Southeast Soil Moisture Buildout Project

Towards a distributed soil moisture network in Alabama: Opportunities for low-cost, easy deployable sensors leveraging citizen science networks

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The Alabama State Climatologist

I ❤ CoCoRaHS!

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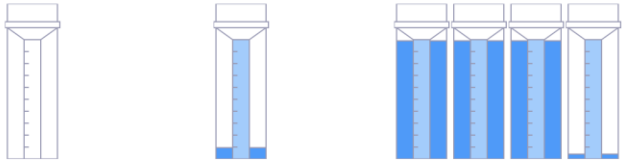
Today: 0.00"

Month-To-Date: 1.86"
11 of 11 days covered by obs

Year-To-Date: 31.37"
163 of 163 days covered by obs



Station Activity

Period of Record

Jul 1, 2023 - Jun 11, 2024

Duration of Record

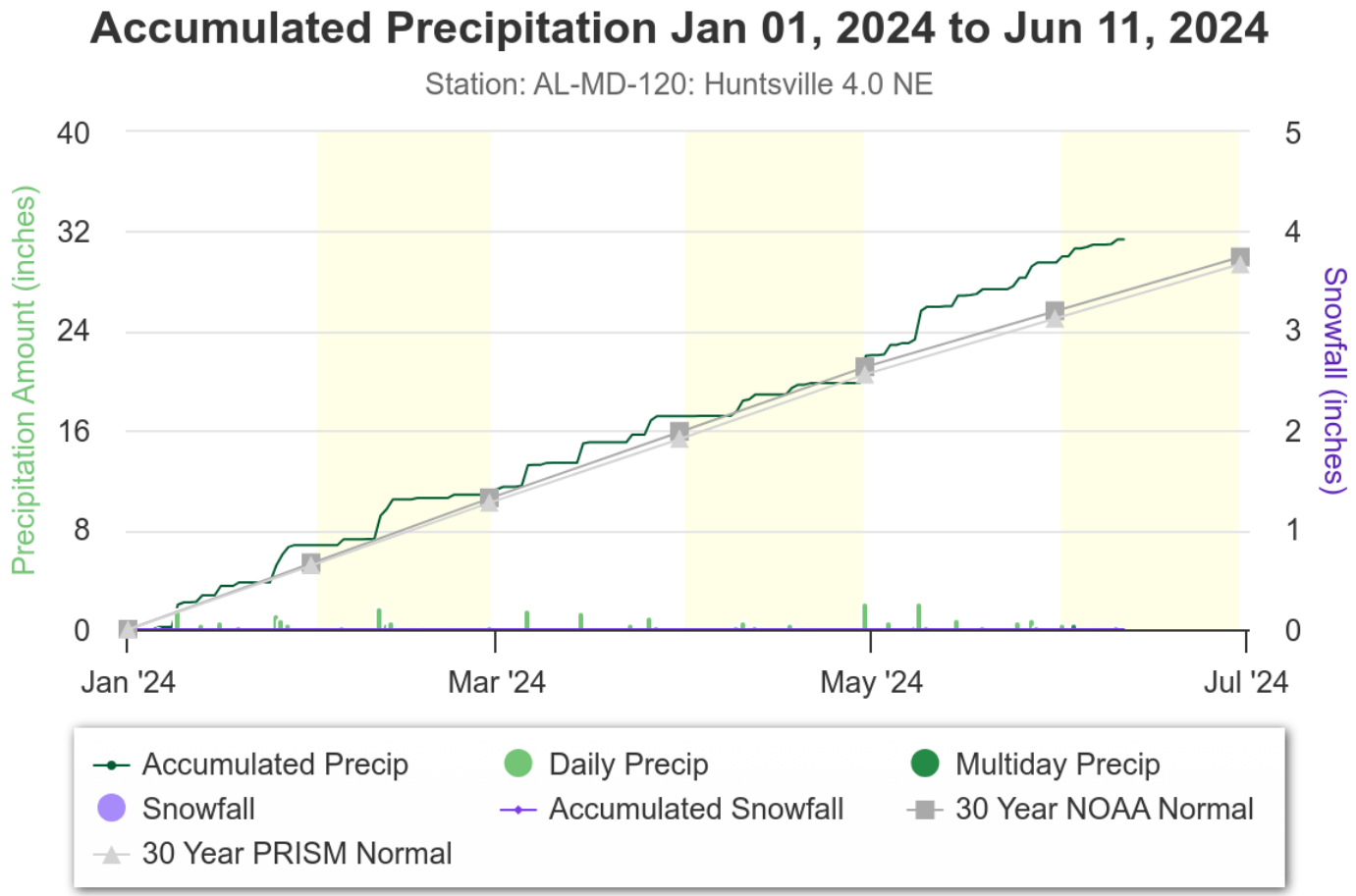
11 months 10 days

Pct of Days covered by Precip Obs

100%

Observation Counts

Daily Precip 343	Multi-day Precip 2
Condition Monitori... 0	Significant Weather 0
Hail 0	Total Obs 345



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Why Soil Moisture?

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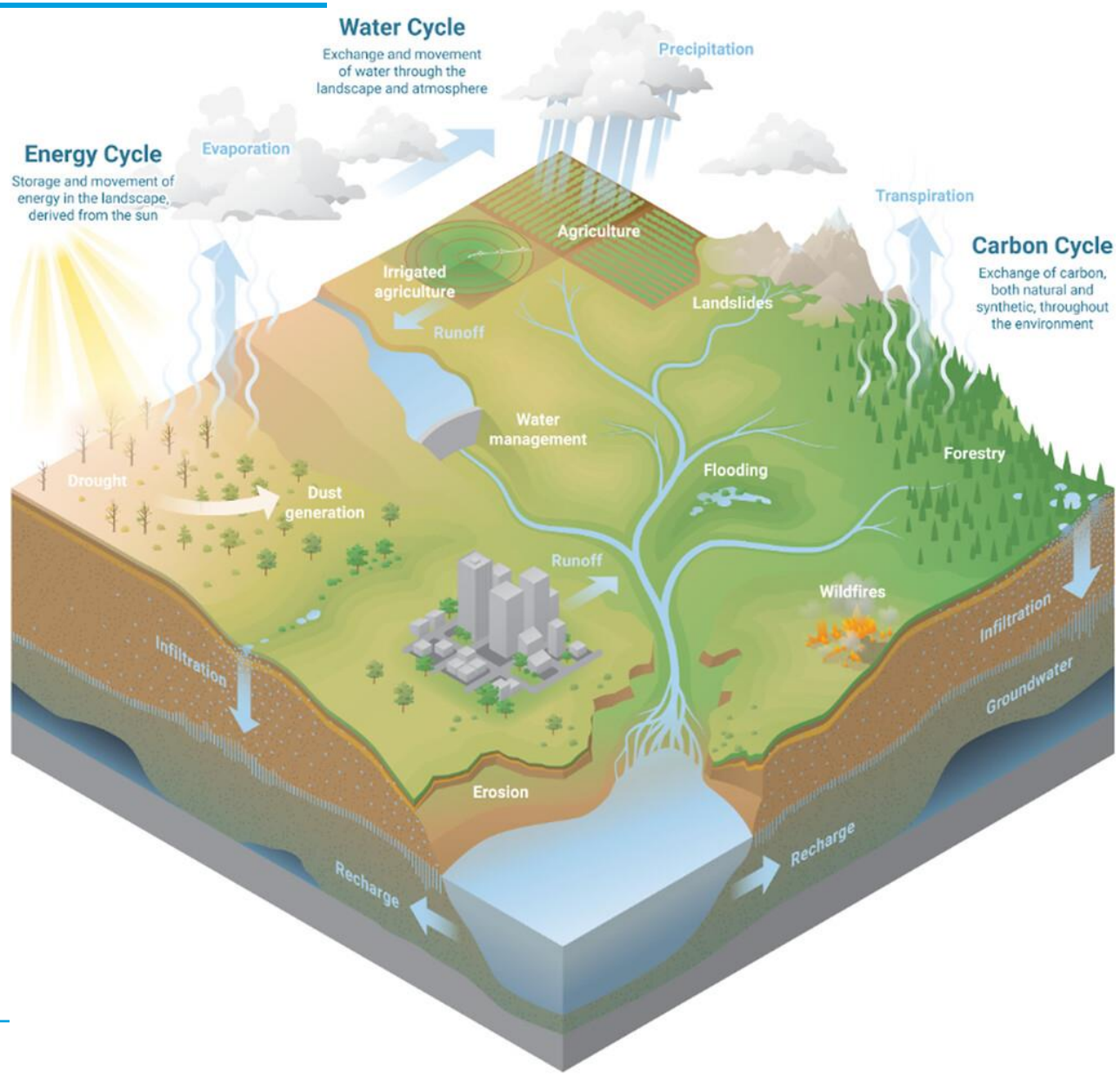
- Earth's primary accessible moisture store
- Measures the effective or meaningful rainfall
  - What the vegetation (crops/trees) actually see/have access too
- Direct observation of vegetation stress
- Directly related to surface runoff conditions and flooding
- Directly related the latent heat flux and associated boundary layer dynamics



Why Soil Moisture?

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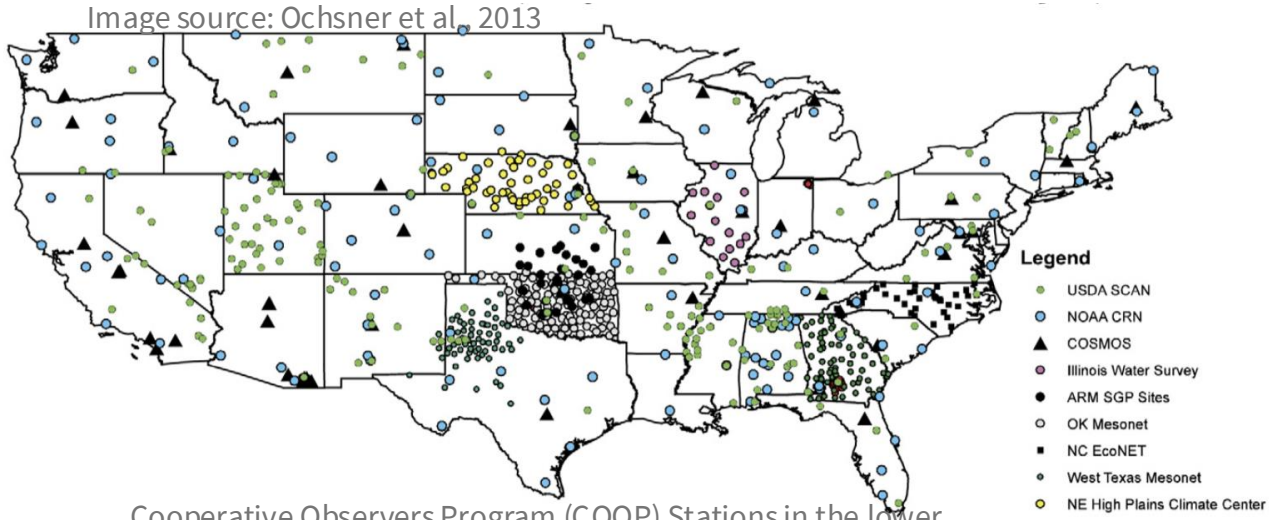
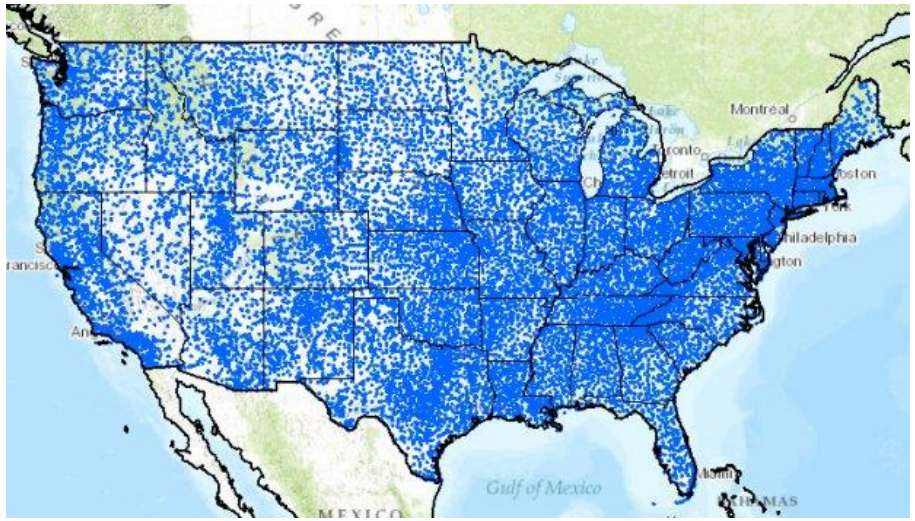
- Relatively sparse observations
- Soil moisture is extremely variable and depends on soil types and vegetation cover
- Satellite products only “see” the surface
- Modeled products can only get better with more in-situ observations

In situ soil moisture monitoring sites across the continental united States. Image source: Ochsner et al., 2013



Cooperative Observers Program (COOP) Stations in the lower 48 states. Image source: COOP



Why NOT Soil Moisture?

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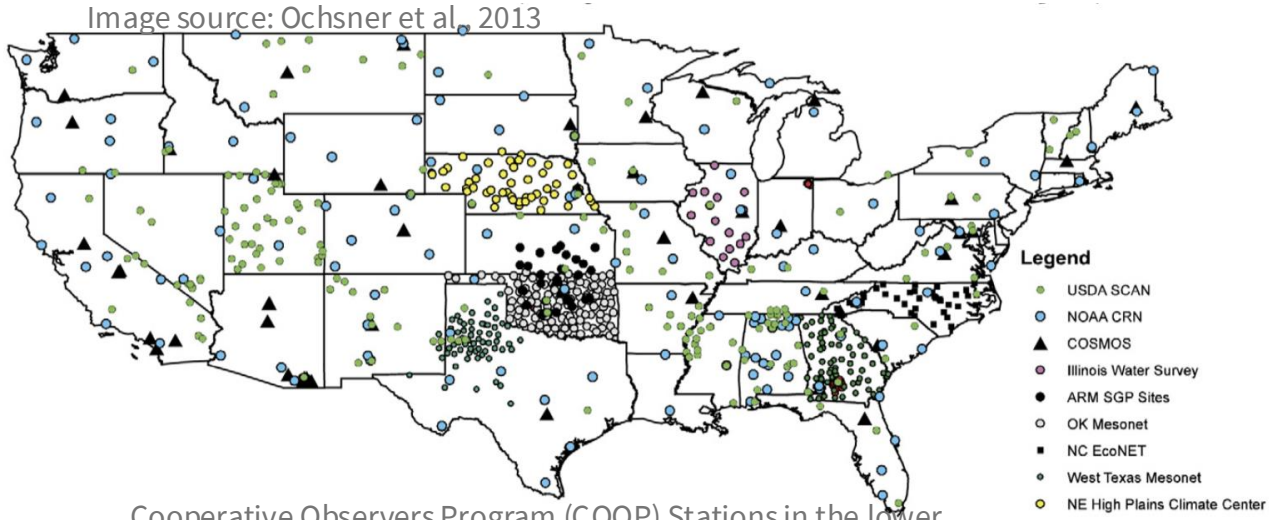
- Expensive
- Extremely heterogenous, in the x and y!
- Soil moisture content is not necessarily available water content

In situ soil moisture monitoring sites across the continental united States. Image source: Ochsner et al., 2013



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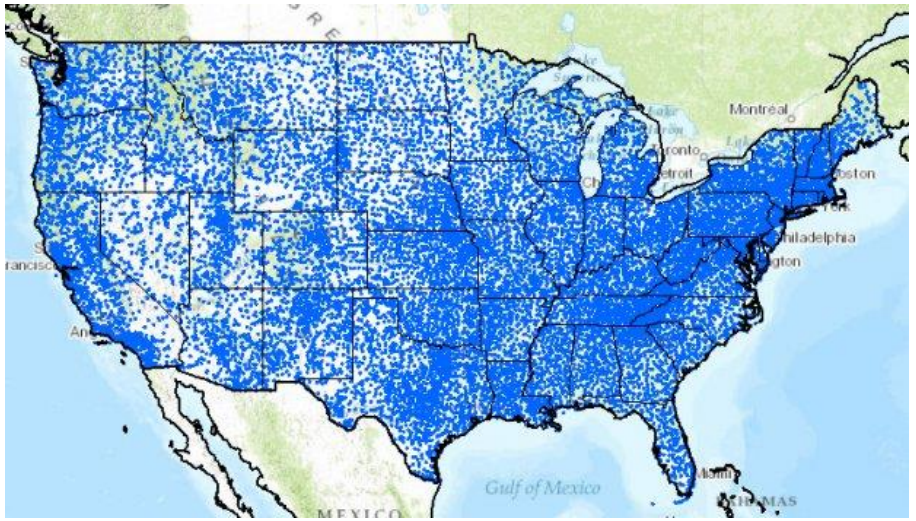

So what are we doing about it

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Building soil moisture stations that are cheap, accurate and easily deployable…
and install as many as we can

Making soil moisture data available, assessable, and affordable

Designing the ”low-cost” station

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- **Version 3 (“Final”)**

Waterproof DS18B20 temperature sensor, digital output, one wire protocol

METER Group TEROS 10 70Mhz

Standard installation
5cm
20cm
50cm

Designing the ”low-cost” station

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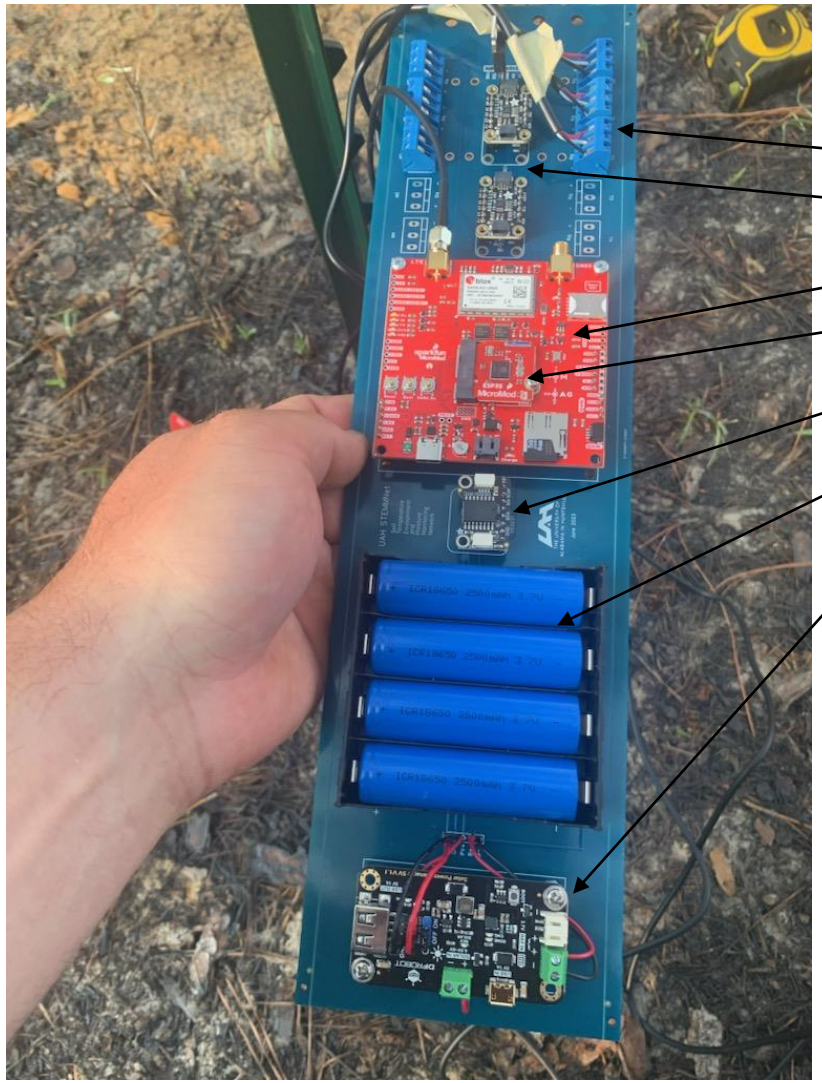
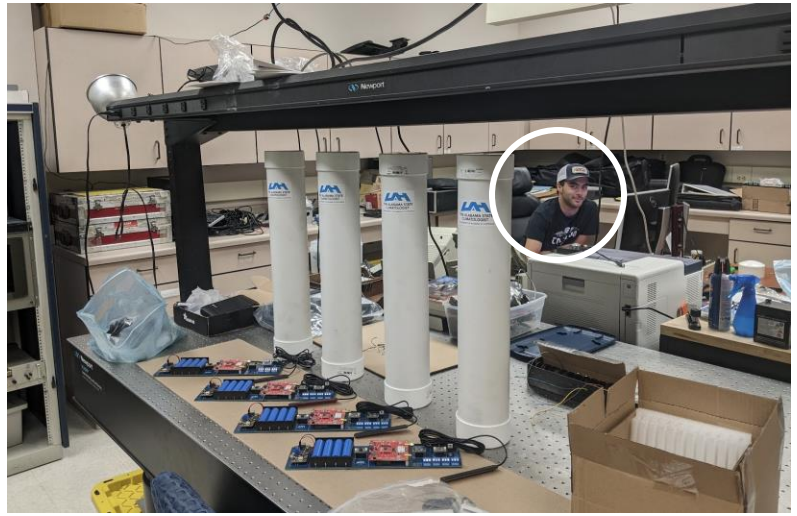
Total cost: ~$600 +/-



Printed board
Room for 10 sensors
2 4-channel ADC
Asset Tracker
ESP32 Processor
Clock (just in case) - GNSS if needed
4 3.7 lithium ion batteries
Solar controller



Electronics wizard Nick Perlaky

Performance

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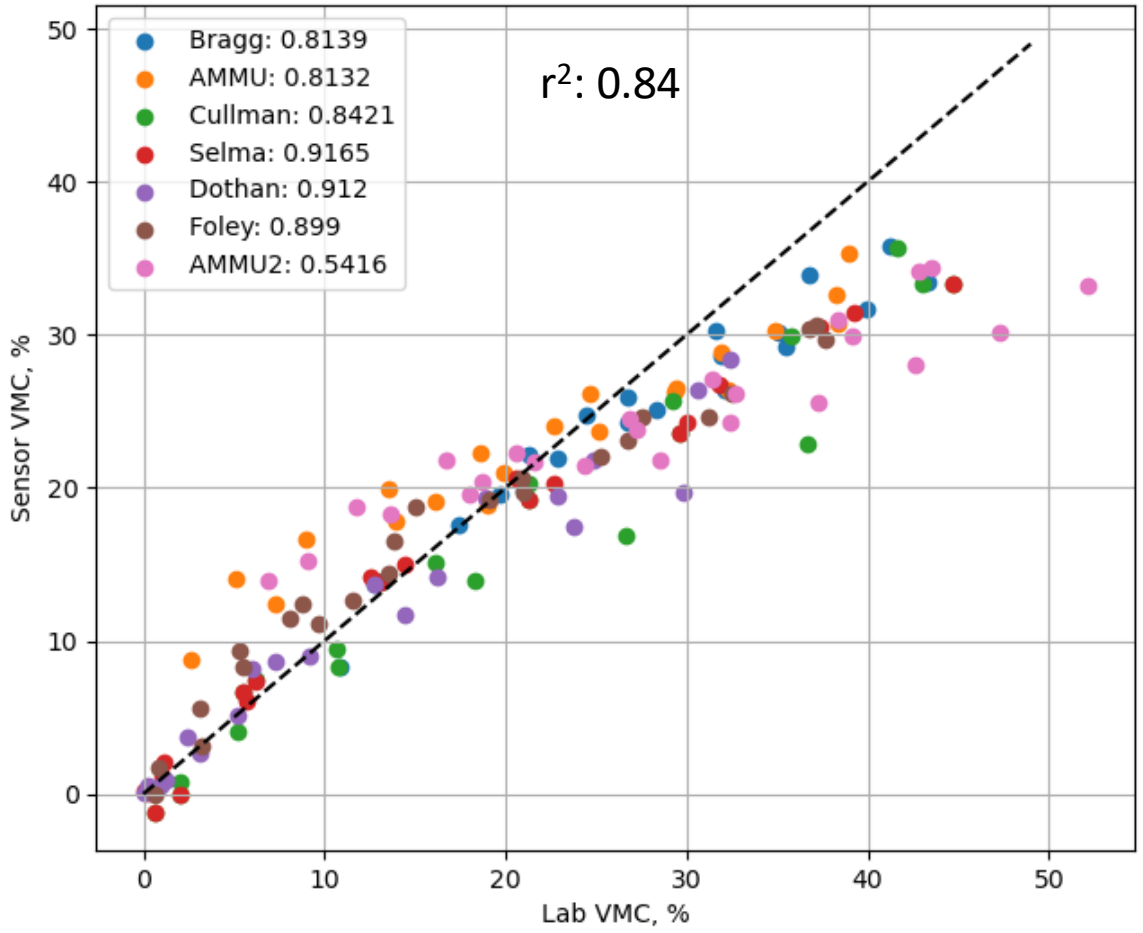
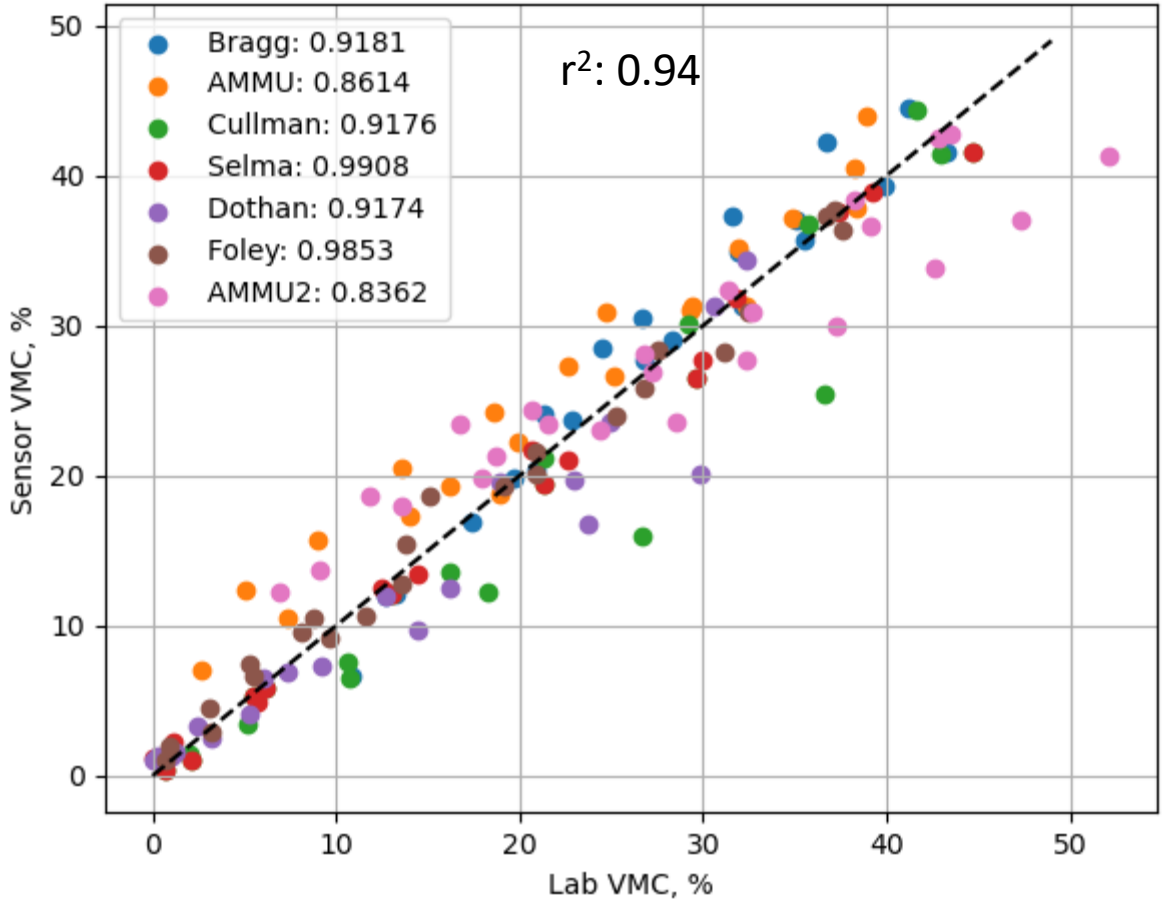
METER Group Factory Calibration

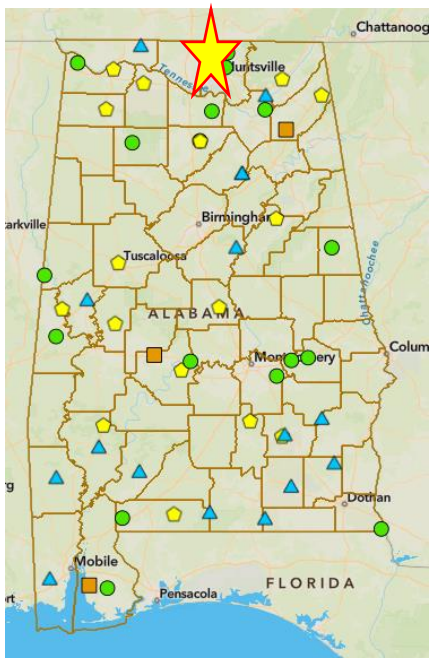


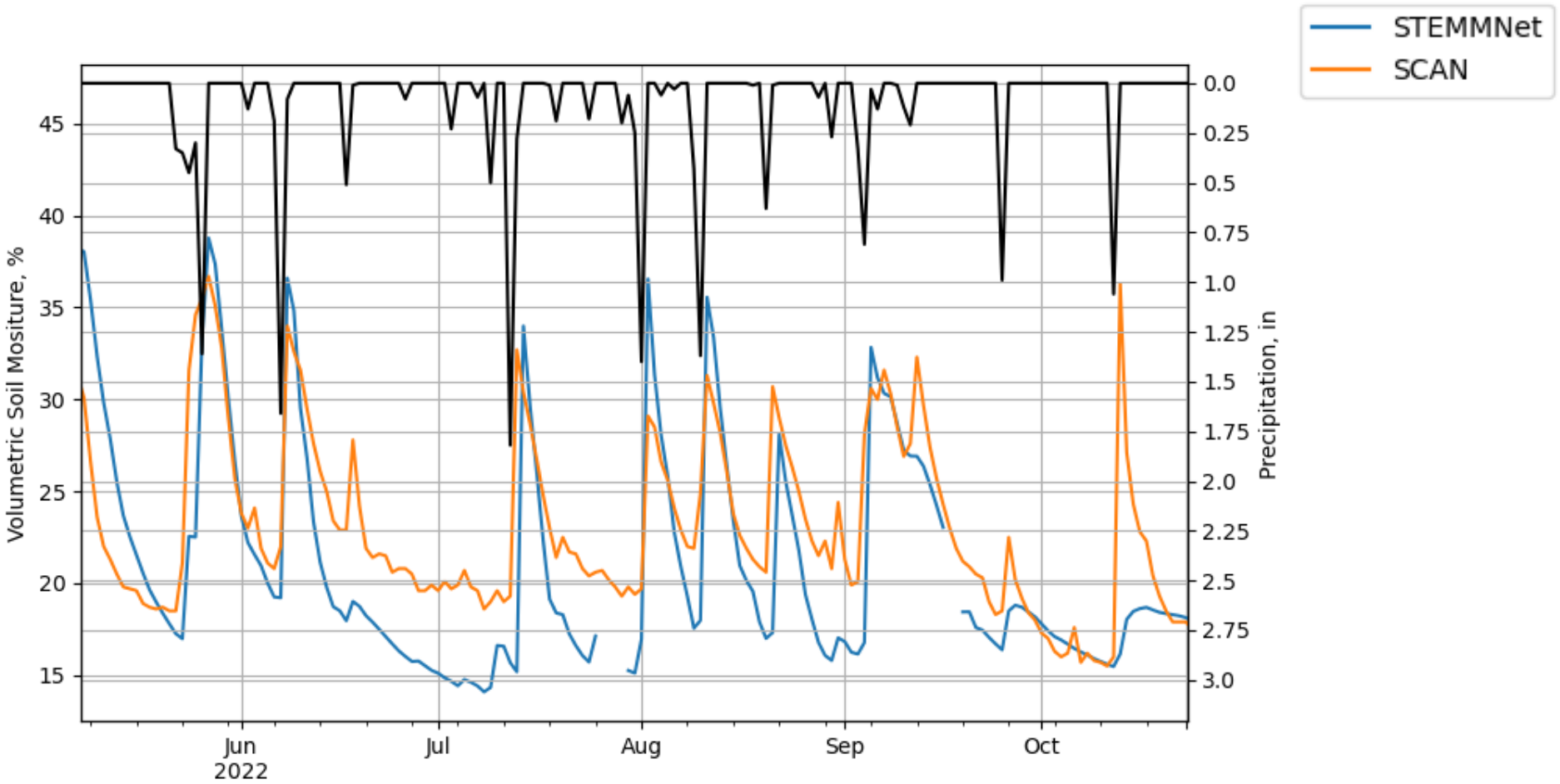
AL Customized Calibration



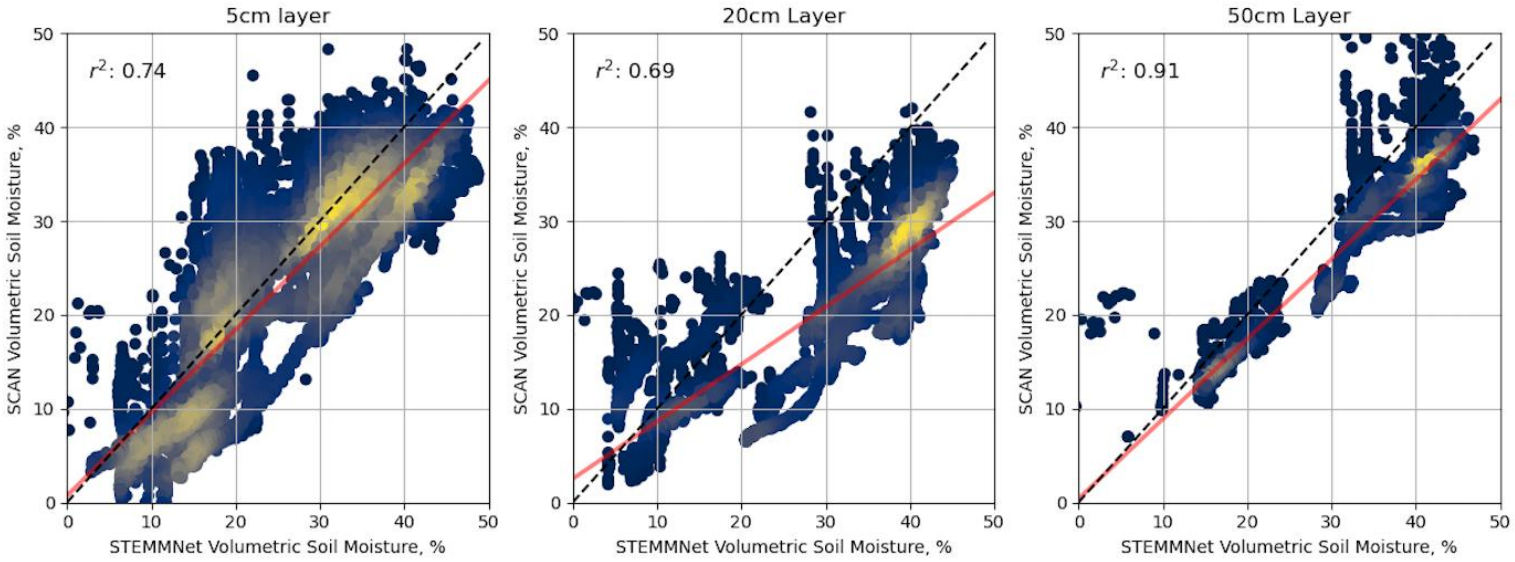
Performance

- TEROS10 Soil Moisture comparisons continue to show relatively good agreement with SCAN





Performance



Hourly Data	r	RMSE	Bias	count
Overall	0.83	8.23	5.57	69168
Season				
Summer	0.78	8.84	6.4	34392
Winter	0.87	7.57	4.75	34776
Texture				
Fine	0.56	8.58	5.85	42015
Medium	0.81	9.87	8.42	13719
Coarse	0.63	4.39	1.75	13434

Towards an integrated network

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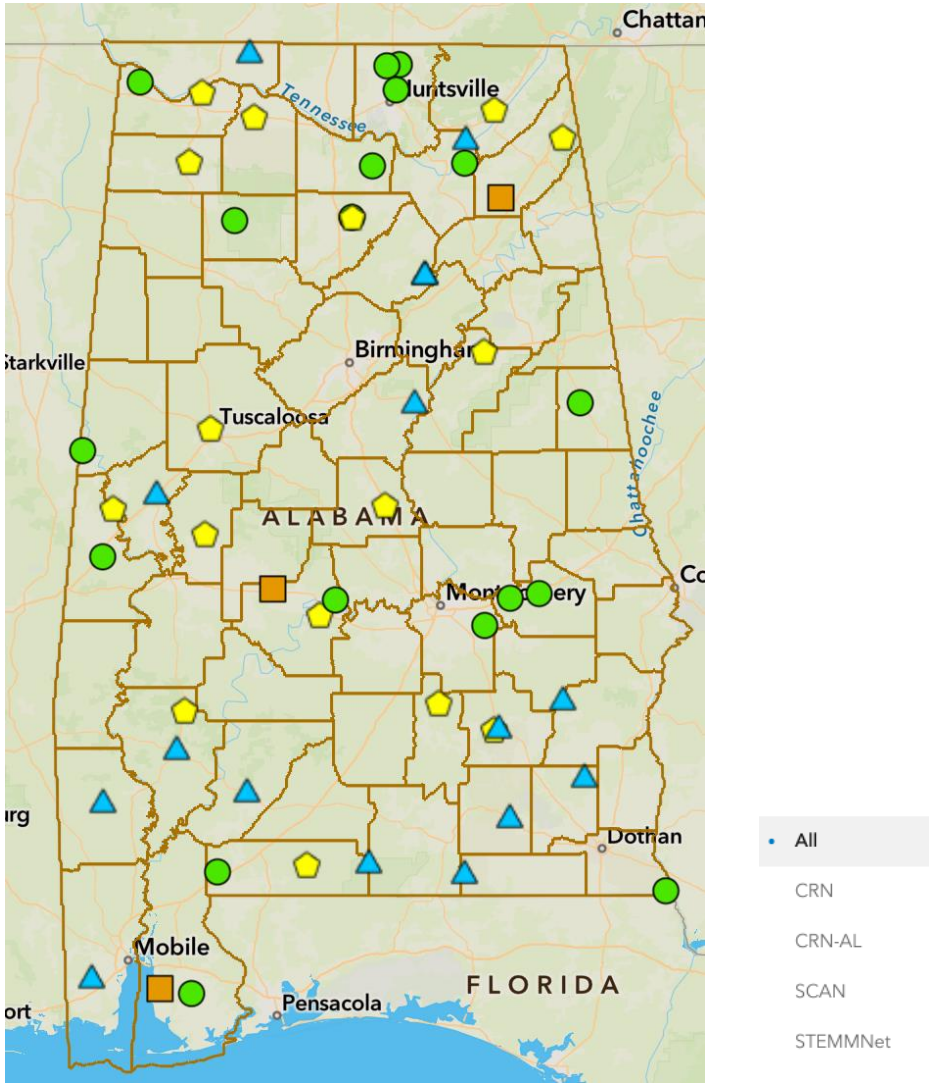
- Don’t reinvent the wheel!
  - Engaging with existing citizen science projects and partners



CoCoRaHS and COOP

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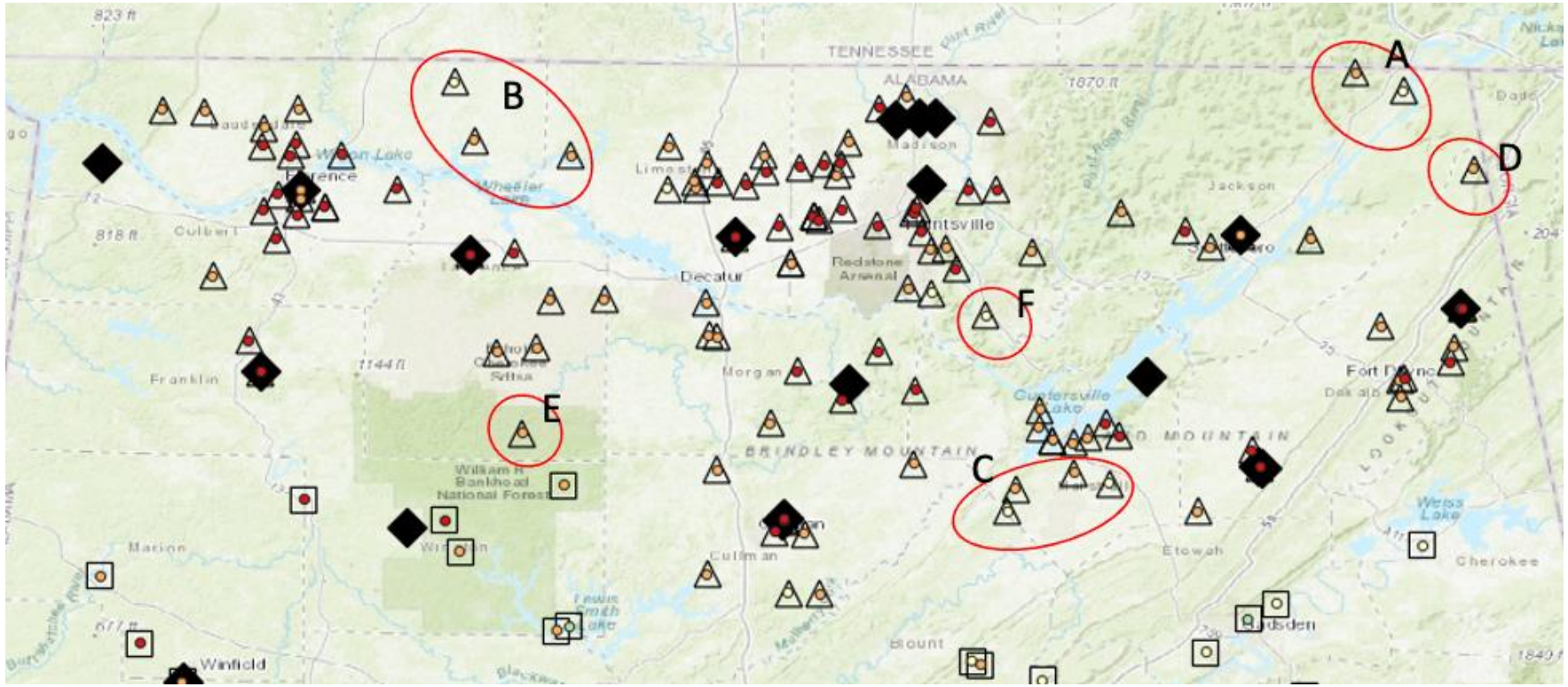
- Reached out to NWS CoCoRaHS Coordinators with priority areas
- Put in direct contact with volunteers



CoCoRaHS Co-locations

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Putting Soil Moisture in Context

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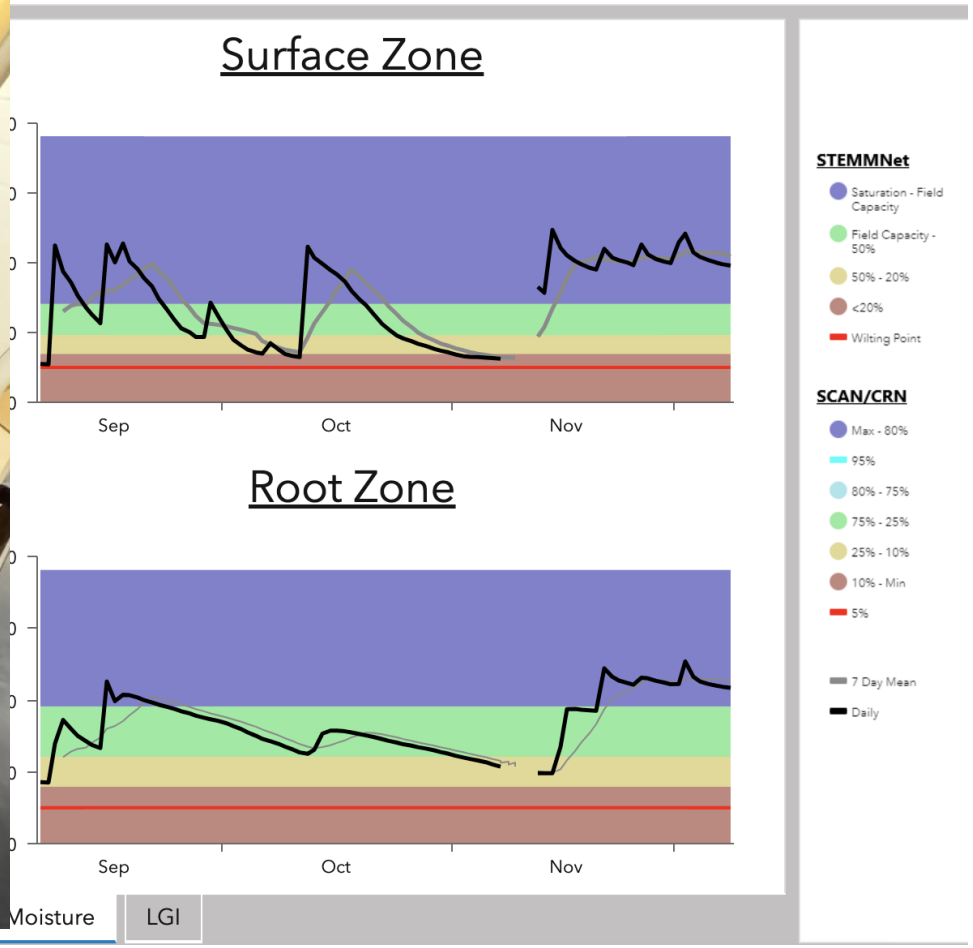

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aldrought.nsstc.uah.edu/dashboard

https://data.alclimate.com/

Available and accessible

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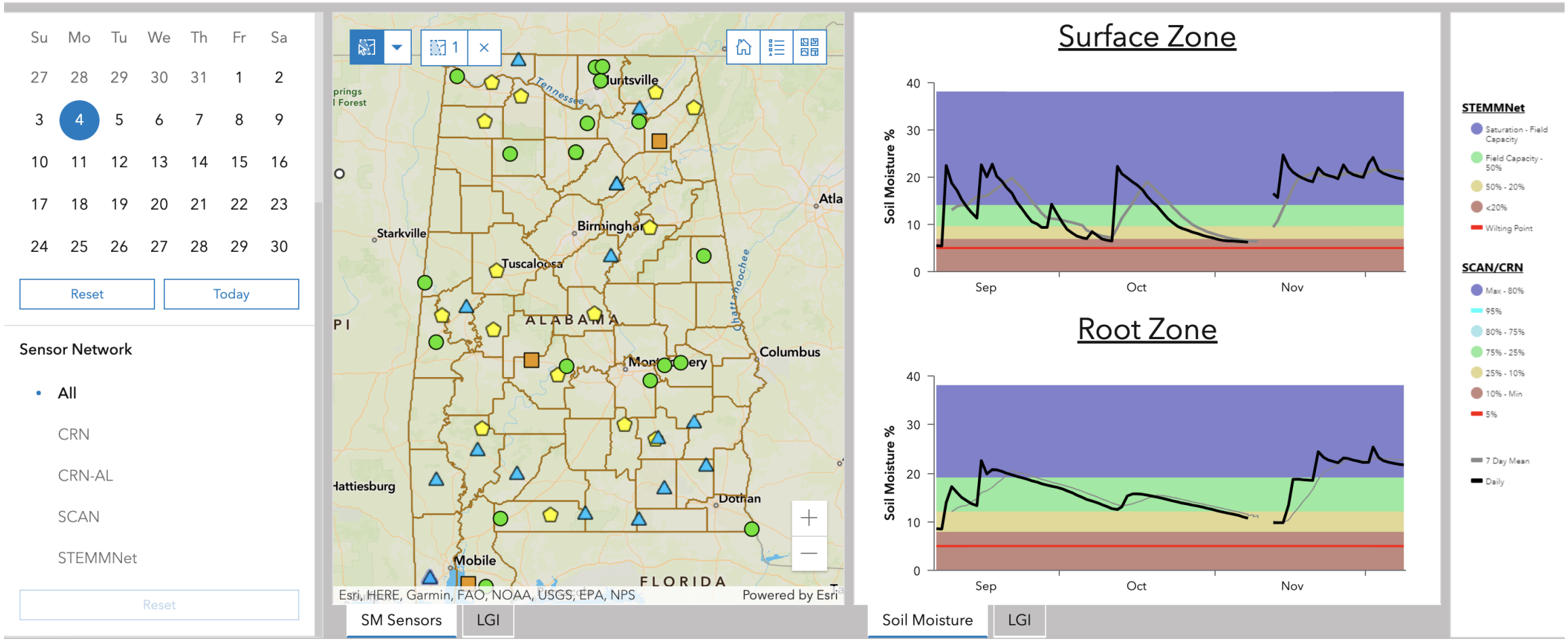
Alabama Drought Dashboard by the Office of the State Climatologist



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aldrought.nsstc.uah.edu/dashboard

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Partnership with Alabama Forestry Commission

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- A partnership to both assess the ability of a soil moisture measurement to provide *useful* information to the AFC and to assess whether our current design would successfully operate in a canopy/understory.
- Nealy all soil moisture stations are next to an agriculture filed in Bermuda grass. Forest are a new frontier in soil moisture observations.

NEWS

AL.com Alabama

Sensors stop planned Alabama burn that could have gone wrong

Published: Sep. 12, 2023, 6:03 a.m.

"The **data that UAH provided gave us a two week heads up** of what conditions on the ground were and allowed us to plan accordingly as the window for the burn approached" Ethan Barrett (Alabama Forestry Commission Fire Analyst)

Partnership with Alabama Forestry Commission

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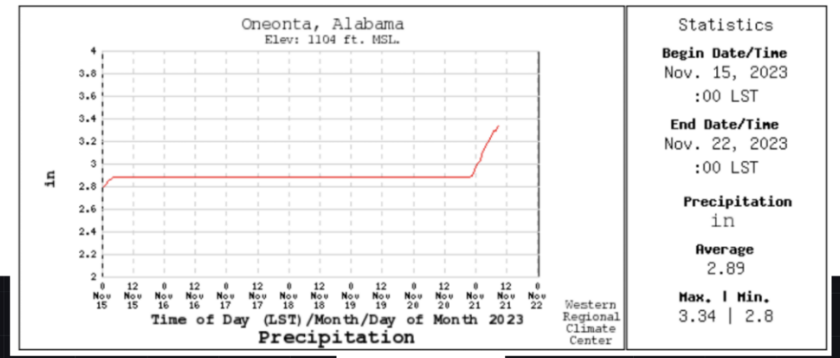
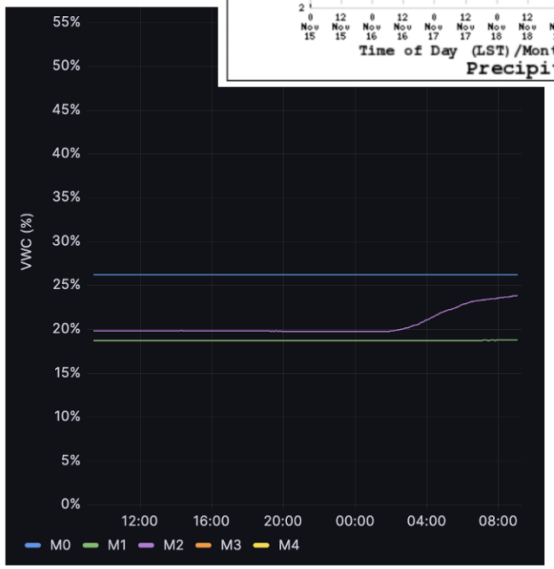
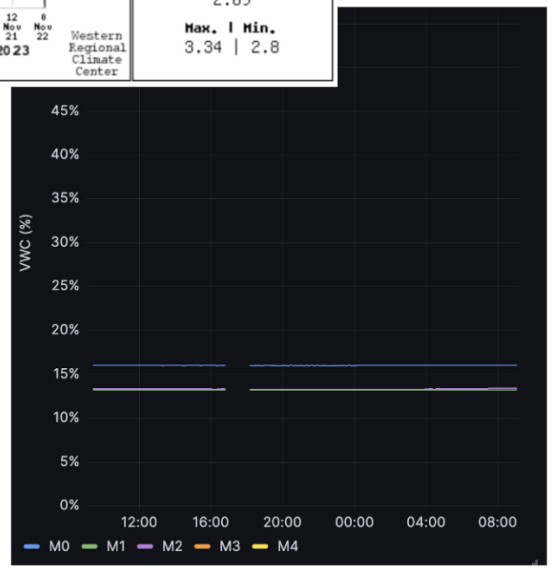
0.49 inches as of 9am





Noticeable in the surface layer next to RAWS



No change in the canopy

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Navi-gatoring Complex Installs

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STEMMNet

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The Soil Temperature, Environment, and Moisture Monitoring Network

- Open Source
- Low – cost
- Customizable
- Flexible and easy to install

- Building capacity
- Providing soil moisture data for decisions
- Proof of concept for future investments

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What's next?

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- Published the design, build instructions, and software on GitHub
  - **https://github.com/mesocom/STEMMNet/**
- Continue leveraging existing and new partnerships and Strategic co-locations
  - Alabama Forestry Commission
  - The Nature Conservancy's and the Paint Rock Forest Research Center
  - Alabama Geological Survey (co-locate with wells for recharge assessments)
  - Private Sector - Barron Weather Institute
  - Stress test the stations (under canopy in prescribed burns)'
- Incorporate into existing networks and data streams
- Continue to maintain the current sensor network and continue evaluation
- Feedback and suggestions welcome.
- Want a station? Find me and lets talk

Thanks!

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