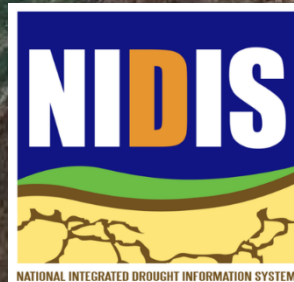


COCORAHS AND THE ROLE OF CITIZEN SCIENCE IN THE NATIONAL SOIL MOISTURE NETWORK

Peter Goble

Colorado Climate Center



Today's Outline

- ▣ What is CoCoRaHS?
- ▣ CoCoRaHS Soil Moisture
- ▣ Citizen Science and the National Soil Moisture Network (how do we want to collect and use these data?)

What is CoCoRaHS??

“CoCoRaHS is a national grassroots, non-profit, community-based, high-density precipitation network

made up of volunteers of all backgrounds and ages . . .



. . . who take daily measurements of precipitation right in their own backyards”



CoCoRaHS

Snow Net

All Types of Precipitation!

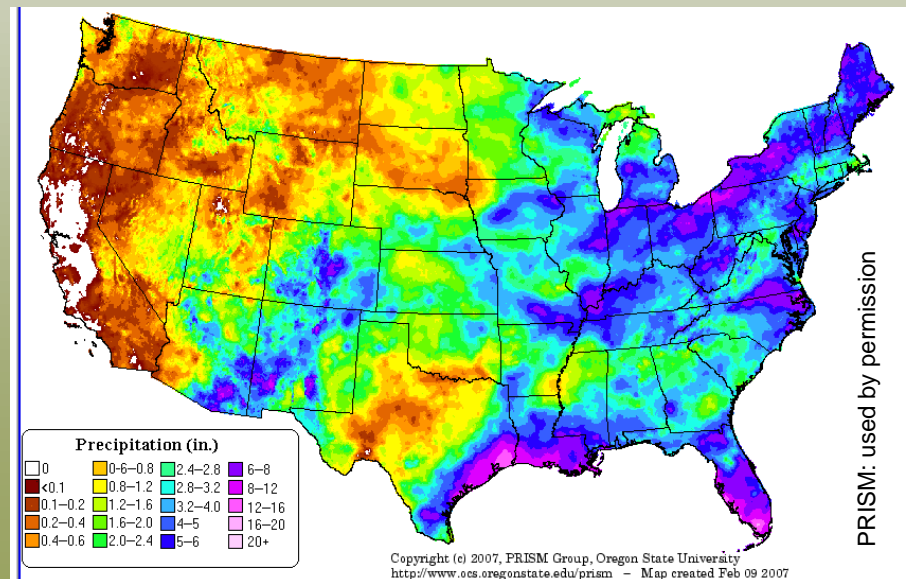


Why CoCoRaHS ??

Precipitation is important and highly variable

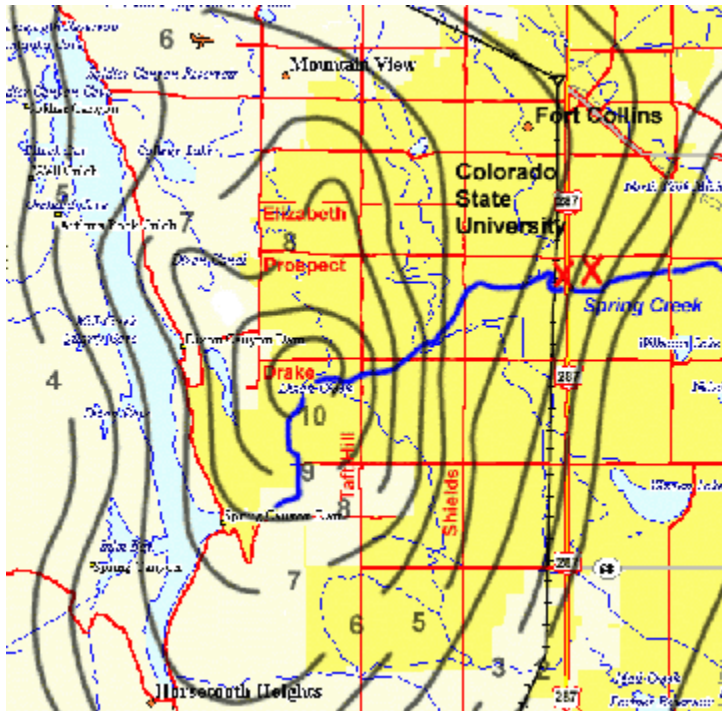


Data sources are few and rain gauges are far apart



The Inciting Incident

- 14.5" of rainfall fell over southwest Fort Collins with 36 hours with over 10" occurring in a four hour span
- Heavy rain was concentrated over a small area and not well warned

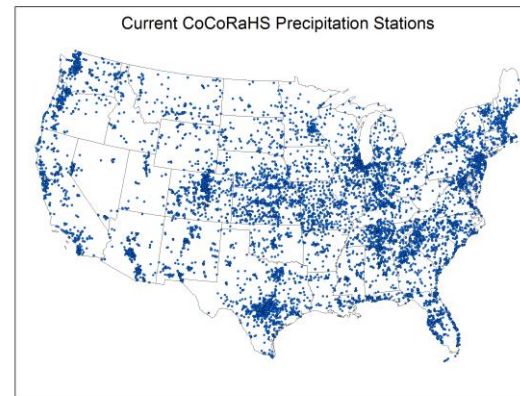
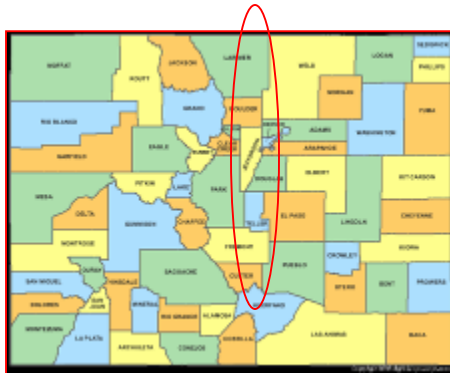
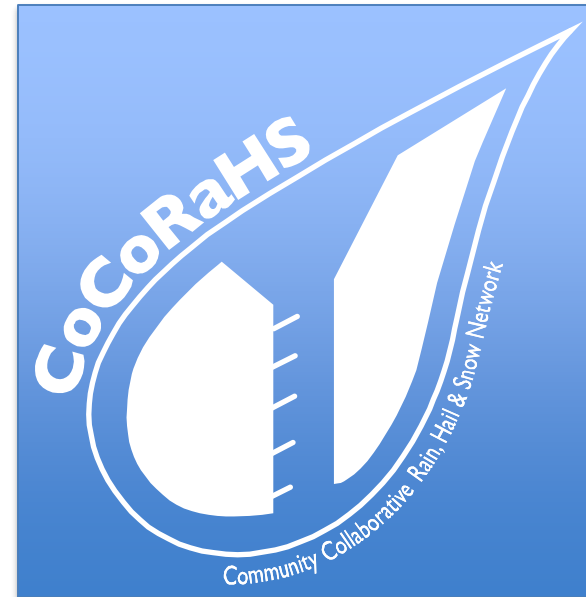


- There were 5 fatalities in the storm
- Following the event, then assistant state climatologist Nolan Doesken conducted a precipitation survey using bins and buckets. There were over 300 participants

1998



Today

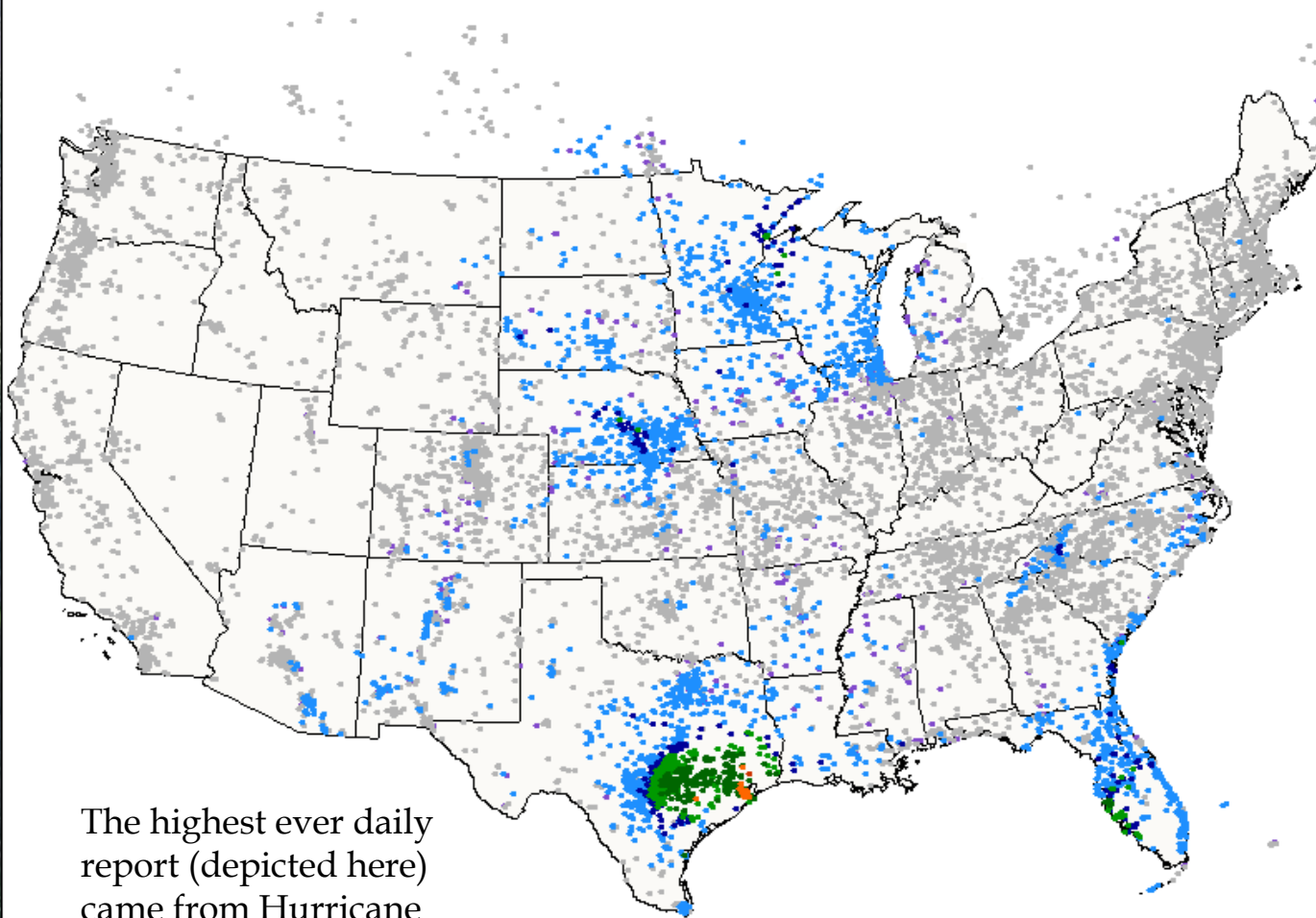


CoCoRaHS Precipitation

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am

USA 8/27/2017

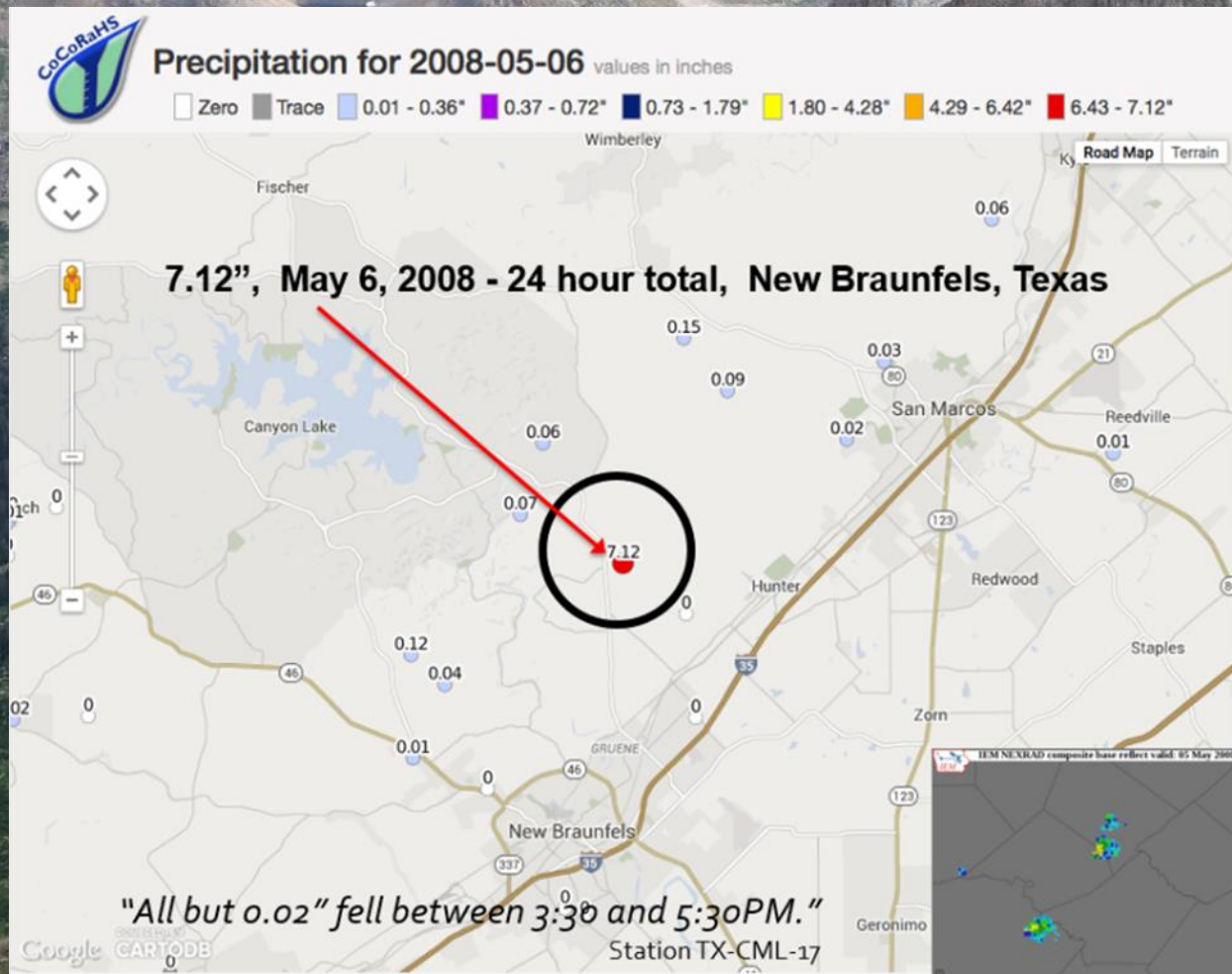
0.0 Trace 0.01 - 1.25 1.26 - 2.50 2.51 - 6.25 6.26 - 15.00 15.01 - 22.50 22.51 - 25.00



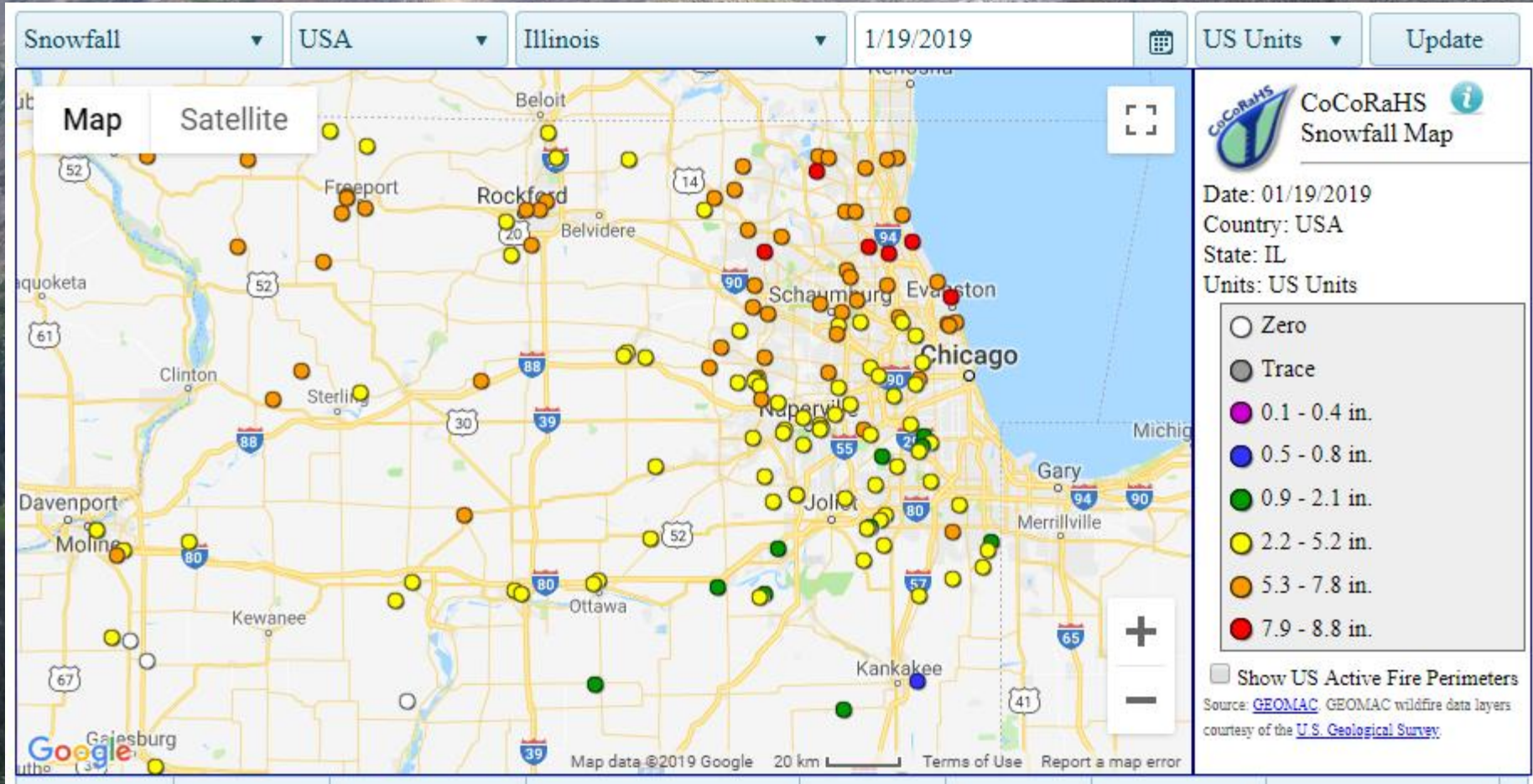
The highest ever daily report (depicted here) came from Hurricane Harvey

- Now CoCoRaHS has nearly 15,000 precipitation reports daily
- Reports come from all states, DC, Puerto Rico, the Bahamas, and all Canadian provinces

Rain Does not Fall the Same on All!



Sample Snowstorm Captured by CoCoRaHS



Hail Data



CoCoRaHS has become one of the largest repositories of hail data in the United States

- National Weather Service
 - Other Meteorologists
 - Hydrologists
 - Emergency Managers
 - City Utilities
 - Water supply
 - Water conservation
 - Storm water
 - Insurance adjusters
 - USDA—Crop production
 - Engineers
 - Scientists studying storms
 - Mosquito control
 - Farm Service Agency
 - Ranchers and Farmers
 - Outdoor & Recreation
- Teachers and Students
 - Geoscience education tool
 - Taking measurements
 - Analyzing data
 - Organizing results
 - Conducting research
 - Helping the community



Are CoCoRaHS data used? You bet !

CoCoRaHS Aims to Measure the Entire Water Cycle, and to Educate

- Education (understanding differences between precipitation and infiltration, and differences between ET and PET)
- CoCoRaHS closing the hydrologic cycle
- Citizen scientist data may be used to supplement existing satellite and in-situ data when/where gaps exist



The Water Cycle

699,390 views

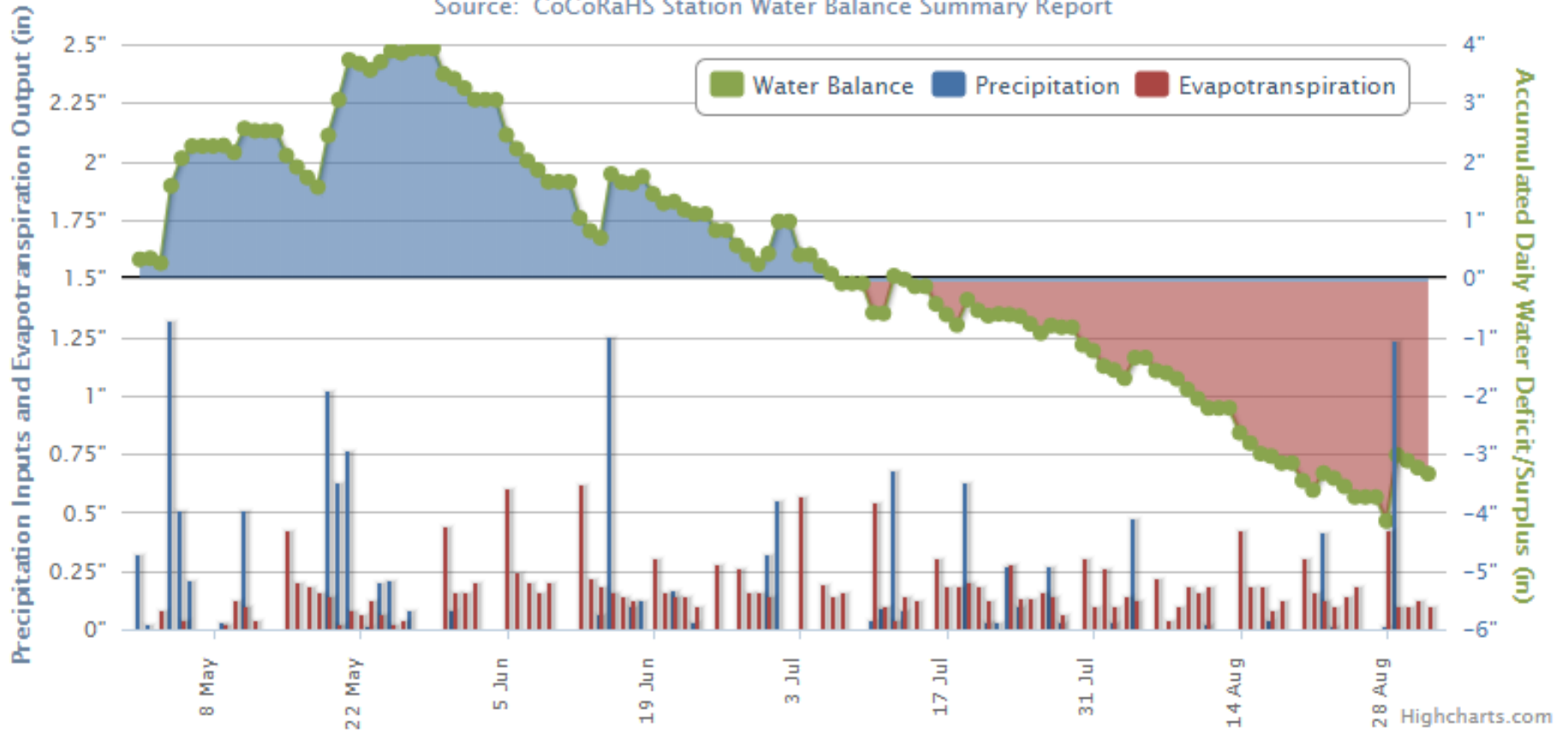
👍 1.6K 💬 267 ➦ SHARE 📌 SAVE ...



Reference ET

May 1, 2017 – September 1, 2017 Water Balance for Station IL-CP-64 (Champaign 2.4 SSE)

Source: CoCoRaHS Station Water Balance Summary Report



What about Soil Moisture?



- ❑ Soil type is assessed using a Master Gardner field guide
- ❑ Samples are taken using a rigid brass ring of ~250 cubic cm volume
- ❑ Rocks and roots removed measured with a graduated cylinder
- ❑ Samples oven dried
- ❑ Mass loss measured with CoCoRaHS scale

All CoCoRaHS measurements are manual, but there may be room to flex that rule for soil moisture

What Does the Form Look Like?

My Data Entry : Soil Moisture Report Form

Soil Moisture Report Form Submit Data Reset

Station Number : CO-LR-1107

Station Name : Fort Collins 4.5 WNW

* Denotes Required Field

1 → *Observation Date ?

2 → *Observation Time ?

3 →

Observation Notes: (This will be available to the public) ?

Information about where the sample was taken

Distance from previous sample in meters: ← 4

Is the land irrigated? Yes No ← 5

Did you begin a new row? Yes No ← 6

Soil Samples

Depth	Soil Type	Weight Before Drying (grams)	Volume of Rocks and Roots Removed(cm3)	Weight After Drying (grams)
0-2"	Sandy Clay	<input type="text"/>	<input type="text"/>	<input type="text"/>
7-9"	Sandy Clay Loam	<input type="text"/>	<input type="text"/>	<input type="text"/>

7 → 8 → 9 → 10 →

Submit Data Reset

1. Date picker
2. Time picker
3. Comments
4. Sample spacing
5. Irrigation (Y/N)
6. New Row (Y/N)
7. Soil Type
8. Wet Weight
9. Volume Removed
10. Dry Weight

What Does a Completed Submission Look Like?

Soil Moisture Report

Station Number	NM-SF-70	Observation Date	5/2/2017
Station Name	Santa Fe 10.5 S	Observation Time	4:30 PM
Submitted	5/13/2017 11:24 AM	Is Soil Irrigated	False
Is Sample Part Of New Row	False	Meters From Previous Sample	0

Depth	Pre-Dry Weight (g)	Dry Weight (g)	Volume Removed (cm ³)	Dry Density (g/cm ³)	Volumetric Water Content(%)	Soil Type
0-2"	456	404	2.0	1.61	20.80	
7-9"	--	--	--	--	--	

Notes

Barriers to Success



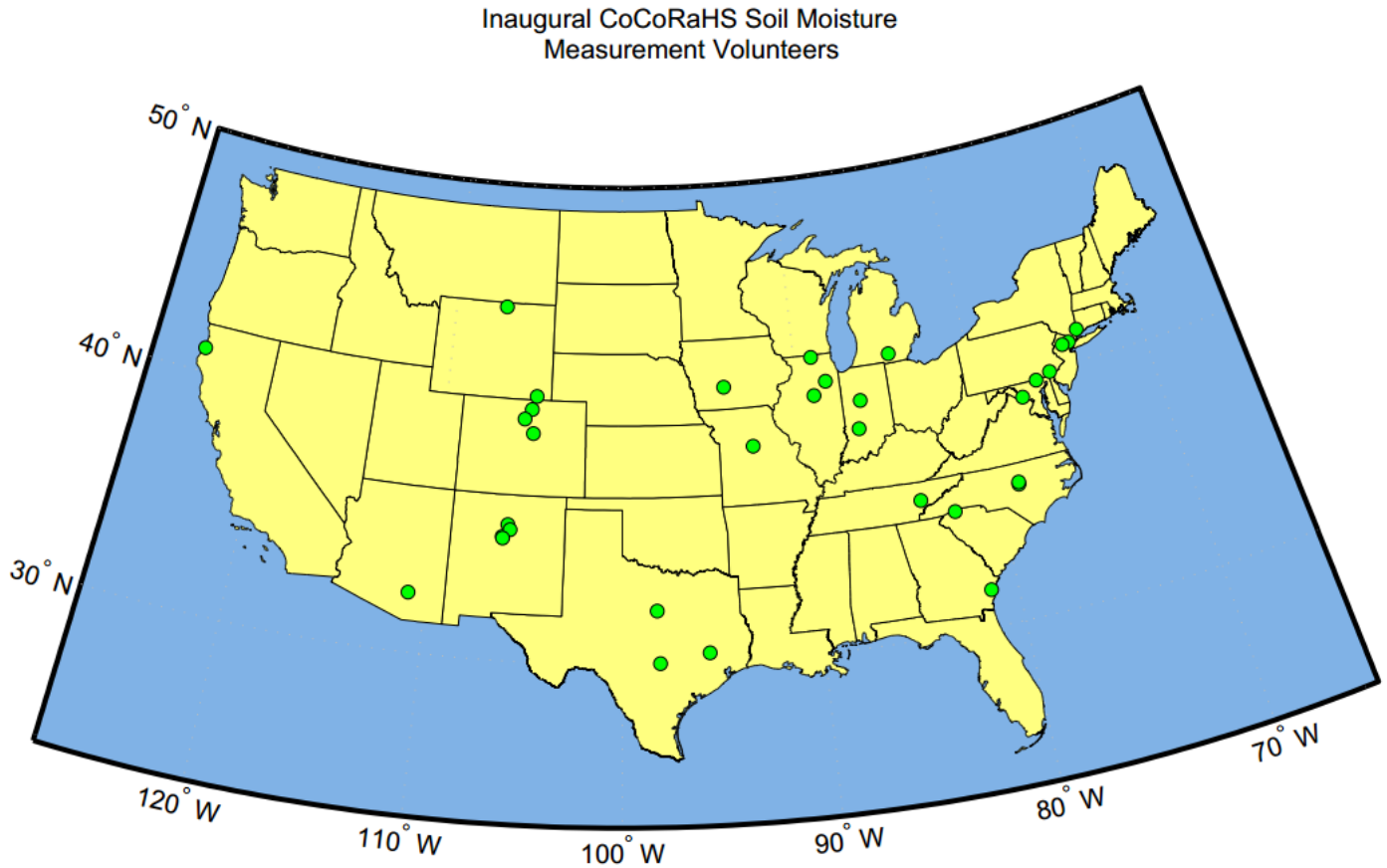
1. Land that is spaced appropriately far from trees and buildings
2. Land that is available for an invasive measurement protocol
3. Finding observers who don't mind baking dirt
4. Labor-intensive compared to rain gauge measurements
5. Retention rates are low compared to precipitation measurement

Conclusion: This is not for everyone!

Our goal: 50+ regular volunteers, 100+ intermittent volunteers

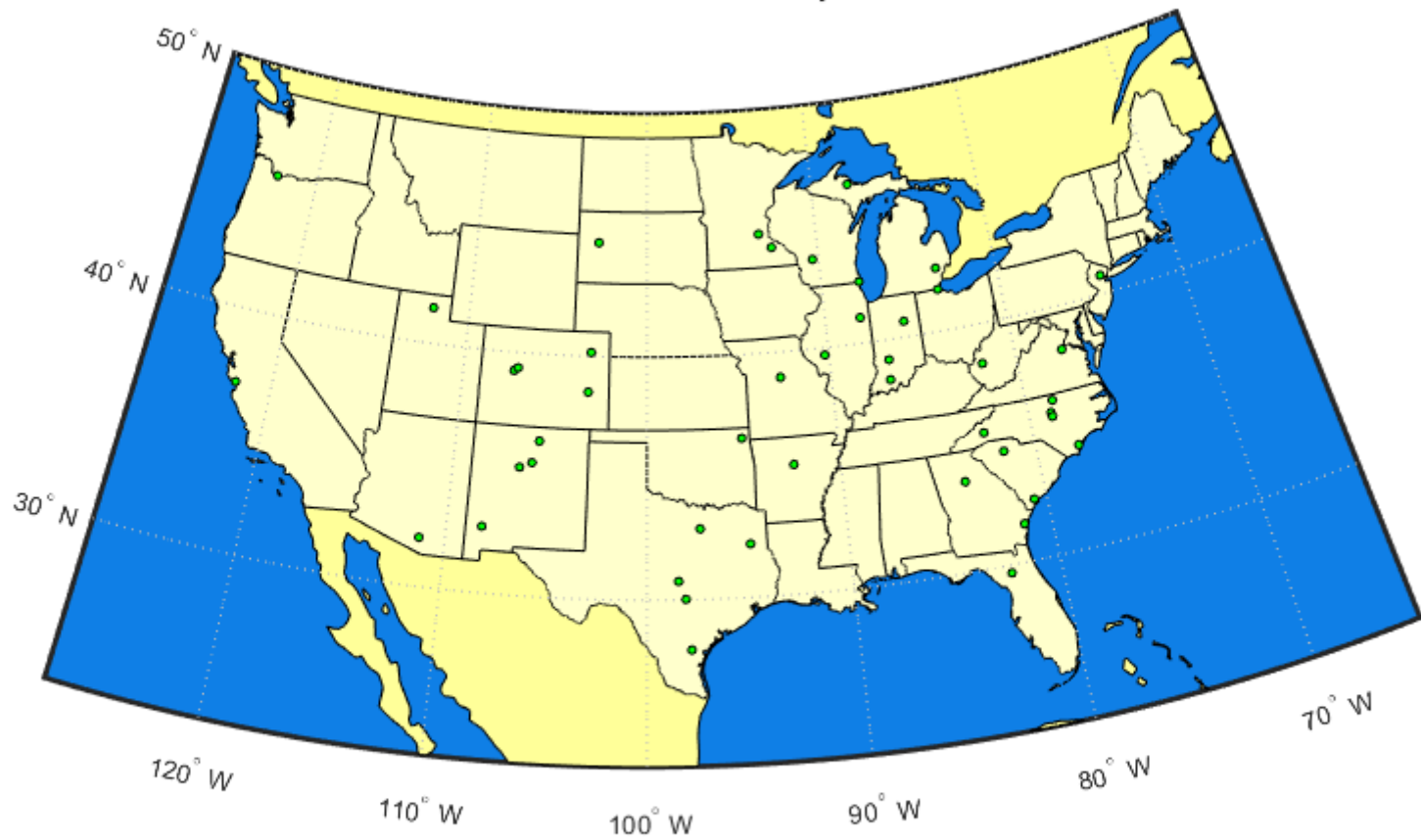
Early Efforts

- 33 volunteers have shared their interest with Nolan
- Samples promised from diverse climate regions and soil types

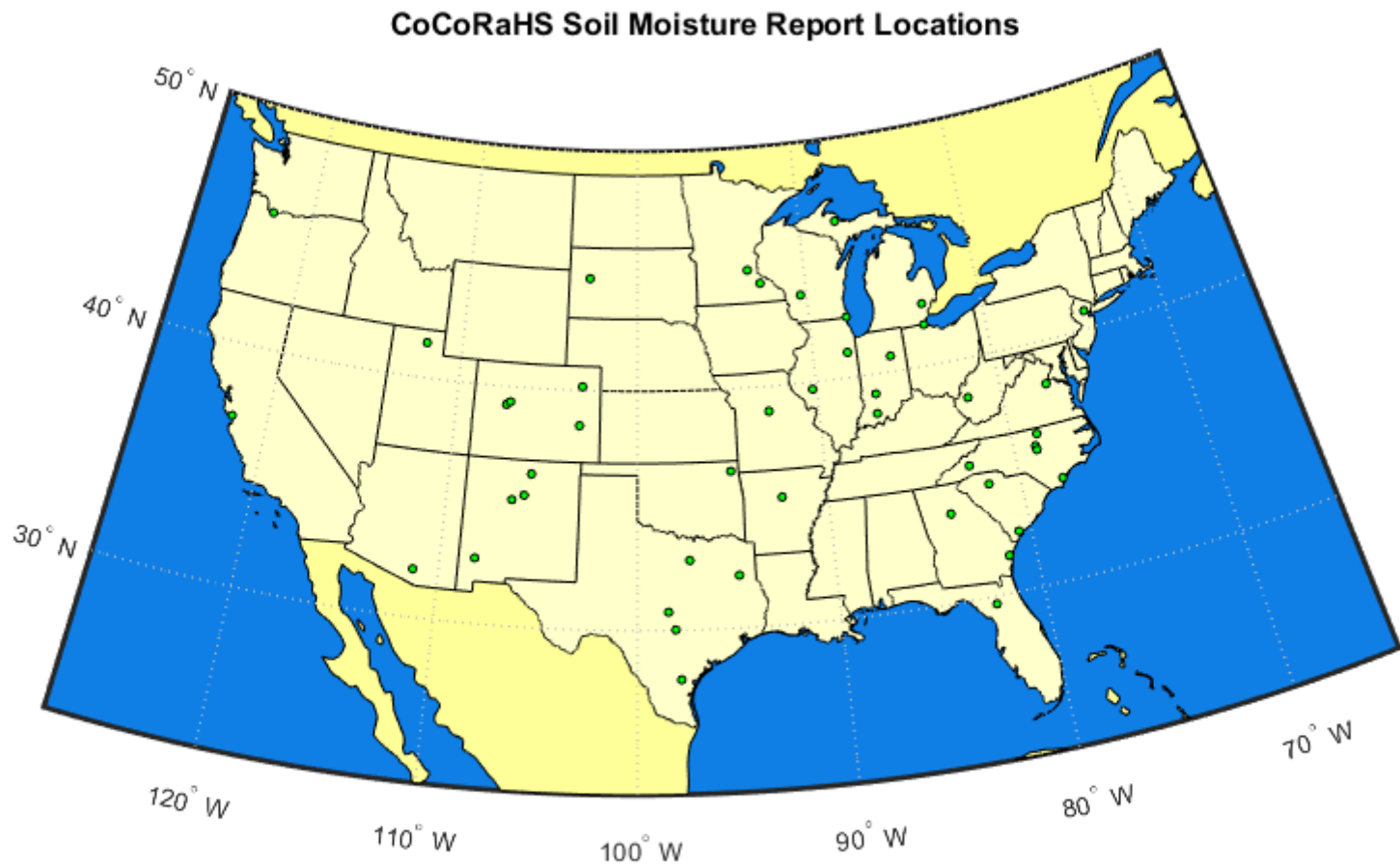


Recent Years

CoCoRaHS Soil Moisture Report Locations



Recent Years



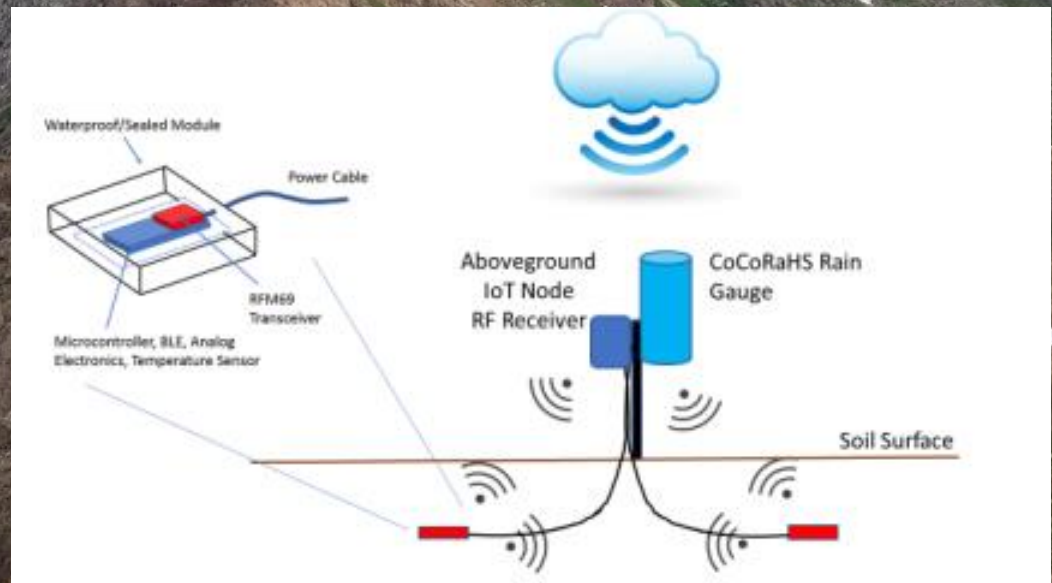
How can we make soil moisture measurement simpler to encourage greater participation?

Disclaimer

- ▣ I am NOT just the “CoCoRaHS Soil Moisture Guy,” or even the citizen science guy
- ▣ If the NSMN wants strong citizen science participation numbers, reporting needs to be easy, or recruiting/retention needs to be aggressive
- ▣ My advice: keep it simple
- ▣ Qualitative reporting

Soil Moisture Recruiting Strategies

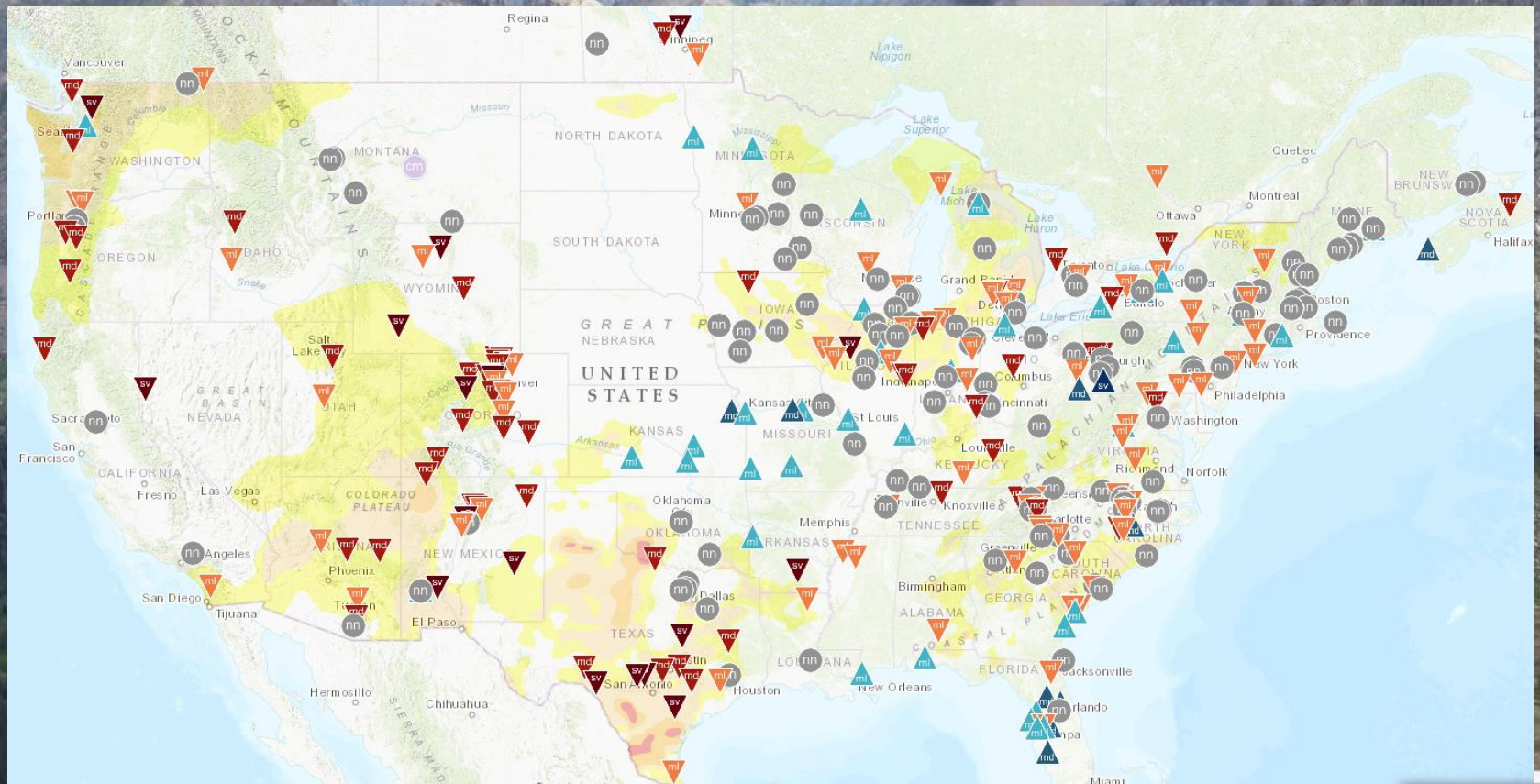
- ❑ Pivot away from gravimetric only
- ❑ Target young volunteer groups with vested interest (4H, Master Gardener, Future Farmers of America, school groups)
- ❑ Simplify the protocol as much as possible while still collecting meaningful data
- ❑ Recruit Savvy condition monitoring reporters



NSMN Motivating Questions

- What kind of measurement protocol do we want to establish?
- Manual measurements or sensors?
(CoCoRaHS measurements have always been manual, but we can do a different direction)
- Quality or quantity / quantitative or qualitative?
- Social media presence?

Qualitative Reports (Condition Monitoring)



Severely Dry	Moderately Dry	Mildly Dry	Near Normal	Mildly Wet	Moderately Wet	Severely Wet
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1. Date Picker
2. Scale Bar
3. Comments
4. Impacted Sector

Condition Monitoring Report Form Submit Data Reset

Station Number : CO-LR-1200

Station Name : Berthoud 2.5 N

Condition monitoring reports are submitted on a regular (weekly, biweekly, monthly) basis to share information about the effects of local precipitation on the environment and society. By submitting reports on a regular basis, you create a baseline to see change through time, such as seasonal differences or changes caused by more or less precipitation. Please refer to the [Condition Monitoring training slide show](#) for more information.
** indicates required field*

Report Date *
9/9/2019 1

Condition Scale Bar [More information on the scale bar](#) Clear Scale Bar

Severely Dry	Moderately Dry	Mildly Dry	Near Normal	Mildly Wet	Moderately Wet	Severely Wet
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	2 <input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Description
Please provide a description of how dry, normal or wet conditions are affecting you, your livelihood, your activities, etc. *
3

Report Categories
Please check at least one report category. If you check a category, please provide supporting information in the description. [More information on condition monitoring categories.](#)

- General Awareness
- Agriculture
- Business & Industry
- Energy 4
- Fire
- Plants & Wildlife
- Relief, Response & Restrictions
- Society & Public Health
- Tourism & Recreation
- Water Supply & Quality

Submit Data Reset

CONNECTING WEATHER AND CLIMATE WITH THE ENVIRONMENT

Your knowledge about the local environment and how weather influences it can reveal much more than can be learned from recording daily rainfall alone.



Condition Monitoring Example

Condition Monitoring Report

Station Number: CO-SM-10

Station Name: Redvale 22.8 SW

Report Date: 8/22/2019

Submitted: 8/22/2019 9:32 AM

Scale Bar: Moderately Dry

Description:

Disappointment Creek stopped flowing this past weekend. It provides water for horses on our land. Rain makes the grass grow, and we haven't had much of that, either. I've spotted a couple of smoke plumes this year but not as bad as last year.

Categories: General Awareness
Agriculture
Fire
Plants & Wildlife
Water Supply & Quality

There are 46,618 condition monitoring reports including the ones from when they were called drought impact reports.

Of those 7,647 include "soil" in the description (16%). If I expand that to also include reports that mention dirt or ground, then there are 15,088 (32%).

I have the kickoff meeting for the AI for Earth project next week where we plan on applying Natural Language Processing to the condition monitoring reports. I have made a note about this in the project overview document so I remember to bring this up. Perhaps we can turn the obs notes into quantitative information the data users can benefit from.

Please let me know any details that come out of your meeting about what the data users need and would use.

- We can use key words/word combinations to filter condition monitoring reports/regular CoCoRaHS reports for those relevant to NSMN
- What key words would be most useful to us?

Using Key Phrases from Reports

Condition Monitoring Report

Station Number: NM-SN-45

Station Name: Placitas 3.8 ENE

Report Date: 9/5/2019

Submitted: 9/05/2019 8:00 AM

Scale Bar: Severely Dry

Description:

With less than an inch of rain for each of the historically wettest months of the year, July and August, coupled with record heat and low humidities, lack of cloud cover, increased UV exposure and desiccating winds, our soil moisture has fallen below 6" down, and we are squarely within drought conditions. The monsoonal rainfall has not come to this area, although some areas of the state are green, we are brown and dormant in historically the most fertile time of year.

Irrigation is needed much more than usual, landscaping and crop plants are dying without it.

I have lost work from the intense heat and dryness. Many hours of the day in July and August have been too hot to work outside.

Fires continue to burn in the region, creating smoke and health risks.

Many native plants did not mature their fruits, nuts and berries, so wildlife is now short on food and water. Natural perennial springs that have been dry and low for years rebounded some from winter/spring moisture, but have since dried up again.

People continue to suffer from allergies and lung conditions from increased dryness, dust, pollen and smoke.

Categories: General Awareness

Agriculture

Business & Industry

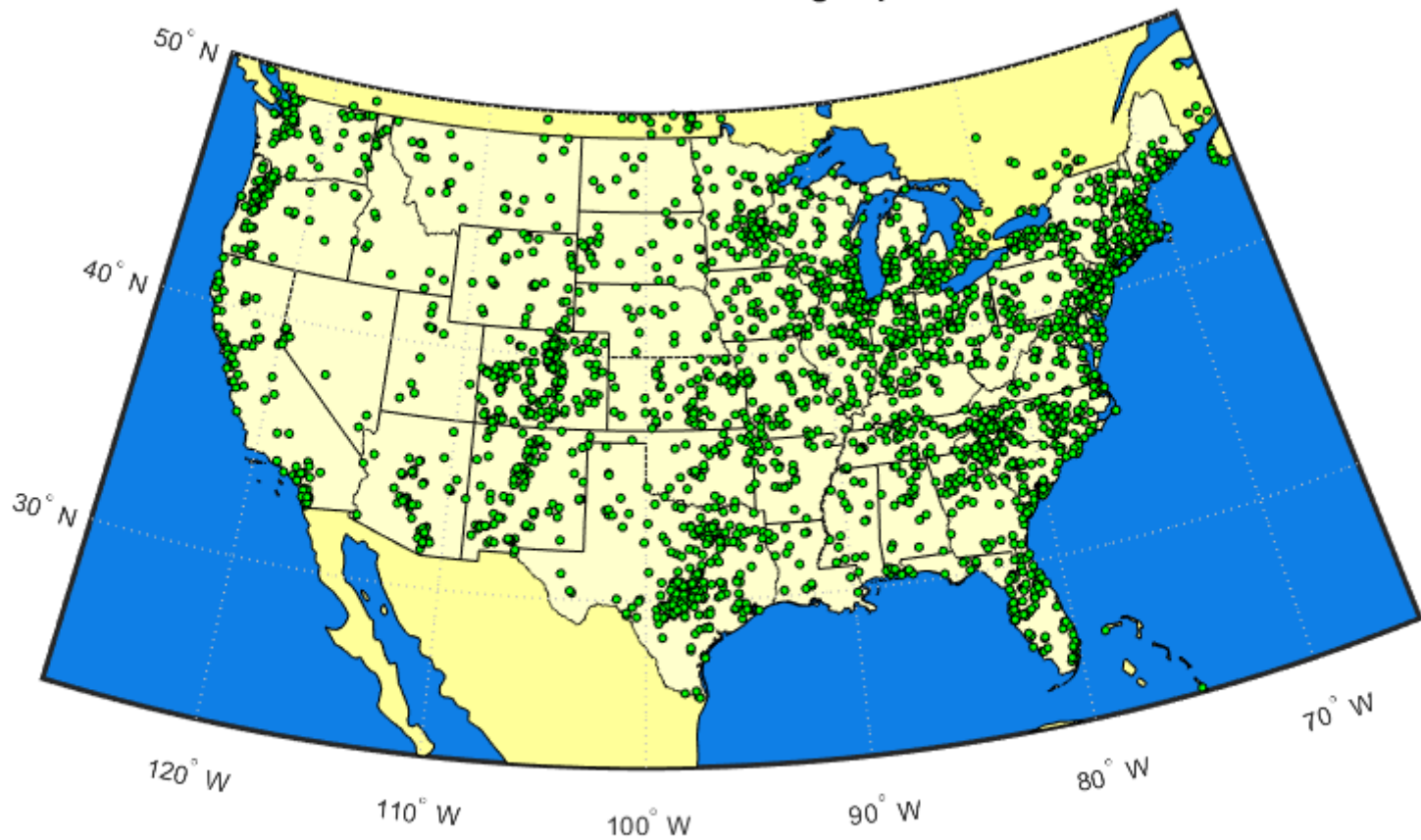
Fire

Plants & Wildlife

Society & Public Health

Water Supply & Quality

CoCoRaHS Conidition Monitoring Report Locations



What Kind of Citizen Science Data do NSMN Wish to Collect

Collection Strategies:

1. Come one come all
2. Offer a range of options
3. Pick one protocol and stick to it

