Hunter College - CUNY
Dept. of Geography & Environmental Science
GEOG 101 Lecture Presentation Summary
Spring 2021

NOTE: In the absence of in-person lecturing and face-to-face explanation of the material presented in the PowerPoint lecture slides, I will summarize the content of each lecture presentation, stressing the concepts and interrelationships that are essential to an introductory geography course. In essence, it is like giving you a transcript of my classroom lectures.

If, after reading this summary and viewing the lecture presentation, the imbedded short videos and hot links to articles, you have any questions, or if you would like to contribute a comment or two, need clarification by other examples or have additional information on the topic, please do not hesitate to email me at agrande@hunter.cuny.edu.

LECTURE 12: The Atmosphere – Weather

- The purpose of this lecture is to introduce you to the **atmosphere**, with emphasis on the elements of weather. This is Chapter 2 of the textbook. Climate will be covered in Lecture 13.

- **Slides 3-4: Focus on the Atmosphere.** The atmosphere is an extremely important part of our physical environment and is instrumental in maintaining conditions to support life (as we know it) on Planet Earth.
  - Our environment-related decision-making and reaction to events depends on knowledge and understanding of atmospheric processes.
  - To exist and thrive, all life depends on favorable atmospheric conditions. When things are not, we feel uncomfortable: too hot, too cold, too humid, too dry, too windy, no breeze, changing air pressure affecting our inner ears, etc.
  - The atmosphere is a shield protecting us from things moving toward Earth from space (radiation, meteors) and also as a blanket, keeping us from losing heating into space.
  - The atmosphere exists as a unit with all its parts interconnected and interrelated. There is a link between the bottom of the atmosphere and the surface of the oceans where heat and moisture transfers take place.
  - People are influenced by atmospheric conditions as well as impacting the conditions found in the atmosphere, both locally and globally, including micro-weather conditions in urban areas and climate change.

- **Slides 5-7: Weather vs. Climate:** We need to differentiate between **weather** and **climate**.
  - **Weather: the state of the atmosphere at any point in time.**
    - There are **four elements of weather:** temperature, air pressure, wind and moisture.
    - Each is element is **dependent** on the others *(they do not stand alone),* therefore, as each one changes, the others change, too.
    - **Weather forecast**: a guess as to what combination the four elements will manifest based on computer models developed from past sequences of events.
  - **Climate: the average of all weather events at a particular location over a long period** (+50 years) **of time.**
    - **Climate changes naturally** in response to changing weather patterns.
    - **People influence changes in climate** by their actions.
    - **Climate map:** shows the distribution of averaged data.

- **Climograph:** gives a snapshot of climate characteristics at a specific location.

- **Slide 8: Elements of Weather.** We will look over each of the four elements of weather starting with temperature. Remember that all four are interrelated and a change in one affects all the others. *View the ABC News coverage of Hurricane Michael (2019) an example of a severe weather event*.

- **Slide 9: Temperature.** The first element of weather is temperature. Temperature is defined as the amount of heat contained in a substance. In this case, the substance is air. To understand air temperature at the surface of the earth, we need to look at the following variables: earth-sun relationships, conditions found in the atmosphere and conditions found on the earth's surface. *Slides 10-24 will explore these variables*. *The animated map shows monthly temperature change. Pay attention to the areas of dark blue and dark red.*

- **Slides 10-12: Earth-Sun Relationships.** ***We were introduced to these in Lecture 10.*** Because of rotation, revolution, inclination and parallelism, the angle at which the rays of the sun strike the earth's surface varies every day and then there are seasonal variations of the sun's position in the sky. Plus, there is latitude.
  - **Slides 10-11.** Due to the curvature of the earth and the tilt of its axis, there is uneven heating and cooling of the surface. The strongest rays (hottest) are experienced in the tropical zone while the weakest rays (minimum reception) are in the polar regions. Less extremes and more variation occur in the middle latitudes. *Slide 11 adds the cultural aspect to this situation.*
  - Latitude, when combined with the causes of seasonality, affects the number of hours of daylight experienced. Daylight translates into the amount of time Earth has to absorb solar energy.
  - **Slide 12** graphs the hours of day and night at five northern hemisphere latitudes *(southern hemisphere diagrams have summer and winter solstices reversed)*.
    - ✓ Note that in the equatorial zone there is equal hours of day and night throughout the year.
    - ✓ At 40°N, we see an expansion of summer hours and a reduction of winter hours of daylight.
    - ✓ At 66½°N, we get 24 hours of daylight at the summer solstice and 24 hours of darkness at the winter solstice.
    - ✓ At 75°N, we have over 3 months of daylight and over 3 months of darkness.
    - ✓ Only at the North Pole (90°N) is there 6 months of daylight and 6 months of darkness.

- **Slides 13-24: Temperature Variations.** The earth's surface temperature also varies with conditions found in the atmosphere and on the ground.
- **Slide 13: Atmospheric Reasons.**
  - Atmospheric reasons include the amount of water vapor, dust (natural and man-made) carbon dioxide (natural and man-made) and the other greenhouse gases present. Each plays a role in the absorption and reflection of solar energy. *Note the graph of carbon dioxide concentration (ppm) vs. yearly average temperature.*
  - Another atmospheric reason is the thickness of the atmosphere in relation to the path of the sun's rays influencing both absorption and scattering of solar energy. *Note that the passage of rays is shortest in the tropical zone, therefore more intense. However, the same rays hitting the polar regions come in at a lower angle encountering more atmosphere to divert energy before it hits the surface*

- **Slide 14: Surface Reasons.** The four variables affecting surface temperature are: the difference in heat transfer of land and water; the color of the surface; the elevation of the surface and the orientation of the surface in relation to the sun.
    - **Land vs. Water.** They absorb and retain heat differently
    - **Color of the Surface.** Reflectivity
    - **Elevation.** With less land area at higher elevations, less surface area to absorb heat; the lapse rate quantifies temperature change with elevation at 3.5°F/1,000 ft.
    - **Orientation.** Sun-facing areas get more solar energy than areas in shadow.

- **Slide 15-16. Clouds.** Cloud formation is part of the Hydrologic Cycle and clouds exist in different forms at various altitudes.
    - It was once thought that low clouds were most important to the earth's maintaining its temperature in what is called the "blanket effect". The cloud bottoms trapped the heat close to the surface.
    - Research in the late 1900s showed that the high clouds play a very important role because of their make-up: *ice crystals*. Ice crystals reflect 21% of incoming solar energy back into space. This regulates incoming solar energy.
    - Of course, any cloud that is capable of producing rain or snow is important to life on earth.
    - Some scientists believe clouds act as the earth's natural thermostat: warming increases evaporation which increases cloud cover which increases heat retention at the surface but also increases shadow (cooling) and reflection (preventing solar energy from reaching the surface). Eventually, the surface will begin to cool down. The question is "*How long will it take?"* And "*If it happens, will it be too late to save the planet?"*
    - *Do not worry about the different types of clouds, only know that they exist and play a function in maintaining earth environment.*
    - *It is important to remember that today's global warming is due to the change in the amount of greenhouse gases in the atmosphere, not cloud formation.*

- **Slides 17-20. The Oceans.** The oceans are a key part to understanding the elements of weather and to global climate change. The oceans function as a heat absorber as well as a heat redistributor. Evaporation of water from the oceans puts moisture into the atmosphere.
    - The solar energy absorbed by the oceans is transferred to the bottom of the atmosphere. The atmosphere, in turn, transfers heat to the surface of the ocean. Ocean currents and global wind systems redistribute the air and water. ***Interrelationships!***
    - **Slide 17's** graph and map show changes in ocean temperature over time. The heating of the Indian Ocean and the Gulf Stream will make tropical storms stronger and adversely impact densely populated areas. **Slide 18** is linked to a *NYTimes* article discussing how oceans have absorbed most of the excess heat trapped by greenhouse gases. Note that ocean temperatures have increased over the last 100 years and have recorded some of their highest temperatures in the past 40 years. **Slide 19** is a snapshot of ocean surface temperatures in September, 2020. The reds and oranges indicate areas that were warmer than average (white); the blues are cooler than average. **Slide 20** is a map showing areas of the ocean that have experienced "heat waves" since the 1950s.

- **Slide 21: Land vs. Water Heat Exchange.** Simple physics comes into to play here. Land (an opaque solid) and water (a clear liquid) have different physical make-ups that react differently to heat *(the specific heat of water is 5X greater than that of land)*. Water allows heat to pass through it and its fluidity allows it to be dispersed through a circulation system. Land

only heats at the surface and the heat does not go anywhere. Therefore, land heats up rapidly and also, cools off rapidly. Water, on the other hand, is slow to heat and slow to cool. *Think about recent NYC weather reports looking at temperatures near the coast verses inland temperatures.* **Water is a moderator of both local weather and of climate wherever it is found in large volumes.**

- **Slides 22-24: Ocean Circulation.** Review the material from the previous lecture, especially the part about the Gulf Stream.

- **Slide 25-26: Air Pressure.** The second element of weather is air pressure. Depending on its temperature, a unit of air (measured in pounds per square inch) has a different weight. Warm air is lighter than cold air. High- and low- pressure zones are created based on this. **Slide 26** depicts global pressure zones based on average latitudinal temperature. The tropics are hot so air rises. As it rises, it cools. Once it is cold and heavy, it sinks back to earth. In the subtropical zone, some air returns to the equator and the rest moves toward the poles where extremely cold, dense air exists. The subtropical air encounters the polar air in the middle latitudes creating "weather fronts". The subtropical air (being warmer and lighter than polar air) is forced up and over the polar air creating a zone of lower pressure. ***See your textbook for a detailed description.***

- **Slide 27: Wind.** The third element of weather is wind and wind is directly related to air pressure. Wind is defined as air moving from an area of high concentration (high pressure) to an area of lower concentration (lower pressure). The difference between the two is called the **pressure gradient.** The closer the two extremes are located (to each other), the faster wind moves. ***Note at the bottom of the slide how wind is named: from where it comes, not in the direction it is moving.***

- **Slides 28-32: Wind Systems.** Wind systems are areas where the wind has unique and predicable characteristics. The three categories are: global, regional and local.
    - **Slide 29.** The **jet stream**, which is a "river" of air flowing between polar and subtropical air masses, is illustrated here. ***View the animation.***
    - **Slide 30** illustrates the **Global Wind Systems**. They are named and are located in the areas of the global belts of air pressure. ***(Remember that pressure and wind are inseparable!)*** Wind systems have both horizontal (surface) and vertical components. ***Global wind systems were extremely important in the days of the sailing ship and explorers used the predominant wind direction to travel around the world.***
    - **Slide 31** illustrates the most famous **regional wind system**: the Asian Monsoon. It is created annually as temperature changes over Siberia and pressure gradients change slope. Regional winds are usually seasonal in nature, as the Santa Ana Winds of Southern California or the Sirocco of the Mediterranean.
    - **Slide 32** illustrates the **Local Wind Systems**: Land-Sea Breeze and Mountain-Valley Breeze. Again, heating and pressure differences during the day create the reversal of wind.

- **Slide 33-37: Moisture.** The fourth element of weather is moisture. All forms of water vapor are included in this category.
    - **Slide 34:** Temperature controls how much moisture an air mass can hold and wind distributes the moisture contained in the air mass.
    - **Slide 35:** *Condensation* is when water vapor turns into a liquid and *precipitation* is when water (in any form) falls from a cloud toward the ground; both are part of the Hydrologic Cycle.

- **Slide 36** shows the three forms of precipitation. Know the difference between the three.
  - ✓ **Convection** is heat generated precipitation. It is associated with tropical areas but is also associated with summertime thunderstorms in the middle latitude.
  - ✓ **Orographic** is landform generated precipitation. It occurs when air is forced to ascend a landmass, cools and loses its ability to hold on to its moisture. Clouds form on the windward side and rain/snow occurs there. The other side of the landmass is called the leeward side or **rain shadow**. This is the dry side. As air descends, it warms and holds onto moisture, creating arid conditions.
  - ✓ **Cyclonic or frontal** is air mass generated precipitation. It is a result of the clash of air masses of different temperatures. Its leading edge is called a front. ***We are in the zone of warm fronts and cold fronts.***
  - ✓ In all cases, precipitation occurs when and where there is a change of temperature. The change triggers precipitation when the air is cooled below the condensation level (relative humidity exceeds 100%). When air warms, a reverse trigger effect occurs: moisture is held and precipitation stops (Slide 37).

- **Slide 38: Elements of Weather Recap.** Remember at all of them are interrelated and dependent on each other.

- **Slide 39: NEXT – The Atmosphere: Climate**