GEOG Climate Science Lab

TEXAS A&M UNIVERSITY




North American Soil Moisture Database: Development and Applications

Steven M. Quiring
Texas A&M University
Trenton Ford
Texas A&M University

http://climatology.tamu.edu

http://facebook.com/GeogCSL

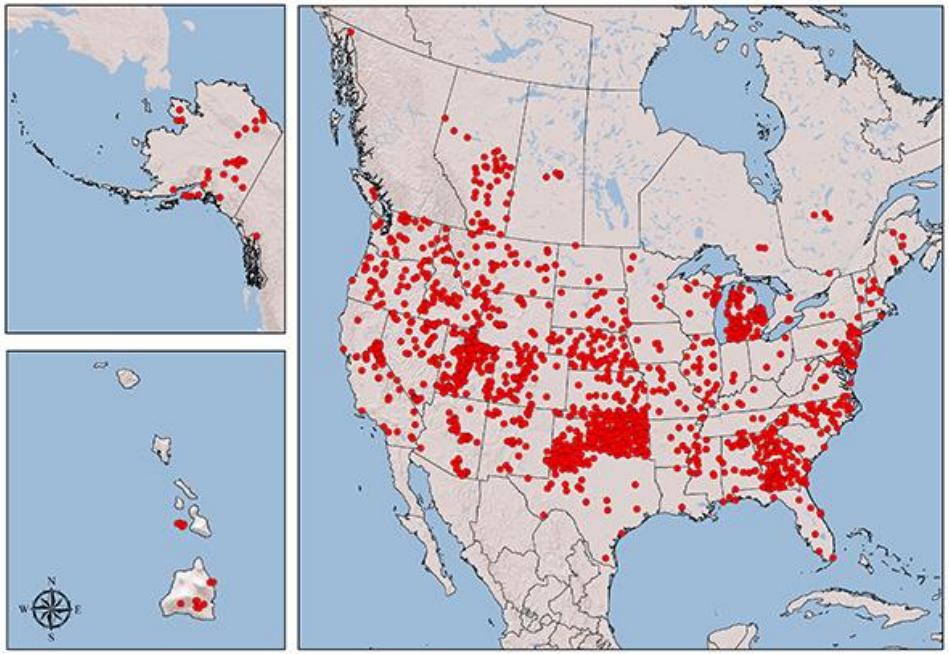
TEXAS A&M GEOSERVICES

Search TAMU North American Soil Mo

About | Maps & Data | Research | Support | Log In

TAMU North American Soil Moisture Database

Start Using Data | Learn About Us



The North American Soil Moisture Database (NASMD) is a harmonized and quality-controlled soil moisture dataset that helps investigate land-atmosphere interactions, validates the accuracy of soil moisture simulations in global land- surface models and from satellite platforms, and describes how soil moisture influences climate on seasonal to inter-annual timescales.

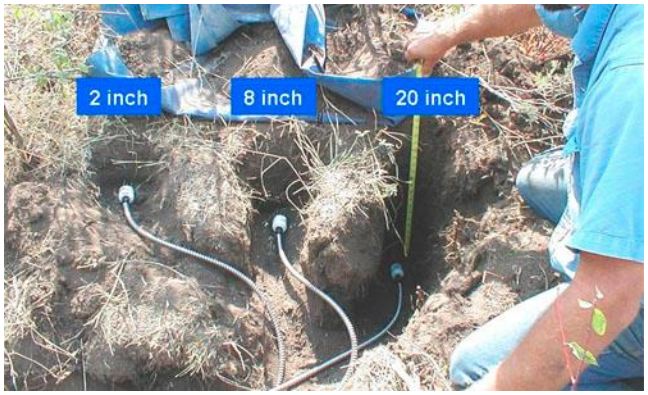
The NASMD was developed and constructed at the Department of Geography's Climate Science Lab at Texas A&M University.

soilmoisture.tamu.edu

North American Soil Moisture Database

- We have identified >1800 stations
- We have data from >1500 stations
- Currently 1431 stations are at:

soilmoisture.tamu.edu



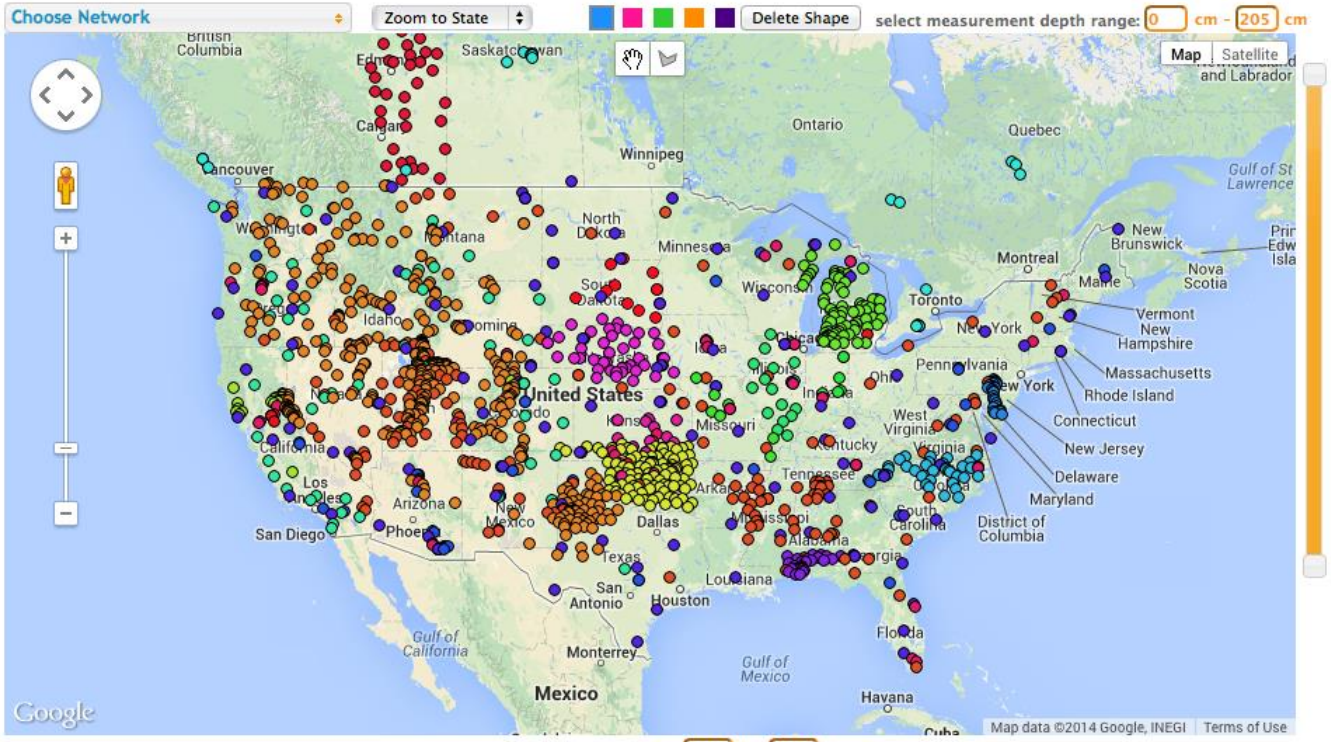
- Although many of these stations are only available since the 1990s, some are available prior to the 1950s

- Includes a variety of sensors, soil water variables, depths, sampling frequencies

North American Soil Moisture Database Interactive Map

This interactive map allows you to view & download station data from the North American Soil Moisture Database.

Choose one or more networks from the dropdown list to see station data. Use the depth & year sliders to filter. Click the extract buttons to download station data.



- Alberta Agriculture and Rural Development
- AmeriFlux
- Atmospheric Radiation Measurement
- Automated Weather Data Network
- Central Plains Experimental Range
- CHILI
- Climate Reference Network
- Cosmic Ray Soil Moisture Observing Station
- Delaware Environmental Observing System
- ECONET
- Fluxnet Canada
- GPS Soil Moisture
- Illinois Climate Network
- ISGMN
- MAW-Missouri
- MAWN
- NOAA HMT
- Oklahoma Mesonet
- SNOTEL
- Soil Climate Analysis Network
- Soilscape
- South Dakota Automated Weather Network
- TW Daniels Experimental Forest
- Water and Environmental Research Center
- West Texas Mesonet

1431 stations available (as of June 2, 2014)

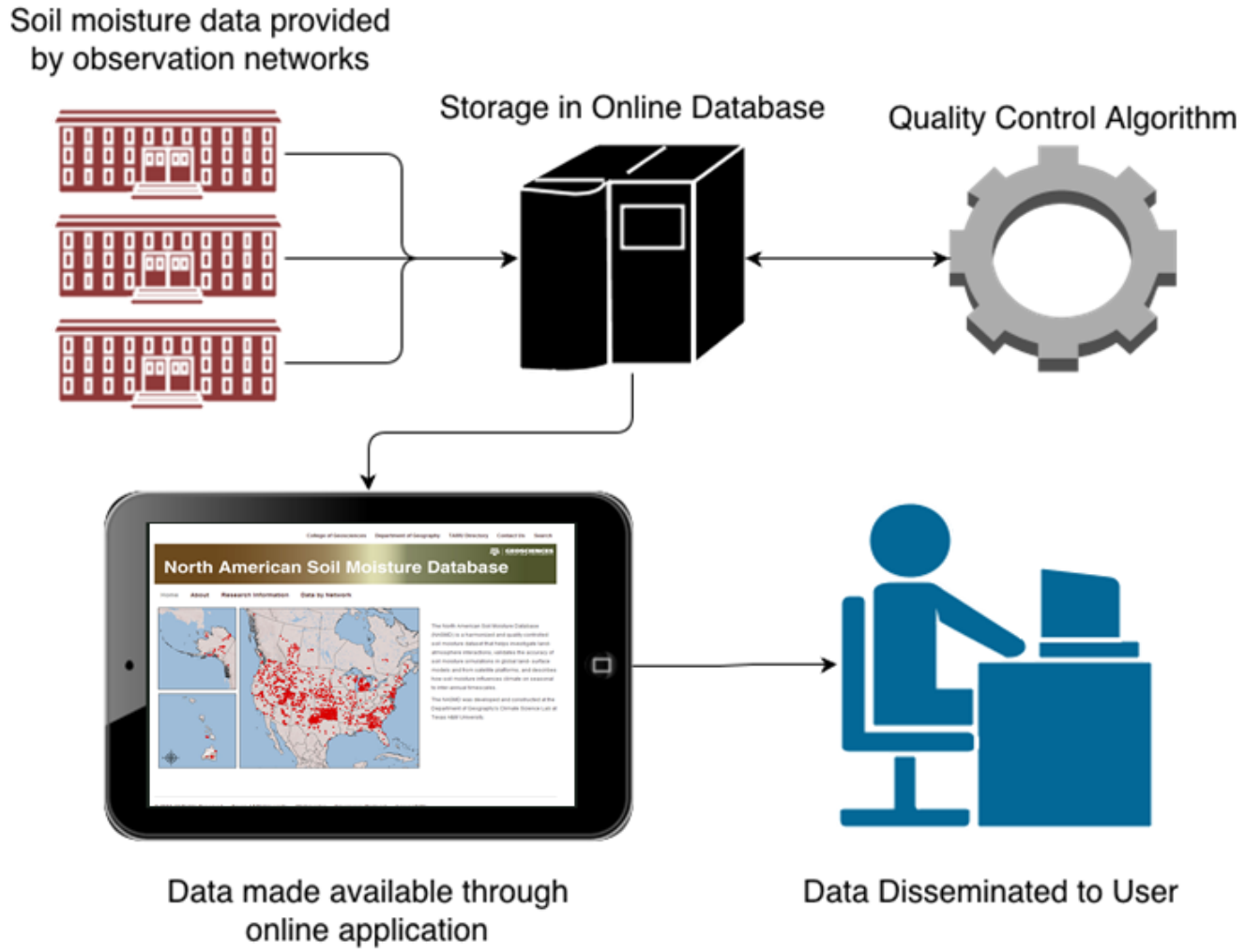
North American Soil Moisture Database

- NASMD includes national, regional, state and local networks. It also includes in situ soil moisture data collected during field campaigns, and research projects.

- Comprehensive meta-data has been developed for all of the stations including sensor, soil characteristics, surface vegetation, and details on instrument calibration.

- All data has gone through our customized QA/QC algorithm. Measurements failing the QC checks are flagged for further analysis.

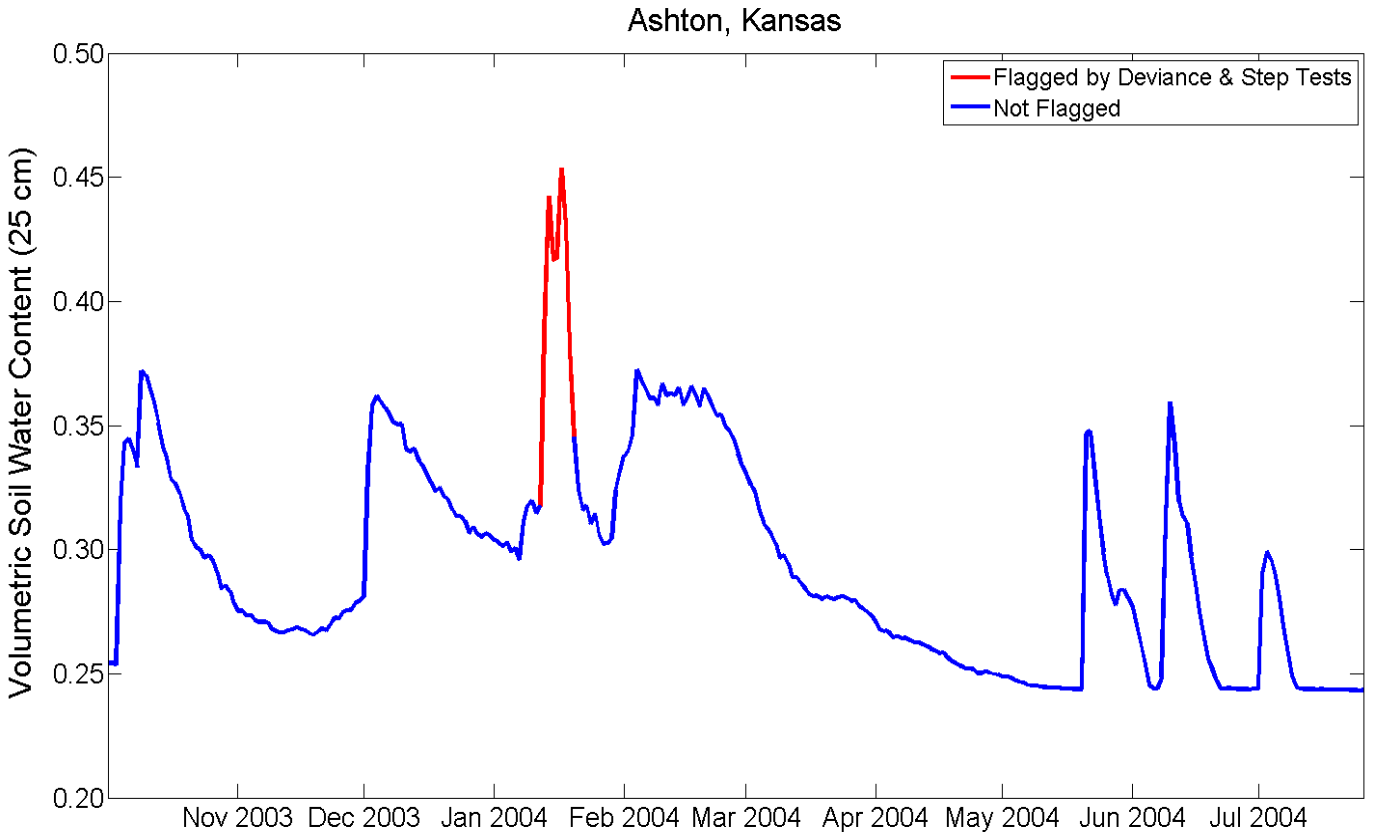
North American Soil Moisture Database



Data Quality Control

- Because each station/network performs varying levels of data quality control, it is necessary to carefully screen all observations using a consistent set of tests
- Multi-stage process patterned after USHCN (Menne & collaborators), and Oklahoma Mesonet (among others)
- Four validation tests: range, streak, deviance, and step
- > 7 million values processed: streak, deviance and step tests flagged 0.52%, 4.40% and 3.22% of the data, respectively

North American Soil Moisture Database

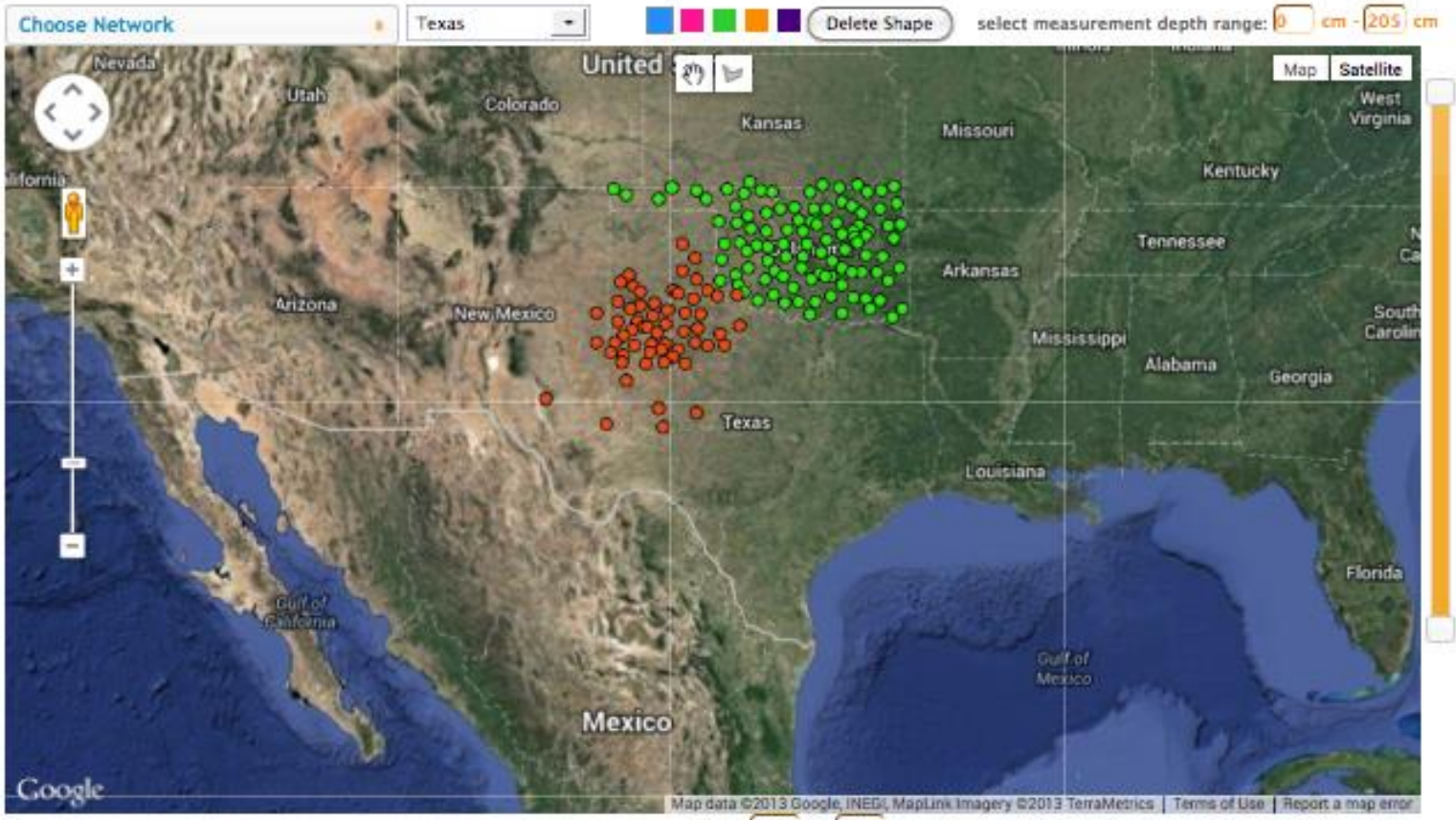


Soil moisture data from the 25 cm depth at Ashton, Kansas. Data shown in blue were not flagged by the deviance and step tests while data in red were flagged.

North American Soil Moisture Database Interactive Map

This interactive map allows you to view & download station data from the North American Soil Moisture Database.

Choose one or more networks from the dropdown list to see station data. Use the depth & year sliders to filter. Click the extract buttons to download station data.



Slide to select data year range: 1991 - 2013

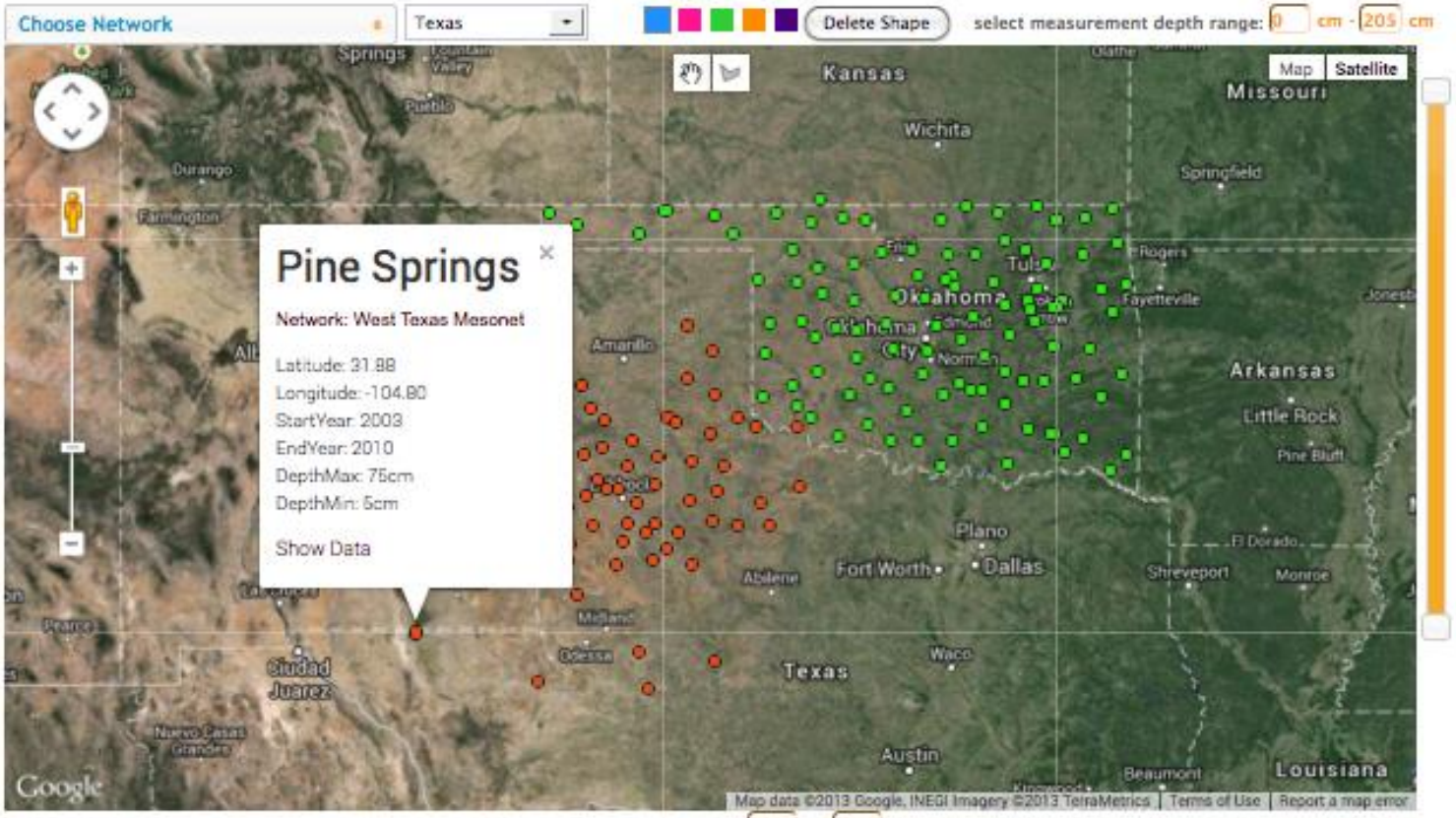
163 Stations have been selected

No.	All	Station	Network	Location	State
1	☐	Norman	Oklahoma Mesonet	Norman	Oklahoma
2	☐	Acme	Oklahoma Mesonet	Rush Springs	Oklahoma

North American Soil Moisture Database Interactive Map

This interactive map allows you to view & download station data from the North American Soil Moisture Database.

Choose one or more networks from the dropdown list to see station data. Use the depth & year sliders to filter. Click the extract buttons to download station data.

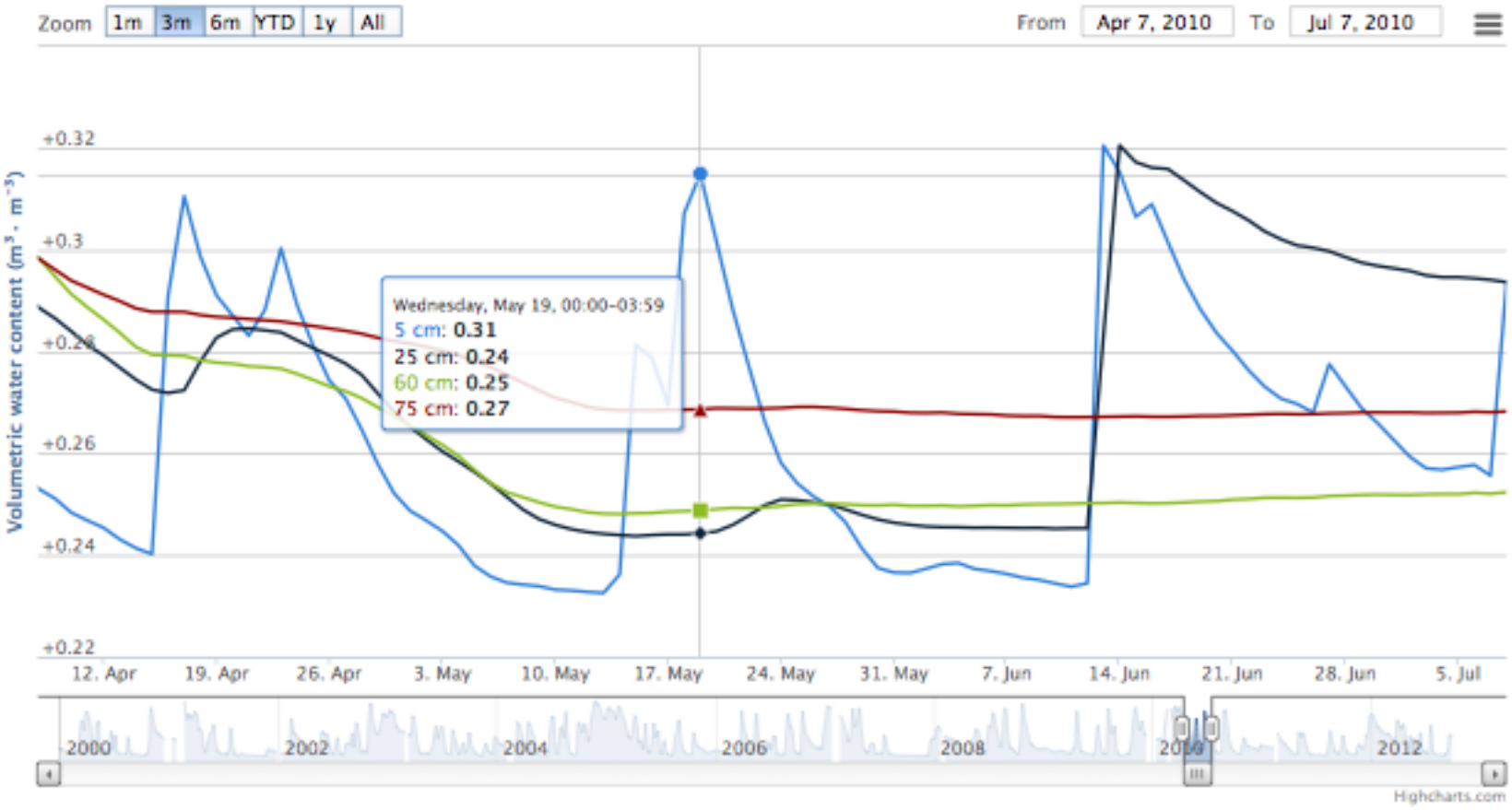


Slide to select data year range: 1991 - 2013

163 Stations have been selected

No.	All	Station	Network	Location	State
1	☐	Norman	Oklahoma Mesonet	Norman	Oklahoma
2	☐	Acme	Oklahoma Mesonet	Rush Springs	Oklahoma
3	☐	Ada	Oklahoma Mesonet	Ada	Oklahoma

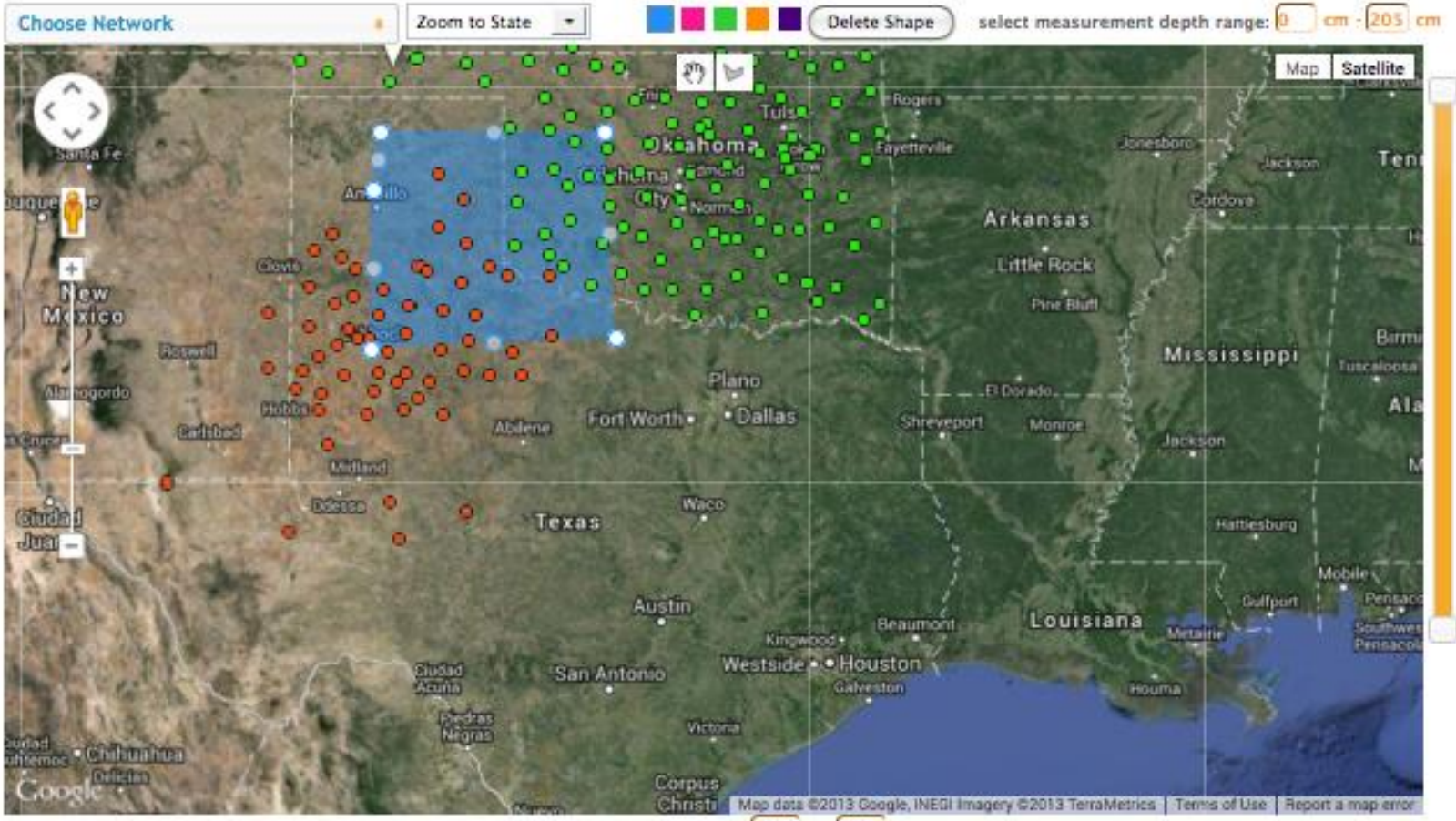
Station Data



North American Soil Moisture Database Interactive Map

This interactive map allows you to view & download station data from the North American Soil Moisture Database.

Choose one or more networks from the dropdown list to see station data. Use the depth & year sliders to filter. Click the extract buttons to download station data.



Slide to select data year range: 1991 - 2013

32 Stations have been selected

No.	All	Station	Network	Location	State
1	☐	Altus	Oklahoma Mesonet	Altus	Oklahoma
2	☐	Arnett	Oklahoma Mesonet	Arnett	Oklahoma

32 Stations have been selected

No.	All	Station	Network	Location	State
1	☑	Altus	Oklahoma Mesonet	Altus	Oklahoma
2	☑	Arnett	Oklahoma Mesonet	Arnett	Oklahoma
3	☑	Bessie	Oklahoma Mesonet	Bessie	Oklahoma
4	☑	Butler	Oklahoma Mesonet	Butler	Oklahoma
5	☑	Camargo	Oklahoma Mesonet	Camargo	Oklahoma
6	☑	Cheyenne	Oklahoma Mesonet	Cheyenne	Oklahoma
7	☑	Erick	Oklahoma Mesonet	Erick	Oklahoma
8	☑	Grandfield	Oklahoma Mesonet	Grandfield	Oklahoma
9	☑	Hobart	Oklahoma Mesonet	Hobart	Oklahoma
10	☑	Hollis	Oklahoma Mesonet	Gould	Oklahoma
11	☑	Mangum	Oklahoma Mesonet	Mangum	Oklahoma
12	☑	Medicine Park	Oklahoma Mesonet	Medicine Park	Oklahoma
13	☑	Putnam	Oklahoma Mesonet	Putnam	Oklahoma
14	☑	Tipton	Oklahoma Mesonet	Tipton	Oklahoma
15	☑	Weatherford	Oklahoma Mesonet	Weatherford	Oklahoma
16	☑	Abernathy	West Texas Mesonet	Abernathy	Texas
17	☑	Childress	West Texas Mesonet	Childress	Texas
18	☑	Clarendon	West Texas Mesonet	Clarendon	Texas
19	☑	Floydada	West Texas Mesonet	Floydada	Texas
20	☑	Goodlett	West Texas Mesonet	Goodlett	Texas

Extract Checked Stations

Extract All Selected Stations

No.	All	Station	Network	Location	State
1	☑	AURO	ECONET	Aurora	North Carolina
2	☑	BEAR	ECONET	Hendersonville	North Carolina
3	☐	BOON	ECONET	Boone	North Carolina
4	☐	BUCK	ECONET	Buckland	North Carolina
5	☐	BURN	ECONET	Burnsville	North Carolina
6	☐	CAST		yne	North Carolina
7	☐	CLA2			North Carolina
8	☐	CLAY			North Carolina
9	☐	CLIN			North Carolina
10	☐	DURH			North Carolina
11	☐	FLET			North Carolina
12	☐	GOLD		o	North Carolina
13	☐	HAML	ECONET	Hamlet	North Carolina
14	☐	HIGH	ECONET	High Point	North Carolina
15	☐	JACK	ECONET	Jackson Springs	North Carolina
16	☐	KINS	ECONET	Kinston	North Carolina
17	☐	LAKE	ECONET	Raleigh	North Carolina
18	☐	LAUR	ECONET	Laurel Springs	North Carolina
19	☐	LEWS	ECONET	Lewiston	North Carolina
20	☐	LILE	ECONET	Lilesville	North Carolina

Extract request queued. You will receive an email shortly.

OK

Extract Checked Stations

Extract All Selected Stations

Ongoing Work & Applications

I. Identify additional stations, especially in Canada and Mexico

II. Develop gridded observational soil moisture products

III. Employ these data for satellite & LSM calibration/validation

IV. Soil moisture applications: seasonal climate forecasting, drought monitoring

the WHITE HOUSE PRESIDENT BARACK OBAMA

BLOG | PHOTOS & VIDEO | BRIEFING ROOM | ISSUES | the ADMINISTRATI

Home • Briefing Room • Statements & Releases

The White House
Office of the Press Secretary

E-Mail | Tweet | Share | +

For Immediate Release June 25, 2013

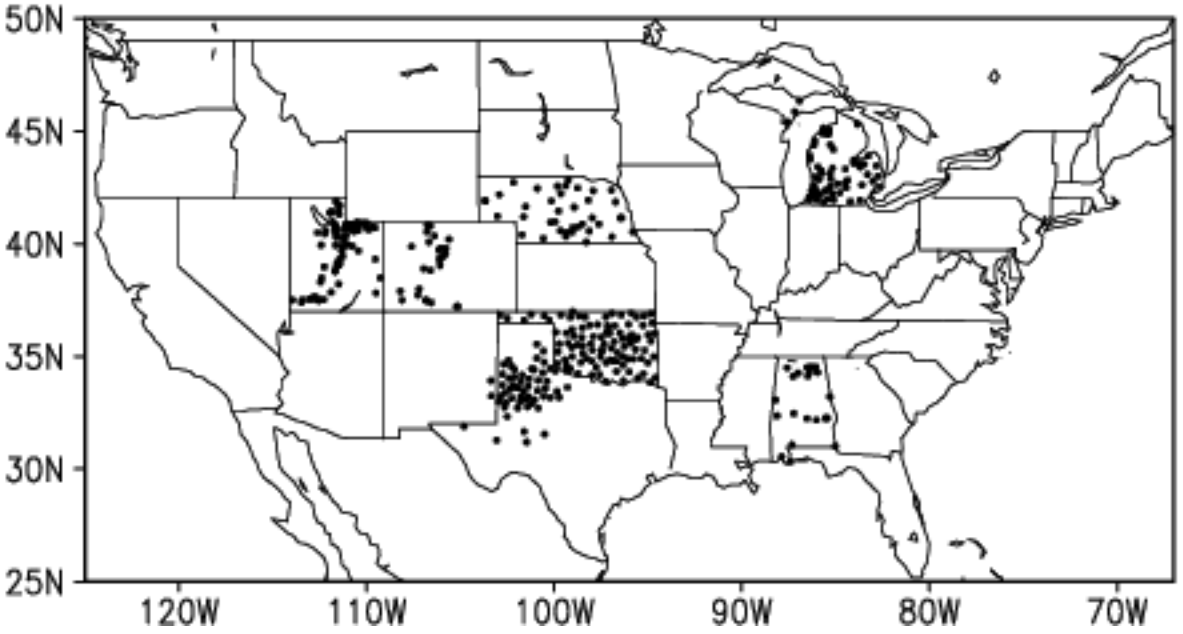
FACT SHEET: President Obama's Climate Action Plan

President Obama's Plan to Cut Carbon Pollution
Taking Action for Our Kids

Managing Drought: Leveraging the work of the National Disaster Recovery Framework for drought, the Administration will launch a cross-agency National Drought Resilience Partnership as a "front door" for communities seeking help to prepare for future droughts and reduce drought impacts. By linking information (monitoring, forecasts, outlooks, and early warnings) with drought preparedness and longer-term resilience strategies in critical sectors, this effort will help communities manage drought-related risks.

III. NLDAS-2 Validation

- 385 sites in AL, CO, MI, NE, OK, TX and UT are used to evaluate 0-10 cm soil moisture
- Spatial averaged SM in each of state is compared to reduce noise
- Simulation skill is assessed using anomaly correlation and Taylor Skill Score



Xia, Y., Ek, M. B., Wu, Y., Ford, T. W. and S. M. Quiring (in review) Comparison of NLDAS-2 Simulated and NASMD Observed Daily Soil Moisture. Part I: Comparison and Analysis. *Journal of Hydrometeorology.*

Daily Anomaly Correlation

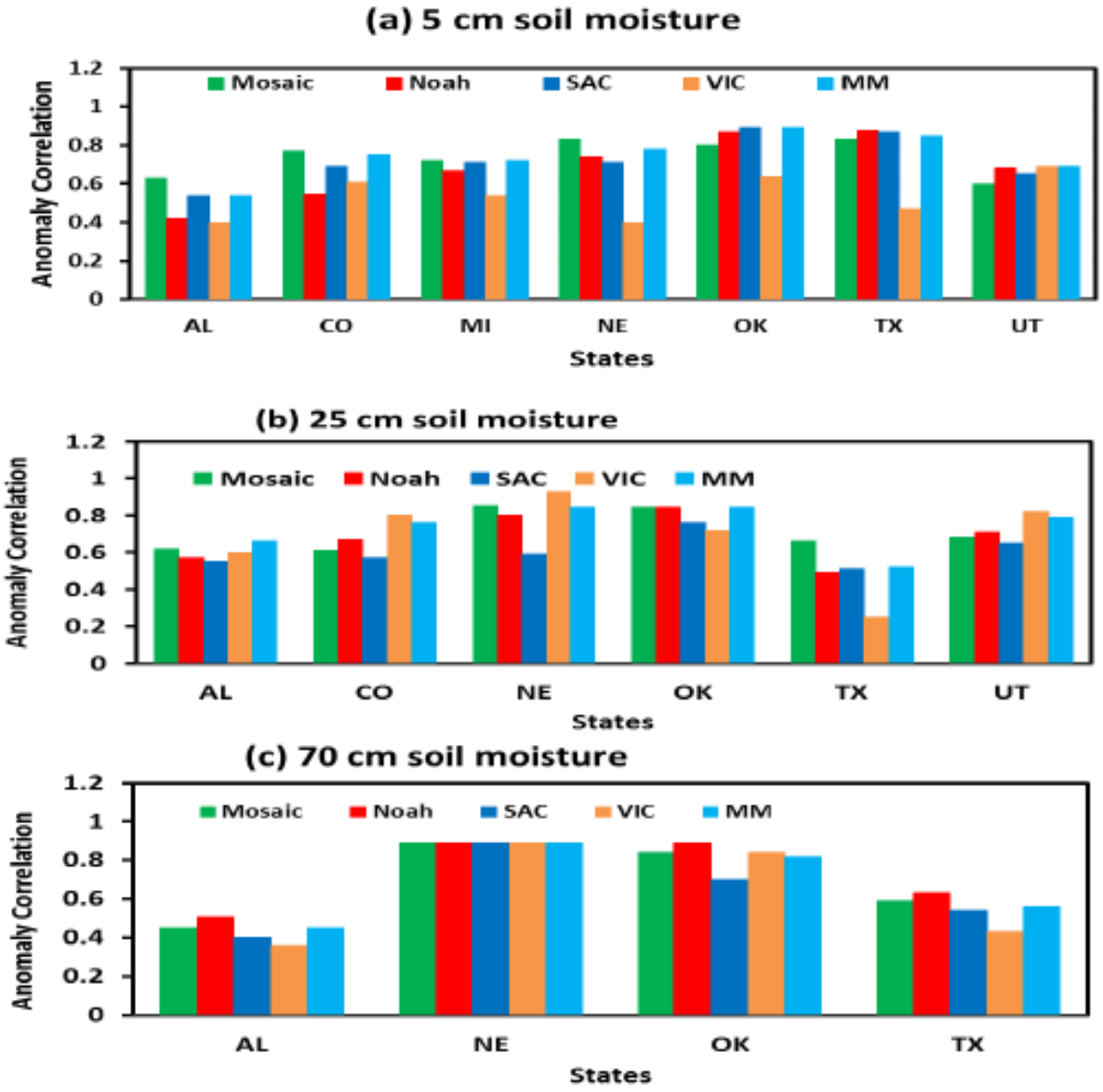


Figure 3: Daily anomaly correlation for Mosaic, Noah, SAC, and VIC model at (a) 5 cm, (b) 25 cm, and (c) 70 cm soil layer in AL, CO, NE, OK, TX and UT.

III. NLDAS-2 Validation

Oklahoma

	Noah	Mosaic	SAC	VIC	MM
RMSE	0.035	0.078	0.103	0.050	0.042
Bias	-0.029	-0.073	-0.100	0.043	-0.040
R Bias (%)	-11.0	-27.8	-38.1	16.4	-15.2

- Overall Mosaic, MM, and SAC have the highest simulation skill
- VIC has the lowest simulation skill, and Noah's performance is in between
- Noah and VIC have wetter soils, Mosaic and SAC have drier soils than the observed soil moisture
- Noah and VIC have lower evapotranspiration than the other models

IV. Predicting Extreme Temperatures

Objective: Quantify relationship between soil moisture and percent hot days (%HD) using quantile regression

Hot days are defined as the days with a maximum temperature greater than the 90th percentile of all days within that month

Based on temperature and soil moisture data from 56 Oklahoma Mesonet sites (1998-2013)

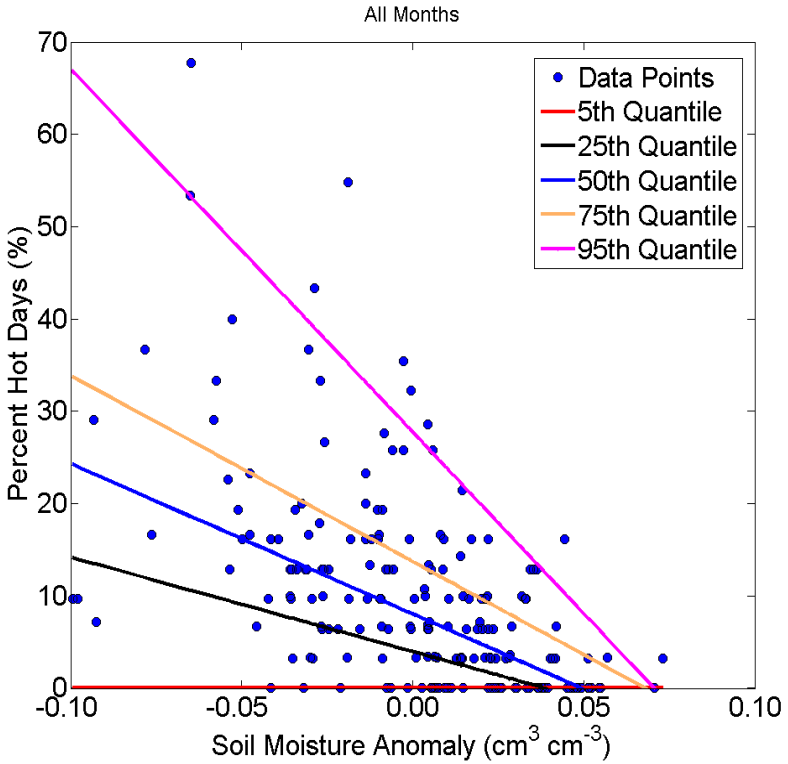


Figure 2. Scatter plots of monthly %HD and soil moisture anomalies from (a) all months, (b) spring, (c) summer and (d) autumn. The regression lines represent the fit at the 95th, 75th, 50th, 25th and 5th quantiles.

Ford & Quiring (in review) Observed soil moisture strongly coupled with extreme temperatures. *Geophysical Research Letters.*

Predicting Extreme Temperatures

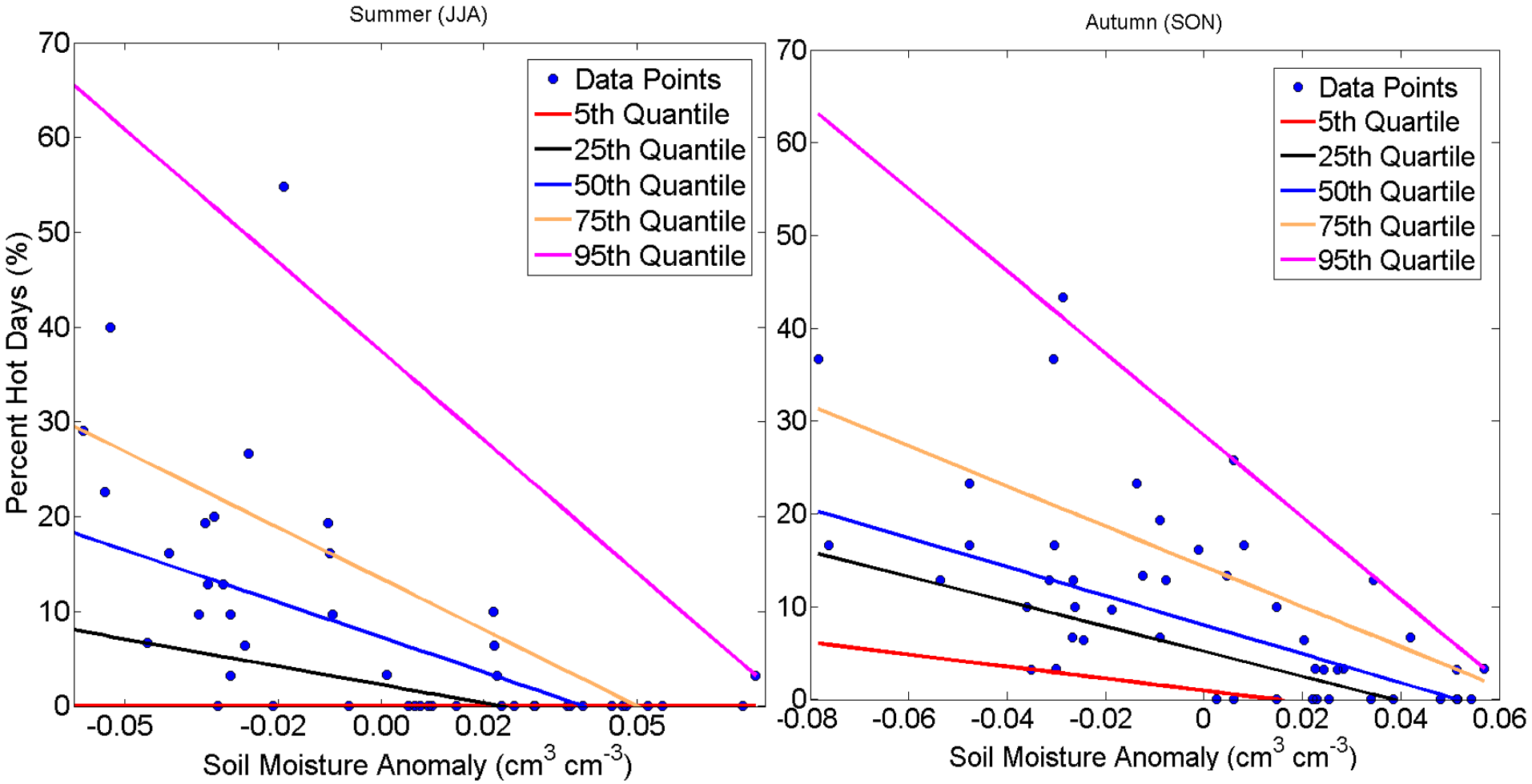


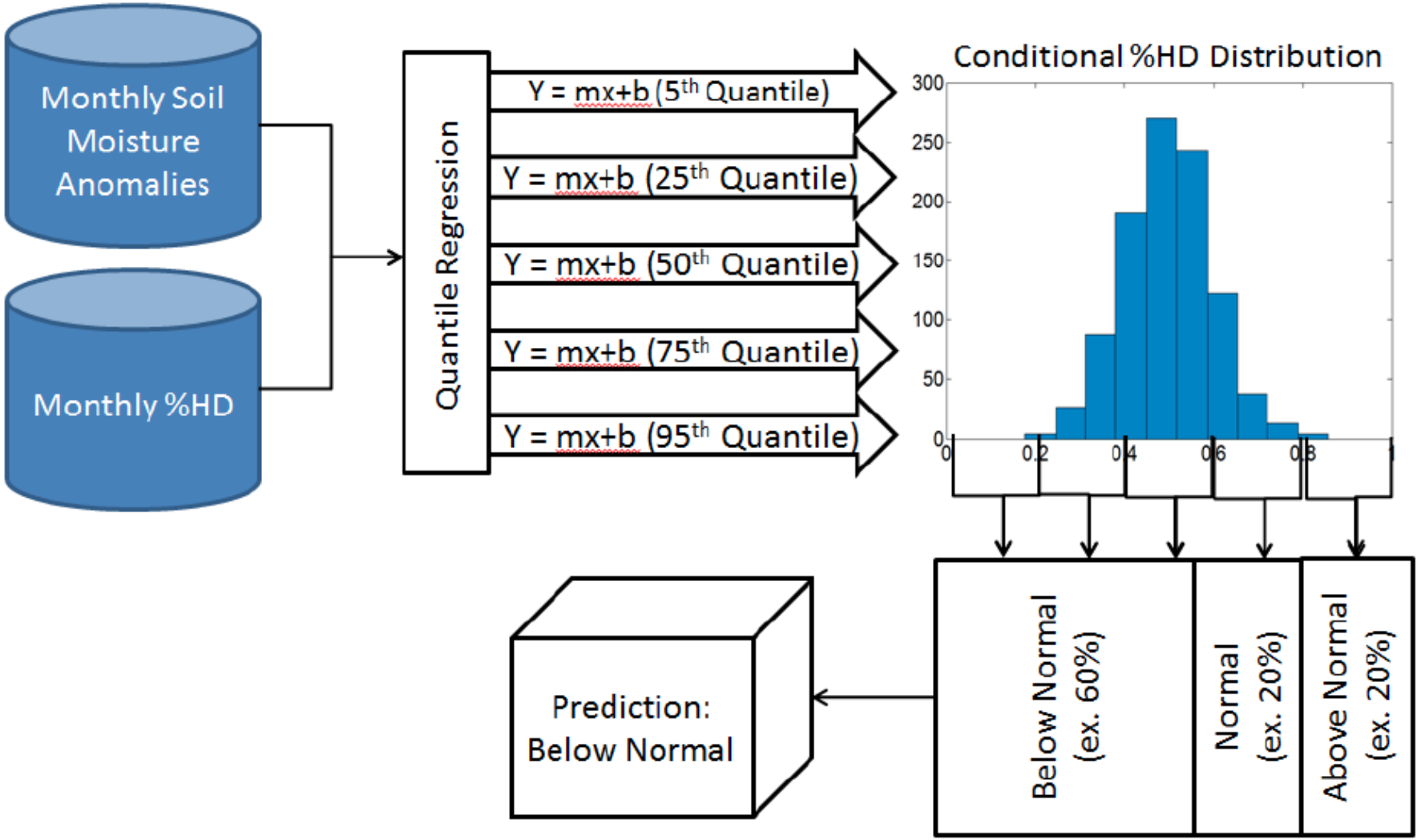
Figure 2. Scatter plots of monthly %HD and soil moisture anomalies from (a) all months, (b) spring, (c) summer and (d) autumn. The regression lines represent the fit at the 95th, 75th, 50th, 25th and 5th quantiles.

Predicting Extreme Temperatures

Quantile	5th	25th	50th	75th	95th
All Months	0.00	-1.02*	-1.63*	-2.02*	-3.93*
Spring (MAM)	0.00	-1.18*	-1.86*	-2.69*	-4.53*
Summer (JJA)	0.00	-0.96*	-1.84*	-2.68*	-4.37*
Autumn (SON)	-0.65*	-1.34*	-1.56*	-2.16*	-4.25*

* Statistically significant at $\alpha = 0.05$

Predicting Extreme Temperatures



IV. Predicting Extreme Temperatures

Season	Spring	Summer	Autumn	Overall
Heidke Skill Score	28.13	15.63	21.88	**22.83**

•When the quantile regression model predicts that the %HD will be below normal or above normal, these predictions are correct approximately 86% and 79% of the time, respectively.

•Heidke Skill Scores vary between 15 (summer) and 28 (spring)

•Heidke Skill Score of CPC 1-month temperature forecast is 2-week lead time is ~15

Other Applications of NASMD

I. *Drought Monitoring.* South Central Climate Science Center & National Coordinated Soil Moisture Network

II. *Land-atmosphere interactions.* Comparison of observed and LSM-derived land surface feedbacks; precipitation-soil moisture feedbacks

III. *Validation of Satellite Soil Moisture.* SMOS, AMSR-E, etc. More details in Trent's presentation.

Acknowledgements

- This project is funded by the NSF Climate & Large-scale Dynamics (CAREER ATM-1056796)

- Major contributors:
  - Trent Ford

- Research Assistants:
  - Elizabeth Harris, Angela Khong, Jessica Wang, Kyle Blount, Chris Labosier, Michelle Ruiz, Laura Quirk, Sam Williams, Daniel Russell, Clair Snodgrass, Jeanne Eckhart, Ryan Underhill, Terra Lindgren, Ole Wulff, Ben Holden, Gretchen Hajdik, Alix Bolten