Drought Characteristics in Colorado 1890 to 2008

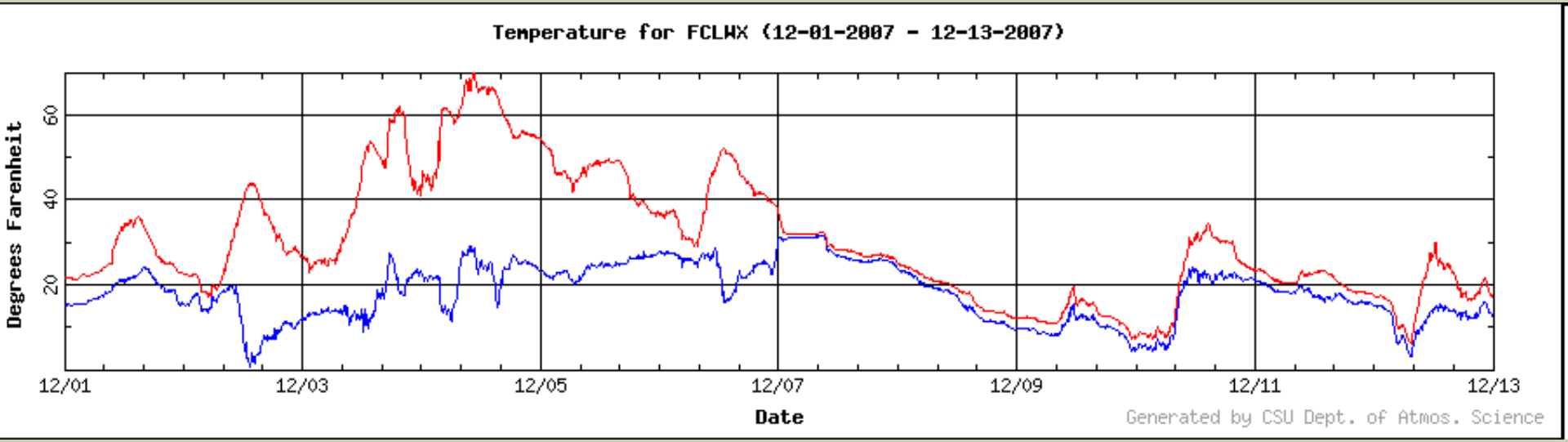
Nolan Doesken
State Climatologist
Colorado Climate Center

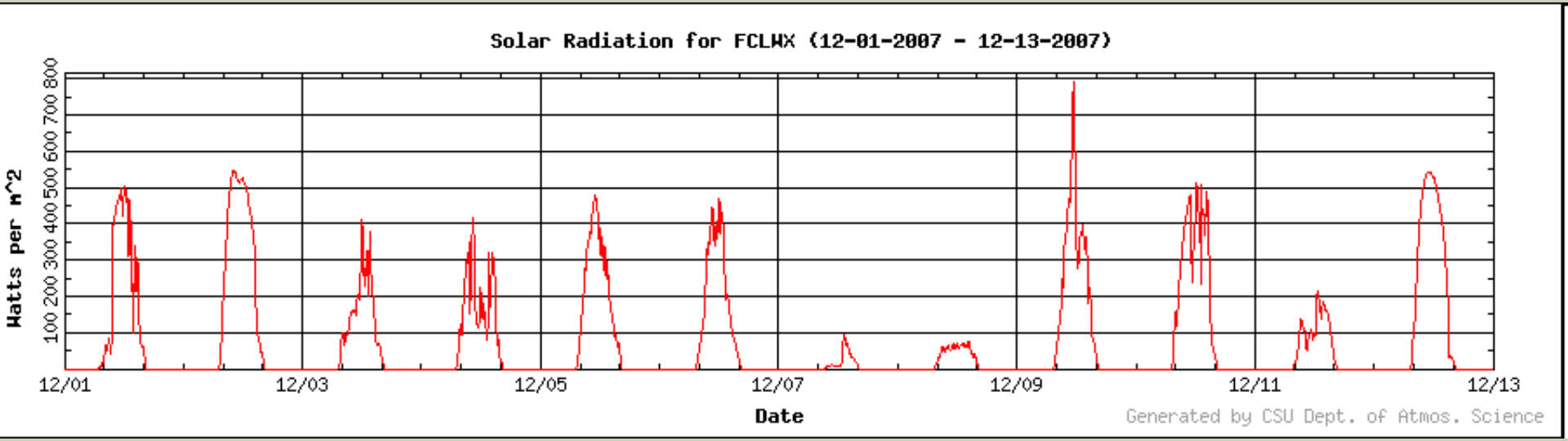
Presented at Governor's Conference on Managing Drought & Climate Risk, October 8–10, 2008, Denver, CO

Colorado Climate Center

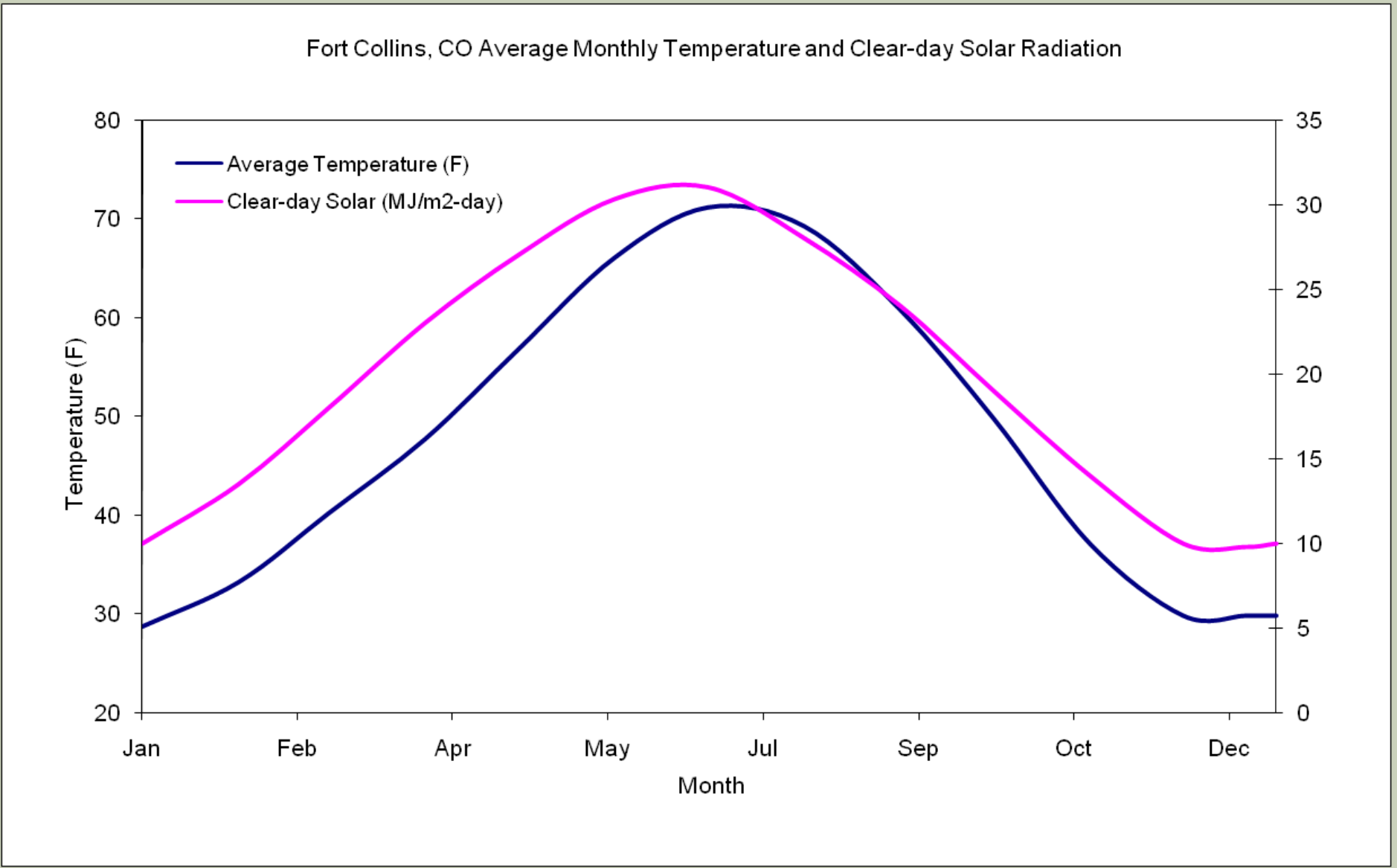
Colorado State University
Knowledge to Go Places

Seasonal changes and year-to-year variations are a natural and exciting part of our climate!

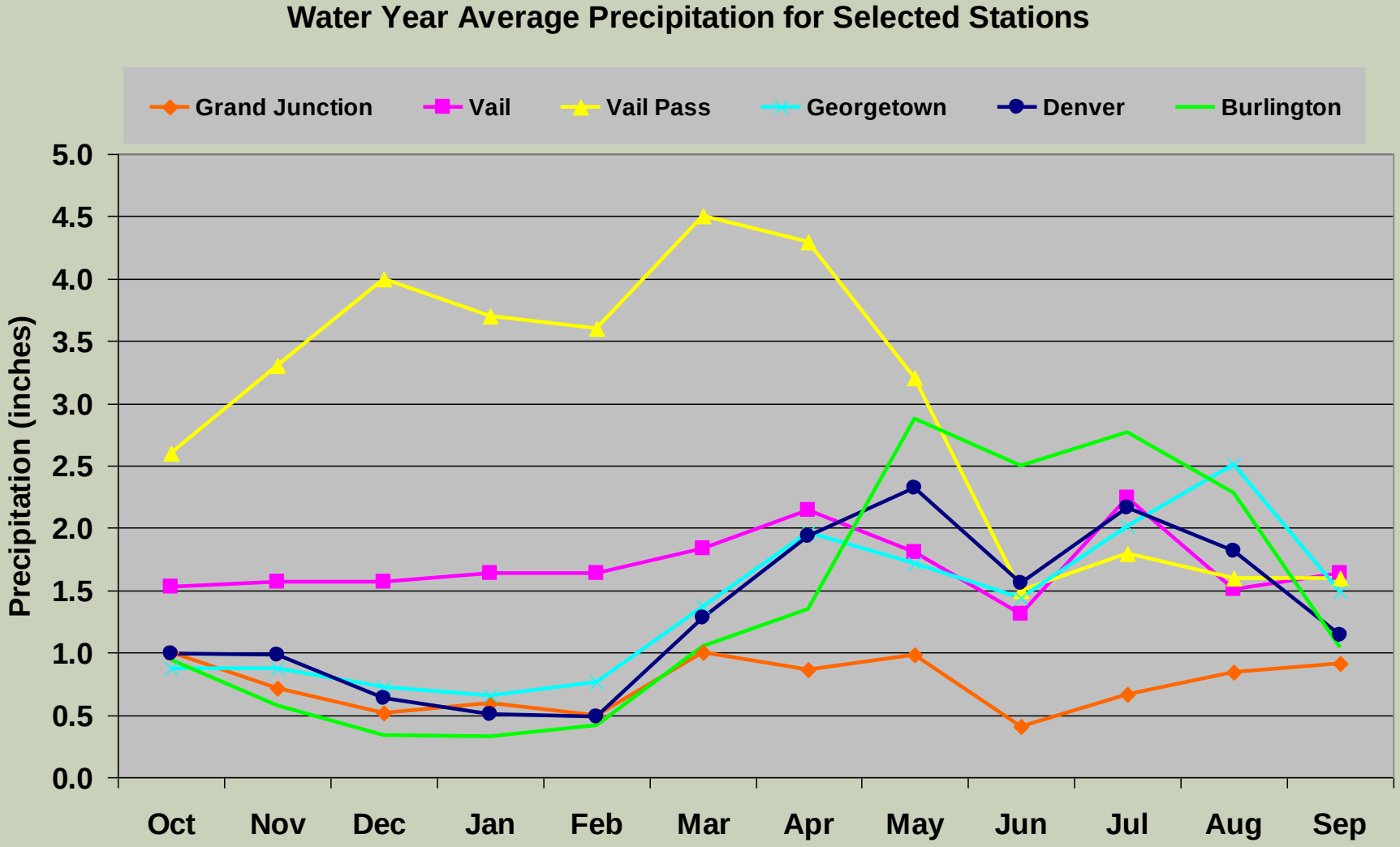




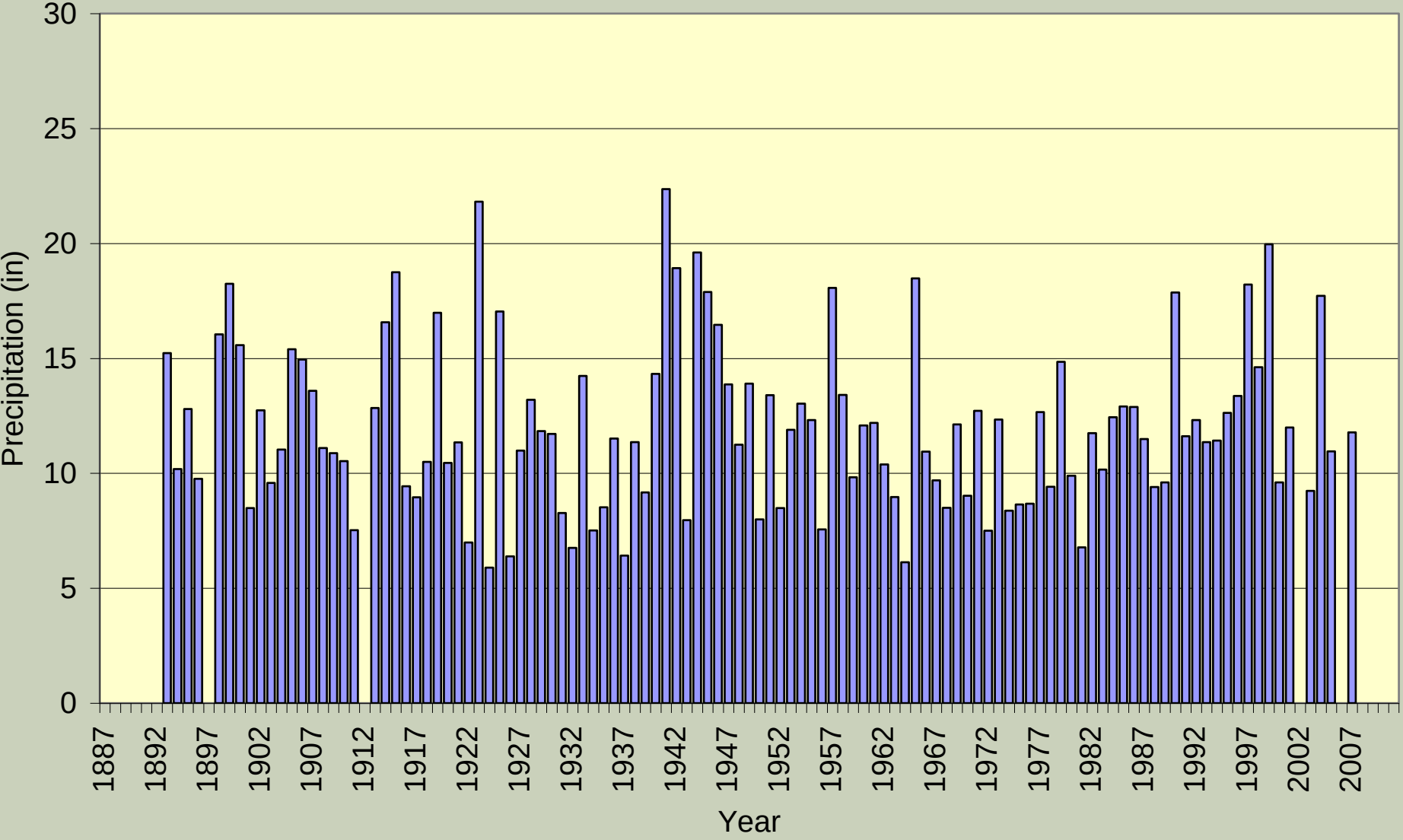
Fort Collins Average Monthly Temperature and Clear-Day Solar Radiation

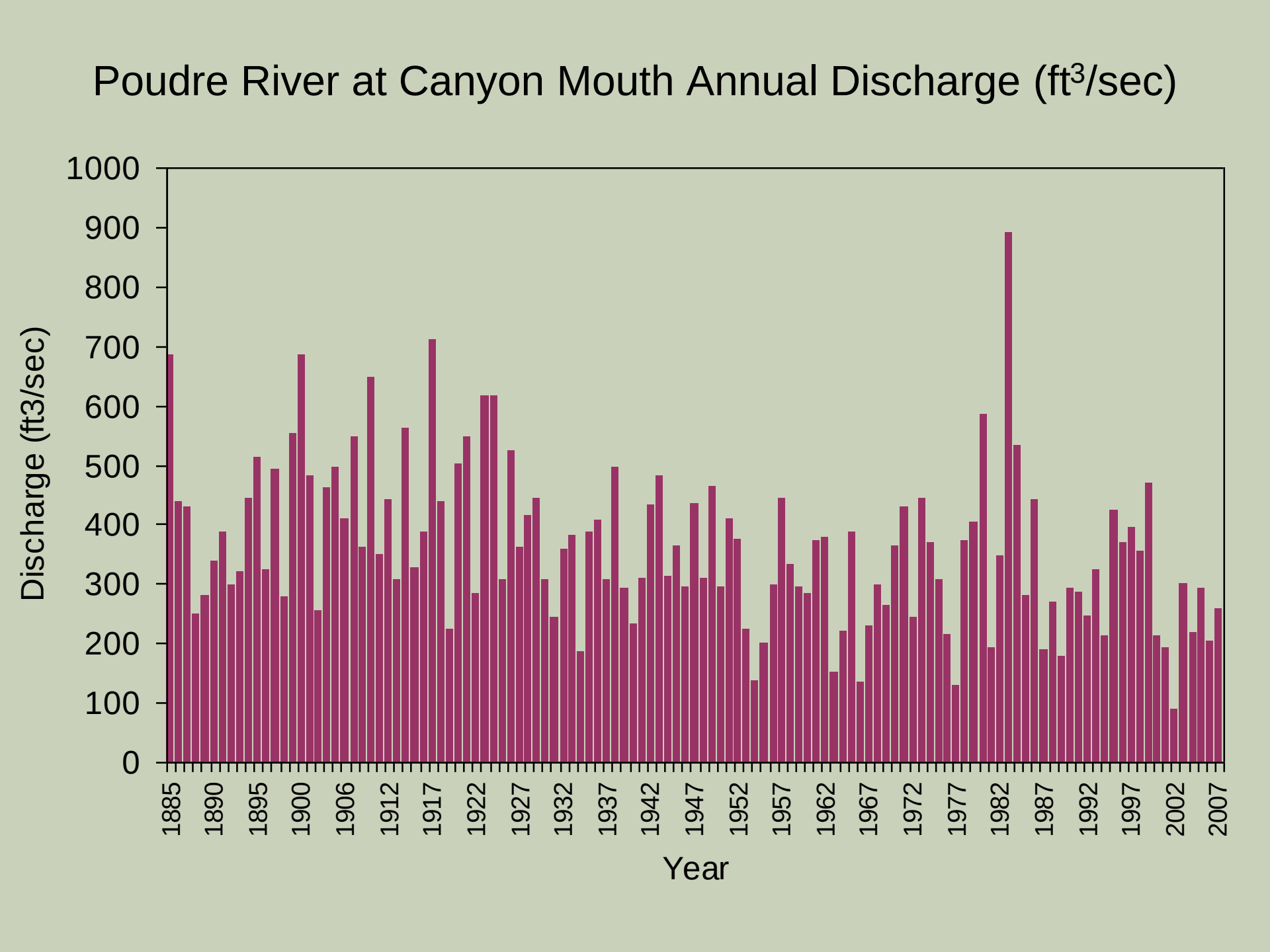


Average Monthly Precipitation Across the State

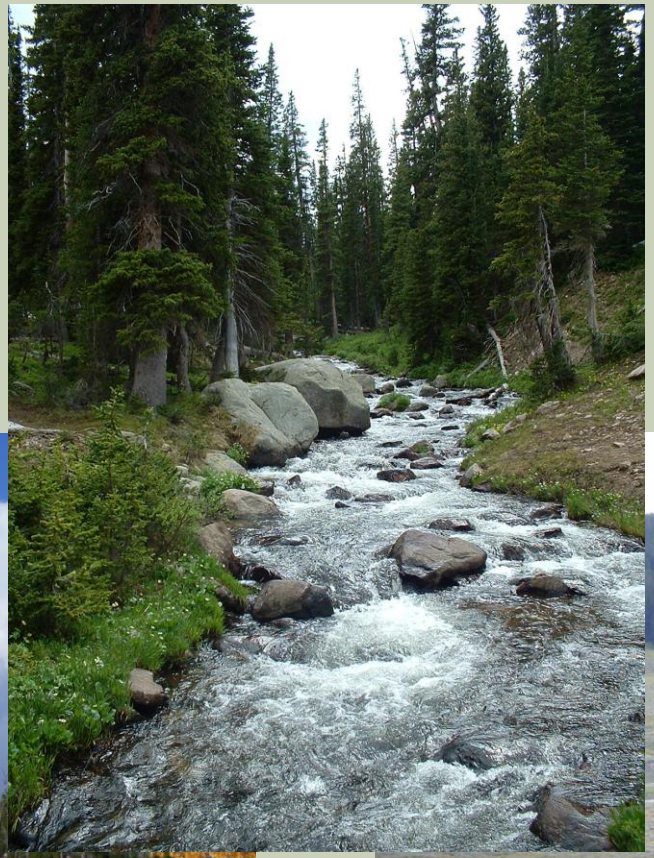


Rocky Ford Annual Precipitation

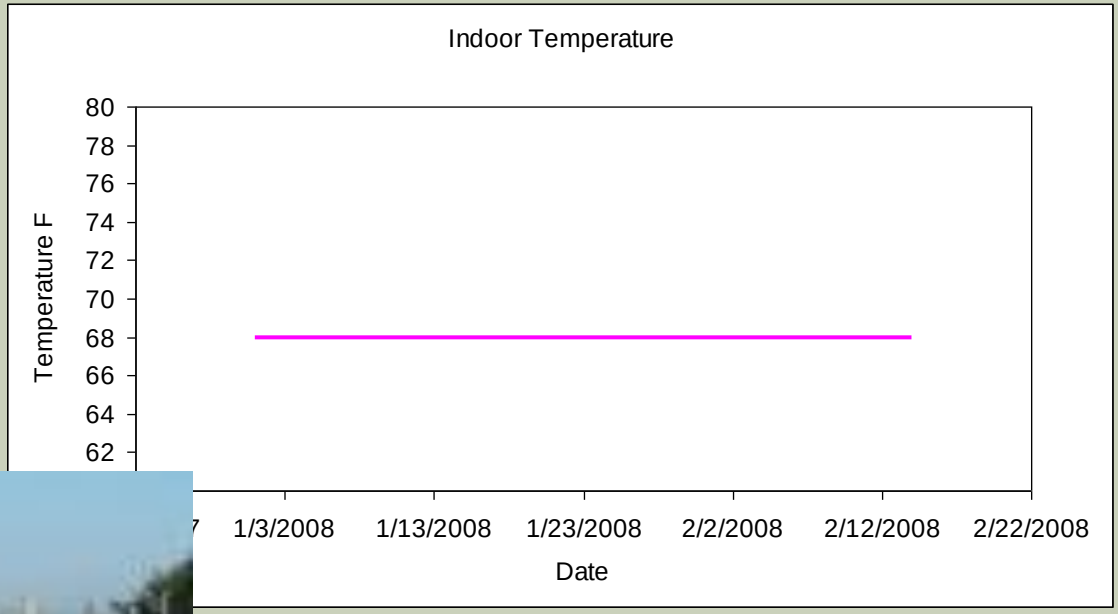



Poudre River at Canyon Mouth Annual Discharge (ft3/sec)
Discharge (ft3/sec)
1000
900
800
700
600
500
400
300
200
100
0
1885
1890
1895
1900
1906
1912
1917
1922
1927
1932
1937
1942
1947
1952
1957
1962
1967
1972
1977
1982
1987
1992
1997
2002
2007
Year

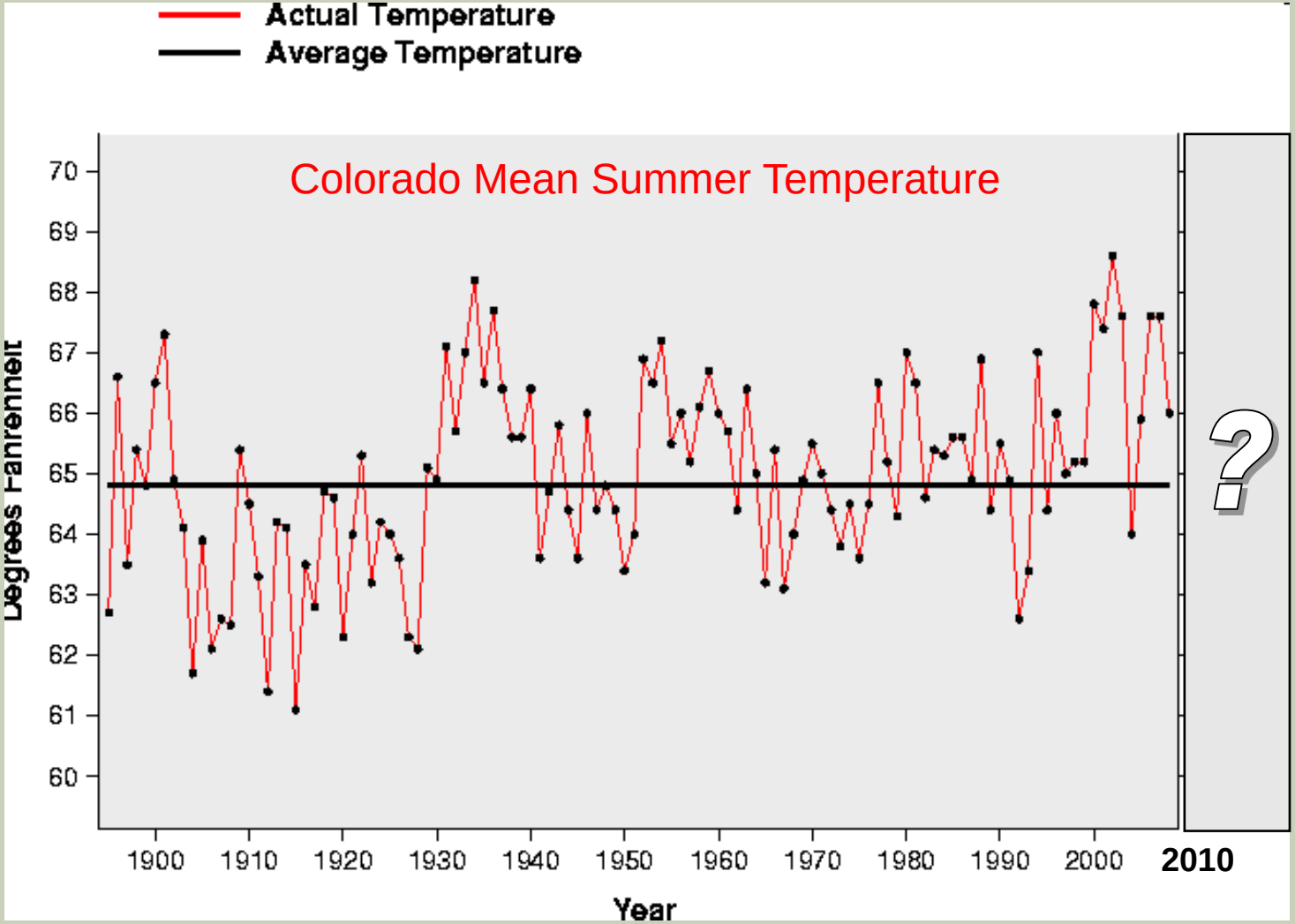
Natural systems accommodate and survive typical variability



Human built and manages systems strive to minimize variability

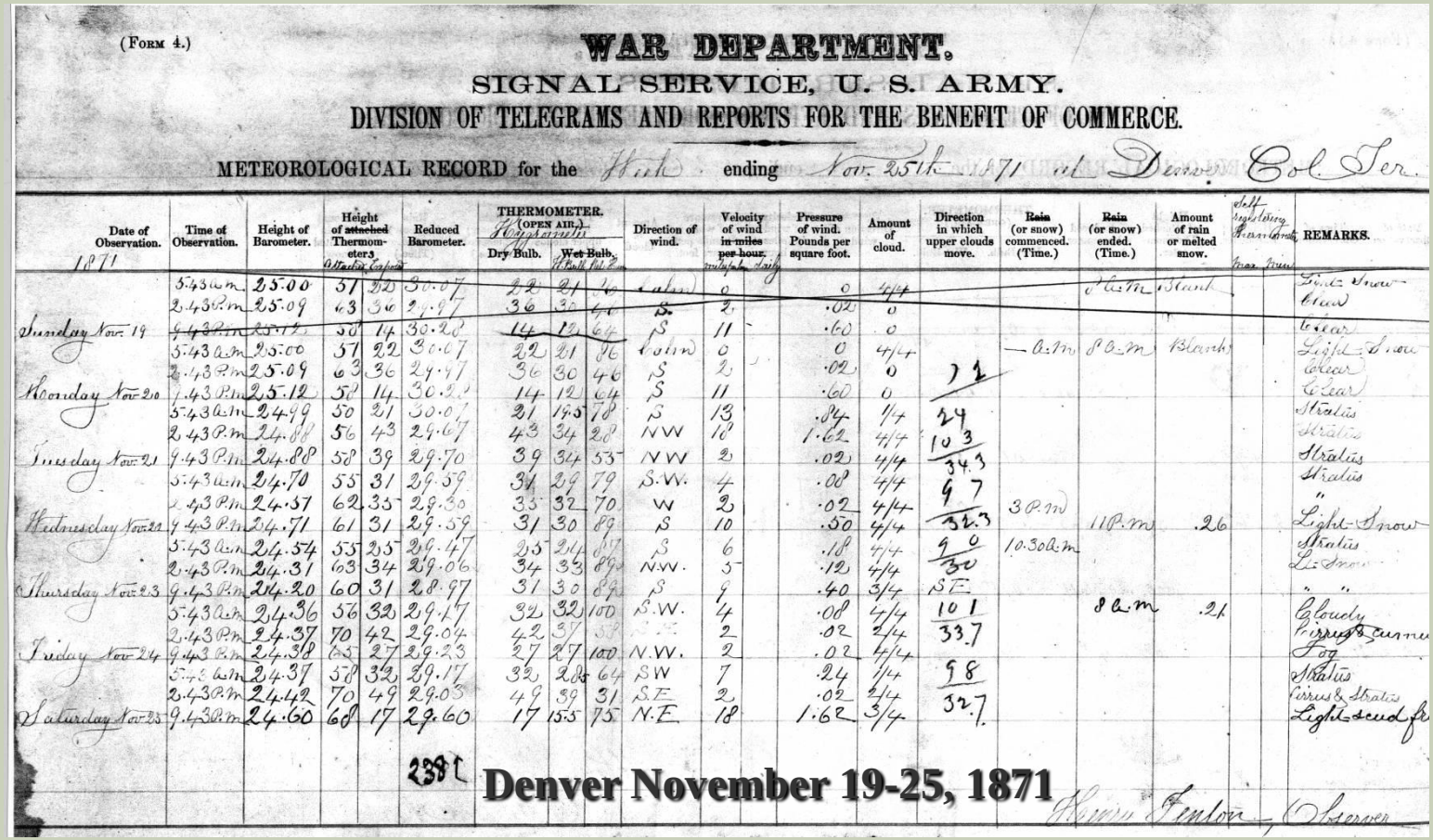


Today, we wonder what lies ahead. Can we manage the climate variability we are sure to face?



Climate and Drought Monitoring

Since the 1870's we have attempted to measure and track our climate and it's variations here in Colorado.



(Form 4.)

WAR DEPARTMENT.

SIGNAL SERVICE, U. S. ARMY.

DIVISION OF TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE.

METEOROLOGICAL RECORD for the Week ending Nov. 25th 1871 at Denver Col. Ter.

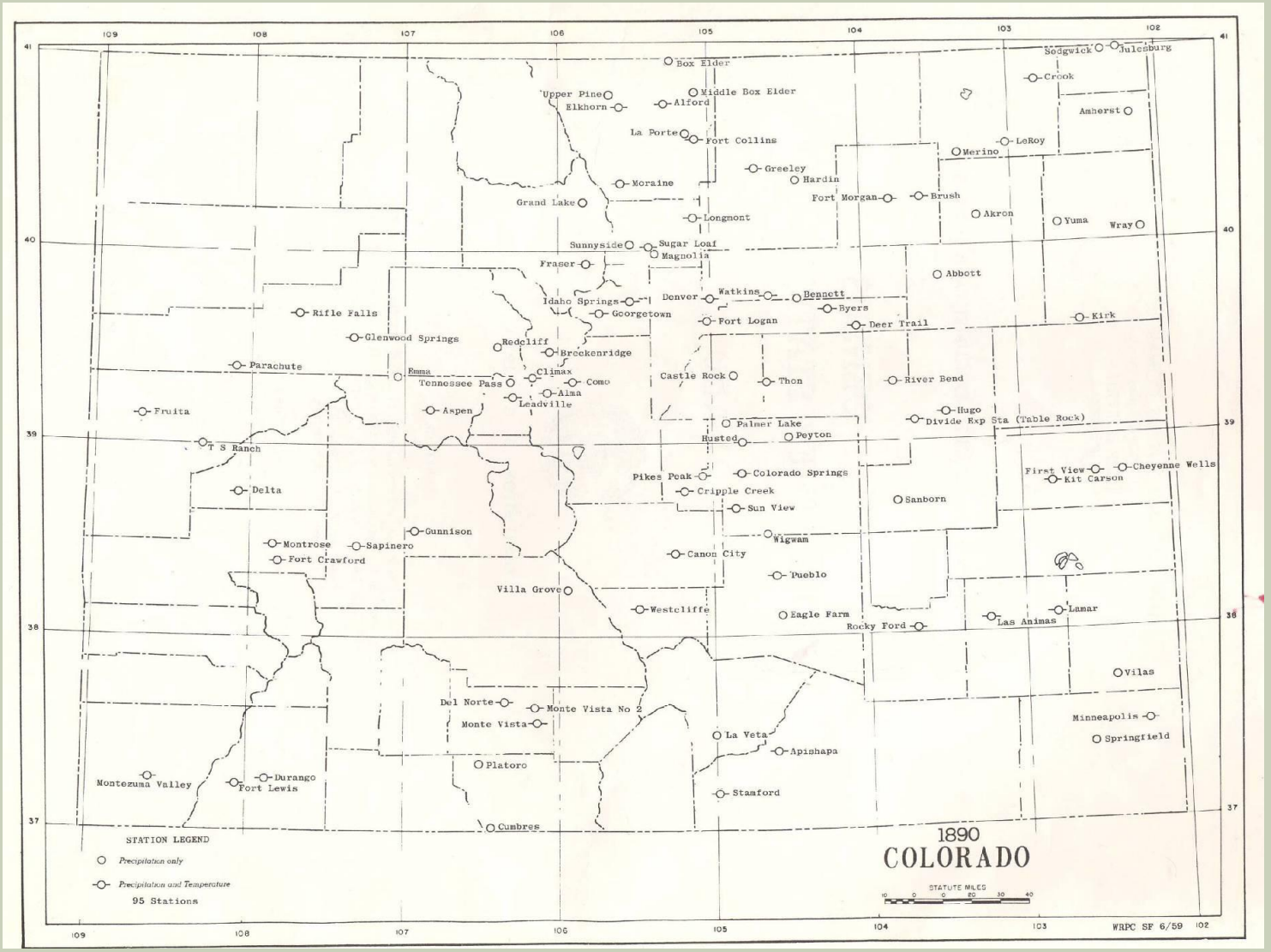
Date of Observation. 1871	Time of Observation.	Height of Barometer.	Height of Thermometer.	Reduced Barometer.	THERMOMETER. (OPEN AIR.) Dry Bulb.	Wet Bulb.	Direction of wind.	Velocity of wind in miles per hour.	Pressure of wind. Pounds per square foot.	Amount of cloud.	Direction in which upper clouds move.	Rain (or snow) commenced. (Time.)	Rain (or snow) ended. (Time.)	Amount of rain or melted snow.	REMARKS.
	5.43 a.m.	25.00	37	30.07	22	21	Calm	0	0	4/4			8 a.m.	Slight	Light Snow
	2.43 P.m.	25.09	43	29.97	36	30	S.	2	.02	0					Clear
Sunday Nov. 19	9.43 P.m.	25.12	38	30.20	14	12	S	11	.60	0					Clear
	5.43 a.m.	25.00	37	30.07	22	21	Calm	0	0	4/4		0 a.m.	8 a.m.	Blanket	Light Snow
	2.43 P.m.	25.09	43	29.97	36	30	S	2	.02	0	12				Clear
Monday Nov. 20	9.43 P.m.	25.12	38	30.20	14	12	S	11	.60	0					Clear
	5.43 a.m.	24.99	50	30.07	21	19	S	13	.84	1/4	24				Stratus
	2.43 P.m.	24.88	56	29.67	43	34	NW	10	1.62	4/4	103				Stratus
Tuesday Nov. 21	9.43 P.m.	24.88	58	29.70	39	34	NW	2	.02	4/4	34.3				Stratus
	5.43 a.m.	24.70	55	29.59	34	29	S.W.	4	.08	4/4	9 7				Stratus
	2.43 P.m.	24.37	62	29.30	33	32	W	2	.02	4/4	32.3	3 P.m.			"
Wednesday Nov. 22	9.43 P.m.	24.71	61	29.59	31	30	S	10	.50	4/4			11 P.m.	.26	Light Snow
	5.43 a.m.	24.54	55	29.47	25	24	S	6	.18	4/4	9 0	10.30 a.m.			Stratus
	2.43 P.m.	24.31	63	29.06	34	33	N.W.	5	.12	4/4	30				Lt Snow
Thursday Nov. 23	9.43 P.m.	24.20	60	28.97	31	30	S	9	.40	3/4	SE.				" "
	5.43 a.m.	24.36	56	29.17	32	32	S.W.	4	.08	4/4	10 1		8 a.m.	.21	Cloudy
	2.43 P.m.	24.37	70	29.04	42	37		2	.02	2/4	33.7				Cirrus & Cumu
Friday Nov. 24	9.43 P.m.	24.38	65	29.23	27	27	N.W.	2	.02	4/4					Fog
	5.43 a.m.	24.37	58	29.17	32	28	SW	7	.24	1/4	9 8				Stratus
	2.43 P.m.	24.42	70	29.03	49	39	SE	2	.02	2/4	32.7				Cirrus & Stratus
Saturday Nov. 25	9.43 P.m.	24.60	68	29.60	17	15.5	N.E	18	1.62	3/4					Light cloud fr

238

Denver November 19-25, 1871

Signal Service Observer

The Colorado Legislature established a state weather service in the mid-1880's



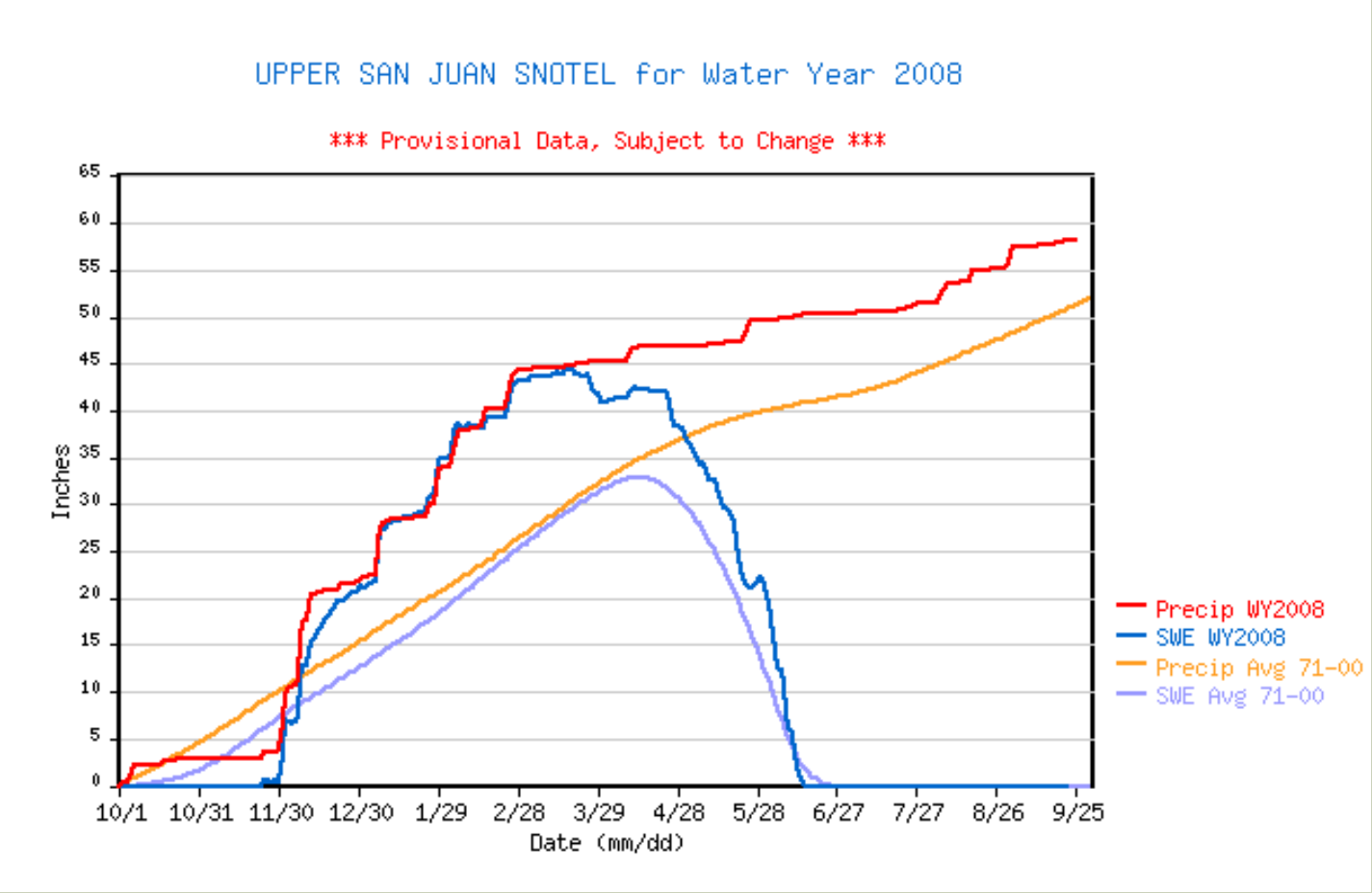
Colorado Weather Stations in 1890

In 1891, a civilian “U.S. Weather Bureau” was created.

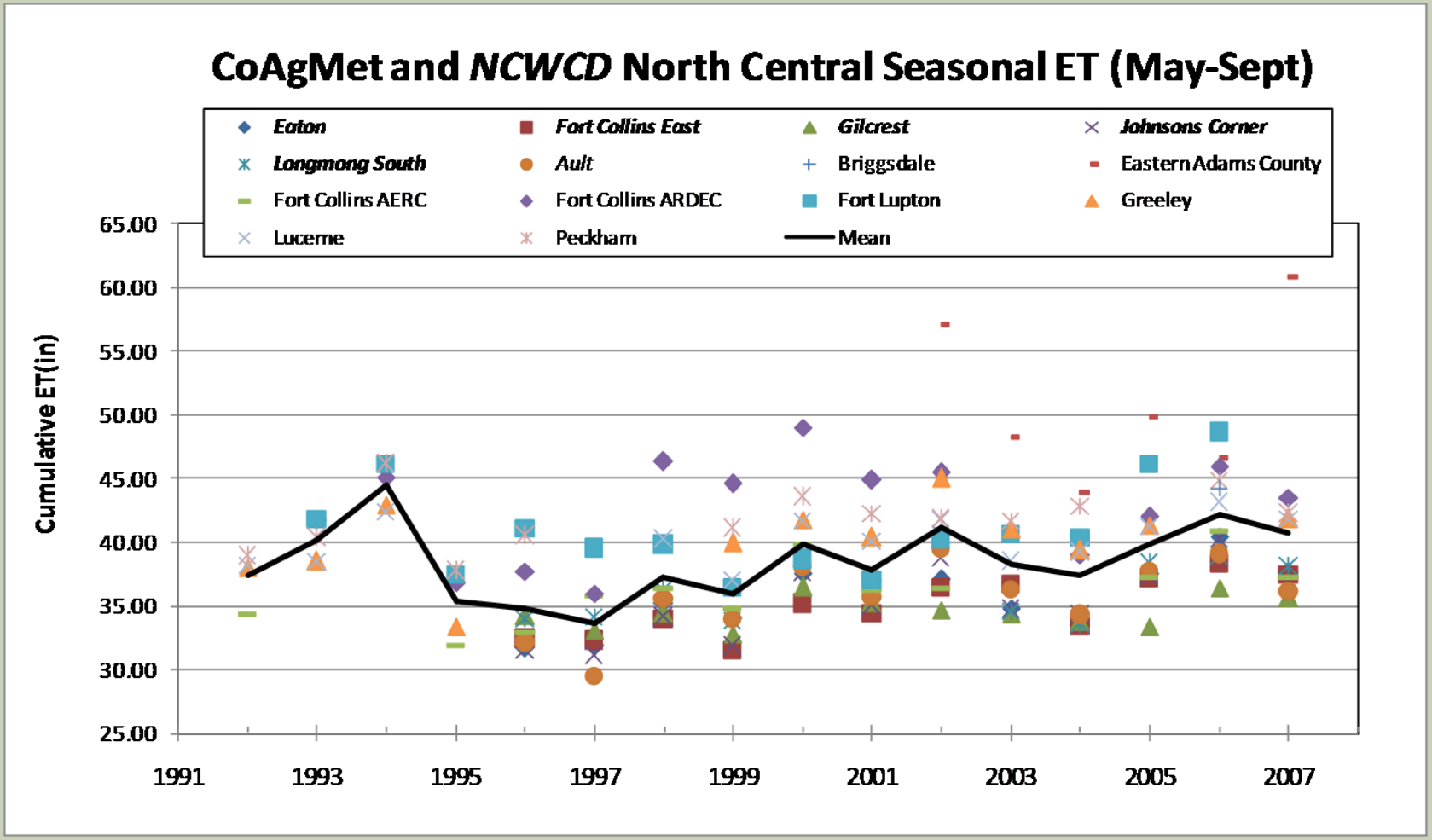
Systematic streamflow measurements began about this same time

Later came measurements of mountain snowpack, followed by water supply forecasts.

More recently, electronic sensors and automation have resulted in expansion of climate and water resources monitoring.

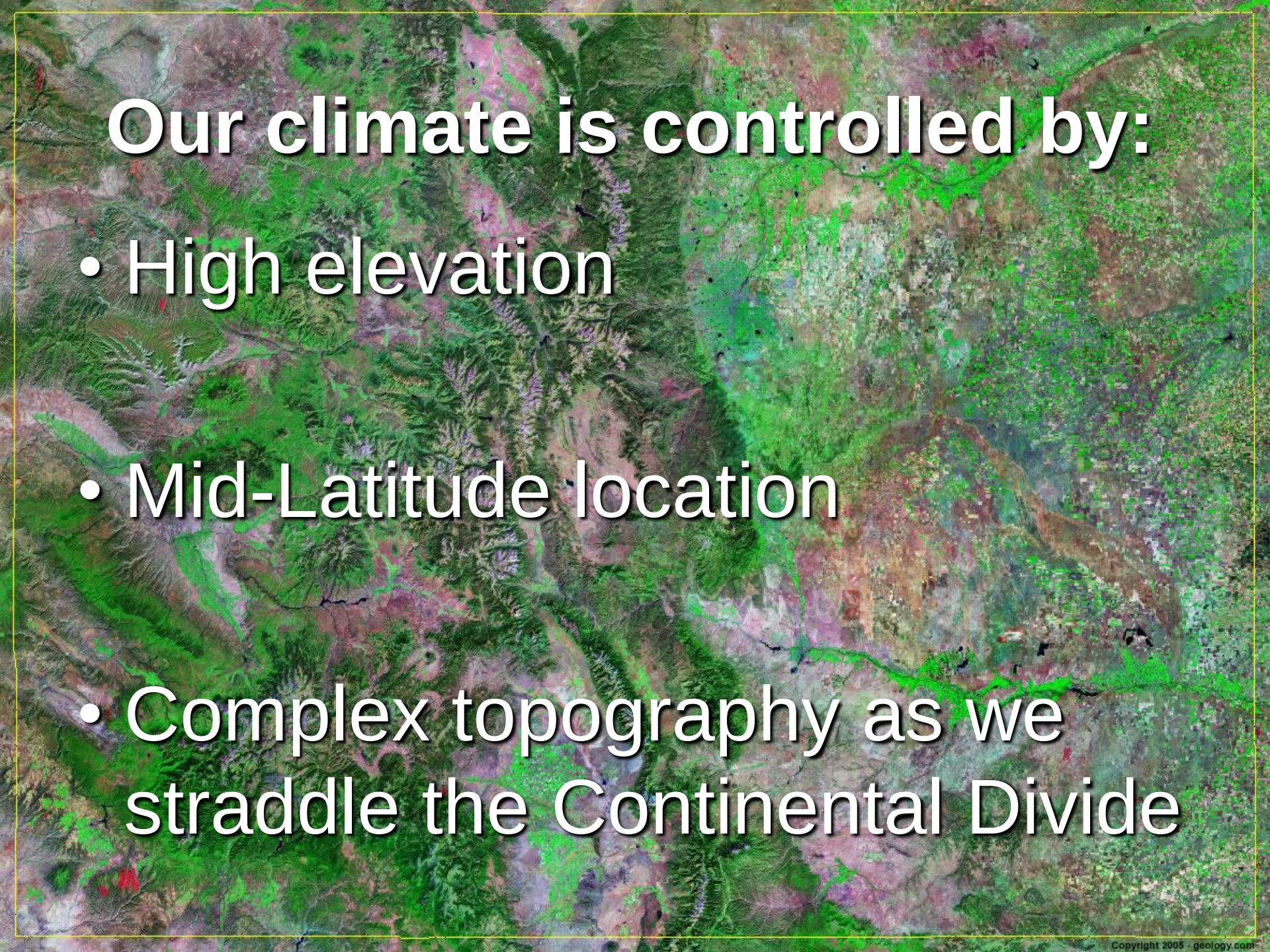


The Colorado Agricultural Meteorological Network (CoAgMet) and similar monitoring systems managed by Northern Colorado Water Conservancy District provide assessments of evapotranspiration to help track water use.



http://www.coagmet.com

Climate and Drought: What have we learned???



Our climate is controlled by:

- High elevation
- Mid-Latitude location
- Complex topography as we straddle the Continental Divide

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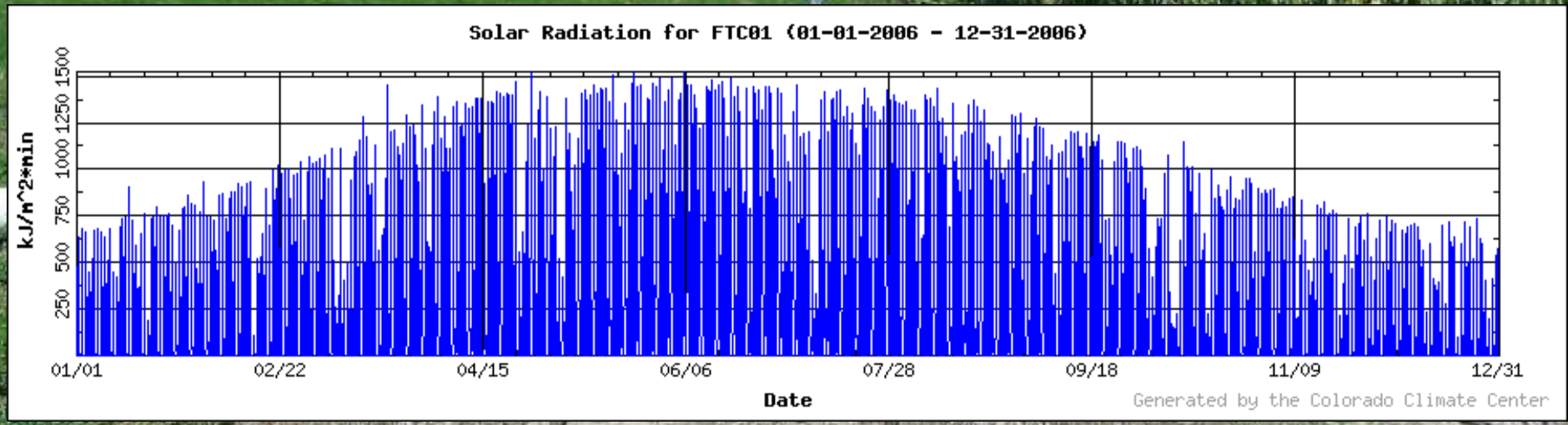
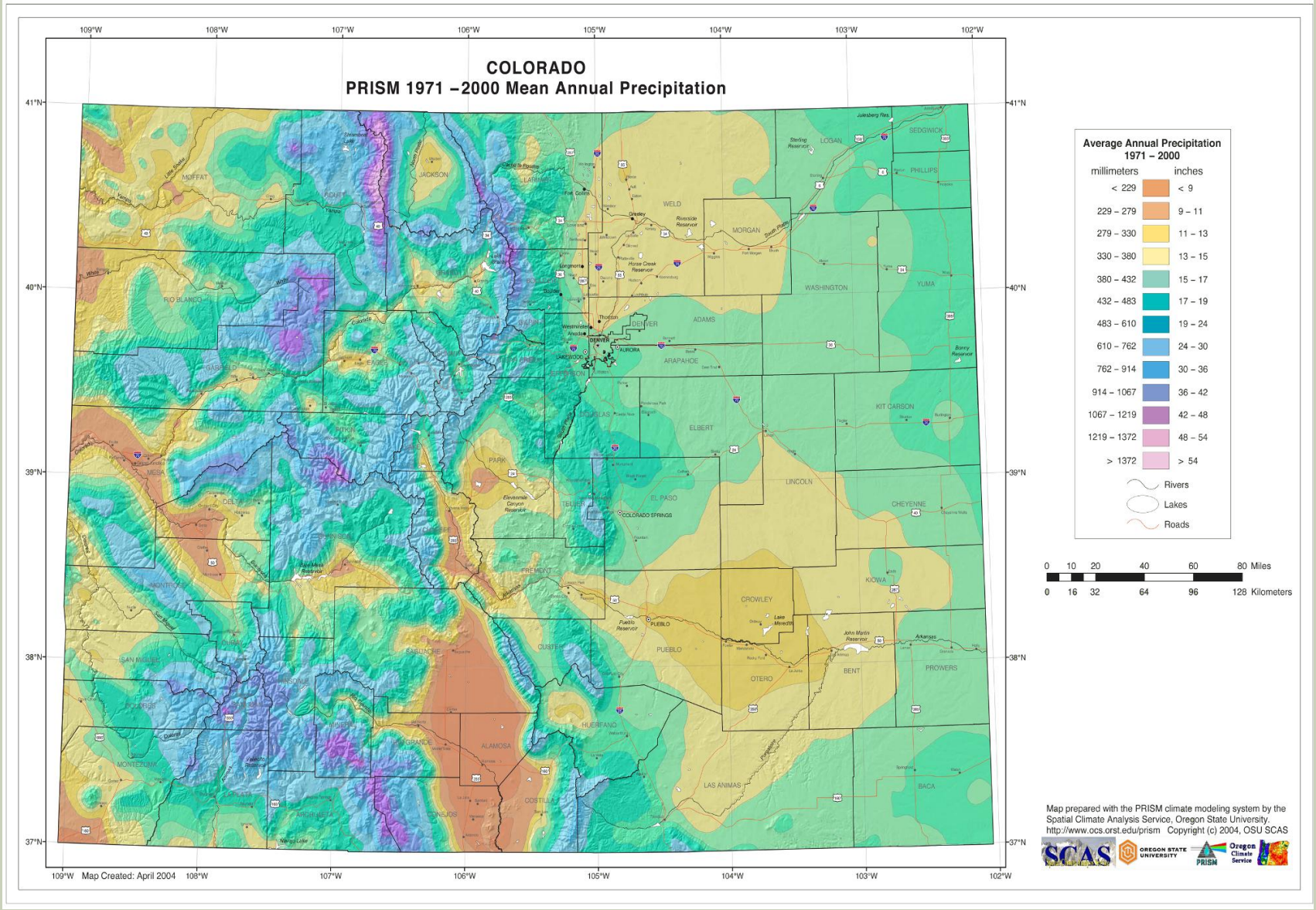
What is the Result?

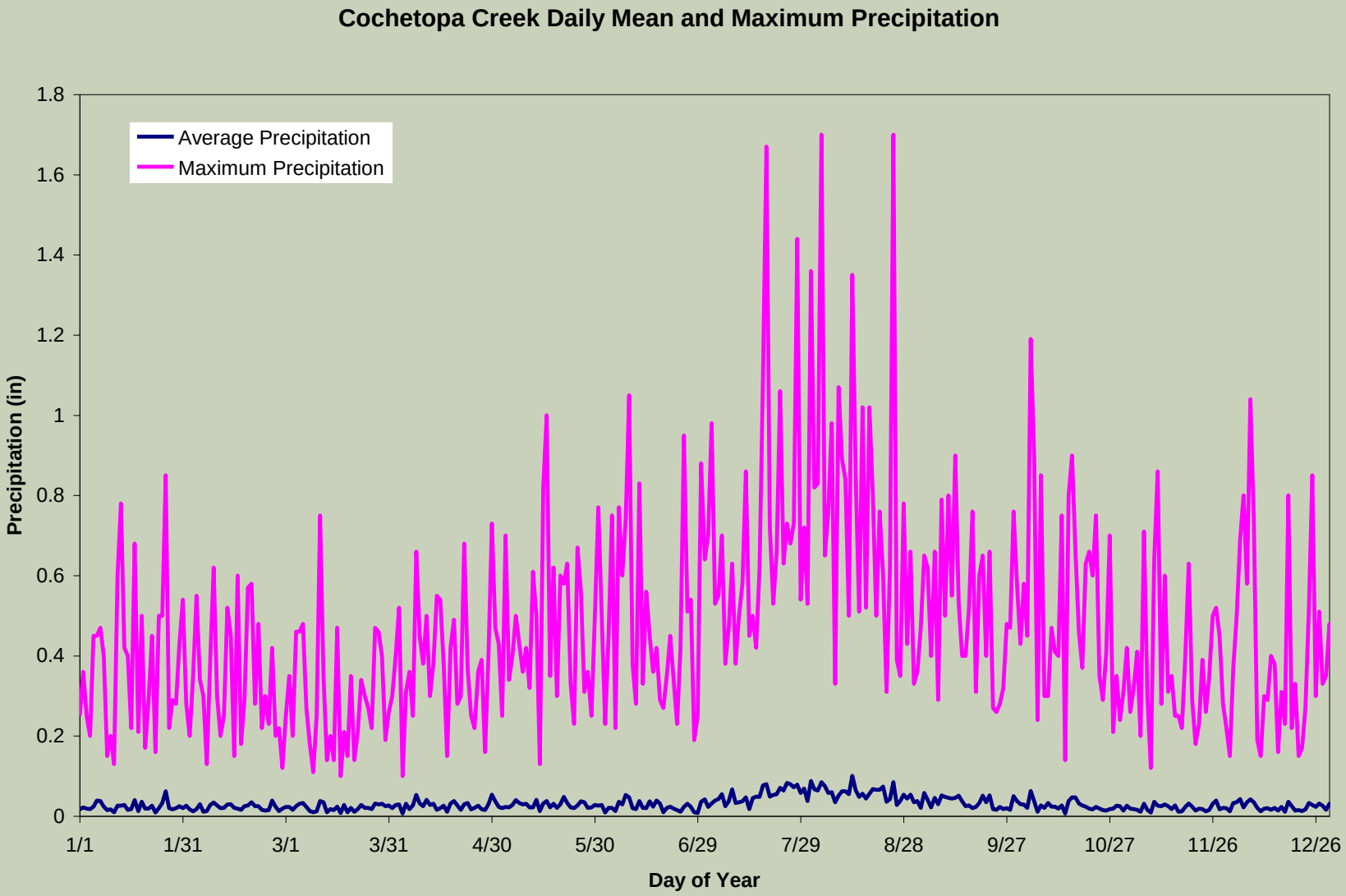
Generous sunshine and low humidity, i.e. people like it here

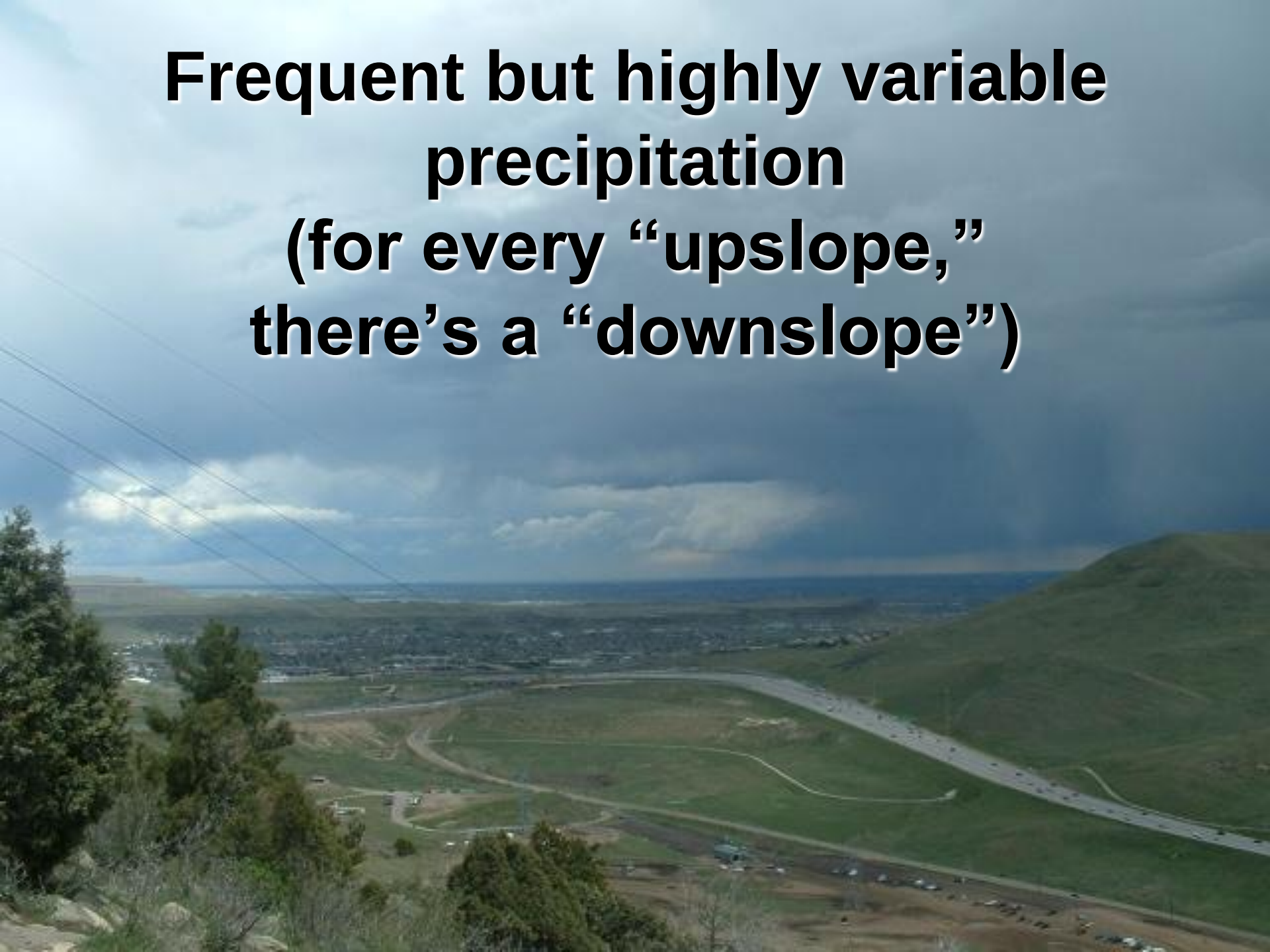


Precipitation patterns are dominated by topography

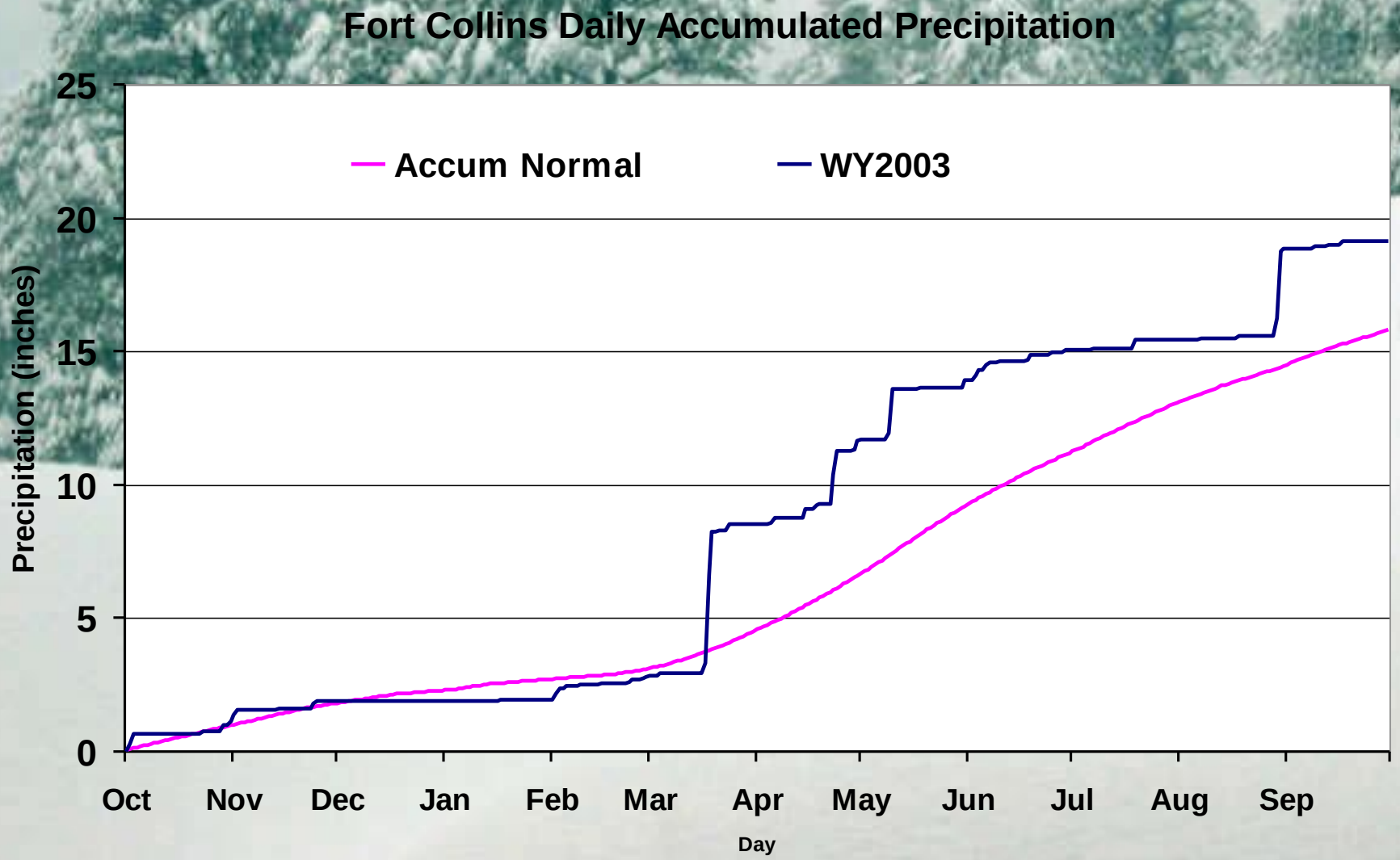


Large daily variations and dramatic seasonal cycles rule



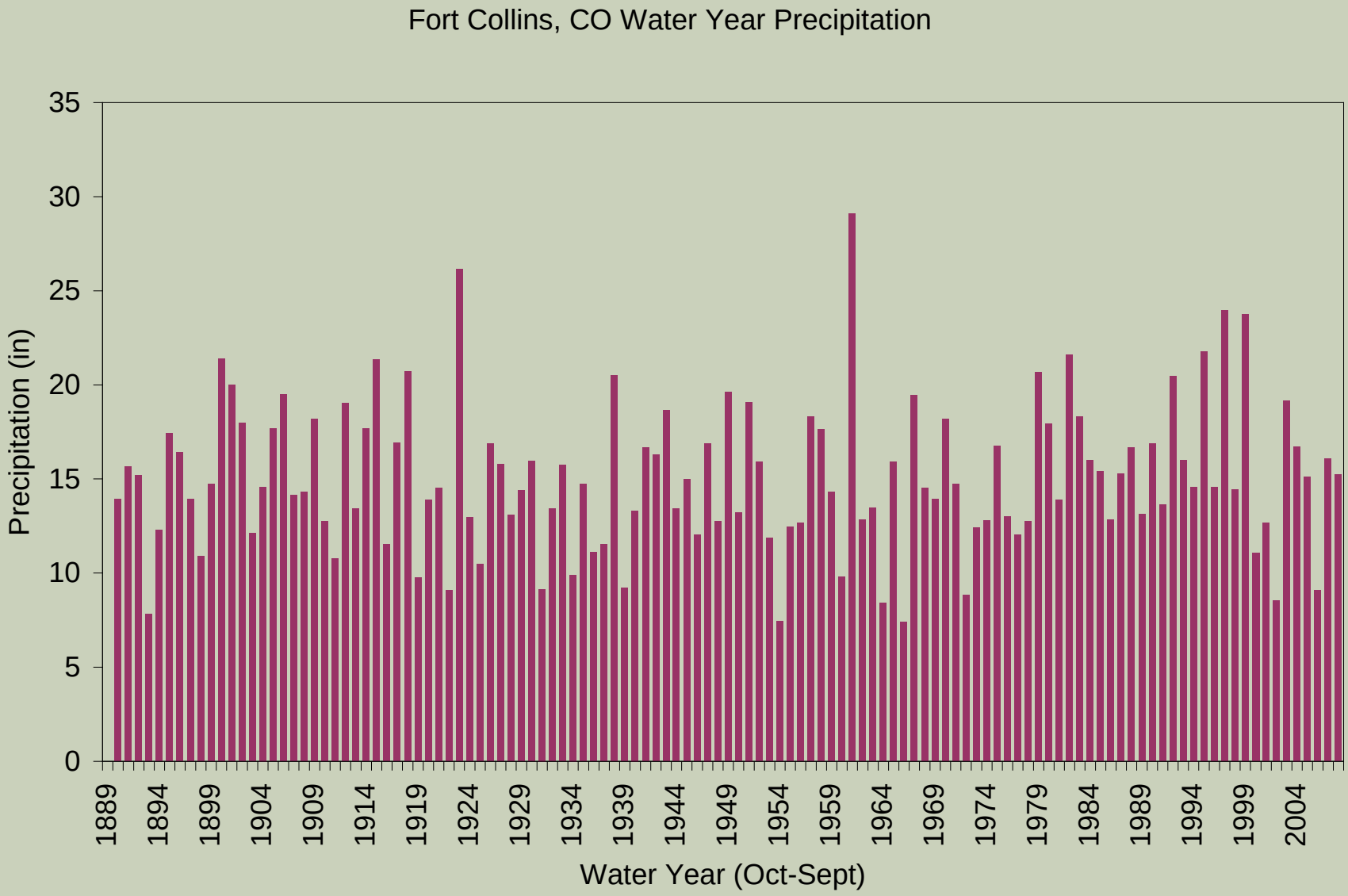

Frequent but highly variable precipitation
(for every “upslope,” there’s a “downslope”)

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



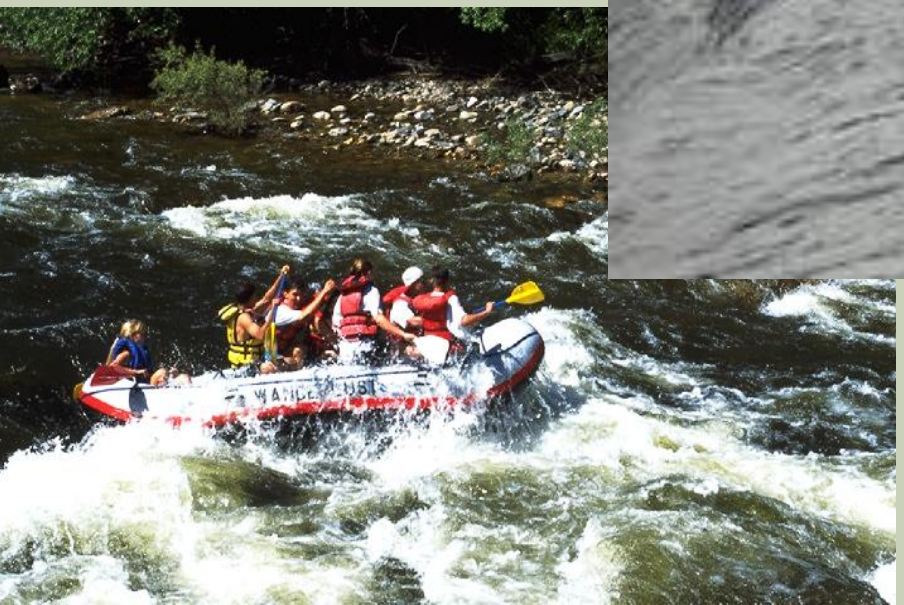

The majority of high elevation precipitation falls as snow

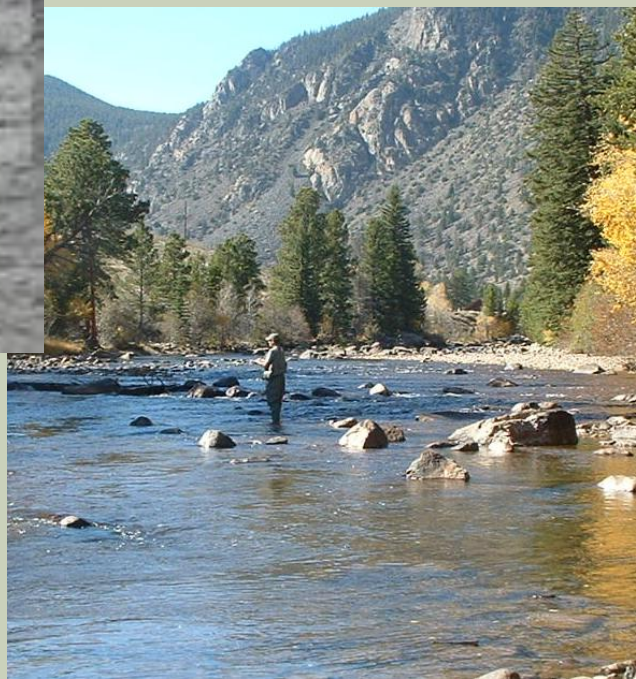
No two years are ever alike!



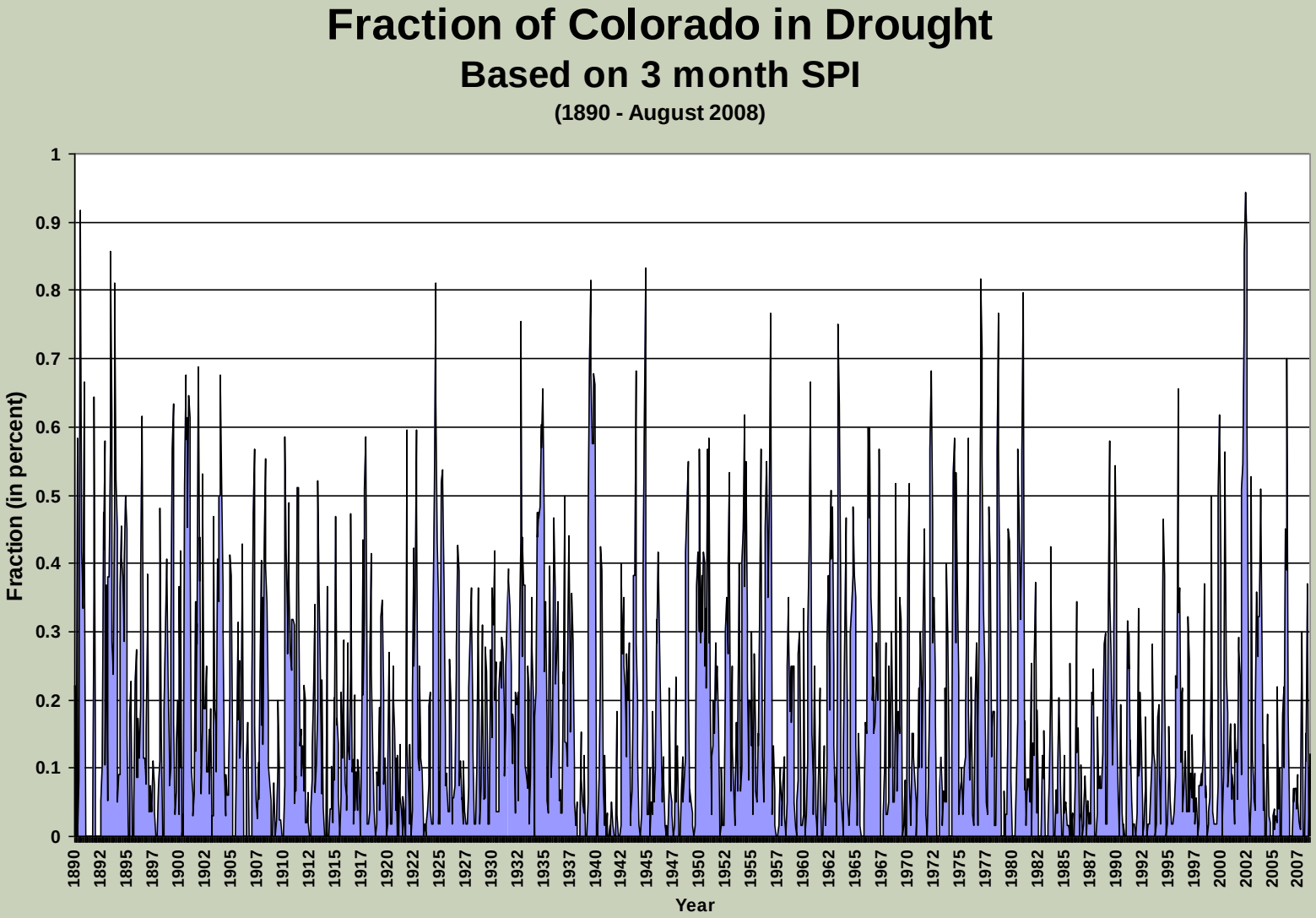
It continues to be difficult to predict weather conditions more than 7-10 days in the future

Talking “drought” in a dry state, especially in a state where recreation is a big part of the economy, can be problematic…





Drought is a frequent visitor to Colorado. Short term (up to 3 months) moisture deficits occur nearly every year.

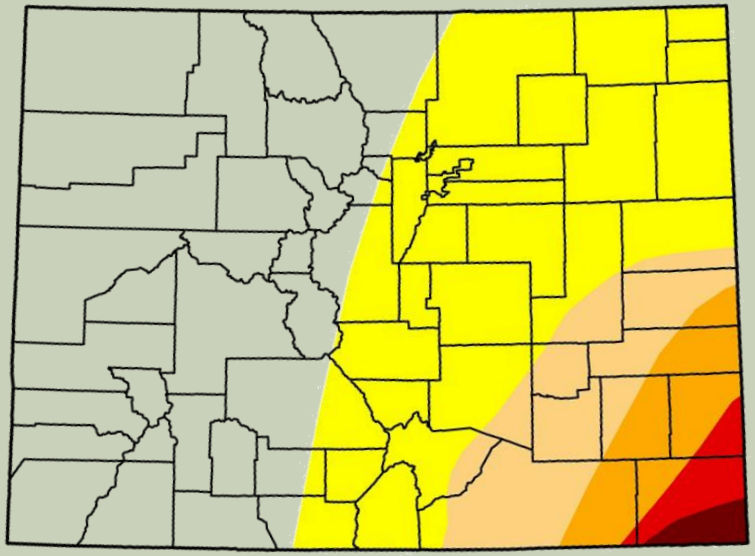


Short term drought can have significant impacts, especially when it occurs at normally wet times of year

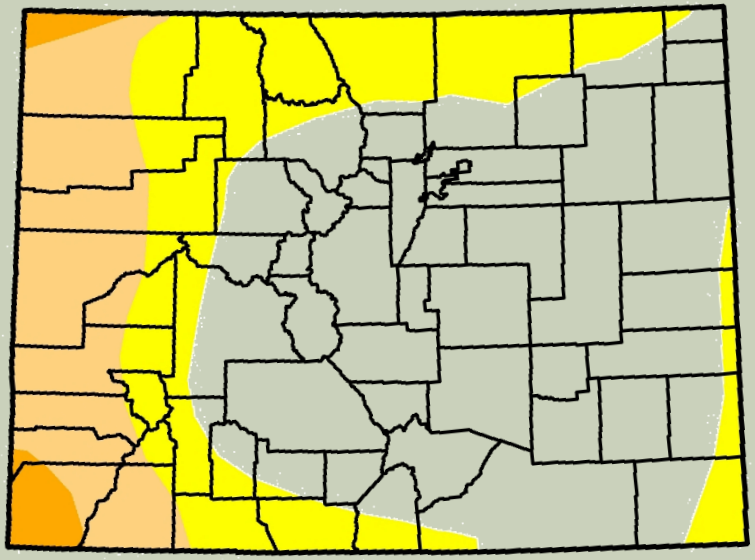
- Winter snow shortages affecting winter recreation
- Spring shortages affecting winter wheat production
- Summer drought increasing wildfire risk and dryland crop production

Drought often does not affect the entire state

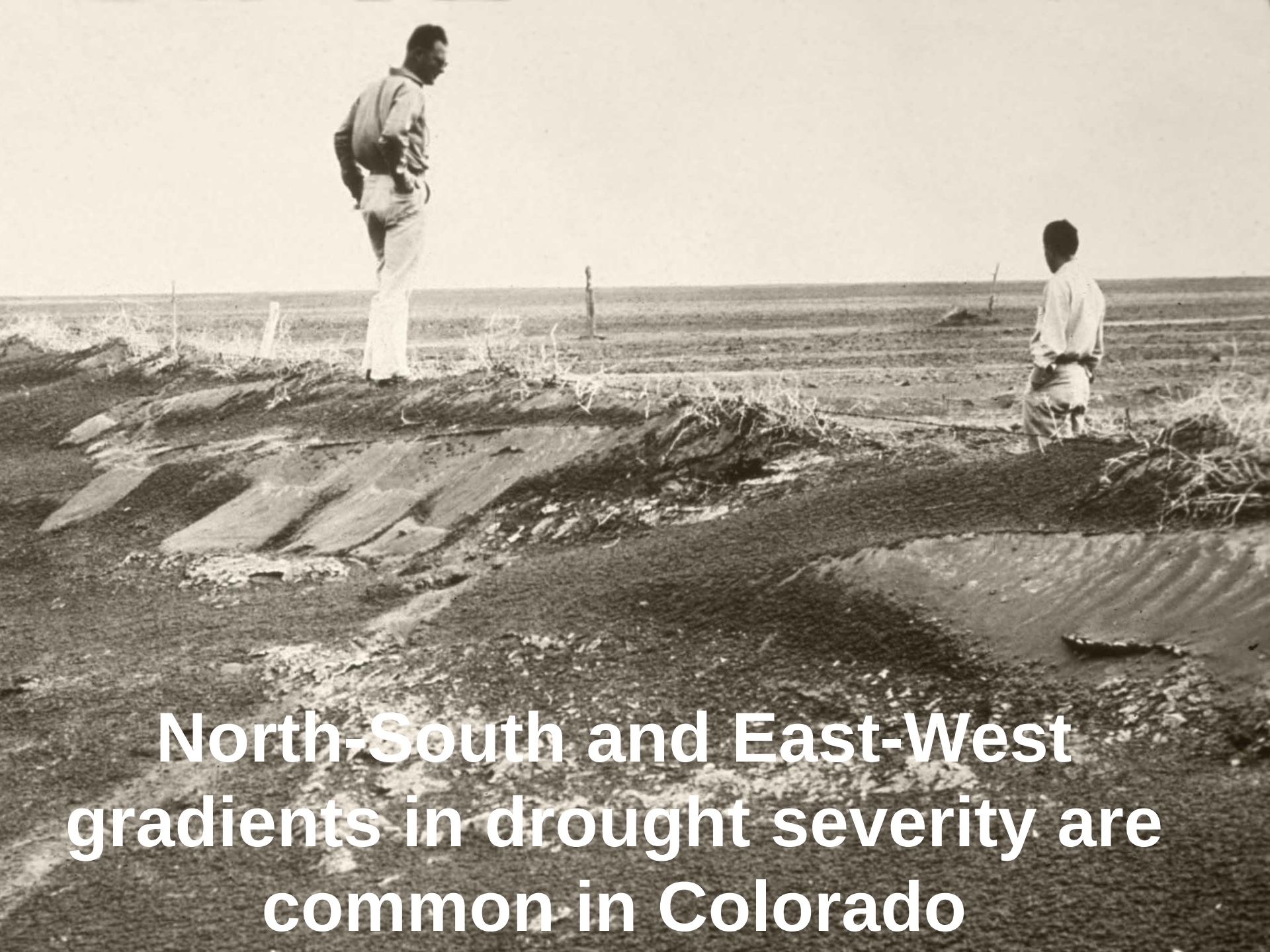
July 8, 2008



July 10, 2007

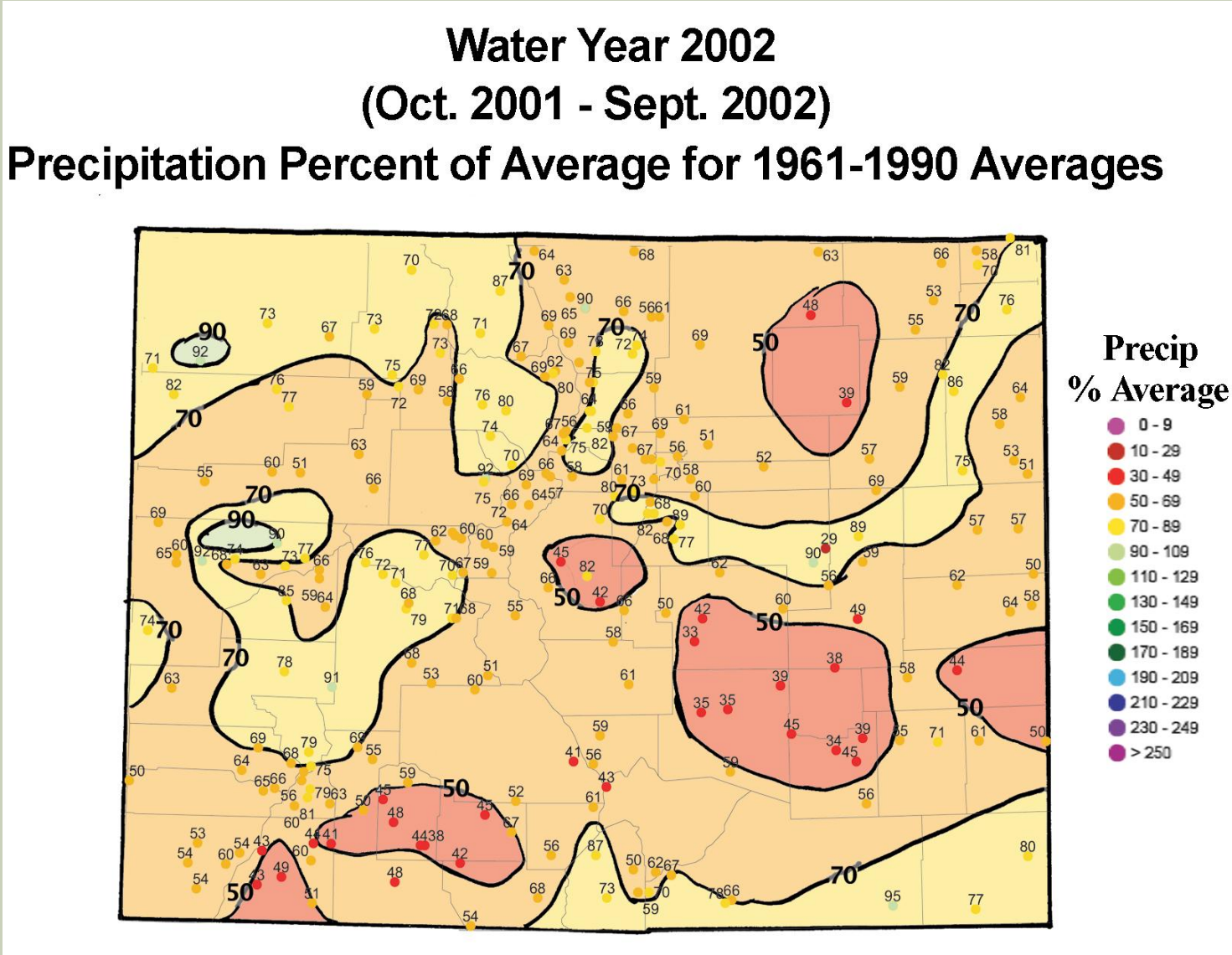


D0: Abnormally Dry
D1: Drought-Moderate
D2: Drought-Severe
D3: Drought-Extreme
D4: Drought-Exceptional

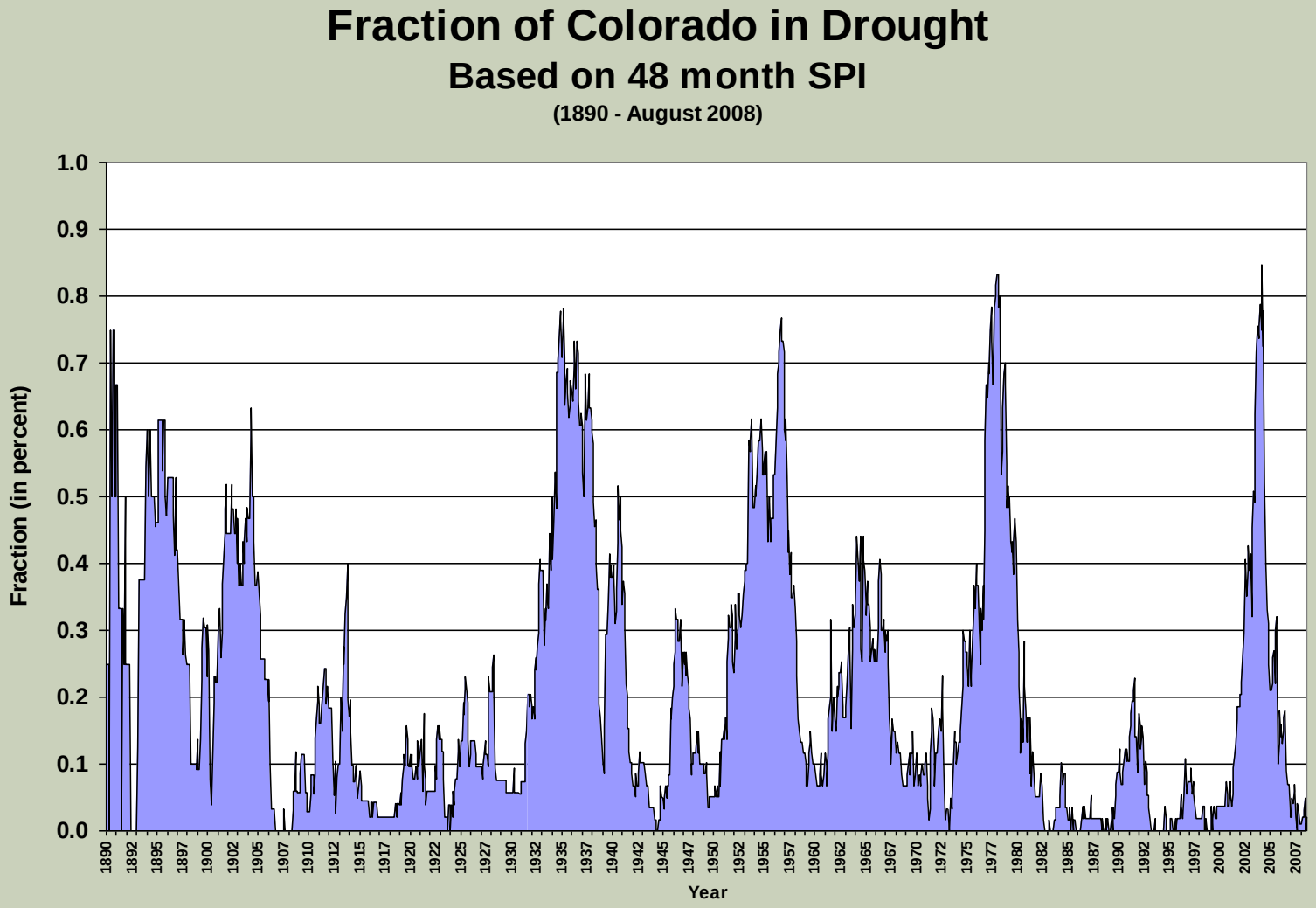


North-South and East-West gradients in drought severity are common in Colorado

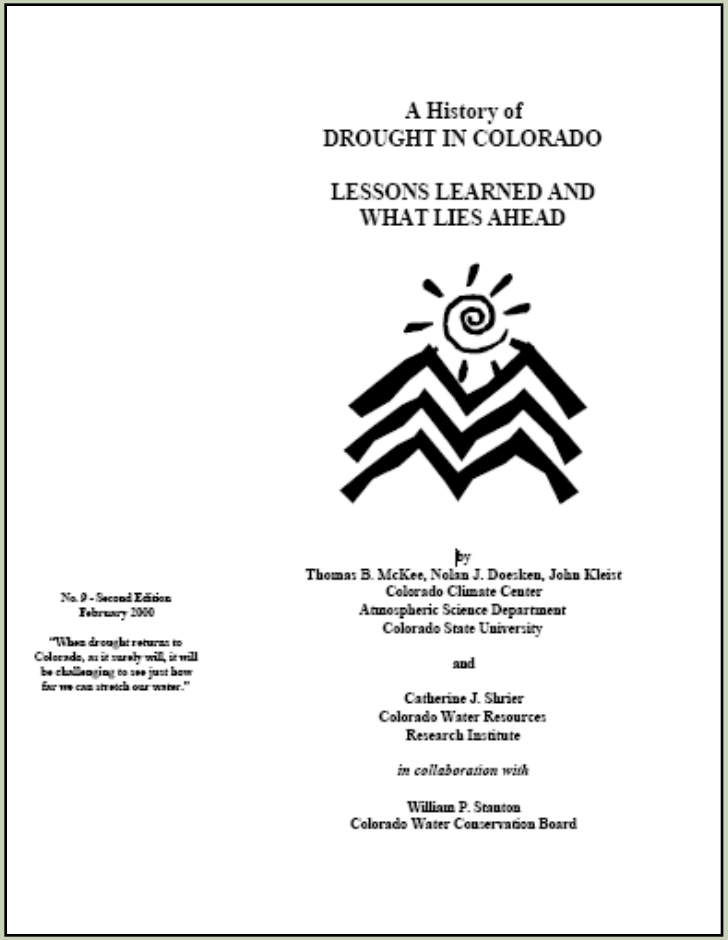
There is no “typical” drought, each has its own story. Annual precipitation less than 60% of average usually results in severe drought.



Multi-year droughts have the greatest impact. They occur infrequently but regularly.



The Drought of 2002 followed some of the script of “worst scenario drought” but was relatively brief compared to what it could be.



A History of
DROUGHT IN COLORADO

LESSONS LEARNED AND
WHAT LIES AHEAD

No. 9 - Second Edition
February 2000

"When drought returns to Colorado, as it surely will, it will be challenging to see just how far we can stretch our water."

by
Thomas B. McKee, Nolan J. Doesken, John Kleist
Colorado Climate Center
Atmospheric Science Department
Colorado State University

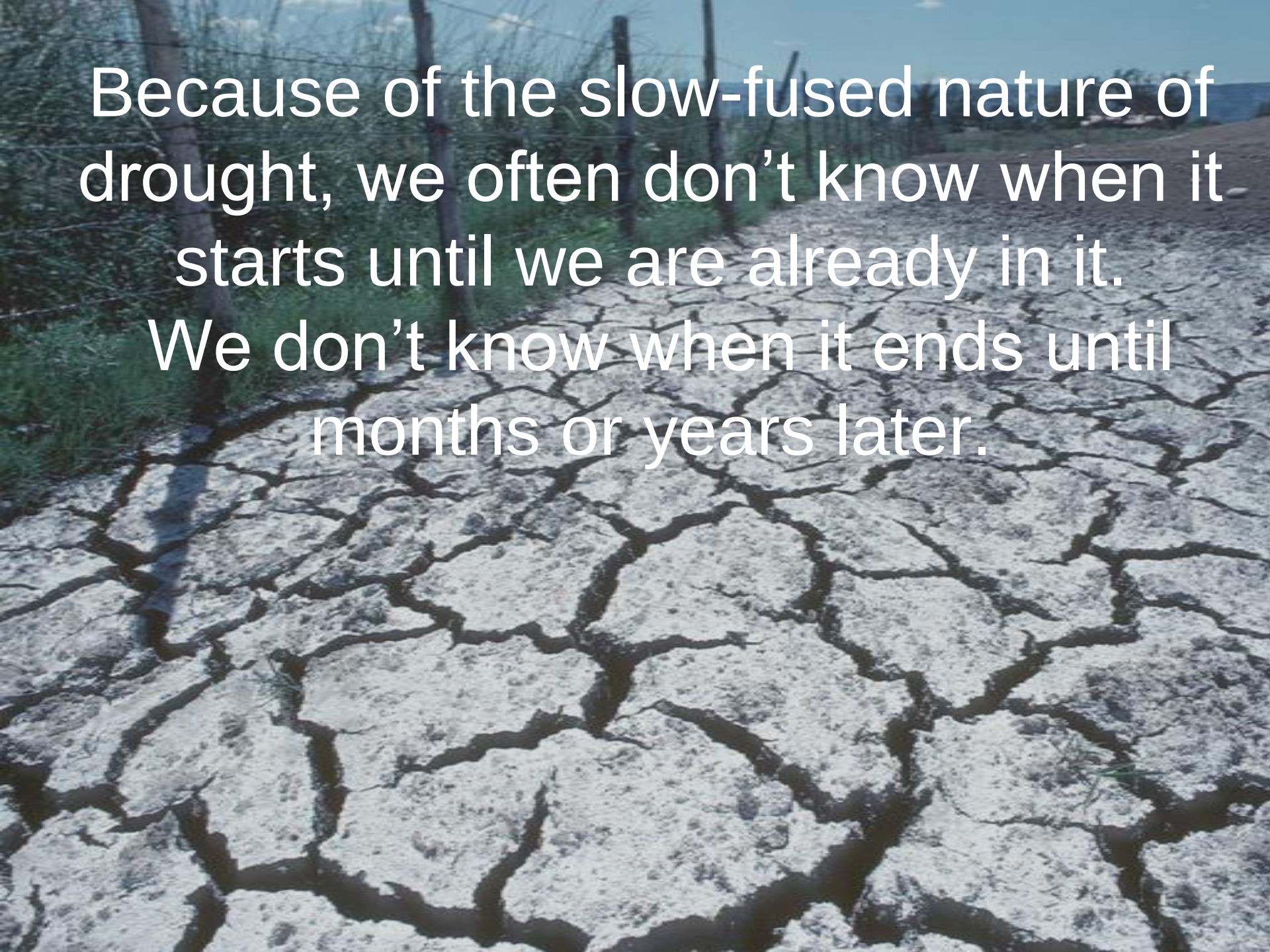
and

Catherine J. Slurier
Colorado Water Resources
Research Institute

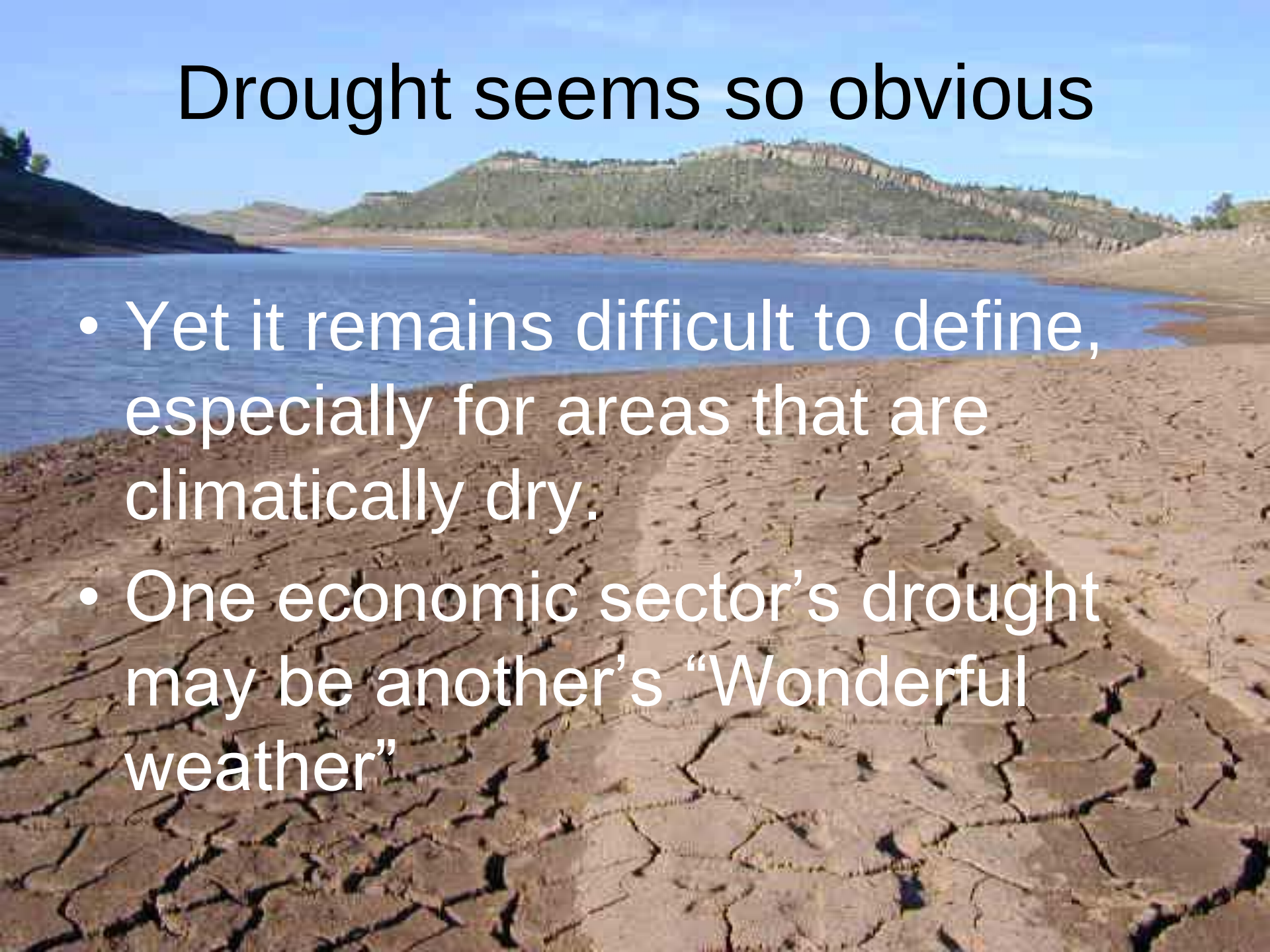
in collaboration with

William P. Stanton
Colorado Water Conservation Board

http://ccc.atmos.colostate.edu/pdfs/ahistoryofdrought.pdf


Because of the slow-fused nature of drought, we often don't know when it starts until we are already in it.
We don't know when it ends until months or years later.

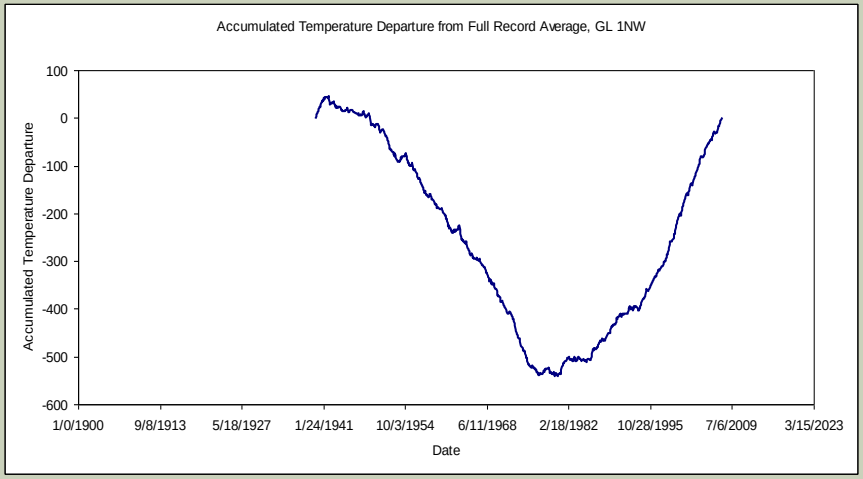
Drought seems so obvious



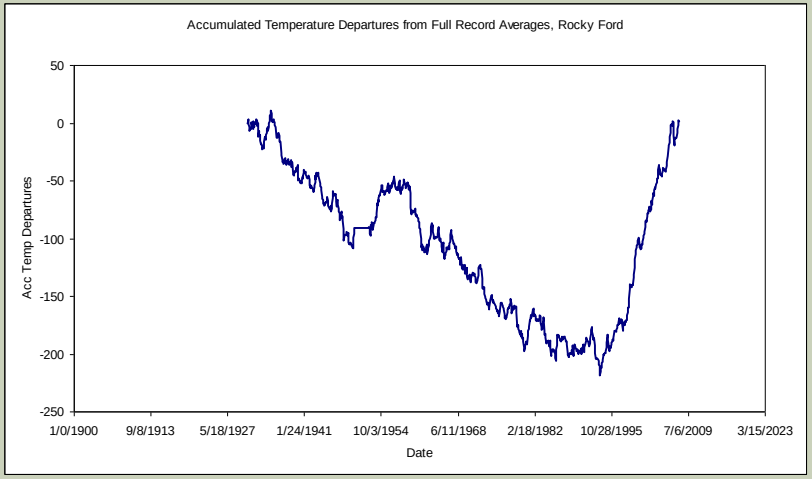
- Yet it remains difficult to define, especially for areas that are climatically dry.
- One economic sector's drought may be another's "Wonderful weather"

Current data show signs of warming in Colorado

- Since 1997, most of Colorado shows a warming trend
- Accumulated departures from normal illustrate this

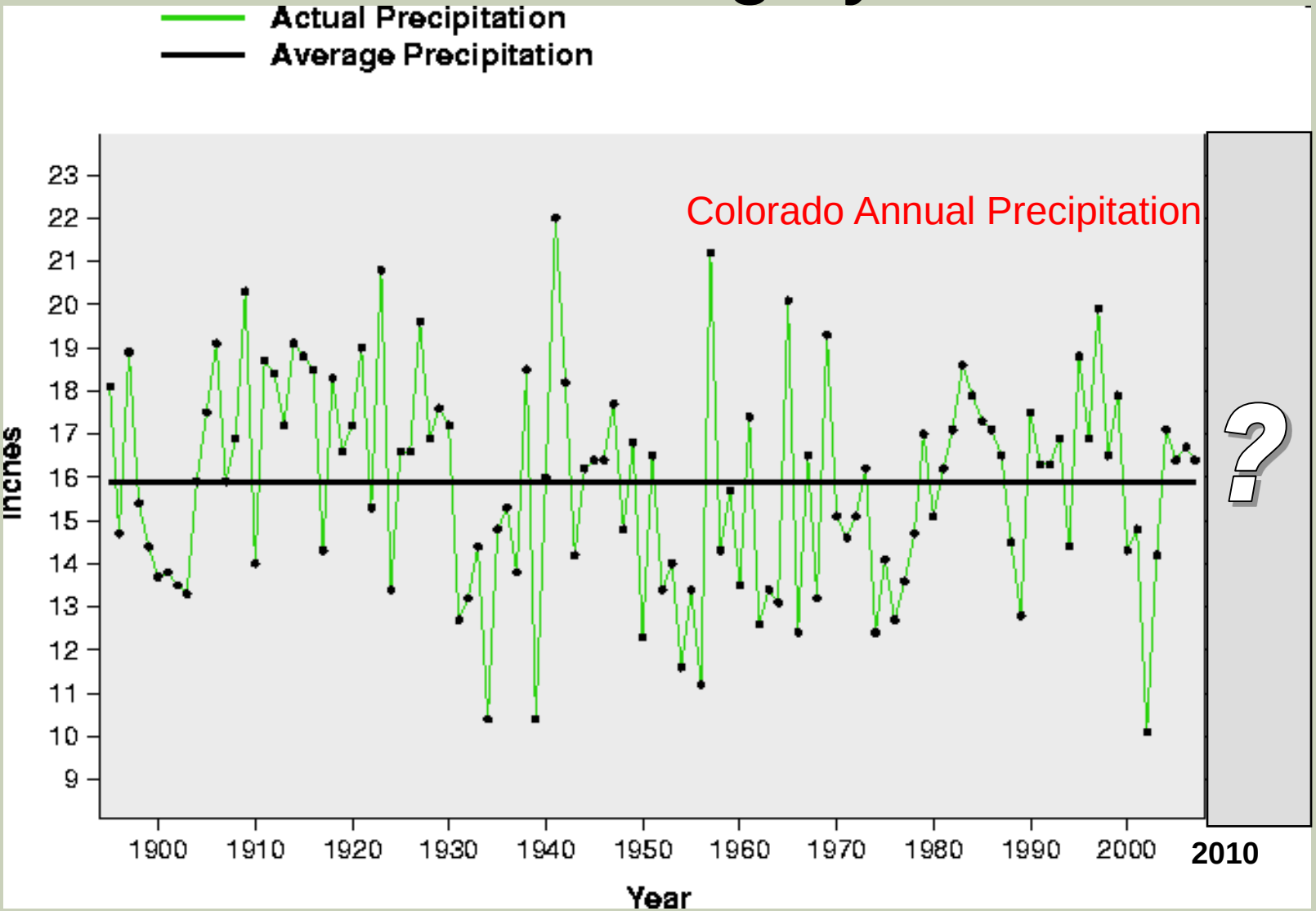


Grand Lake 1NW



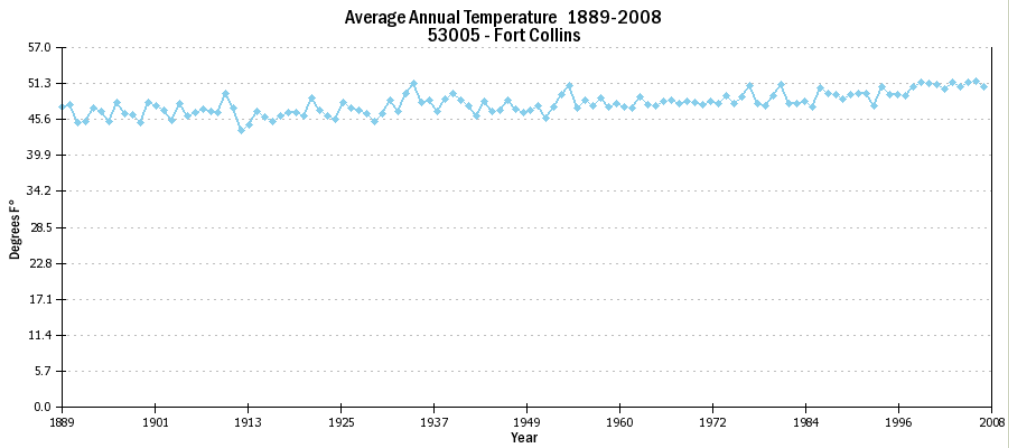
Rocky Ford

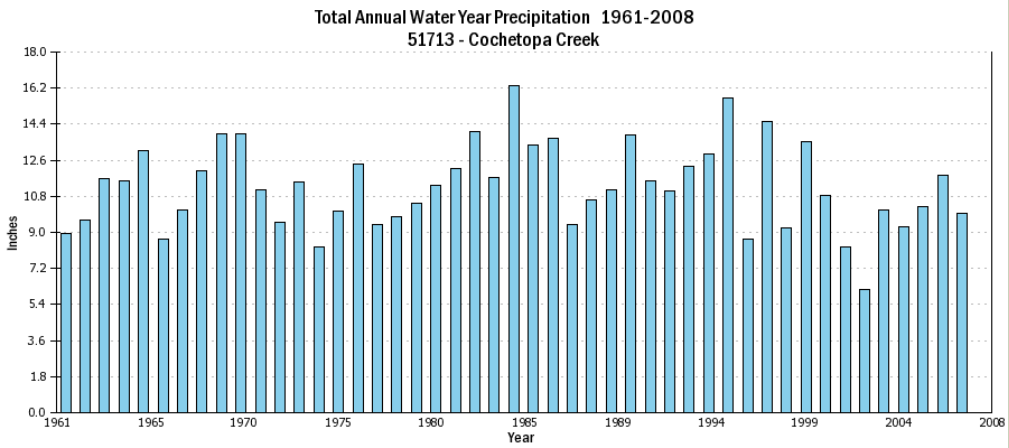
Future precipitation is uncertain, but sure to be highly variable.



Warmer temperatures COULD mean more precipitation will evaporate leaving less for streamflow

Coming Soon: Climate Trends Website





Access Colorado long-term station data and station history

Generate and download graph images

Customizable data frequency for graphing (monthly, water year, calendar year, etc)

http://climatetrends.colostate.edu

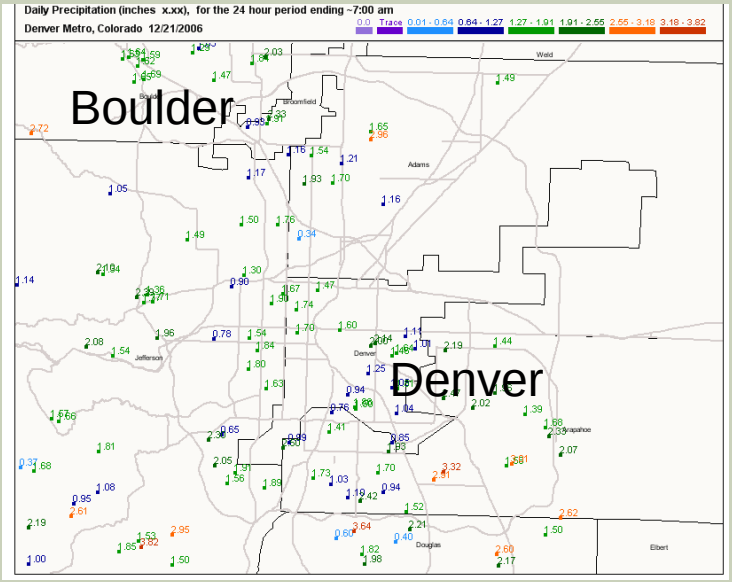
A Suggestion…

Join CoCoRaHS!!

Join CoCoRaHS !!

Help monitor drought and water supplies in Colorado.

Individual, family and community awareness is the beginning of effective drought early warning and response!



12,000+ Volunteer observers nationwide

CoCoRaHS

Community Collaborative Rain, Hail & Snow Network

www.cocorahs.org

In Memory of Odie Bliss (1956-2008)

- Colorado State University from September 1974 – August 2008
- Thirty years of dedicated service as Colorado Climate Center office coordinator providing extraordinary climate information services to the citizens of Colorado

Odie, we miss you.

NOLAN DOESKEN
Colorado State Climatologist, Colorado State University

Nolan Doesken is the State Climatologist for Colorado and Senior Research Associate at Colorado State University. Nolan began work at the Colorado Climate Center at CSU in 1977 as Assistant State Climatologist. Much of his work over the past 31 years has involved in collecting and utilizing weather data to help make practical everyday and long-term plans and decisions. Drought monitoring, research and climate/water education are particularly high priorities. Mr. Doesken oversees the Colorado Agricultural Meteorological Network (CoAgMet) and the historic Fort Collins Weather Station. Following the Fort Collins flash flood of July 1997, Nolan founded the Community Collaborative Rain, Hail and Snow network (CoCoRaHS) to increase citizen participation in climate monitoring in Colorado and across the nation.