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THE COMMUNITY COLLABORATIVE RAIN, HAIL AND SNOW NETWORK (COCORAHS)—A GREAT WAY TO LEARN AND TEACH ABOUT OUR CLIMATE

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1. HISTORY: PAST, PRESENT AND FUTURE

CoCoRaHS, the Community Collaborative Rain, Hail and Snow Network, is a unique, non-profit, community-based, high density network of individual and family volunteers of all ages and backgrounds, who take daily measurements of rain, hail, and snow in their backyards. Volunteers as young as five years old on up to seniors close to 90, use low-cost measurement tools; 4-inch diameter high capacity plastic rain gauges and aluminum foil-wrapped Styrofoam hail pads (Figure 1). With some basic training and with frequent interaction with participating scientists, volunteers are able to collect and share data of considerable scientific value. Their daily precipitation measurements are transmitted on-line using an interactive web site: www.cocorahs.org. Observations are then immediately available in map and table form for project scientists and the public to view. By providing high quality, accurate measurements on the internet, the observers are able to supplement existing networks and provide many useful results to scientists, resource managers, decision makers and other end users on a timely basis.

Figure 1. A rain gauge and hail pad at a typical CoCoRaHS volunteer weather station.

The Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) came into existence in 1998 as the Colorado Collaborative Rain and Hail Study. A flash flood that took several lives in Fort Collins, Colorado in July of 1997 pointed out the extreme local variations in rainfall possible from convective storms and the important role individuals can play in measuring, mapping and reporting precipitation. At first the project was very small with only a few dozen volunteers in Northern Colorado reporting precipitation on a website created by local high school students. Each year since then the project has grown as more people and organizations get involved. In 2003, thanks to a National Science Foundation Informal Science Education grant, the network took its largest step and expanded into the Central Great Plains. Today the network is growing rapidly with over 2000 active participants in six states (Colorado, Nebraska, Kansas, Wyoming, New Mexico and Texas) each administered by state leaders and regional or local county coordinators (Figure 2).

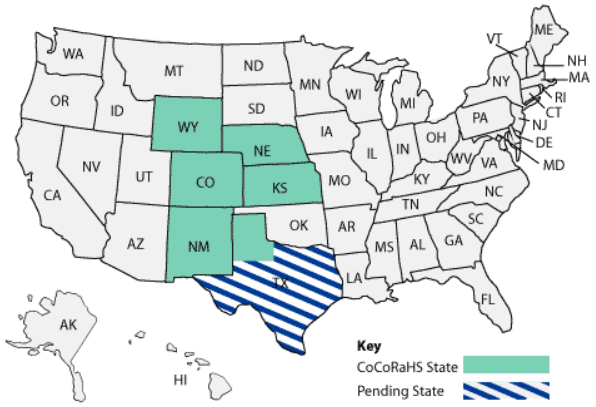

Figure 2. 2005 participating states in the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS).

Each observation of rain, hail and snow may be of interest, but in isolation they are of limited value. However, each report when seen in context with hundreds of others become a colorful and

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ever changing depiction of the weather patterns that water our land and grow our crops. Seven years into the project we now see hundreds of new volunteers joining each year, and there is a growing demand to expand the network into other states. In collaboration with other networks, it is our goal to eventually have a density of observers approaching one per square mile in urban areas and at least one per 36 square miles in rural areas. Data collected so far have shown this spacing to be ideal for the spatial scales of storms and the precipitation patterns we have experienced.

2. WHAT HAVE WE LEARNED SO FAR

Working with volunteers, using the Internet as the primary means of two-way communication, is stimulating, rewarding but with moments of frustration. It has been surprisingly easy to recruit volunteers in many areas – particularly urban and suburban locations, mountain communities, and areas with higher concentrations of retired people. Recruiting in sparsely populated rural areas and in lower income urban areas has been more difficult even though many people are really interested in weather. Here it often works best to ask individuals directly for help rather than waiting for people to volunteer. One of the larger downsides to this project is the very large load of personal e-mail it tends to generate.

We have learned that it is extremely helpful, if not essential, to have local volunteer leaders who serve as our local representatives in recruiting, training, and equipping volunteers. Without a strong and active volunteer leader, progress and growth tends to be slow. This becomes more and more obvious as the project has grown to several states.

Volunteers of all ages participate in CoCoRaHS from as young as 5 years old right up to 90 or above. We have found that our largest sector of highly committed volunteers tend to be retired citizens and families and individuals who have very close connections to water, natural resources management, farming and gardening. On the other end of the spectrum, hundreds of students have signed up to help but most only collect data for short periods of time and do not become long-term volunteers. More men participate than women, although there are many weather enthusiasts of both sexes.

The four-inch diameter high-capacity all-weather plastic rain gauge has proven to be an acceptable gauge for accurately measuring precipitation. Data from these gauges have compared very favorably with the National Weather Service 8-inch diameter Standard Rain Gauge used across the country for more than a century in the NWS Cooperative Program. The main limitations of the 4-inch diameter gauges, which are only occasionally a problem, have been obvious undercatch of windblown snow, insufficient capacity for large snowfall events, proportionally more snow accumulation on the rim of the gauge than is observed with the NWS Standard Rain Gauge, and undercatch of very heavy rainfall events and accompanying hail, most likely due to splash and bounce out of the funnel. With careful siting and positioning of gauges, these problems can be minimized. While CoCoRaHS data are not flawless, they have proven to be of sufficient quality and consistency for most research and operational applications.

One of the very satisfying parts of CoCoRaHS is seeing that the data collected by so many volunteers is, in fact, used. Several dozen organizations have become CoCoRaHS local or regional sponsors. This is not just due to the goodness of their hearts, but because accurate and timely precipitation measurements provide valuable data that help many organizations. Examples of some of our current sponsors and data users include:

- NOAAs National Weather Service who uses reports of heavy rain and hail to help issue severe weather warnings or to verify local forecasts.
- The US Dept. of Agriculture who utilized rain, hail and snow reports to assess crop conditions, determine drought severity, and predict crop production and yield.
- The U.S. Bureau of Reclamation who has been supporting the expansion of CoCoRaHS in order to more carefully track precipitation patterns and snow melt in order to better forecast stream levels and flow volumes.

Many other local and state agencies and business are also involved. Departments of Natural Resources help out in several states. Local water and storm water utilities use CoCoRaHS to anticipate both water supply and local demands as well as monitor and analyze flooding associated with local storms, Agricultural organizations, and local conservation districts are very interested in knowing and helping collect local rainfall data. The fact is that anytime there is a storm, there are many organizations who benefit by knowing where the moisture fell. CoCoRaHS is able to provide this information quickly and easily.

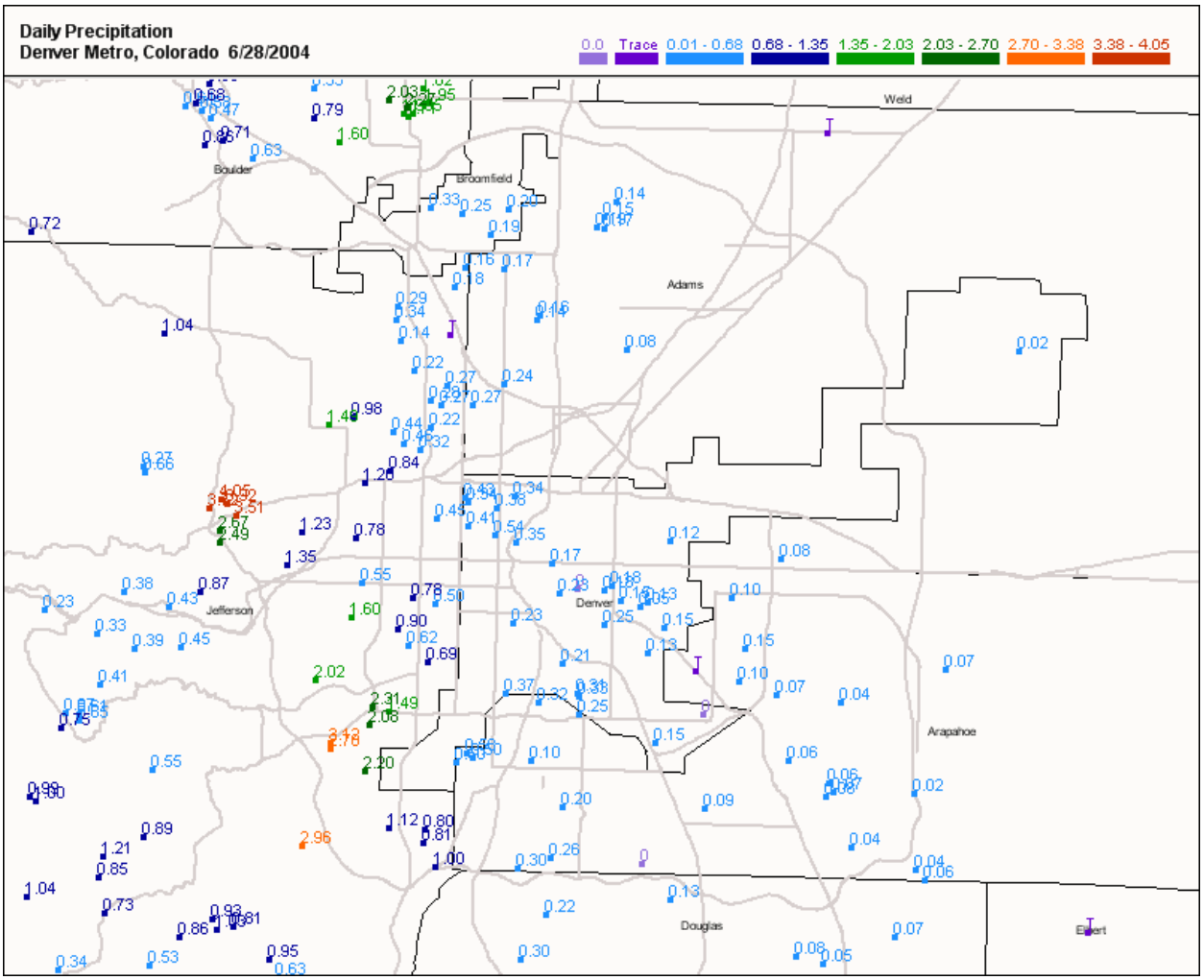

Figure 3 Daily rainfall (inches) for the Denver, Colorado metropolitan area for the 24 hours ending 0700 MDT 28 June 2004.

3. SOME EXAMPLES OF RECENT FINDINGS FROM DATA OBSERVED BY THE NETWORK

Easy access to hundreds of rain, hail and snow reports over the central Rocky Mountains and Central Great Plains have made climate analyses quick and easy for both scientists and volunteer participants. For example, during calendar year 2004, measurable precipitation fell somewhere in the state of Colorado on 306 days. However, on only 94 days did precipitation fall at more than half of the reporting stations in the state, and there were no occurrences of precipitation falling at all reporting stations in the state on the same day. This shows the orographic influences and the localized nature of precipitation in this region. Similarly, while most individual locations received hail on only 1-5 days during the year, over the state as a whole, hail was reported on 118 days in 2004.

CoCoRaHS does an excellent job of verifying heavy rainfall patterns and is being used routinely as ground truth for remote sensing applications. The rainfall pattern over Denver, Colorado for the 24-hours ending at 7 am MDT 28 June 2004 is shown in Figure 3. This storm produced significant urban and small stream flooding over western portions of the Denver metro area. Figure 4 shows a recent example of an extreme rainfall event in Nebraska 11–12 May 2005. Thirteen volunteer stations, most near Grand Island, received eight or more inches of rain.

The network does a comparable job of documenting individual snow and hail storms. Over time, climatological assessments become possible. In the Fort Collins, Colorado local area,

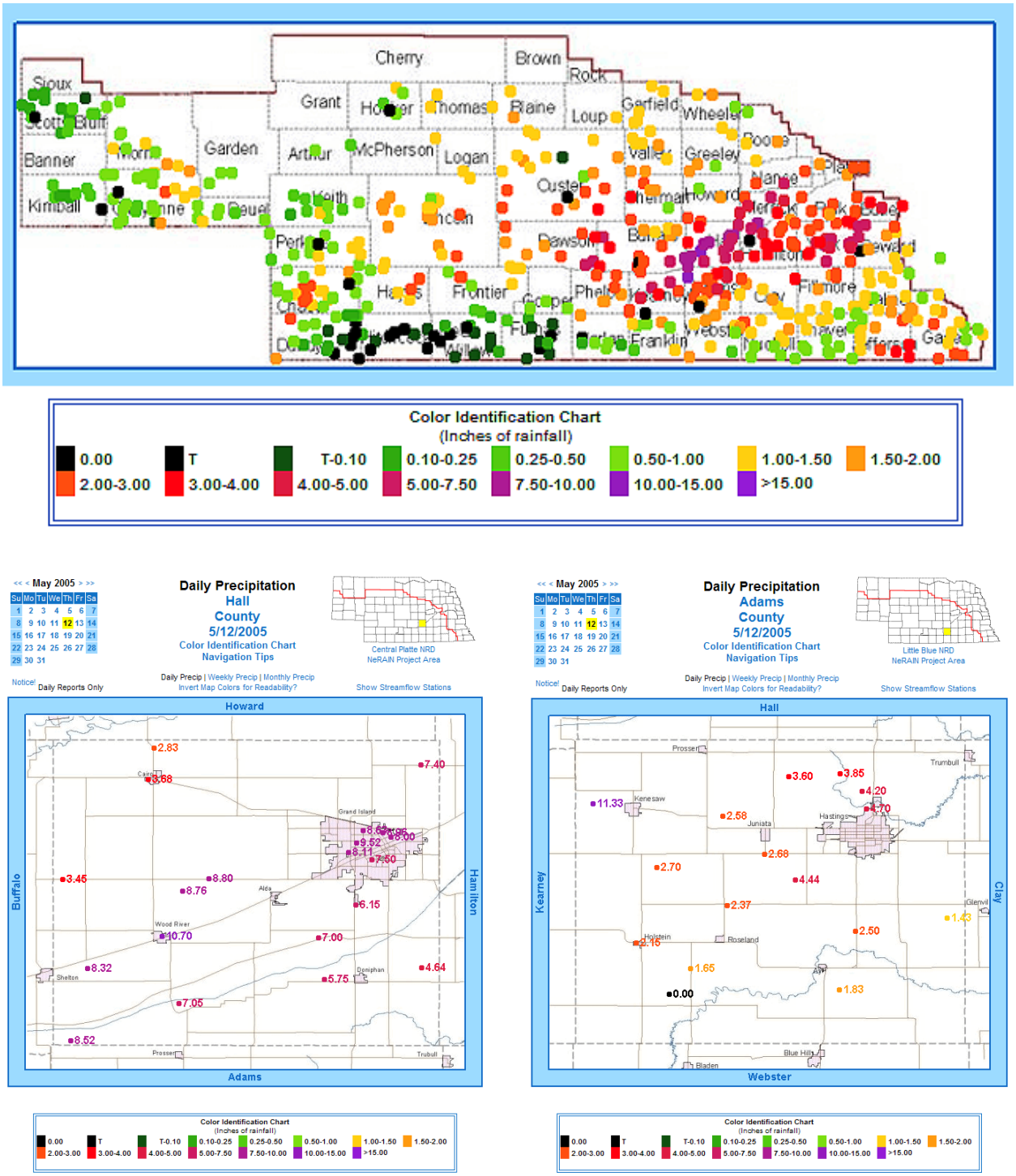

Figure 4. Daily rainfall (inches) for the southwestern half of Nebraska (top map) for the 24 hours ending at 0700 CDT 12 May 2005 with county enlargements for Hall County including Grand Island (lower left chart) and Adams County including Hastings (lower right chart). Nebraska operates their own program called NeRAIN (Nebraska Rainfall Assessment and Information Network (http://dnrdata.dnr.state.ne.us/NeRAIN/index.asp) under the CoCoRaHS umbrella. The maximum observed rainfall was 11.33 inches west of Hastings, Nebraska.

seven years of data have shown a much larger variation in annual precipitation than was previously thought. Over a distance of only 10 miles, mean annual precipitation decreases by nearly 4 inches form southwest Fort Collins to the northeastern edge of the city. This is more than 25% of the mean annual precipitation at the official historical weather station on the campus of Colorado State University.

4. WHAT HAVE WE BEEN ABLE TO TEACH

CoCoRaHS, by design, is a two-way project. We are not just gathering data collected by volunteer observers to help scientists and resource managers. We are engaging volunteers in active learning. Beginning with instruction on how to set up a backyard rain gauge and how to deal with the challenges of melting, settling and drifting snow, participants learn the importance of instrument siting and exposure, and consistent observing practices for ensuring accurate scientific data. Volunteers are strongly encouraged to look at the rain, hail and snow maps that are produced each day on the website and see where precipitation fell and how it varied in their areas. They are encouraged to see how their local observations helped produce a more complete picture of storm tracks and water resources. Beyond that, volunteers can participate in other research and learning activities as much or as little as they have time for. All participants with e-mail addresses and who are interested in our activities receive weekly project updates and weather reports. A printed newsletter is sent out at least once per year highlighting observing, research and education activities. We also attend or sponsor a large variety of formal and informal educational events each year ranging from the Colorado Farm Show, Children's water festivals, various field trips, teacher workshops, to the annual Rocky Mountain Weather and Climate Workshop.

Through the internet, volunteers have direct access to project scientists and can ask questions at any time. Participants are encouraged to help with data analysis and with special experiments. Currently, several volunteers are helping design low-cost wind shields for CoCoRaHS rain gauges to improve gauge catch efficiency during strong winds. Others are helping study backyard precipitation variability to help determine optimal placement of rain gauges.

Students at any grade level are able to be a part of CoCoRaHS. While most students only participate for short periods, teachers are delighted that their classes can be a part of "real research collecting real data".

Finally, CoCoRAHS increases community awareness about our weather and it's impacts. With each day's precipitation available for viewing on-line, both scientists and citizens alike are fascinated by the always-differing patterns of precipitation across their states and local areas.

5. CONCLUSION

CoCoRaHS works. Precipitation data are important. Volunteers do provide valuable data. What is working in Colorado and adjacent states can work anywhere in the country. In combination with existing long-term observing networks of the National Weather Service, we could create the best water resources monitoring program of all time. As the network continues to expand, it remains our hope to keep a "local feel" to the network for the observers in each state. By collaborating with state climatologists, National Weather Service offices, the USDA, NRCS, and other individuals and local organizations, we hope that new states can develop their own local flavor and emphasis while still being part of the larger national CoCoRaHS "umbrella." By keeping the efforts of the observers to a minimum, using low tech affordable equipment and making science fun, we look forward to seeing many more data gaps filled in on the map of this great country of ours.

6. ACKNOWLEDGEMENTS

This research is supported by the National Science Foundation (NSF) grant number 0229723 and numerous Charter Sponsors listed at www.cocorahs.org/about/sponsors.html.