

Climate and Water:
from the perspective
of the
Colorado State Climatologist

August 31, 2010

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CSU Department of Atmospheric Science

Some topics we'll cover

- What does a State Climatologist do?
- Climate vs. Weather
- Some highlights of our Colorado climate
- The Water Year and why we use it
- Seasonality and variability
- Detecting Climate trends – not so easy
 - Temperature varies some, precipitation varies a lot
- CoCoRaHS – A hobby out of control 😊

First, Some Definitions...

- **Meteorology** - a science that deals with the atmosphere and its phenomena and especially with weather and weather forecasting
- **Weather** - the state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness
- **Climate** - the statistical collection of weather conditions at a place over a period of years

Weather vs. Climate

□ Weather

- Condition of the atmosphere at any particular time and place, day-to-day state of the atmosphere

□ Climate

- Accumulation of daily and seasonal weather events over a long period of time (weeks, months, years and longer)
- Includes weather and weather extremes (heat waves, cold spells)
- Long-term averages of weather variables (e.g., temperature, precipitation amount and type, air pressure, humidity, cloudiness, sunshine, wind speed and direction), departures of weather variables from *normals* (more about normals later!)

Weather vs. Climate

- Type of clothing we wear today
- Windows open or closed today? This week?
- If a crop will reach maturity: hail can destroy a crop in a day!
- Warm and rainy for a day: *raincoat*
- Type of clothing we buy and keep
- Housing: straw hut vs. brick house
- Crop selection (timing and species): Mangoes are not a good crop in Oklahoma
- Warm and wet for MANY years: *rainforest*

What *weather* determines

What *climate* determines

In other words -- Climate is
what you expect, but the
weather is what you get.

So What does a State Climatologist do?

Nolan Doesken

State Climatologist, Colorado Climate Center
Atmospheric Science Department
Colorado State University

We are - - -

- Data gathers
- Historians and archivists
- Climate monitors and analysts
- Research scientists
- Interdisciplinary collaborators
- Teachers and advisors
- Climate interpreters
- Writers and public speakers

The Colorado Climate Center was established by the state in 1973, through the Colorado State University Agricultural Experiment Station, to provide information and expertise on Colorado's complex climate. Through its threefold program of ***Climate Monitoring*** (data acquisition, analysis, and archiving), ***Climate Research*** and ***Climate Services***, the Center is responding to many climate related questions and problems affecting the state today.

Let's Talk a bit about what I know
the most about –

Colorado's Climate

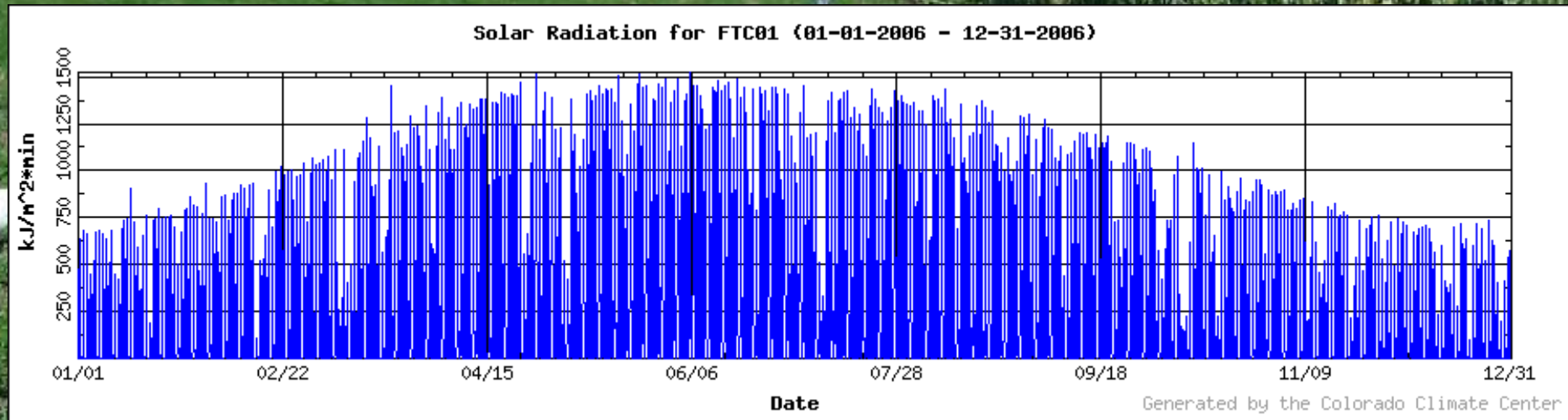
What's so Amazing about Colorado?

- High elevation (highest state in the Union – by far)
- Mid-Latitude location (lively seasonal changes)
- Interior Continental Location far from atmospheric moisture sources
- Complex Mountain topography

The Result?



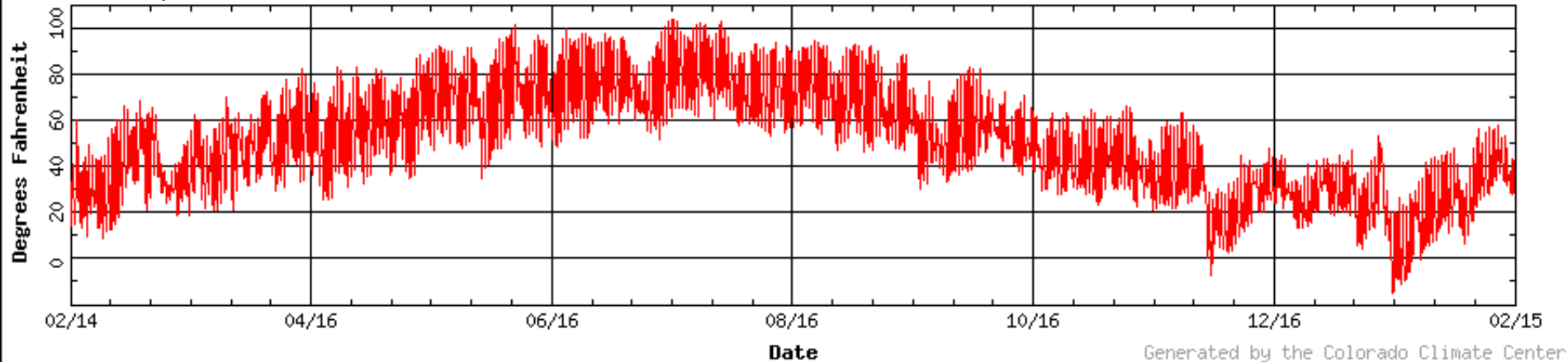
Generous sunshine and low humidity, i.e. people like it here



Large Seasonal Temperature Variations

Fruita, Colo.

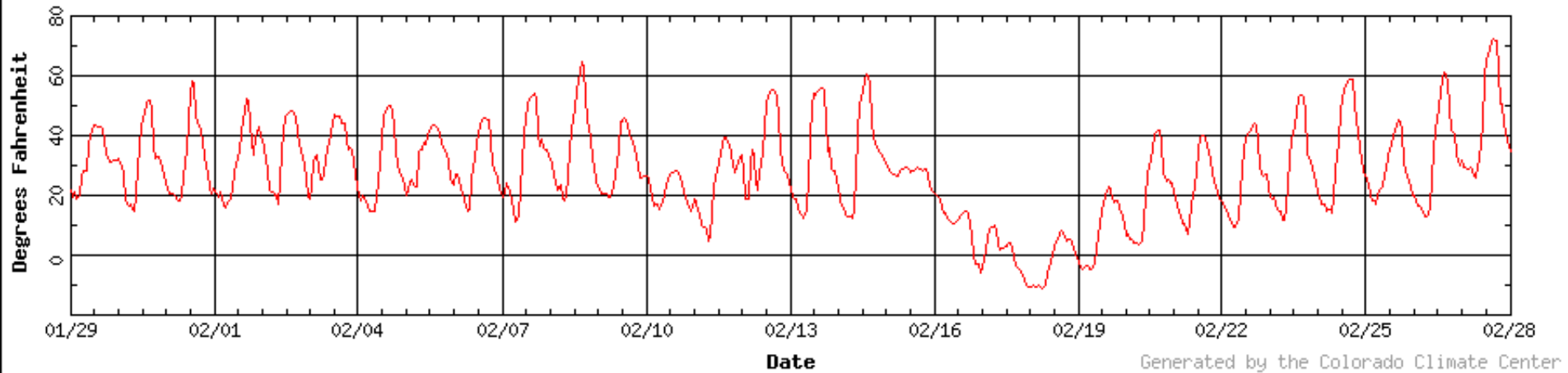
Temperature for FRT02 (02-14-2006 - 02-15-2007)



Large diurnal temperature ranges and rapid changes

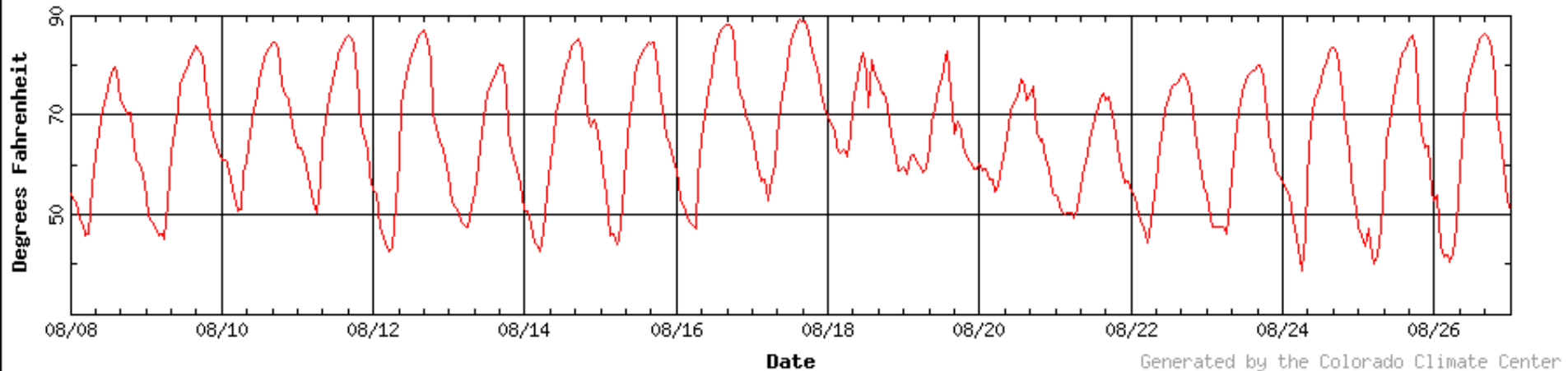
Kersey, Colo.

Temperature for KSY01 (01-29-2006 - 02-28-2006)



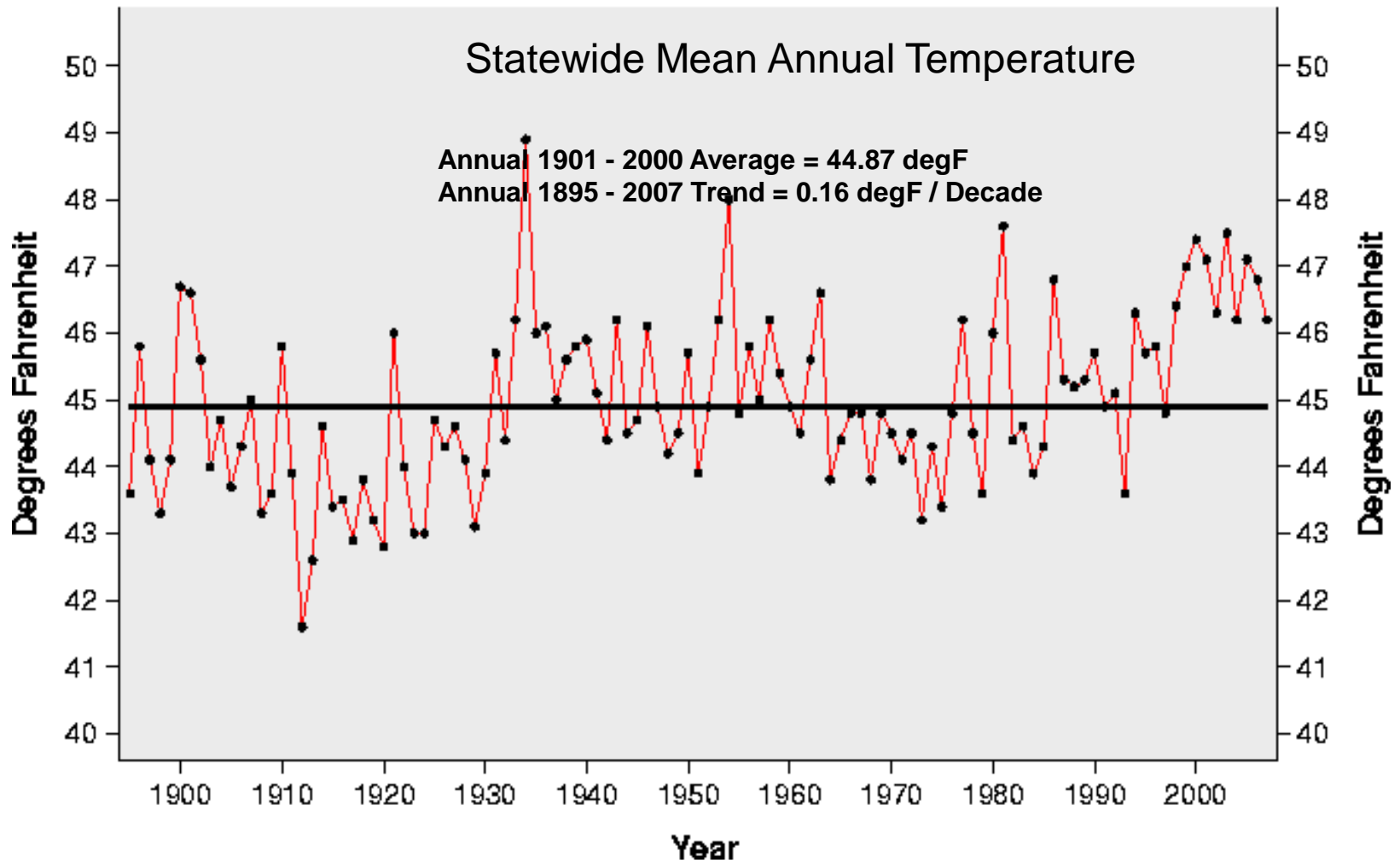
Blanca, Colo.

Temperature for BLA01 (08-08-2002 - 08-27-2002)



Year to Year Variations in Climate are Expected

— Actual Temperature
— Average Temperature



**Frequent but highly variable
precipitation
(for every “upslope,”
there’s a “downslope”)**



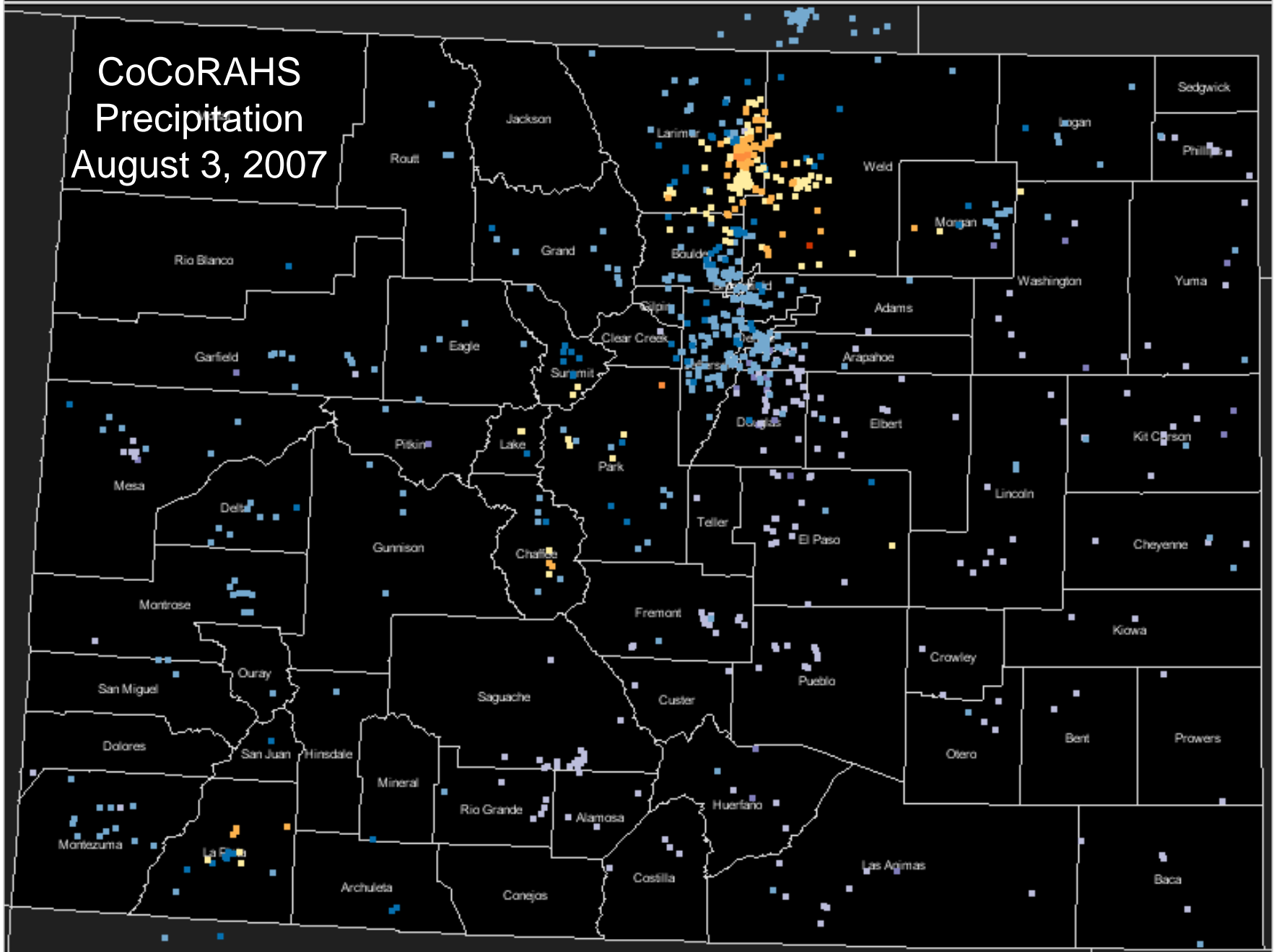
Photo by Wendy Ryan

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

Colorado 8/3/2007

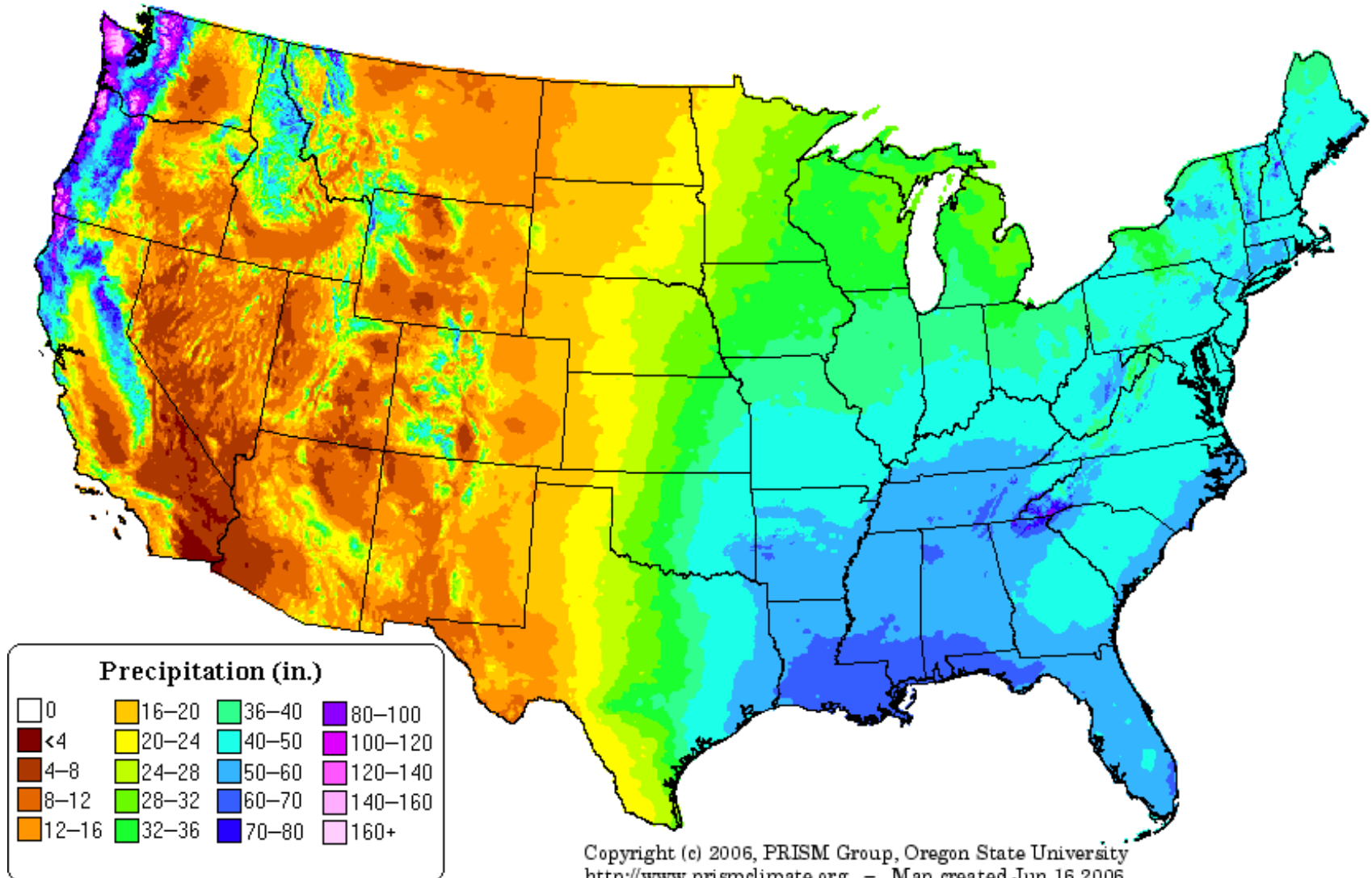


CoCoRAHS Precipitation August 3, 2007



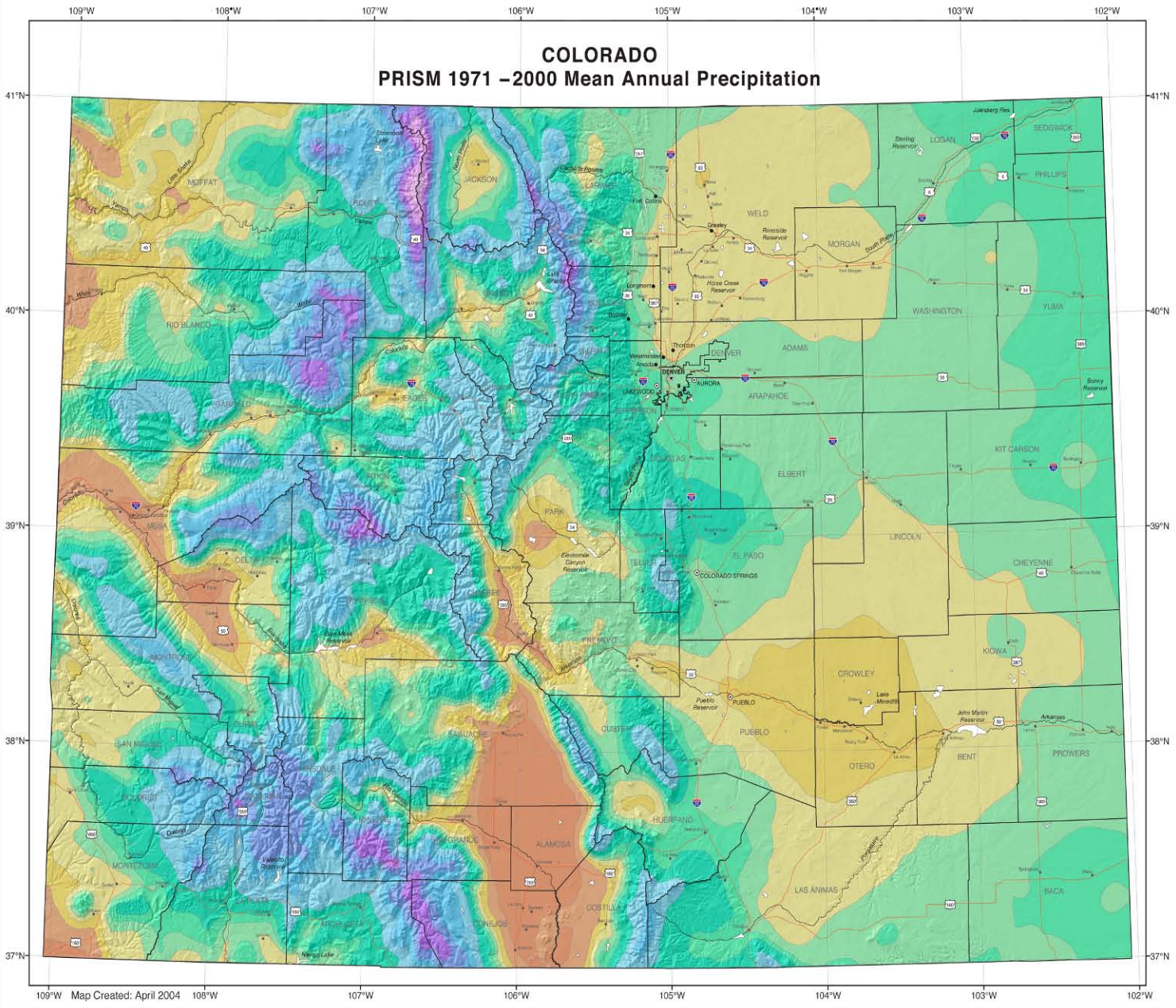
Where we fit in the national picture

Precipitation: Annual Climatology (1971–2000)



COLORADO

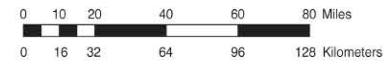
PRISM 1971 – 2000 Mean Annual Precipitation



**Average Annual Precipitation
1971 – 2000**

millimeters	inches
< 229	< 9
229 – 279	9 – 11
279 – 330	11 – 13
330 – 380	13 – 15
380 – 432	15 – 17
432 – 483	17 – 19
483 – 610	19 – 24
610 – 762	24 – 30
762 – 914	30 – 36
914 – 1067	36 – 42
1067 – 1219	42 – 48
1219 – 1372	48 – 54
> 1372	> 54

Rivers
 Lakes
 Roads

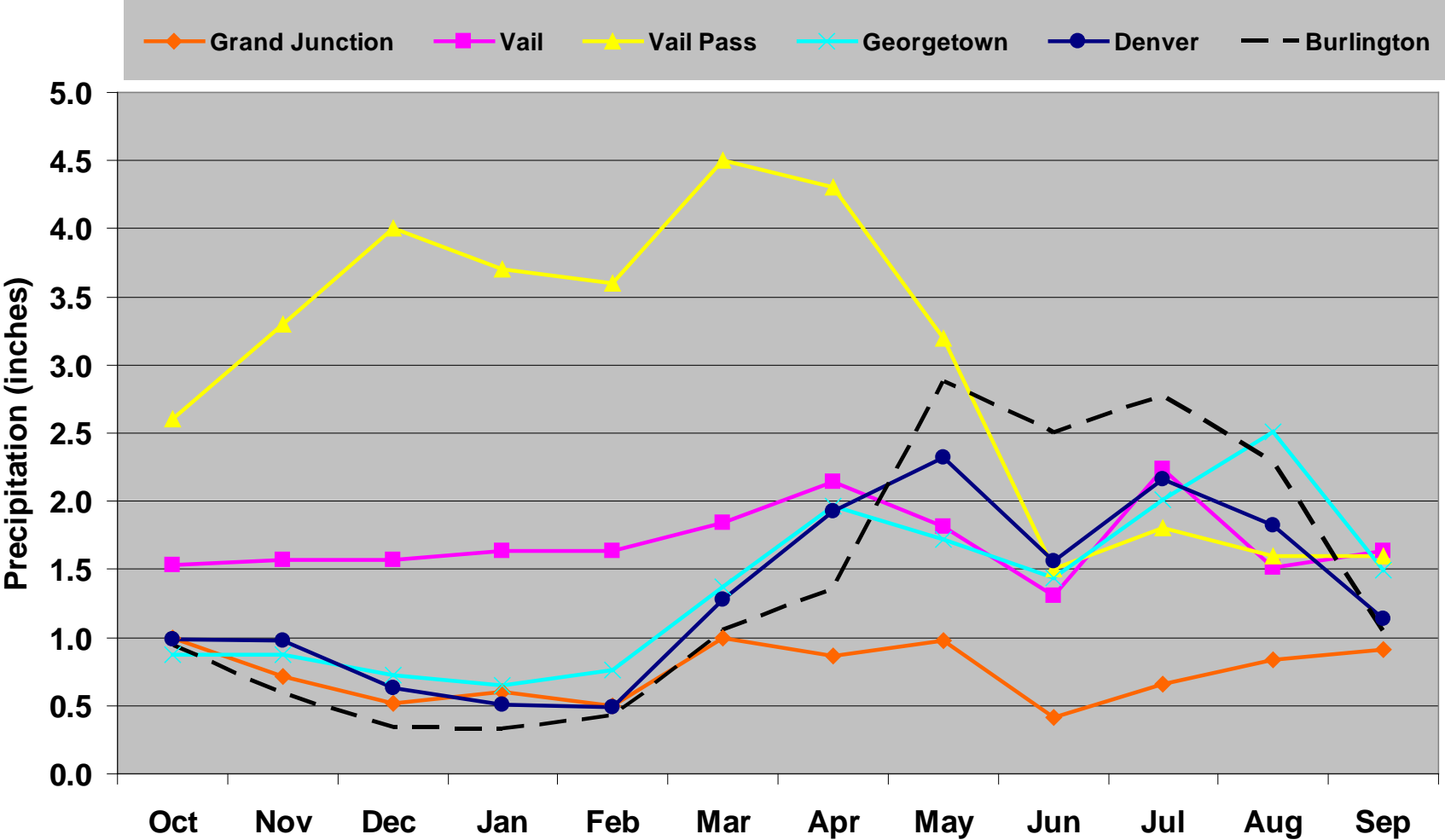


Map prepared with the PRISM climate modeling system by the Spatial Climate Analysis Service, Oregon State University.
<http://www.ocs.orst.edu/prism> Copyright (c) 2004, OSU SCAS



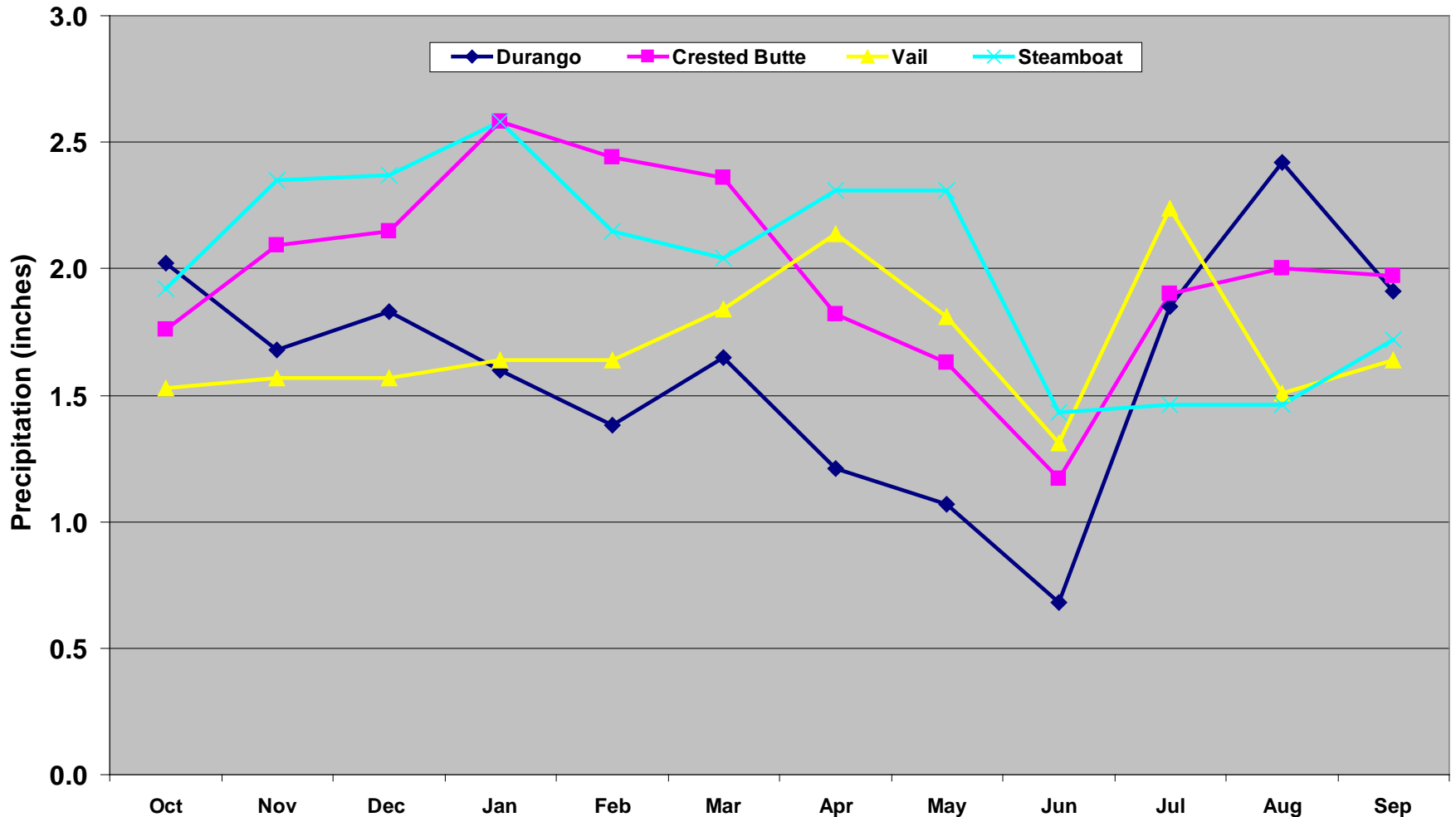
Highly seasonal precipitation patterns with considerable geographic diversity in “seasonality”

Water Year Average Precipitation for Selected Stations



Seasonal Precipitation Averages North-South Transect

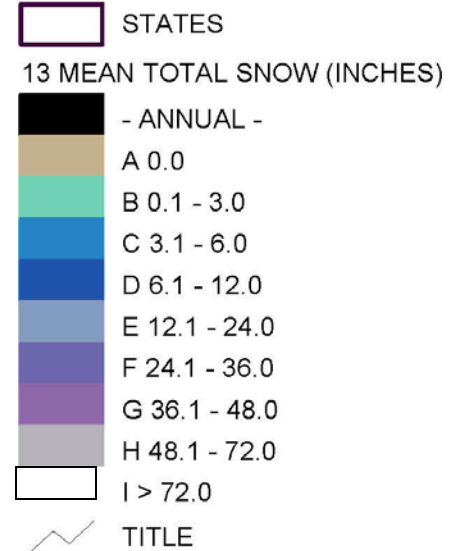
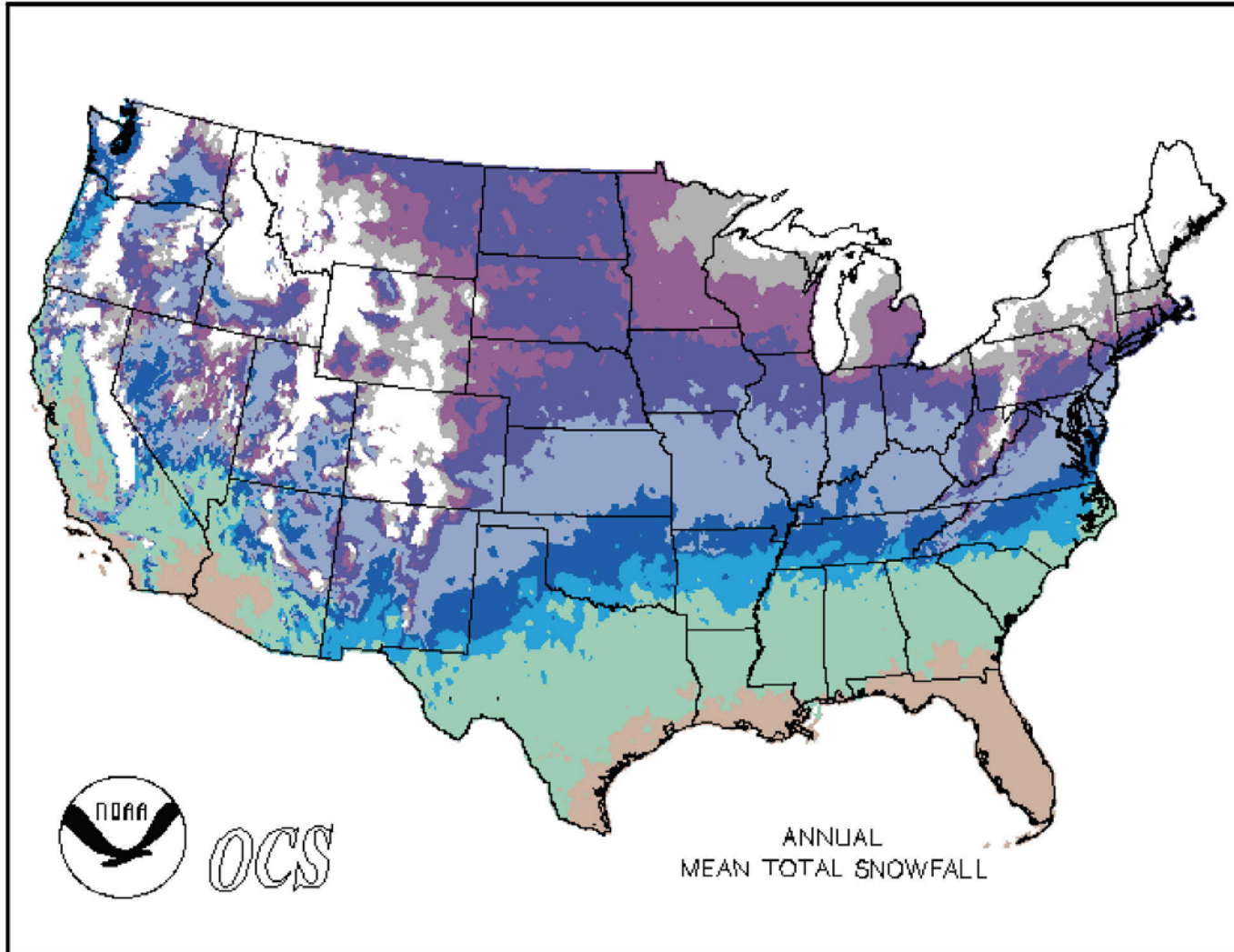
North-South Transect Water Year Precipitation Averages



**Lots of Snow,
sometimes and some places**



National Annual Average Snowfall

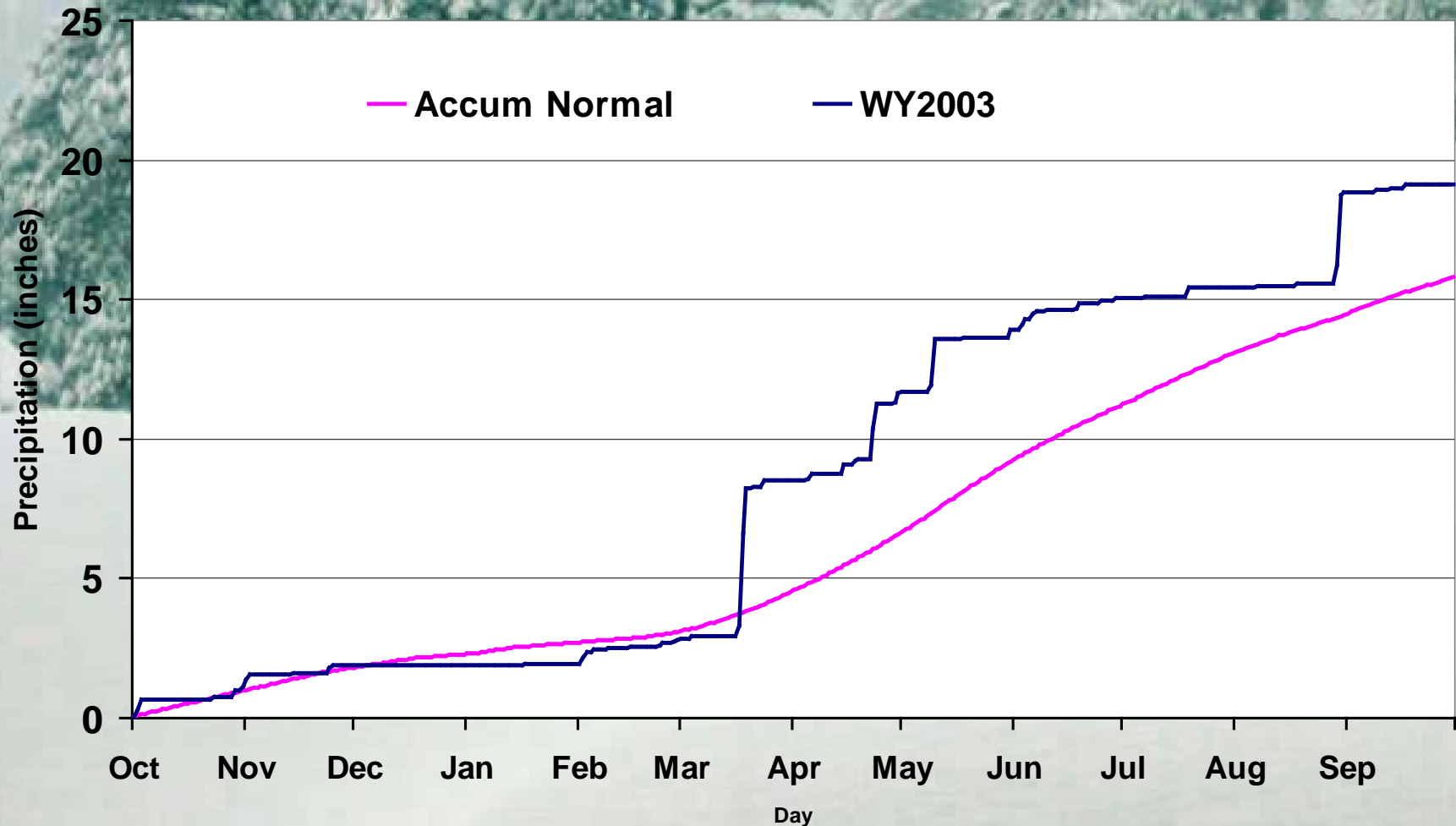


OCS



A few storms contribute a large fraction of the annual precipitation in many years

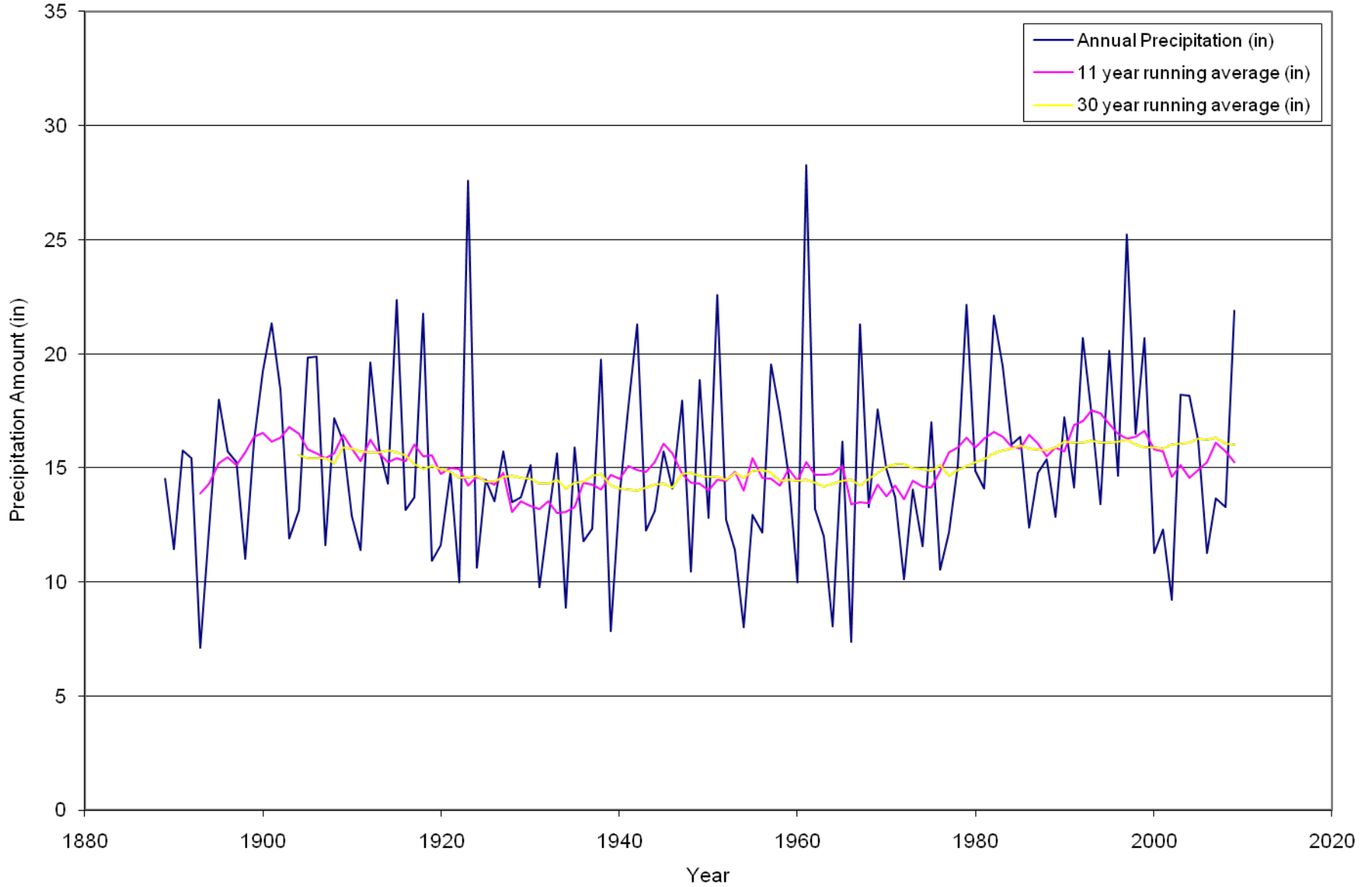
Fort Collins Daily Accumulated Precipitation



Large Year-to-Year Variations in Precipitation



Fort Collins Total Annual Precipitation



Drought Visits Our Area Regularly

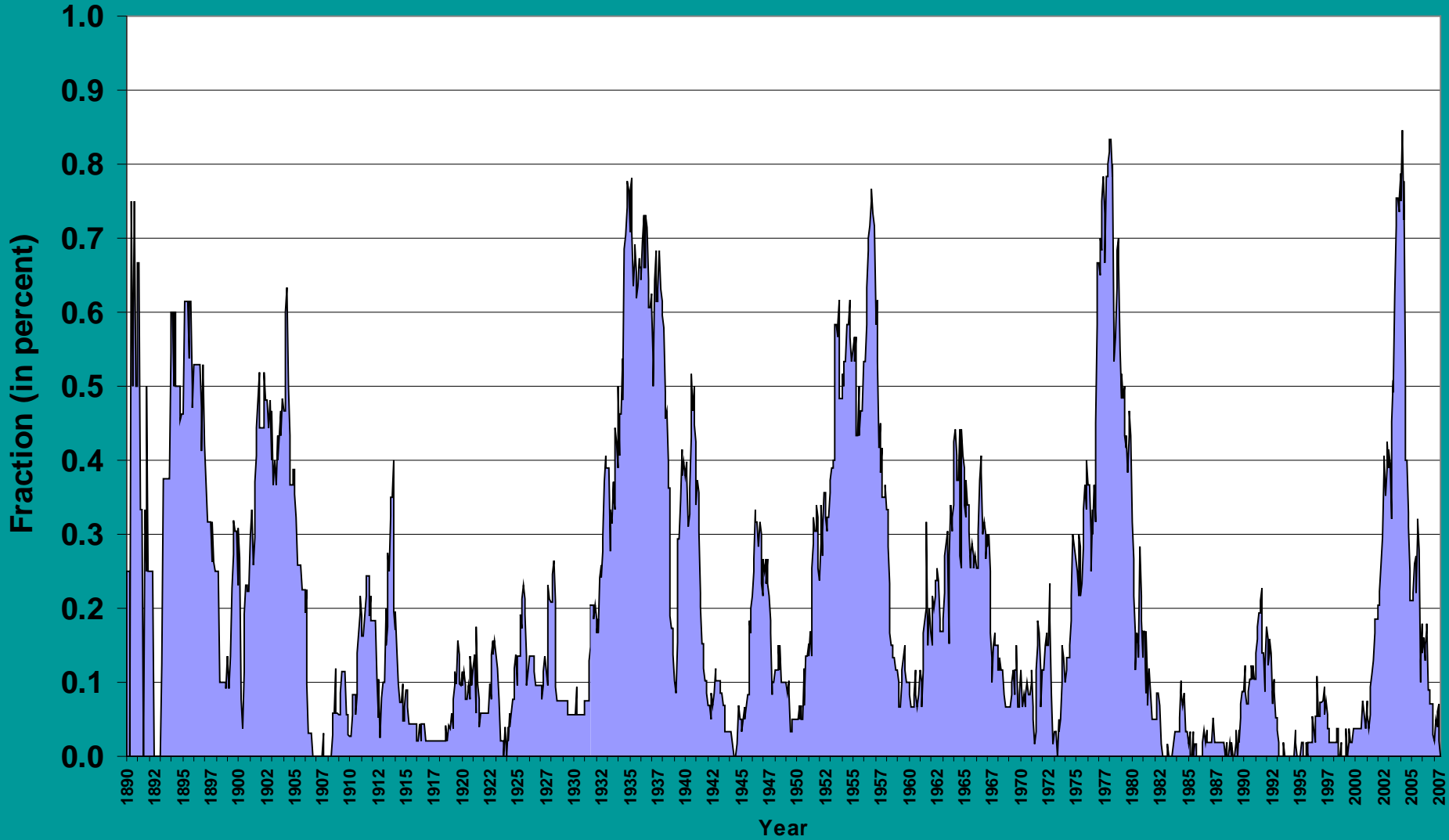


Photo by NRCS

Fraction of Colorado in Drought

Based on 48 month SPI

(1890 - July 2007)



Floods are regular visitors too --



The Fort Collins Flood of July 28, 1997

Of all the many elements of our climate here in Colorado, day in and day out ***the most asked for and needed information is precipitation and the relationship between climate and water resources***

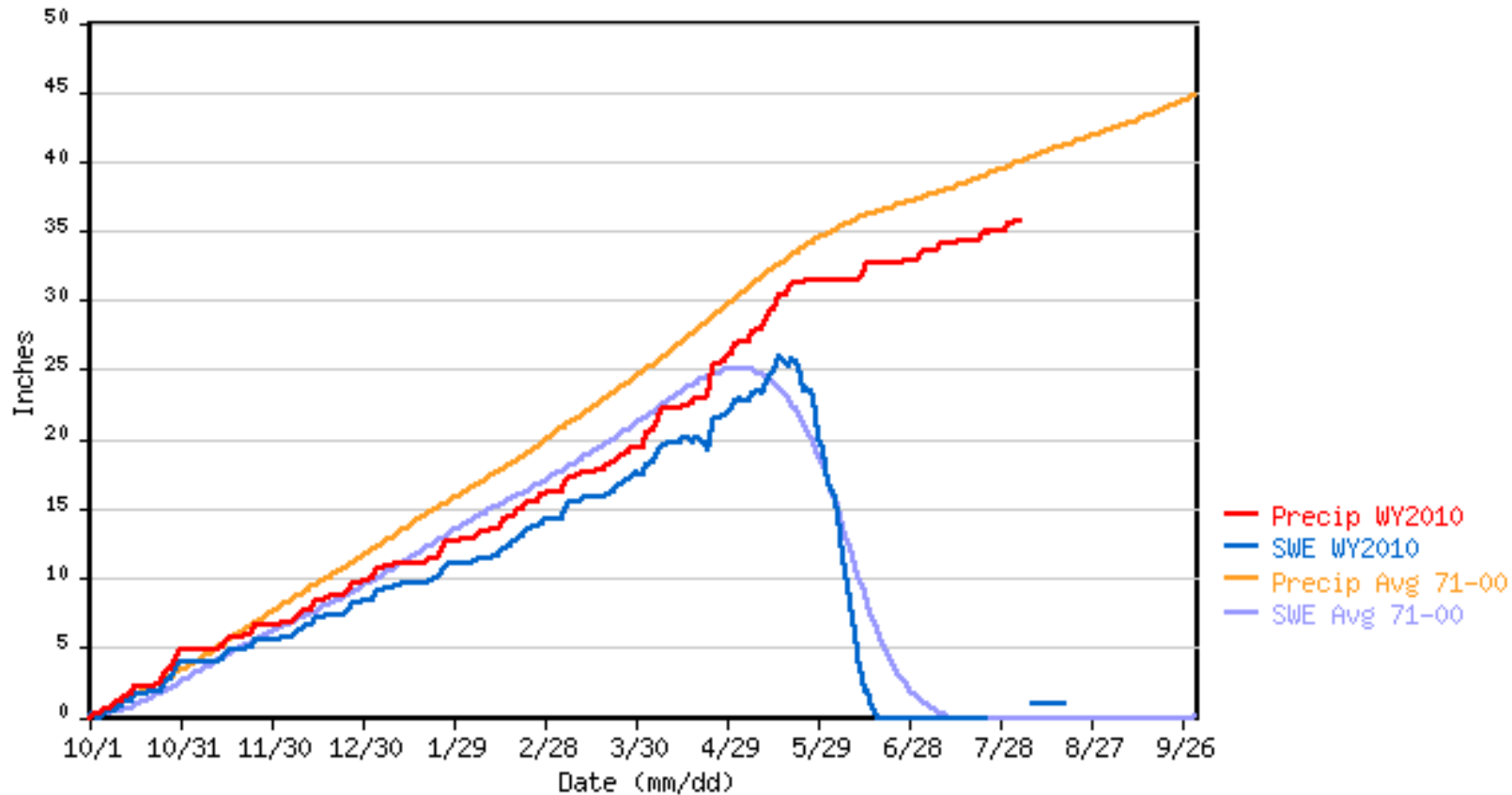
The Water Year

- What is it and why do we use it?
- October 1 through Sept 30
- Corresponds to the water storage – water usage cycle that we live out and experience each year.

Water Year – the snow accumulation, snow melt, runoff annual cycle

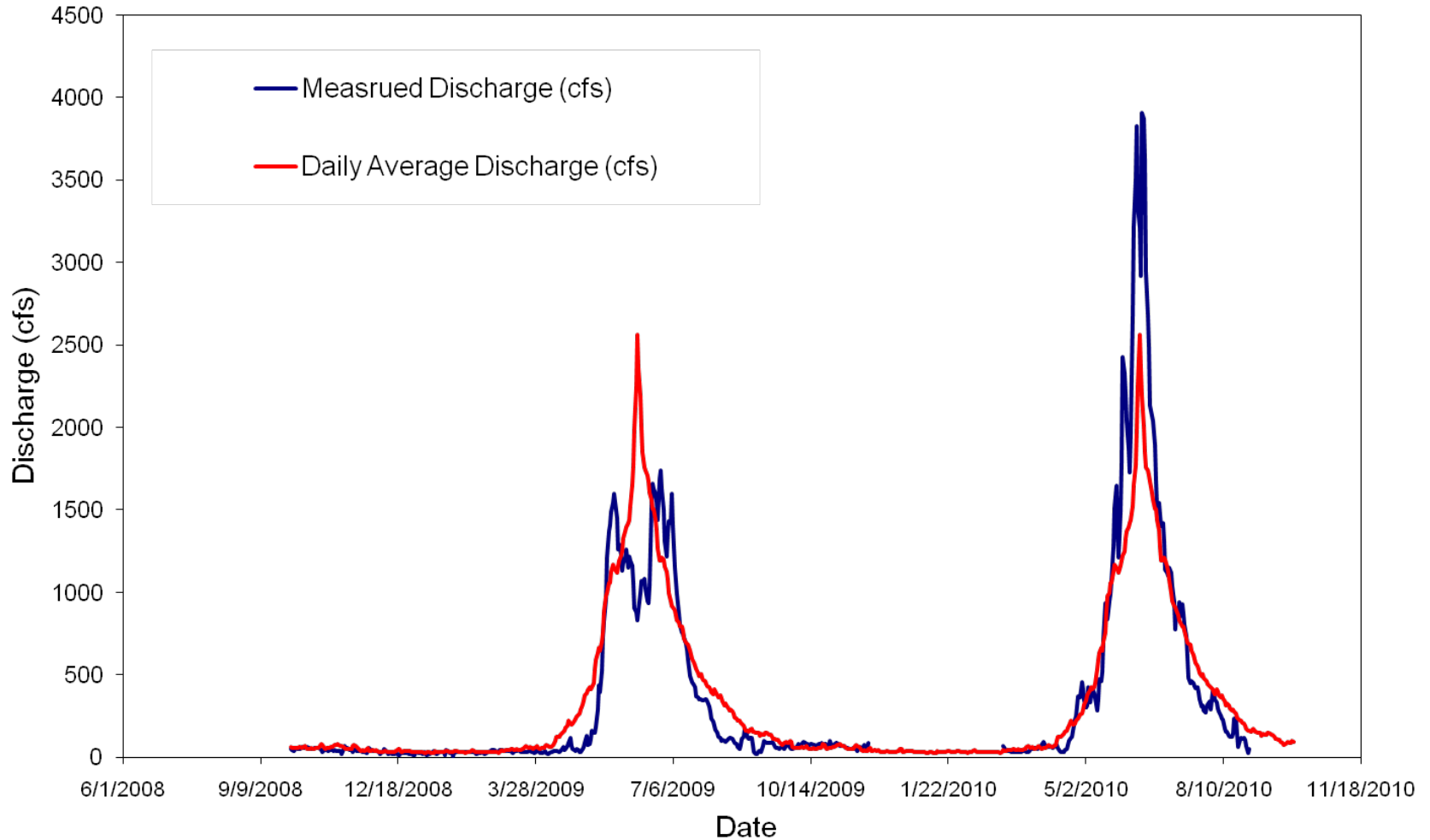
JOE WRIGHT SNOTEL for Water Year 2010

*** Provisional Data, Subject to Change ***

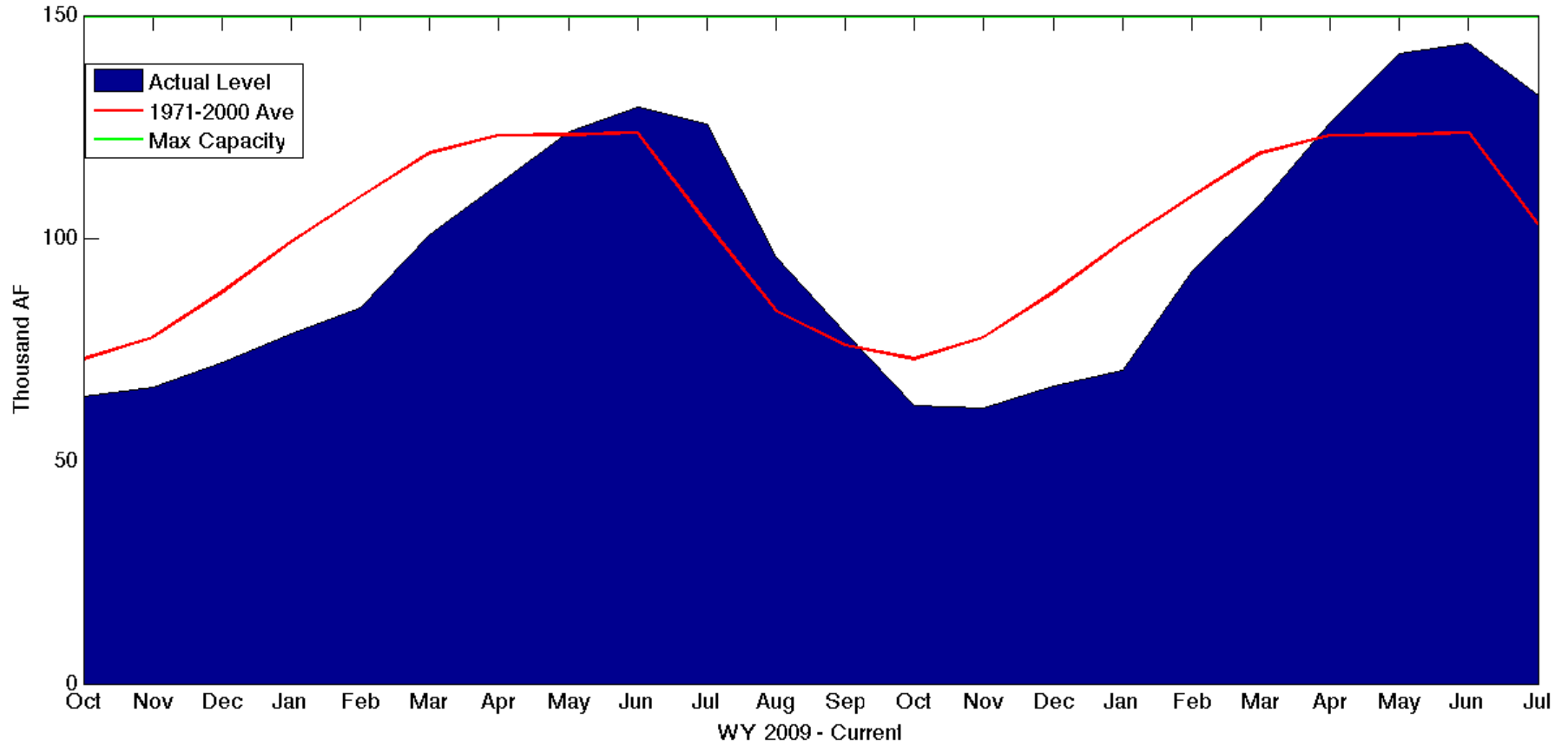


Every Year is Different!

Poudre River Discharge (cfs) at the Canyon Mouth

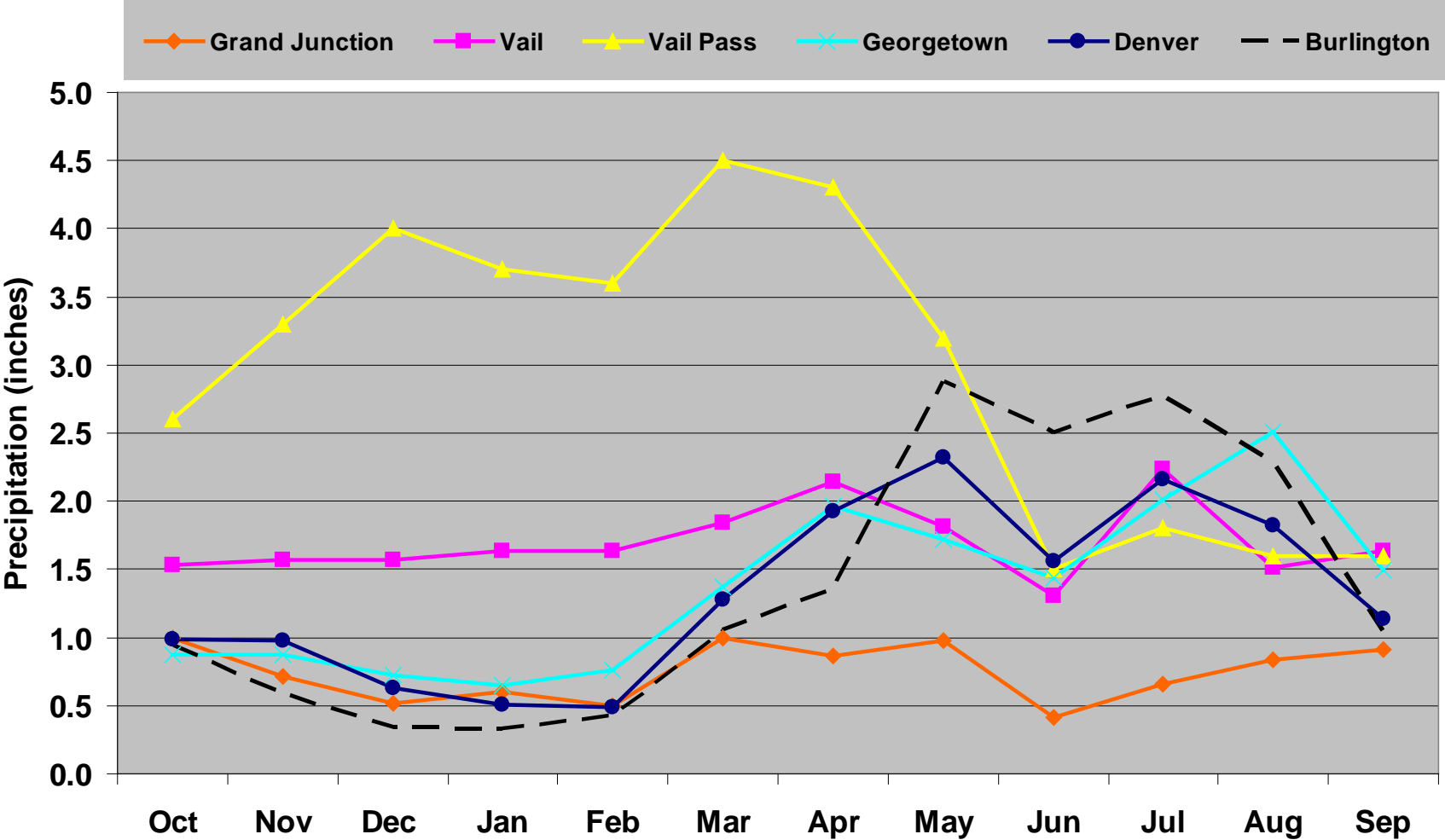


Horsetooth Res. Levels

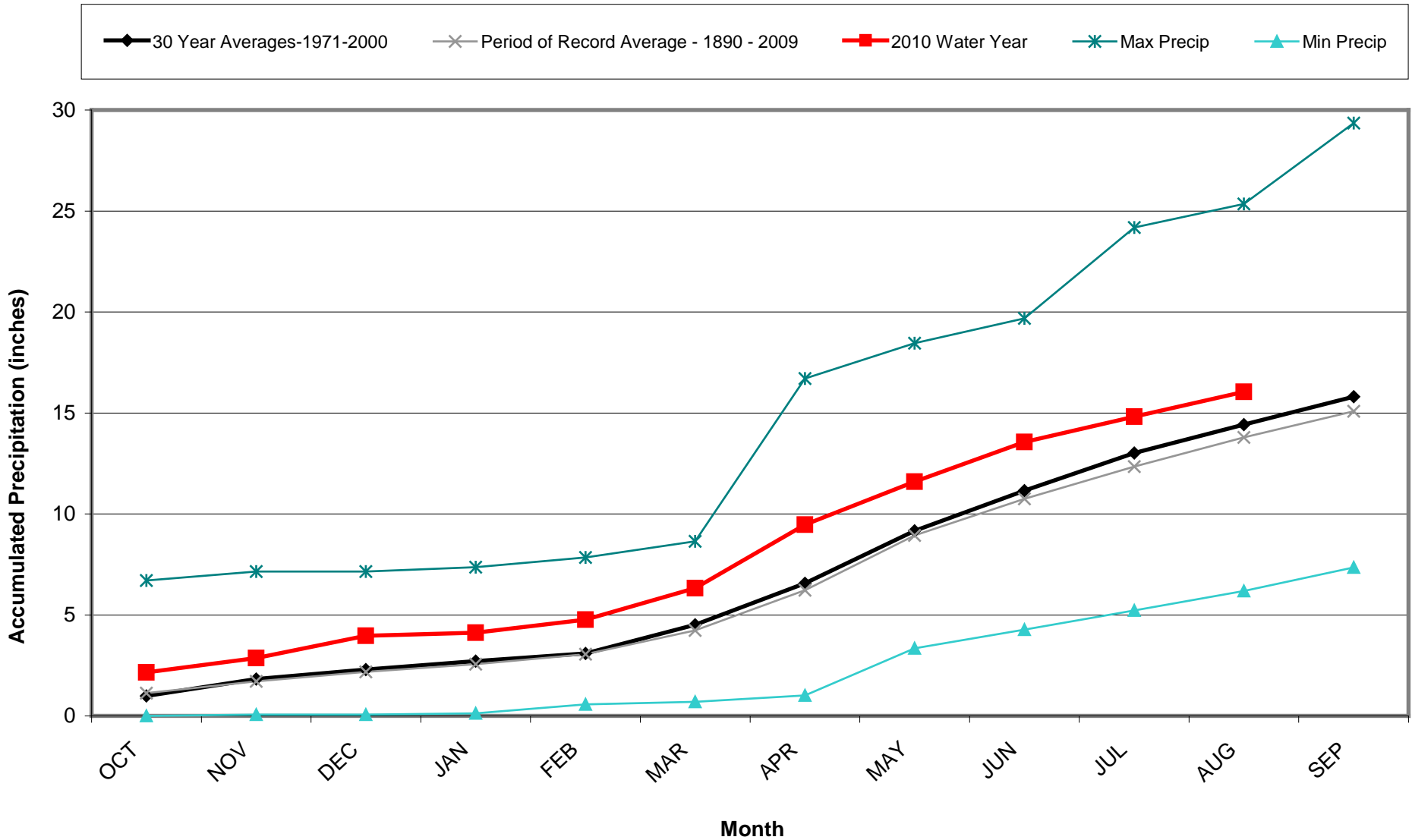


Highly seasonal precipitation patterns with considerable geographic diversity in “seasonality”

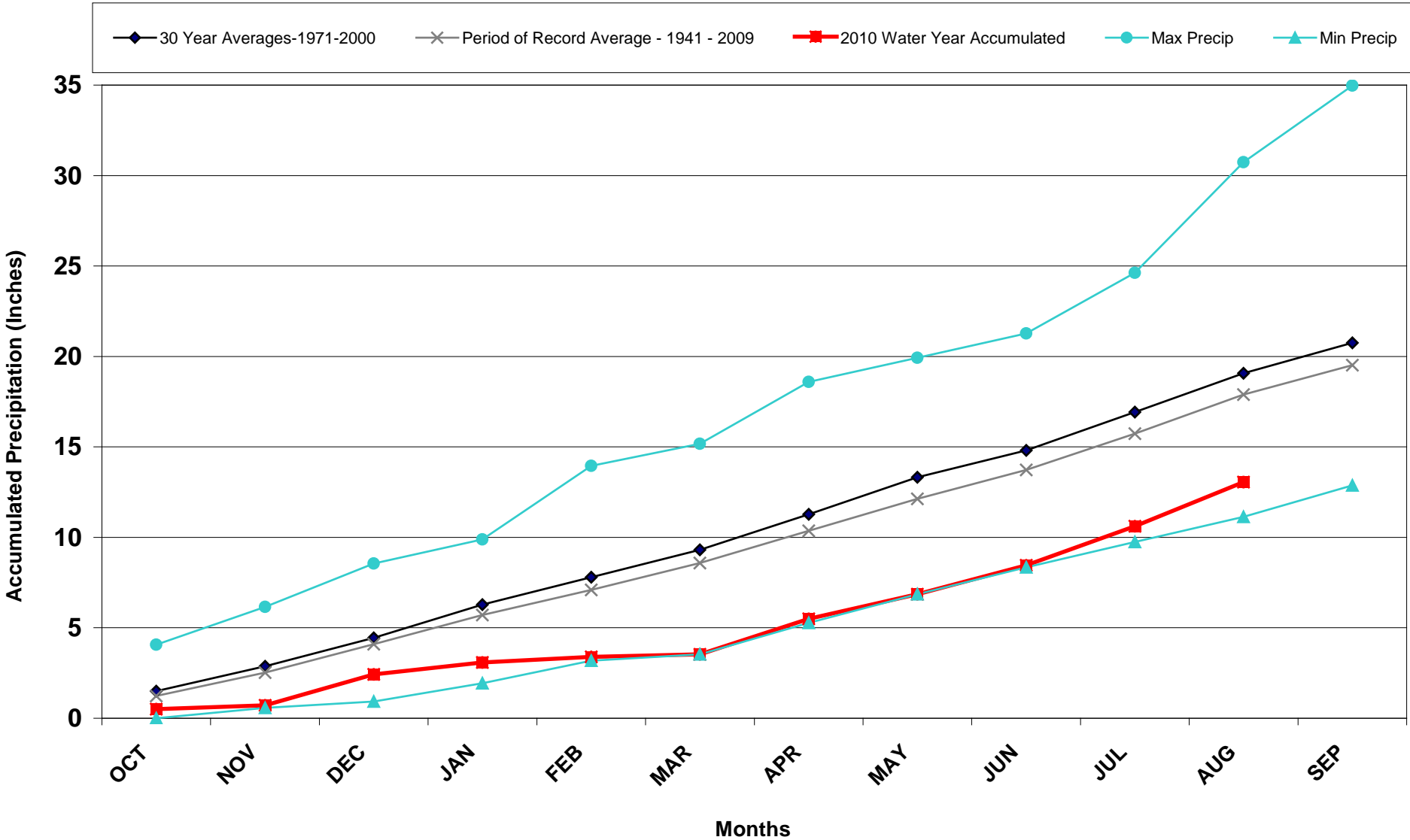
Water Year Average Precipitation for Selected Stations



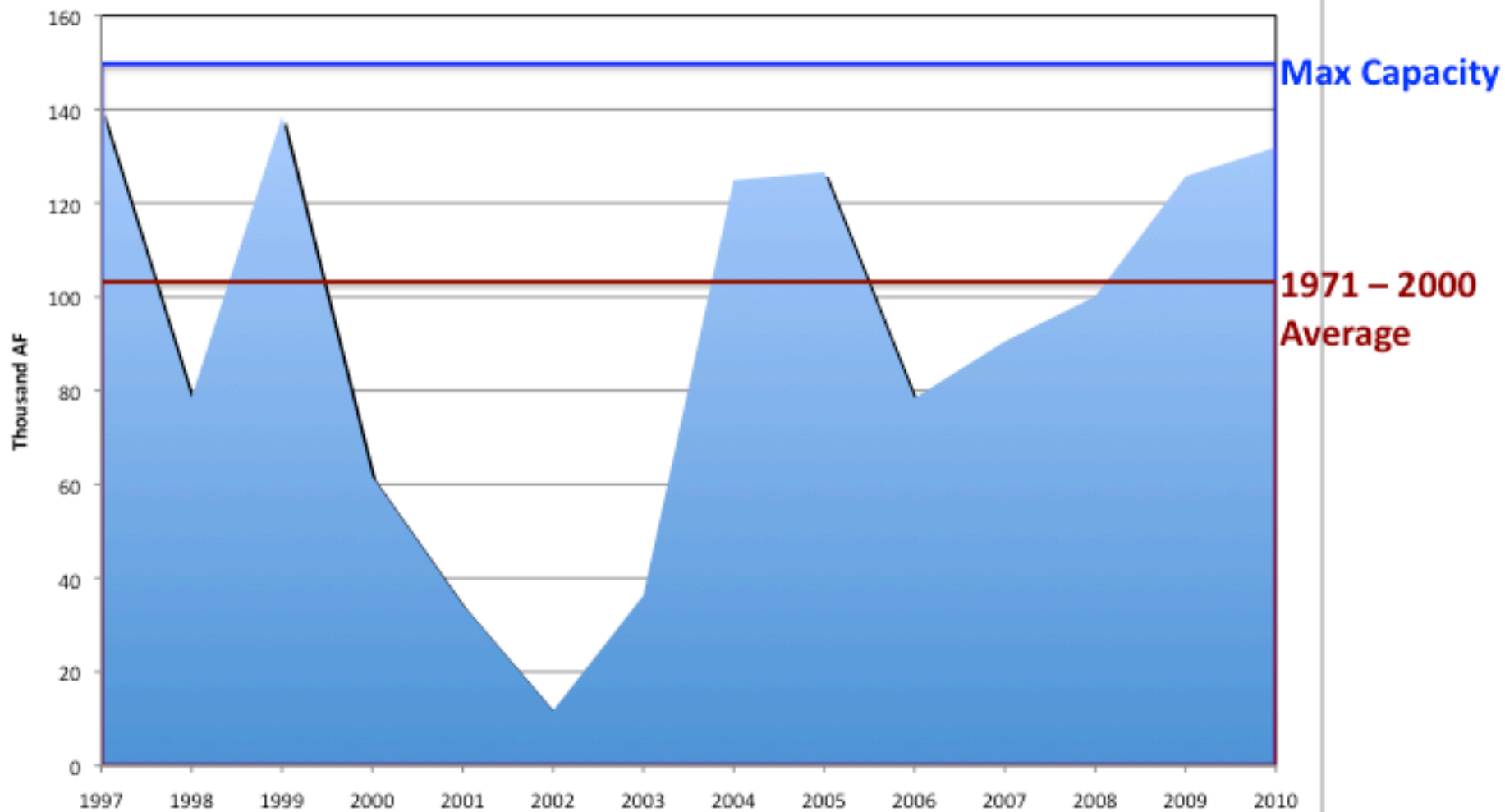
Fort Collins 2010 Water Year



Grand Lake 1 NW 2010 Water Year



Horsetooth Reservoir July Reservoir Storage



Variability -- -- -- the nature
of Climate

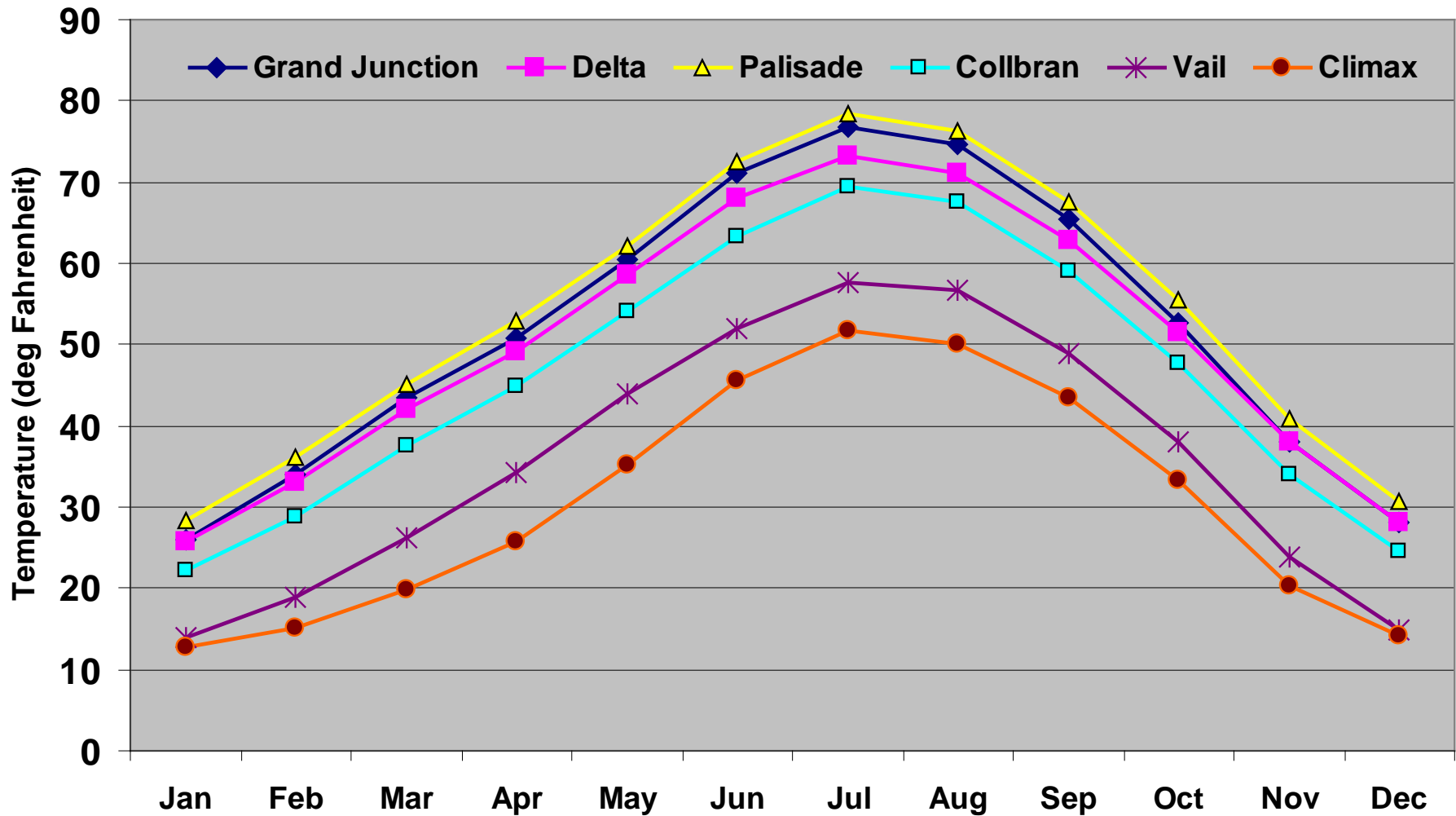
and the “Challenge” for
detecting and documenting
trends and changes

Temperature -- relatively well behaved – summers always warmer than winters, etc – easier to observe variations over time

Precipitation, much more variable – trend much more difficult to determine in a modest number of years

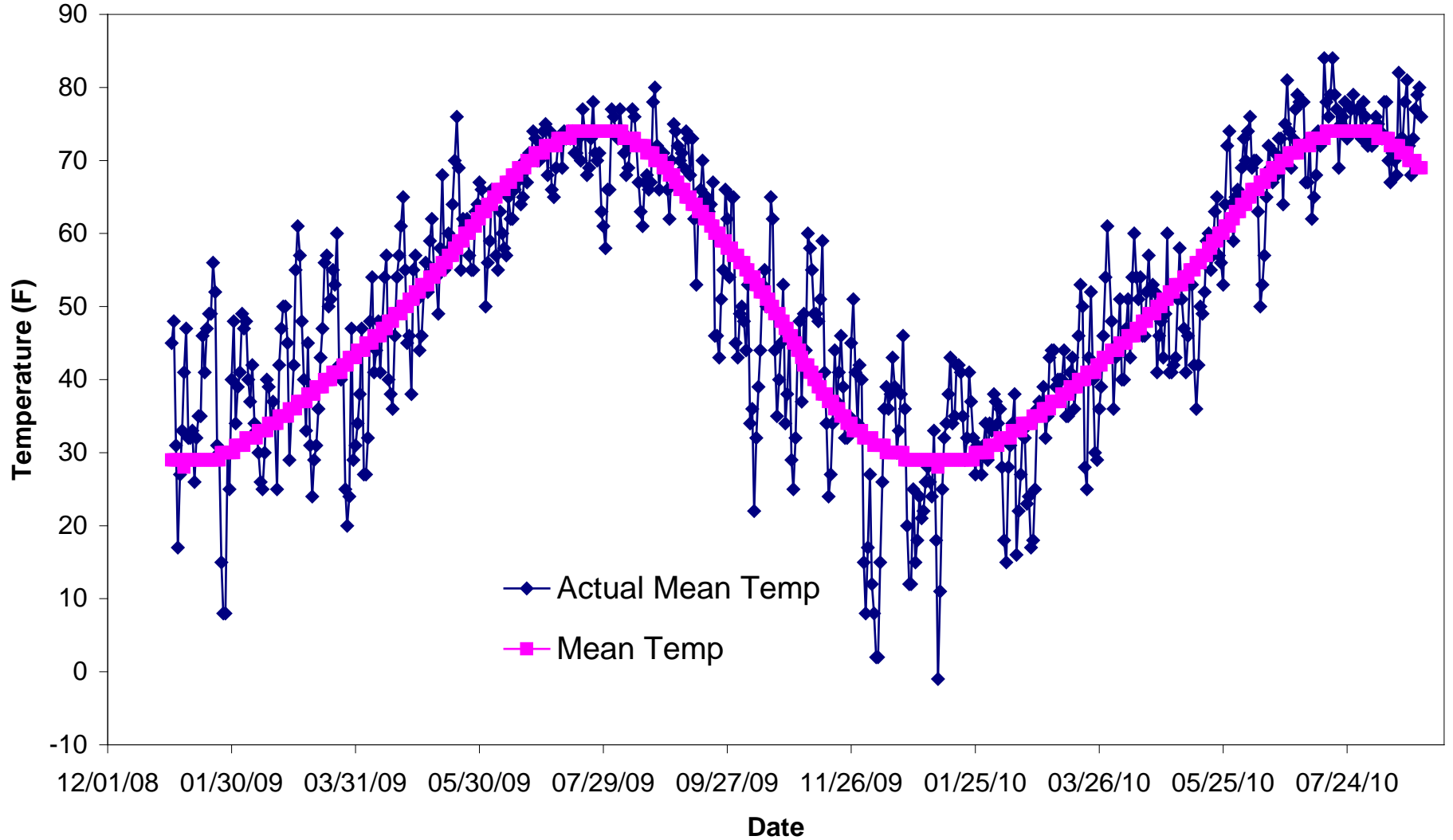
Temperatures are different, but annual cycles are similar

Average Monthly Temperature (9171-2000) for Selected Station



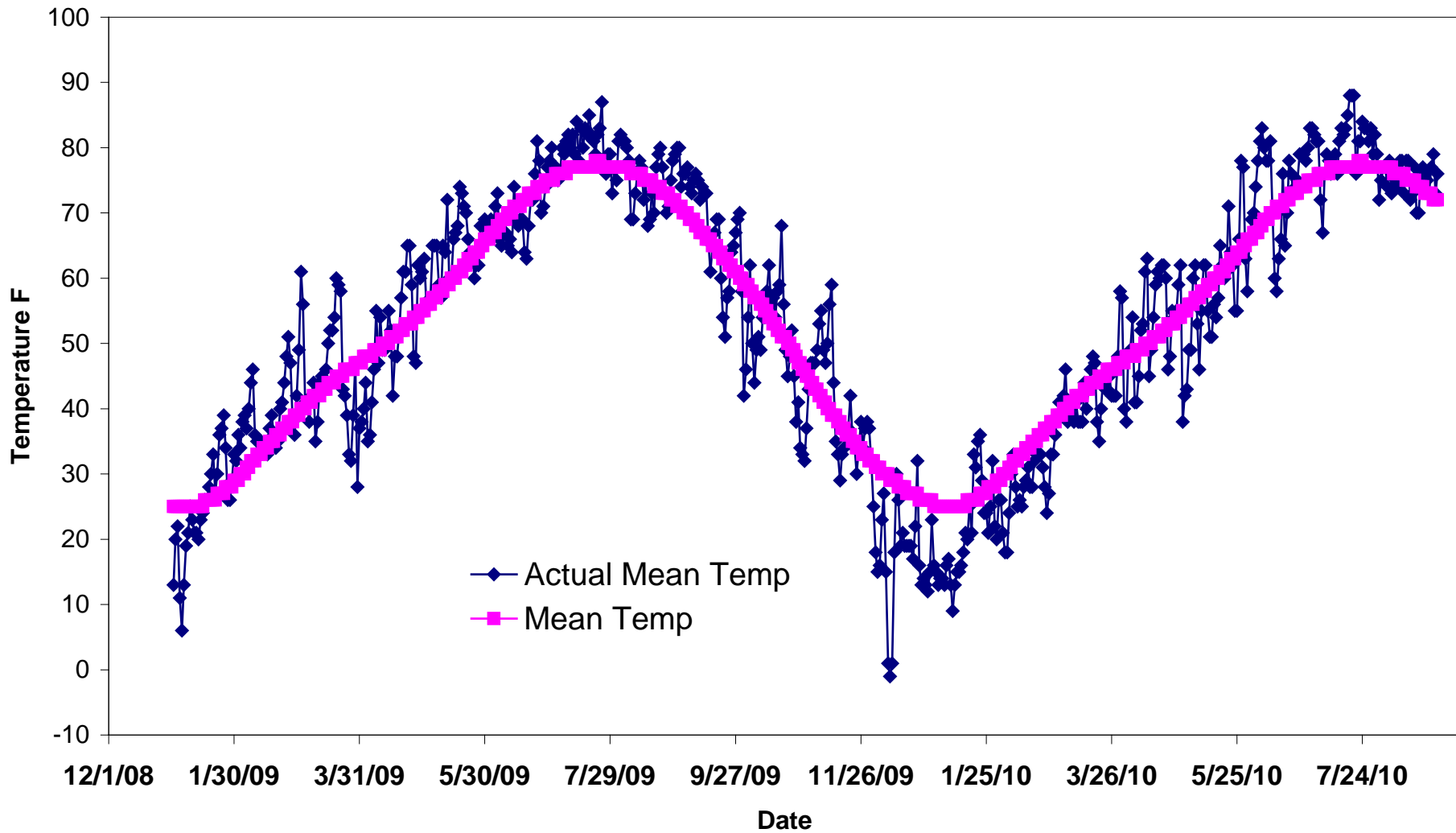
Denver, CO Jan 1, 2009 - August 29, 2010

Mean and Actual Daily Temperature



Grand Junction Jan 1, 2009 - August 29, 2010

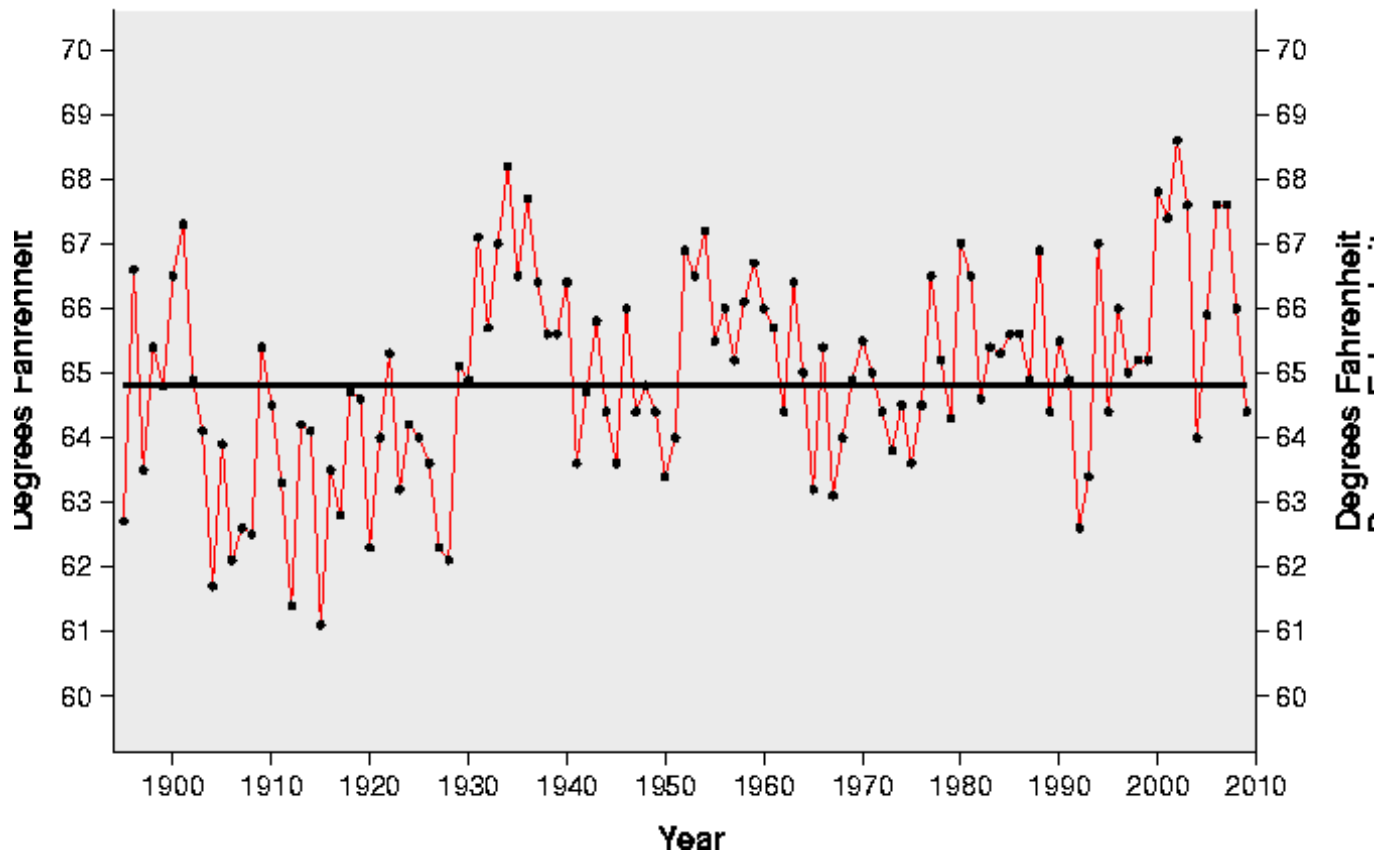
Mean and Actual Daily Temperature



When significant temperature trends begin, we will be able to detect them

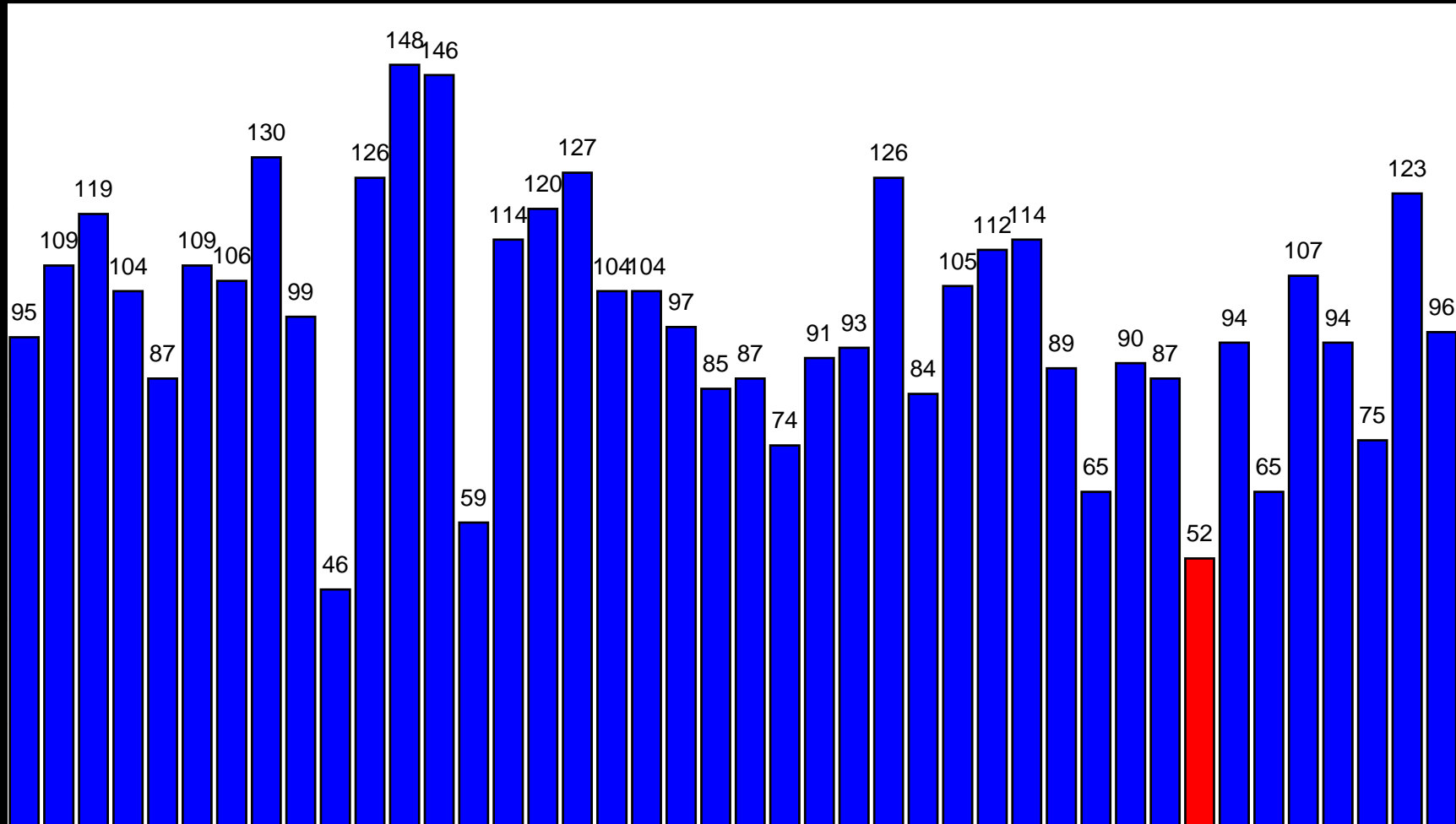
Colorado Statewide Summer Temperatures

— Actual Temperature
— Average Temperature

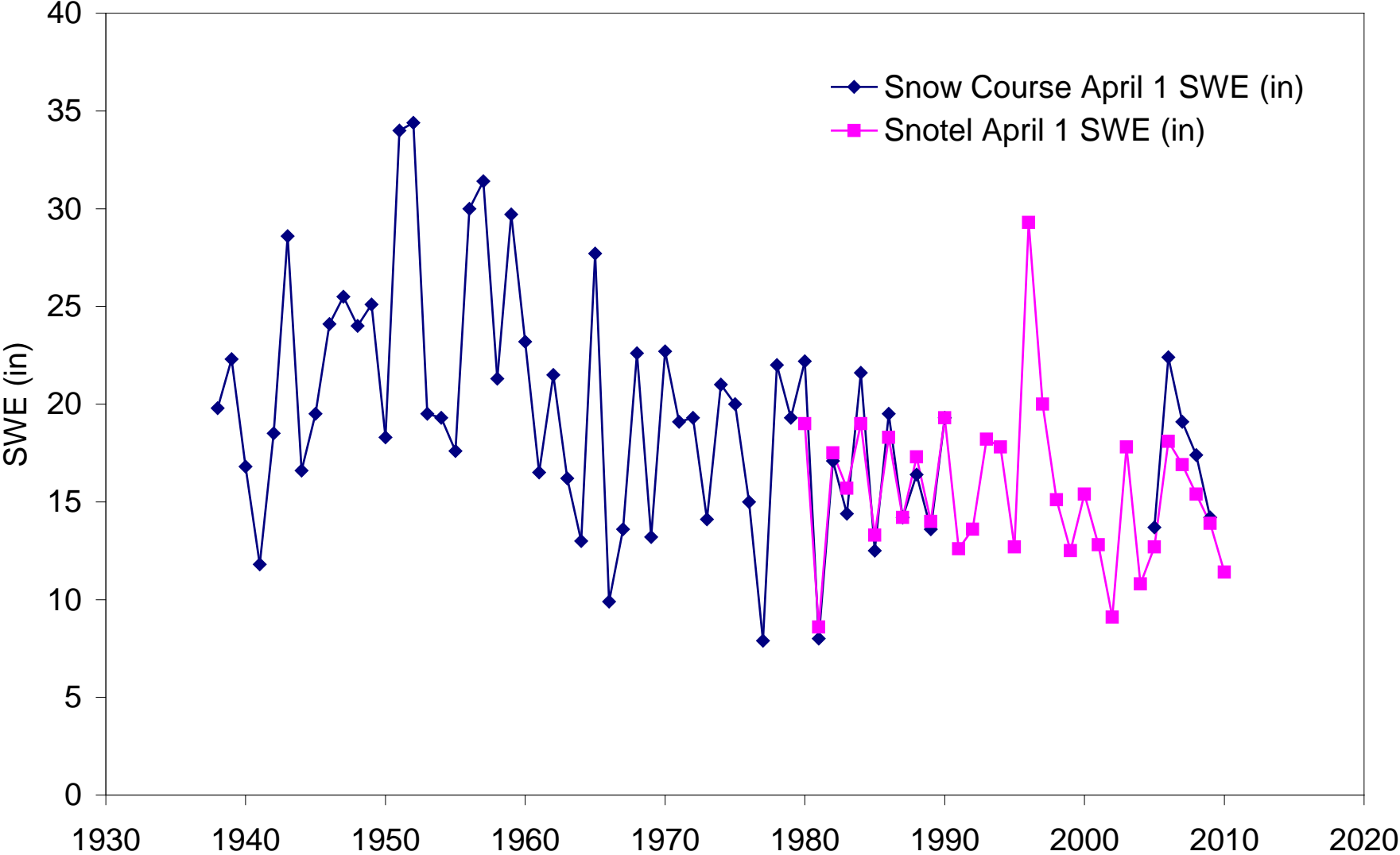


Precipitation and Snowpack – a
whole ‘nother animal

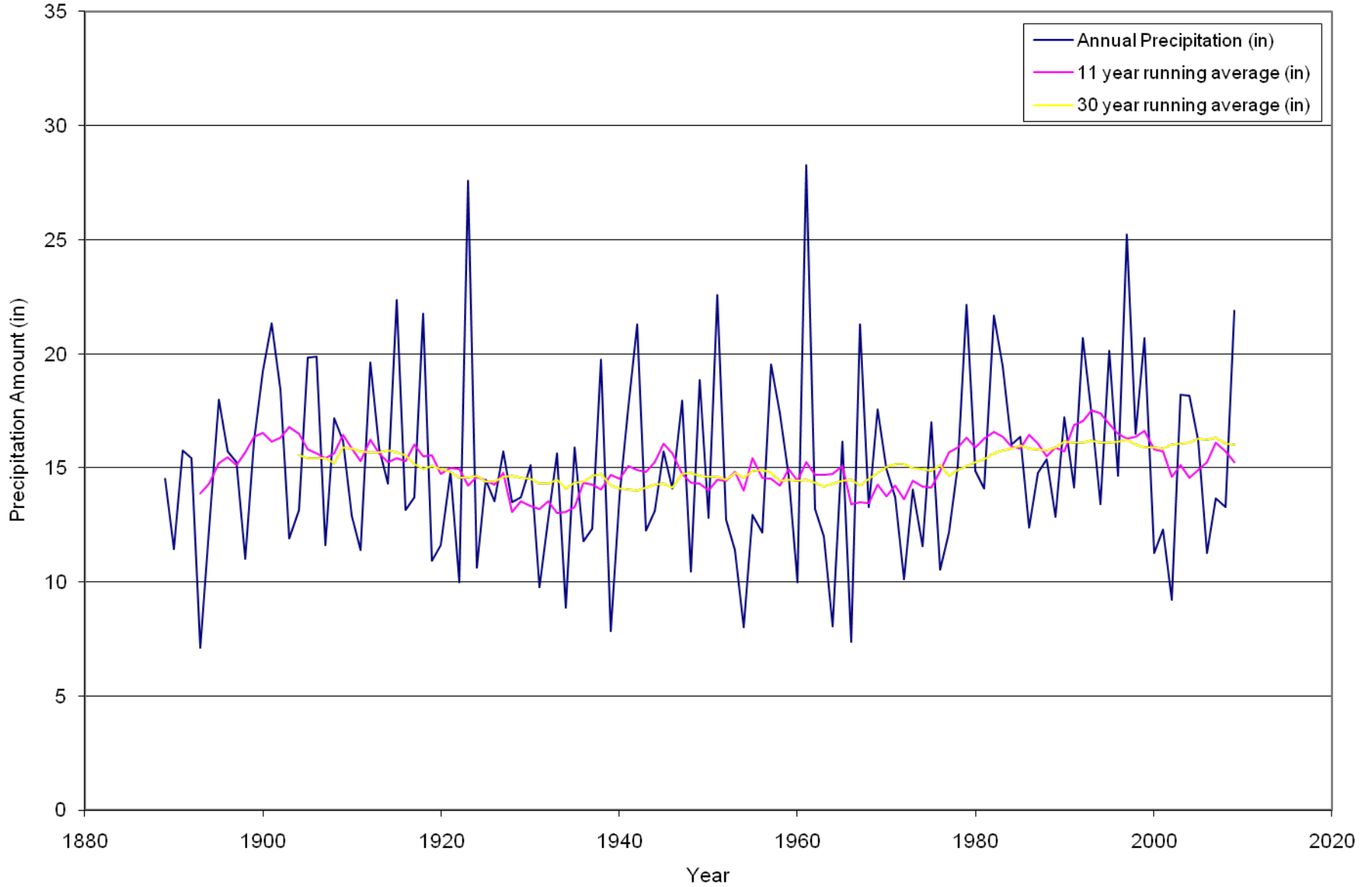
Colorado Statewide April 1 Snowpack



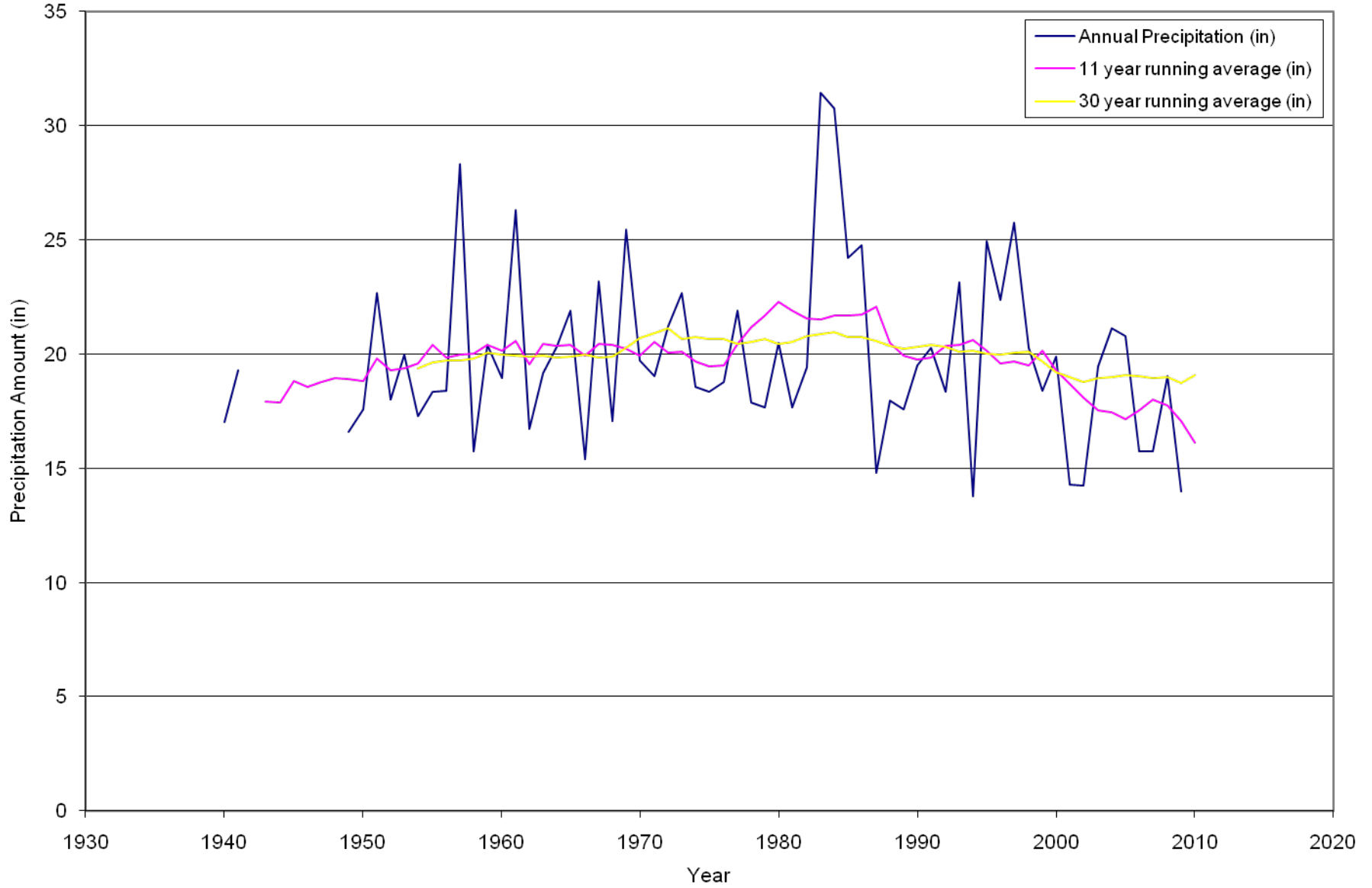
Universtiy Camp, CO (Elevation 10,300') April 1 SWE (in) 1939 - 2010



Fort Collins Total Annual Precipitation

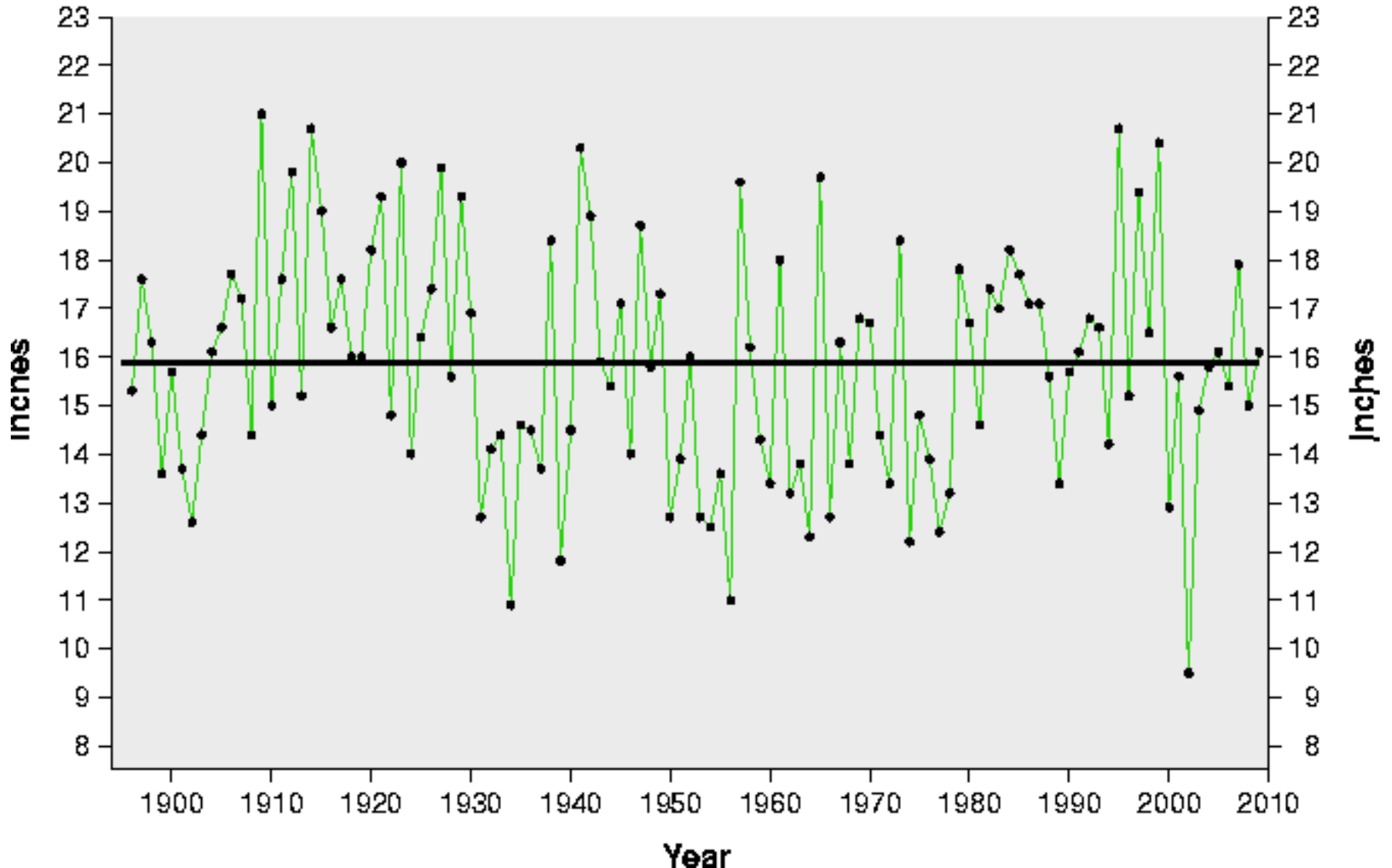


Grand Lake 1NW Total Annual Precipitation



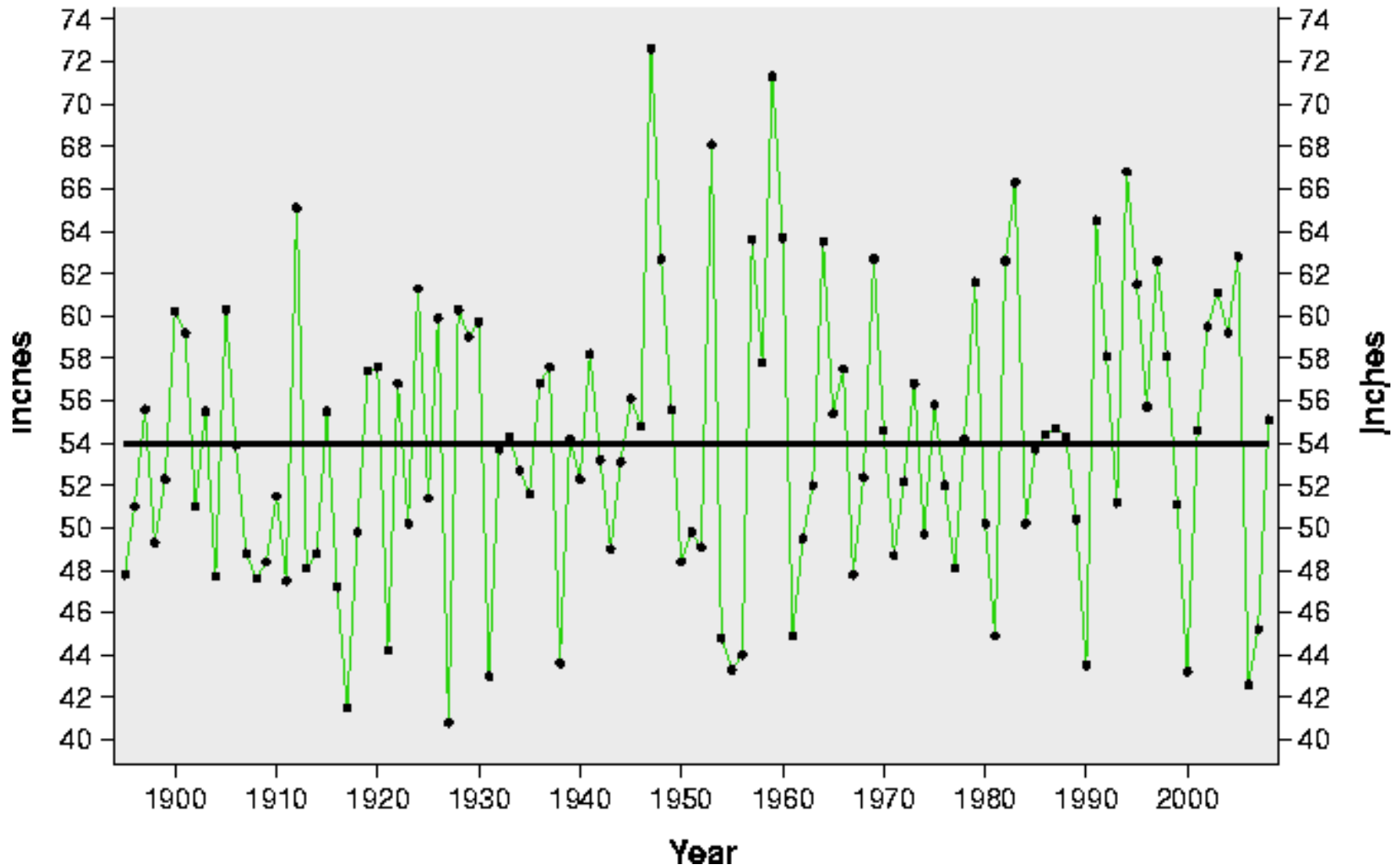
Colorado Statewide Water Year Precipitation

- Actual Precipitation
- Average Precipitation



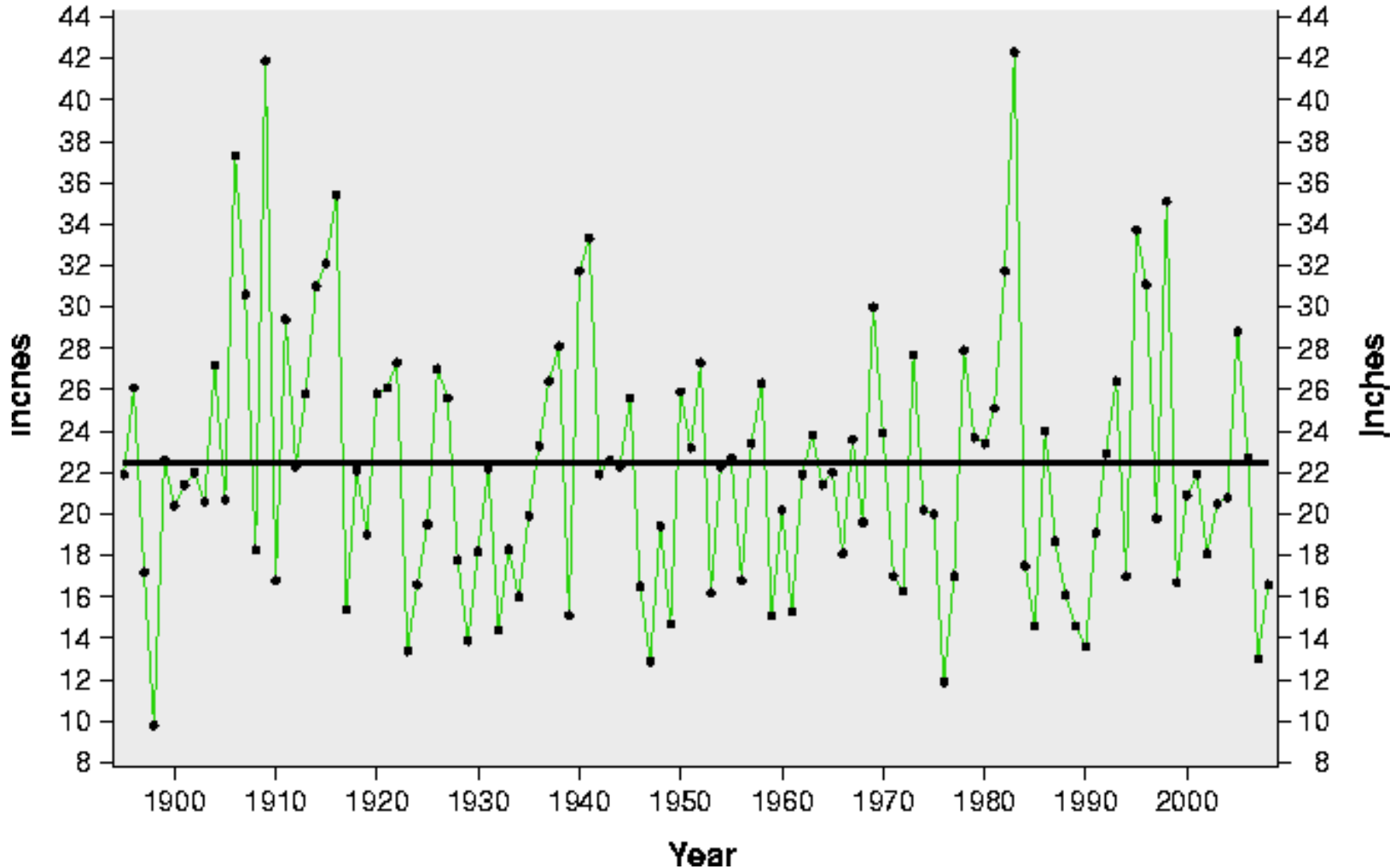
Florida Annual Precipitation

— Actual Precipitation
— Average Precipitation



California Annual Precipitation

— Actual Precipitation
— Average Precipitation



CoCoRaHS

“BECAUSE EVERY DROP COUNTS”



“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 “just precipitation” right in their own backyards”



CoCoRaHS

Snow Netw...

Once trained, our volunteers collect data using low-cost measurement tools . . .



4-inch diameter high capacity rain gauges



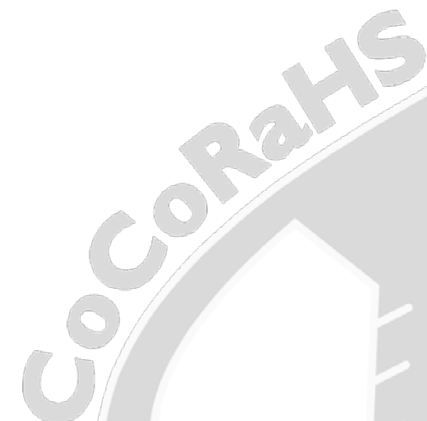
Aluminum foil-wrapped Styrofoam hail pads



Things to know about...

- ▼ **Rain**
 - Overview
 - Weather Radar
 - Measuring Rain
- ▲ **Hail**
 - Overview
 - Hail Facts
 - Hail Floures
 - CoCoRaHS & Hail
 - Hail Pad Examples
 - Measuring Hail
- ❄❄ **Snow**
 - Overview
 - Measuring Snow

Training is important to assure accurate, high quality data



and report their daily observations on our interactive Web site: www.cocorahs.org

My Data Entry : Daily Precipitation Report Form

Precipitation Report Form	
<input type="button" value="Submit Data"/> <input type="button" value="Reset"/>	
Station Number : CO-LR-610	
Station Name : Fort Collins 3.5 SW	
* Denotes Required Field	
5/20/2008	*Observation Date ?
7:00 AM	*Observation Time ?
0.59	*Total Rain and Melted Snow in gauge in inches to the nearest hundredth ?
<input checked="" type="radio"/> Yes <input type="radio"/> No Report was taken at registered location?	
Observation Notes: (This will be available to the public) ? It has been so dry, that the cows are now giving powdered milk. Thank God for today's rain!!	
New Snow	
0.0	Depth of new snow in inches to the nearest tenth ?
NA	Melted value from core to the nearest hundredth ?
Total Snow on Ground	
NA	Depth of total snow in inches to the nearest half inch ?
NA	Melted value from core to the nearest hundredth ?

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."

Main Menu

- Home
- About Us
- Join CoCoRaHS
- Contact Us
- Donate

Resources

- FAQ / Help
- Education
- Training Slide-Shows
- Drought Impacts

- Volunteer Coordinators
- Hail Pad
- Distribution/Drop-off
- Help Needed
- Printable Forms

- The Catch
- Message of the Day
- Data Analysis

Has your community been

IMPACTED BY DROUGHT?

Tell us by submitting a "CoCoRaHS Drought Impact Report"

Daily Precipitation (inches x.xx)
USA
5/14/2010

0.0	Trace
0.00 - 0.29	
0.30 - 0.76	
0.77 - 1.91	
1.92 - 4.69	
4.80 - 6.29	
6.90 - 7.67	

Join CoCoRaHS
Click Here

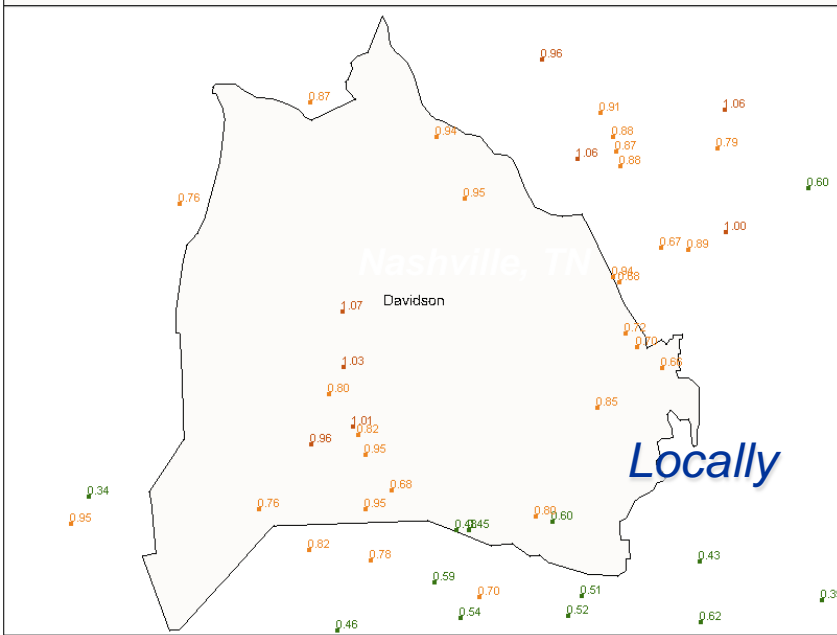
DONATE

CLICK HERE TO GIVE TO COCORAHHS

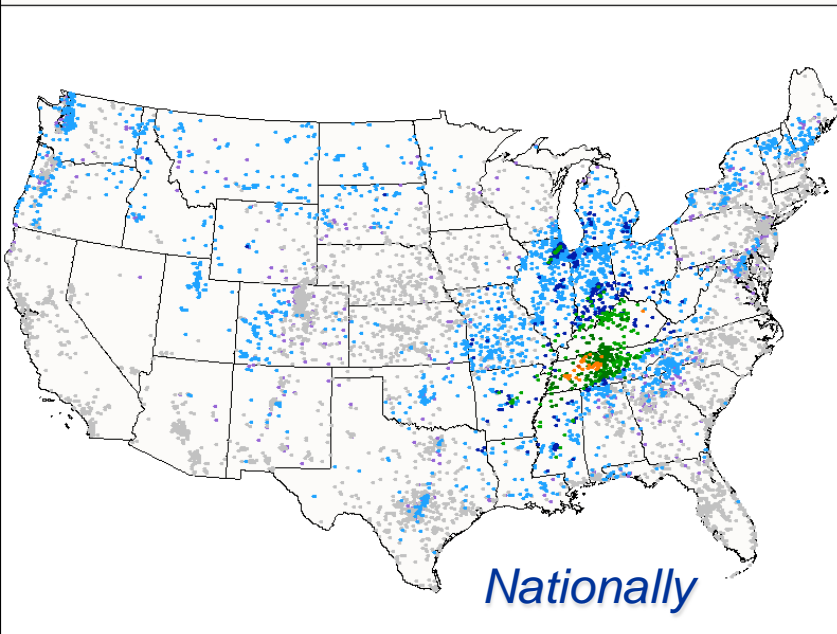
TRAINING
SLIDE-SHOWS

Things to know about...

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am
 Davidson County, Tennessee 1/27/2009



Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am
 USA 5/2/2010



Volunteer's observations are immediately available in map and table form for the public to view.

Date	Time	Station Number	Station Name	Total Precip .Ins	New Snow .in	Total Snow .In	State	County	View
1/19/2009	7:00 AM	RI-PR-10	Woonsocket 0.3 W	1.00	11.5	NA	RI	Providence	
1/19/2009	7:00 AM	RI-PR-7	Cranston 1.9 E	0.84	7.0	9.5	RI	Providence	
1/19/2009	8:00 AM	RI-PR-13	Pawtucket 1.4 NE	0.83	8.7	13.0	RI	Providence	
1/19/2009	7:00 AM	RI-PR-11	Providence 3.0 ENE	0.82	9.0	12.0	RI	Providence	
1/19/2009	8:00 AM	RI-WS-8	Saunderstown 2.2 NW	0.73	6.0	NA	RI	Washington	
1/19/2009	8:30 AM	RI-KN-2	East Greenwich 2.3 ESE	0.67	5.5	9.5	RI	Kent	
1/19/2009	7:00 AM	RI-NW-3	Jamestown 2.6 NNW	0.62	5.4	11.0	RI	Newport	
1/19/2009	7:00 AM	RI-WS-7	North Kingstown 3 N	0.59	5.0	9.0	RI	Washington	
1/19/2009	8:30 AM	RI-KN-1	Coventry Center	0.54	8.6	10.0	RI	Kent	
1/19/2009	7:00 AM	RI-WS-6	Narragansett Pier 0.5 N	0.49	4.2	7.5	RI	Washington	
1/19/2009	8:00 AM	RI-WS-9	Charlestown 3.9 NNW	0.46	6.2	9.0	RI	Washington	
1/19/2009	9:00 AM	RI-WS-1	Hope Valley 3.7 S	0.34	3.9	NA	RI	Washington	
1/19/2009	9:30 AM	RI-WS-5	Kingston 0.5 NW	0.31	3.4	8.0	RI	Washington	
1/19/2009	11:59 PM	RI-PR-14	Woonsocket 1.3 ESE	0.13	2.0	12.0	RI	Providence	
1/19/2009	7:00 AM	RI-NW-4	Middletown 1.1 SW	NA	3.0	7.0	RI	Newport	

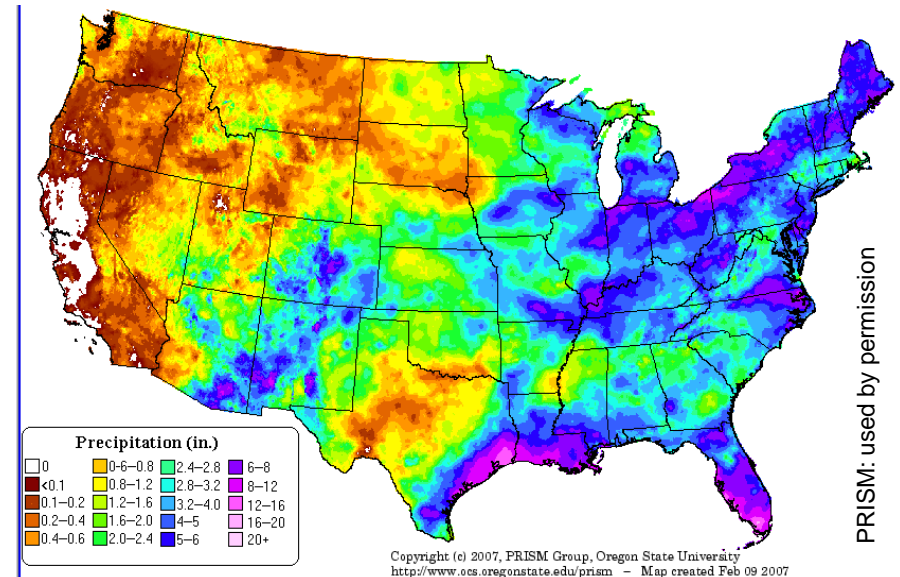
WHY CoCoRAHS ??



Precipitation is important and highly variable



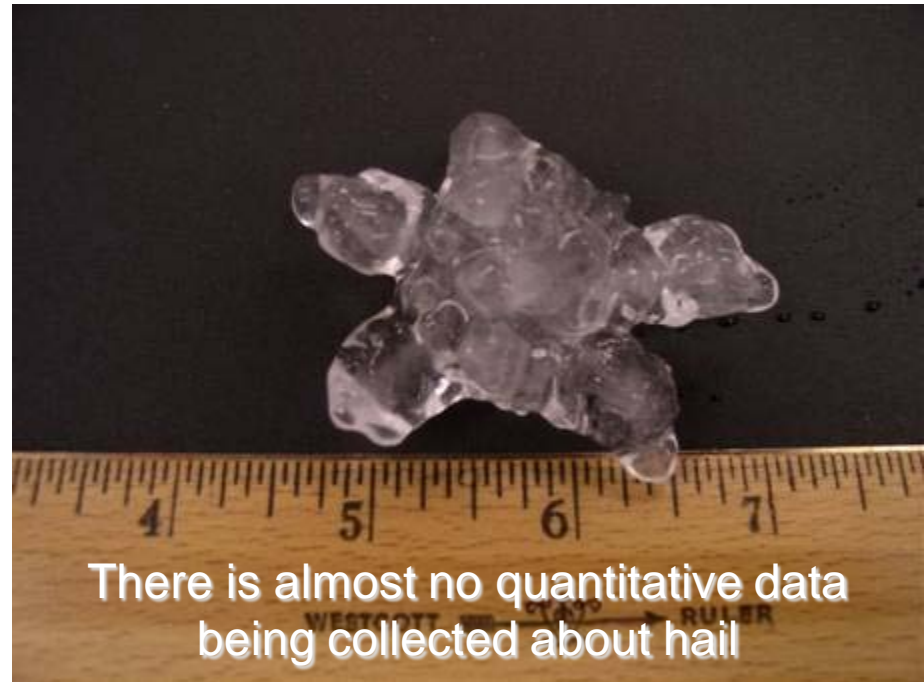
Data sources are few and rain gauges are far apart



PRISM: used by permission



Measurements from many sources are not always accurate (especially snow)



There is almost no quantitative data being collected about hail

Storm reports can save lives

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.

Wednesday
REPORT ONLINE
COLORADOAN
City death toll at 5; damage in millions
CSU's book losses speak volumes
Herald breaks 20-year record

July 30th 1997

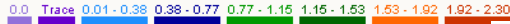




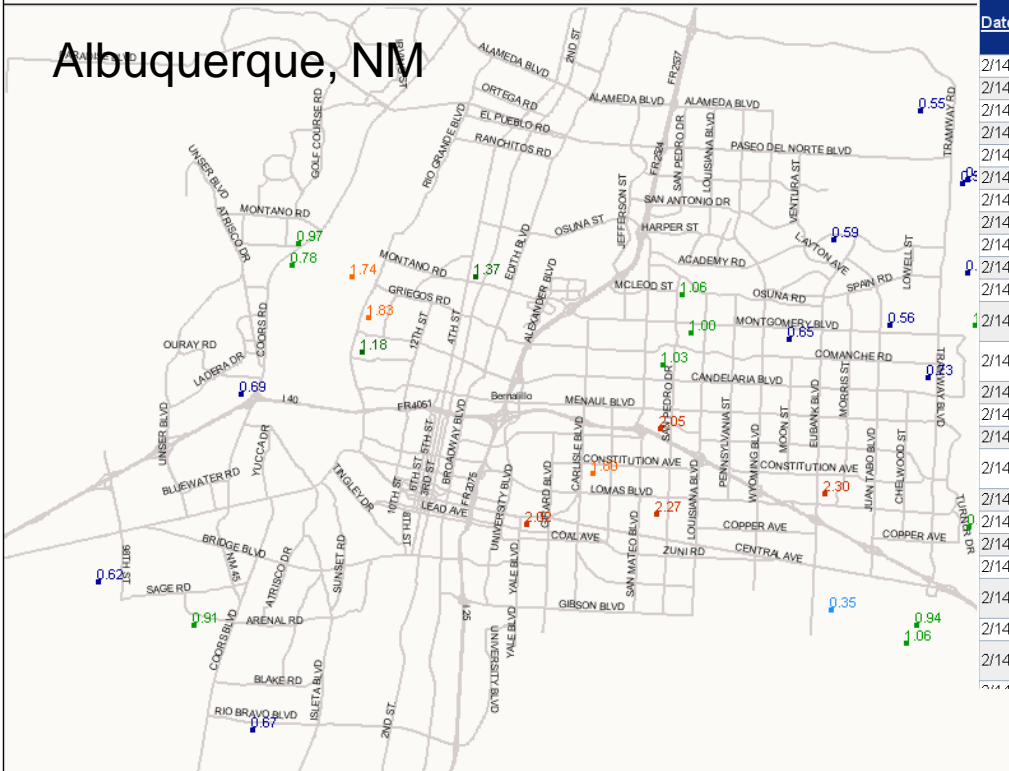
CoCoRaHS's main focus is to provide:

precipitation data . . .

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am
Albuquerque, New Mexico 8/1/2006



Albuquerque, NM



Date	Time	Station Number	Station Name	Total Precip. in	New Snow in	Total Snow in	State	County	View
2/14/2007	7:00 AM	MD-GR-1	Mc Henry 4.0 SSE	2.85	6.7	12.5	MD	Garrett	View
2/14/2007	11:59 PM	MD-MG-8	Gaithersburg 2 WNW	2.80	4.2	4.0	MD	Montgomery	View
2/14/2007	10:00 AM	MD-CR-7	Westminster 1.0 W	2.10	5.5	5.5	MD	Carroll	View
2/14/2007	7:40 AM	MD-MG-1	Montgomery Village 1.3 SSW	2.05	4.1	3.0	MD	Montgomery	View
2/14/2007	5:44 AM	MD-WH-1	Williamsport 2.8 ENE	1.92	2.6	5.0	MD	Washington	View
2/14/2007	7:15 AM	MD-CR-3	Mount Airy 0.2 SE	1.90	5.1	5.0	MD	Carroll	View
2/14/2007	7:00 AM	MD-CR-6	Taneytown 3.2 NE	1.83	5.0	NA	MD	Carroll	View
2/14/2007	7:00 AM	MD-HW-2	Sykesville 1.7 SSE	1.78	5.0	5.0	MD	Howard	View
2/14/2007	7:00 AM	MD-HW-12	Sykesville 2.6 SE	1.61	0.0	NA	MD	Howard	View
2/14/2007	8:00 AM	MD-MG-3	Potomac 0.9 NNW	1.54	3.2	NA	MD	Montgomery	View
2/14/2007	7:00 AM	MD-MG-2	Redland 0.8 NNE	1.52	4.5	4.5	MD	Montgomery	View
2/14/2007	7:00 AM	MD-PG-37	Brandywine 6.7 ESE	1.49	T	T	MD	Prince George's	View
2/14/2007	7:00 AM	MD-PG-1	Bowie 0.5 E	1.47	1.0	1.5	MD	Prince George's	View
2/14/2007	7:00 AM	MD-SM-3	Leonardtown 0.6 NE	1.42	0.0	NA	MD	St. Mary's	View
2/14/2007	7:00 AM	MD-CH-7	Waldorf 3.2 SW	1.40	0.8	0.7	MD	Charles	View
2/14/2007	7:00 AM	MD-HW-11	Columbia 1.7 W	1.40	3.2	3.5	MD	Howard	View
2/14/2007	7:00 AM	MD-PG-7	Camp Springs 1.6 NNW	1.38	1.8	NA	MD	Prince George's	View
2/14/2007	4:00 PM	MD-BL-7	White Hall 3.5 NE	1.38	NA	NA	MD	Baltimore	View
2/14/2007	7:00 AM	MD-CV-1	Marlton 6.0 E	1.37	0.3	0.0	MD	Calvert	View
2/14/2007	7:00 AM	MD-SM-4	Charlotte Hall 3.6 ENE	1.37	0.3	T	MD	St. Mary's	View
2/14/2007	7:00 AM	MD-MG-24	White Oak 1.2 N	1.35	2.5	2.0	MD	Montgomery	View
2/14/2007	7:00 AM	MD-PG-35	Brandywine 2.5 NNW	1.35	1.0	1.4	MD	Prince George's	View
2/14/2007	7:00 AM	MD-WC-1	Vienna 11.3 SSW	1.35	0.0	NA	MD	Wicomico	View
2/14/2007	7:00 AM	MD-PG-6	Friendly 1.0 N	1.32	2.4	1.8	MD	Prince George's	View

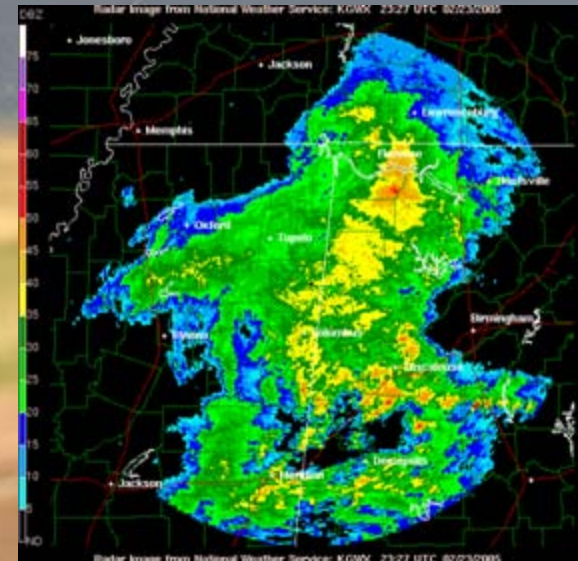
Daily data
in table form

Daily precipitation maps:
Rainfall, Hail and Snowfall

This data allows CoCoRaHS to supplement existing networks and provide many useful results to scientists, resource managers, decision makers and other end users on a timely basis.

CoCoRAHS DATA ARE USED BY MANY

- 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



. . . as well as educational opportunities



Volume 5, Issue 2 October 2006

THE GAUGE

The CoCoRaHS Network Newsletter

A New Look, A New Web site! by Henry Rogers

Those of us who have been active in CoCoRaHS before 2005, know all too well the old Web site-often one that was first developed back in 1998 primarily by high school students. The reputation of the site improved steadily since 1998 with the help of our volunteers. Most notably, but the look changed very little. Our something worked the way we liked, but it was a bit like riding that 4-wheel-old car to school.

Then along came 2005. There were station plus hundreds of new volunteers measuring CoCoRaHS. We were quickly improving our old friend. Furthermore, our sponsors and donors were strongly urged to develop a new website. Andrew Turner, our Web developer took the challenge. His vision of data collection and display is a link over 10 months. This spring we finally launched the new site.

It was not easy to switch over from the old site to the new. Our staff has spent hundreds of hours helping volunteers learn how to find and use their new instruments and passwords and try the new software.

"Because Every Drop Counts!" by Nolan Deskins

When a lot has happened since our last newsletter, let me tell you how we have improved our CoCoRaHS. It really surprised me to see that we have improved our network of snow stations. Five hundred new stations have been added since our last newsletter. We've had some staff changes. The one thing has not changed. The staff, our staff and our volunteers and reports.

Inside This Issue:

- A New Look & New Web Site! 1
- Because Every Drop Counts! 2
- Mail Pad: The CoCoRaHS Mail Pad Analysis 3
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- CoCoRaHS Has a New Name 2
- CoCoRaHS Has a New Name 2
- Monthly CoCoRaHS Team 3
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- Education Counts on Ice 4
- CoCoRaHS Data Quality 7
- The CoCoRaHS Data Quality 7
- Volunteer Spotlight 9
- Tip On Measuring Snow 10

The CoCoRaHS Network is headed by the National Science Foundation and CoCoRaHS Chapter Operations.



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

Home | Station | View Data | Map | My Data | My Account | Admin | Logout

Mail Pad Examples

Rain Drops



Soft Hail Stones



Small Hail Stones



Message of the Day:

Don't forget to remove the funnel and inner tube from your rain gauge if freezing weather is expected.

We realize that many of you have had to reenter your login information to get into our system recently. Apparently the server configuration change will cause a change in our cookies, which caused your saved login information to be lost. We apologize for the inconvenience and would like to thank everyone for the patience.

Now would be a good time to print out and save your login information in case this ever happens again. You can always have your user name and password sent to your e-mail address by clicking on the "Find your login info" link on the Login page.

Confirmation:

- The Daily Precipitation Report was saved.

Daily Precipitation Report		Print	
Station Number:	CO-LR-610	Station Name:	Fort Collins 2.8 SR
Observation Date:	10/27/2006 7:30 AM		
Submitted:	10/27/2006 9:43 AM		
Total Precip Amount:	0.00 inches		




TRAINING SLIDE-SHOW



Things to know about...

Rain

- [Overview](#)
- [Weather Radar](#)
- [Measuring Rain](#)

Hail

- [Overview](#)
- [Hail Facts](#)
- [Hail Figures](#)
- [CoCoRaHS & Hail](#)
- [Hail Pad Examples](#)
- [Measuring Hail](#)

Snow

- [Overview](#)
- [Measuring Snow](#)

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

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My Data Entry : View Daily Precipitation Report

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CoCoRaHS hopes to one day achieve a network of . . .

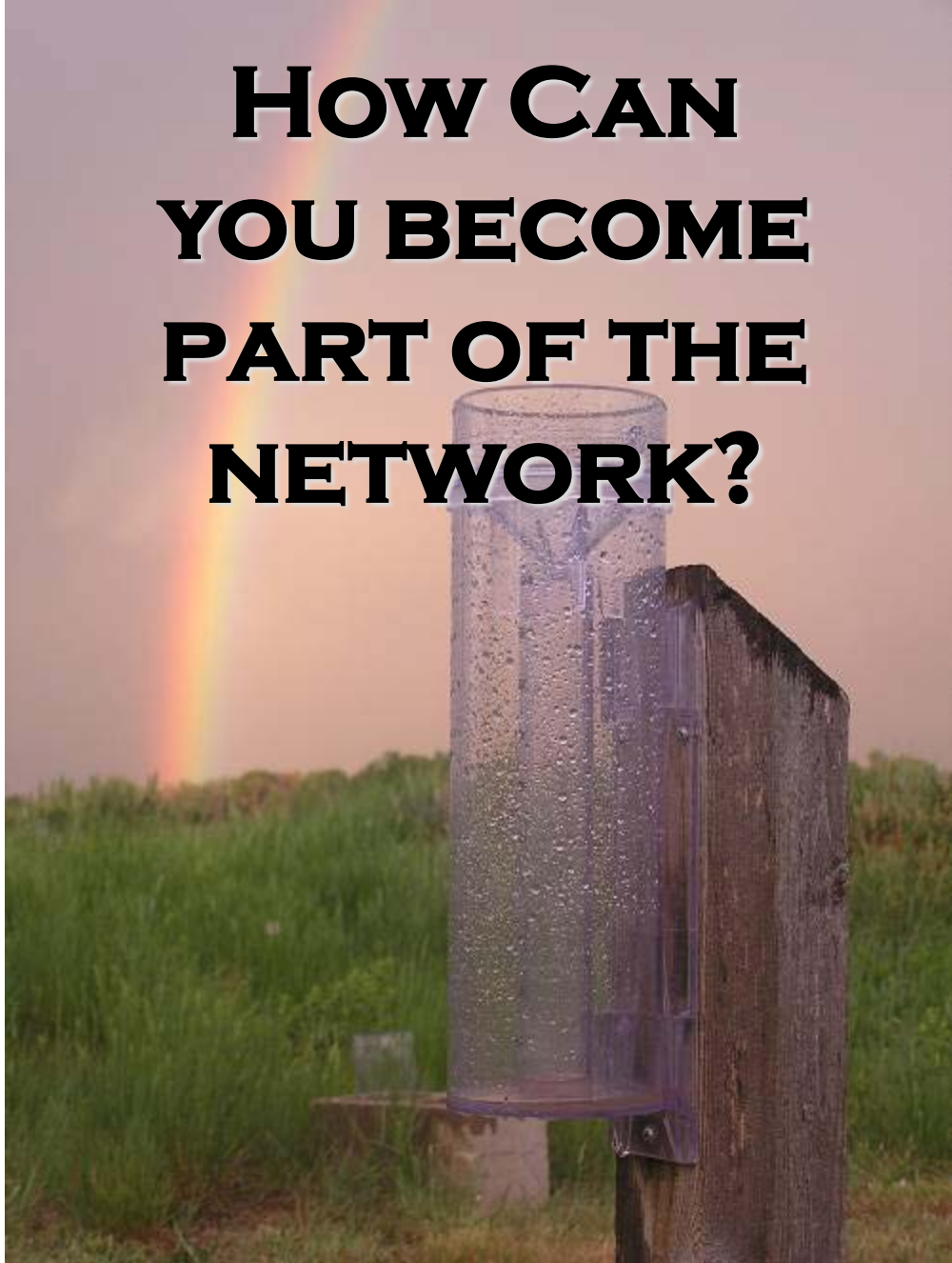


one observer **every square mile**
in **urban** areas



one observer **every 36 square miles**
in **rural** areas

HOW CAN YOU BECOME PART OF THE NETWORK?



Five easy steps

*Simply sign-up on the
CoCoRaHS web page
www.cocorahs.org*

*Obtain a 4" plastic rain gauge
(info available on web site)*

*View the "training slide show" or
attend a training session*

*Set-up the gauge in a "good"
location in your backyard*

*Start observing precipitation
and report on-line daily*



Just 5 minutes a day!

It's easy and fun!

We're Cuckoo For CoCoRaHS!

www.cocorahs.org

