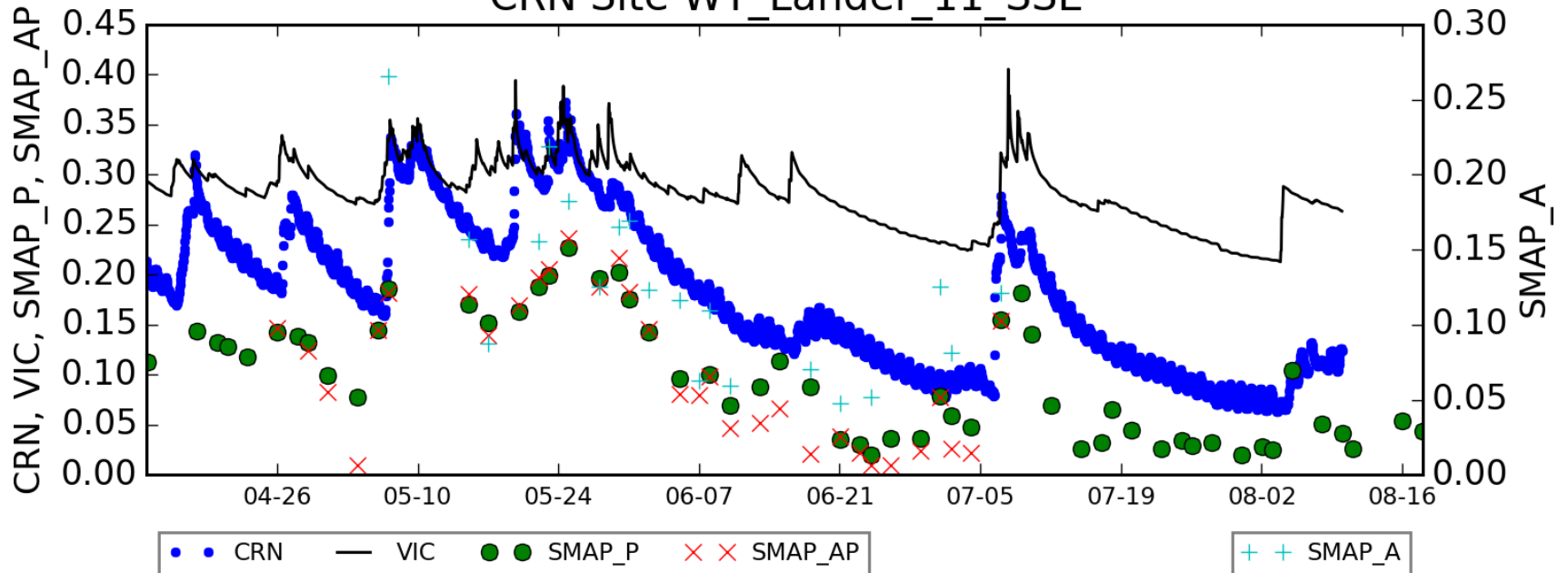
+ SMAP_A

Initial Comparisons over CONUS

CRN Site IL_Shabbona_5_NNE

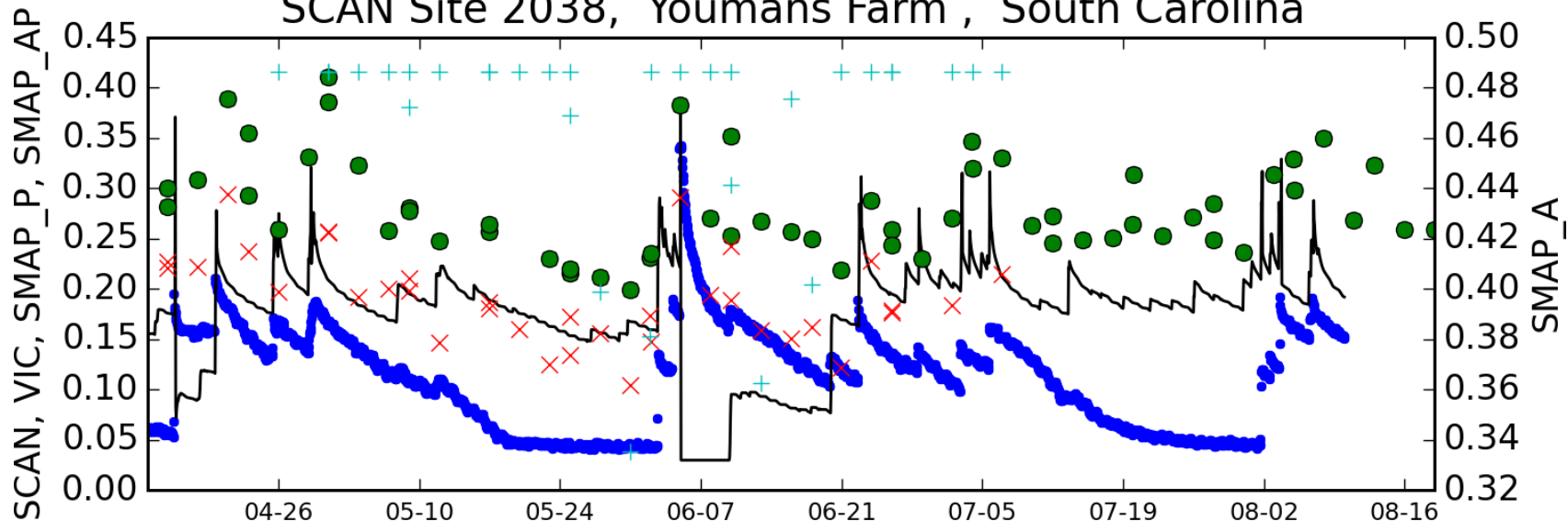


CRN Site WY_Lander_11_SSE

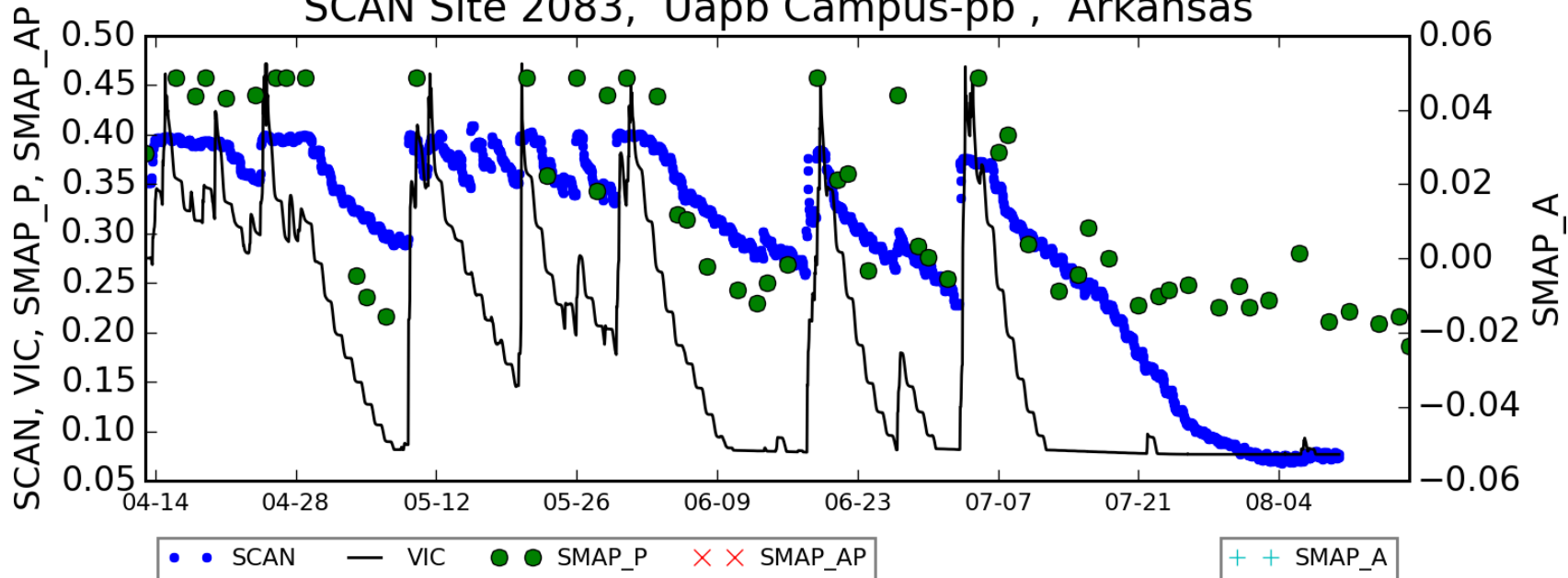


Comparisons over CONUS

SCAN Site 2338, Youmans Farm , South Carolina

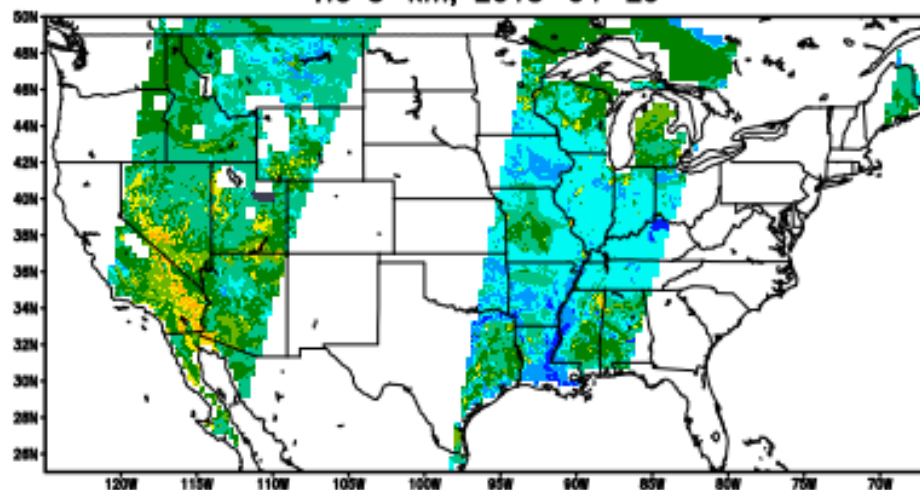


SCAN Site 2083, Uapb Campus-pb , Arkansas

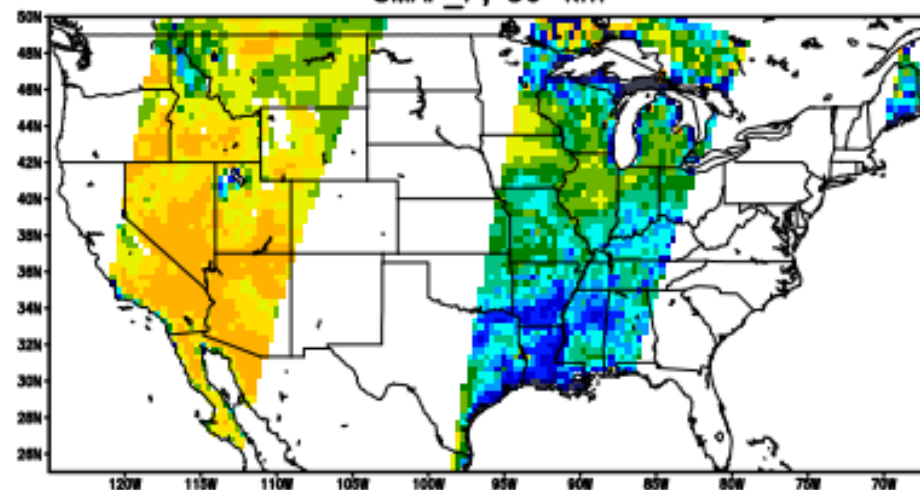


Comparisons over CONUS

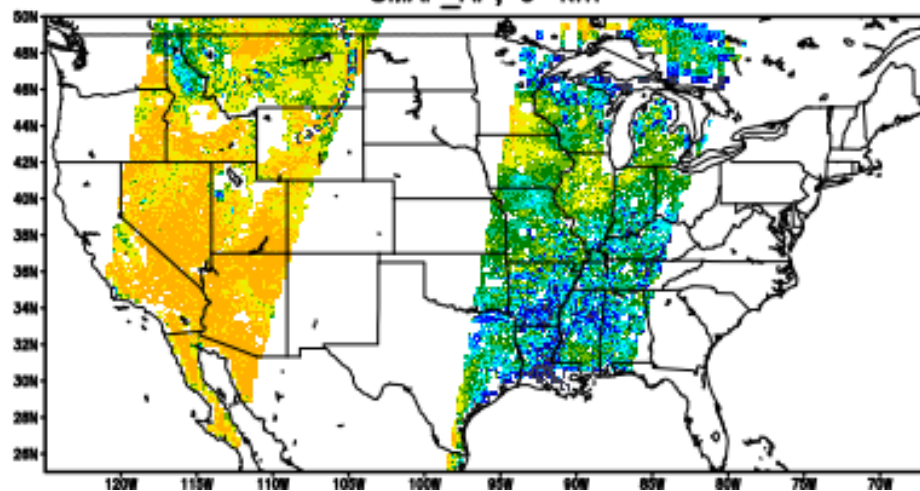
VIC 3-km, 2015-04-29



SMAP_P, 36-km



SMAP_AP, 9-km



SMAP_A, 3-km

