



Why we started a Volunteer Rain Gauge Network

Nolan Doesken
Colorado State University



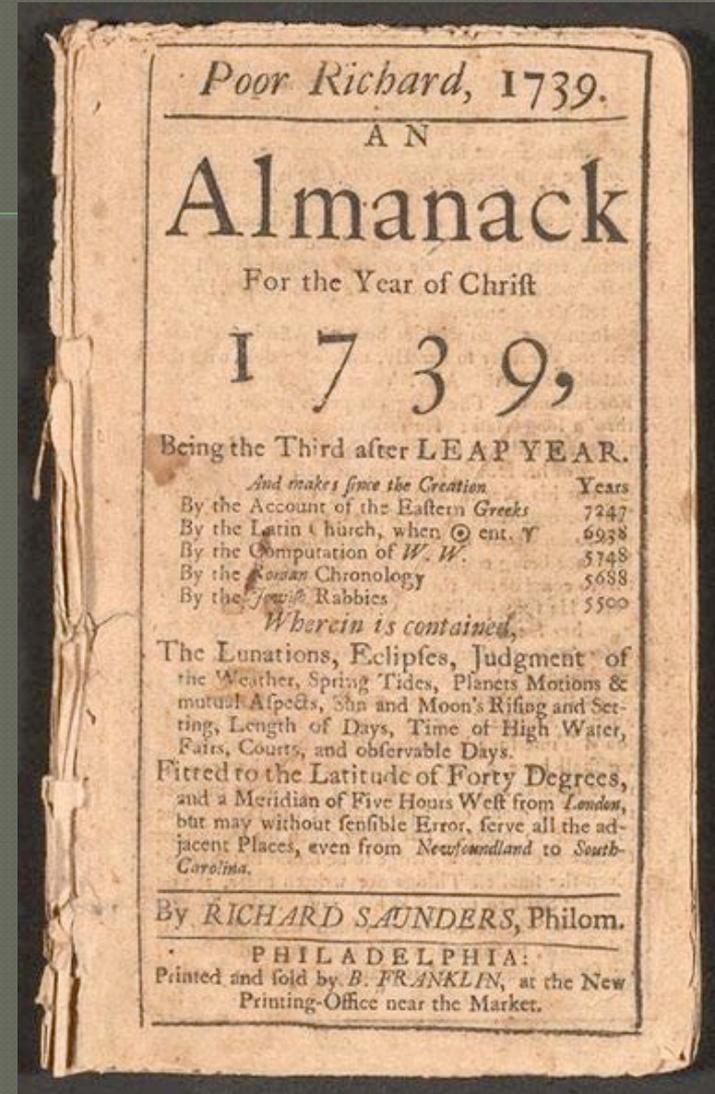
Presented at AAAS
February 15, 2013
Boston, MA

In the fields of meteorology and climatology there is a long and colorful history of volunteer participation in data collection and research.





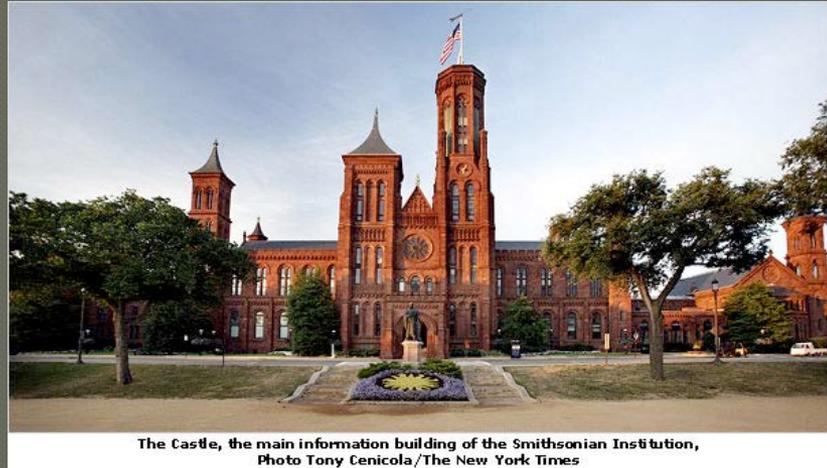
Benjamin Franklin



A champion for Public Participation in Scientific Research



Joseph Henry
First Secretary of the
Smithsonian Institution



The Castle, the main information building of the Smithsonian Institution,
Photo Tony Cenicola/The New York Times

Henry envisioned a network of Volunteer weather stations to help document the climate resources of the country and provide science-based weather forecasts

The Smithsonian Meteorological Project began in 1849 and grew to over 600 active participants at times

Secretary Henry helped introduce new technologies – **such as the use of the telegraph** for sharing weather observations



Louise Rochon Hoover's painting, "Secretary Henry Posts Daily Weather Map in Smithsonian Building, 1858." Commissioned for the Smithsonian exhibition at the Chicago Century of Progress Exhibition in 1933.

Analysis and interpretation of volunteered data proved more difficult than recruiting volunteers.

James H. Coffin, professor of mathematics and natural philosophy at Lafayette College in Easton, Pennsylvania, was contracted to analyze the data. Receiving as many as half-a-million separate observations in a year, Coffin complained that some contained "new-coined characters & hieroglyphics" that made them unintelligible.

Smithsonian Institution,

Washington, June 6, 1872.

To the Meteorological Observers
of the Smithsonian Institution:

The Ministry of Public Instruction in Italy, desiring to ascertain whether the aurora borealis makes its appearance simultaneously, or at the same moment of absolute time, on different meridians, have requested the Smithsonian Institution to procure information on the following points:

1. The time at which an aurora makes its appearance.
2. When it reaches its maximum.
3. When it begins to diminish.
4. When it ceases entirely.

Please give this information, if possible, in regard to any aurora you may have observed, especially with regard to those of the 4th—5th of February, 1872, and *any you may hereafter observe.*

Very respectfully,

Your obedient servant,

JOSEPH HENRY,

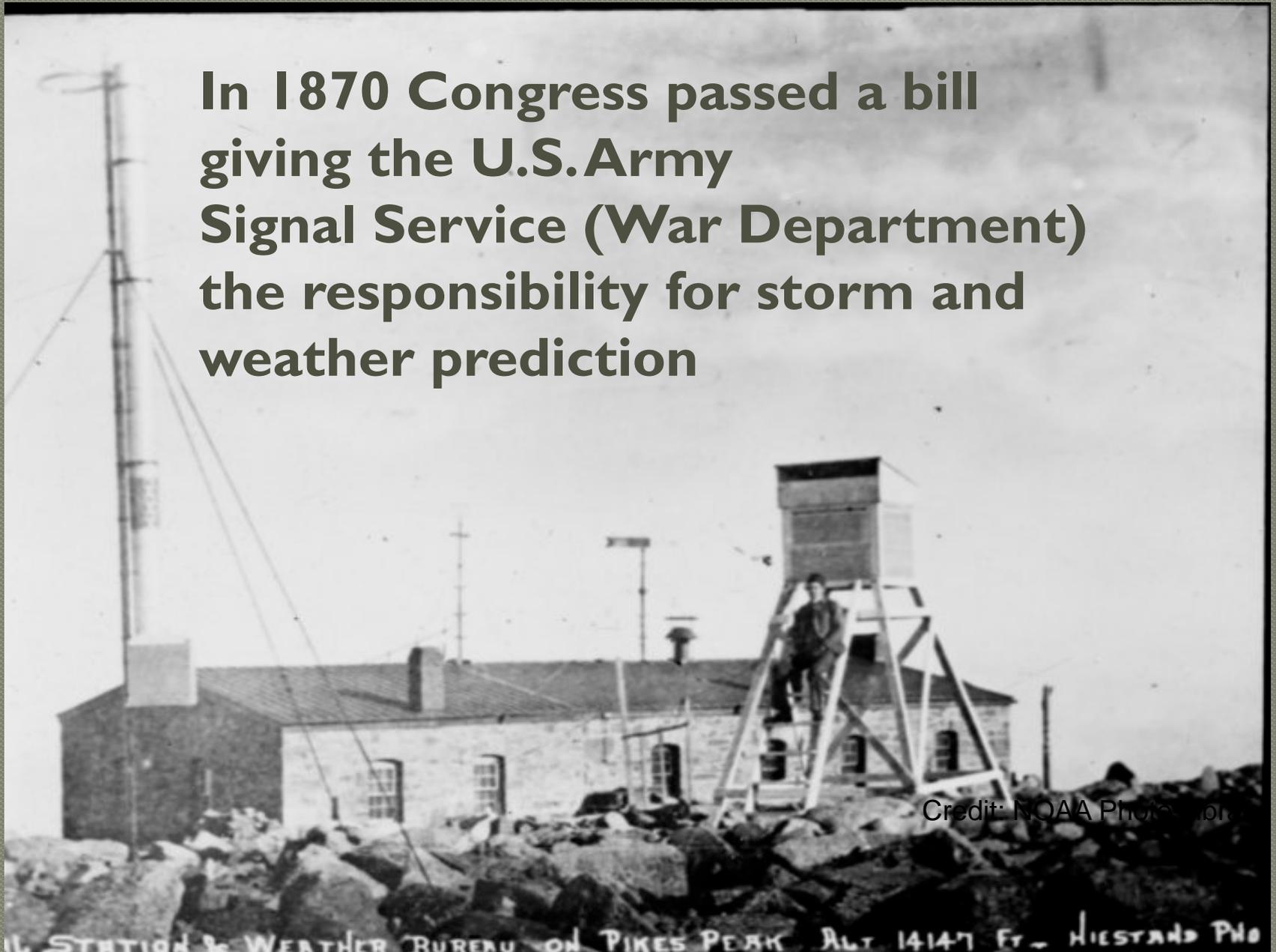
Secretary Smithsonian Institution.

The first compilation of data from the Smithsonian Meteorological Project was published in 1861

i.e. Patience was required by volunteers to see their data put to use.

Weather reports began on Pikes Peak in 1873

In 1870 Congress passed a bill giving the U.S. Army Signal Service (War Department) the responsibility for storm and weather prediction



IN 1874 THE SMITHSONIAN METEOROLOGICAL PROJECT
ENDED – BUT PUBLIC PARTICIPATION CONTINUED

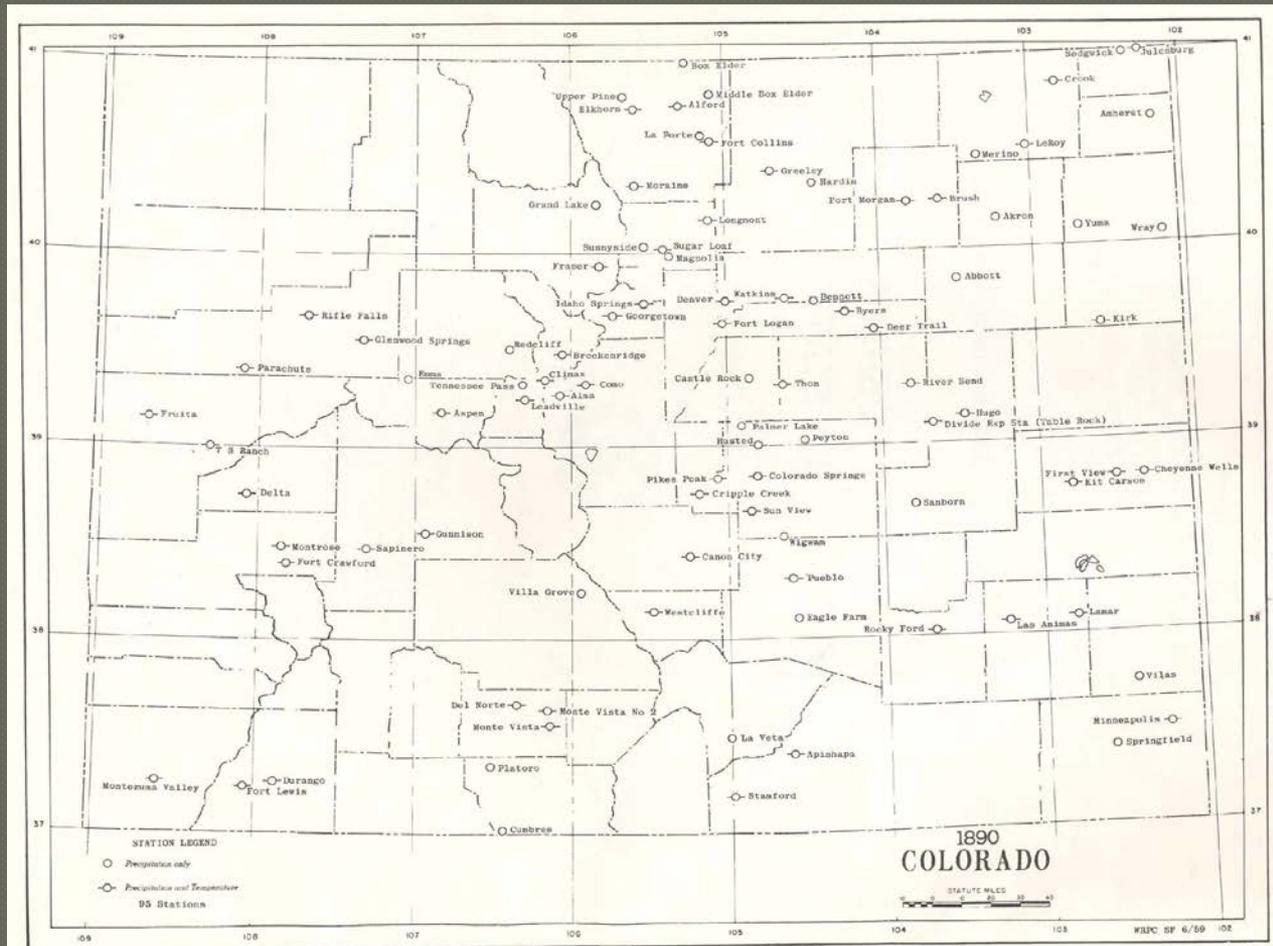


Credit: NOAA Photo Library

COLORADO STATE WEATHER SERVICE

- ◉ IN THE LATE 1880S THE COLORADO STATE LEGISLATURE PASSED LEGISLATION CREATING THE “COLORADO STATE WEATHER SERVICE”.
- ◉ \$2,000 WAS APPROPRIATED, AND AN EFFORT WAS STARTED IMMEDIATELY TO ESTABLISH IMPROVED MONITORING UTILIZING VOLUNTEER WEATHER OBSERVERS
- ◉ MANY OTHER STATES DID THE SAME

BY 1890 A ROBUST STATEWIDE WEATHER REPORTING NETWORK WAS IN PLACE WITH SIMILAR NETWORKS NATIONWIDE



In 1890 the USDA took over the responsibilities of climate monitoring on a national level, and the first civilian “national weather service” was formed – the “U.S. Weather Bureau”

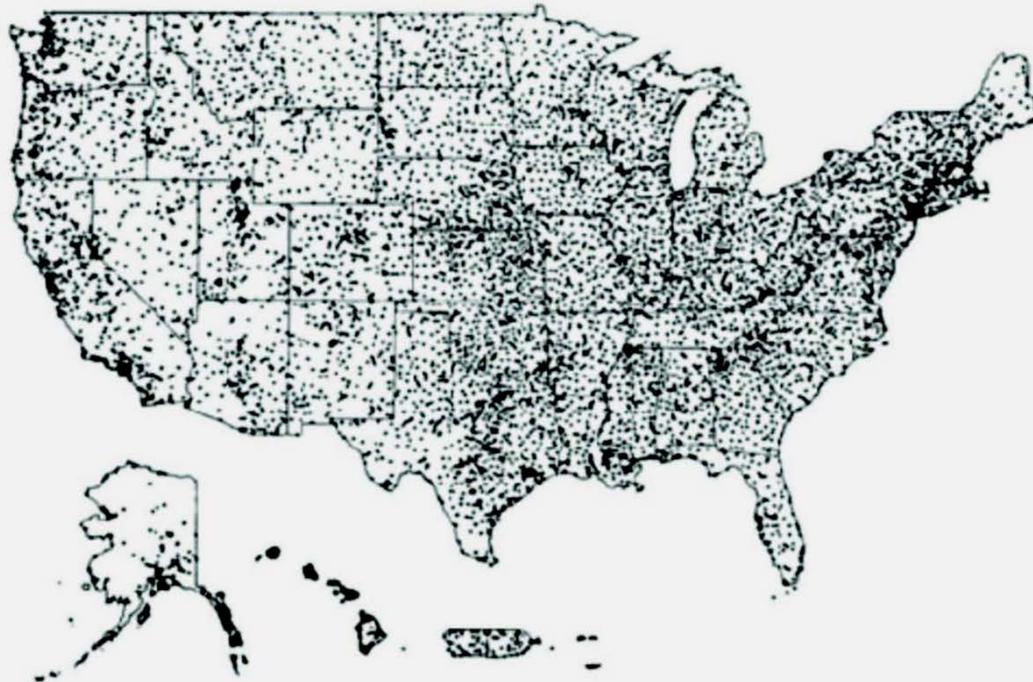


A nationwide network, called the
“Cooperative Program”
was formalized then
It continues today



Example of a traditional National Weather Service
“Cooperative Weather Station”
in eastern Colorado

THE *NWS* CO-OP NETWORK REMAINS AS A BACKBONE NETWORK FOR LONG-TERM CLIMATE MONITORING AND RESEARCH



Approximately 5000 daily max/min temperature stations, 8000 daily precipitation stations, 3000 automated hourly precipitation stations.

Our program was born in response to the 1997 Fort Collins, Colorado Flood



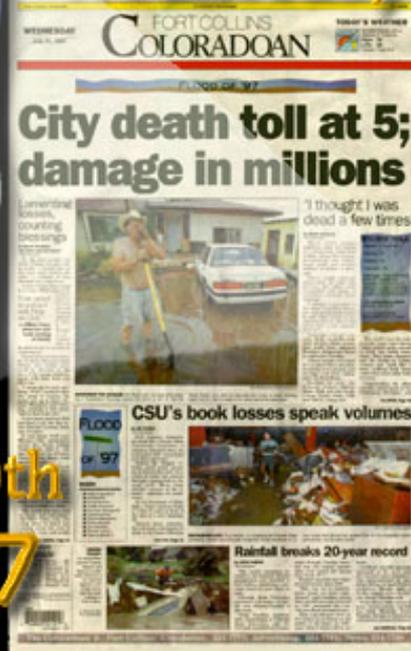
STORM TOLL

Deaths - 5 confirmed
Injuries - 40
Missing - 16
Rescued - 160

Damages - Tens of millions of dollars at Colorado State University, \$1.5 million to \$2 million to city roads and bridges; \$1 million to city parks and trails; no estimate for private property.

Source: Emergency Officials
All information as of 1 a.m. today

Wednesday



July 30th 1997



The flood pointed out:

1. Extreme local variations in rainfall from convective storms
2. The important role individuals can play in measuring, mapping and reporting precipitation.

Distance between A and B = 5 miles

A = 14.5 inches
B = 2.0 inches

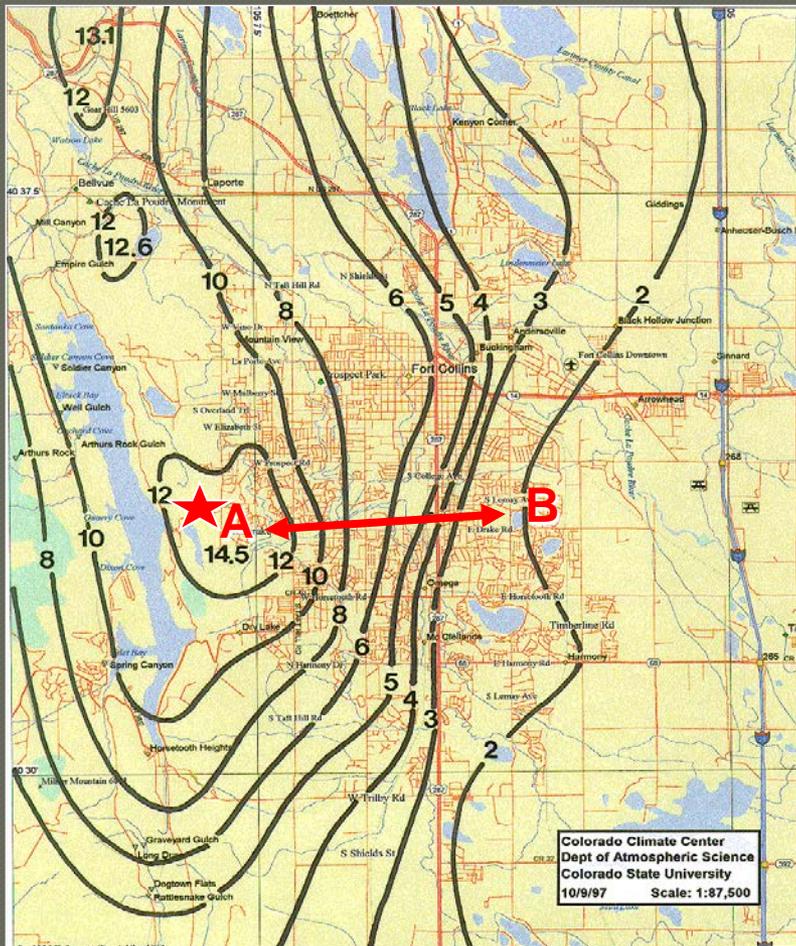
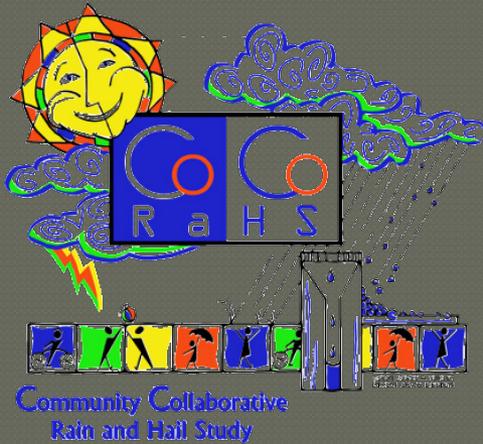
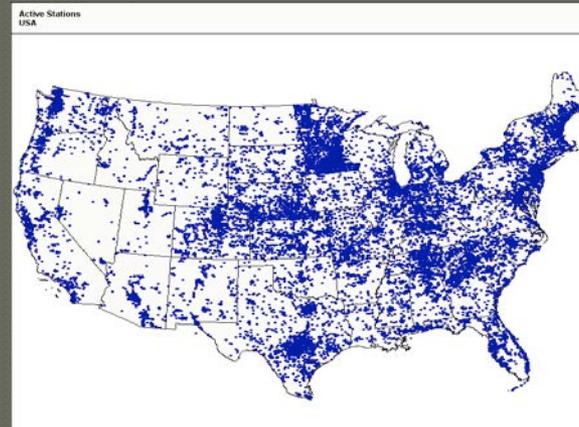


Figure 14. Rainfall (inches) for Fort Collins, Colorado, for 4:00 p.m. MDT July 27, 1997 through 11:00 p.m. MDT for July 28, 1997

1998



Today



A few dozen volunteers
in Northern Colorado

16,000+ volunteers in all 50 states



What is CoCoRaHS? A quick two-minute intro

16,000+ Volunteers nationally

All ages and backgrounds



Take daily measurements of precipitation in their backyards

Simple low-cost measurement tools



4-inch diameter
High capacity rain gauges



Aluminum foil-wrapped
Styrofoam hail pads



Snow rulers marked
in tenths of an inch

Just precipitation



Rain



Hail



Snow

CoCoRaHS has quickly become the largest source of daily precipitation measurements in the United States

Internet based



COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK
"Because every drop counts"

Home | States | View Data | Maps | My Data | My Account | Admin | Logout

Welcome to CoCoRaHS! "Volunteers working together to measure precipitation across the nation."

Measuring Reference Evapotranspiration **ET_o**
"The 'up' side of the water cycle"

JOIN COCORAHHS

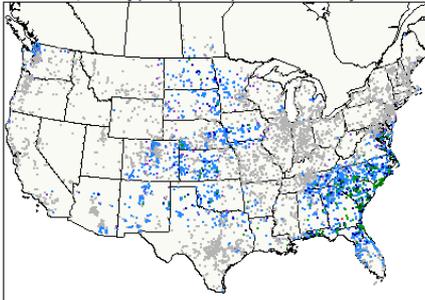
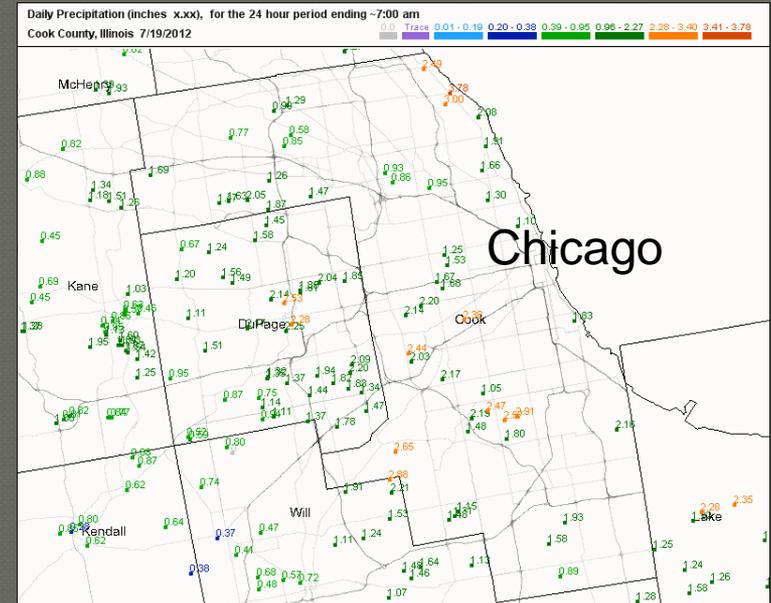
TRAINING SLIDE-SHOWS

Things to know about...

-  Rain
-  Hail
-  Snow

7,151 daily precipitation reports received today as of 8/8/2012 3:53 PM EDT

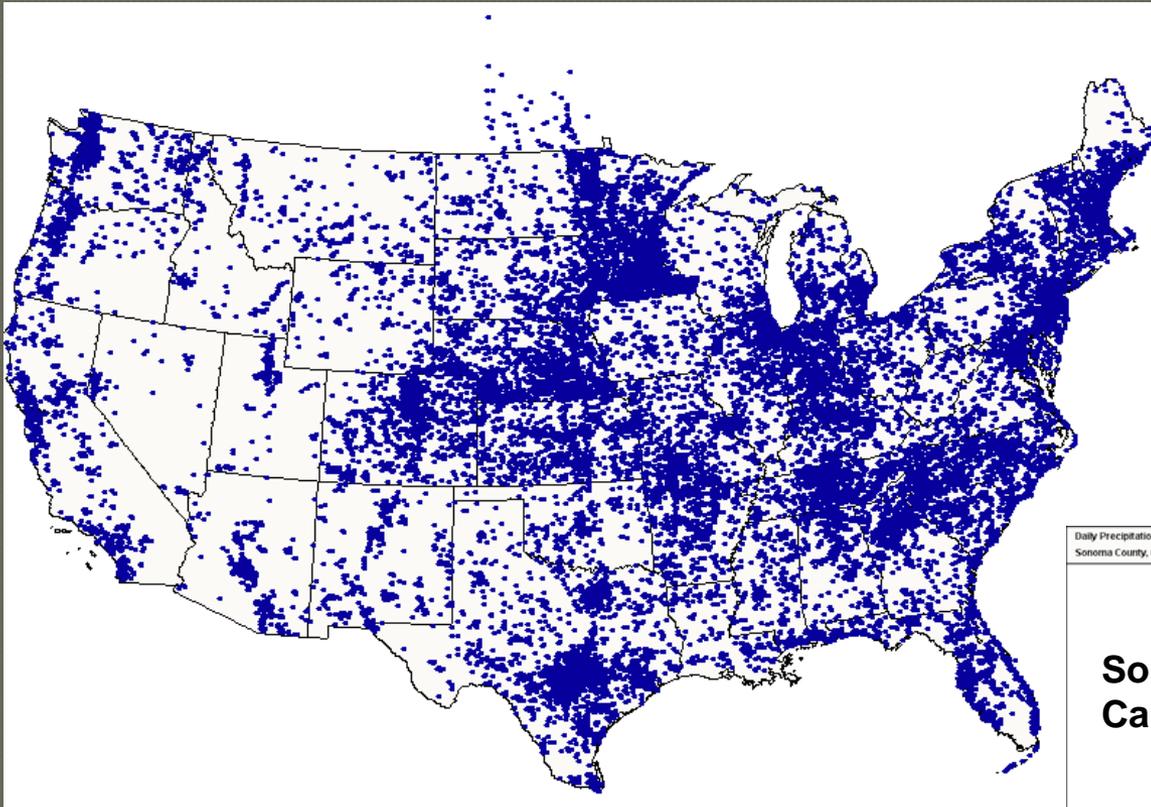
Daily Precipitation (inches x.xx)
USA
8/8/2012

Date	Time	Station Number	Station Name	Total Precip .Ins	New Snow .In	Total Snow .In	State	County	View
12/9/2010	7:00 AM	CA-SN-71	Rohnert Park 0.9 SW	0.80	NA	NA	CA	Sonoma	
12/9/2010	7:00 AM	CA-SN-87	Santa Rosa 2.0 NE	0.70	NA	NA	CA	Sonoma	
12/9/2010	7:15 AM	CA-SN-84	Sonoma 1.9 NNW	0.69	NA	NA	CA	Sonoma	
12/9/2010	6:00 AM	CA-SN-61	Santa Rosa 1.3 NW	0.57	NA	NA	CA	Sonoma	
12/9/2010	7:10 AM	CA-SN-46	Sebastopol 3.0 SW	0.55	NA	NA	CA	Sonoma	
12/9/2010	8:00 AM	CA-SN-88	Occidental 2.8 SW	0.55	NA	NA	CA	Sonoma	
12/9/2010	8:00 AM	CA-SN-31	Sebastopol 2.6 SSE	0.52	NA	NA	CA	Sonoma	
12/9/2010	7:00 AM	CA-SN-28	Santa Rosa 3.1 NW	0.51	NA	NA	CA	Sonoma	
12/9/2010	7:00 AM	CA-SN-49	Sebastopol 1.1 SSE	0.49	NA	NA	CA	Sonoma	

Volunteers report observations on website, where the information is made immediately available for the public to view in map and table form

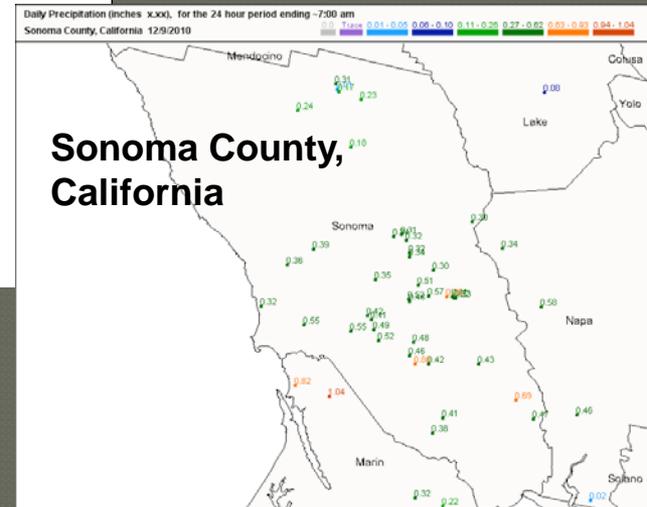
National with a local community emphasis

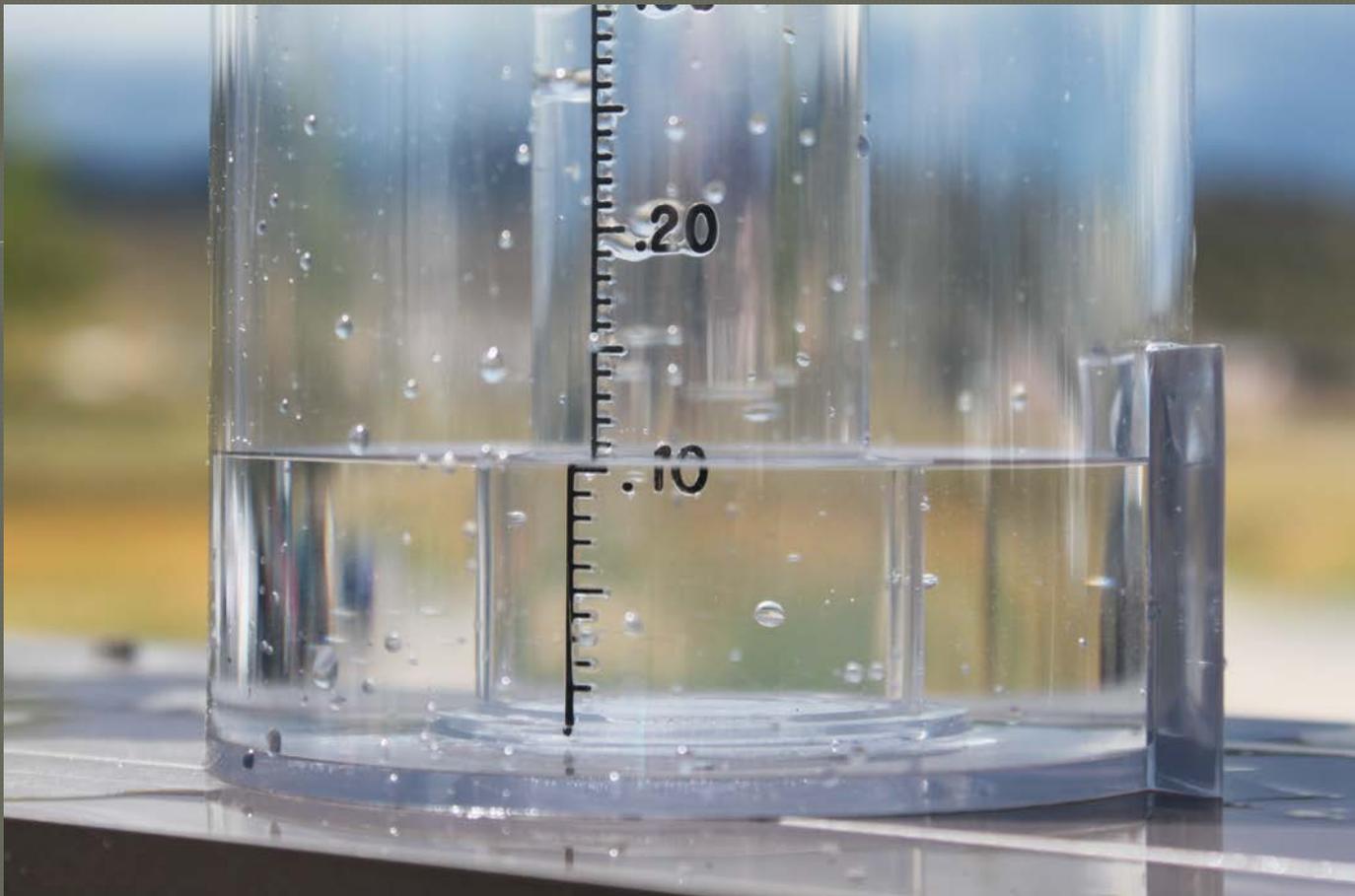


Over 250 volunteer
state/regional coordinators

16,000 +
volunteer observers

By taking observations, volunteers learn
important local patterns of climate and weather

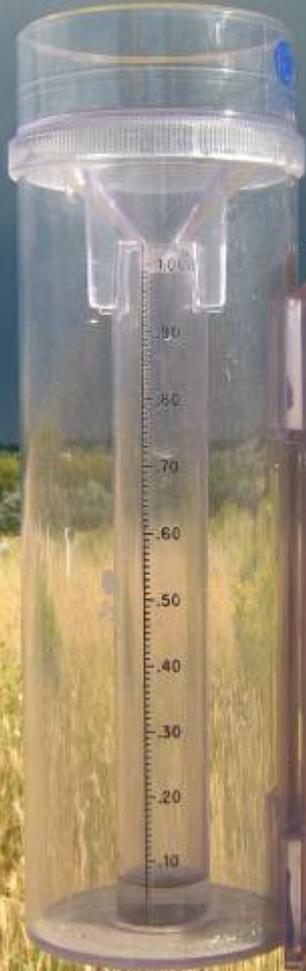




CoCoRaHS' s goal is to provide:

*High Quality Precipitation Data
and
Educational Resources and Outreach*

Rainfall Data



CoCoRaHS has quickly become the largest source of daily precipitation measurements in the United States



Rainfall can be extremely variable. With a dense network of rain gauges we hope to capture observations from that obscure storm.

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

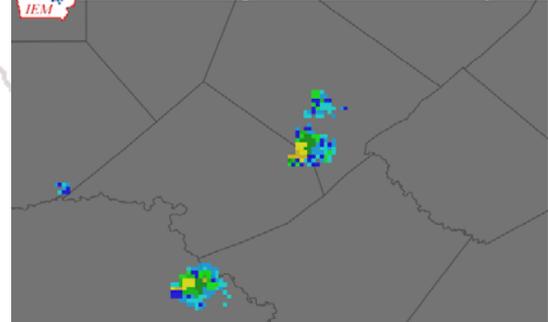
Comal County, Texas 5/6/2008



A great example of one observation making a difference

7.12" May 6, 2008, New Braunfels, Texas

IEM NEXRAD composite base reflect valid: 05 May 2008 0



"All but .02" fell between 3:30 and 5:30 pm."

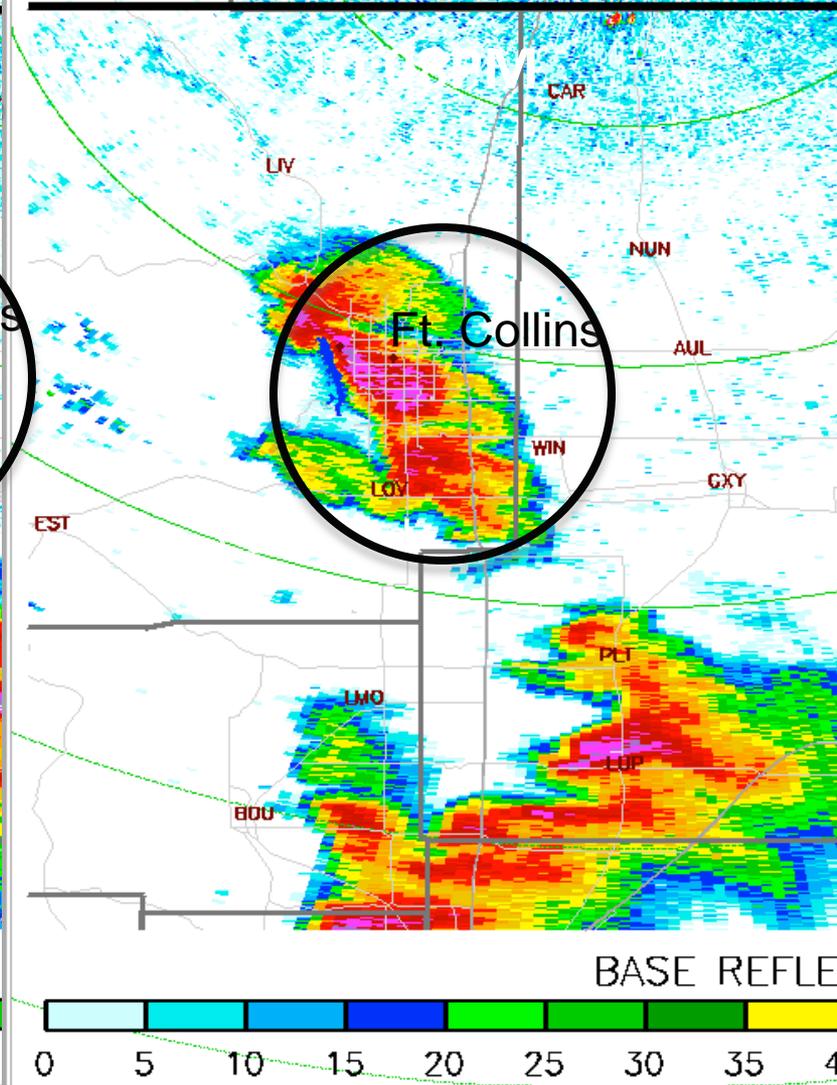
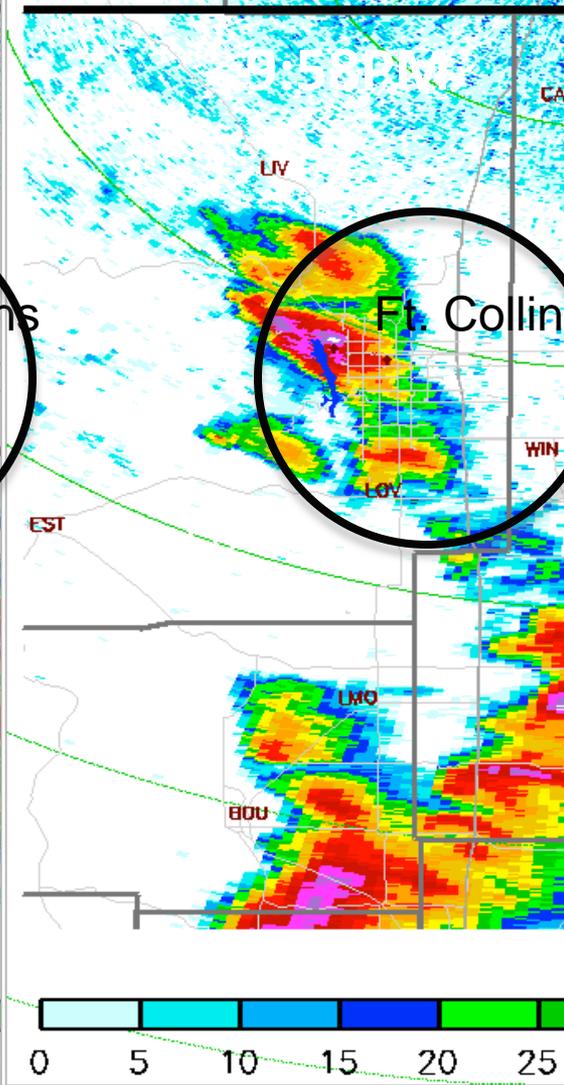
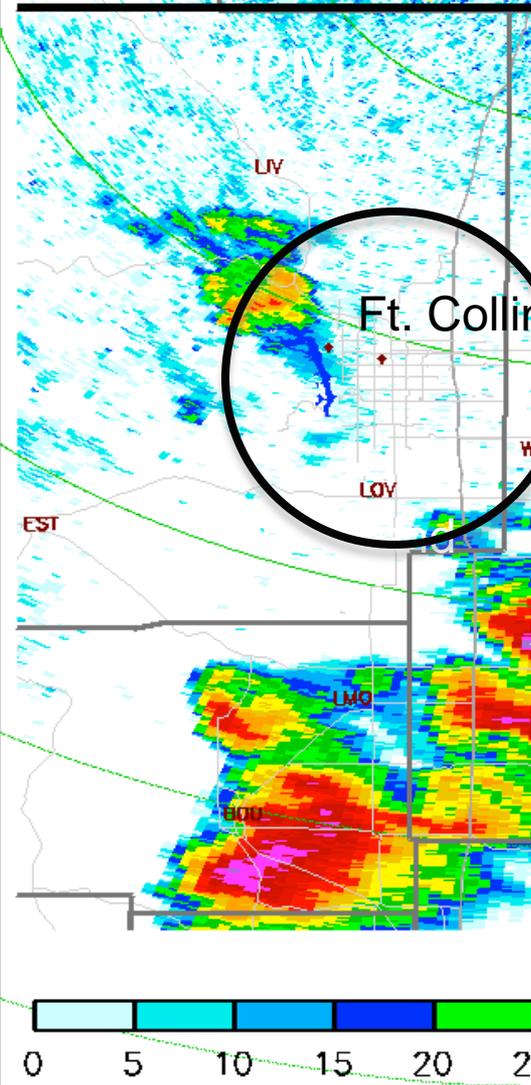
Station TX-CML-17

21 JUL 2009 03:00

21 JUL 2009 03:00

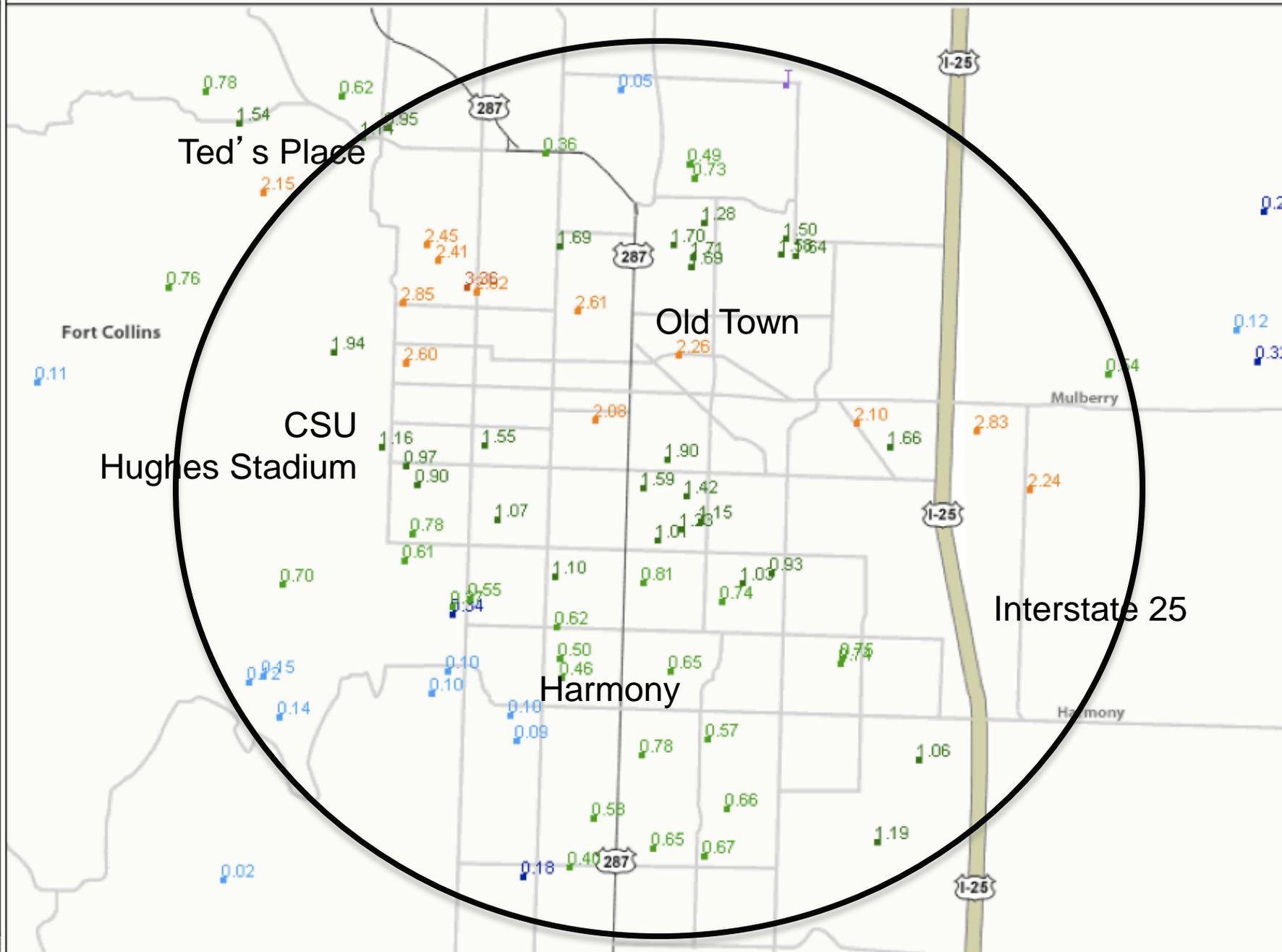
21 JUL 2009 04:08 UTC --

Severe Thunderstorm over Fort Collins, Colorado Monday, July 20, 2009

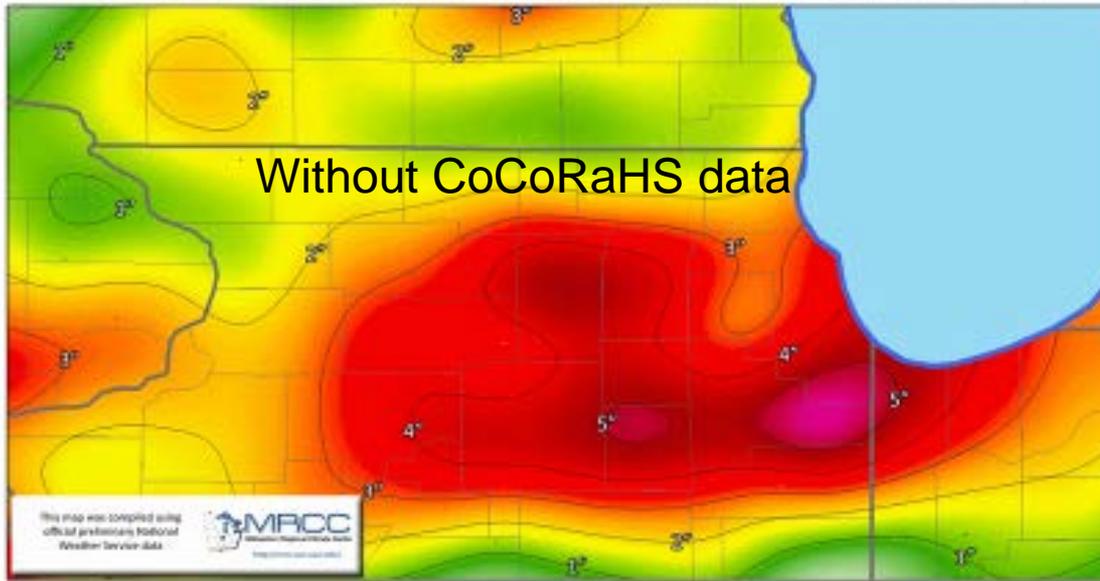


Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am

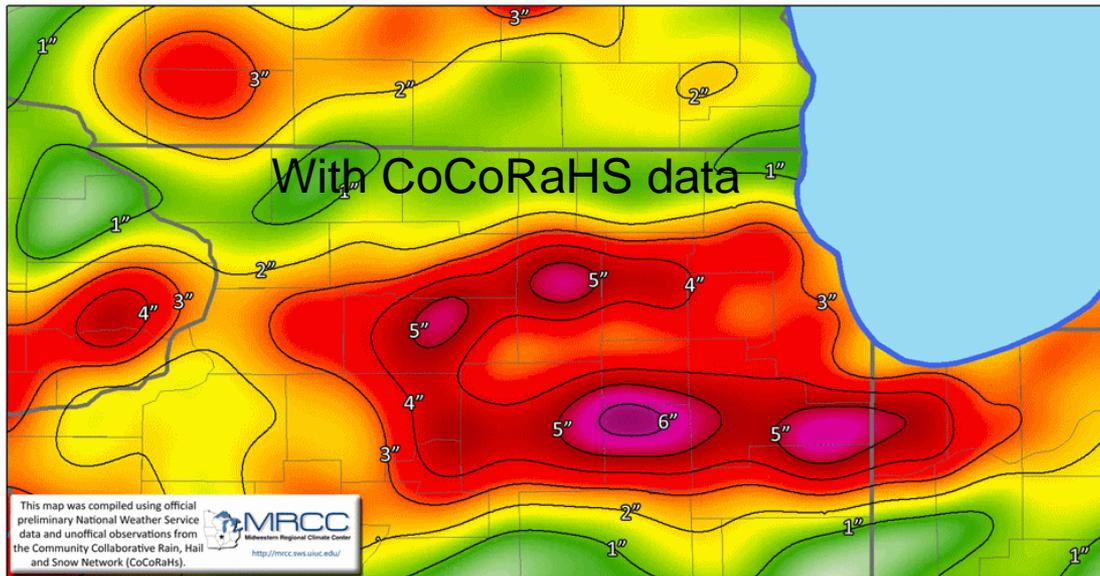
Fort Collins, Colorado 7/21/2009



(A) August 23 & 24 Accumulated Precipitation



(B) August 23 & 24 Accumulated Precipitation



“With CoCoRaHS it’s like increasing the number of pixels on your digital camera.”

You get a much clearer picture of where precipitation did and did not fall!”

Snow Data

CoCoRaHS



Radar doesn't measure snow well

- Satellite-based precipitation products have many limitations for precipitation estimation.

With our local volunteers CoCoRaHS is providing additional “winter weather” measurement capabilities in many states across the country.

In some Colorado cities, there is approximately one CoCoRaHS observer per sq. mile.



CoCoRaHS Volunteers measure both the snowfall depth (new and accumulated) as well as the water content of the snow (SWE)

Hail Data



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



Photo: Virginia Waters

Is CoCoRaHS data used? You bet !

Impacts locally and nationally



Allowing neighbors to compare how much rain has fallen in their community as well as what fell 2,000 miles from home has an impact on improving their climate literacy.



Beneficial to Agriculture and Local Gardeners

CoCoRaHS is a natural fit for agricultural and gardening interests.

Website features include:

- computing water balance
 - comparing measurements
 - evapotranspiration
- observers



CoCoRaHS



Climate Resources
for Master Gardeners



Reference Evapotranspiration

Monitoring water supply and demand together



Measure what comes down
with a rain gauge

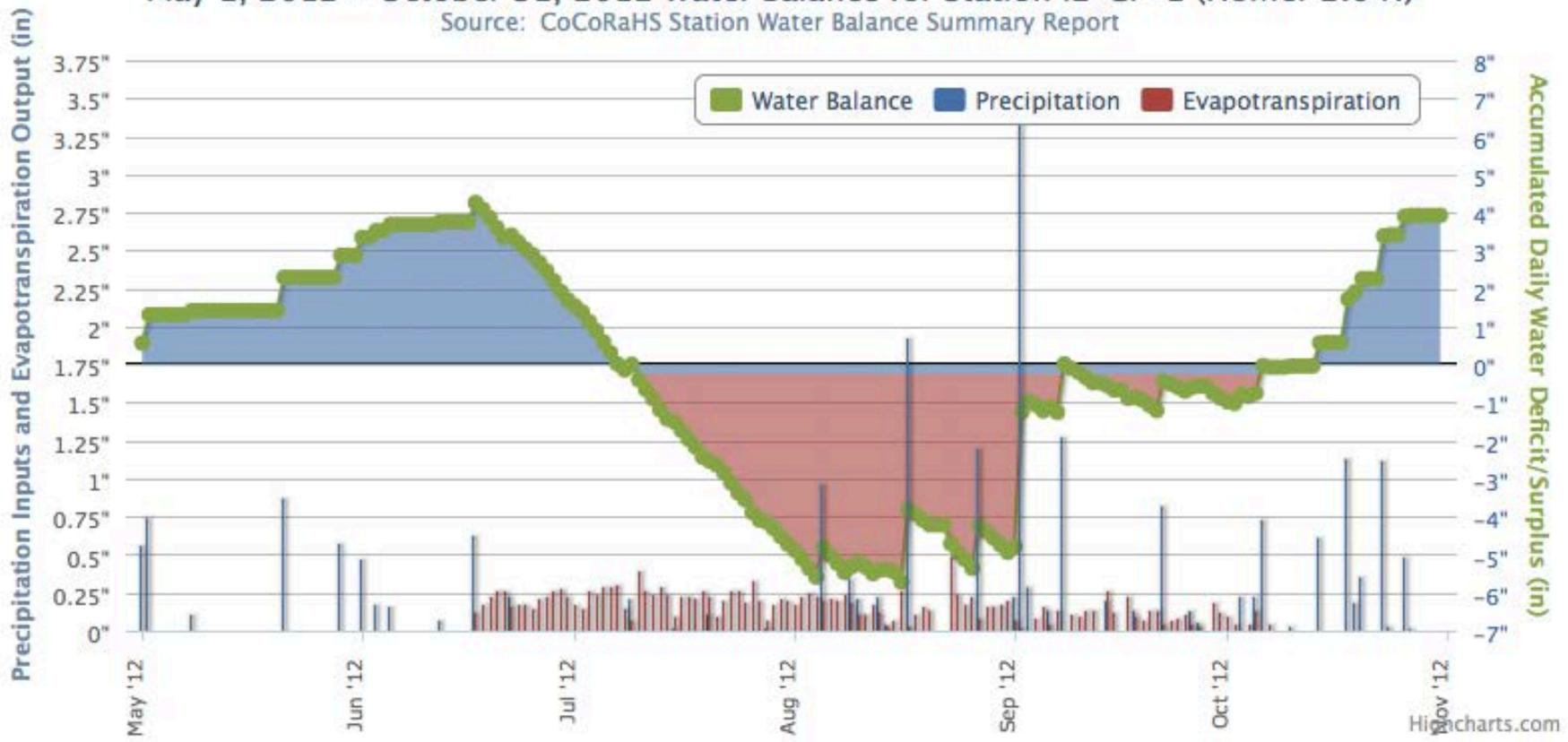


Measure what goes back up
with an ETgauge



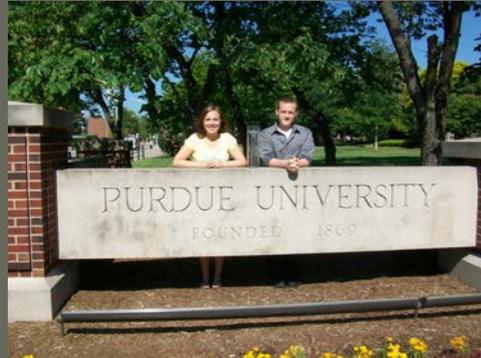
May 1, 2012 – October 31, 2012 Water Balance for Station IL-CP-1 (Homer 2.0 N)

Source: CoCoRaHS Station Water Balance Summary Report



Midwest's Summer Drought of 2012 and fall recovery

Engaging Universities



college of arts and sciences

Weather project engages backyard climatologists

Volunteer weather enthusiasts in the High Country are helping researchers better understand the processes of precipitation in the region through the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS).

"It's very challenging to forecast precipitation in the mountains because of the complex topography. Computer forecast models can't account for the variation of elevation in peaks and valleys, and this is an impediment to developing accurate forecasts," said Bales Perry, an assistant professor in the Department of Geography and Planning.

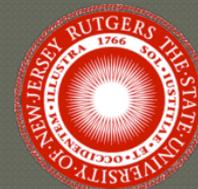
Data collected by CoCoRaHS volunteers provide critical firsthand observations on precipitation in mountain topography according to Perry.

"They also help the National Weather Service and other forecasters better verify their forecast products, ultimately improving weather forecasts," he said.

CoCoRaHS originated with the Colorado Climate Center at Colorado State University in 1998. It now includes more than 4,500 observers in 20 states. All CoCoRaHS affiliates are linked with the National Weather Service and their state's climate office.

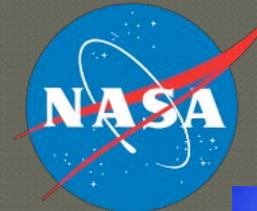
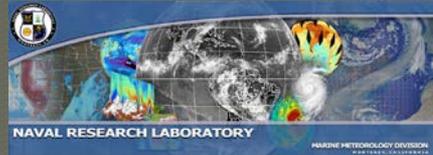
Perry, along with Pete Soule in the Department of Geography and Planning, and Tom Rahnke of the Department of Physics and Astronomy have recruited 17 CoCoRaHS volunteers in Watauga County, and several others in Perry and Ashe counties. ■

Many universities encourage their communities to participate in CoCoRaHS. It's a collaborative effort!



Data used by national entities

CoCoRaHS data is used by national entities on a daily basis. The high quality of the data has proven to be a valuable source of precipitation information.



Improved Drought Awareness

“Making citizens aware of how the lack of precipitation can impact they daily lives”

Drought Impact Report

Station Number: TX-BND-5

Station Name: Bandera 3.9 E

Start Date: 12/10/2010

End Date:

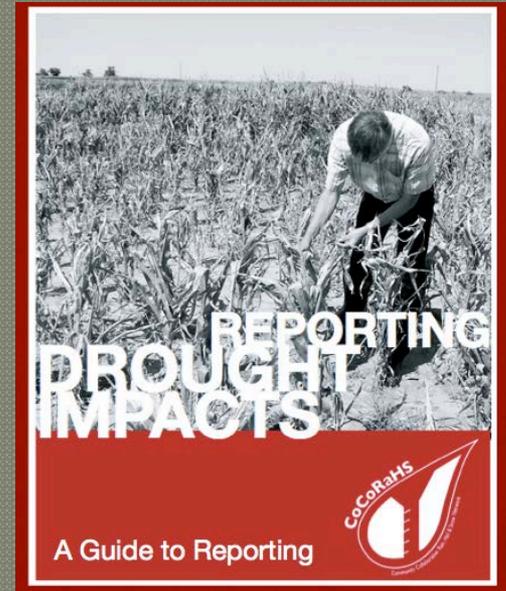
Submitted: 12/10/2010 7:31 AM

Description:

Have curtailed outside burning. Native plants are suffering, large and small wildlife are attracted to any available water source, smaller ponds and creeks are drying up, level of Medina river (about 1/2 mile from property) is noticeably dropping. Local roads are deep in dust.

Drought Impact Categories:

- ▶ Fire : \$0.00
- ▶ Plants and Wildlife : \$0.00



DRINKING WATER TASTE DUSTY?

CoCoRaHS Drought Impacts

Report how drought is impacting your community with a "Drought Impact Report"

Water Supply and Water Quality

The effects of drought have significant impacts on our **water supply and water quality**.

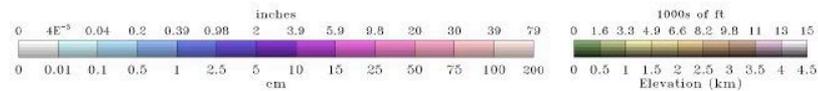
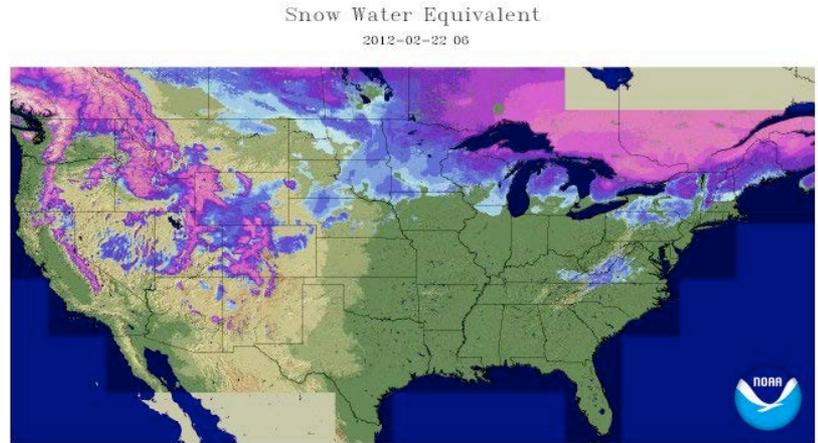
Examples of drought-induced water supply and quality impacts include: Dry wells, water restrictions, changes in water rates, easing of water restrictions, increase in requests for new well permits, changes in water use in water use due to water restrictions, greater water demand, decrease

Citizens Reporting
Drought Impacts

NOHRSC - SNOW WATER EQUIVALENT (SWE) FOR SNOWPACK MONITORING -- GETTING A HEADS UP ON SNOWMELT – VOLUNTEERED DATA HELPS!



National Snow 2011-12 Analysis 2012



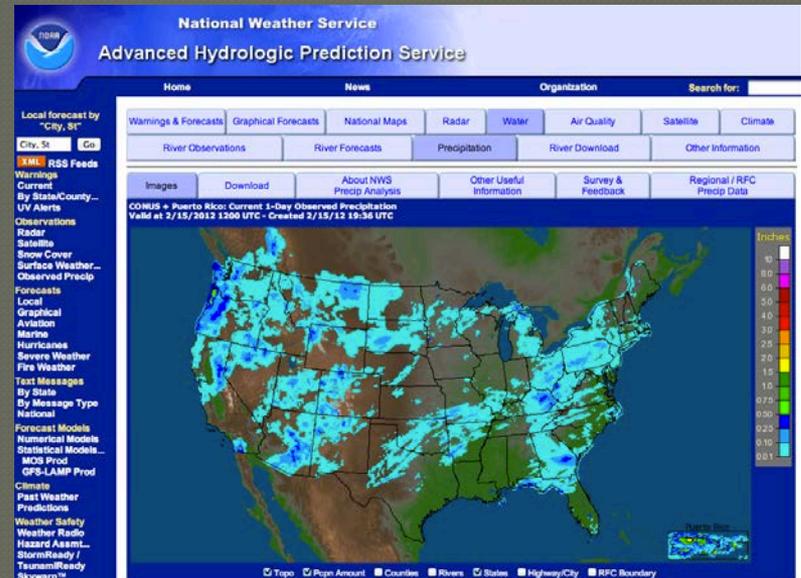
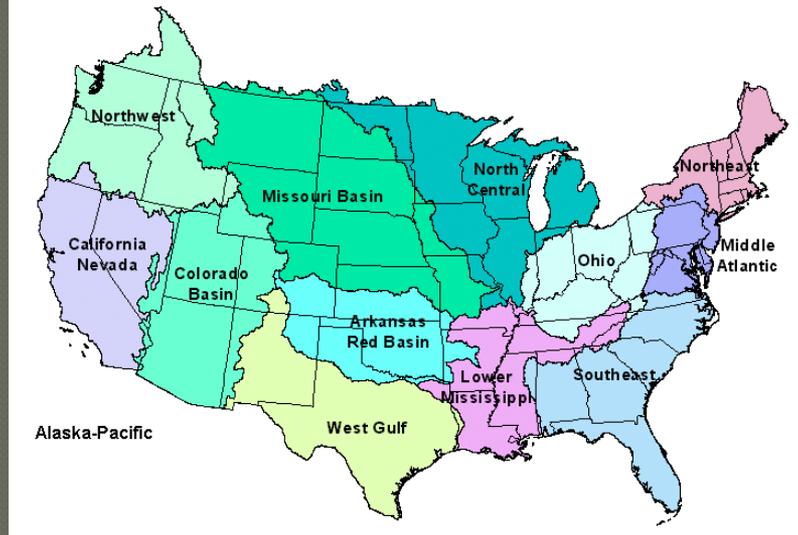
2011 – Souris River, Minot, ND

Photo: Washington Post

Over 50% of their 2011 snow observation reports came from CoCoRaHS observers

NOAA's River Forecast Centers

River Forecast Centers



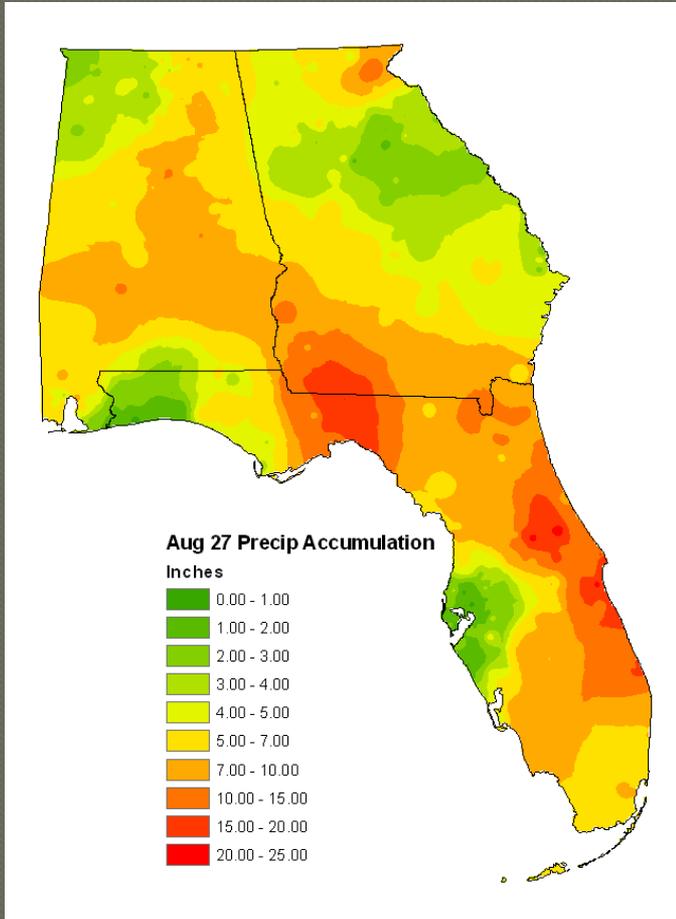
"Your data have filled in the holes in our NWS/USGS gage network. It also is used to improve the bias used in our Multisensor Precip Estimates. The more ground truth we have - the more accurate our river forecasts are."

Patricia Wnek – Mid Atlantic River Forecast Center

Monitoring Tropical Systems



"We use the CoCoRaHS data in our post-storm summary to describe the overall impacts of a tropical cyclone event."



2008 – Tropical Storm Fay

Dan Brown - National Hurricane Center



NexSat & CoCoRaHS

Used in ground truthing satellite precipitation measurements

**GROUND
TRUTH**

The screenshot shows the NexSat web interface. At the top, there are navigation links for 'Training', 'NexSat', 'Feedback?', and 'About_Nexsat'. Below these are buttons for 'Global_Map', 'CONUS', and '/NorthAmerica/CONUS'. A banner at the top right features the NP-ESS logo (Naval Postgraduate School, Monterey, CA) and logos for BGC-Dub and NASA. A red banner below the navigation says 'NEW! CoCoRaHS Precip Comparison product. View here. Found under Rain Totals->cocorah_montage.' On the left is a 'Products' menu with options like Google Earth, Visible, Infrared, Vapor, True Color, GEO-Color, Cloud Tops, Cloud Layers, Cirrus, Snow Cover, Rain Rates, Rain Totals, Contrails, BioMass, CloudSat, Winds, Aerosol, Low Cloud, and Model Overlays. The main content area has a 'NOTE: IE7 users; set browser security setting to MEDIUM for controls to work. Tools > Internet Opt' and a control panel with 'Mode: Direction: Frame: 10' and various navigation buttons. Below the controls are two maps: 'Accum. Precip. for 24 hrs ending: 1001.1400 Z' and '1001.0030 Z'. The left map shows a precipitation map of the US with a color scale from 0.00 to 0.15 inches. The right map shows a satellite-style precipitation map of the US.

CoCoRaHS instantly provides the NWS with data for possible Severe Weather Warnings



DENCCRAHS



Possible Flash Flood or
Severe Thunderstorm
Warnings issued



Hail Reports



Instant Snow Reports



Significant Weather Reports

Additional "Real-Time" Reports

Environmental Outreach

Visitors to nature facilities learn about precipitation, as measurements are gathered and used regularly. Engagement in Maine and North Carolina for coastal applications such as shellfish harvesting.



 **WANTED: Volunteers to Measure Precipitation**
"Because every drop counts" 

The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) is a group of grassroots volunteer backyard weather observers of all ages and backgrounds working together to measure and map precipitation in their local communities. By using low-cost measurement tools, stressing training and education, and utilizing an interactive Web-site, our aim is to provide the highest quality data for natural resource, education and research applications.

The Department of Marine Resources Public Health Division is partnering with CoCoRaHS to recruit volunteers to report rainfall that impacts shellfish growing areas in coastal waters. These data will be used in combination with other criteria to manage shellfish flats during rainfall events. Come and be part of our team!



TRAINING DATES (All trainings start at 6:00 PM and are free and open to the public);

Educational Outreach Opportunities

The screenshot shows the CoCoRaHS website interface. At the top, it says 'COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK' with the tagline 'Because every drop counts'. Below this are navigation links for Home, States, View Data, Maps, My Data, My Account, Admin, and Logout. The main content area is titled 'Hail Pad Examples' and features two images: 'Rain Drops' showing a hand holding a white pad with a small amount of water, and 'Soft Hail Stones' showing a hand holding a white pad with a larger amount of water. A sidebar on the left contains a 'Main Menu' with links like Home, About Us, and Contact Us, and a 'Resources' section with links for FAQ/Help, Education, Training Slide-Shows, Training Video, Drought Impacts, Volunteer Coordinators, Hail Pad Distribution/Drop-off, Help Needed, Printable Forms, The Catch, Message of the Day, Data Analysis, CoCoRaHS Blog, Web Groups, and State Newsletters, and a 'Sponsors' section.

A graphic for the CoCoRaHS WxTalk Webinar Series. It features the CoCoRaHS logo on the right. The text reads: 'CoCoRaHS WxTalk Webinar Series Today's Guest: Dave Changnon "So You Want to Become a Meteorologist?"'. A small portrait of Dave Changnon is shown on the right side of the graphic.

A vertical banner titled 'Things to know about...'. It lists three categories: 'Rain', 'Hail', and 'Snow'. Each category has a corresponding icon and a list of links. Under 'Rain' (a rain drop icon), there are links for 'Overview', 'Weather Radar', and 'Measuring Rain'. Under 'Hail' (a hailstone icon), there are links for 'Overview', 'Hail Facts', 'Hail Figures', 'CoCoRaHS & Hail', 'Hail Pad Examples', and 'Measuring Hail'. Under 'Snow' (snowflake icons), there are links for 'Overview' and 'Measuring Snow'.

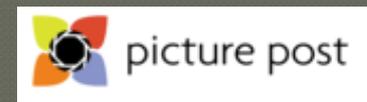
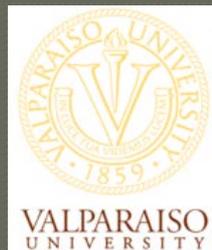
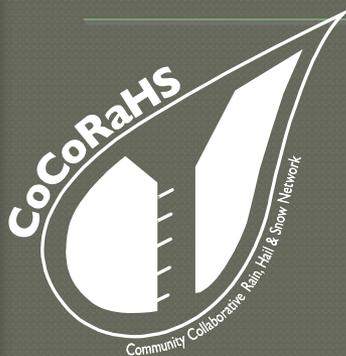


A grid of four training slide show thumbnails. Each thumbnail has a title and links to HTML and PDF versions. The thumbnails are: 1. 'GETTING STARTED' with a CoCoRaHS logo and a landscape background. 2. '"IN DEPTH" SNOW MEASURING' with a background of snow-covered trees. 3. 'ICE ACCRETION' with a background of a person measuring ice on a surface. 4. 'MEASURING THE WATER CONTENT OF SNOW BY WEIGHT' with a background of a person measuring snow in a container.

"Helping to provide the public with a better understanding of weather and climate"

Continue to seek collaborators/partners

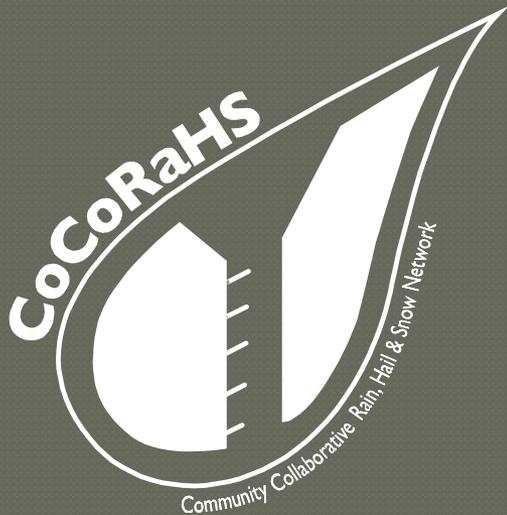
Project BudBurst



CoCoRaHS is a lowest common denominator that continues connections to scientists at universities, federal agencies and citizen-science networks all across the country.

Please let us know of interested parties !

For information and to volunteer,
visit the CoCoRaHS Web Site



www.cocorahs.org

ACKNOWLEDGEMENT:

Support for this project provided by
NSF Informal Science Education Program,
NOAA Environmental Literacy Program
and
many local sponsors.

