Climate through a PRISM: Exploring the Spatial Patterns of Climate Across the United States

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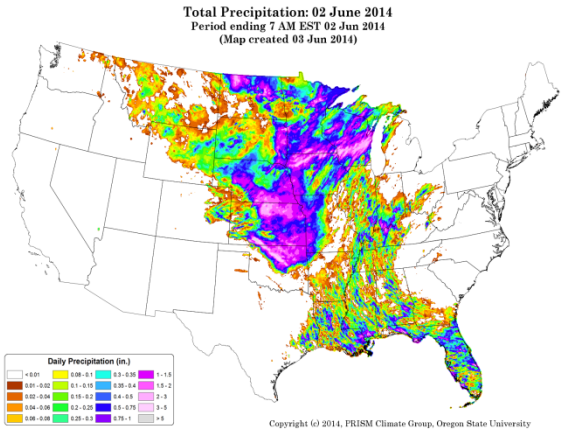
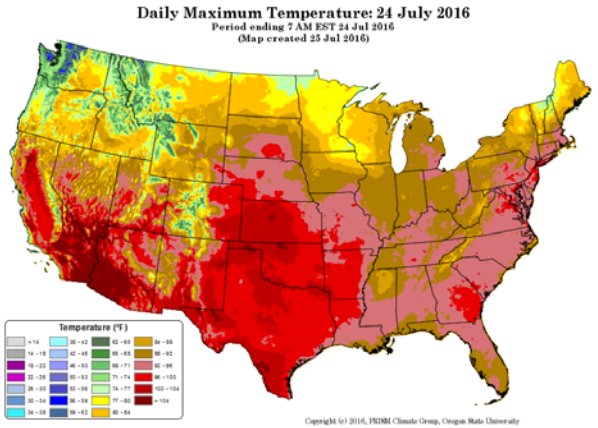
Northwest Alliance for Computational Science and Engineering

Oregon State University



CoCoRaHS Webinar

1 Dec 2016



Topics

- Who and what is PRISM?
- What rules govern US climate patterns?
- How does PRISM put these rules into play across the country?
- How can we explore PRISM data?

Question #1

If you gathered all the active rain gauges in the country together and put them in one place, they would cover an area the size of:

- The state of Rhode Island
- The city of San Francisco
- A football field
- A tennis court **(2) 1 – CoCoRaHS, 1 – other networks**
- I don't know

Question #2

The wettest place in the lower 48 states is:

- Michigan's Upper Peninsula
- Olympic Mountains, Washington **~200-260"**
- Coastal Louisiana
- New York City
- I don't know

Question #3

The driest place in the lower 48 states is:

- Death Valley, California **2”**
- Denver, Colorado New York City
- Boise, Idaho
- I don’t know

Question #4

True or False: Temperatures at high elevations are always colder than those at low elevations

- True
- False

Cold air pooling

Question #5

A rain shadow is characterized by:

- An increase in precipitation on the leeward side of a major mountain range
- A decrease in precipitation on the leeward side of a major mountain range
- I don't know

PRISM Climate Group Overview

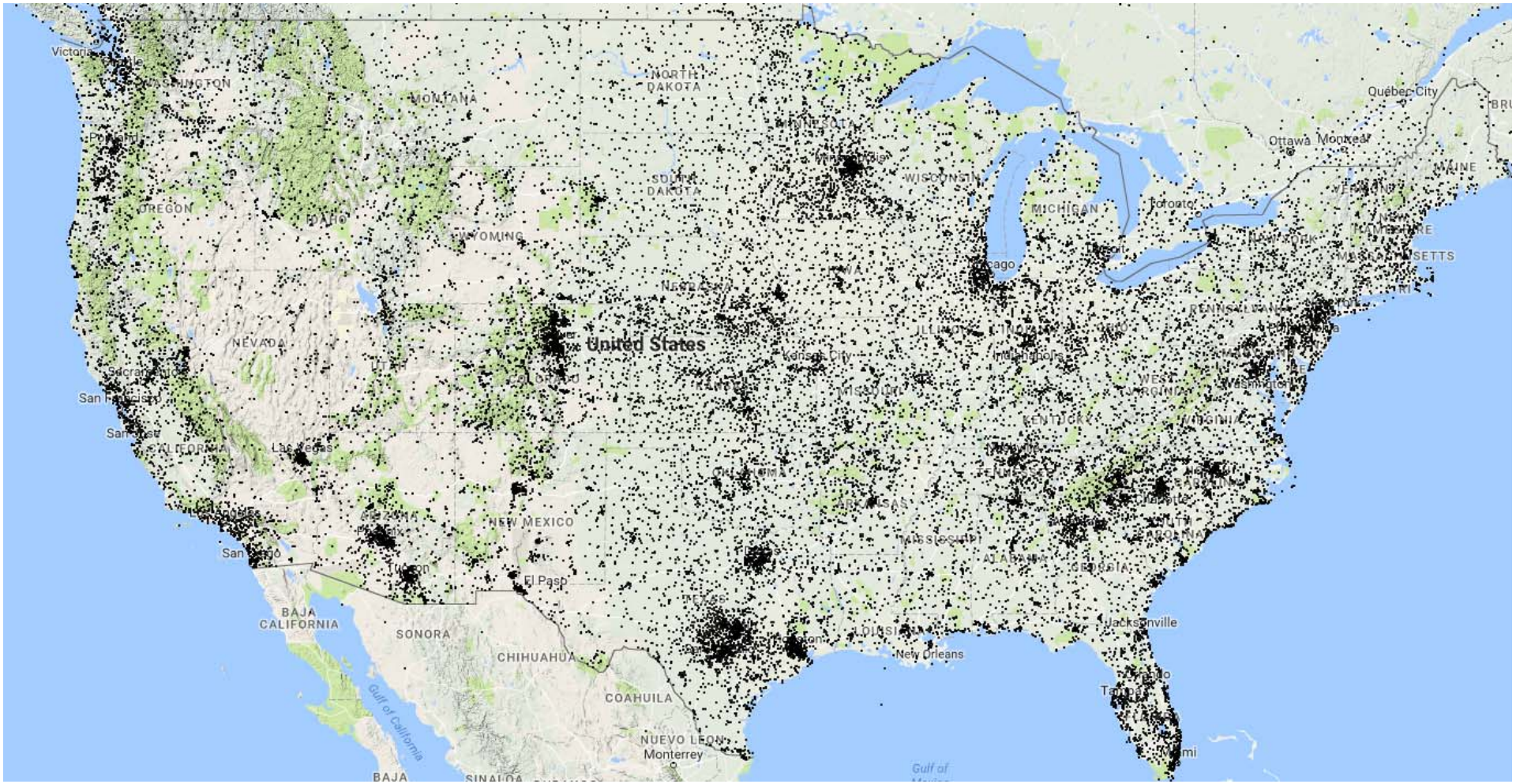
- Applied research team since 1991, founded and directed by Dr. Christopher Daly
- Housed within the Northwest Alliance for Computational Science and Engineering (NACSE), College of Engineering, Oregon State University (10 FTE)
- Climate mapping center for the USDA; *de facto* climate mapping center for the US
- Federal sponsors cut across many departments and disciplines

OSU
Oregon State
UNIVERSITY

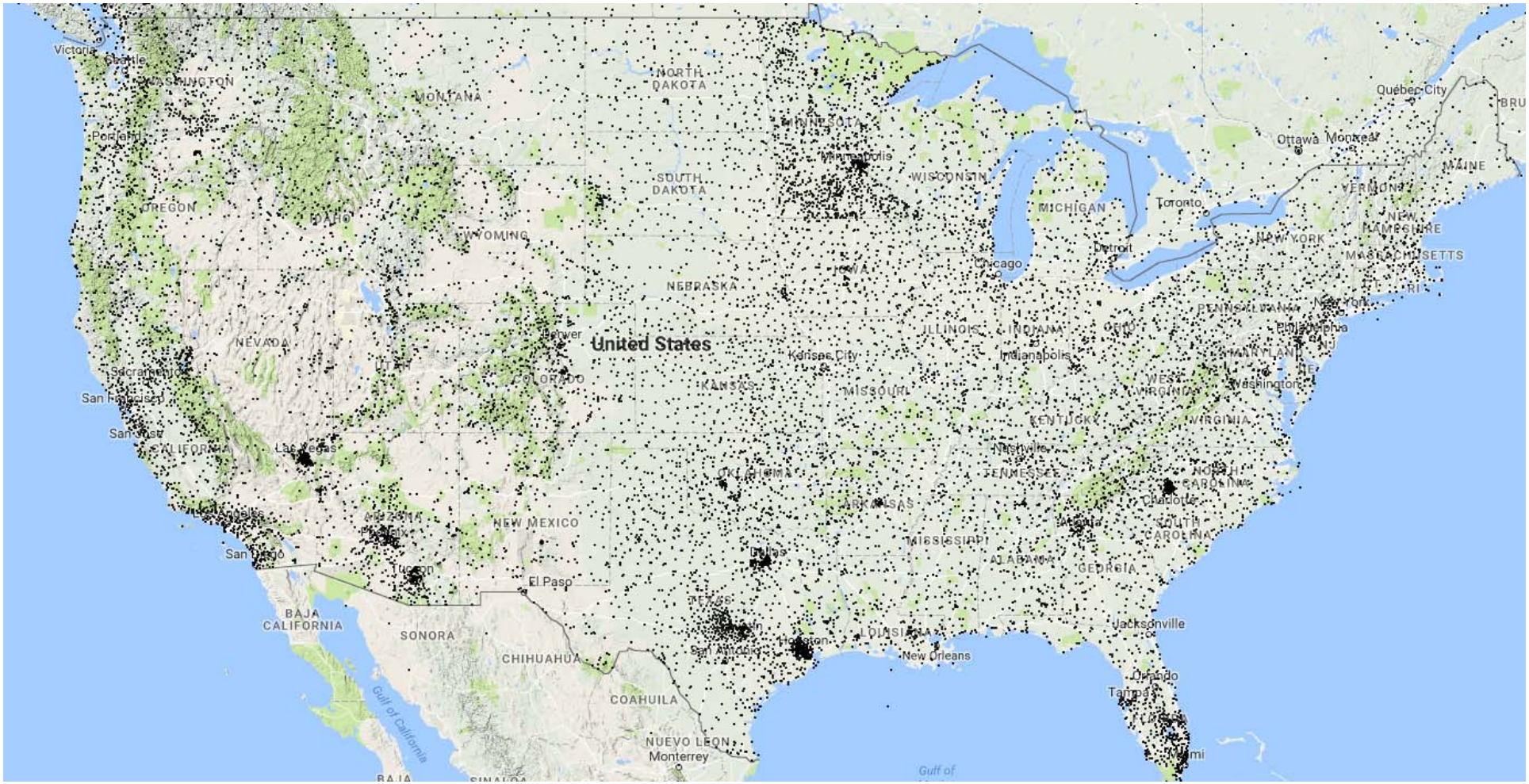
Geospatial Climatology

- The study of the spatial and temporal patterns of climate on the earth's surface and the physical features that control those patterns
- The most important physical features are mountains and water bodies

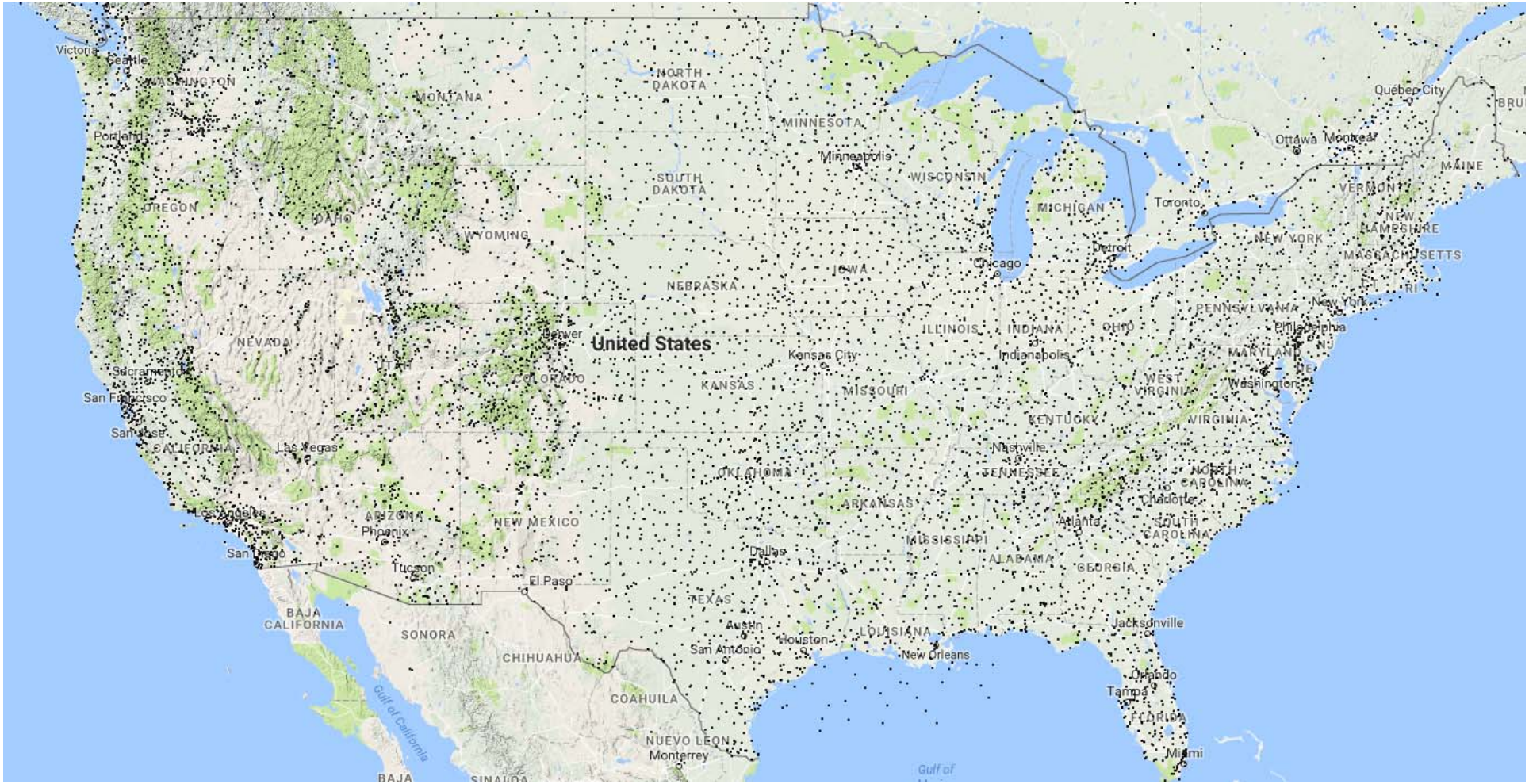
Precip Stations
July 2015



Precip Stations, no CoCoRaHS
July 2015



Temperature Stations
July 2015

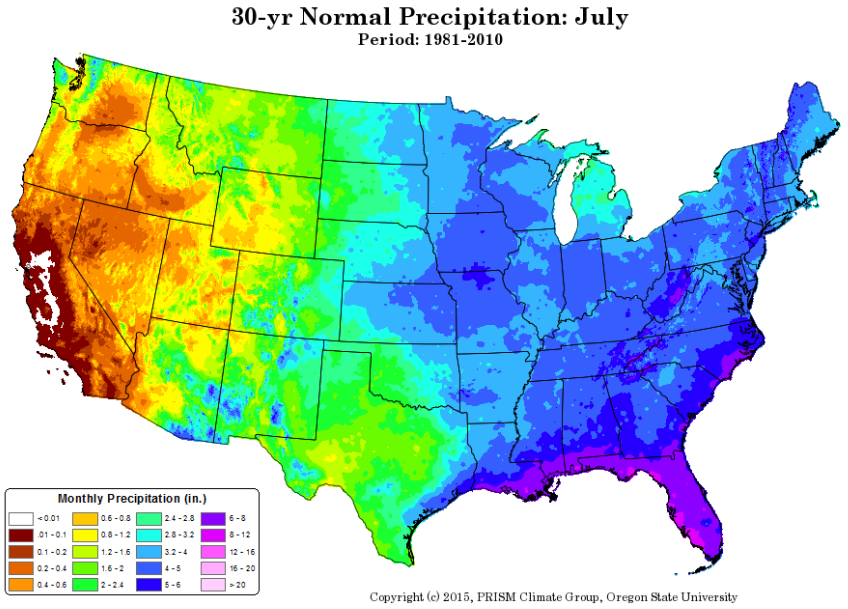


What is PRISM?

- There are many locations in the US for which no climate observations exist.

- To create a continuous map across the country, station observations are fed into a computer model called PRISM (**Parameter-elevation Regressions on Independent Slopes Model**).

PRISM estimates climate variables, such as temperature and precipitation, for a grid of millions of pixels, each measuring about 1/2 mile across over the entire conterminous US.



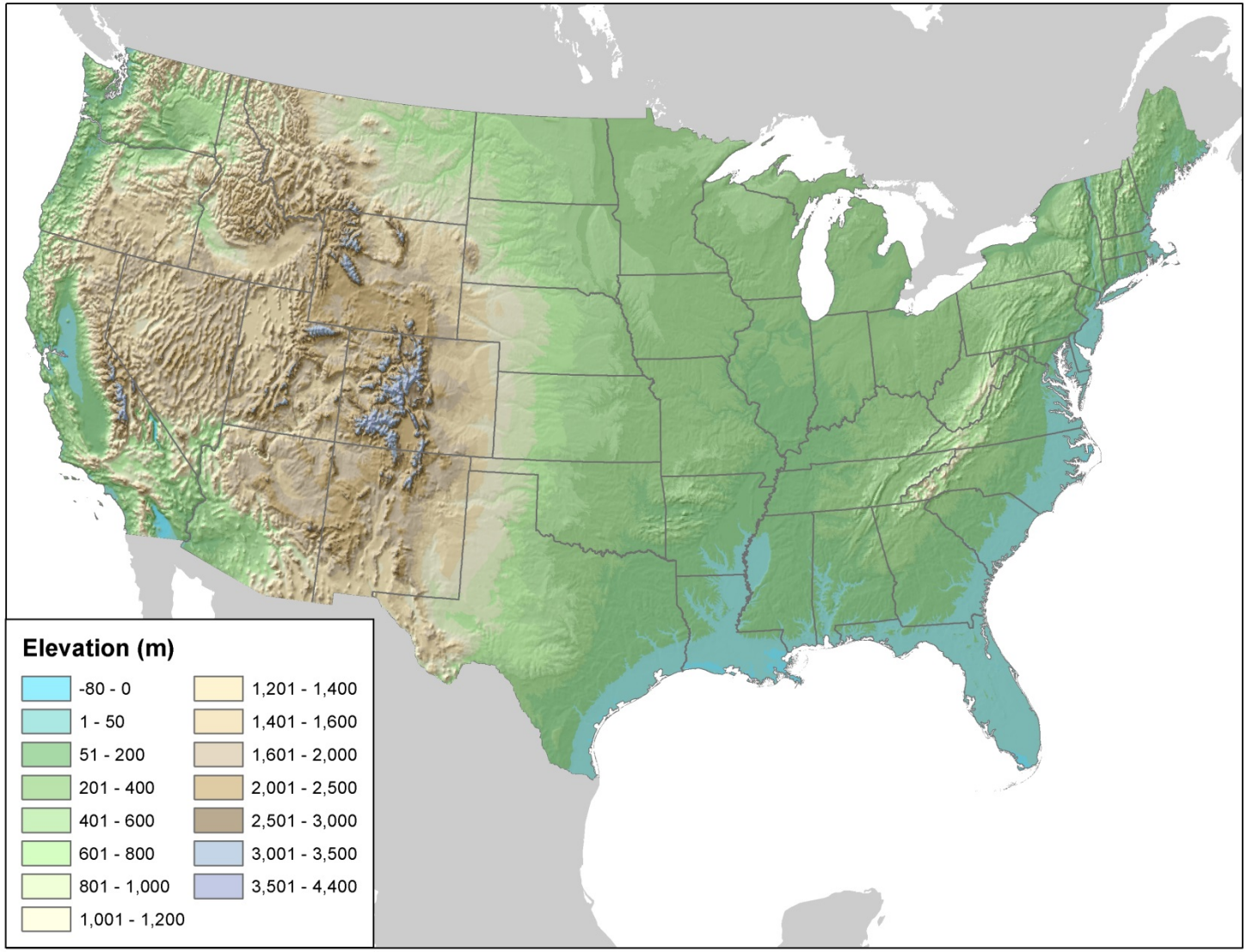
What's Behind PRISM?

We don't have stations everywhere, so in order to create wall-to-wall maps, we need a source of information that

- Drives many climate patterns
- Is available wall-to-wall

The answer is ..

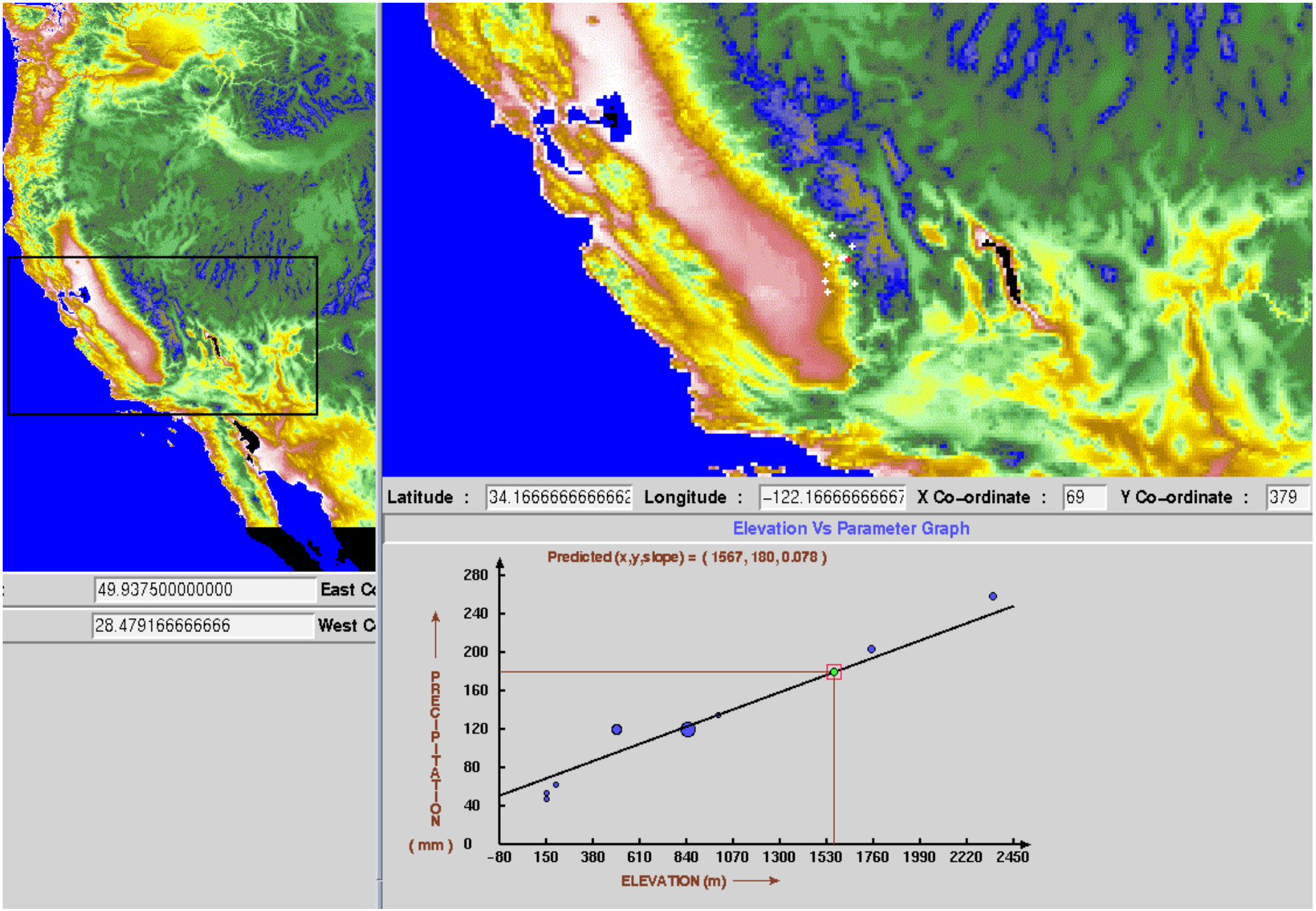
Terrain!


Elevation (m)
-80 - 0
1 - 50
51 - 200
201 - 400
401 - 600
601 - 800
801 - 1,000
1,001 - 1,200
1,201 - 1,400
1,401 - 1,600
1,601 - 2,000
2,001 - 2,500
2,501 - 3,000
3,001 - 3,500
3,501 - 4,400

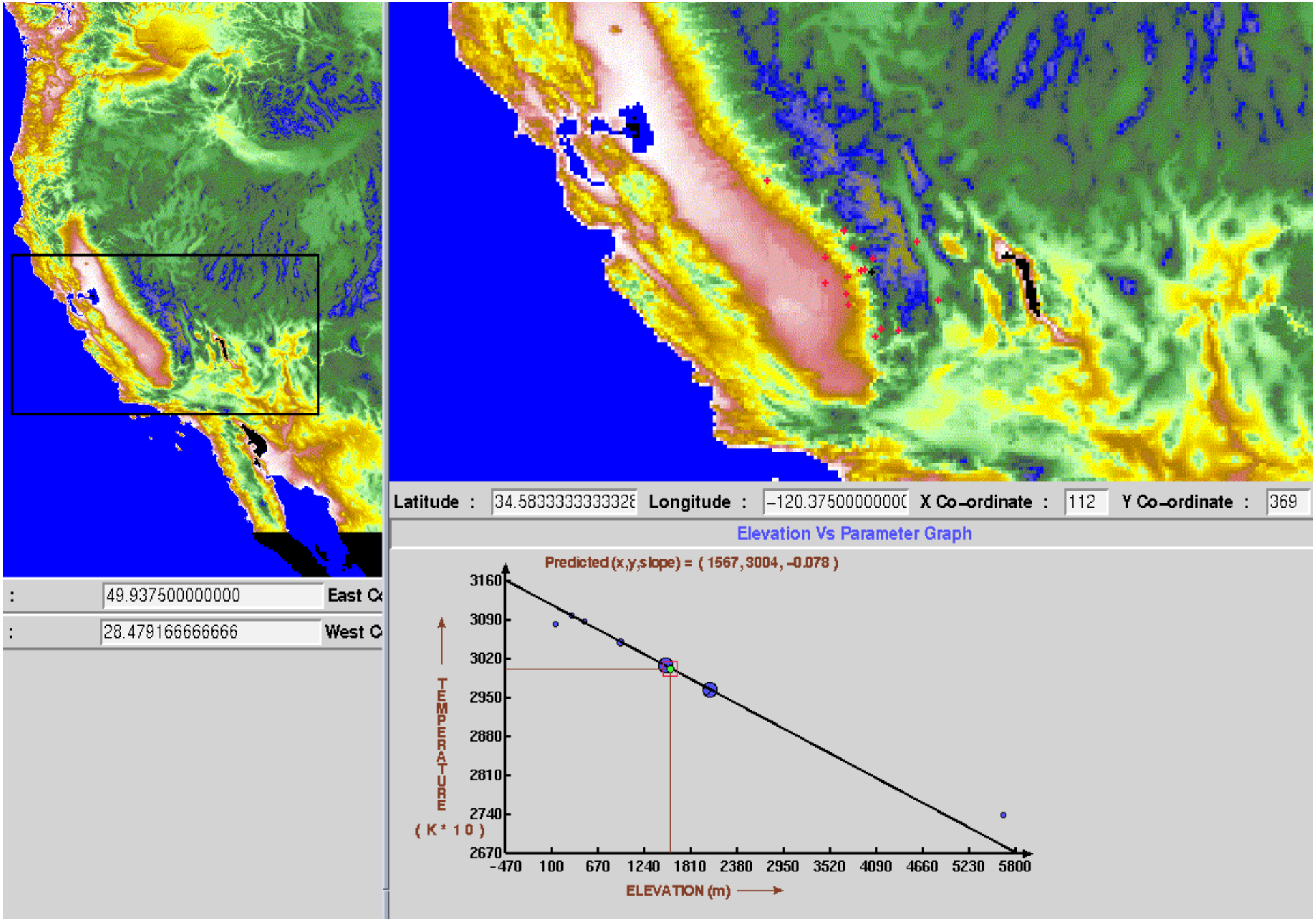
Terrain Has Direct Effects on Climate

- Precipitation tends to increase with elevation
- Temperature tends to decrease with elevation

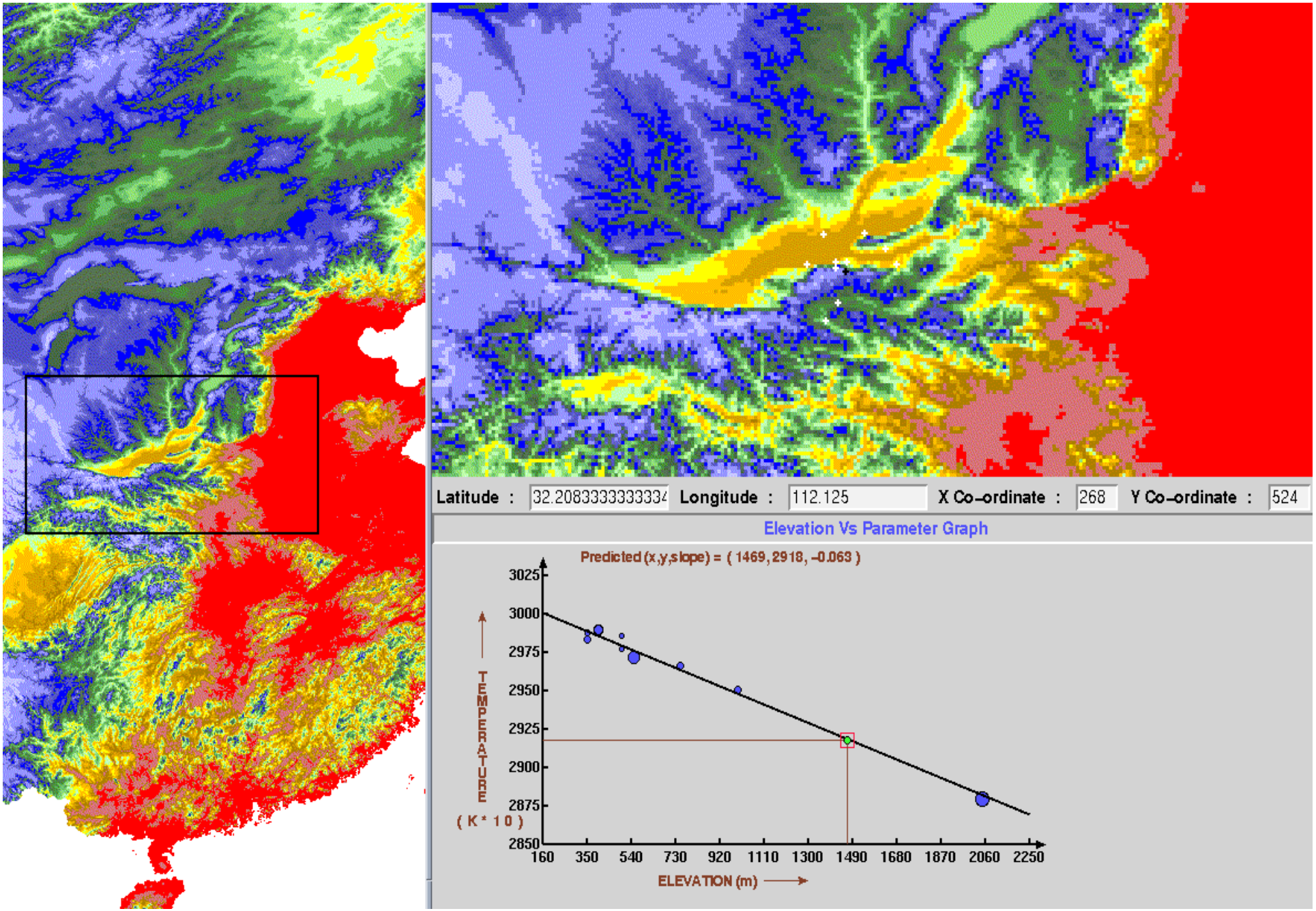
1961-90 Mean January Precipitation, Sierra Nevada, CA, USA



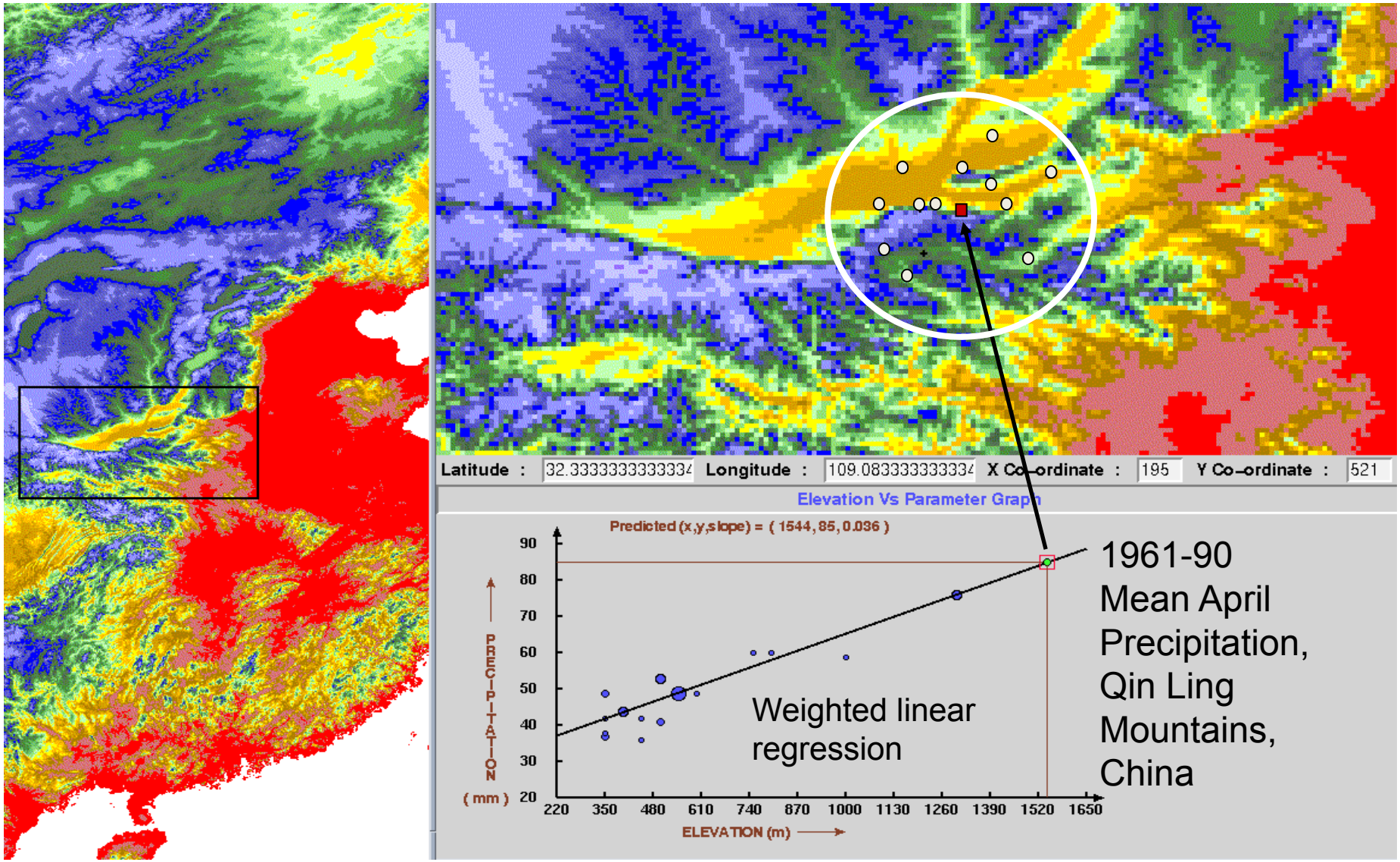
1961-90 Mean August Max Temperature, Sierra Nevada, CA, USA



1961-90 Mean September Max Temperature, Qin Ling Mountains, China

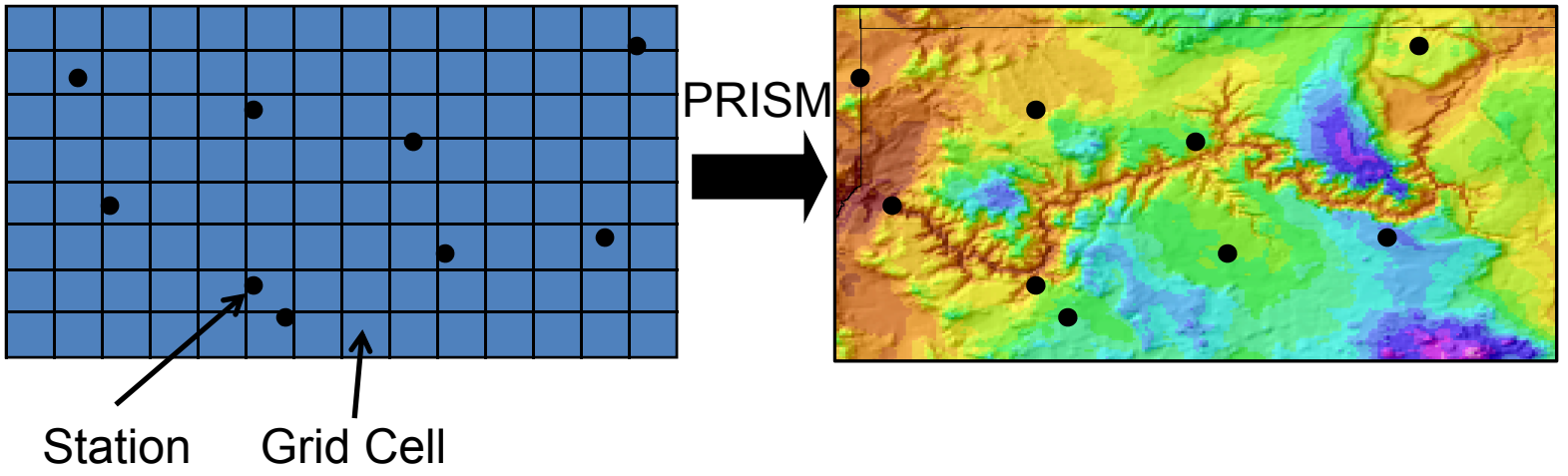


PRISM Moving-Window Regression Function



Using a Terrain Grid to Map Temperature

Grand Canyon temperature map:
PRISM incorporates the effects of elevation



Add in Those Complicating Factors

From terrain grids we can also:

- Identify storm barriers
  Rain shadows
- Identify coastlines
  Marine influences
- Tell valleys from ridges
  Cold air pooling

Rules for Getting Wet
Engage the Bucket Brigade

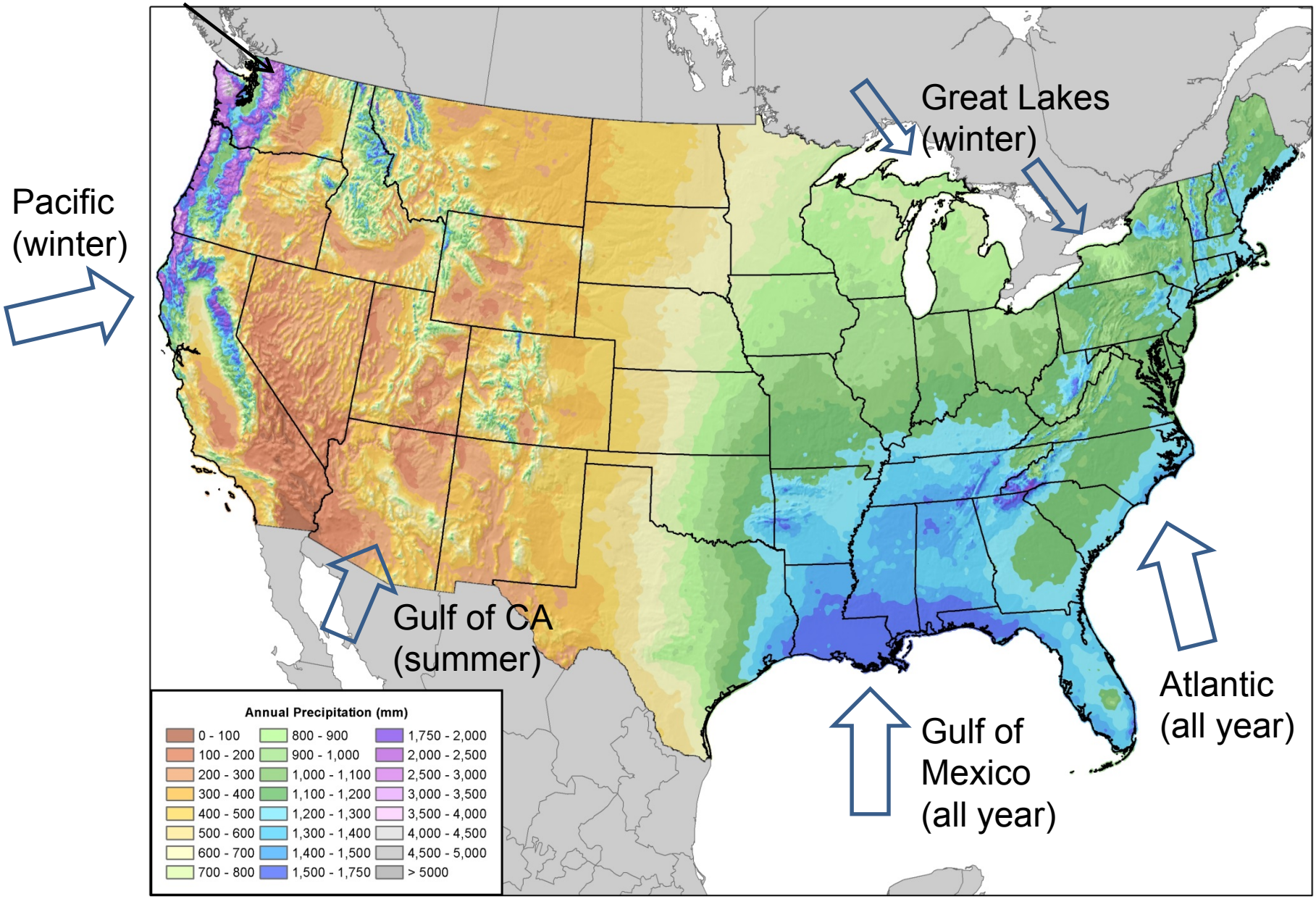
- **Proximity to a Water Source**

Is there a clear path to a water source and a prevailing wind that can carry water buckets to your location?

- **Elevation**

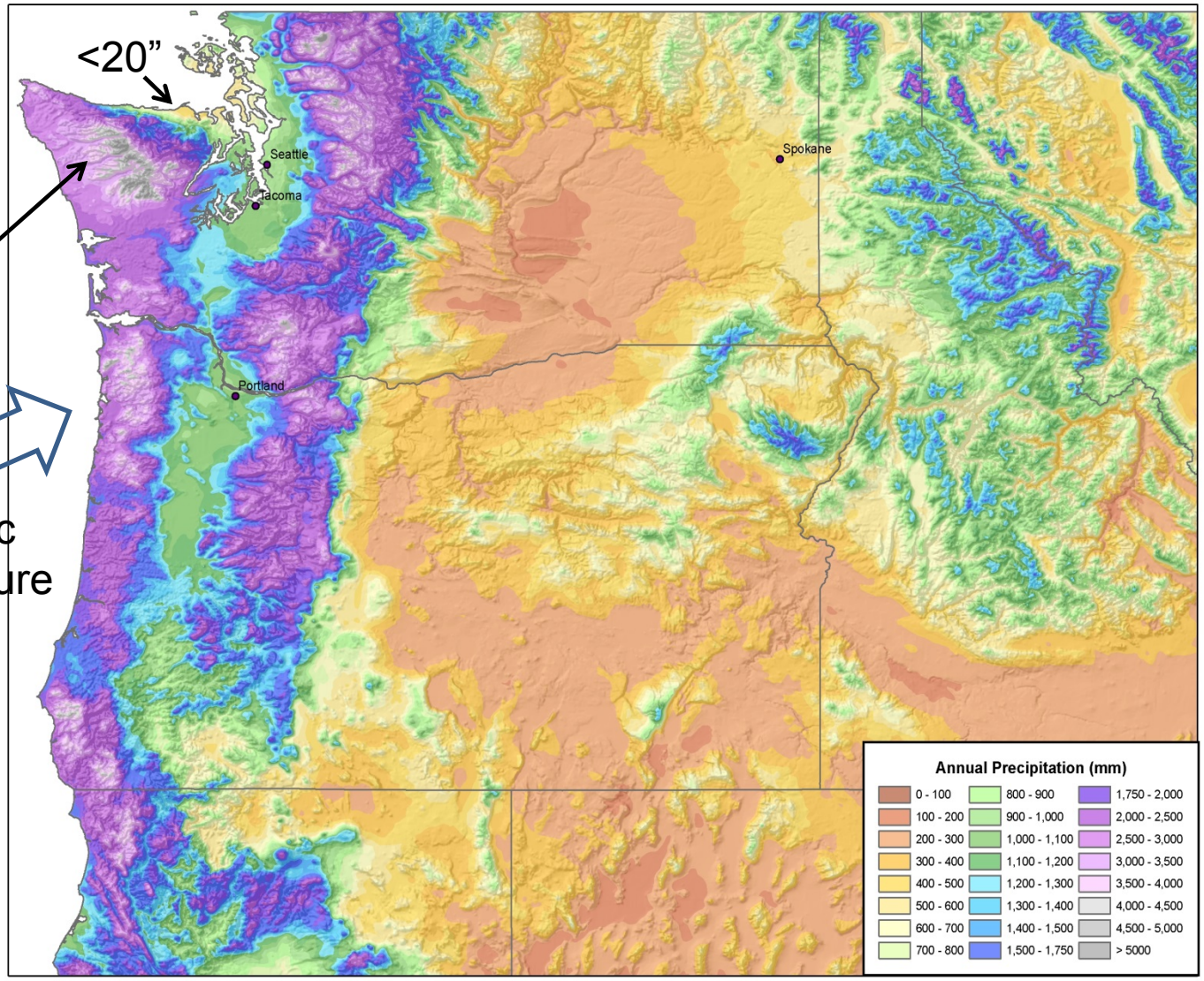
Are you are high on a mountain? Air forced to move up and over a mountain barrier makes the buckets dump more of their water as they pass over you.

Mean Annual Precipitation



- Exposed to Pacific moisture
- Favorable wind direction
- Frequent storms
- Elevated terrain = Wet!

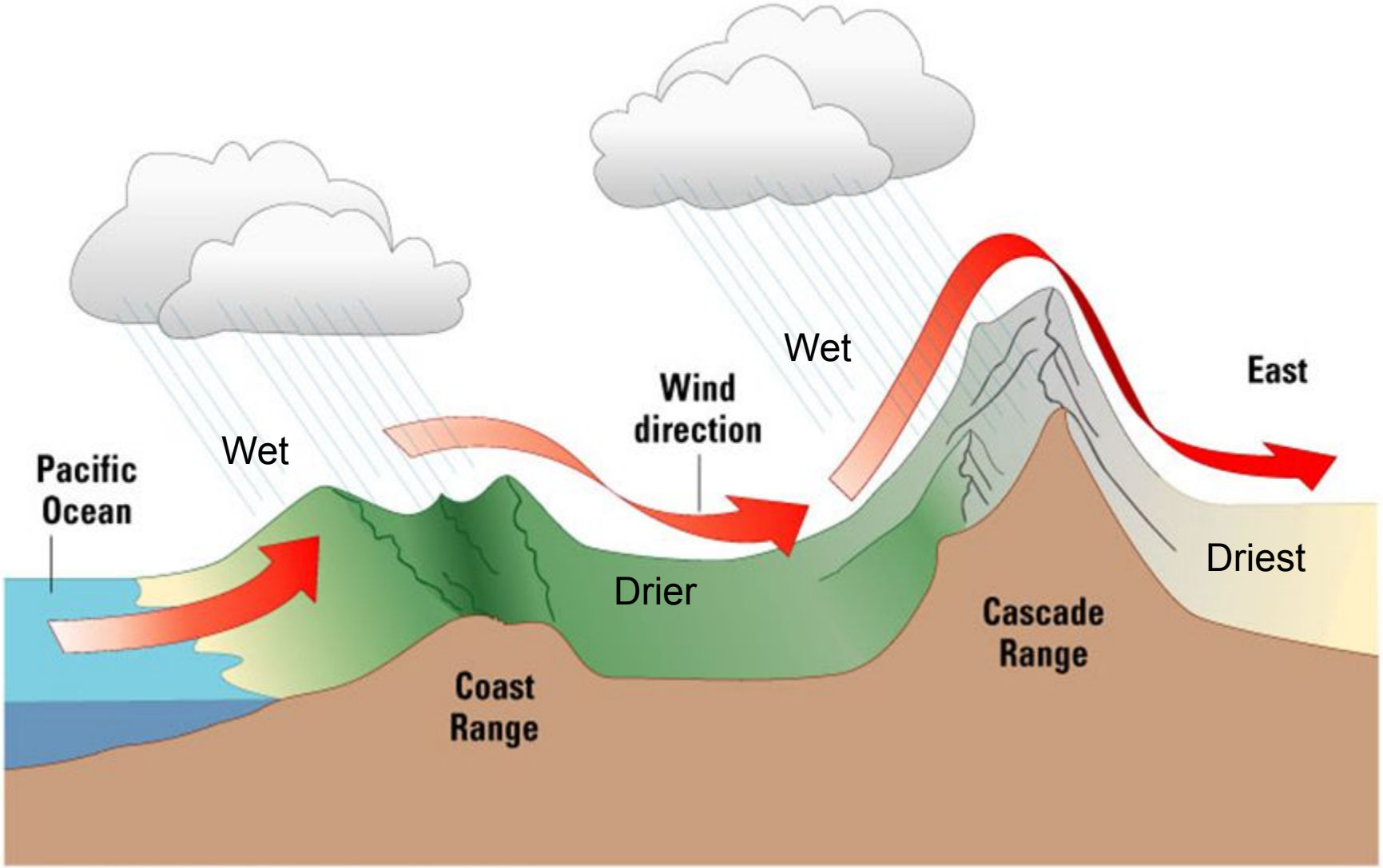
PNW Mean Annual Precipitation



Windward Olympics 200+”

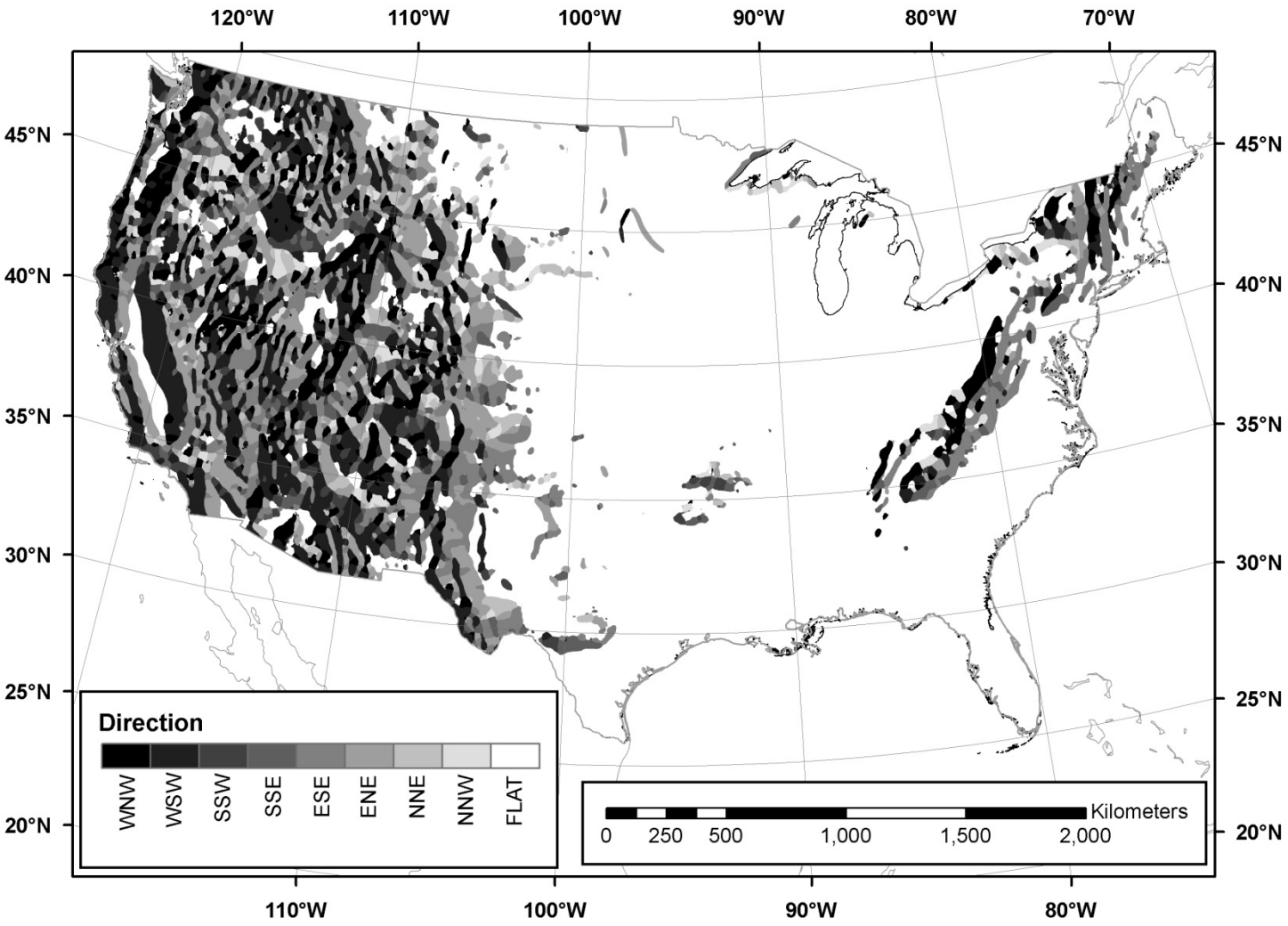
Pacific Moisture

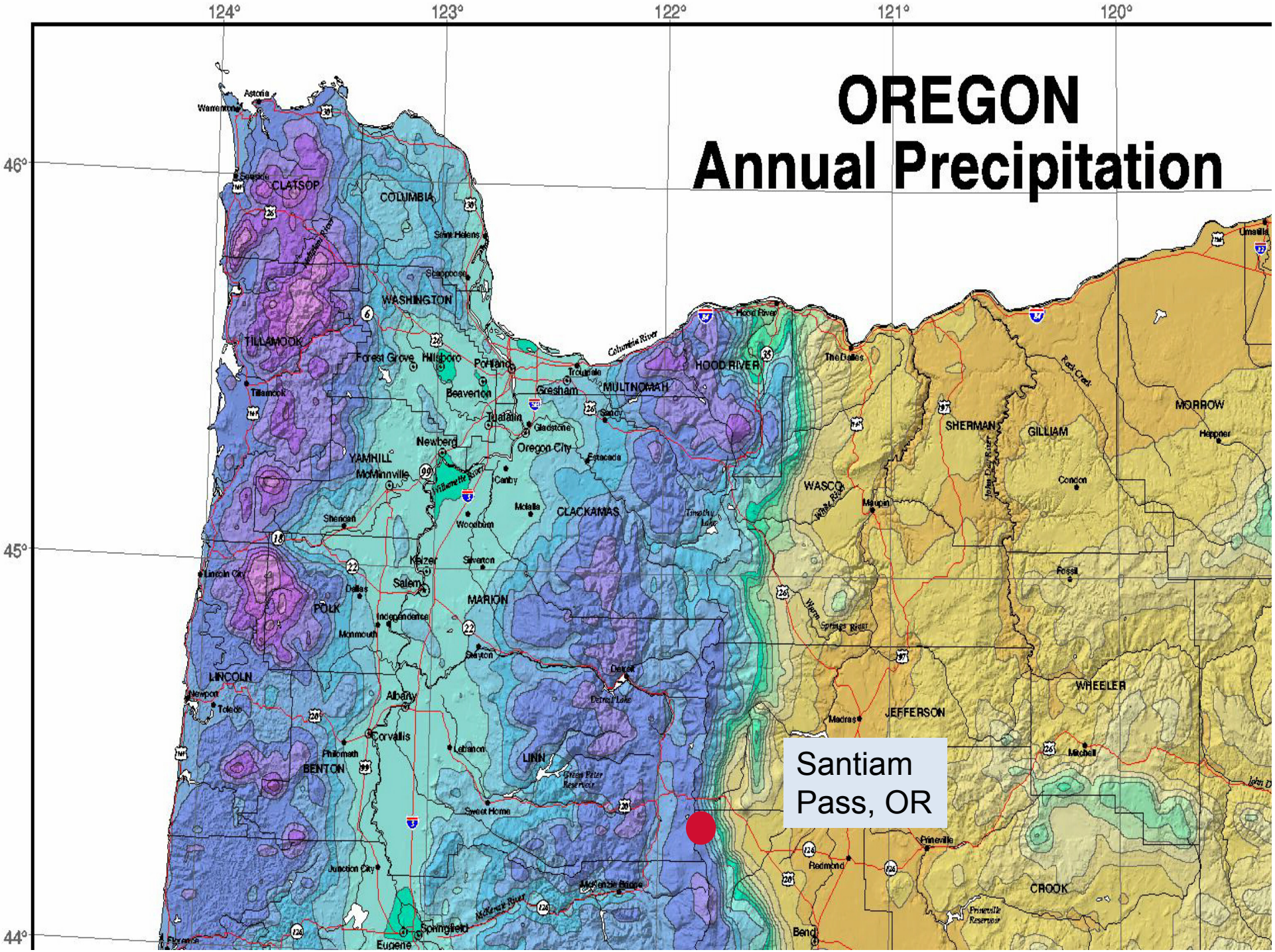
Rain Shadow Effect



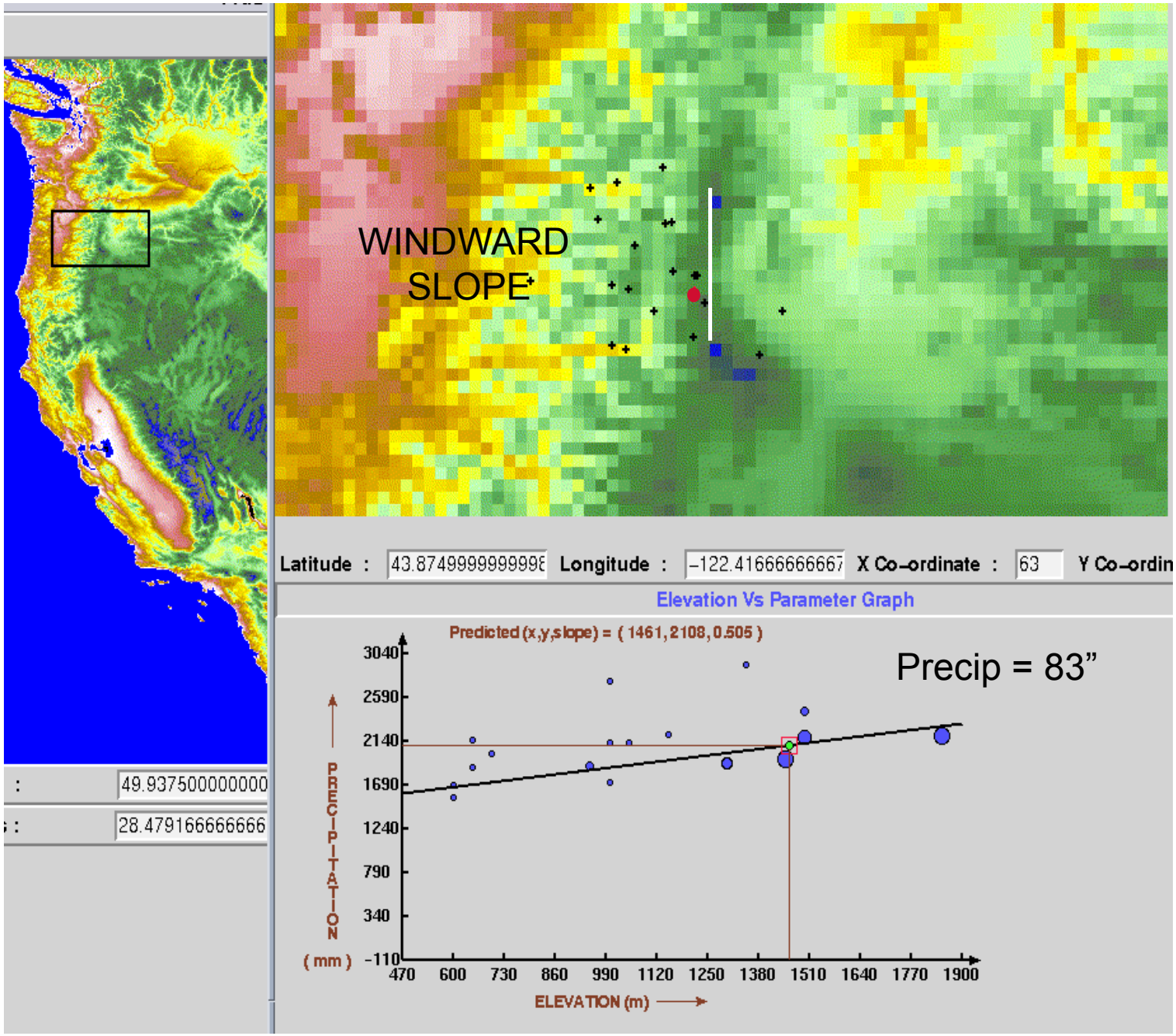
Topographic Facets

Terrain Barriers/Rain Shadows

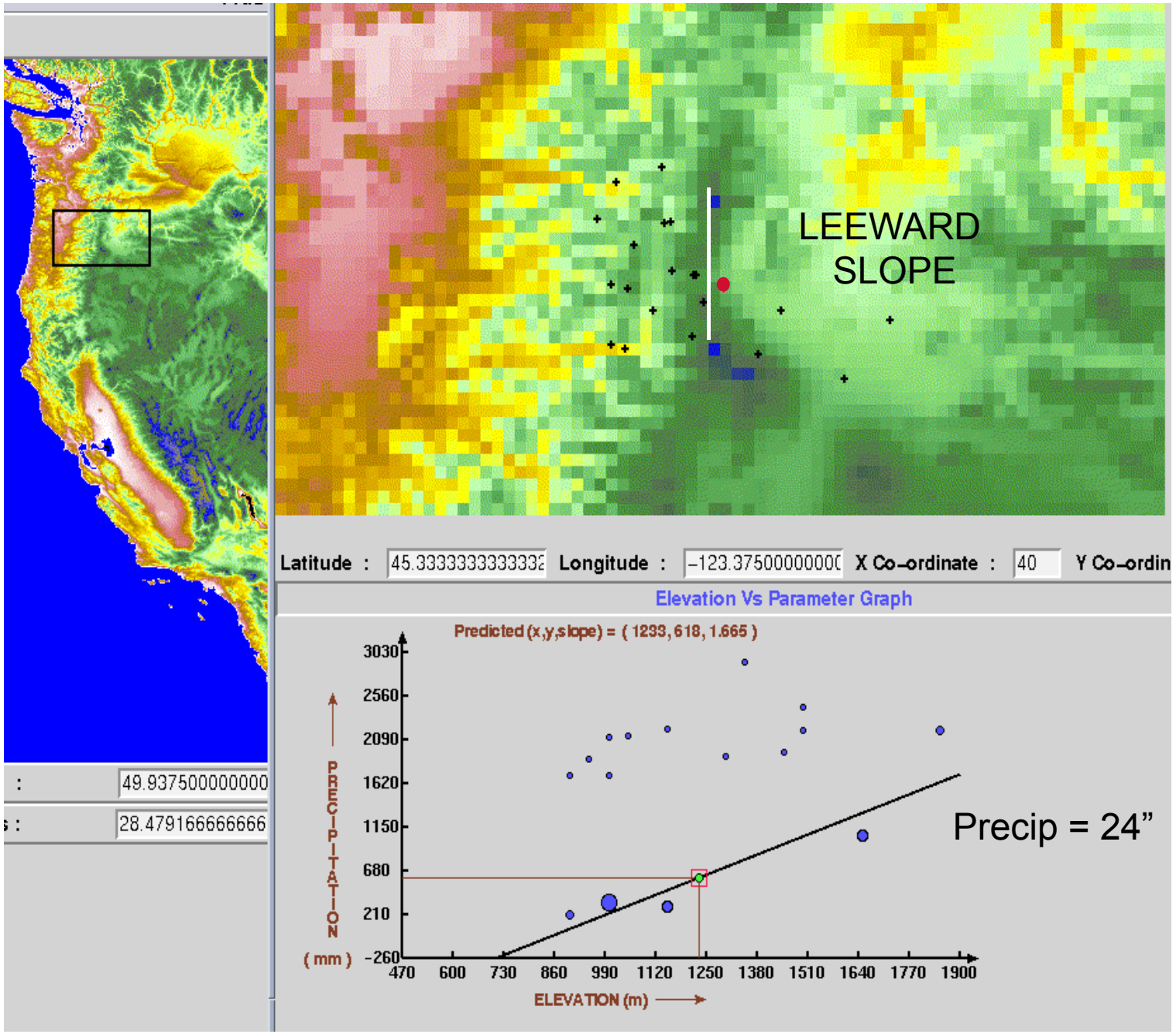



OREGON
Annual Precipitation
124°
123°
122°
121°
120°
46°
45°
44°
Santiam
Pass, OR
CLATSOP
COLUMBIA
WASHINGTON
TILLAMOOK
YAMHILL
MULTNOMAH
HOOD RIVER
CLACKAMAS
MARION
POLK
LINCOLN
BENTON
LINN
JEFFERSON
WHEELER
CROOK
SHERMAN
GILLIAM
MORROW
WASCO
Portland
Salem
Eugene
Springfield
Bend
Redmond
Columbia River

Rain Shadow - Santiam Pass, Oregon

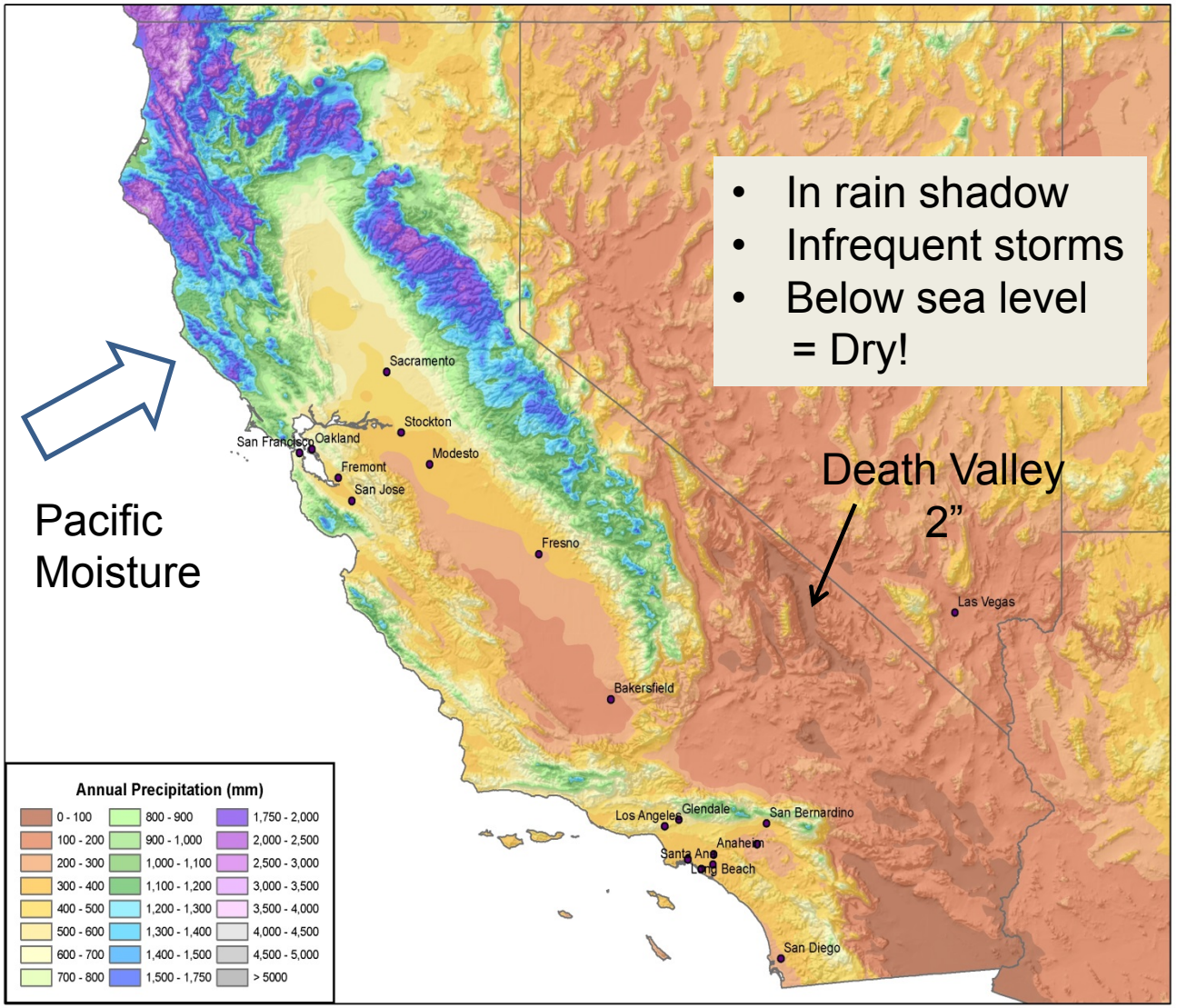


Rain Shadow - Santiam Pass, Oregon



California Mean Annual Precipitation

More storms

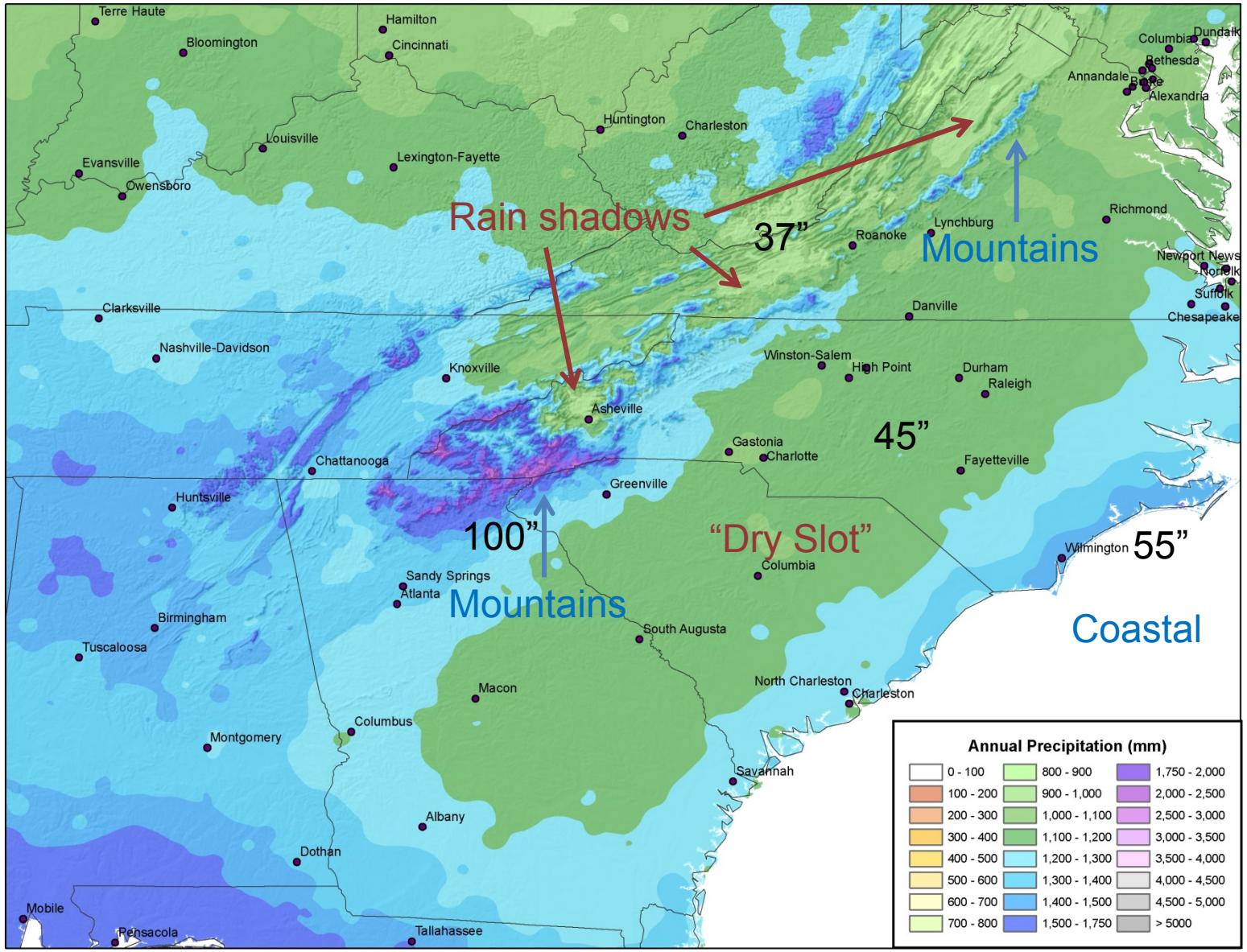


Fewer storms

Olympic Mountains

Death Valley

SE US: Coastal and Mountain Effects



Rules for Staying Cool in Summer
Get High or Go to the Beach

- Latitude

Are you in the northern US? Because of the lower sun angle, it is usually cooler at high latitudes than at low latitudes

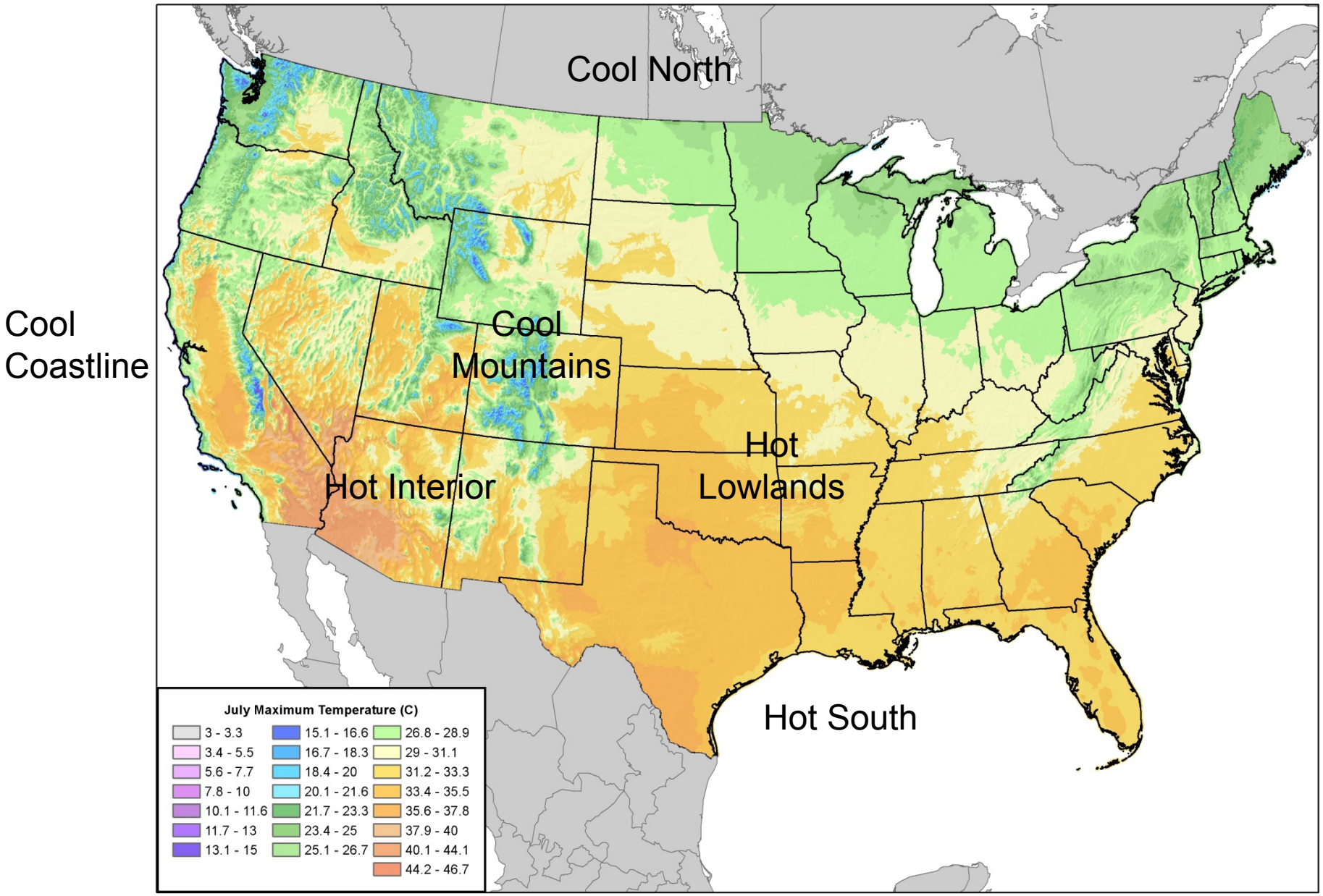
- Coastal Proximity

Because of its high heat capacity, water stays cooler in summer. Is there a clear path to a large water body and a prevailing wind direction that can carry coastal air to your location?

- Elevation

Are you are at high elevation? Summer temperatures at high elevations are usually cooler than those at low elevations

July Mean Maximum Temperature

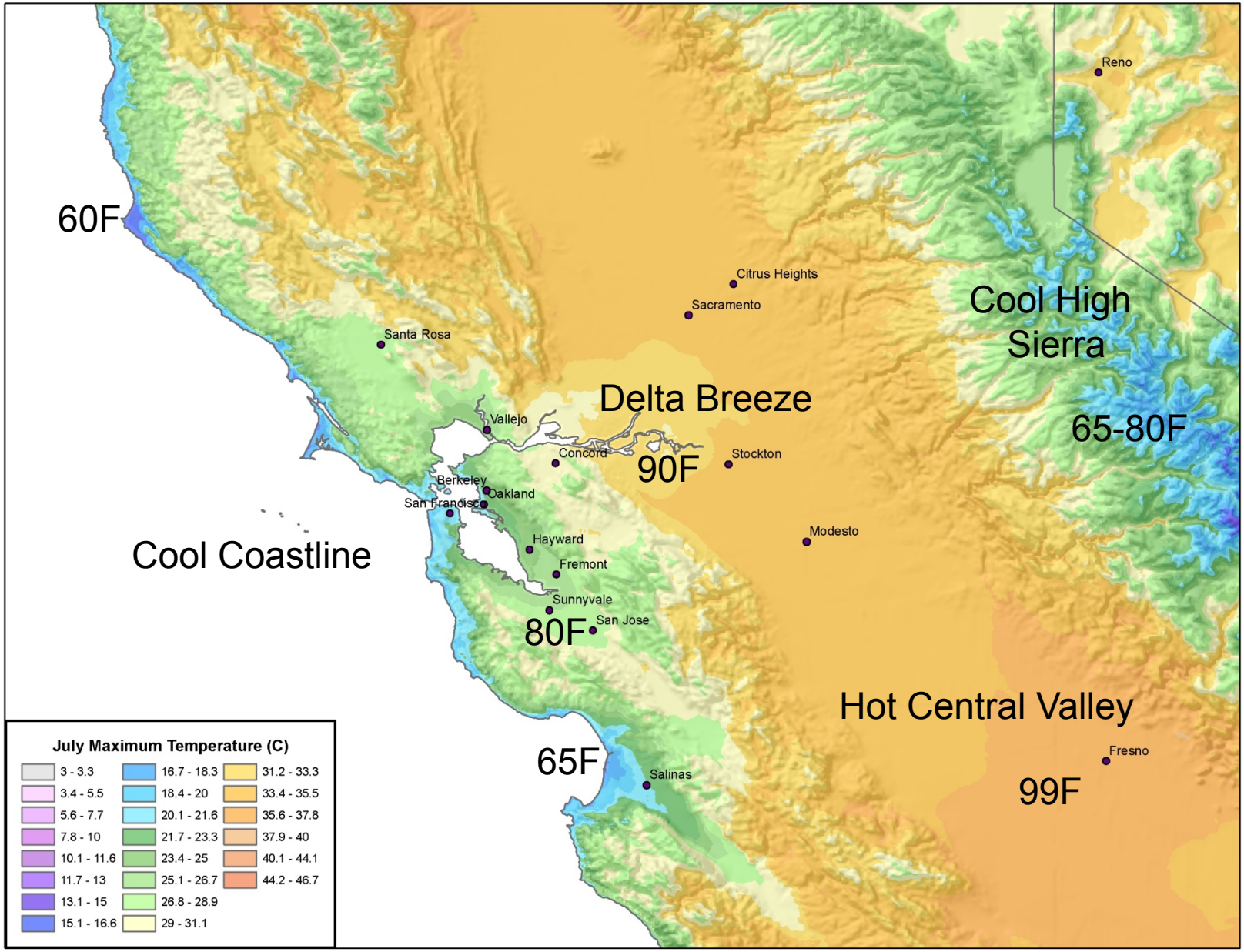


Coastal Fog

Golden Gate

Salinas Valley

Central CA: Coastal and Mountain Effects



Rules for Staying Warm in Winter
Get Down or Go to the Beach

- Latitude

Are you in the southern US? Because of the higher sun angle, it is usually warmer at low latitudes than at high latitudes

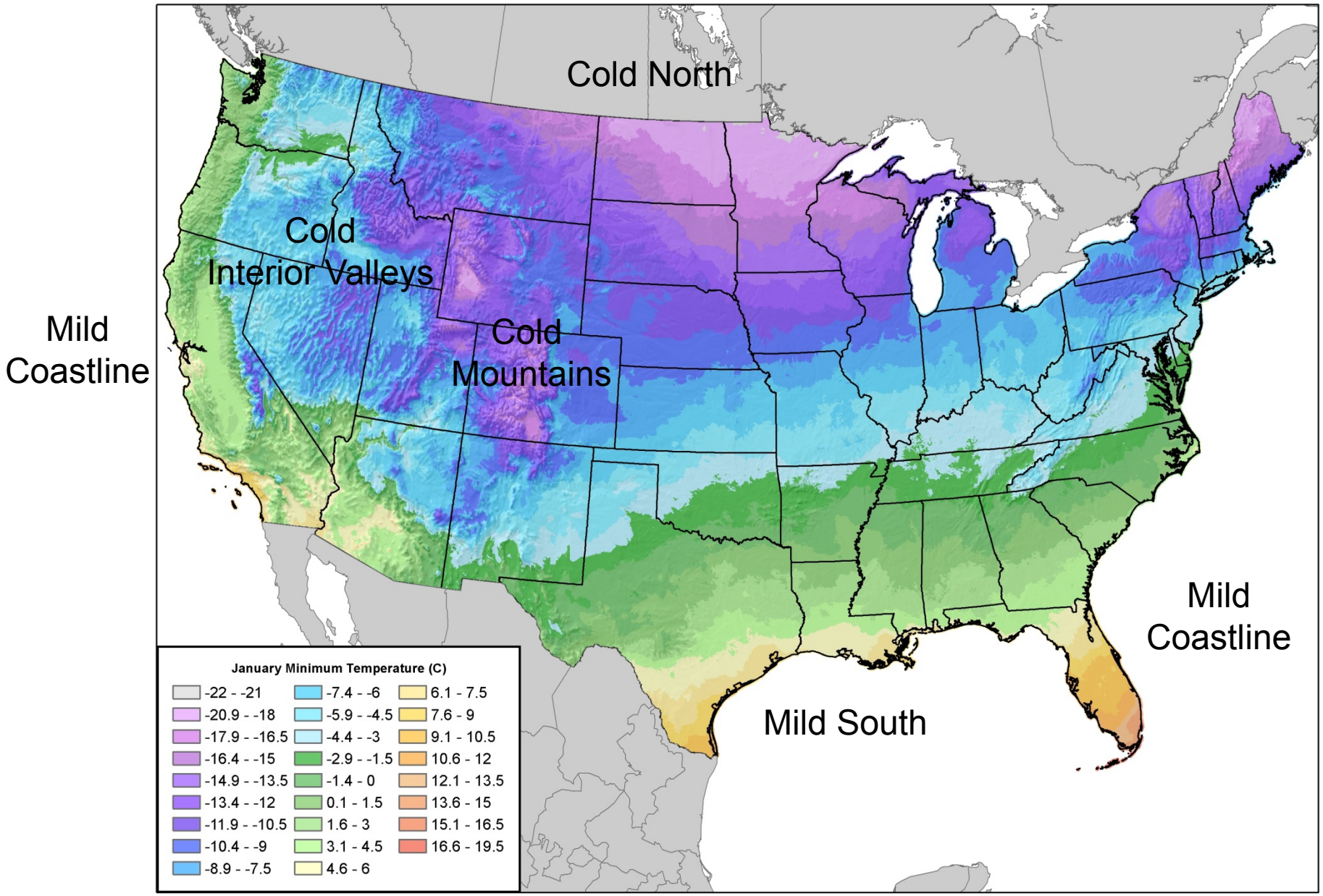
- Coastal Proximity

Because of its high heat capacity, water stays warmer in winter. Is there a clear path to a large water body and a prevailing wind direction that can carry coastal air to your location?

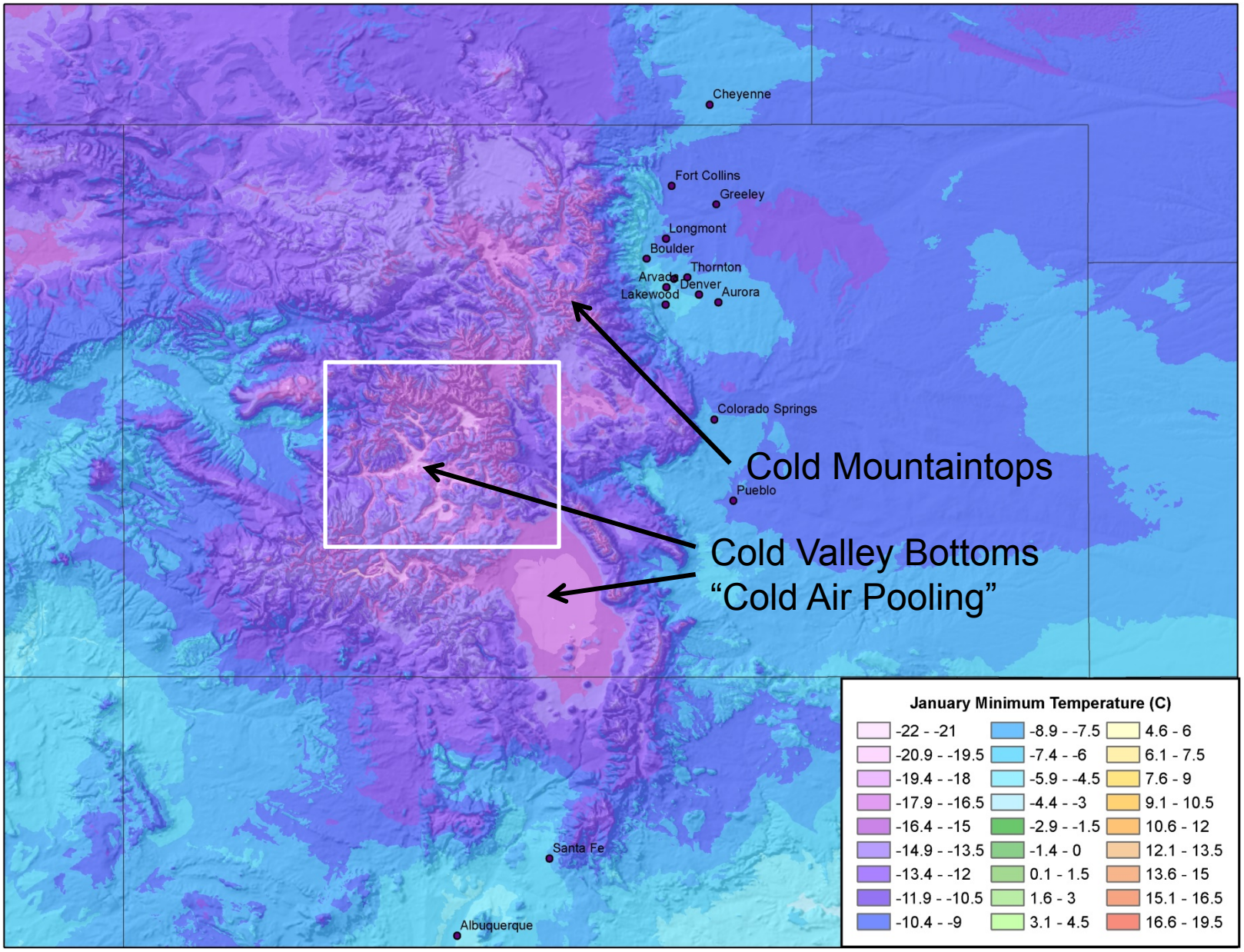
- Elevation

Are you are at low elevation? Winter temperatures at low elevations are warmer than those at high elevations, UNLESS you are in a **COLD POOL**

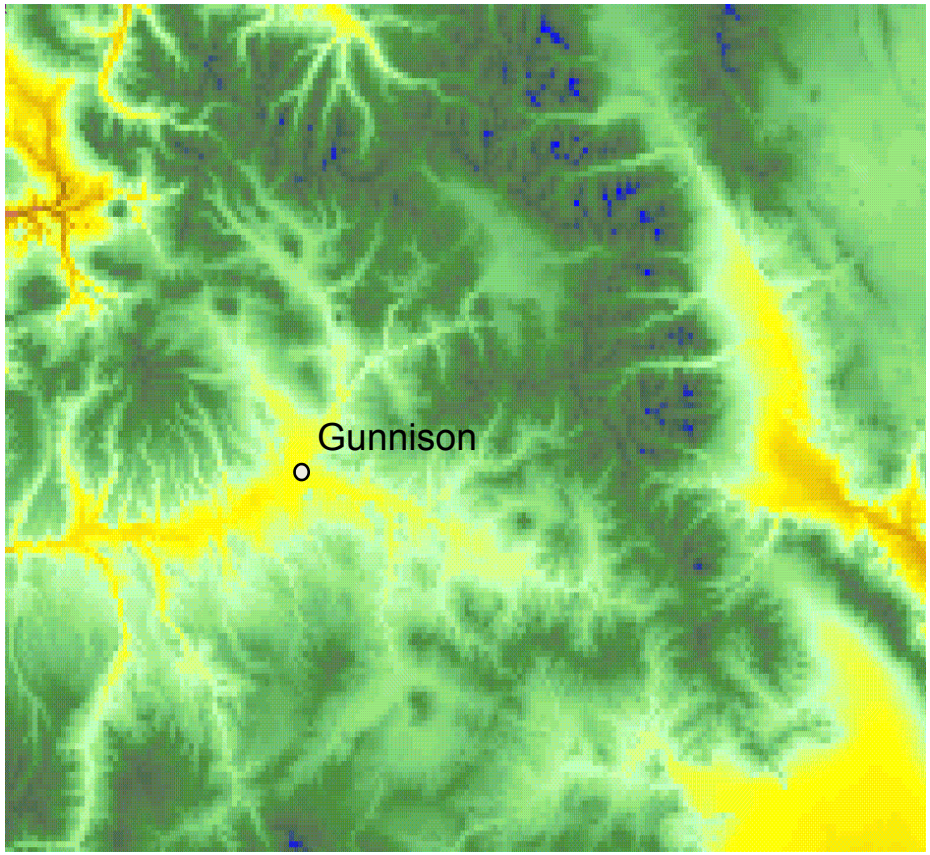
January Mean Minimum Temperature



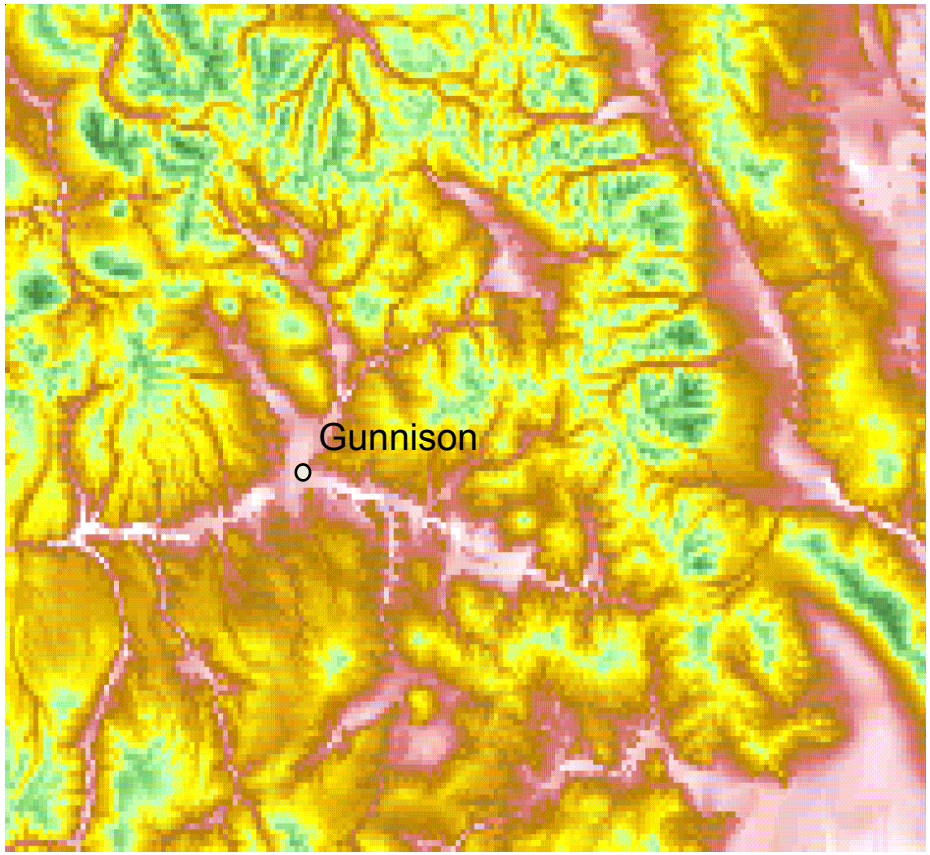
Cold Mountains, Colder Valleys



Central Colorado Terrain and Topographic Position



Terrain



Topographic Position

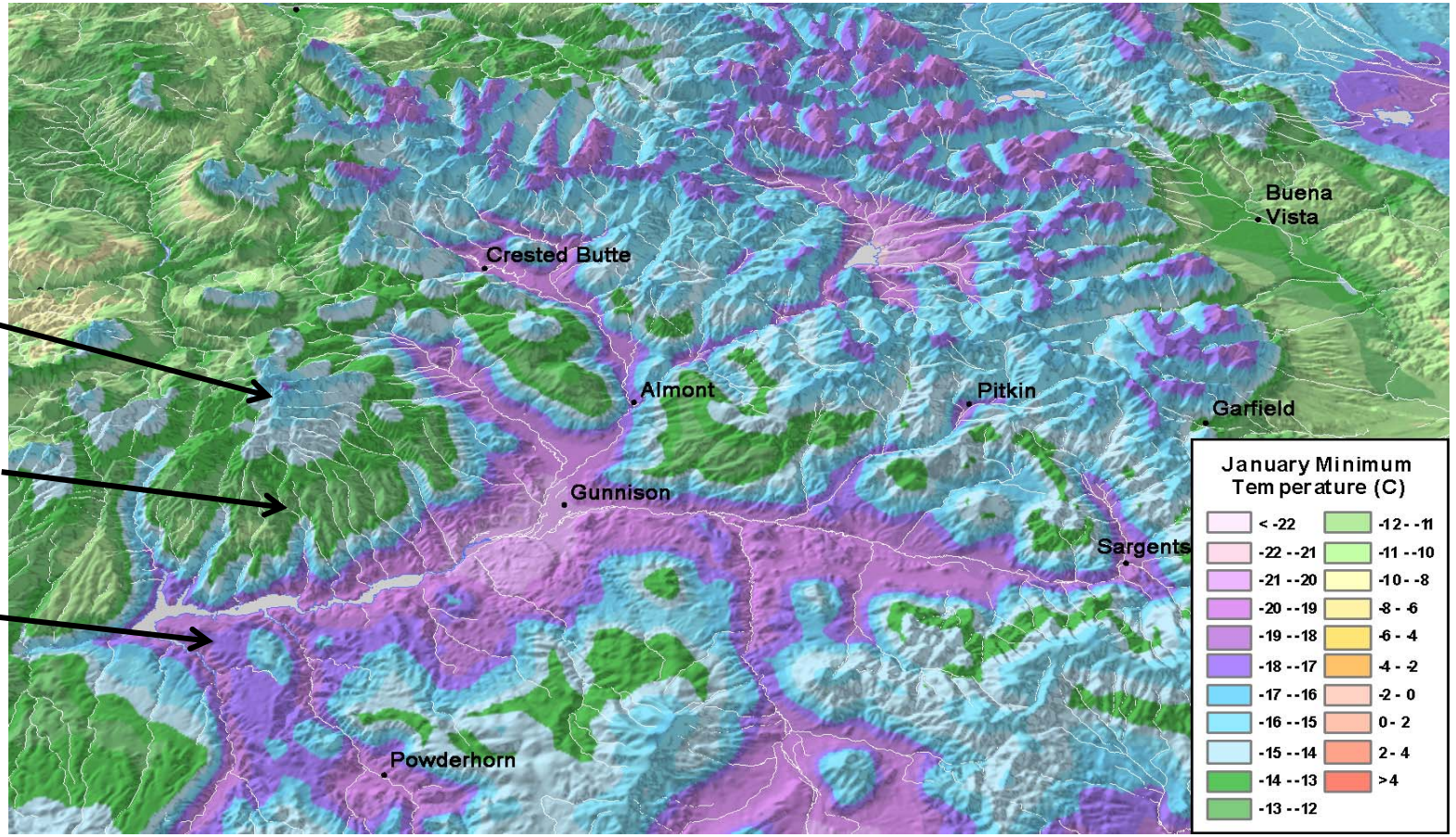
Cold Air Pools Create Temperature Inversions

1971-2000 Mean January Minimum Temperature
Central Colorado

Cold Mtn Top

Mid-Slope
"Banana Belt"

Cold Valley
Bottom

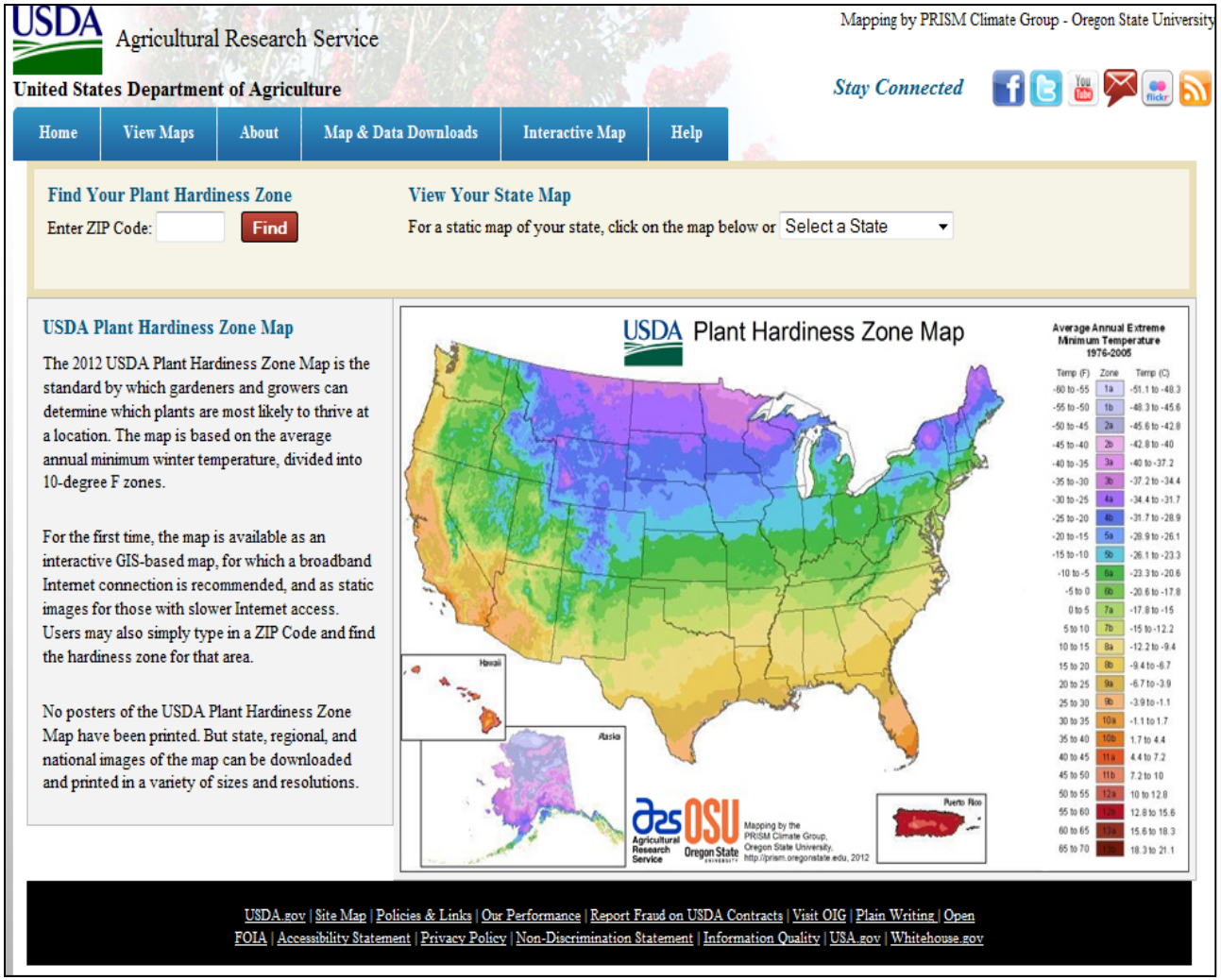


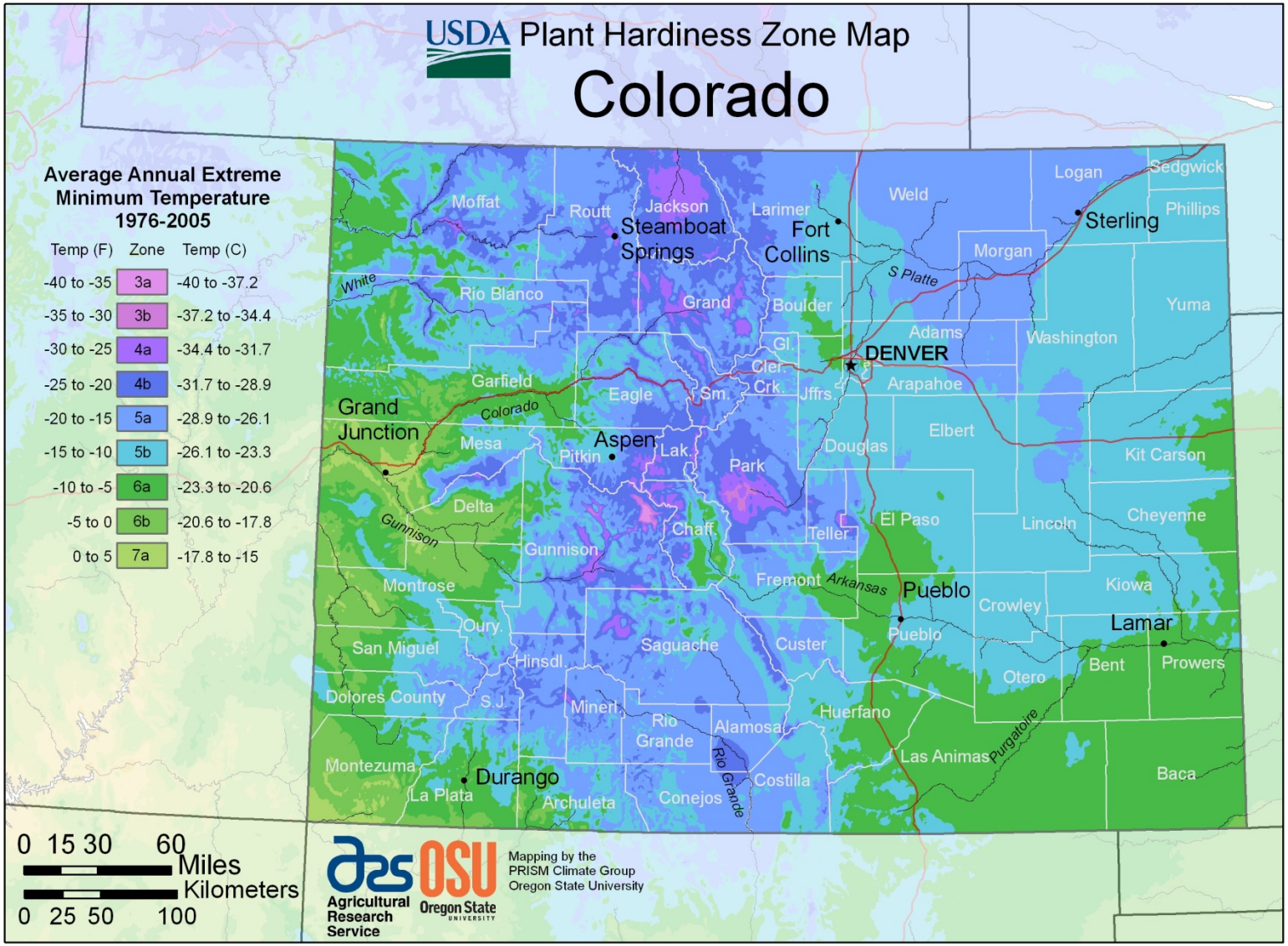
2012 USDA Plant Hardiness Zone Map

Created with PRISM

The average coldest night of the year

Used by millions of gardeners to select perennials that will survive the winter




USDA Plant Hardiness Zone Map
Colorado
Average Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-40 to -35 3a -40 to -37.2
-35 to -30 3b -37.2 to -34.4
-30 to -25 4a -34.4 to -31.7
-25 to -20 4b -31.7 to -28.9
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
Moffat
Routt
Jackson
Steamboat Springs
Larimer
Fort Collins
Weld
Logan
Sedgwick
Phillips
Sterling
Morgan
S Platte
Yuma
White
Rio Blanco
Grand
Boulder
Adams
Washington
DENVER
Gl.
Clear Crk.
Jffrs
Arapahoe
Garfield
Eagle
Sm.
Colorado
Grand Junction
Mesa
Aspen
Pitkin
Lak.
Park
Douglas
Elbert
Kit Carson
Delta
Gunnison
Chaff.
Teller
El Paso
Lincoln
Cheyenne
Montrose
Fremont
Arkansas
Pueblo
Crowley
Kiowa
Oury.
San Miguel
Saguache
Custer
Lamar
Hinsdl.
Bent
Prowers
Dolores County
S.J.
Mineral
Rio Grande
Alamosa
Huerfano
Otero
Montezuma
Durango
La Plata
Archuleta
Conejos
Costilla
Las Animas
Purgatoire
Baca
0 15 30 60
Miles
Kilometers
0 25 50 100
Agricultural Research Service
Oregon State University
Mapping by the PRISM Climate Group Oregon State University

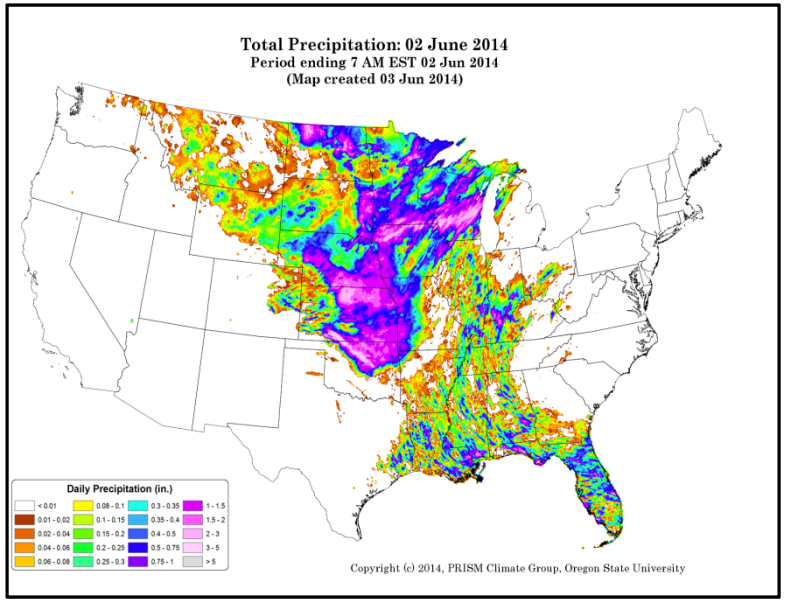
PRISM Public Data Portal

http://prism.oregonstate.edu

- More and more climate-driven modeling and analysis activities are performed within computer mapping environments that need climate grids

- Since 2014: 70 million gridded dataset downloads

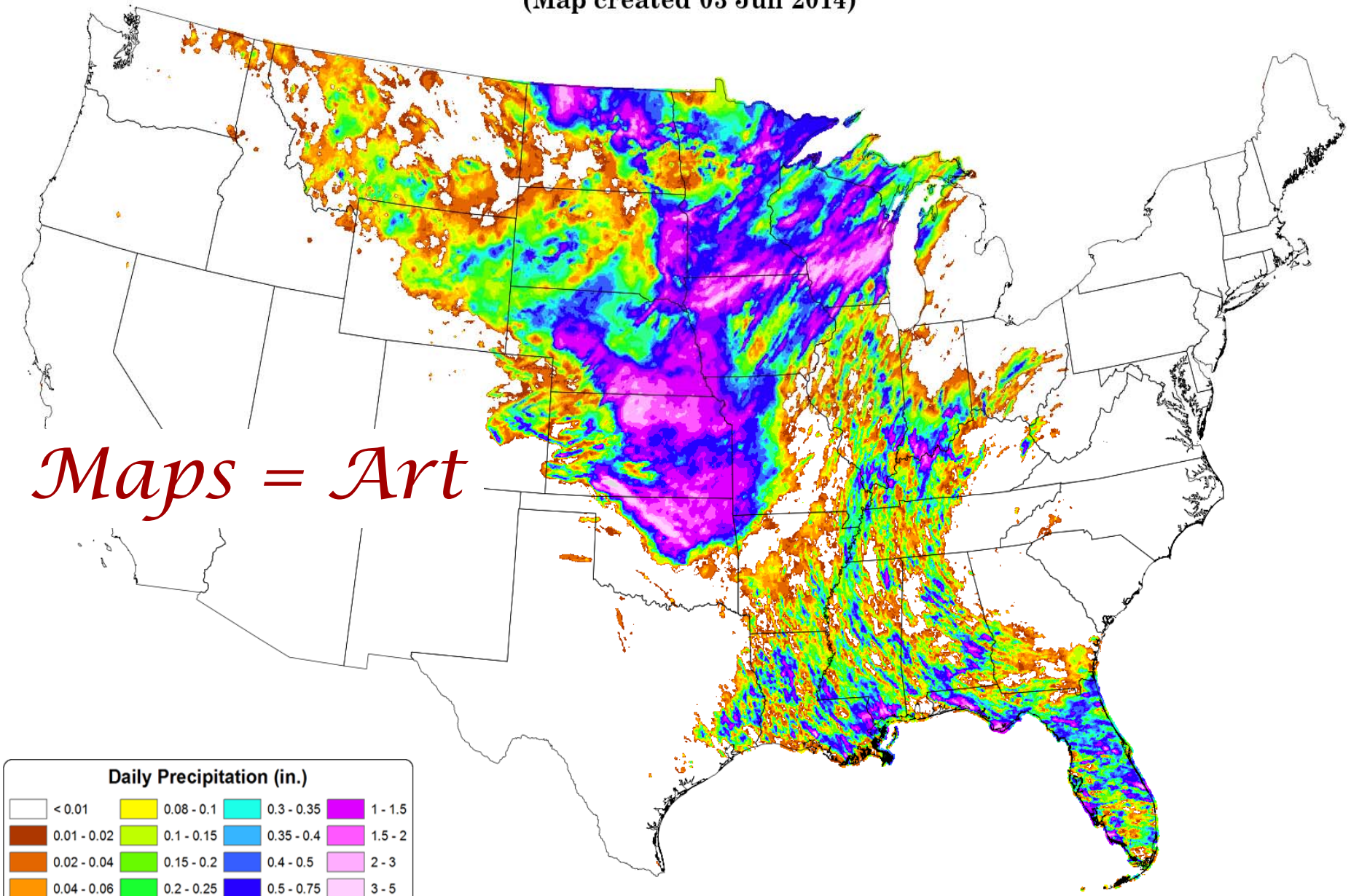
PRISM data are used in a broad range of applications in agriculture, hydrology, engineering, ecology, economics, retail, and many others.



Total Precipitation: 02 June 2014

Period ending 7 AM EST 02 Jun 2014

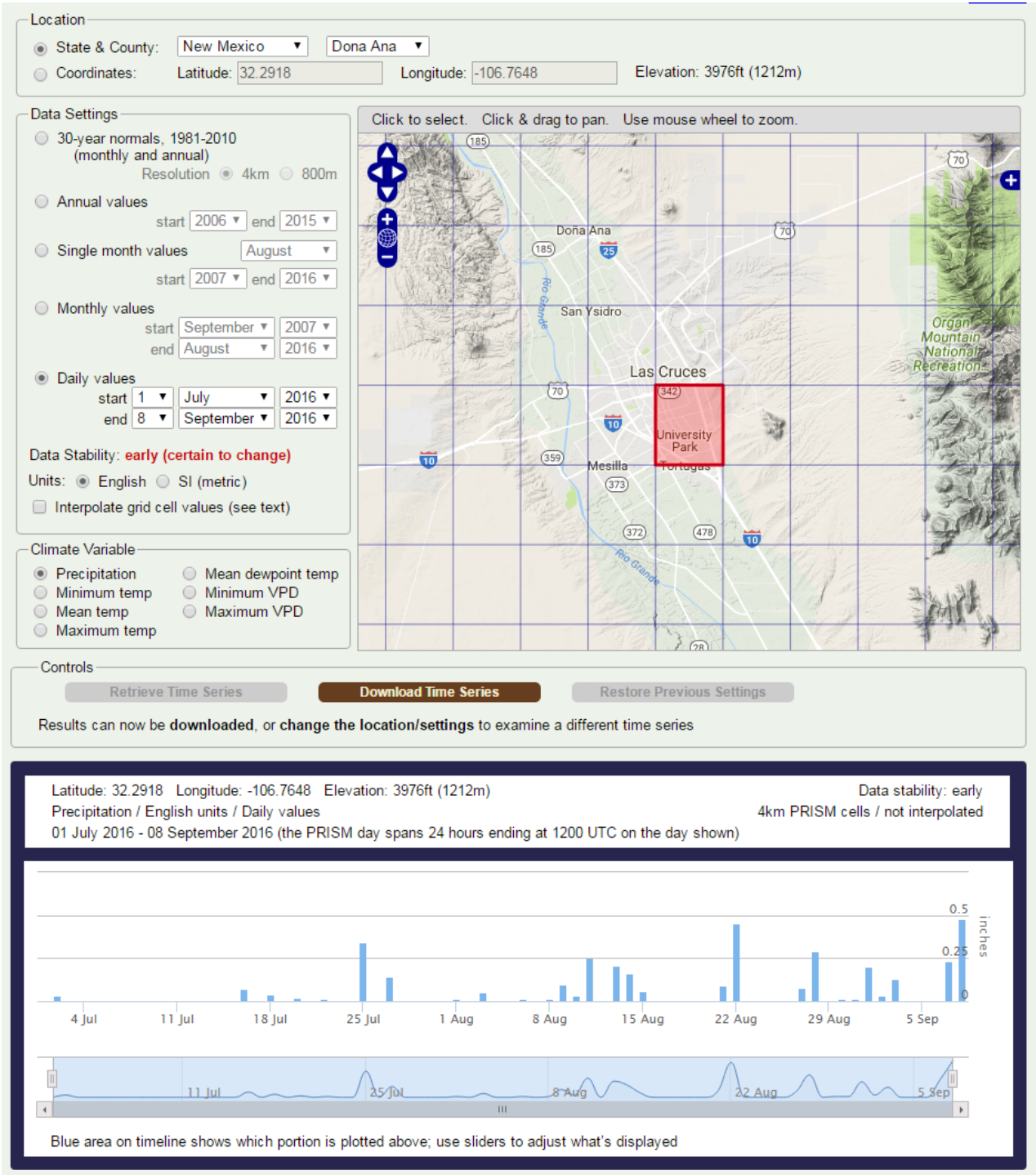
(Map created 03 Jun 2014)



PRISM Data Explorer

Example:

Daily precipitation for
Las Cruces, NM
1 July – 8 September

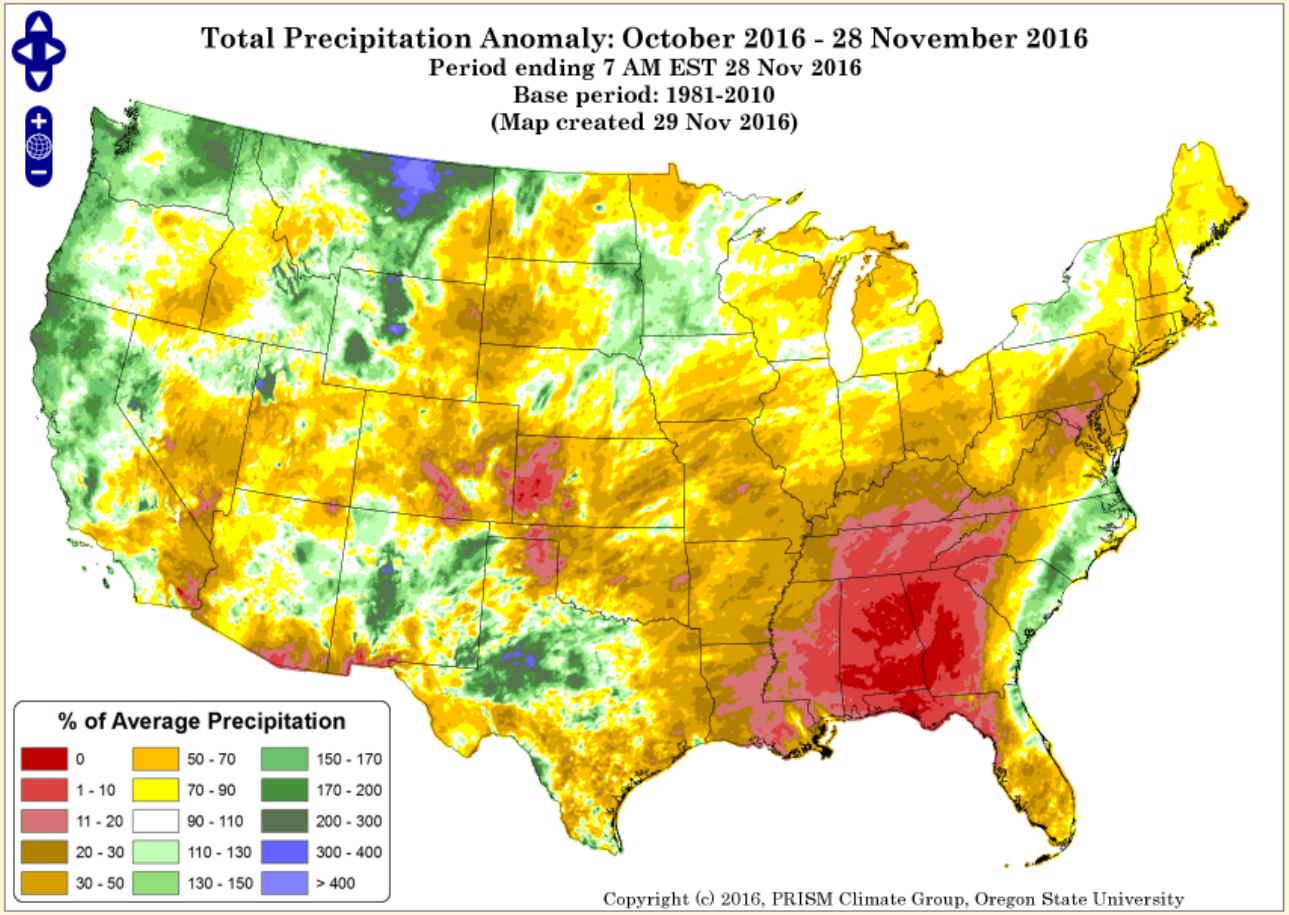


PRISM Drought Indicator

Example:

Precipitation % of normal

1 Oct – 28 Nov 2016



To change the window on the slider, use the dropdown lists or drag the scale handles.

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016

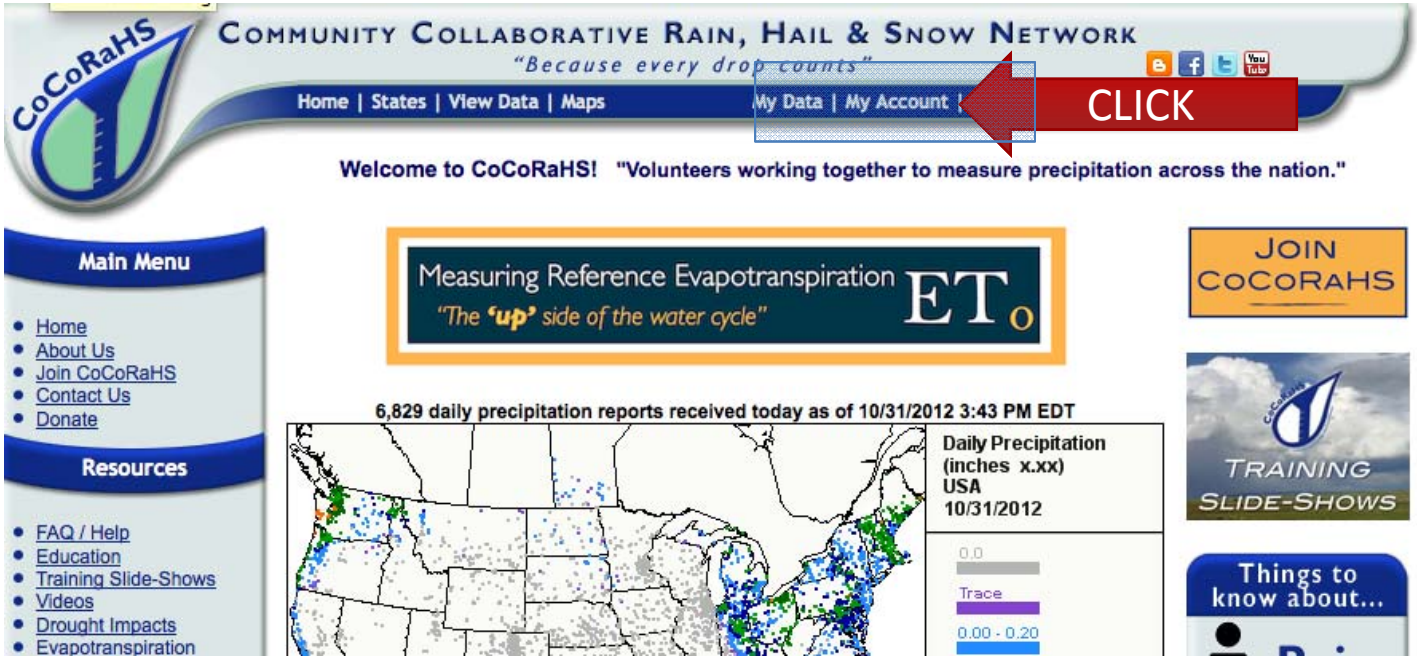
Duration (months): 1 Start month: 2016 Oct End month: 2016 Nov (partial)

Choosing the current month as end date extends the time window to include whatever days have elapsed so far this month (e.g., a duration of "2" months is actually "2 plus the fractional month").

PRISM PORTAL

ACCESSING THE PORTAL

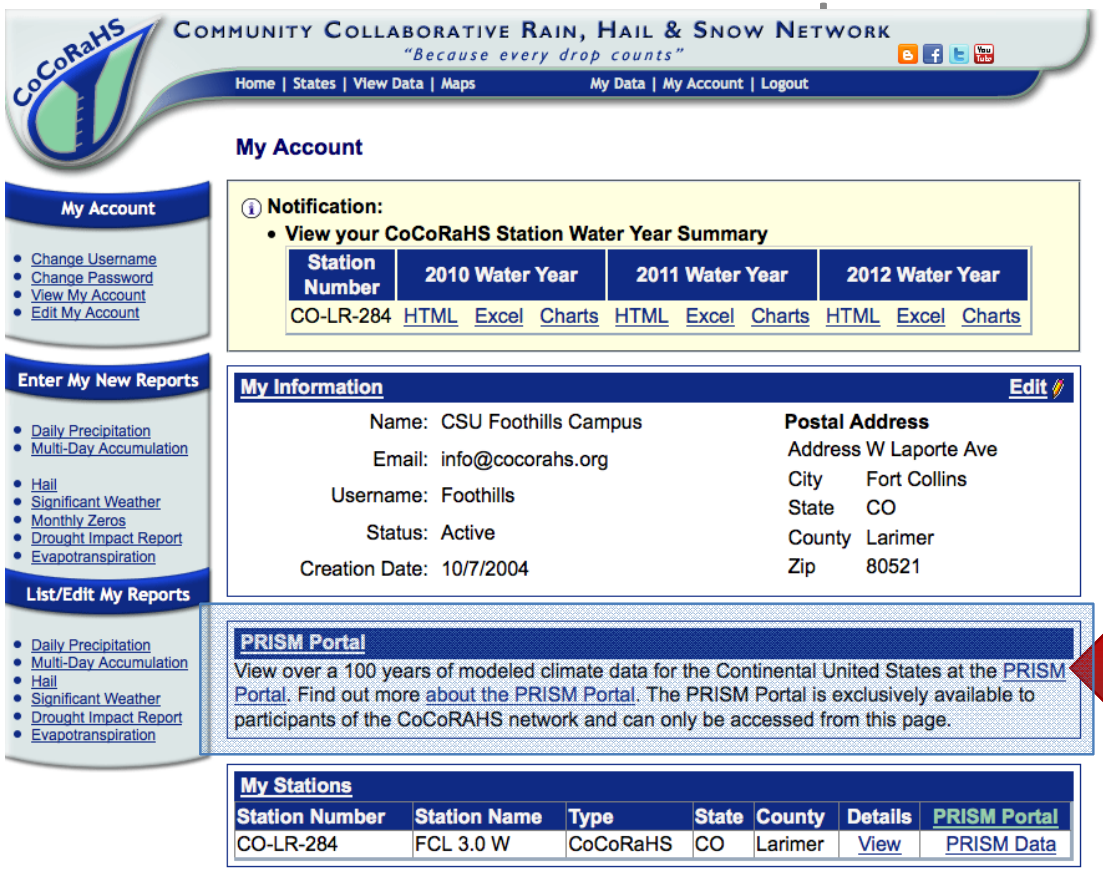
To access the portal, make sure you are logged into your CoCoRaHS account and then click on my account from the CoCoRaHS homepage



www.cocorahs.org

PRISM PORTAL

ACCESSING THE PORTAL – National PRISM

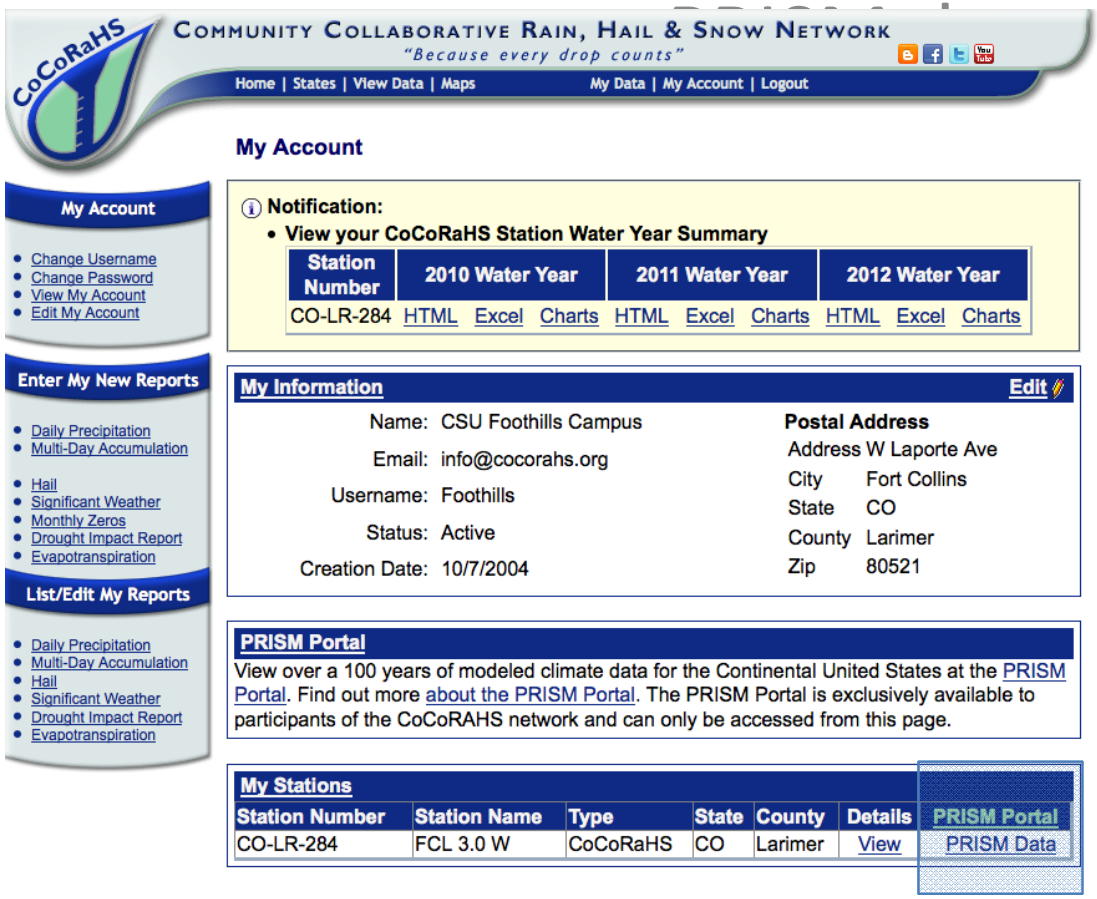


One option is to click on the "blue" words PRISM PORTAL to get access to the Continental United States

CLICK

PRISM PORTAL

ACCESSING THE PORTAL – your station's

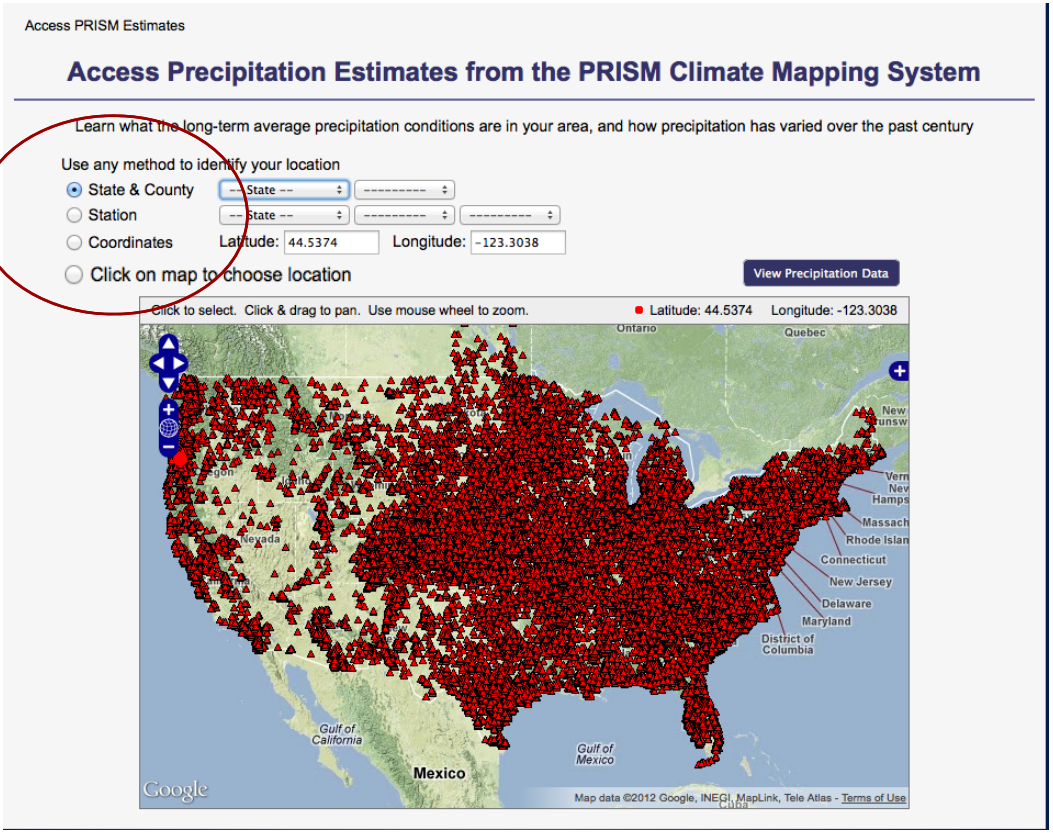


The other option is to click on the "blue" words PRISM data to get access to your specific station's PRISM data.

CLICK

PRISM PORTAL

ACCESS – Getting started



You are now in the PRISM PORTAL.

You have four button options to find your desired geographic location:

1. State and County
2. Station number
3. Coordinates
4. Clicking on the map

Historical "Normals" from PRISM - Mozilla Firefox

File Edit View History Bookmarks Tools Help

PRISM/RMA ... | cai_tmax_us... | WERA 1012-... | Oklahoma Cli... | Welcome to ... | PRISM/RMA ... | PRISM/RMA ... | Access Preci... | Historical ...

cocorahs.nacse.org/normals.php?lat=40.3389&lon=-105.5721&state=Colorado&county=Larimer&state1=CO&cou

wera 1012 estes park 2013

ScholarsArchive at Or... | Oregon Climate Servi... | FNMOC WXMAP | NRCS National Water ... | National Weather Ser... | TripCheck - Road Ca... | FAO Methodologies o...

PRISM CoCoRaHS Climate Portal

Access PRISM Estimates > Historical Normals

Historical "Normals" from the PRISM Climate Mapping System

Climatologists use **normals** as a baseline for determining the amount of precipitation expected at a given location. Normals are sets of 30-year averages, and are recomputed at the end of each decade. The current PRISM normals cover the period 1981-2010, and include some CoCoRaHS data.

Learn how the PRISM normal estimates are made

Learn how CoCoRaHS data were included in the normals

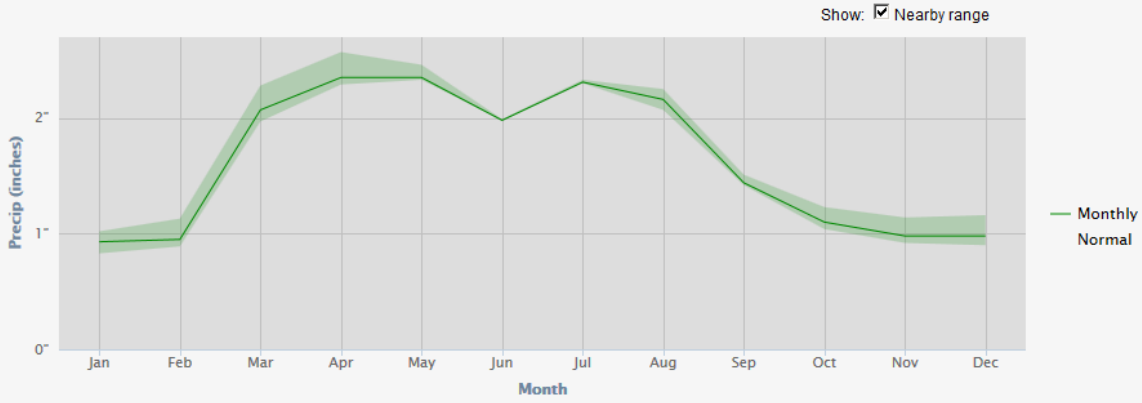
Average monthly precipitation (inches) for **40.3389/-105.5721**
(Larimer County, Colorado) and nearby locations over 30-year "normal" period

Average annual precip: 19.60"

View or download data values

Mouseover to view individual values
Click-and-drag to zoom
"Reset zoom" link restores full display

Show: Nearby range



Time Series Precipitation Data

Monthly and annual precipitation values computed by the PRISM model are also available. Select the months you would like plotted for your

Annual Time-Series Data from the PRISM Climate Mapping System

Learn how the PRISM normal estimates are made

Start Date: **1895** Data for this date is unlikely to change

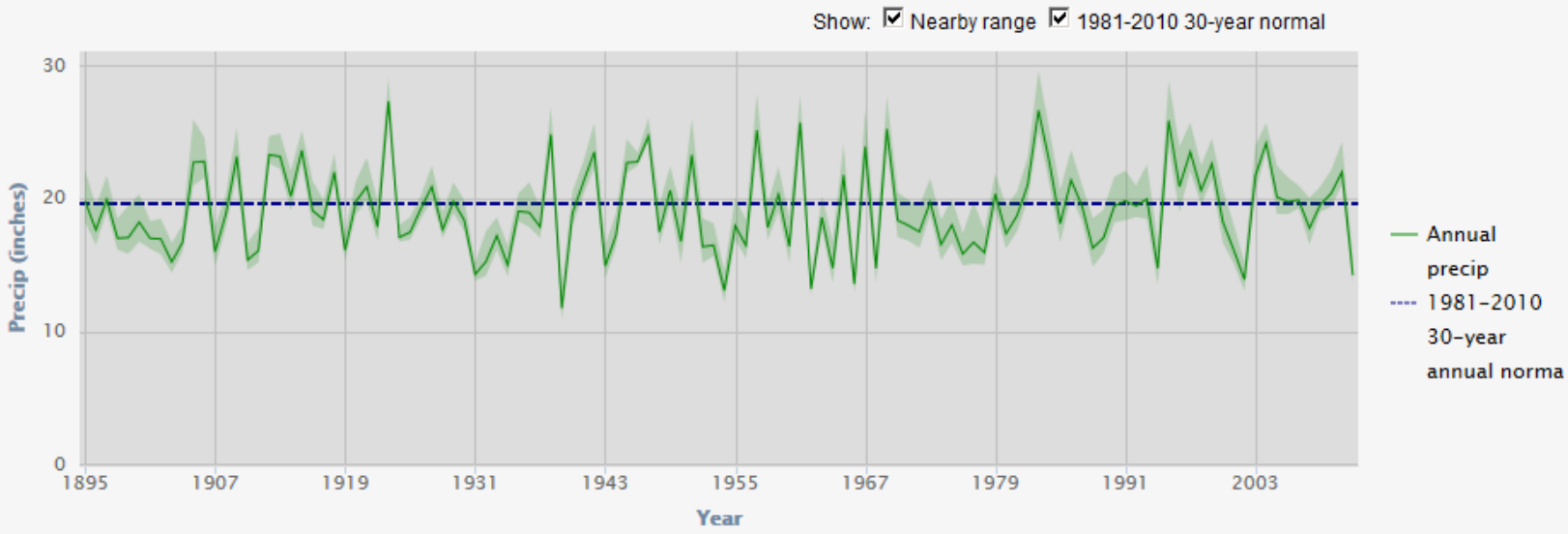
End Date: **2012** Data for this date is unlikely to change

Annual precipitation (total inches) for **40.3389/-105.5721**
(Larimer County, Colorado)

1981-2010 30-year **annual** normal: 19.6"

View or download data values

Mouseover to view individual values
Click-and-drag to zoom
"Reset zoom" link restores full display



- PRISM time series grids incorporate all CoCoRaHS data that have fewer than two missing days per month
- But you can always see PRISM data for your station!

What is this? An A-Bomb?

Close – A "Microburst"

Phoenix, AZ, 19 July 2016

So How Much Rain Fell? Must Have Been HUGE!

Uh, dunno, there were no rain gauges there

PRISM Public Data Portal

http://prism.oregonstate.edu

- More and more climate-driven modeling and analysis activities are performed within computer mapping environments that need climate grids

- Since 2014: 70 million gridded dataset downloads

PRISM data are used in a broad range of applications in agriculture, hydrology, engineering, ecology, economics, retail, and many others.