Western Regional Climate Center

Desert Research Institute

Climate in Three Dimensions: Integrated Mountain Climate Observations

Kelly T. Redmond

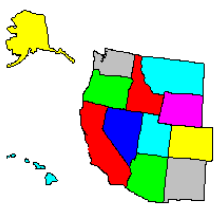
Western Regional Climate Center

Desert Research Institute

CCSP Workshop

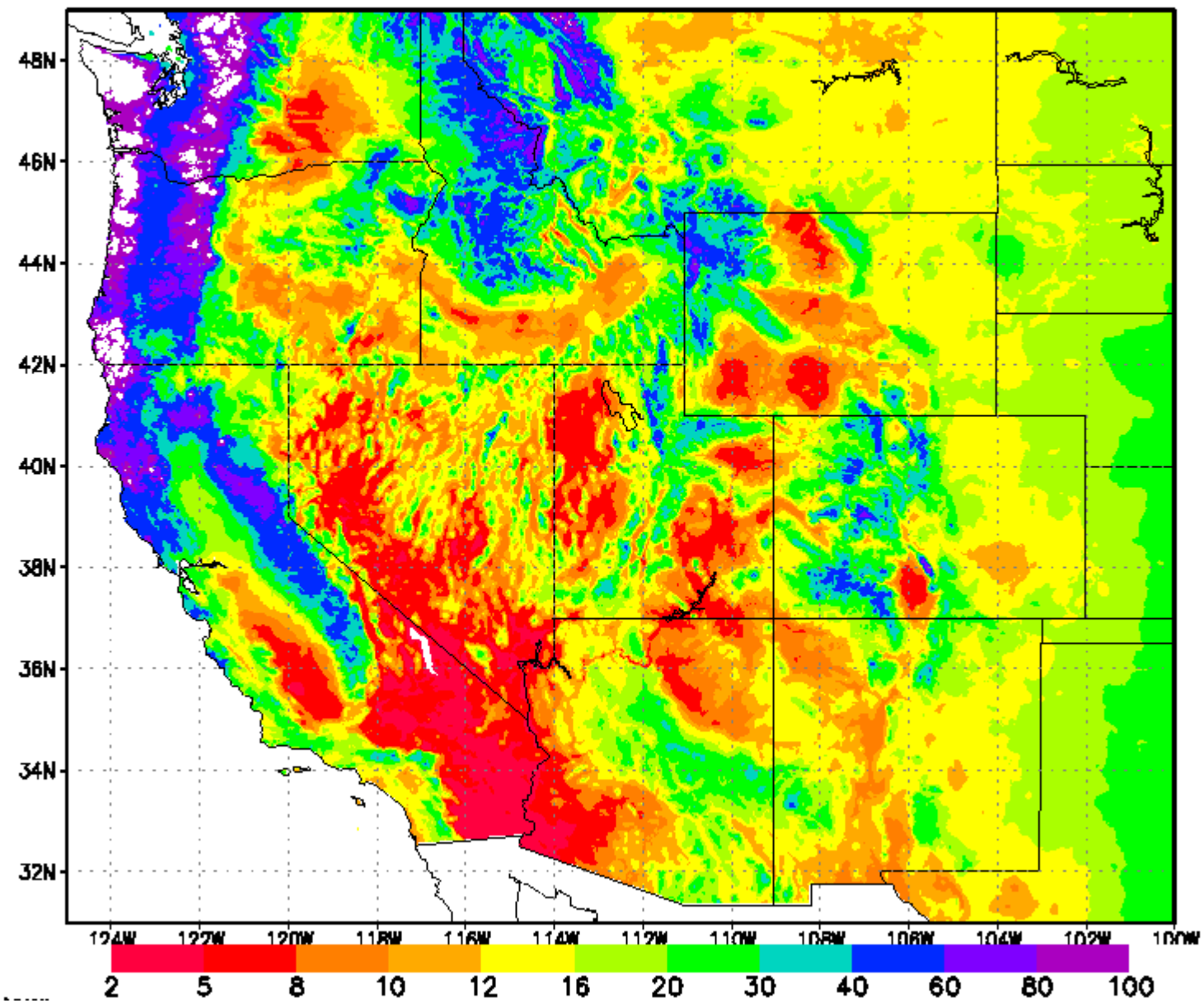
Climate Science in Support of Decision Making

14-16 November 2005 Arlington VA



Western Regional
Climate Center


March 10, 2004
70” / 1800 mm
55” / 1400 mm
12” / 300 mm
7.5” / 170 mm


Annual Precipitation (inches)
1961–90 Average (PRISM OSU/WRCC)
48N
46N
44N
42N
40N
38N
36N
34N
32N
124W
122W
120W
118W
116W
114W
112W
110W
108W
106W
104W
102W
100W
2
5
8
10
12
16
20
30
40
60
80
100

Western Hydrology 101

High elevations: supply region.

Low elevations: demand region.

Supply largely falls in winter.

Demand largely occurs in summer.

Usage is often separated from supply, in space and in time.

(Can become out of sight, out of mind.)

Climates elsewhere matter for local purposes.

Water flows toward

a) the gravitational center of the earth,

b) money.

Snow is extremely important (approx 2/3 – 3/4 of water supply).

Snow is the cheapest reservoir there is.

Western populations depend on a mountain resource base

Water

The most necessary and most prominent resource.

Other major mountain resources are affected by water

Timber production and harvest

Grazing lands

Minerals extraction

Recreation

Change is under way in all mountain systems:

Demographic

- Large increases in population
- Wildland – urban interface encroachment

Technological

- Internet, wireless, cable, phone connectivity
- Physical presence not needed for some occupations

Attitudinal

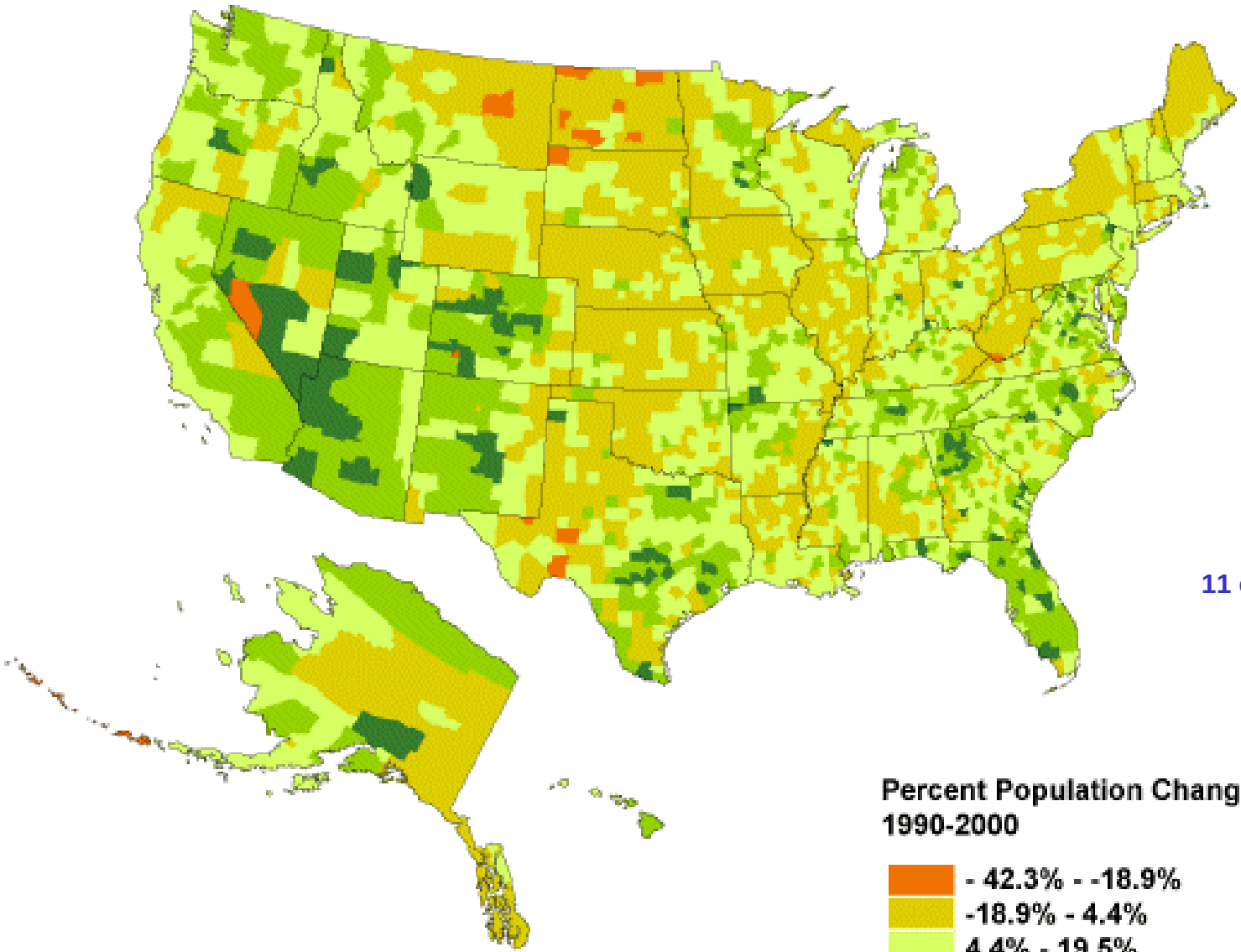
- Getting away from it all (with everybody else !)
- Population less tied to urban centers
- No longer remote and forbidding

Physical

- Habitat fragmentation
- Atmospheric contaminants
- Climate

POPULATION CHANGE, 1990-2000

Click on a state to view related charts and data.



Population Growth 1990-2000

1	Nevada	66 %
2	Arizona	40
3	Colorado	31
4	Utah	30
5	Idaho	29
10	Washington	21
11	Oregon	20
12	New Mexico	20
16	Alaska	15
18	California	14
20	Montana	13
31	Hawaii	9
32	Wyoming	9

11 contiguous states

11	West	28

CIRMOUNT

Consortium for Integrated Climate Research in Western Mountains

Anticipating Challenges to Western Mountain Ecosystems and Resources

ABOUT US

MEDIA

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PHOTOS

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EMAIL POSTINGS

The Consortium for Integrated Climate Research in Western Mountains (CIRMOUNT) is a collaborative, interdisciplinary consortium dedicated to understanding climates and ecosystems of western North American mountains. CIRMOUNT's goal is to bring together researchers from diverse disciplines and institutions to measure and understand climate-driven changes in the unique landscapes that define western North American mountains, and to respond to the needs and challenges of western society for mountain resources imposed by climate change. CIRMOUNT is sponsored by a diverse group of agencies, universities, and institutions, and is endorsed as a pilot project of the International Mountain Research Initiative.

What's New

- CIRMOUNT sponsors a session at the upcoming AGU meeting. More Info
- New GLORIA target region installed. pdf
- New mountain meteorological stations installed. pdf
- MTNCLIM 2006: Sept 19-26, 2006, Mt. Hood, OR. More info

www.fs.fed.us/psw/mtnclim

CIRMOUNT COORDINATING GROUP

Constance I. Millar, *Co-Chair*	USDA Forest Service, Pacific Southwest Research Station, Albany CA
Henry F. Diaz, *Co-Chair*	NOAA Climate Diagnostics Center, Boulder CO
Daniel R. Cayan	University of California, Scripps Institution of Oceanography, La Jolla CA
Michael D. Dettinger	USGS Water Resources Division, La Jolla CA
Daniel B. Fagre	USGS Biological Resources Division, West Glacier MT
Lisa Graumlich	Big Sky Institute, Montana State University, Bozeman MT
Greg Greenwood	Mountain Research Initiative, Berne, Switzerland
Malcolm K. Hughes	University of Arizona, Laboratory of Tree-Ring Research, Tucson AZ
David L. Peterson	USDA Forest Service, Pacific Northwest Research Station, Seattle WA
Frank L. Powell	University of California, White Mountain Research Station, San Diego CA
Kelly T. Redmond	Desert Research Institute, Western Regional Climate Center, Reno NV
John Smiley	University of California, White Mountain Research Station, San Diego CA
Nathan L. Stephenson	USGS Biological Resources Division, Three Rivers CA
Thomas W. Swetnam	University of Arizona, Laboratory of Tree-Ring Research, Tucson AZ
Connie Woodhouse	NOAA Paleoclimatology Program, Boulder CO

Mountain Climate Sciences Symposium

Anticipating Challenges to Western Mountain Ecosystems and Resources

North Tahoe Conference Center
Kings Beach, Lake Tahoe, CA
May 25 - 27, 2004

MTNCLIM 2005

Consortium for Integrated Climate Research in Western Mountains

Anticipating Challenges to Western Mountain Ecosystems and Resources

AGU Fall 2004 2005

BACKGROUND & PURPOSE | PROGRAM, ABSTRACTS, TALK & POSTER PDFS | WORKING GROUPS | PHOTOS | LOCATION & LODGING | CONVENORS | CONTACTS | MEDIA INFO | AGU 2004 PDFS

MARCH 1-4, 2005 AT CHICO HOT SPRINGS, PRAY, MONTANA

home

CIRMOUNT 2006

Consortium for Integrated Climate Research in Western Mountains

Anticipating Challenges to Western Mountain Ecosystems and Resources

Timberline Lodge, Mt Hood, Sept 19-22

Mapping New Terrain (anticipated date January 2006)

Four urgent challenges facing western North America climate science and policy communities:

1. **Mountain regions are vastly under-instrumented to measure climate and long-term changes.**

2. **Research on western mountain climates and ecosystems is intensive, but scattered and poorly integrated.**

3. **Societal demands on western mountain ecosystems are exponentially escalating, imposing new stresses on natural resources and rural community capacities.**

4. **Although mountains are particularly vulnerable to climate-change impacts, projected climate changes have generally been ignored in mountain land-use planning and natural-resource policies to the detriment of their ecosystems and natural resources.**

CIRMOUNT Work Groups

1. **Mountain Climate Network (MONET)**
   Kelly Redmond, Mark Losleben

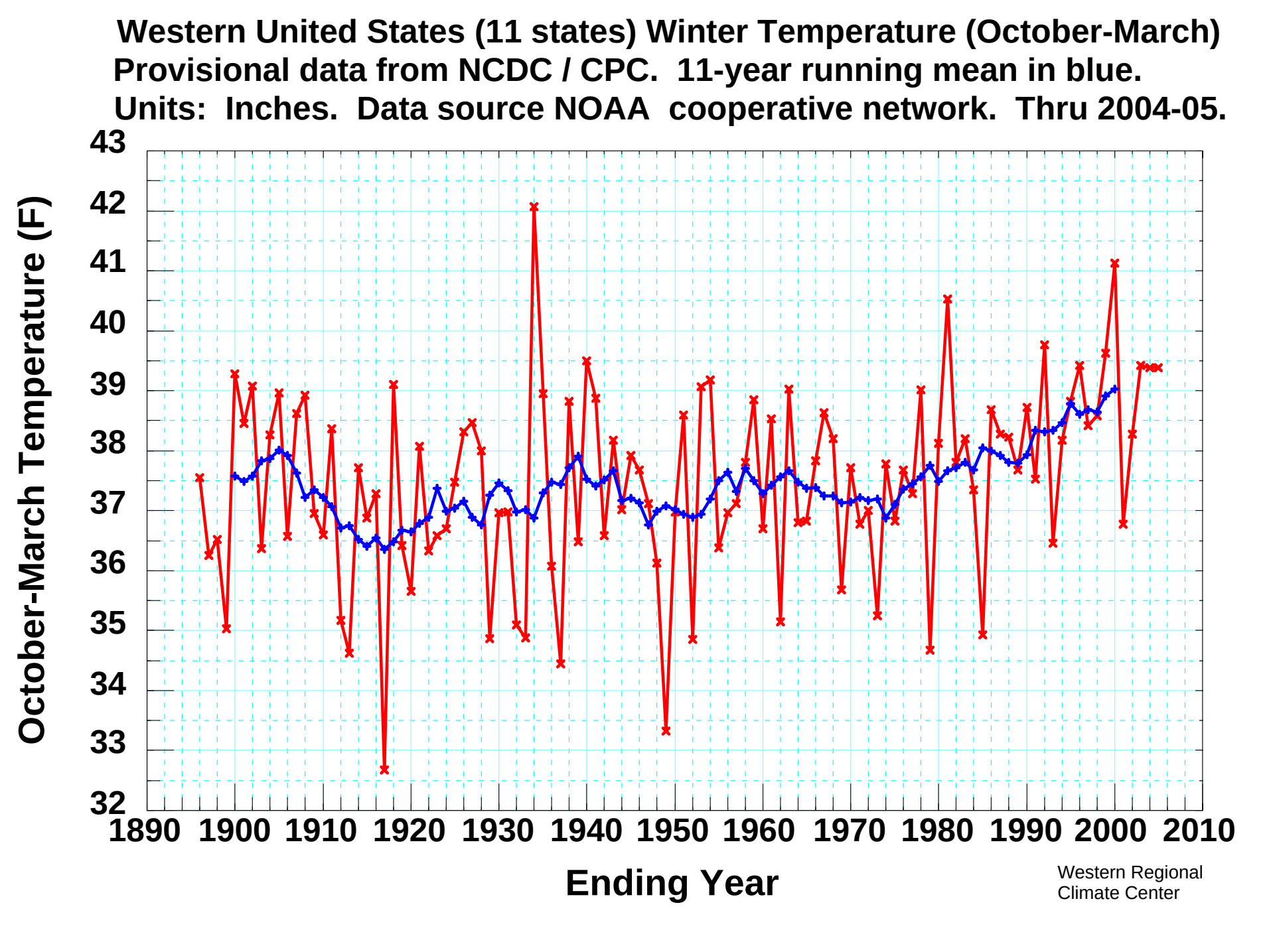
2. **Mountain-Based Hydrologic Observatories**
   Roger Bales, Mike Dettinger

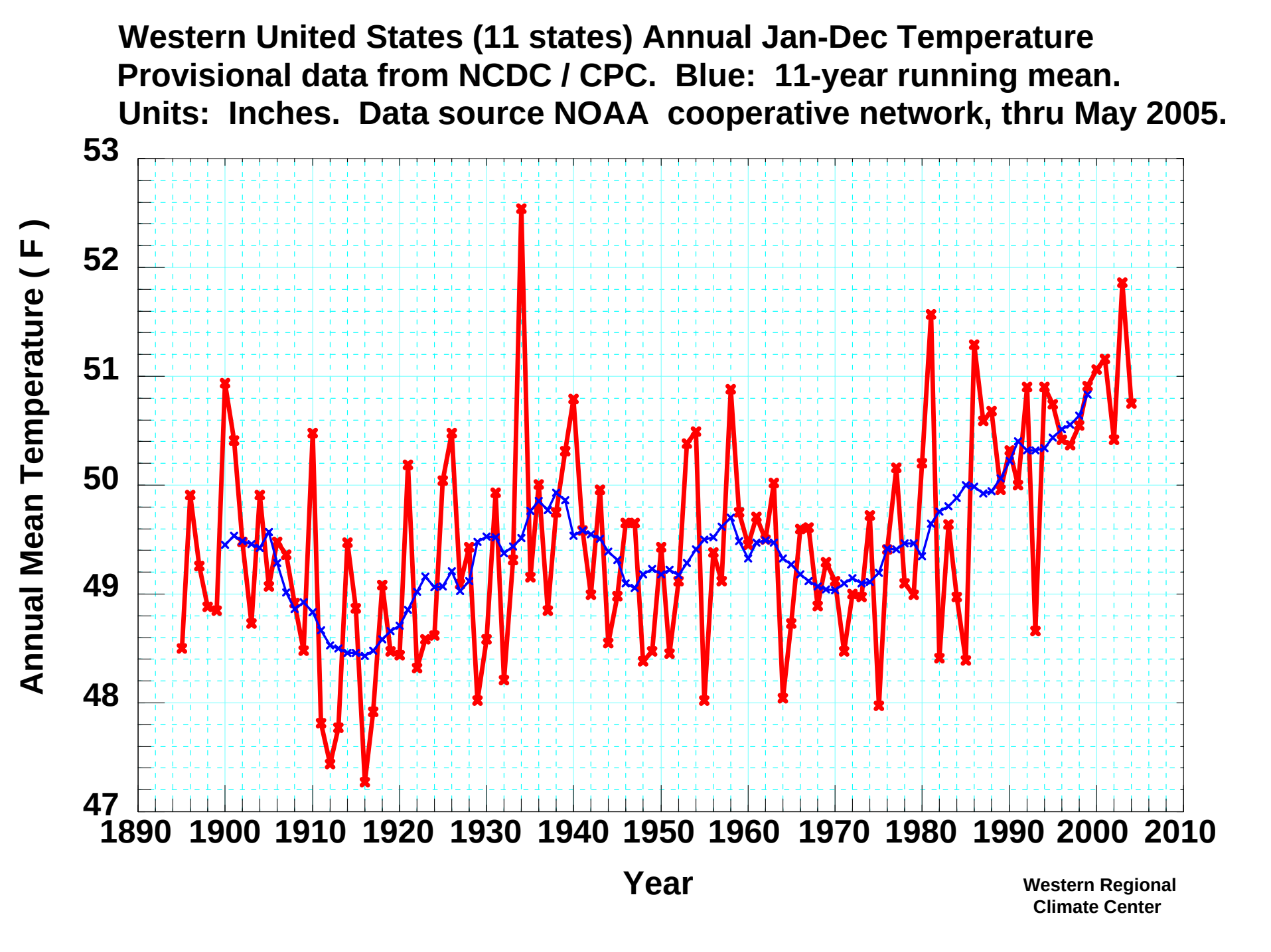
3. **North American GLORIA (Global Observation Research Initiative in Alpine Environments), alpine plants and climate**
   Connie Millar, Dan Fagre

4. **Mountain Ecosystem Responses to Climate**
   Jeremy Littell, Jeff Hicke

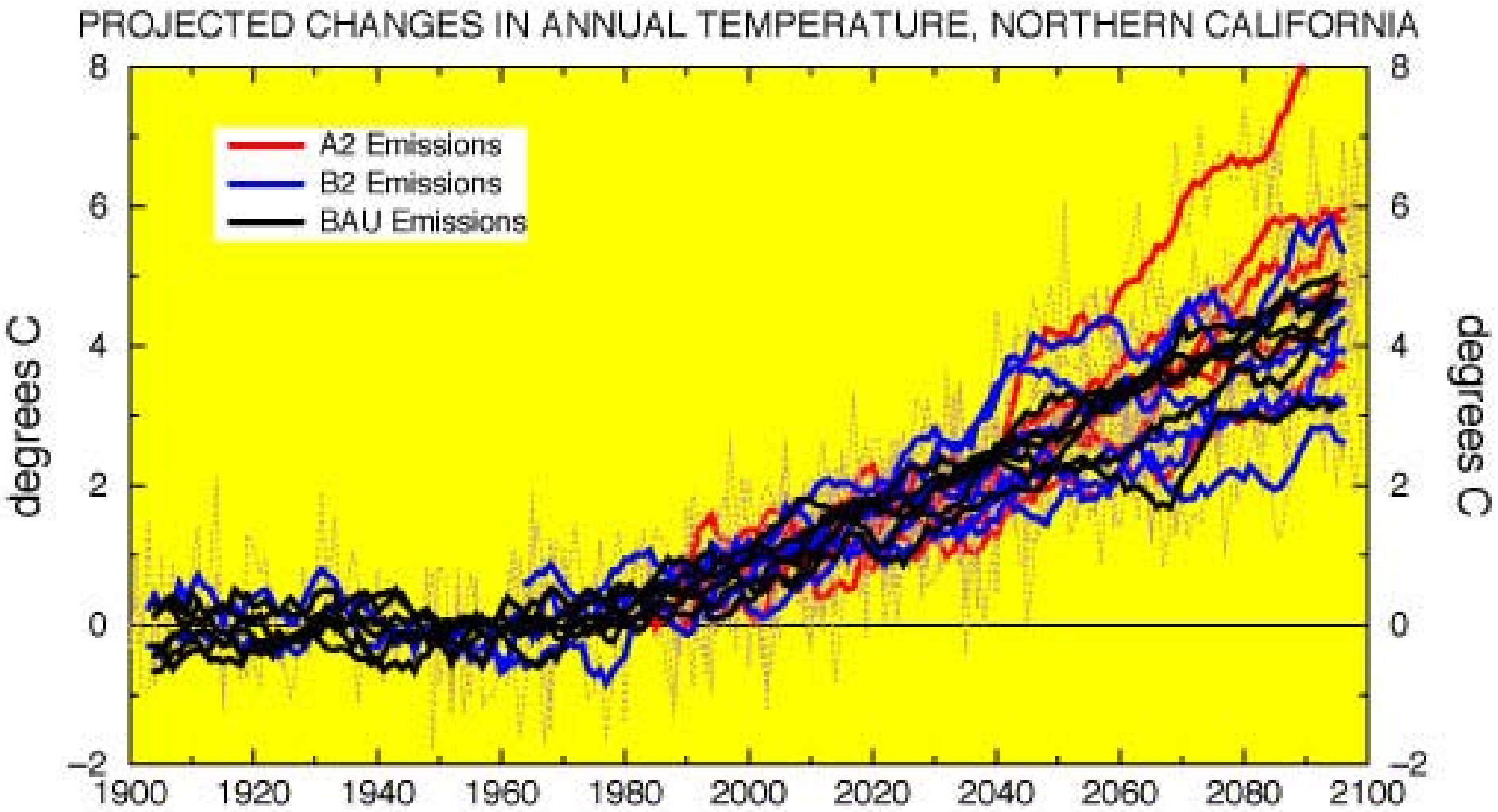
5. **CIRMOUNT and International Relations, such as Mountain Research Initiative**
   Greg Greenwood, Craig Allen

6. **Paleoclimatic Archives for Resource Management**
   Connie Woodhouse, Franco Biondi

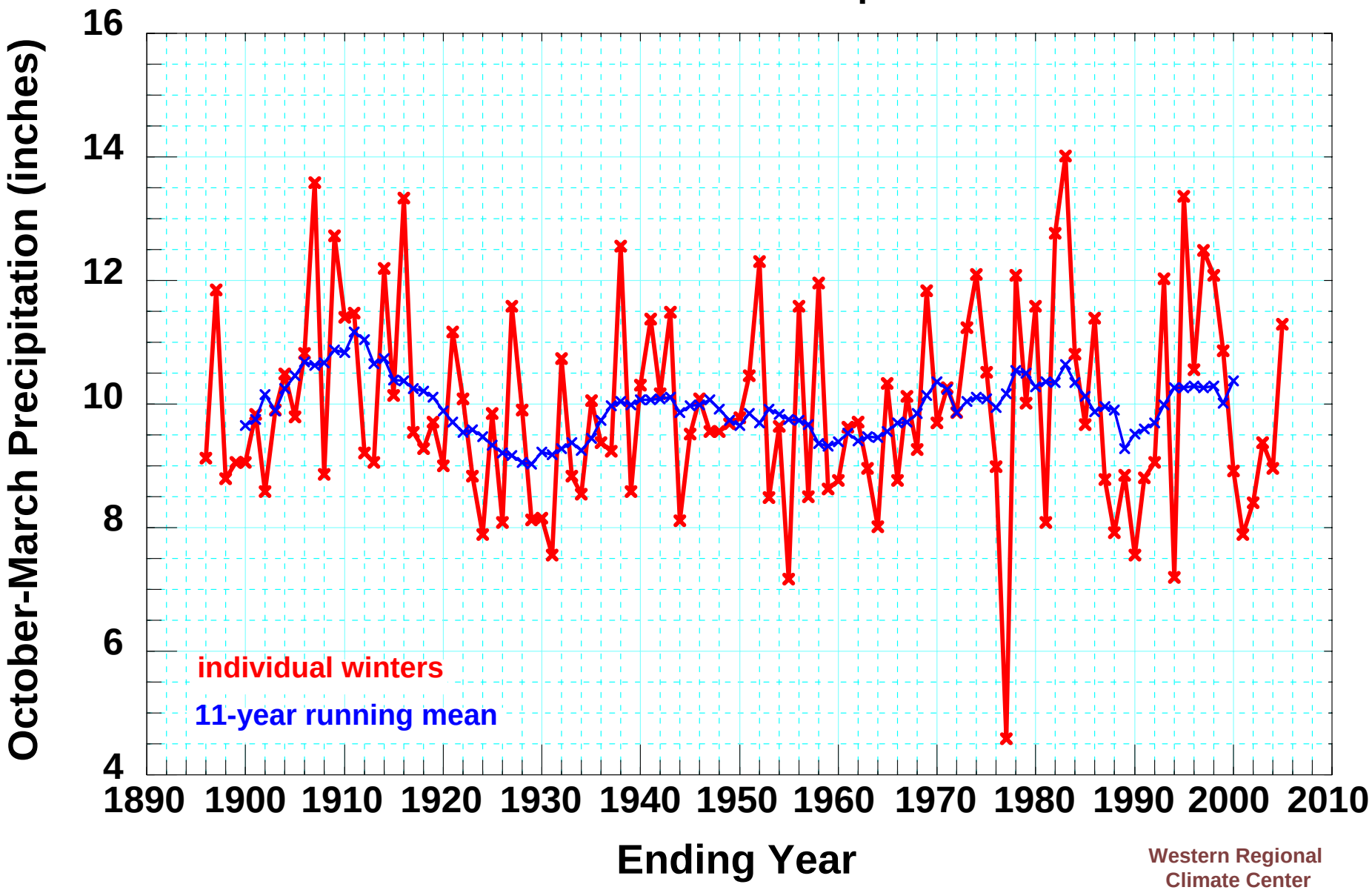

Western United States (11 states) Winter Temperature (October-March)
Provisional data from NCDC / CPC. 11-year running mean in blue.
Units: Inches. Data source NOAA cooperative network. Thru 2004-05.
October-March Temperature (F)
43
42
41
40
39
38
37
36
35
34
33
32
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Ending Year
Western Regional
Climate Center


Western United States (11 states) Annual Jan-Dec Temperature
Provisional data from NCDC / CPC. Blue: 11-year running mean.
Units: Inches. Data source NOAA cooperative network, thru May 2005.
Annual Mean Temperature (F)
53
52
51
50
49
48
47
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year
Western Regional
Climate Center

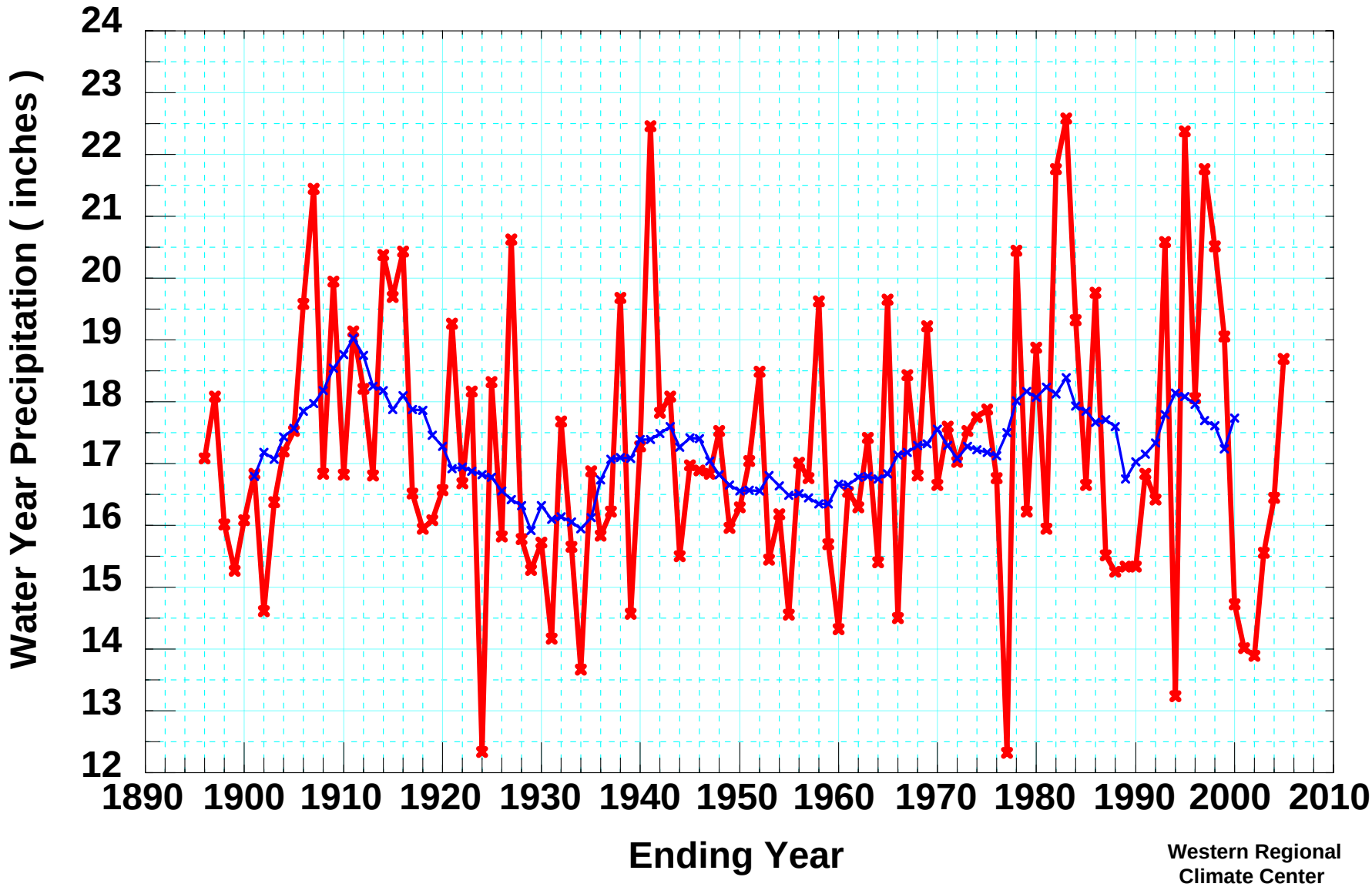
Courtesy of Mike Dettinger, USGS / Scripps.



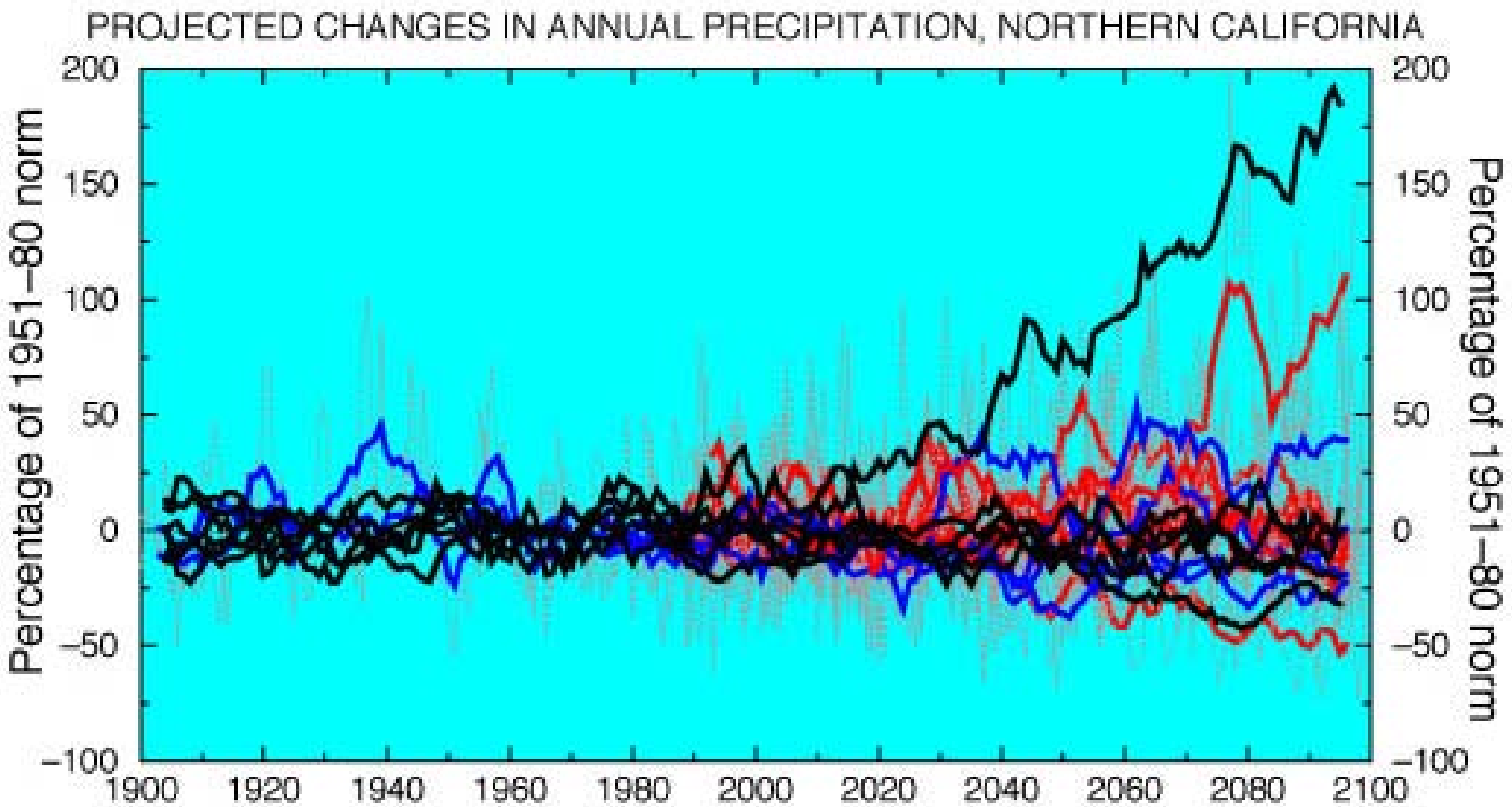
Dettinger MD. 2005. From climate change spaghetti to climate-change distributions for 21st Century California. San Francisco Estuary and Watershed Science. Vol. 3, Issue 1, (March 2005), Article 4. http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art4


Western United States (11 states) October-March Precipitation.
Provisional data from NCDC / CPC. 111 Winters, 1895-2005.
Units: Inches. Data source NOAA cooperative network.
October-March Precipitation (inches)
16
14
12
10
8
6
4
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Ending Year
individual winters
11-year running mean
Western Regional
Climate Center

Western United States (11 states) Water Year (Oct-Sep) Precipitation.
Provisional data from NCDC / CPC. Blue: 11-year running mean.
Units: Inches. Data source NOAA cooperative network, thru mid Sept 2005.



Courtesy of Mike Dettinger, USGS / Scripps.



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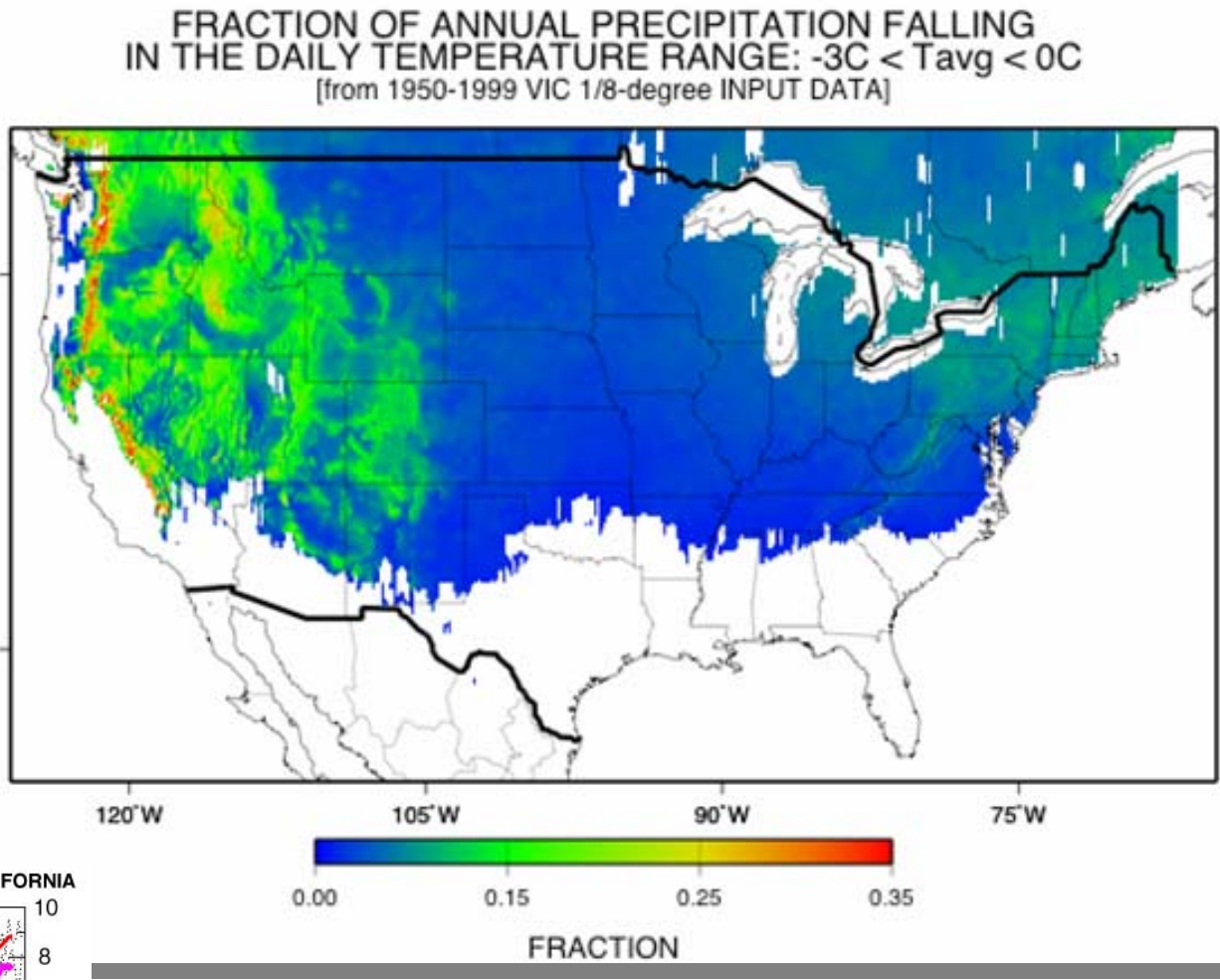
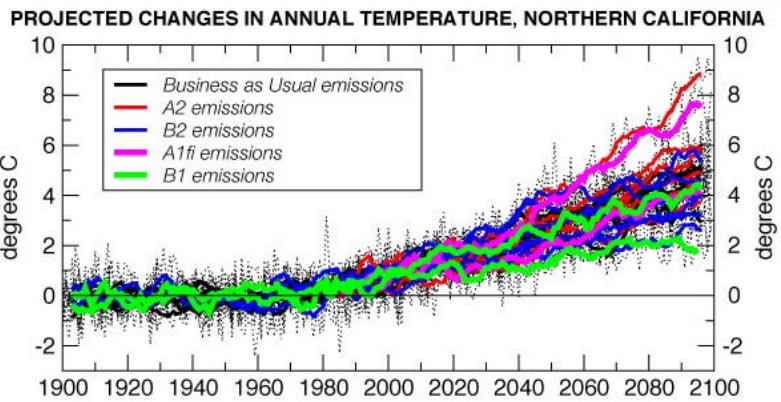
A SIMPLE INDEX OF SENSITIVITY OF SNOWFED HYDROCLIMATE TO A +3ºC WARMING … Rain? or Snow?

What fraction of each year's precipitation historically fell on days with average temperatures just below freezing?





← +3 **Less vulnerable** **More vulnerable**

Computed from UW's VIC model daily INPUTS (Bates et al, in rev). Courtesy Mike Dettinger.

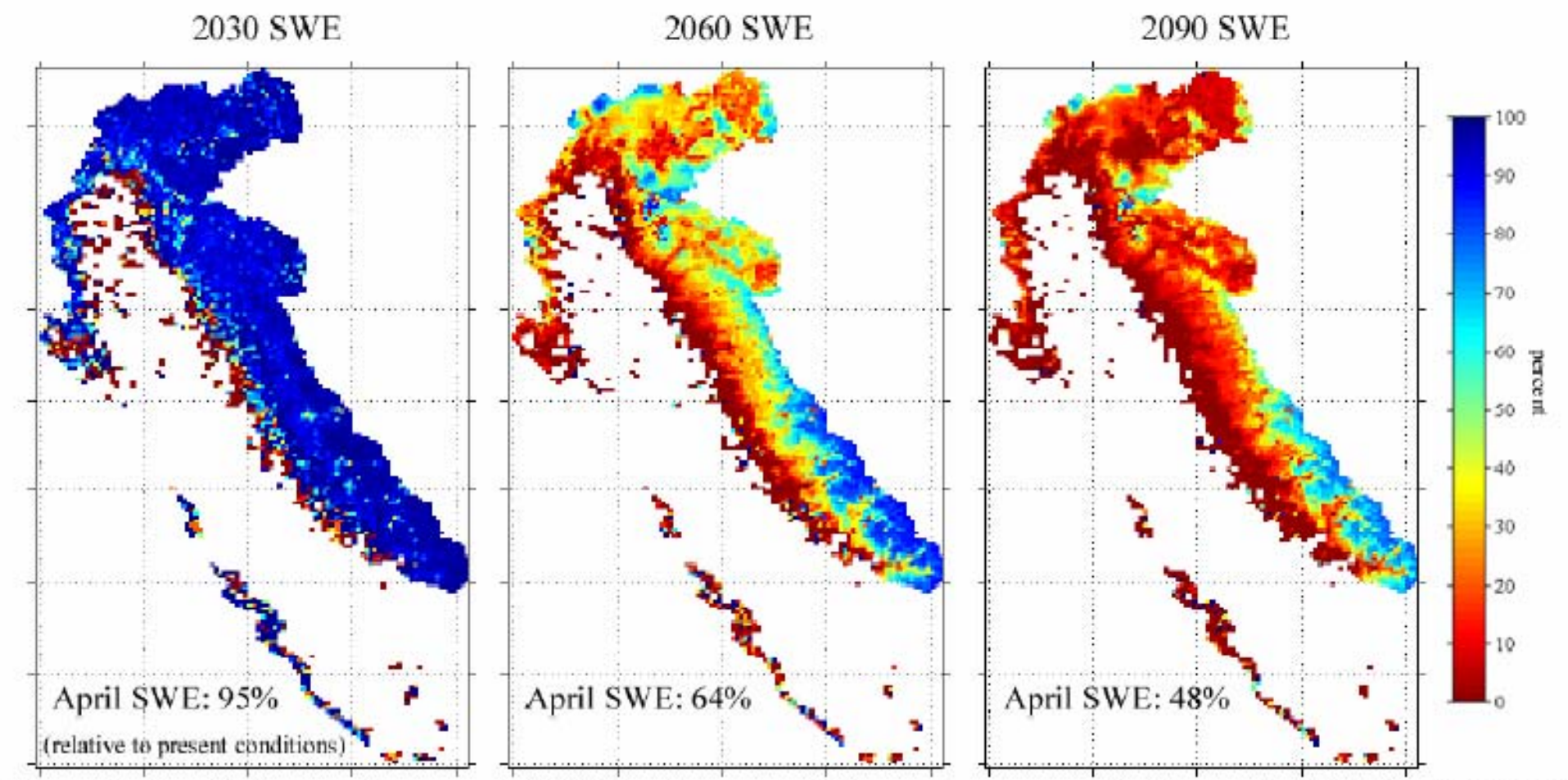


Figure 3. Simulated snow water equivalent (SWE) under a projected temperature increase for the periods 2020-2039, 2050-2069 and 2080-2099, expressed as a percentage of average present conditions.

Potential effects of warming temperatures on the Sacramento / San Joaquin watershed and the San Francisco estuary

Noah Knowles and Dan Cayan, Climate Research Division, Scripps Institution of Oceanography

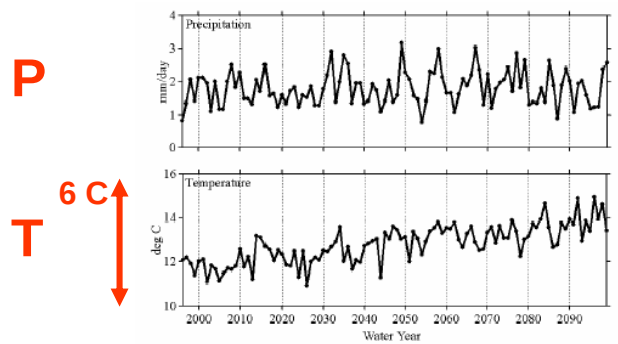


Figure 2. PCM-simulated watershed-averaged annual precipitation and temperature for WY 1995-2099.

Boulder Glacier, 1985-2003.

North Cascades Glacier Climate Project

Easton Glacier, 1985-2003.

Grinnell Glacier from Grinnell Lake Glacier National Park, 1910-1997

Photo by Elrod, GNP Archives, ca 1910

Photo by Hileman, GNP Archives , 1931

Photo by Fagre, 1997

1910

Elrod

Glacier National Park Archives

1931

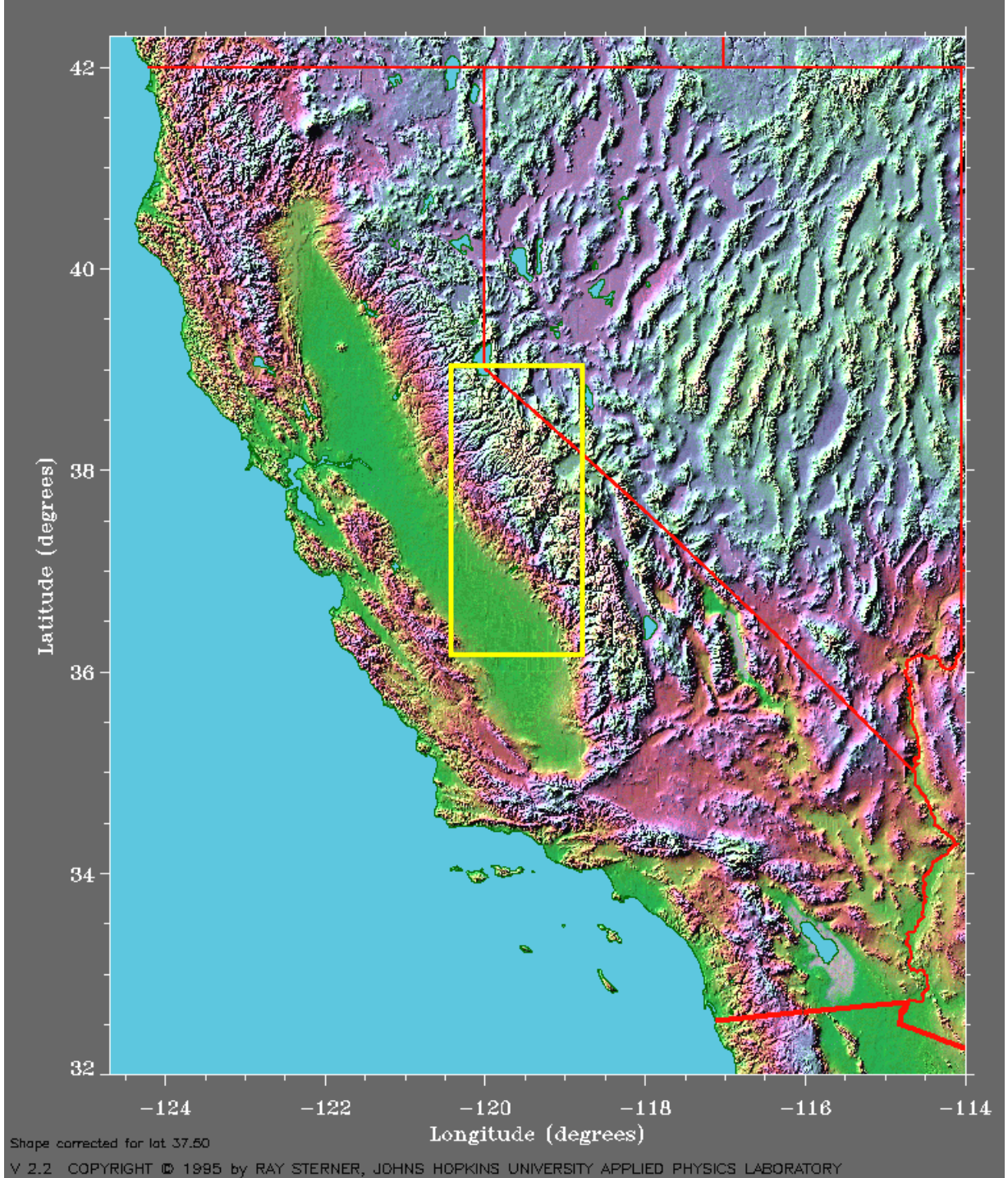
Hileman

Glacier National Park Archives

1997

Fagre

USGS / Glacier National Park



Grids.

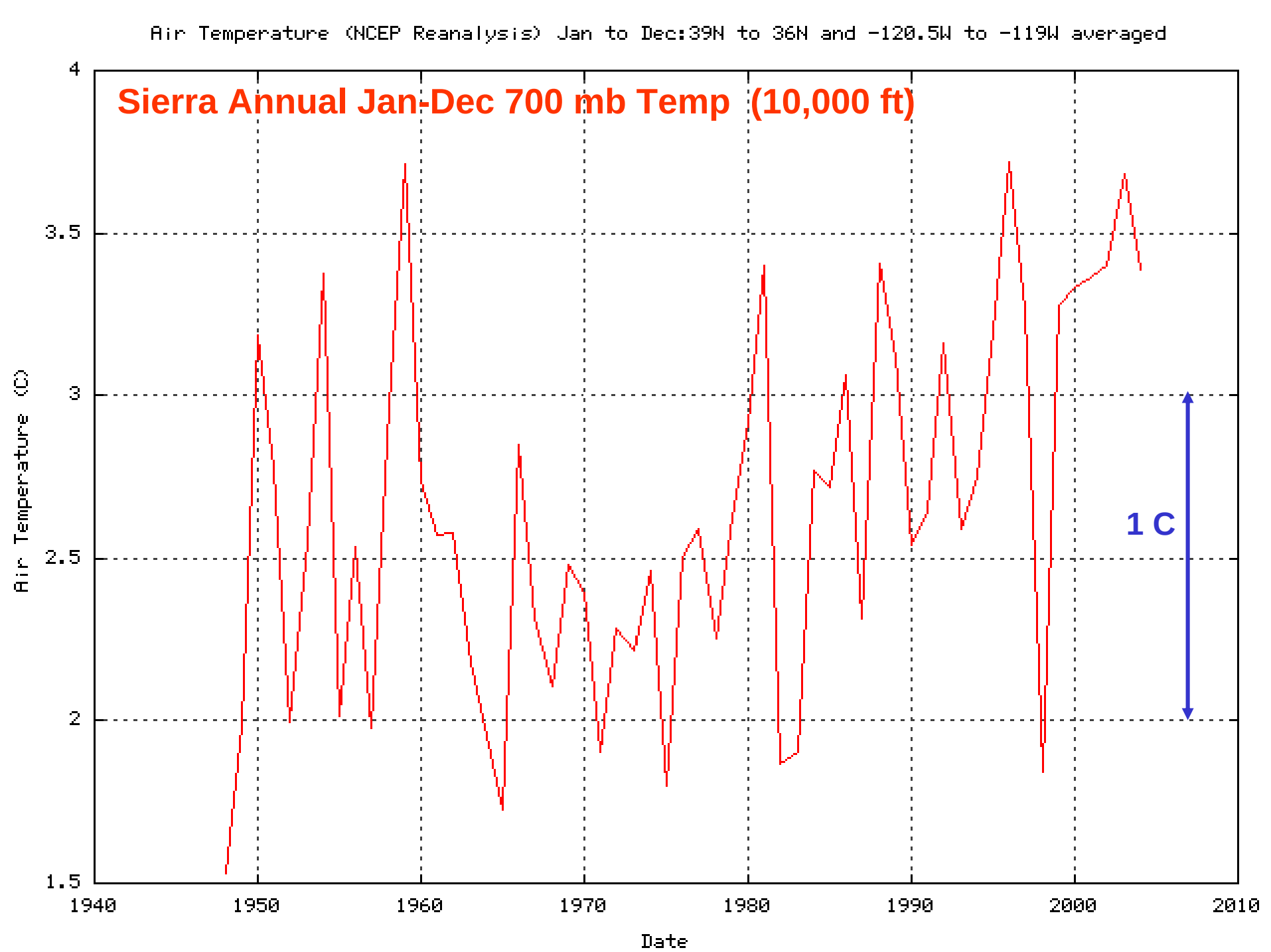
Reanalysis Resolution:

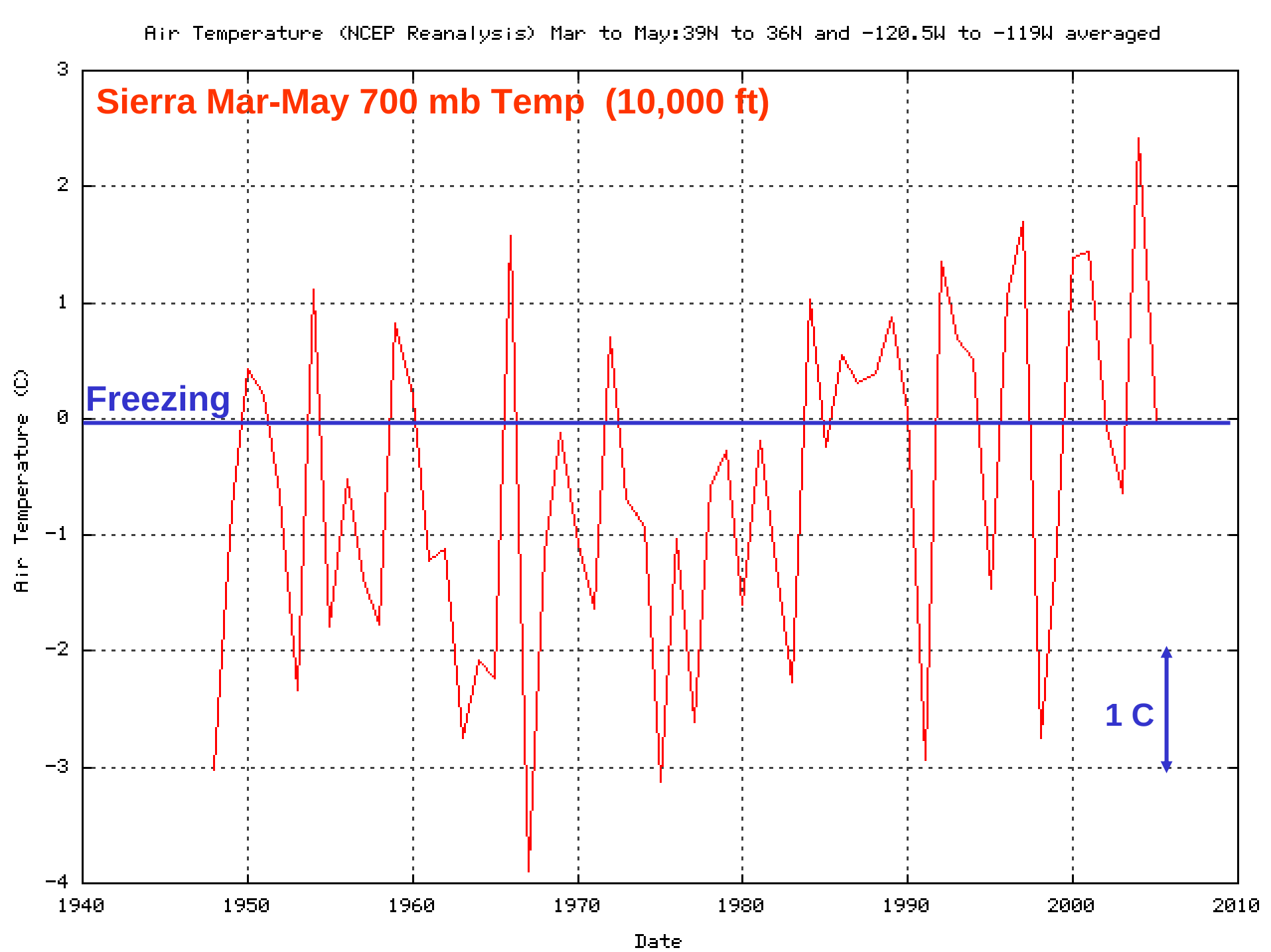
Global

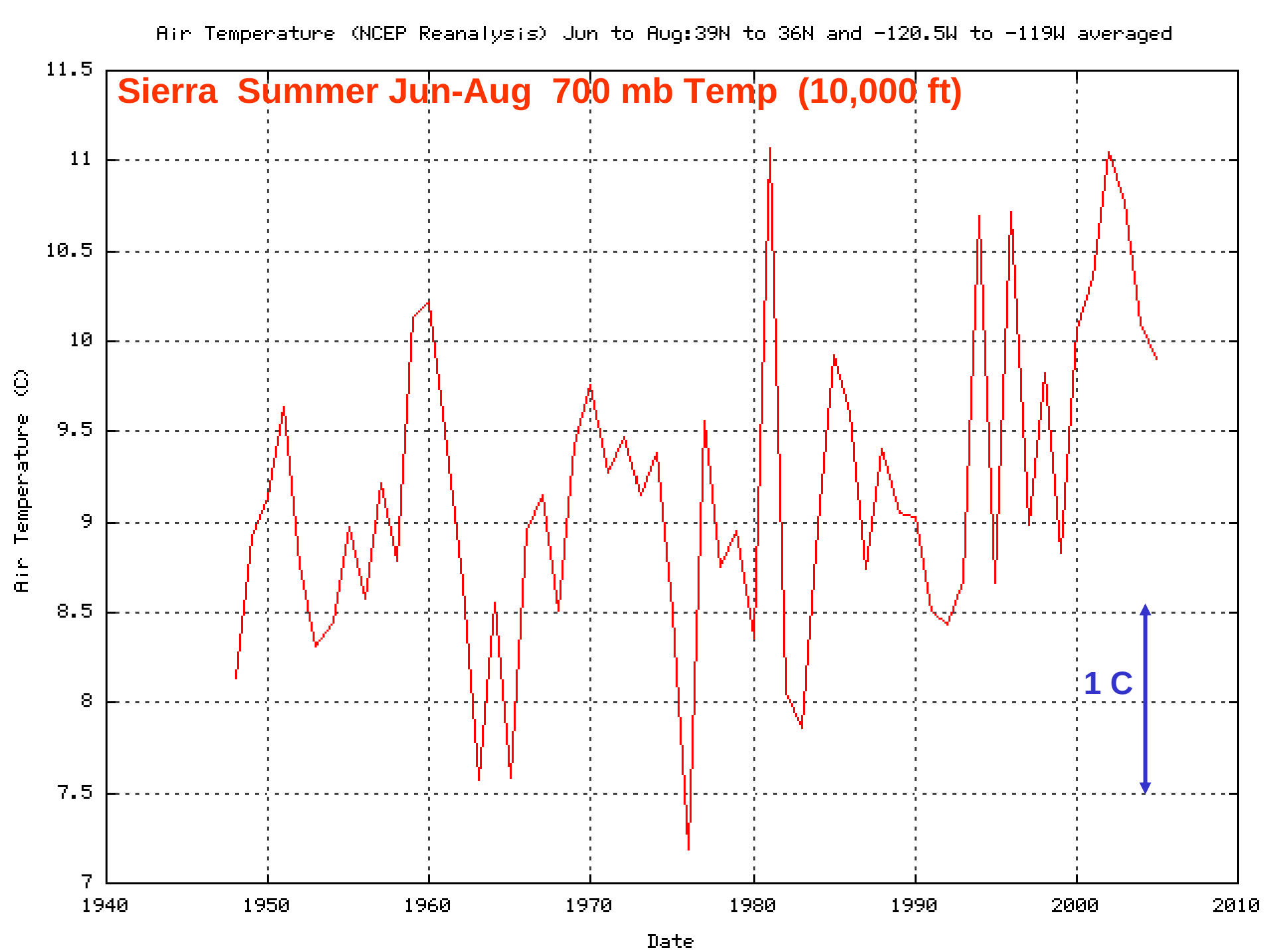
Regional
(slightly smaller; pixel resolution)

Desired Resolution

About 1 km


Air Temperature (NCEP Reanalysis) Jan to Dec:39N to 36N and -120.5W to -119W averaged
Sierra Annual Jan-Dec 700 mb Temp (10,000 ft)
Air Temperature (C)
Date
4
3.5
3
2.5
2
1.5
1940
1950
1960
1970
1980
1990
2000
2010
1 C


Air Temperature (NCEP Reanalysis) Mar to May:39N to 36N and -120.5W to -119W averaged
Sierra Mar-May 700 mb Temp (10,000 ft)
Freezing
1 C
Air Temperature (C)
Date
3
2
1
0
-1
-2
-3
-4
1940
1950
1960
1970
1980
1990
2000
2010


Air Temperature (NCEP Reanalysis) Jun to Aug:39N to 36N and -120.5W to -119W averaged
Sierra Summer Jun-Aug 700 mb Temp (10,000 ft)
Air Temperature (C)
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
1940
1950
1960
1970
1980
1990
2000
2010
Date
1 C

Last six years

Sep-Aug Temperature

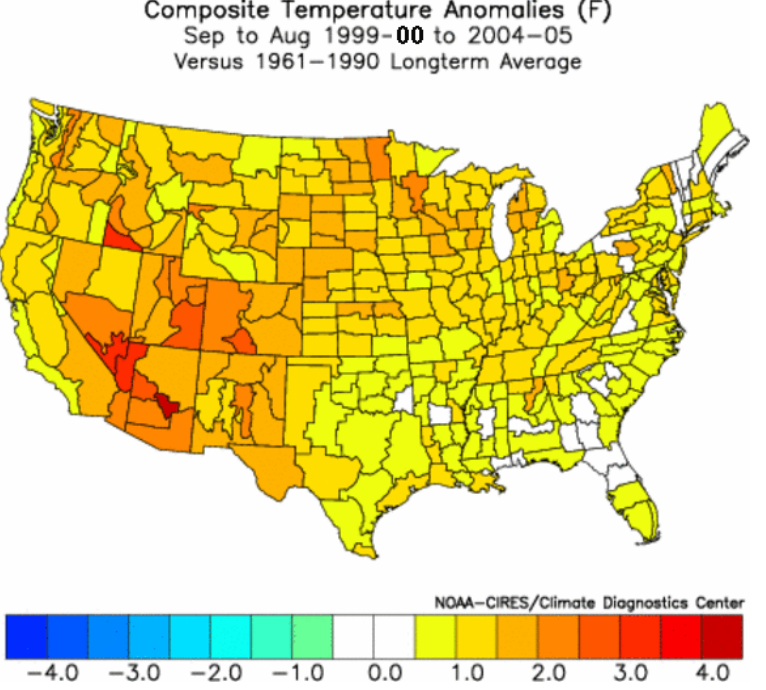
As departure (F) from

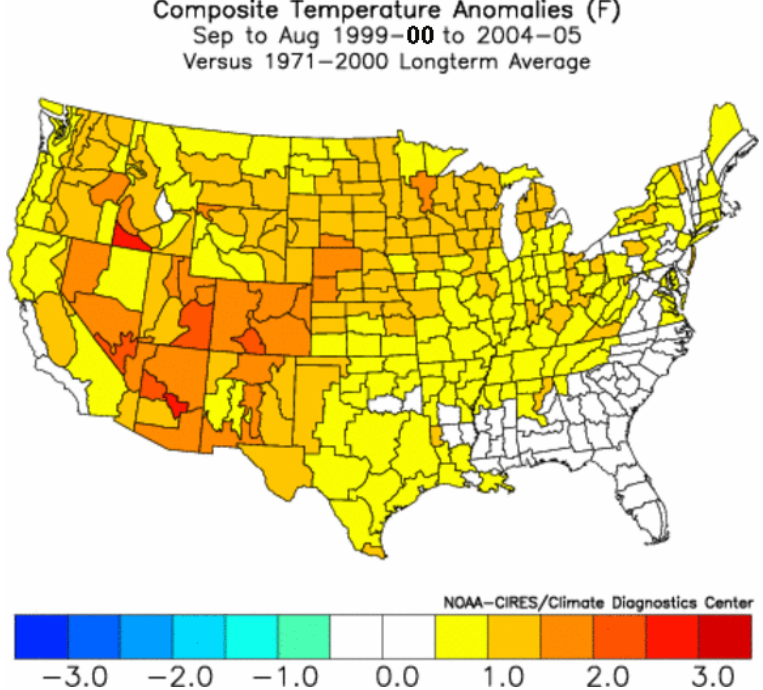
1961-1990

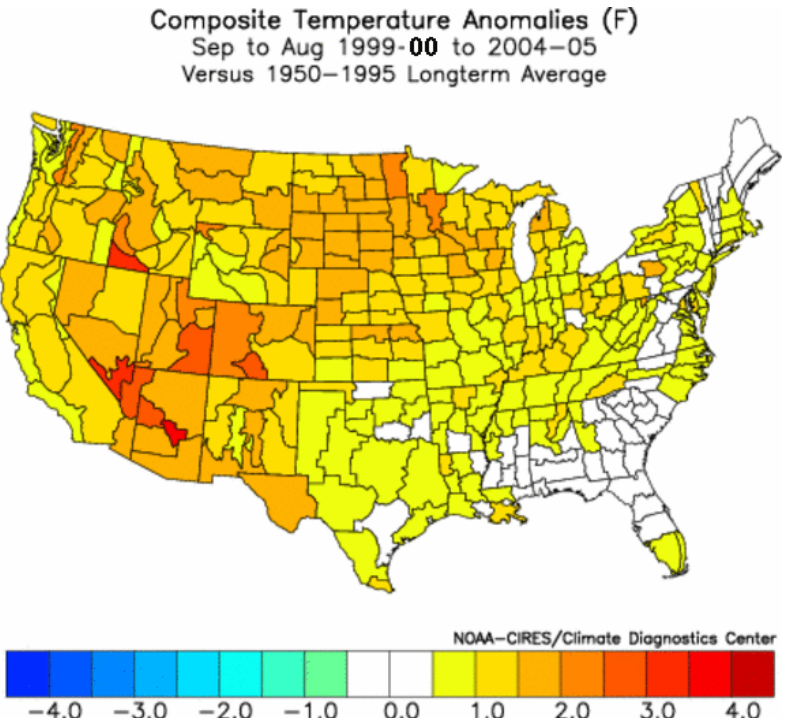
1971-2000

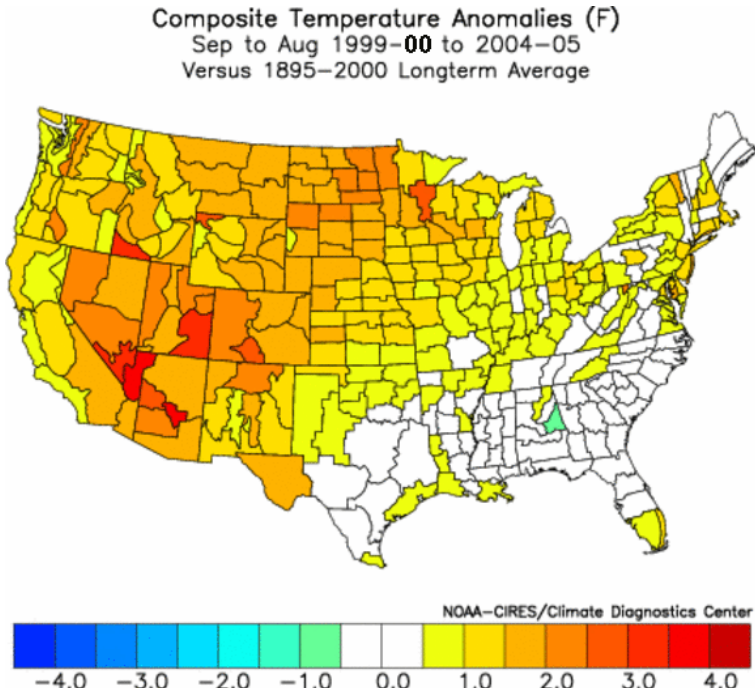
1950-1995

1895-2000









August 30, 1997

Agriculture ··········→ **Cities**

Workshop: Urban Water Supplies and Climate Change in the West

2005 September 22-23 Las Vegas.

Sponsors

- Southern Nevada Water Authority
- Natural Resources Defense Council
- Desert Research Institute

Purpose

Initiation of a dialog: urban water managers and climate scientists

Approximately 15 urban water districts, 8 climate specialists.

Follow-on: Urban Water Coalition meeting, 2005 October 21, Reno.

- Represents the major western cities

Outcome:

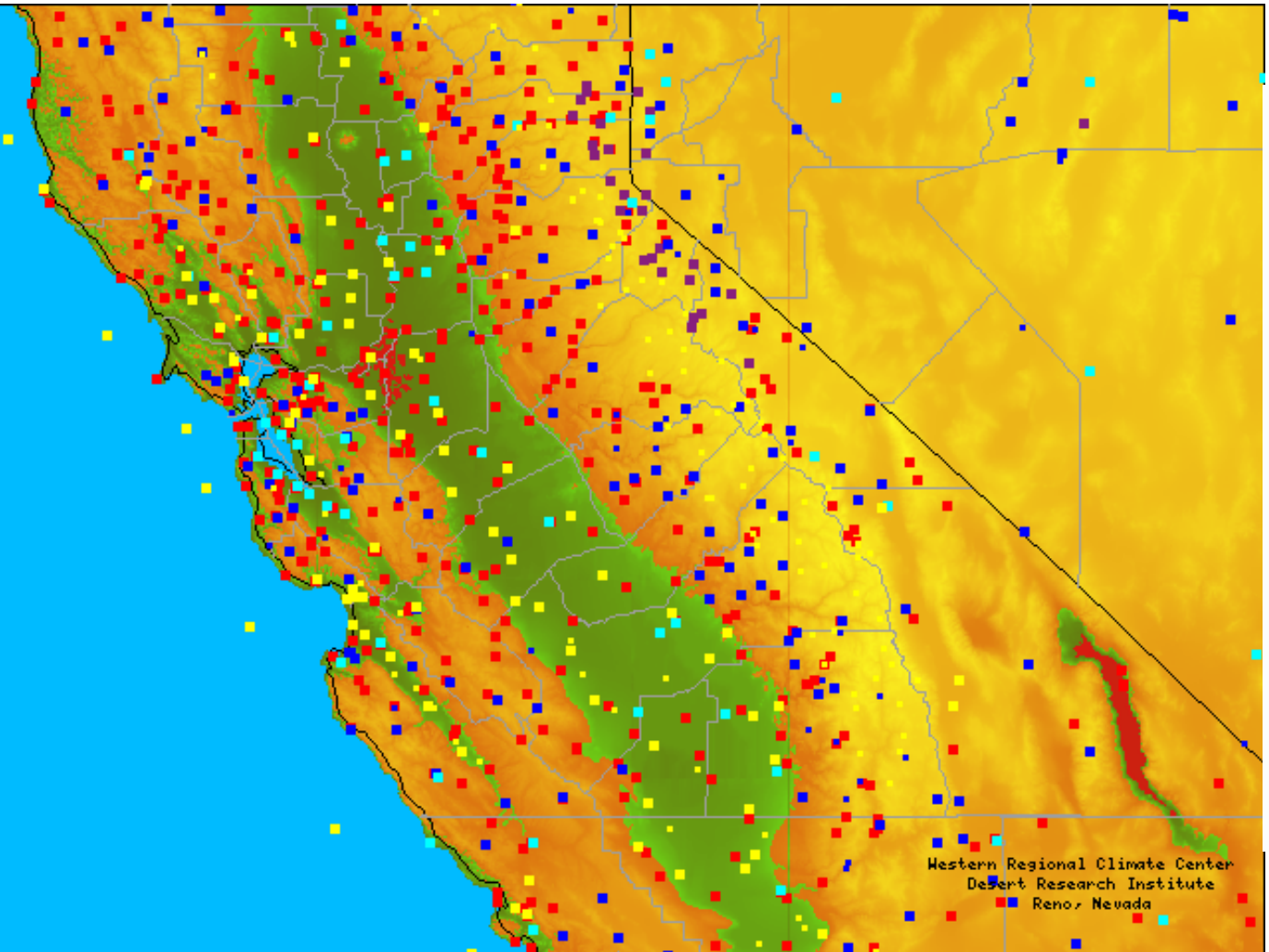
1. Vulnerability to water supply disruption from temperature effects is of significant concern to cities and water suppliers.
2. Climate issues are intersecting with many other stressors.
3. Need to understand entire water budget: atmosphere, surface, groundwater as an integrated system.
4. Keep the dialogue going.

CalClim: Integration of networks.

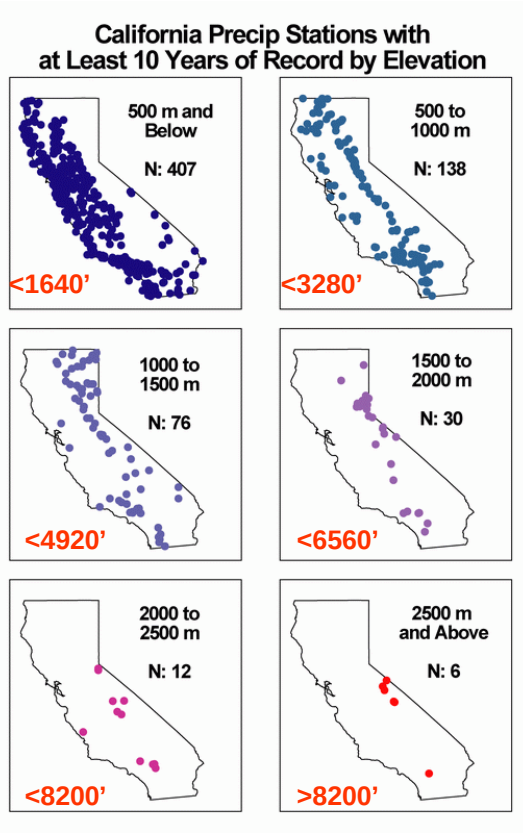
www.calclim.dri.edu
Cal Energy Commission

Coop CIMIS Snotel Buoy RAWS

CDWR ASOS Research



But still not enough at higher elevations !



South **Central Sierra Snow Lab** East

Photo: Dave Simeral


Slide Mountain
Toward SSW

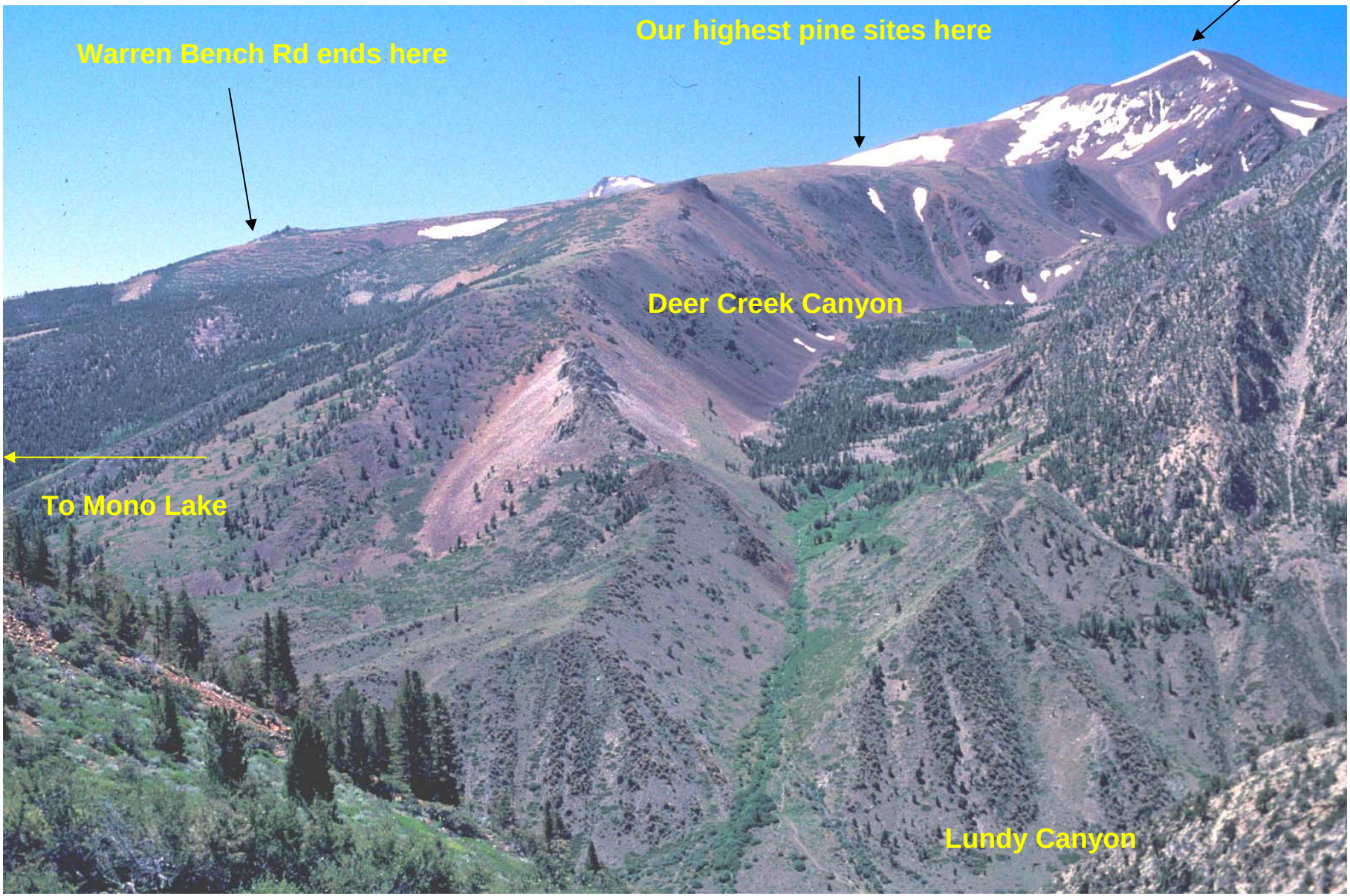

2003 March 10


White Mountain
Summit.
Highest active live
transmission station
in North America.
14246 ft. / 4342 m.
Summer 2003
www.wrcc.dri.edu/weather/wmtn.html


White Mtn Summit
Looking North


White Mtn Summit
Looking South

Mt Warren (12327 ft) Toward South. July 2000.



View looking south up Deer Cr (NB: beautiful Pleistocene Rock Glacial cyn), a tributary of Lundy Cyn (note also limber pines at left foreslope (one of our sites). 7/00

Photo: Connie Millar

“You can observe a lot, just by watching.”

-Yogi Berra


Thank You