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COCO RAHS – COMMUNITY COLLABORATIVE RAIN AND HAIL STUDY

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1. INTRODUCTION

The Community Collaborative Rain and Hail Study (CoCo RaHS) is now in its 6th year and is completing its first year under the support of the National Science Foundation's Informal Science Education program. The project began as a community response to a devastating but highly localized flash flood which brought havoc to portions of Fort Collins, Colorado July 28, 1997. For several months following that storm, scientists worked to gather data, map rainfall patterns and gain some understanding about what caused this extreme but highly localized storm (Petersen et al, 1999). Total precipitation ranged from less than 2 inches (50mm) over some of the city to more than 14 inches (350 mm) near the core of the storm. These huge differences occurred over distances of only about 5 km such that many residents had no idea of the devastation that was occurring until friends or relatives from other parts of the country and world who saw pictures on television called them to see if they were OK.

Much of the data used to analyze rainfall patterns came from hundreds of local citizens who happened to have rain gauges or other receptacles in place for collecting rain. These reports proved critical to meteorologists, hydrologists and emergency managers attempting to understand what had happened that night. The enthusiastic participation of local citizens of all ages gave a strong indication that a volunteer network could be employed to help study local storms.

The Colorado Climate Center at Colorado State University launched CoCo RaHS in northern Colorado in the spring of 1998. Seed money from the Colorado Office of Emergency Management and the City of Fort Collins Utilities Department along with in-kind support from the National Weather Service and several other organizations made this possible. Since that time, the network of volunteers has grown steadily, and CoCo RaHS has become a climate monitoring network and science education program serving an ever-growing community of rural and urban participants.

2. HOW CoCo RaHS WORKS

The concept of CoCo RaHS is very simple. Volunteers are recruited by any of a variety of means ranging from newspaper articles and school announcements to personal invitations. People of all ages and backgrounds are welcome. Volunteers attend training sessions in their communities. CoCo RaHS staff, sponsors and/or local volunteer leaders describe the goals of the project and provide basic training in how to measure rain, snow and hail. Emphasis is placed on the importance of very accurate and consistent measurements for scientific research. Experience has shown that the most effective training sessions are often those that include participants of all ages – school age right up through senior citizens. Volunteers who decide to join the project are then equipped with simple instruments – a rain gauge (Figure 1) and a supply of "hail pads" (squares of Styrofoam covered by extra-heavy duty aluminum foil) (Figure 2). Sponsoring organizations often provide these instruments free of charge or at a reduced cost for the volunteers.

Figure 1. The CoCo RaHS rain gauge is a clear plastic gauge four inches in diameter suitable for use in all seasons and weather conditions. This gauge is able to measure accurately in increments of 0.01" and can hold up to a total of 11 inches of rain without spilling. It is used extensively by the National Weather Service in weather spotter networks.

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Figure 2. A CoCo RaHS "Hail Pad" showing the clearly visible dents caused by a recent hail storm.

The control center for the CoCo RaHS project is the website:

http://www.cocorahs.org

This is where daily rainfall reports and special severe weather reports are submitted and where data are displayed. The website also serves as the educational center of the project with on-line training materials, questions and answers, links to various informative weather and climate websites and announcements of CoCo RaHS activities. A calendar of CoCo RaHS training sessions and events is posted and updated. Most volunteers report each day by using the web-based data entry system. Volunteers without internet access can report by phone. The benefit of internet access is that volunteers can immediately see the data they have entered and note the local patterns for precipitation in their own community and neighborhoods (see Figure 3).

All data from volunteers are archived from the time the project first started in 1998. Rain, hail and snow data are displayed on various map and report formats easily accessible on the WEB. These information products derived from volunteer data help scientists describe storm patterns. In addition to showing patterns of precipitation from individual storms, the data are also used to identify the average rainfall, frequency and severity of hail, the extent of drought, the rainfall needed to cause flooding and much, much more. As more and more data are being gathered, preferred storm tracks are being identified and the effects of mountain ranges (both elevation and orientation) are clearly being shown. Scientists and

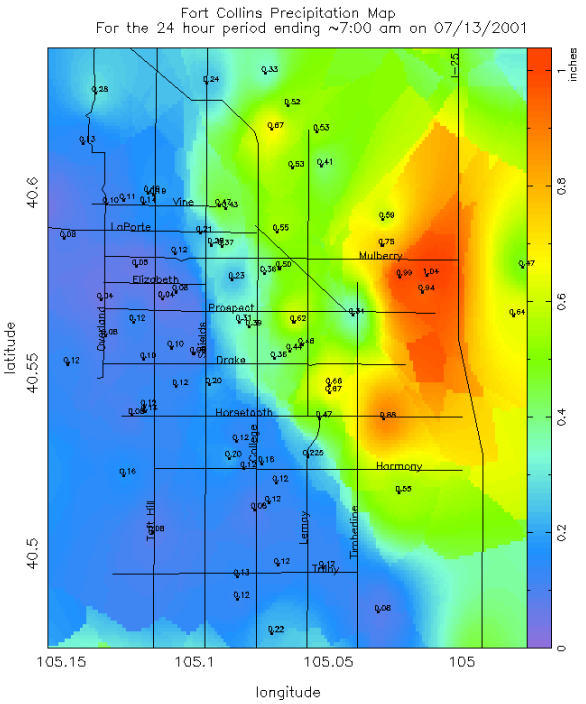

Figure 3. Fort Collins contour precipitation map for July 2001 created from CoCo RaHS volunteer's data.

participants are all learning together about Rocky Mountain and Great Plains weather.

When the project first got started in 1998 there were only a few dozen volunteers, many of them local students from the Fort Collins area of northern Colorado. The original CoCo RaHS website was created and maintained by high school students. Enthusiasm was high, but professionalism was a little shaky. Now just a few short years later, many people in Colorado know about CoCo RaHS. Volunteers can now sign up and train online. The program is growing almost daily. In late 2002 CoCo RaHS was selected for funding through the NSF Informal Science Education program. This has allowed the addition of staff, resources and activities focused on outreach and education while maintaining the participatory research program concept. A variety of activities for students, adults, teachers and communities are now being offered. CoCo RaHS also has support from more than 30 local, state, and federal agencies in Colorado as well as several businesses. Many of these groups have provided funds for materials or in-kind donations since the project was initiated.

The program is very popular in Colorado for one simple reason. It provides accurate and easily accessible precipitation data via the Internet that meets the immediate needs of a variety of users. These users range from weather forecasters and professional hydrologists to farmers, ranchers, government officials as well as students and teachers.

3. THE POWER OF VOLUNTEERS

CoCo RaHS is powered by a large and growing army of volunteers who share a desire to help measure rain, snow and hail and to learn about the weather of their region. Recruiting volunteers is proving to be one of the easiest parts of the project. Wherever we go, people are interested in helping. Since 1998 over 1500 individuals have signed up to join CoCo RaHS and over 1200 volunteers have been equipped and received training to help measure and report precipitation. More than 550 new volunteers have joined the program in 2003 alone, many simply hearing about the project from friends, neighbors, family members or on the Web. There are now volunteers in more than 2/3 of all Colorado counties with more than 200 in Larimer County where the project first began. At the peak of the summer thunderstorm season, 750 volunteers were actively collecting and reporting precipitation. A recent inventory of participation showed that in 2003, volunteers contributed close to 15,000 hours of their time helping track and map the precipitation patterns that are so important to the lives and livelihoods of the people of the Central Great Plains and Rocky Mountain region. That equates to 15,000 hours learning about the climate and water resources of the land.

As the project grows, CoCo RaHS staff are relying more and more on local volunteer leaders to help manage project logistics on a county or community basis. Local community and/or county volunteer coordinators are now in place in 25 counties of Colorado including all but two of the 19 counties of northeastern Colorado that constitutes the primary volunteer target area for the ISE project. There are now more than 35 volunteer coordinators and volunteer specialists, including the other CoCo RaHS volunteers such as those who specialize in distributing supplies, answering phone calls, checking data and providing feedback to volunteers.

4. 2003 ACCOMPLISHMENTS – A BIG YEAR FOR CoCo RaHS

Support from the NSF Informal Science Education program has provided a great boost to CoCo RaHS. What used to be a “nights and weekends” activity for the staff of the Colorado Climate Center at Colorado State University is now a budgeted and high priority project helping the Center accomplish one of its major goals – timely statewide climate monitoring. Two staff members were hired during the spring of 2003. Ms. Bonnie Brzezinski is the CoCo RaHS project coordinator and Mr. Julian Turner works half time as CoCo RaHS web developer. The ISE grant also established a partnership between the Colorado State University CHILL Radar facility (NSF supported) and the Colorado Climate Center with its strong existing infrastructure for education and outreach.

A CoCo RaHS Advisory Board was convened in 2003 to help set realistic goals, review project plans and activities, and respond to the challenges of a fast growing research and education program. Dr. Leonard Albright from the CSU Education Dept. joined the CoCo RaHS team to assist the group in conducting and utilizing appropriate evaluation techniques to track progress and effectiveness.

The foundation was laid during the summer of 2003 to begin the expansion into the Central Great Plains regions of Wyoming and Nebraska in the months to come. The project has been received enthusiastically in both states although the means of expansion will differ. Leadership in Nebraska will likely be in the hands of the Nebraska Department of Natural Resources while in Wyoming the University of Wyoming in conjunction with the Wyoming Water Development Commission and Wyoming Water Resources Data System will spearhead the program. One thing both states will have in common is a local support structure specific that makes the project look and feel like a local activity to those who participate.

- *Formal Education Activities*
  Formal education accomplishments during 2003 included a half-day workshop for science and math teachers in NE Colorado. Emphasis was placed on measuring and mapping rainfall patterns and how weather radar works in tracking storms. CoCo RaHS staff participated in the annual “Earthworks” field camp carried out by the University of Colorado. Presentations were made at several schools in Colorado including one

school where most students can speak only Spanish. One high school science teacher in Fort Collins has made CoCo RaHS participation a requirement for about 60 students who build and calibrate their own rain gauges and use home-made scales to measure rainfall.

- *Informal Education:*
  Informal science education was the main focus of 2003 activities. More than 20 training sessions were held in 11 counties of Colorado. CoCo RaHS staff lead many of the training sessions, but trained local coordinators handled all of the training activities in several counties.

  - Field trips were arranged for volunteers to visit the CHILL Radar facility near Greeley, Colorado.
  - CoCo RaHS was present at the Colorado Farm Show and the Greeley Conservation Fair as well as annual water festivals held for elementary students and teachers in several eastern Colorado communities.
  - CoCO RaHS volunteers helped staff a CoCo RaHS display that was a part of the 12-week "Make a Difference" program held at the Denver Museum of Nature and Science in conjunction with the Jane Goodall Chimpanzee exhibit.
  - A public program entitled "The Joy of Natural Phenomena" was held in Boulder, Colorado cosponsored by the National Center for Atmospheric Research.
  - A highlight of the year was the Rocky Mountain Weather and Climate Workshop, an all-day workshop for CoCo RaHS volunteers. This program included talks by renowned scientists, tours of the National Weather Service, the NOAA Space Environment Center and the National Center for Atmospheric Research and opportunities for volunteers to meet with and talk in person to a number of experts on Rocky Mountain weather and climate.
  - The most effective means of informal education, within CoCo RaHS, has been e-mail. All volunteers with e-mail addresses can sign up to receive regular periodic updates on weather conditions and CoCo RaHS findings. More than 800 families or individuals are currently receiving these CoCo RaHS updates several times per month.

5. CLIMATE SUMMARY FOR 2003 -- SOME GREAT WEATHER TO REPORT

Snow: For the period of January through October 2003, measurable snowfall was reported over sizeable portions of Colorado on 73 days. The snowstorm of March 17-19th was a great success story for the project. While the snowfall along the Colorado Front Range far exceeded the capacity of the precipitation gauges we use, the diligence of hundreds of volunteers resulted in what is likely to become the best mapped and best analyzed major snowstorm in Colorado history. In all, 391 volunteers submitted snowfall reports on March 18th with that number dropping off on the 19th and 20th as the snow blockaded some people. Snowfall for the storm exceeded 70 inches in the foothills west of Denver and Boulder. Even in Denver and Fort Collins over 30 inches of very heavy, wet snow fell. Snow water content for the storm exceeded 5" in Fort Collins and in many foothills locations making this one of the 3 worst snowstorms in Colorado Front Range history based on total water content. Dozens of buildings were damaged or totally destroyed by the weight of this storm (Figure 4).

Figure 4. Bed Bath & Beyond collapsed roof from March 17-19th snowstorm. Photo taken by John Fischbach, City of Fort Collins.

Rain: After a very dry 2002, 2003 brought a return to near average rainfall. Now that stations are located in more than half the counties of the state, we found that precipitation fell somewhere in Colorado on the large majority of days during the year. Precipitation of at least a Trace was reported at 20 or more CoCo RaHS reporting sites

on 211 days during the period January through October – not bad for a dry semiarid state. Only 33 days during the same 10-month period had no measurable precipitation at any CoCo RaHS reporting stations in Colorado. June had the most frequent and widespread rainfall events of the year, while late October brought long periods of consecutive dry days to the entire region.

Hail: More than 900 reports of hail were submitted by volunteers during 2003 (Figure 5). 500 hail pads have been turned in for processing and analysis (Figure 6). Hail was reported on more than 80 separate days during the spring and summer including almost every day in June. Student assistants count hail stone sizes, photograph hail pads, and post digital images of all 2003 CoCo RaHS hail pads on the website so that all of this data are publicly available. Quantitative data on the number and size of hail stones and the duration of hail events is generally not available from any other source of data in the U.S. We welcome and encourage anyone interested in the characteristics of hail to consider making use of this unique data set.

Figure 5. One inch hailstone recorded by a CoCo RaHS volunteer from impromptu station in a parking lot in Golden, CO.

6. FUTURE PLANS

The next step in CoCo RaHS is expansion into the neighboring states of Wyoming and Nebraska. It is not easy keeping track of so many volunteers, so as we begin our expansion we will be striving to establish a strong local group or team of collaborators to provide leadership in each state. The CoCo RaHS staff will then be able to focus more of our attention on improving project infrastructure and education support. Plans are in place to launch a new CoCo RaHS website early in 2004 that will automate more of the data quality checking and provide more on-line training and learning opportunities for participants. This new website will also make it possible for weather enthusiasts for other parts of the country to make use of the CoCo RaHS system for collecting and sharing weather data.

Figure 6. Mountain of hail pads ready to be categorized and photographed for the CoCo RaHS web site.

Research will become a greater part of CoCo RaHS. Remote sensing research conducted with the CSU CHILL Radar and the National Weather Service facilities across the region is exploring how to improve the prediction and tracking of severe and damaging hail. Ground truth measurements of rain and hail from CoCo RaHS volunteers will be very important to this research effort.

CoCo RaHS will be offering more educational opportunities in 2004. We are working with the Board of Cooperative Educational Services in NE Colorado to bring personalized weather and climate training opportunities to teachers and students in small, rural communities of the Central Great Plains. We will be teaming with the National Weather Service and the GLOBE program which has recently moved its offices to Colorado.

Mostly, we'll all just keep enjoying the marvels of our atmosphere and the amazing ways that clouds and storm systems bring water to our thirsty land.

7. REFERENCES

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