Introduction

For 30 odd years I taught Geography

\*Not memorizing names and places

\*Study of the location and distribution of resources-tangible things like waterways, mountain, trees, cities, dams, arable soil

\*As well as intangible things like language, migration, and disease.

Location, Place, Human Environment Interaction, Movement, Regions

Fit my personality – so much to teach and so many things to cover that you couldn’t possibly do it all so you teach generalities and give examples. The examples are so numerous you can change them all the time and I liked that. I never got bored teaching it. And there are so many ways to teach the different concepts – again never got bored.

So why is it important that we “talk” about climate?

***It* is a significant factor in the development of all major aspects of the life.**

* Slide - It is the climate that attracts people to a location and the weather that makes them leave.
* Slide - Rich, my husband, won’t live north
* Slide - I was born and raised in Colorado. Came to Austin to attend college. Visited in March – beautiful – came in Aug. SO HOT!
* Certain ecosystems attract people (a system of interconnecting and interacting parts) – we watch “Living off the Grid”
* Initially (back in the day) it was climate and natural resources determined where people settled (i.e. along rivers, arable land, where there were trade routes)
* What was available for people to begin to be able to stay in one place?
* This came to determine how the world developed.

Much of that was the result of climate … but what creates climate?

WHAT CREATES CLIMATE?

We’ll start with two important questions

* What are the systems involved?
* What is the human effect on Climate?

Slide - Climate – is the average of the day-to-day weather conditions over a long period of time. Studies should be based on “at the least” 10 year increments. Be careful about studies that are not. Weather – the day to day conditions that involve moisture and temperature.

* Two major Elements of climate :
  + Temperature and Moisture
* Controls-
  + Latitude, Land/Water distribution, Geographic Position, Pressure, Wind, Mountains

Slide **Latitude** – How close you are to the equator.

**Land/ Water distribution**

Minnesota is a good example: How much water is in the area compared to how much land

**Geographic Position** –

Mountains, close to large bodies of water, inland

SLIDE **Pressure** often determines [wind](http://geography.about.com/od/climate/a/windpressure.htm) and [weather](http://weather.about.com) patterns across the globe.

* By definition, atmospheric or air pressure is the force per unit of area exerted on the Earth’s surface by the weight of the air above the surface.
* The force exerted by an air mass is created by the [molecules](http://chemistry.about.com/od/atomicmolecularstructure/a/moleculesmoles.htm) that make it up and their size, motion, and number present in the air. An air mass from the north is dense and high an air mass from the south is airy and low.
* A low pressure system, or "low," is an area where the atmospheric pressure is lower than that of the area surrounding it.
* Lows are usually associated with high winds, warm air, and atmospheric lifting. Because of this, lows normally produce clouds, precipitation, and other bad weather such as tropical storms and cyclones.
* In addition, areas prone to low pressure do not have extreme diurnal (day vs. night) nor extreme seasonal temperatures because the clouds present over such areas reflect incoming [solar radiation](http://geography.about.com/od/physicalgeography/a/solarradiation.htm) back into the atmosphere so they cannot warm as much during the day (or in the summer) and at night they act as a blanket, trapping heat below.
* And just the opposite, a high pressure system, or "high," is an area where the atmospheric pressure is greater than that of the surrounding area. In some places highs are referred to as anticyclones. These move clockwise in the northern hemisphere and counterclockwise in the southern due to the [Coriolis Effect](http://geography.about.com/od/physicalgeography/a/coriolis.htm) due to the rotation of the earth.
* Unlike areas of low pressure, the absence of clouds means that areas prone to high pressure experience extremes in diurnal and seasonal temperatures since there are no clouds to block incoming solar radiation or trap outgoing longwave radiation at night. Thus such areas have higher high temperatures and lower lows.
* Winds blow away from a high pressure zone. If you think of the wind like a squeezed balloon, the more pressure you put on the balloon, the more air will be pushed away from the source of the pressure.

SLIDE **The prevailing wind systems** of the earth blow from the several belts of high pressure toward adjacent low-pressure belts.

* Because of the earth's rotation or Coriolis Effect, the winds do not blow directly northward or southward to the area of lower pressure, but are deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
* These wind systems are
* the [trade winds](http://www.infoplease.com/ce6/weather/A0849225.html); BLOW TOWARD THE EQUATOR
* the prevailing westerlies, moving outward from the poleward sides of the horse-latitude belts toward the 60° latitude belts of low pressure (from the southwest in the Northern Hemisphere and from the northwest in the Southern Hemisphere);
* and the polar easterlies, blowing outward from the polar caps of high pressure and toward the 60° latitude belts of low pressure.
* The winds can change seasonally because of the tilt of the earth on its axis and the consequent migration of the belts of temperature and pressure.
* In addition, the pattern is considerably modified by the distribution of land and water, especially in the temperate regions, where temperature differences between land and water are greatest. In winter, areas of high pressure tend to build up over cold continental land masses, while low-pressure development takes place over the adjacent, relatively warm oceans.

Slide **Ocean Currents** :

Notice difference between east coast and west coast.

Mediterranean climate – mix of prevailing winds, changing seasons, ocean currents.

SLIDE Lets look at the Koppen-Geiger Climate Classification-

Slide Five major types of climate – (mostly has to do with location) A- Tropical Humid B – Dry, C – Mild Midlatitude (Continental), D – Severe Midlatitude, E – Polar

Then Precipitation and lastly Temperature

SLIDE This is one that is more familiar to us. Not as technical but fits our understanding of the U.S. as we perceive it.

SLIDE Let’s look at Texas more specifically –

CLIMATE DIVISIONS

The National Climatic Data Center divides Texas into 10 climate divisions. SLIDE - Climate divisions represent regions with similar characteristics so it includes: vegetation, temperature, humidity, rainfall, and seasonal weather changes.

Division 1 (High Plains): Continental steppe (grassland with no trees or trees only along creeks) or semi-arid savanna (savanna – grassland with scattered trees)

Division 2 (Low Rolling Plains): semi-arid savanna

Division 3 (Cross Timbers): Sub-tropical sub-humid mixed savanna and woodlands

Division 4 (Piney Woods): Sub-tropical humid mixed evergreen-deciduous forestland

Division 5 (Trans-Pecos): Except for the slightly wetter high desert mountainous areas, sub-tropical arid desert

Division 6 (Edwards Plateau): Sub-tropical steppe or semi-arid brushland and savanna

Division 7 (Post Oak Savanna): Sub-tropical sub-humid mixed prairie, savanna, and woodlands

Division 8 (Gulf Coastal Plains): Sub-tropical humid marine prairies (wetlands) and marshes

Division 9 (South Texas Plains): Sub-tropical steppe or semi-arid brushland

Division 10 (Lower Rio Grande Valley): Sub-tropical sub-humid marine

SLIDE This next map I think will make a lot of sense to us also:

◦ The eastern third of Texas has a Subtropical Humid climate that is most noted for warm/humid summers.

◦ The central third of Texas has a Subtropical Subhumid climate characterized by hot summers and dry winters.

◦ The broad swath of Texas from the mid-Rio Grande Valley to the Pecos Valley has a Subtropical Steppe climate and is typified by semi-arid to arid conditions.

◦ The basin and plateau region of the Trans-Pecos features a Subtropical Arid climate that is marked by summertime precipitation anomalies of the mountain relief.

◦ A Mountain type climate is common in the higher elevations of the Guadalupe, Davis and Chisos Mountains

**So from this we can see how the climate/weather is a combination of water and heat and location etc. Lets look at some other controls on climate**

For the most part, life is dependent upon the existence of sunlight. Life on Earth exists in a fairly delicate balance concerning the amount of sunlight that its gets.

Slide Tilt of the Earth’s axis Currently it is 23.5° in relation to the elliptical plane. The greater the axis is tilted, the greater the temperature difference between winter and summer. The range of tilt can be 22° to 24.5°

* If the earth was not tilted we would not have wind and we would have the same weather day in and day out.
* The Sun- Tilt – Rotation – Revolution creates weather.

**Throughout recorded geologic time the balance of heat and moisture has stayed in balance over periods of thousands of years**

* whether it’s long term or short term, there is a strong correlation between global temperatures and the level of greenhouse gasses most specifically carbon dioxide. The greenhouse effect – where radiation from the sun is absorbed and held in the atmosphere by greenhouse gasses makes our planet livable and a runaway greenhouse effect changes climate patterns.
* To better understand this lets look more closely at the one of those systems that control climate – the greenhouse gasses that create the greenhouse effect.
* Lets start with the atmosphere:
* SLIDE Here is a picture of the atmosphere

Altitude is on the lt. side and temperature is along the bottom, the red line is the temperature change.

People generally assume that temperature decreases with altitude. BUT as you can see here the vertical pattern of the temperature consists of layers where temperature decreases and increases.

* Average temp. at sea level is about 59°. When it reaches the tropopause the temp is -71°F – then it begins to increase again.
* **Troposphere** (tropo is Greek for turn or churn) – the depth varies in time and place
* Deepest over tropical regions (11 miles) and shallowest over the poles (5 Miles) (11 miles is like the Rockdale McDonalds to Milano)
* This changes from summer to winter due to the amount of sunlight
* **Stratosphere** – (stratos - Greek for cover)
* 11 miles to about 30 miles deep (Milano to VA hospital in Temple)
* Air is stagnant and does not churn but it is warm
* **Mesoshpere** – (meso – Greek for middle) is in the middle of the five stages and the air here cools
* As you get higher up in the mesosphere, the temperature gets colder. The top of the mesosphere is the coldest part of the Earth’s atmosphere. The temperature there is around - 90° C (-130F)!
* The mesosphere is hard to study. Weather ballons and jet planes cannot fly high enough to reach the mesosphere. The orbits of satellites are above the mesosphere. We don’t have many ways toget scientific instruments to the mesosphere to take measurements there. BUT this is where meteors burn up.
* **Thermosphere** – (thermos – Greek for Heat) air warms
* It’s intuitive that the Thermosphere should be warm because energy coming from the sun strikes the thermosphere first. What’s interesting though is – Despite the high temperature of up to 1800°C an average thermometer would actually register well below 0°C. Temperature is the average amount of energy of motion of each molecule of a substance. The gas molecules in the thermosphere move very rapidly so the temperature is very high however, the molecules are spaced far apart in the thin air and there is not enough of them to collide with a thermometer and warm it.
* **Exosphere** – (exo-Greek for outer)
* Outer space and its cold

The troposphere is where we live and it is made up of a bunch of atmospheric gasses. The mixture contains a group of gases of nearly constant concentrations and a group with concentrations that are variable in both space and time.

Atmosphere is made up of 78% nitrogen and 21% oxygen the other 1% is made up of : slide

Gasses of constant concentration which are

nitrogen (N2)

oxygen (O2)

argon (Ar) krypton (Kr)

neon (Ne) hydrogen (H2)

nitrous oxide (N2O)

xenon (Xe)

helium (He)

**It is the gases of variable concentrations**, that I’m going to talk about tonight. These are only parts per million in the atmosphere but they can reek havoc. **The ones of principal importance are:** [water vapor](http://www.britannica.com/EBchecked/topic/637333/water-vapor), ozone, carbon dioxide, [sulfur dioxide](http://www.britannica.com/EBchecked/topic/572748/sulfur-dioxide), methane and [nitrogen dioxide](http://www.britannica.com/EBchecked/topic/416281/nitrogen-dioxide)

Slide Water vapor (H20)– the distribution is variable, the amount is consistent

* It is the most abundant of the greenhouse gasses even though the amount of water in the atmosphere varies between 1% and 4%.
* Why is such a small amount such a big deal?
* absorbs heat energy given off by the Earth AND
* absorbs solar energy
* it drives storms
* When water changes from one state to another it absorbs or releases heat. This heat is often called latent (hidden) heat and is the source that helps drive a lot of storms. What makes it change in the atmosphere depends greatly on the surface the air mass passes over...i.e. a forest, a desert, a water body a city A GOOD EXAMPLE is if the air is warm and passes over warm water, as in a hurricane, it picks up more moisture.

SLIDE Ozone

* \*is made of three oxygen atoms (http://www.ucar.edu/learn/images/o3.gif).
* \*The oxygen we find in our atmosphere is made up of two oxygen atoms http://www.ucar.edu/learn/images/o2.gif.
* Ozone and oxygen molecules in the stratosphere absorb ultraviolet light from the sun, providing a shield that prevents this radiation from passing to the earth's surface.
* While both oxygen and ozone together absorb 95 to 99.9% of the sun's ultraviolet radiation, only ozone effectively absorbs the most energetic ultraviolet light, known as UV-C and UV-B, which causes biological damage.
* The protective role of the ozone layer in the upper atmosphere is so vital that scientists believe life on land probably would not have evolved - and could not exist today - without it.

Methane

* Methane, CH4, is a chemical compound composed of one [carbon](http://www.wisegeek.org/what-is-carbon.htm) atom and four [hydrogen](http://www.wisegeek.org/what-is-hydrogen.htm) atoms. It is valued for its energy-production capabilities, methane also has the ability to potentially wreak havoc on the Earth's fragile ecosystems. Therefore, the gas has properties that are both good and bad.
* it is odorless and colorless.
* [Wetlands](http://www.wisegeek.com/what-are-wetlands.htm) and oceans are where most of the Earth's natural methane is produced. Thus, the gas is sometimes called swamp gas. Approximately 40% of the world's methane is produced through these areas. However, most of the rest comes from human sources, such as burning fuel and raising livestock.

Carbon Dioxide -

* historically distributed uniformly
* it’s affect on weather is its ability to absorb infrared radiation
* Prior to the Industrial Revolution it was regulated by [photosynthetic](https://en.wikipedia.org/wiki/Photosynthesis) organisms and geological phenomena.
* When carbon dioxide in the atmosphere combines with water it forms carbonic acid. Carbonic acid dissolves rock (picture of gargoyle) and vegetation (Picture of forest) the resulting bicarbonate acid washes down streams and into the ocean.

**Human Effect on Change**

Humans have managed to significantly alter the planet in just 200 years.

One of the largest effects of human activities has turned out to be the atmosphere.

Carbon dioxide is a primary force of change

Carbon dioxide levels have fluctuated within a narrow range for millions of years, but starting with the burning of coal during the Industrial Revolutions about 200 years ago and now, they are at the highest level in 420,000 years and levels are rising faster than ever recorded.

CO2 is removed from the air by natural geological-scale processes and these take a long time to work. Consequently [CO2 stays in our atmosphere for years and even centuries](http://www.skepticalscience.com/co2-residence-time.htm" \t "_self). A small additional amount has a long-term effect.

Some of the excess carbon is absorbed by forests actually making forests stronger and healthier (but this is not thought to be an infinite process) (trees can only absorb so much) The rest is absorbed by the atmosphere and raises global temperatures through increases in other greenhouse gasses especially water vapor.

Andrew Dessler and colleagues from Texas A&M University in College Station confirmed that the heat-amplifying effect of water vapor is potententially enough to double the climate warming

The making of cement, which is made from limestone, emits carbon dioxide. Cement plants account for 5 percent of global emissions of carbon dioxide, a major cause of [global warming](http://topics.nytimes.com/top/news/science/topics/globalwarming/index.html?inline=nyt-classifier). Cement has no viable recycling potential; each new road and each new building uses new cement.

Methane (Ch4) is the second most prevalent greenhouse gas emitted in the US from human activities.

Enteric Fermentation is a major the source of methane production are in the US. Does anybody know what Enteric Fermentation is? SLIDE

It is a digestive process by which carbohydrates are broken down by microorganisms into simple molecules for absorption into the bloodstream of an animal. And then Methane is produced in the [large intestine](https://en.wikipedia.org/wiki/Large_intestine) and passed out as flatulence.

Comparing Methane to Carbon Dioxide

Methane’s lifetime in the atmosphere is much shorter than carbon dioxide but methane is more efficient at trapping radiation than Carbon Dioxide. Pound for pound the comparative impact of methane on climate change is more than 25 times greater than carbon dioxide over a 100 year period

Pollution from particulates and aerosols also causes an increase in cloud cover.

Sulfur oxides and nitrous oxides have significantly increased the acidity of rain.

It can sound like a litany of mess ups but

We passed legislation that stopped the production of chlorofluorocarbons, and the growth of the ozone hole has largely stopped.

The Clean Water Act went into effect between 1972 and 1977 and began cleaning up polluted lakes and streams

In 1973 the United State began to phase out lead in gasoline that was leaching into streams but we can see from the problem in Michigan that we still have a long way to go..

Nuclear testing was moved underground and now such testing is almost nonexistent around the globe. Exception???

**Some of those effects on land are:**

**Erosion rates** have increased dramatically primarily through the removal of vegetation and increase in agriculture.

35% of the land on earth is used to produce human food so...

* Each year 70 gigatons of valuable topsoil is lost, although that number is decreasing some as better agricultural practices have been developed.

**Wetland regions** have been drained or filled in, removing water from the land and local atmosphere, making regions more arid. This also causes larger seasonal temperature changes.

The amount of the US that is now **paved** is greater than the area of Ohio. This aff**ects land temperatures**, which in turn **affects storm patterns.**

* **Paving also affects water flow** patterns because it increases the amount of water that is removed from land and put into streams. It prevents water from going into the ground-it all gets washed out to the sea. This is a huge problem in urban areas. Has a big effect on ground water replacement.

The US generates about **450 million tons of garbage each year**. Major source of methane

* Recycling has improved in the US. It has actually doubled in the last 10 years but has a long way to go to improve the problem with waste disposal
* Europeans lead the way

Some of those effects on surface water are:

* A lot of water was in aquifers but now it is at the surface and this creates a new dynamic in the atmosphere. **More humidity in places** like Phoenix, Denver, Salt Lake City, Austin TX that used to be drier.
* Many streams have high levels of pathogenic bacteria due to livestock and human wastes. Not as much in the US (Pittsburgh)
* Groundwater reserves in many parts of the world have been significantly contaminated
* Contamination comes from a variety of sources: industry, dumping, petroleum spills, and agricultural chemicals in farming areas and domestic gardening.
* It may be thousands of years before the groundwater recovers from the impact we have had on it.
* Rivers around the world have been significantly altered
* Part of the year not a single drop of the Colorado River actually reaches the ocean because it all gets removed to grow food in places in California’s Imperial Valley.
* Water resources across the US have been diverted and rerouted to provide drinking water for its growing populations.
* Glaciers are melting, seal levels are rising, and regions along the eastern United States are sinking from pumping water and petroleum out of the ground. These areas will be at tremendous risk of flooding.

**What needs to be foremost in our minds and at our dinner table conversations is Climate change feedback.**

* Climate Change Feedback in general is the process in which changing one quantity changes a second quantity, and the change in the second quantity in turn changes the first and/or a third.

**So lets re-cap Texas Climate/Weather** - **This may come to no surprise to you but Texas has more diverse weather on a typical day than any other state within the union—with the possible exception of California**. There are a number of weather elements that characterizes Texas’ climate some it because of the size, but also due to its position on the North American continent.

Variable - The climate of Texas is, has been, and will continue to be variable.

Rainfall- Most of the annual rainfall in widespread parts of Texas occurs during rain storms, when a large amount of precipitation falls over a short period of time.( **I’ve heard it referred to as drought interrupted by flooding)** Exceptions to that are the subtropical humid climate of the eastern quarter of the state, and when evaporation exceeds precipitation—creating a semi-arid or steppe climate in far west Texas.

* From east to west the Average annual precipitation decreases from over 55 inches in Beaumont to less than 10 inches in El Paso, again mostly influenced by the Gulf of Mexico.
* However, precipitation in the Trans-Pecos and the Panhandle regions of Texas originates mostly from the eastern Pacific Ocean and from convection.

Temperatures - From North to South the Average annual temperature gradually increases from about 52°F in the Panhandle of Texas to about 68°F in the Lower Rio Grande Valley. From west to east doesn’t change much average in the west 64.7 to 66.25 in the east. In Far West Texas, the average annual temperature sharply increases from about 56°F in the Davis and Guadalupe mountains to about 64°F in the Presidio and Big Bend areas. These temperatures a good bit of the year are affected by cool Canadian air, and the warm air masses from the Gulf. **How long an air mass stays over its place of origin determines how powerful it is and the effect it will have as it travels. Like a hurricane.** The Gulf coast is 370 miles long and large target area for hurricanes.

• **Where TX is in relation to the Rocky Mountains** is significant because the mountains guide polar fronts of cold arctic air southward into the state during the fall, winter, and spring.

• In the rest of Texas, **the jet stream during the spring and fall seasons** pushes air changing weather patterns.

• We get Warm dry air masses from the high plains of northern Mexico that collide with humid air masses from the gulf and create **severe thunderstorms and tornadoes.**

• **El Niño and La Niña** are the warm and cool phases of a recurring climate pattern across the tropical Pacific—the El Niño-Southern Oscillation, or “ENSO” for short can change weather patterns in Texas

• This pattern can shift back and forth irregularly every two to seven years, and each phase triggers predictable disruptions of temperature, precipitation, and winds.

* These changes disrupt the large-scale air movements in the tropics, triggering a cascade of global side effects.