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

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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?
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**  
- I don’t know

(2) 1 – CoCoRaHS, 1 – other networks
### 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
The driest place in the lower 48 states is:

- Death Valley, California 2"
- Denver, Colorado
- New York City
- Boise, Idaho
- I don’t know
True or False: Temperatures at high elevations are always colder than those at low elevations

- True
- False
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
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!
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

1961-90 Mean April Precipitation, Qin Ling Mountains, China

Weighted linear regression
Using a Terrain Grid to Map Temperature

Grand Canyon temperature map:
PRISM incorporates the effects of elevation

Station  Grid Cell
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 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

- Gulf of Mexico (all year)
- Atlantic (all year)
- Pacific (winter)
- Gulf of CA (summer)
- Great Lakes (winter)
- Exposed to Pacific moisture
- Favorable wind direction
- Frequent storms
- Elevated terrain
  = Wet!

**PNW Mean Annual Precipitation**

- Windward Olympics 200+”
- Pacific Moisture
- <20”
Topographic Facets

Terrain Barriers/Rain Shadows

[Map of the United States with shading representing different directions and distances in kilometers.]
Rain Shadow - Santiam Pass, Oregon

Precip = 83"
California Mean Annual Precipitation

More storms

Pacific Moisture

Fewer storms

- In rain shadow
- Infrequent storms
- Below sea level = Dry!

Death Valley 2”
Olympic Mountains

Death Valley
SE US: Coastal and Mountain Effects

Rain shadows

"Dry Slot"

Mountains

100"

Mountains

37"

Mountains

45"

Coastal

55"

Annual Precipitation (mm)

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,750
- 1,750 - 2,000
- 2,000 - 2,500
- 2,500 - 3,000
- 3,000 - 3,500
- 3,500 - 4,000
- 4,000 - 4,500
- 4,500 - 5,000
- > 5,000

Tapascola

Tuscaloosa

Birmingham

Nashville-Davidson

Clarksville

Evansville

Lexington-Fayette

Louisville

Cincinnati

Hamilton

Columbus

Terre Haute

Bloomington

Richmond

Alexandria

Alexandria

Annapolis

Washington

Baltimore

Kansas City

St. Louis

Chicago

Chicago

Grand Rapids

Cleveland

Columbus

Cincinnati

Lexington

Richmond

Richmond

Washington

Baltimore

Kansas City

St. Louis

Chicago

Chicago

Grand Rapids

Cleveland

Columbus
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 at high elevation? Summer temperatures at high elevations are usually cooler than those at low elevations
July Mean Maximum Temperature

- Cool North
- Cool Coastline
- Cool Mountains
- Hot Interior
- Hot Lowlands
- Hot South

Legend:

- 3.3 - 3.3
- 3.4 - 5.5
- 5.6 - 7.7
- 7.8 - 10
- 10.1 - 11.6
- 11.7 - 13
- 13.1 - 15
- 15.1 - 16.6
- 16.7 - 18.3
- 18.4 - 20
- 20.1 - 21.6
- 21.7 - 23.3
- 23.4 - 25
- 25.1 - 26.7
- 26.8 - 28.9
- 29 - 31.1
- 31.2 - 33.3
- 33.4 - 35.5
- 35.6 - 37.8
- 37.9 - 40
- 40.1 - 44.1
- 44.2 - 46.7
Coastal Fog

Golden Gate

Salinas Valley
Central CA: Coastal and Mountain Effects

- Cool Coastline
- Delta Breeze
- Hot Central Valley
- Cool High Sierra

July Maximum Temperature (°C):
- 3 - 3.3
- 3.4 - 5.5
- 5.6 - 7.7
- 7.8 - 10
- 10.1 - 11.6
- 11.7 - 13
- 13.1 - 15
- 15.1 - 16.6
- 16.7 - 18.3
- 16.4 - 20
- 20.1 - 21.6
- 21.7 - 23.3
- 23.4 - 25
- 25.1 - 26.7
- 26.8 - 28.9
- 29 - 31.1
- 31.2 - 33.3
- 33.4 - 35.5
- 35.6 - 37.8
- 37.9 - 40
- 40.1 - 44.1
- 44.2 - 46.7
- 46.8 - 48.9

- 60F
- 80F
- 65-80F
- 90F
- 99F
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 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

- **Mild Coastline**
- **Cold Interior Valleys**
- **Cold Mountains**
- **Cold North**
- **Mild South**

Legend:
- January Minimum Temperature (°C):
  - -22 - -21
  - -20.9 - -18
  - -17.9 - -16.5
  - -16.4 - -15
  - -14.9 - -13.5
  - -13.4 - -12
  - -11.9 - -10.5
  - -10.4 - -9
  - -8.9 - -7.5
  - -7.4 - -6
  - 6.1 - 7.5
  - 7.6 - 9
  - 9.1 - 10.5
  - 10.6 - 12
  - 12.1 - 13.5
  - 13.6 - 15
  - 15.1 - 16.5
  - 16.6 - 19.5
  - 4.6 - 6
Cold Mountains, Colder Valleys

Cold Mountaintops
Cold Valley Bottoms
“Cold Air Pooling”
Central Colorado Terrain and 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
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.
Maps = Art
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 access the portal, make sure you are logged into your CoCoRaHS account and then click on my account from the CoCoRaHS homepage.
One option is to click on the “blue” words PRISM PORTAL to get access to the Continental United States.
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.
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 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: 16.50"

View or download data values

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

Show: Nearby ranges

Monthly Normal

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
• 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

We ALWAYS need more rain gauges!
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http://prism.oregonstate.edu

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