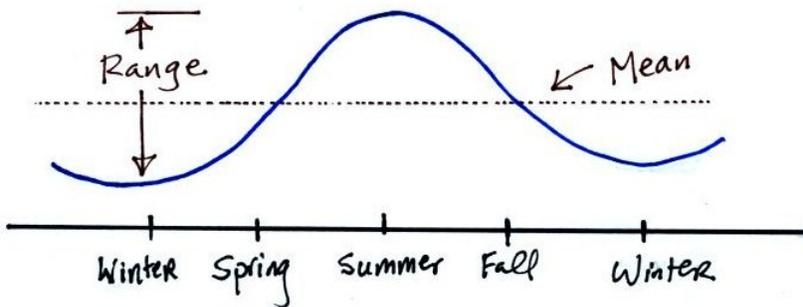


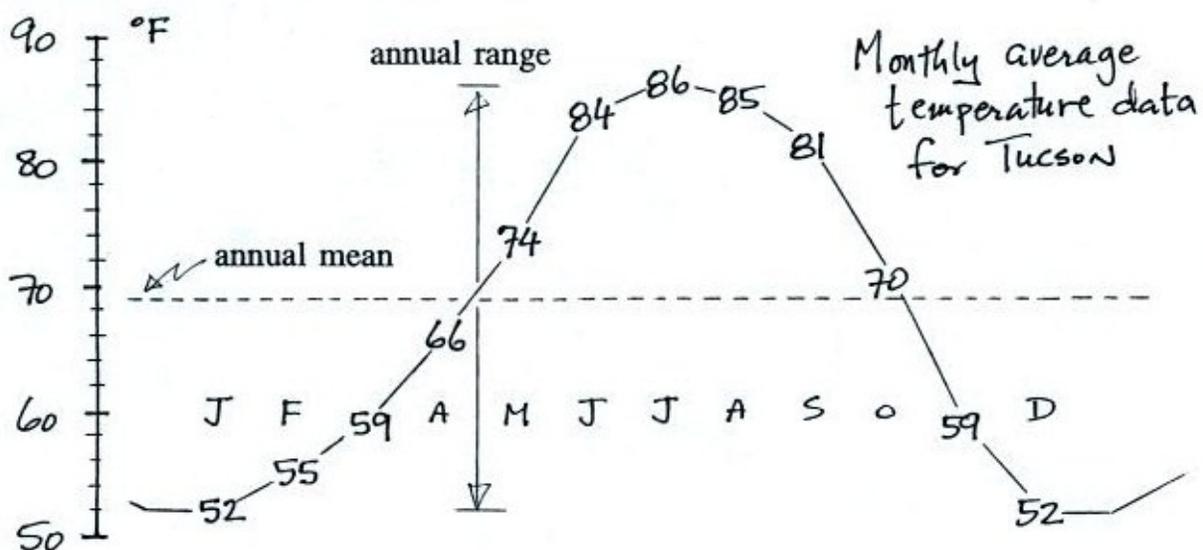
Module 6 - Lecture 18

How would you describe Tucson's climate? Hot and dry? You are basically conveying information about temperature and precipitation. Here we will focus primarily on temperature. With just two numbers, the annual mean or average temperature and the annual range of temperature, you can give someone a fairly complete idea of the temperature in Tucson (or some other location) and how it changes during the year.

Controls of Temperature



Before we look at the factors that determine the annual mean and range of temperature, here are some average temperature and precipitation data for Tucson. Monthly average temperatures are plotted here. To determine the annual mean temperature add the twelve monthly average temperatures and divide by 12 (68.5°F for the data shown here). You can get a pretty good estimate of the annual mean temperature by adding the highest and lowest average monthly temperature values and dividing by 2 (69°F).



Average Monthly Temperature and Precipitation data for Tucson

Average Monthly Temperature	Month	Average Maximum Temperature	Average Minimum Temperature	Difference	Precipitation (inches)
52	January	64	39	25	0.99
55	February	68	42	26	0.88
59	March	73	45	28	0.81
66	April	82	50	32	0.28 (see Note 1)
74	May	90	59	31	0.24
84	June	100	68	32	0.24
86	July	100	73	27	2.07 (see Note 3)
85	August	97	72	25	2.30
81	September	94	68	26	1.45
70	October	84	57	27	1.21
59	November	72	45	27	0.67
52	December	65	39	26	1.07 (see Note 5)

Notes

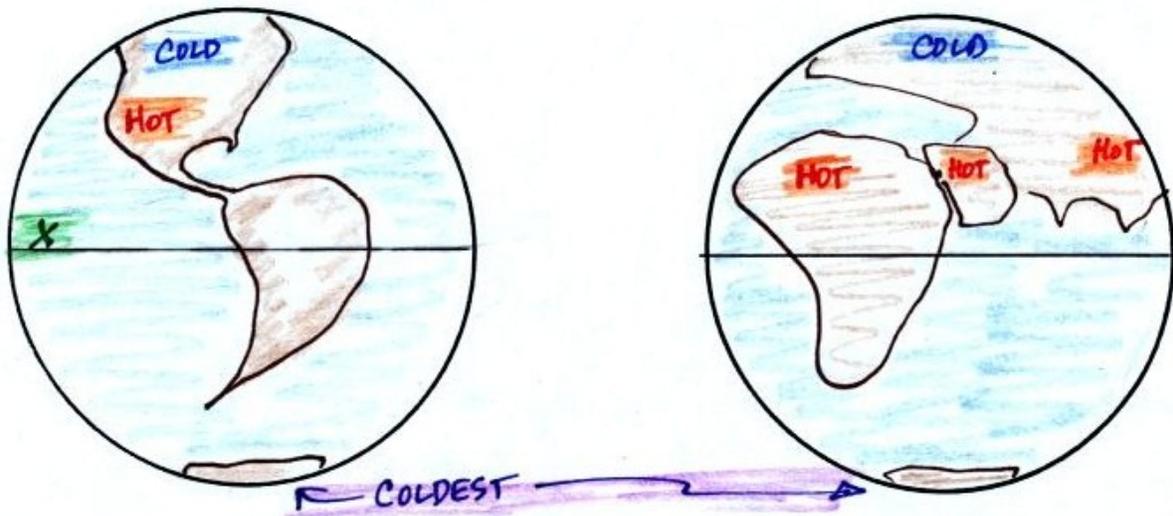
1. April, May, and June are generally the driest months in Tucson. This is reflected in the low monthly average precipitation values. It is fairly common to go a month or more without rain at this time of year.
2. Because the air is usually dry and the skies are usually cloud free, there is generally a large difference between daytime high and nighttime low temperatures.
3. The summer thunderstorm season usually begins in early July when the daily average dew point temperature remains 54⁰F or above for three days in a row. July, August, and September are usually the wettest months of the year in Tucson. Tucson gets nearly half its annual rainfall during the summer thunderstorm season.
4. Note how the difference between daytime high and nighttime low temperatures decreases once the summer thunderstorm season gets underway. This is due to the increase in humidity and cloud cover. Clouds will lower the daytime high temperature and raise the nighttime minimum temperature.

5. During the winter, middle latitude storms will occasionally drop far enough south to bring precipitation to southern Arizona. Sometimes these storms will pull up moisture from the tropics and rainfall amounts can be significant.

There are three main factors that determine a region's annual mean and annual temperature range: latitude, proximity to large bodies of water and altitude.

The annual range of temperature increases with increasing latitude and the annual average temperature decreases with increasing latitude. There is little or no seasonal temperature change at the Equator. The polar regions have colder annual average temperatures than any other location on earth. The South Pole is colder than the North Pole because it is in the middle of a large land mass (Antarctica) and is also found at a higher altitude. The North Pole is in the ocean.

The hottest regions on earth are found near the 30 degree latitude, not at the Equator. This is where the optimal combination of the solar elevation angle and length of day delivers the greatest amount of sunlight energy to the ground. Tucson, which has latitude of 32 degrees, is located in this subtropical region of clear skies and high temperatures.

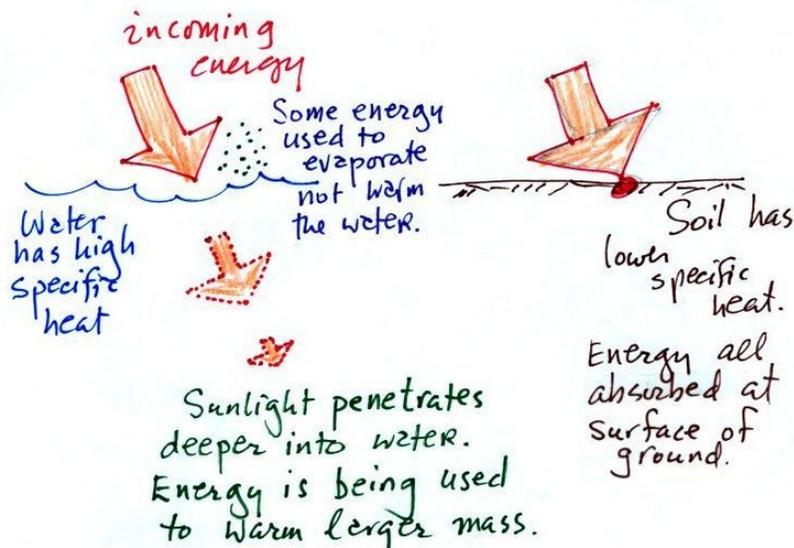


A region surrounded by land will have a much larger annual range of temperature than a region near the ocean. There is also a larger diurnal temperature range over land than over ocean. During the summer, the ocean is slower to warm than the land and during the winter, the ocean is slower to cool than land. If you have ever been to the beach in the summer you know that the sand on the beach gets much hotter during the day than the ocean water. We will see this effect in action in a later lecture on satellite photographs.

What kind of climate would you expect to find at **Point X** in the figure above? This point is near the Equator in the middle of the Pacific Ocean. The answer to the question includes a short story that features such things as carved wooden pigs, tropical island beverages, and something called betelnut. You can read about it later in this lecture.

The moderating influence of the ocean on weather is explained in the following figure. The Great Lakes have a similar moderating effect on climate.

- Water has a higher specific heat than soil, which means it can absorb more energy without an increase in temperature.
- Some of the incoming energy is used to evaporate the water rather than warm it.
- Incoming sunlight penetrates into a body of water and is used to try and warm a larger mass of water.

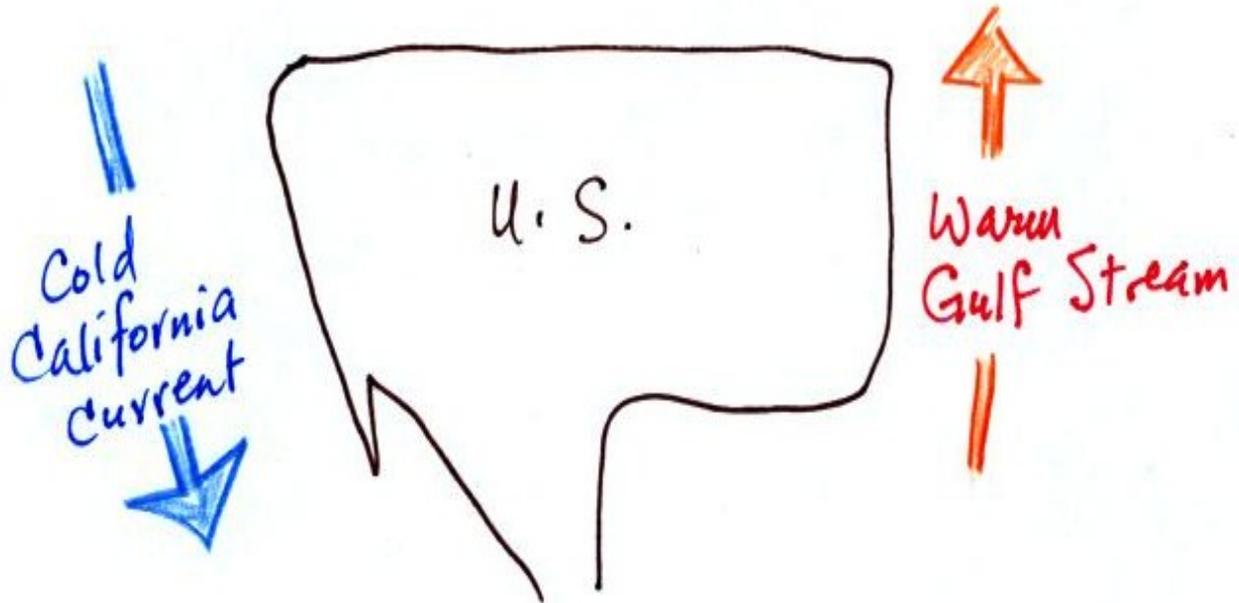


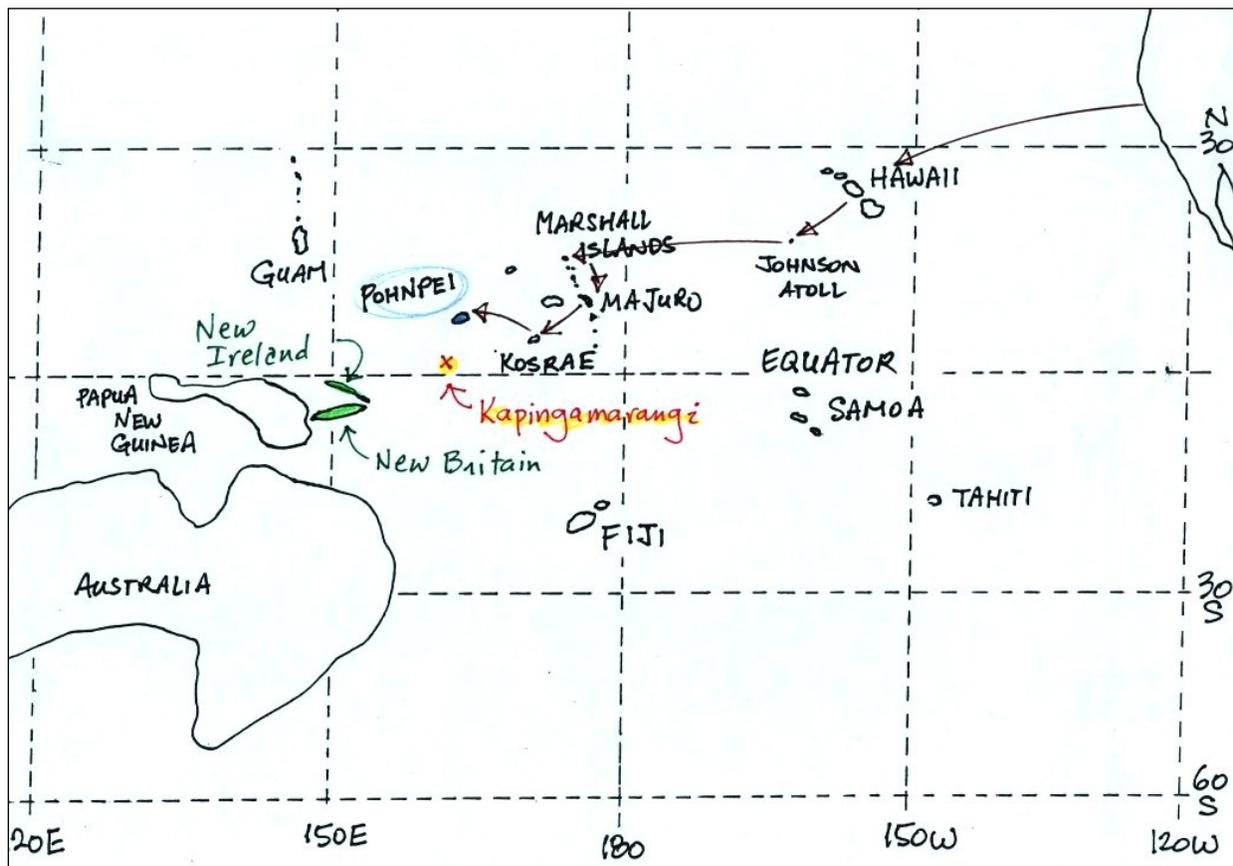
The table below summarizes the three controls of temperature that we have covered so far. Latitude affects both the annual mean and annual range, altitude affects only the mean, and proximity to the ocean affects only the annual range.

Summary

	Annual Mean	Annual Range
Latitude	✓	✓
Land/Ocean		✓
Altitude	✓	

Ocean currents are another factor that influences the annual mean temperature. Cities on the west coast and east coast of the US have different climates even if they are at the same latitude and altitude. A cold, southward flowing ocean current is flows along the West Coast while the warm Gulf Stream current flows northward along the East Coast. Winds at middle latitudes generally blow from west to east. The city on the West Coast will feel the full moderating effect of the ocean. The city on the East Coast will be affected by the Gulf Stream current and also by winds blowing across the interior of the US.





Pohnpei is a fairly large island and, together with some of the other Micronesian islands, is a popular snorkeling and scuba diving destination. Pohnpei also has a weather station that is operated by the US National Atmospheric and Oceanic Administration (NOAA). Pohnpei is located at low latitude in the middle of the Pacific Ocean. Both of those factors will reduce the annual range of temperature. The annual range is less than one degree (it is about 34⁰F in Tucson)!

Here is some information about the island of Pohnpei.

Pohnpei Federated States of Micronesia

Population - about 25,000

13 mile diameter island, 7° N lat.
2600 ft. mountain in interior
no sandy beaches (mangrove swamps)
coral reef offshore

last hit by a hurricane in 1905

The average monthly temperatures in Pohnpei range from a high of 80.8⁰F in February and March to a low of 80.0⁰F in July. The all-time record high temperature is 96⁰F; it has never dropped below 66⁰F on Pohnpei. The controls of temperature that we have learned about can have quite an effect.

Average Monthly Temperatures
(Fahrenheit degrees)

Month	Mean	Maximum	Minimum
January	80.7	86.0	75.3
February	80.8	86.0	75.6
March	80.8	86.4	75.2
April	80.7	86.8	74.8
May	80.7	86.8	74.5
June	80.4	87.0	73.8
July	80.0	87.1	72.9
August	80.1	87.6	72.6
September	80.1	87.6	72.6
October	80.1	87.6	72.6
November	80.4	87.4	73.4
December	80.7	86.6	74.8

The following precipitation data for Kolonia, the largest town on the island, show that Pohnpei is also one of the rainiest locations on earth. Close to 400 inches of rain may fall in the interior of Pohnpei. The rainiest location on earth is in Hawaii with about 460 inches of rain per year.

Average Precipitation
Kolonia, Pohnpei
(Thirty-five Year Period)

January	11.41"	July	17.73"
February	11.21"	August	16.72"
March	14.30"	September	16.39"
April	18.74"	October	15.94"
May	20.42"	November	16.62"
June	17.24"	December	15.70"

Total: 194.42 Annually