**Earth Science Review Packet #3—workbook chapters 7-9**

Earth’s early atmosphere formed when volcanic eruptions vented gases formed beneath Earth’s crust (outgassing). Gases given off were chiefly water vapor, carbon dioxide and nitrogen. The atmosphere changed when photosynthetic life added oxygen.

Earth’s atmosphere is layered, with changes in temperature, pressure and water vapor content as altitude increases (see ESRT pg. 14).

**ATMOSPHERIC VARIABLES**

Air **temperature** is a measurement of the **average kinetic energy of molecules**. As heat energy is added, molecules move faster and temperature increases. **Increasing temperature🡪 decrease in air density. Cold air is more dense than warm air. Warm air rises, cold air sinks.**

**Temperature is measure in degrees Celsius, Fahrenheit, or Kelvin (See ESRT p. 13).**

**Air pressure** is cause by the weight of the atmosphere (pull of gravity on air molecules).

As altitude increases, air expands (less gravitational pull) and becomes less dense.

Air pressure decreases as altitude increases (less dense atmosphere = lower air pressure). Air pressure is measured in **inches or millibars** (see ESRT p. 13)

**As temperature increases, air pressure decreases** (air is less dense).

**Adding water vapor to the atmosphere** (through evaporation & transpiration) **decreases air density** (big molecules replaced by smaller ones).

**SO:** **cold, dry air is more dense, sinks, creating higher pressure on Earth surfaces.**

 **Warm, moist air is less dense, rises, creating lower pressure on Earth’s surfaces.**

**MOISTURE IN THE ATMOSPHERE**

**Relative humidity** is the amount of water vapor in the air compared to what the air can hold at a given temperature. If air contains as much water vapor as it can hold at a given temperature, it is **saturated,** and has **100% relative humidity**. (See ESRT p. 12)

**Dew point** is the **temperature** at which air is completely saturated with water vapor (100% relative humidity). Cooling temperatures will cause the water vapor in air at dew point to condense. (See ESRT p. 12).

A **sling psychrometer** is used to measure dew point and relative humidity. As water evaporates from the wet bulb thermometer, its temperature drops. The difference between the wet and dry bulb temperatures indicates relative humidity and dewpoint. Difference = **wet bulb depression**.

As wet bulb depression increases, relative humidity and dew point decrease**. When the temperature** **and dew point are far apart, air is drier.** As temperature and dew point get closer together, relative humidity increases.

**WEATHER**

Weather is the condition of the atmosphere at a given point in time.

**WINDS** are created by differences in air pressure. **Wind blows from high to low pressure** and are named by the direction the wind comes from. A SE wind comes from the southeast.

If the pressure changes greatly over a relatively small area, the **pressure gradient** **is high and wind speed is** **greater.** The lower the pressure gradient, the gentler the winds. **Isobars close together = high winds; isobars spread apart = low winds.**

**Water has the highest specific heat** of all naturally occurring substances, so it takes longer to warm up and cool off. (Front page of ESRT—Specific heat chart).

**Land has a lower specific heat than water, so it heats up fast and cools off fast.**

Near large bodies of water, **sea breezes** develop during the day as warm, less dense air over the land rises and is replaced by cooler water over the ocean. At night, the reverse occurs: **land breezes** flow from the land to replace less dense air rising over the ocean.

**Winds around** **high pressure systems blow** **outward and clockwise** in the northern hemisphere; around **low pressure systems blow inward and counterclockwise.**

**The Coriolis effect,** created by Earth’s rotation, causes winds and ocean currents to **deflect to the right in the northern hemisphere, to the left in the southern hemisphere.**

**Jet Streams** are fast-moving winds in the upper atmosphere that move air masses. (See p. 14 in ESRT)

**Prevailing/Planetary winds** are the general winds that blow between certain latitudes. They are created by convection cells that form in the atmosphere. **Prevailing winds in the US cause weather to track from the west to the east. Prevailing winds in the US blow from the SW to the NE.** (See p.14 in ESRT).

**WEATHER SYSTEMS**

**Station models** show current weather conditions in a particular location (see p. 13 in ESRT). They are updated every three hours (precipitation updated every 6 hours).

**AIR MASSES** 

An **air mass** is a large parcel of air that takes its temperature and humidity characteristics from its **source region** (the area over which the air mass lies). Over water = maritime, over land = continental; near the low latitudes = tropical, high latitudes = polar or arctic. 4 major air masses affect weather in the US (see p. 13 in ESRT): **continental polar(cP), continental tropical (cT), maritime polar (mP), maritime tropical (mT).**

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The boundary between two air masses with different characteristics is called a **FRONT**.

**PRESSURE SYSTEMS**

**High pressure system: divergences or anticyclones;**

**cold, dry air sinks; winds move outward and clockwise;**

**bring fair weather.**

**Low pressure systems: convergences or cyclones;**

**warm, moist air rises; winds move inward and**

**counterclockwise; bring poor weather.**

**FRONTS**

**All fronts are low pressure systems, because at a front, air is rising, expanding, cooling past dew point and forming clouds.**

**How clouds form:** warm, moist, rising air expands, causing it to cool past dew point and condense on dust particles (condensation nuclei) in the atmosphere. This is called **adiabatic cooling**—air gets cooler because the air pressure gets lower.

**Fronts are classified by which air mass is moving:**

cold air mass moves under a warm air mass = cold front

warm air mass rises over cold air mass = warm front.

Occluded fronts = warm air trapped between two cooler air masses and lifted off the ground; stationary front: neither air mass is moving.

**Cold front, Occluded front:** puffy clouds form, precipitation is brief, heavy, scattered, followed by clear skies, cooler temperatures, higher air pressure.

**Warm front, Stationary front:** starts withhigh thin clouds that get lower and thicker during the day; precipitation: long periods of light precipitation over a widespread area. Afterwards, temperatures are warmer, some clouds remain, and pressure is lower than before front came through.



**Synoptic weather maps** are used to predict weather. They show temperatures, pressures, fronts, and areas of precipitation. (See p. 13 ESRT)

**Hurricanes** are extreme low pressure systems that occur in late summer/early fall. They start to form off the coast of Africa and move by prevailing winds toward the eastern US coastline or across Florida into the Gulf of Mexico. Most damage is caused by high winds and storm surges that cause flooding.

**Mid-latitude cyclones** are low pressure systems that commonly form in the Midwest when a cP air mass moves down from Canada to meet mT air mass coming up from the Gulf or Southern Atlantic. Mid-latitude cyclones move into our area by prevailing winds.

**Tornadoes** are extreme low pressure systems that occur in late spring/early summer when warm mT air masses meet cooler cP air masses. Extreme high winds can be accompanied by thunderstorms.

**WATER MOVEMENT THROUGH THE GROUND**

Water will infiltrate, or seep into the ground, until it reaches an impermeable layer of rock. Ground water is that water that is stored in the layers of soil beneath the surface.

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| Zone of aeration—water clings to soil; plant roots get water from here |
| Capillary fringe—upward movement of water through soil |
| Zone of Saturation—where ground water is found (top of the zone of saturation = water table) |
|  Impermeable rock |

**Porosity** = the amount of empty space between soil particles. It does not depend on particle size if particles are all round and sorted. (Small round sorted particles have the same porosity as large round sorted particles).

**Permeability** = the rate at which water infiltrates, or seeps into, the ground. The less time it takes water to infiltrate, the higher the permeability rate (**rate increases as time decreases**). **Permeability** **depends upon pore size**—the larger the pore space, the faster the water infiltrates.

**Capillarity** = the **upward** movement of water into small interconnected spaces. Capillarity increases as particle size decreases.

**Water Cycle**



**PHASE CHANGE GRAPH**

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There is NO temperature change during a phase change. Heat added to ice to change it to water = **latent heat of fusion**. Heat added to water to change it to water vapor = **latent heat of vaporization**. During freezing and condensation, latent heat is released.

**Heat energy (infrared wavelengths**) moves from the hotter object (**the source**) to the cooler object (**the sink).** H**eat energy is transferred by radiation (energy flows in all directions), conduction** (energy transferred by molecules colliding with each other), and **convection** (in gases and liquids—transfer of energy by differences in density).



**Insolation** is incoming solar radiation (sunlight). About half the energy emitted by the sun actually reaches Earth’s surface. The **greater the intensity of insolation**, **the hotter Earth’s surfaces become**.

**Intensity** of insolation depends upon the **angle** at which the sun’s rays hit the surface. Because Earth is a sphere, and because Earth’s axis is tilted, the location of direct, vertical rays (90o) change during the year.

**Duration of insolation** is also a factor in how warm Earth surfaces becomes. Longer daylight hours in summer make us warmer. On **June 21st**, the northern hemisphere has the most daylight hours and the highest angle of insolation, **yet this is NOT the hottest day of the year**. That occurs later in the summer when the amount of insolation Earth receives equals the amount of heat energy it gives off to the atmosphere.

Earth’s atmosphere warms by heat radiated off Earth’s surfaces. Three gases in the atmosphere: carbon dioxide, water vapor and methane, trap and hold onto the heat radiated from Earth. This is called **the Greenhouse Effect**: carbon dioxide, water vapor and methane act like the glass in a greenhouse—they **allow short wavelength radiation (sunlight, visible light) to pass through the atmosphere but stop longer wavelengths (heat, infrared energy) from escaping.**

**CLIMATE—**atmospheric conditions observed in a large geographic area over a long period of time

Factors affecting climate:

 Latitude: low latitudes are warmer; high latitudes are colder

Altitude: as air rises, it expands and cools **adiabatically** (due to decrease in air pressure). So as altitude increases, temperatures decrease

 Mountain ranges: **windward side** of a mountain range is **cool, wet** because air is forced to rise and cool adiabatically (due to decrease in air pressure with altitude); **leeward side is warm, dry** because **air sinks and warms adiabatically** as air pressure increases).



 **Oceans and large bodies of water modify or moderate temperature ranges**. Coastal

 cities tend to have cooler summers and warmer winters than cities that lie inland.

 Planetary/prevailing winds: influence ocean currents. The warm Gulf stream is driven

 by prevailing winds and runs along the east coast of the US.

 El Nino: under normal conditions in December, warm water off the west coast of South America are pushed toward Australia by strong westerly winds. During El Nino, these westerly winds weaken, causing droughts in the western Pacific areas and extra rainfall in eastern Pacific regions.