1 **The Atmosphere**

Chapter 11

Earth Science

2 **Atmospheric Composition**

- Ancient Greeks believed that air was an element that could not be broken down.
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- We now know that air is made of a combination of many gases.
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- These gases form Earth's atmosphere.

3 **Atmospheric Composition**

- Atmosphere is the envelope of gaes that surrounds that planet.
- 99% of the atmosphere is made of nitrogen and oxygen.
- 1% is everything else: argon, hydrogen, carbon dioxide, water vapor, and other gases

4 **Atmospheric Composition**

- The percentages of nitrogen and oxygen are important for life.
  - 78% nitrogen
  - 21% oxygen
  - 1% everything else (0.9% argon, everything else is trace)

5 **Key Atmospheric Gases**

- The amount of water vapor at any given time or place changes constantly.
- Invisible & the source of clouds, rain & snow.
- The percentage changes with the seasons, the altitude of a particular mass of air, and with the surface features beneath the air.

6 **Key Atmospheric Gases**

- The level of carbon dioxide and water vapor regulate the amount of energy the atmosphere absorbs.
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- Water is the only substance in the atmosphere that exists in three states: solid, liquid, and gas.
  - When water changes state, heat is absorbed or released, which leads to weather and climate.

7 **Key Atmospheric Gases (Particles)**

- Dust and salt
  - Dust is carried into the atmosphere by wind.
  - Salt is picked up from ocean spray.

– Both play a role in cloud formation.
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- Ice
  – Third solid found in the atmosphere in the form of hail and snow.

8 **Air Pressure**

Section 11.2

9 **Air Pressure and Density**

- Air Pressure
  – You are used to the pressure that the air exerts on you.
  – Fish are adapted to live under the pressure of the water.
  – Pressure increases with depth in the ocean.
  – Pressure decreases with height on land.

10 **Air Pressure and Density**

- Density
  – Proportional to the number of particles of air occupying a particular space.
  – Varies with temperature:

11 **Instrument and Air Pressure**

- Barometer- used to measured air pressure
- Two common types of barometers are mercury barometers and aneroid barometers.
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- Weather reports use inches of mercury
- National Weather Service uses millibars
- One inch of mercury equals 33.86 millibars

12 **Mercury Barometer**

- Long glass tube that is closed at one end and open at the other end in a dish of mercury.

13 **Aneroid Barometers**

- Without liquid and sensitive to changed in air pressure.
- Air pressures increases the thin wall of the chamber push in.
- Air pressure drops the walls bulge out.
- Connected to a dial by springs & levels. When they move the needle on the dial moves.

14 **Altitude Affect Air Pressure & Density?**

1 Air Pressure

2
- Decreases as altitude increases
- Sea level has the weight of the whole atmosphere

3 Density

4 • Air pressure decreases so does density
- Higher you go the less O_2 molecules you take in.

15 **Layers of the Atmosphere**

Section 11.3

16 **Structure of the Atmosphere**

17 **Lower Atmospheric Layers**

- Troposphere
  - Layer closest to Earth's surface.
  - Contains most of the mass of the atmosphere, including water vapor.
  - General decrease in temperature from bottom to top.
  - Varies in height from around 16 km at the tropics to 9 km or less at the poles.
  - This is the layer in which most weather takes place and most air pollution collects.
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18 **Lower Atmospheric Layers**

- Stratosphere
  - Made up primarily of concentrated ozone.
  - Ozone absorbs more UV radiation than air, so the stratosphere is heated.
  - Temperature gradually increases to the top of the layer.
  - Located about 50 km above Earth's surface.

19 **Upper Atmospheric Layers**

- Mesosphere
  - No concentrated ozone.
  - Temperature decreases.
  - Protects Earth's surface from being hit by most meteoroids.
  - Begins 50 kilometers above earth's surface

20 **Upper Atmospheric Layers**

- Thermosphere
  - Contains a tiny portion of the atmosphere's mass.
  - Temperature increases with height to more than 1000°C.
  - Molecules are so far apart that it would not feel warm to a human.
  - Has two layers in the Thermosphere
    - Ionosphere
    - Exophere

21 **Thermosphere**

1 Ionosphere

2 • It is made up of electrically charged particles and layers of progressively lighter gasses.

3 Exosphere

4 • Outer layer of Earth’s atmosphere.
- Light gases such as helium and hydrogen are found in this layer.

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25 **Energy in the Earth’s Atmosphere**

Lesson 4

26 **Energy from Sun to Earth**

- Travels as electromagnetic waves
- From sun it travels as visible light and infrared radiation
- Smaller amount arrives as ultraviolet radiation

27 **Solar Fundamentals**

- Radiation
  - The transfer of energy through space by visible light, UV radiation (invisible), and other forms of electromagnetic waves.
  - Visible light
    - Includes all the colors you see in a rainbow
  - Ultraviolet radiation
    - Invisible, shorter in wavelengths, can cause sunburn
  - Infrared radiation
    - Wavelengths longer than those of red, not visible to humans but can be felt.

28 **Solar Fundamentals**

- Radiation
  - Different areas absorb energy and heat up at different rates.
  - Does not heat air directly.
  - Air is heated by conduction and convection (talk about this in 11.5)

29 **What happened then it reaches earth?**

- Upper atmosphere: different wavelengths of radiation are absorbed by different layer in the atmosphere.
- Troposphere: Clouds act as mirrors, reflecting the sunlight back into space, disperse into all directions, scattering. Gas molecules scatter shorter wavelengths of visible light so when you look in the sky you see it looks bluer than red or orange
- Earth’s Surface: 50% of energy reaches earth surface & absorbed by land and water then changes into heat.

30 **Earth’s Energy Budget**

- Earth’s surface radiates some energy back into the atmosphere as infrared radiation

- Most of the radiation doesn't travel all the way back into space, it is absorbed by water vapor, carbon dioxide, methane and other gases in the air.
- These gases hold the heat near earth and is commonly known as the greenhouse effect.

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32 **Heat Transfer**

Lesson 5

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- Temperature is a measurement of how rapidly or slowly molecules move around. More molecules are faster-moving molecules in a given area generate a higher temperature.
- Thermal energy measures the total energy of motion in the particles of a substance.

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- Heat is the transfer of energy that occurs because of a difference in temperature between substances.

- Temperature can be measured in degrees Fahrenheit or degrees Celsius or in Kelvin's.
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35 **How is Heat Transferred?**

- In Three Ways
  - Convection
  - Conduction
  - Radiation

36 **How is Heat Transferred?**

- Conduction
  - The transfer of energy that occurs when molecules collide.
  - Example: Put a pot of water on the stove. The element heats the lower molecules which then heat the molecules above them.
  - Substances MUST be in contact with one another.
  - Affects only a very thin layer near Earth's surface.

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39 **How is Heat Transferred?**

- Convection
  - The transfer of energy by the flow of a heated substance.
  - Hot air rises, cools, falls, heats, rises.

– Over and over again.

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42 **How is Heat Transferred?**

- Radiation
  - The direct transfer of energy by electromagnetic waves.
  - You can not see it, but you can feel it.

43 **Temperature vs. Heat**

- Temperature
  - A measure of how rapidly or slowly molecules move around.
  - More molecules or faster-moving molecules in a given space generate a higher temperature.
  - Fewer molecules or slower-moving molecules in a given space generate a lower temperature.

44 **Temperature vs. Heat**

- Heat
  - The transfer of energy that occurs because of a difference in temperature between substances.
  - The direction of heat flow depends on temperature.
  - Heat flows from hot to cold.

45 **Temperature vs. Heat**

- Measuring Temperature
  - Degrees Fahrenheit (°F)
  - Degrees Celsius (°C)
  - Kelvin (K)
    - SI unit
    - No negatives. 0 K is absolute zero.

46 **Temperature vs. Heat**

- Dew Point
  - The temperature to which air must be cooled at constant pressure to reach saturation.
    - Saturation – the point at which the air holds as much water vapor as it possibly can.
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- Condensation
  - When matter changes state from a gas to a liquid.
  - Water falls as rain.

47 **Winds**

Lesson 6

48 **Wind**

- Differences in air pressure cause the air to move.

- Most differences in air pressure are caused by the unequal heating of the atmosphere.

49 **Wind**

- Air moves in response to unbalanced heating and cooling of Earth's surface.
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- Imbalances create areas of high and low pressure.
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- Wind moves from areas of high pressure to areas of low pressure.
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- Changes with height in the atmosphere.

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1 Measuring Wind

2 • Anemometer
  – 3 or 4 cups mounted at the end of spokes that spin on an axle.
  – Force of the wind against the cups turns the axle.
  – Meter connected to the axle shows the wind speed.

3 Windchill Factor

4 • Wind blowing over your skin removes body heat.
- Stronger the wind the colder you feel.
- Windchill factor is that increased cooling the wind causes.

51 **Measuring wind**

- Winds are described by their direction and speed
- Direction is measure by a wind vane
- Wind speed is measured with an anemometer.

52 **Local Winds Vs. Global Winds**

- Local Winds
  - Blow over short distances
  - Unequal heating of Earth's surface within small area cause local winds
  - Sea Breeze
    - Wind that blows from a lake or ocean

– Land Breeze
  • Flow of air from land to a body of water

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54 **Local Winds Vs. Global Winds**

- Winds that blow steadily from specific directions over long distances.
- Created by unequal heating of Earth's surface BUT unlike local winds, global winds occur over a large area.

55 **Wind-chill factor**

- The stronger the wind, the colder you feel
- Wind-chill factor: the increased cooling a wind can cause

56 **Global convection currents**

- Temperature differences between the equator and poles produce giant convection currents in atmosphere
- Warm air rises at the equator, cold air sinks at poles
  - Air pressure lower new the equator, greater at poles
- Difference in pressure causes winds at surface to blow from the poles towards the equator
- Higher in the atmosphere, air flows away from equator toward the poles
- These air movements produce global winds

57 **The Coriolis Effect**

- Because the Earth is rotating global winds do not follow a straight path
- As the winds blow, Earth rotates from west to east underneath them, making it seem as if the winds have curved
- The way Earth's rotation makes winds curve is called the Coriolis effect
- Global winds in Northern hemisphere gradually turn toward the right
- In the Southern hemisphere, winds curve toward the left

58 **Global Wind Belts**

- Global convection currents and other factors produce a pattern of calm areas and wind belts around Earth.
- The major global wind belts are the trade winds, the polar easterlies, and the prevailing westerlies

59 **Doldrums**

- Regions near the equator with little or no wind

60 **Horse latitudes**

- Warm air that rises at the equator divides and flows both north and south.
- Latitude is the distance from the equator, measured in degrees

- At about 30 degrees north and south the air stops moving toward the poles and sinks.
  - This area is known as the horse latitudes
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61 **Trade Winds**

- In the northern hemisphere between 30 degrees north and the equator generally blow from the northeast
- In the southern hemisphere between 30 degrees and the equator the winds blow from the southeast
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62 **Prevailing Westerlies**

- Between 30 and 60 degrees north and south winds that blow toward the polies are turned toward the east by the Coriolis effect
- They blow from west to east
- Blow from the southwest in north latitudes and from the northwest in the south latitudes.

63 **Polar Easterlies**

- Cold air near the poles sink and flow back toward lower latitudes
- The Coriolis effect shifts these polar winds to the west
- The polar easterlies meet the prevailing westerlies at 60 degrees north and 60 degrees south latitudes along a region called the polar front
- This mixing of warm and cold air along the polar front has a major effect on weather in the US

64 **Jet Streams**

- About 10km above Earth’s surface are bands of high-speed winds called jet streams
- Hundreds of km wide but only a few km deep
- Blow from west to east at speeds of 200 to 400 km per hour
- As they travel they wander north and south along a wavy path

65 **Types of air masses**

- Four major types of air masses influence the weather in North America:
  - Maritime tropical: Warm, humid air masses form over tropical oceans
  - Continental tropical: Hot, dry air masses form mostly in summer over dry areas of the Southwest and northern Mexico.
  - Maritime polar: Cool, humid air masses form over the icy cold North Pacific and North Atlantic oceans.
  - Continental polar: Large continental polar air masses form over central and northeren Canada and Alaska.

66 **How air masses move**

- Prevailing Westerlies: push air masses from west to east
- Jet Streams: As jet streams blow from west to east, air masses are carried along their tracks.
- Fronts: As huge masses of air move across the land and the oceans, they collide with each other. The air masses do not easily mix. The boundary where the air masses meet become a front. Storms and changeable weather often develop along fronts.

67 **Types of fronts**

- Colliding air masses can form four types of fronts: cold fronts, warm fronts, stationary fronts and occluded fronts.
  - Cold front: a fast-moving cold air mass overtakes a warm air mass
  - Warm front: a warm air mass overtakes a slow-moving cold air mass
  - Stationary fronts: cold and warm air masses meet but neither can move the other
  - Occluded front: a warm air mass is caught between two cooler air masses

68 **Cyclones and anticyclones**

- Cyclones: a swirling center of low air pressure
  - As air rises in a cyclone, the air cools, forming clouds and precipitation
  - Cyclones and decreasing air pressure are associated with clouds, wind and precipitation
- Anticyclones: high pressure centers of dry air.
  - As the cool air falls, it warms up, so its relative humidity drops
  - The descending air in an anticyclone generally causes dry, clear weather