Section 1: The Causes of Weather

Objectives
1. Compare and contrast weather and climate.
2. Analyze how imbalances in the heating of Earth’s surface create weather.
3. Describe how and where air masses form.

A. Weather vs. Climate
   • ___________________ : the current state of the atmosphere, including the short-term variations that affect our lives
   • ___________________ : the average weather over a long period of time (usually averaged over the course of 30 years or more)

B. The Distribution of Solar Radiation
   • At the equator, the Sun’s rays strike Earth directly, so the energy is concentrated in a small area.
   • At the polar regions, the Sun’s rays strike Earth at a low angle, so the energy is spread over a larger area.

C. Air Masses
   • Are large bodies of air that take on the characteristics of their source regions, or the areas over which they form
   • Are classified according to their source regions:
     (1) ____________________________________________ (cT)
     (2) ____________________________________________ (mT)
     (3) ____________________________________________ (cP)
     (4) ____________________________________________ (mP)
     (5) ____________________________________________ (A)
   • North American source regions:
     (1) cT: forms over the desert Southwest and Mexico
     (2) mT: forms over tropical and subtropical oceans, such as the Caribbean Sea and the Gulf of Mexico
     (3) cP: forms over the interior of Canada and Alaska
     (4) mP: forms over the cold waters of the North Atlantic and North Pacific
     (5) A: develops over latitudes above 60°N in the ice- and snow-covered regions of Siberia and the Arctic Basin
   • As an air mass moves, it transfers heat from one area to another and acquires some of the characteristics of the new surface beneath it.
   • ____________________________________________ is the exchange of heat or moisture with the surface over which an air mass travels.
Eventually, an air mass’ characteristics are almost the same as the new surface over which it is traveling.

Section 2: Weather Systems
Objectives
1. Describe how the rotation of Earth affects the movement of air.
2. Compare and contrast wind systems.
3. Identify the various types of fronts.

A. The Coriolis Effect

• ____________________________________________
• Causes moving particles (such as air) to be deflected to the ___________ in the N hemisphere and to the ___________ in the S hemisphere
• Coriolis effect + heat imbalance = ______________________________

B. Global Wind Systems

• ___________________: process by which converging air is forced upward, creating an area of low pressure
• Near the equator, convergence occurs over a large area called the intertropical convergence zone (ITCZ; AKA the __________), which
  o Migrates N and S of the equator as the seasons change
  o Is characterized by a band of cloudiness and occasional showers
1. Trade winds
• Flow at ________________ latitude, where air sinks, warms, and returns to the equator in a westerly direction
• Sink around _____ latitude (AKA ____________________________), which creates a belt of high pressure that, in turn, causes generally weak surface winds
2. Prevailing westerlies
• Flow between ________________ latitude in a circulation pattern opposite that of the trade winds
• __________________________
3. Polar easterlies
• Flow between __________________________
• Are characterized by cold air

C. Jet Streams
• Are narrow bands of high-altitude, westerly winds that flow at speeds ≤185 km/h at elevations of 10.7-12.2 km
  (1) _______________________________ separates the polar easterlies from the prevailing westerlies
  (2) _______________________________ located where the trade winds meet the prevailing westerlies

• Vary in position
• Can split into different branches and later reform into a single stream
• Represent the strongest core of westerly winds
• Are generally followed by weather systems
• Affect the intensity of weather systems by moving air of different T from one region to another

D. Fronts
• Are the narrow regions that form when two air masses of different D (caused by differences in T, P, and humidity) collide, which can cause dramatic changes in weather.
  
1. Cold Fronts
• Occur when cold, dense air displaces warm air and forces the warm air up along a steep front
• Are characterized by clouds, showers, and sometimes thunderstorms
  
2. Warm Fronts
• Occur when advancing warm air displaces cold air along a gradual frontal slope rather than a steep boundary
• Are characterized by extensive cloudiness and precipitation
  
3. Stationary Fronts
• Occur when two air masses meeting and neither advances into the other’s territory, stalling the boundary between them
  
• Are represented on a weather map by a combination of short segments of cold- and warm-front symbols

4. Occluded Fronts
• Precipitation is common on both sides of front
• Are represented on a weather map by a line with alternating purple triangles and semicircles that point toward the direction of motion

E. Pressure Systems
Rising or sinking air, combined with the Coriolis Effect, causes the formation of rotating low- and high-P systems in the atmosphere.

Air in these systems moves in a circular motion around either a low- or high-P center.

1. **Low-Pressure Systems**
   - Move in a _________________________ direction in the N hemisphere
     (_________________________ in the S hemisphere)
   - Can form due to the counterclockwise or cyclonic circulation created when part of a stationary front moves S as a cold front and another part moves N as a warm front

2. **High-Pressure Systems**
   - Move in a _________________________ direction in the N hemisphere
     (_________________________ in the S hemisphere)

### Section 3: Gathering Weather Data

**Objectives**
1. Recognize the importance of accurate weather data.
2. Describe the technology used to collect weather data.
3. Analyze the strengths and weaknesses of weather observation systems.

#### A. Surface Data

★ The two most important factors in weather forecasting are (1) _________________________ and (2) _________________________.

1. **Standard Surface Instruments**
   - **Thermometer**: used to measure _________________________
   - **Barometer**: used to measure _________________________
   - **Anemometer**: used to measure _________________________
   - **Hygrometer**: used to measure _________________________

2. **Automated Surface Observing System** (ASOS)
   - Is operated by the National Weather Service’s (NWS)
   - Is made up of ~1700 official sites, which gather data in a consistent manner at regular intervals – usually once/hour (minimum)
• In addition to standard surface instruments, sites use rain gauges, which measure precipitation, and ________________, which measure the height of cloud layers and estimate the amount of sky covered by clouds.

B. Upper-level Data
• To make accurate forecasts, meteorologists must gather atmospheric data at heights ≤30,000 m.
• ________________: balloon-borne sensor packages that measure T, air P, and humidity and that can be tracked to determine wind speed and direction at various altitudes

C. Weather Radar
• Is used to pinpoint where rain is falling
• Mechanism:
  (1) __________________________________________
  (2) __________________________________________
  (3) __________________________________________
• Doppler Radar
  o Is based on the ______________________, which is the change in wave frequency that occurs in energy, such as sound or light, as that energy moves toward or away from an observer
  o Used to plot the speed at which raindrops move toward or away from a radar station, and because the motion of the moving raindrops is caused by wind, it provides a good estimation of the wind speeds

D. Weather Satellites
• ____________________________
• Observe the atmosphere using both ____________________________ and ____________________________... These observations, in turn,
  (1) Are used to map either cloud cover or surface temperatures based on the thermal energy differences detected
  (2) Are used to determine the temperature of a cloud, and thus, infer what type it is and estimate its height
  (3) Can be used to establish a storm’s potential to produce severe weather, as thunderstorm strength is related to its height

Section 4: Weather Analysis
Objectives
1. Analyze a basic surface weather chart.
2. Distinguish between analog and digital forecasting.
3. Describe problems with long-term forecasts.
A. Weather Analysis
• ______________________: record of weather data (represented using meteorological symbols) for a particular site at a particular time

B. Surface Analysis
• To plot data nationally or globally, meteorologists use ____________________, which are lines that connect points of equal or constant values
  o P isopleths = ______________________
  o ______________________ isopleths = isotherms
• Isobars that are close together indicate a large P difference over a small area and thus, strong winds, whereas isobars that are spread far apart indicate a small difference in P and light winds.
• Isobars also indicate the locations of high- and low-P systems.

C. Short-term Forecasts
• Over time, weather systems change direction, speed, and intensity in response to changes in the upper atmosphere.
• Thus, in order to make a reliable forecast, meteorologists must analyze data from different altitudes.
  1. Digital Forecasts
     • Rely on numerical data
     • Are highly dependent on the amount of data available
     • Are the main method used by modern meteorologists
  2. Analog Forecasts
     • Compare current weather patterns to past weather patterns based on the assumption that weather systems will behave similarly
     • Are useful for making monthly or seasonal forecasts, which are based mainly on the past behavior of cyclic weather patterns

D. Long-term Forecasts
• 1- to 3-day forecasts
  o Are dependent on the behavior of larger surface and upper-level features, such as low-P systems
  o __________________________________________________________________________
• 4- to 7-day forecasts: attempt to predict changes in surface weather systems based on circulation patterns throughout the troposphere and lower stratosphere
• 1- to 2-week forecasts: based on changes in large-scale circulation patterns
• Longer-term forecasts are based largely on patterns or cycles involving changes in the atmosphere, oceans, or the Sun.