Global Weather 1

Outcome: (212-1)

Content: Page 212-213

Water and the Weather – The Water Cycle

- The earth has a **limited amount of water**. That water keeps going around and around and around and around and (well, you get the idea) in what we call the "**Water Cycle**".
- If you fill a glass with water, it may have fallen from the sky as rain just last week, but the **water itself has been around pretty much as long as the earth has**!
- The earth's water is contained in lakes and streams, the salt water of the oceans, the ice of the giant polar glaciers and a small amount in the atmosphere.
- All the Earth's water is know as the **hydrosphere**.
- Since 70% of the earth's surface is covered by water it is no wonder that the **hydrosphere plays such an important role in the weather**.

The Water Cycle:

- The main driving force for the water cycle is the **sun**.
- The sun's energy is responsible for the energy needed for the **evaporation of liquid water and sublimation of ice**.
- **There are two main parts of the water cycle:**

1. Getting water into the air...

a. Evaporation:

- When the sun heats up liquid water in rivers or lakes or the ocean and turns it into **vapour or steam**, which goes into the air.

b. Sublimation:

- **Sublimation** is when the **sun heats up snow and ice**. This energy **changes the ice directly into vapour**. It skips the liquid phase!
- So if a pair of wet jeans are hung out, they freeze up, and then the solid ice sublimes.. the jeans are freeze dried!

c. Transpiration:

- **Transpiration** is the process by which **plants lose water out of their leaves**.
- Plants version of sweating

2. Removing the water from the air...

a. Condensation:

- The water vapour rises with the warmed air. As the **air begins to cool the water vapour in the air gets cold and changes back into liquid, forming clouds**. This is called **condensation**.
- When this condensation **occurs on a cold surface close to the ground we call it dew**. If the surface is below zero the water vapour **re-sublimes** to form **solid frost**.

Precipitation:

- Precipitation occurs when so much **water has condensed that the air cannot hold it up anymore**.
- The clouds get heavy and water falls back to the earth in the form of **rain, hail, sleet or snow**.
- The type of precipitation we get depends on the air temperature and in some cases the ground temperature.

Types of Precipitation: (BLM 4.6b)

1. **Rain**

- **As the water vapour condenses small droplets form**. These small droplets collide with other droplets forming bigger droplets, which fall from the atmosphere.
- **Drizzle** is rain that is made up of drops smaller than 1/2 mm.
- **Rain** is made up of drops between 1/2 mm and 5.0 mm.

2. **Hail**
   - **Hail is formed as water droplets ride the updrafts inside thunderclouds**.
   - Each time the hailstone rises, **a new layer of ice forms on its surface**.
   - After about 20 trips up the hailstone is too heavy to rise again and then crashes down to earth!
3. **Sleet**
   - Sleet is formed by **snow that passes through a layer of warm air**, melts slightly, and then passes through a cold layer air **re-freezing as a little ball of ice**.
4. **Snow**
   - Snow forms when **water vapour crystallizes** (turns into a solid) **on the surface of tiny dust particles**.
   - We get wet snow if the snowflakes pass through some warm air, melting the snowflake slightly.
5. **Freezing rain**
   - Freezing rain forms when a **super cooled raindrop** (the drop is still liquid below 0^{o}C) **hits an object on the ground**.
   - The raindrop **freezes on contact**.

Homework: Page 212: #2

BLM 4.6a & 4.6b

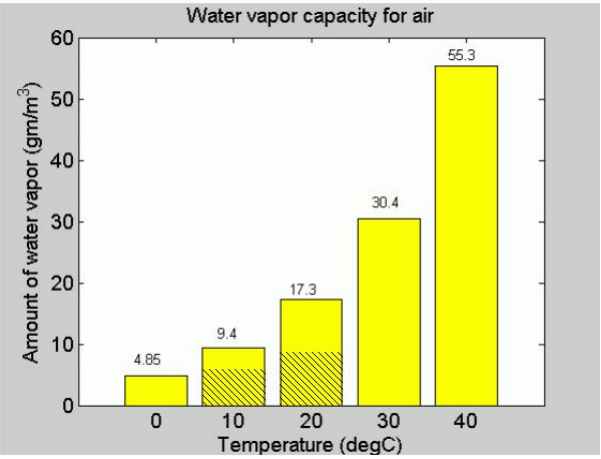
Global Weather 2

Outcome: (212-1)

Content: Page 214-215

- As you recall from a previous lesson, humidity is a **measure of the amount of water vapour in the air.**
    - The humidity in the air can be measured using a **hygrometer**.
- Relative humidity is a measure of the **amount of water vapour that is in the air compared to the maximum amount of water vapour that the air can hold.**
    - Relative humidity can be measured using a **psychrometer**.

Humidity – Water in the Air

- The humidity of an air mass depends a great deal on the **temperature of the air**.
- 

- **Figure 1 Page 214** shows us the maximum amount of water that air can hold at **different temperatures**. From this figure we can see that **warm air can hold much more water vapour than cold air**.
- The reason for this is because warm air molecules are more spread out which **makes more space for water vapour to fit in between**.

What does humidity have to do with our level of comfort?

- Your body **tries to maintain a constant temperature of 37°C** at all times. In hot weather makes you sweat. The sweat then evaporates. **When water evaporates it has a cooling effect**.
- If humidity levels are high (high moisture content) **sweat does not evaporate as easily.**
    - This is because **there is already a great deal of water vapour in the air**.
    - The sweat remains on your body leaving **you feeling hot and sticky**.
    - Sweat evaporation stops completely when the relative humidity reaches about **90 percent**.
- At low humidity levels the air is **not holding much water**.
    - The dry air can soak up more water vapour **and your sweat evaporates more quickly**.
    - This makes you feel **dry and comfortable**.

What happens when the air is cooled?

- Warm air has more room between its air **molecules and holds more water vapour than cold air**.
- As the air cools, the air molecules begin to contract and there is **no longer enough room for all the water vapour**.
- If the air is cooled enough eventually a temperature is reached when the **water vapour is forced out and the water condenses**.
- The temperature at which condensation occurs is called the **Dew point**.
- If the air has a high humidity **it won't take much cooling to reach the dew point**.

- This makes sense since **the air is already pretty much full**. A tiny amount of cooling will be enough to squeeze out some water.

- **Questions:** Which mass of air will reach its dew point first? air at 20°C with humidity of 70% or air at 20°C with humidity of 50% ?
  - **70% because they are at the same temperature so the one with the higher humidity makes all the difference**

Common examples of Dew Point:

- Dew point can be observed when you see **mirrors steam up when you are in the shower**.
  - The steam from the hot shower **fills the air in the room with water vapour**.
  - When this warm moist air hits a cooler mirror the **water vapour condenses on the mirror**.
- On calm clear nights we see the same effect when the land cools **quickly causing the air touching the land to cool quickly too**.
  - If the air cools below its dew point, dew will form on the ground.
  - During the winter, the same effect can occur but this time is the ground cools below freezing **and we see the formation of frost**.
- During the summer, basements tend to get damp because of the high humidity. What could we do to dry up the air in the basement?
  - Use a de-humidifier which **cools the air to its dew point and takes in the moisture that is released**
  - Turn the heat up **which we know holds more moisture**

What does humidity have to do with the weather?

- When the air reaches its maximum amount of water that it can hold (saturation point) **the water vapour will start to condense forming clouds and precipitation**.
- In other words, the higher the humidity, **the greater the chance of rain or snow**.

Homework: Page 215: #'s 1, 2, 4

SRL: 4.7, Page 335 - 336

Global Weather 3

Outcome: (115-2), (331-1)

Content: Page 228-229

Clouds

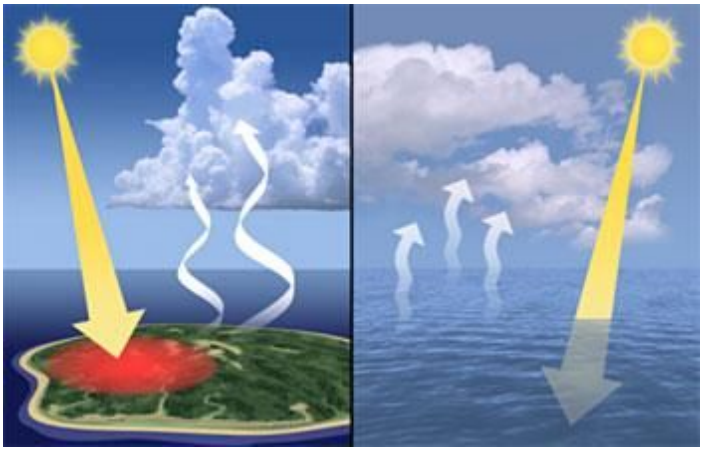
Have you ever wondered how clouds are formed?

- Recall from other lessons that **when air is warmed it begins to rise**.
- As the air rises **it begins to cool and expand**.
- This cooled air **can no longer hold all its moisture**.
- The water vapour begins to **condense on dust particles as very tiny water droplets**.
- There are so many water droplets that they **appear white and block out the sky above**.
- Depending on the temperature clouds may be made up of **tiny water droplets and or tiny ice crystals**.

Three main types of clouds:

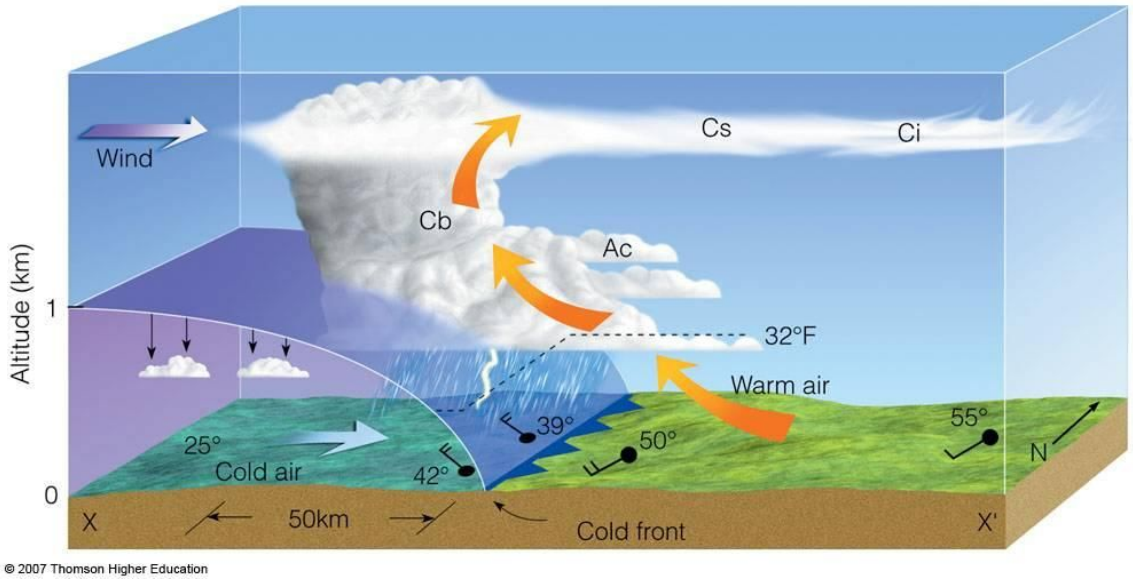
1. Convective

- Formed when a land mass is heated and the **warmed air begins to rise, expand, cool and water condenses**.
- We see these types of clouds where **thermals and sea breezes are formed**.



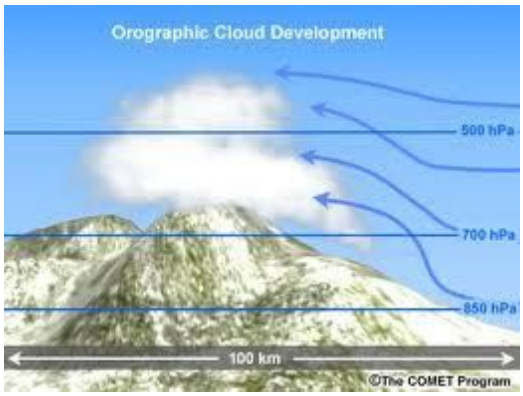
2. Frontal

- Form at the frontal zone where **two large air masses meet**.
- The warmer air mass is forced to **rise up over the cooler air mass**.
- As the warmer air mass is forced to rise it **expands and cools resulting in the formation of condensation**.



3. Orographic

- Formed because of **geography**.
- Formed when air is forced to **rise up a large hill or mountain**.
- As the wind blows into the **side of the mountain it rises up**.
- As the air rises it **expands and cools causing water vapour to condense as clouds**.

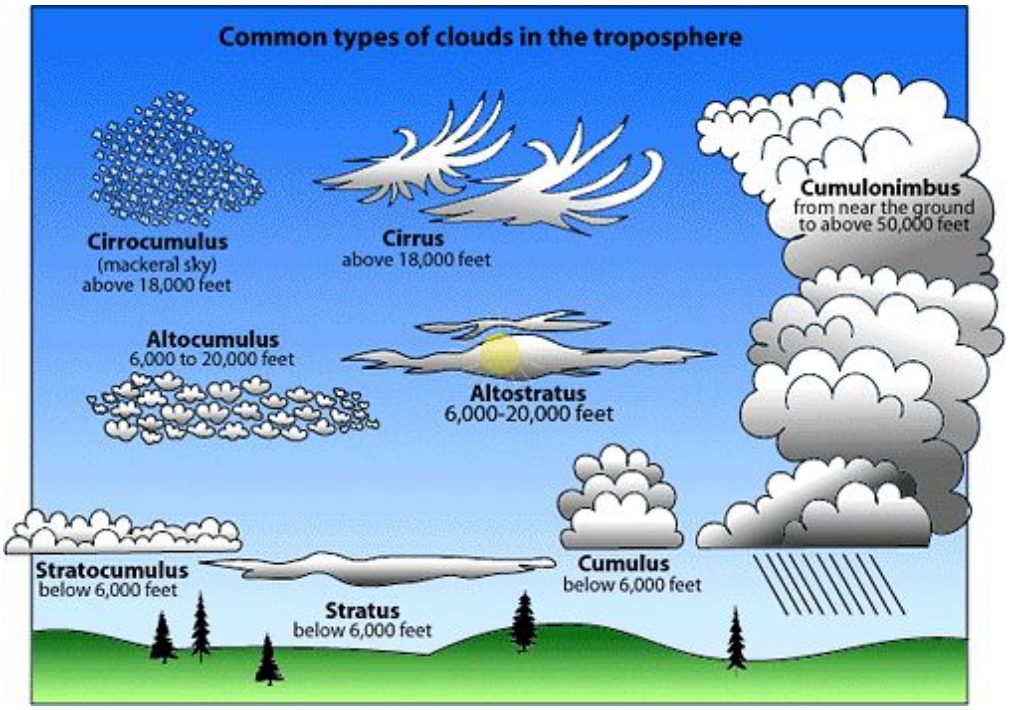


Fog:

- Cloud type that **forms near the ground**.
- Fog forms when **warm moist air moves over a colder surface**
- The cool surface causes the warm air to **cool and release its moisture as very fine water droplets**.
- In Newfoundland warm air from the south follows the **Gulf Stream**.
    - This warm moist air then pushes over the **cold Labrador Current**.

- These **two ocean currents collide** off the coast of Newfoundland at the Grand Banks.
- Not surprisingly, the Grand Banks are **known as one of the foggiest places in the world**!

Cloud shapes tell us about atmospheric conditions:



1. Cumulus Clouds:

- Heaped" or "lumpy" clouds result when **strong vertical (upward) motions exist in the atmosphere**.
- This shows us that the air mass is **being forced to rise very rapidly**.
- Cumulus clouds are a clue that the **atmosphere is unstable and are usually associated with stormy or severe weather**.

2. Stratus Clouds:

- Wide **spread out, smooth, layered clouds**.
- These clouds give a clue that the air **motion is horizontal** (across) rather than vertical (up and down).
- We see this when the **air mass that the clouds are forming in are rising slowly**.
- This type of cloud is a **sign of a stable atmosphere**.

Cloud cover Maintains balance on earth:

- Clouds play two main roles
- The first is that they **simply act as a blanket**.
  - On cloudy nights the **cloud cover traps the heat from the earth keeping the air warm**.
  - When the night sky is clear **the earth's heat escapes and the air cools quickly**.
- The second role of clouds is to **keep the earth cool during the day**.
  - The formation of white cloud cover, **reflects the sun's energy away**.

When is there a greater risk of frost, on a cloudy night or a clear night?

- **Clear night because temperature drops quickly therefore reaching the dew point and if it is cold enough, frost will form**

Deserts regions are so dry that clouds do not form during the day or the night. What do you think the temperature conditions would be like?

- **In the day due to lack of cloud cover, the desert would receive high temperatures caused by direct sunlight**
- **In the night, the temperatures will likely get very cold due to lack of cloud cover which results in most of the heat escaping into space**

Homework: Page 229: # 1

Global Weather 4

Outcome: (116-1), (117-10)

Content: Page 218-219

Meteorologist:

- A **professional weather forecaster**
- They study atmospheric conditions and **make predictions regarding future weather conditions.**

Early Professional Forecasting:

- In the early days of weather forecasting the meteorologist would collect **data on temperature, air pressure, winds, humidity, precipitation, cloud cover and wind speed and direction.**
- This information would be gathered **from different weather stations all across the country.**
- They would put all this information on **great big charts and would try to forecast the weather**.
- The best they could do, however, was **accurately predict the weather for about one day in advance.**

- The main problem was that the everyday view of the weather was **from the surface of the earth, looking up and out.**

Modern Meteorology:

- In the 1960's when the first satellite was put into orbit the way we **looked at the world and the weather had changed forever.**
- **Weather satellites** now give **us a bird's eye view of weather systems.**
- The weather satellites still collected the same basic data that the meteorologist collected before, but the difference **is that satellites are orbiting at extremely high altitudes and produce a very large view of the surface of the earth.**
- Meteorologists still forecast the weather **but the tools they use now is helped a great deal by technology.**
- Some of the devices used to forecast the weather today are; **weather satellites, weather balloons, and radar.**

There are two types of weather satellites:

- **Low-orbit satellites** orbit at **about 1000 km above the earth.**
  - **These satellites send back information regarding global winds, air temperature and humidity levels in the upper atmosphere.**
- **High-orbit satellites** **orbit at about 36 000 km.**
  - These satellites **take pictures of cloud cover.**
  - They also **take Infra red (IR) images, which show the heat being given off by the earth.**
  - The high orbit satellites **take a much larger picture of the earth.**

Weather Balloons:

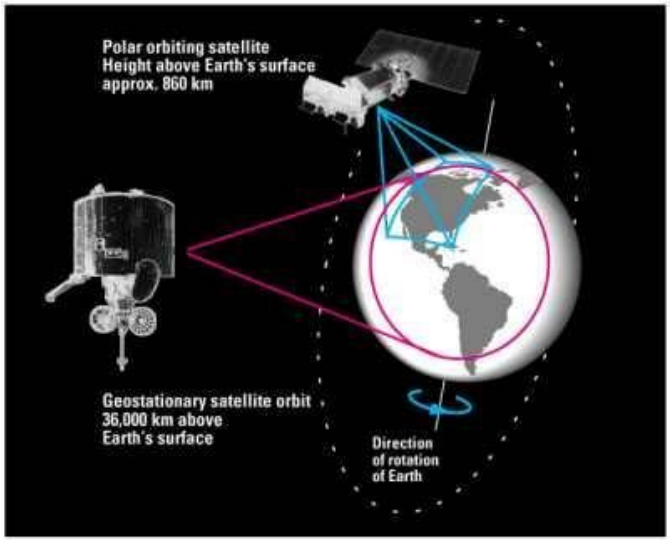
- Large **helium filled balloons that are released into the atmosphere on a daily basis.**
- Carries a radiosonde up through the atmosphere.
- The **radiosonde** houses on board computer **instruments that record temperature, pressure, humidity and amount of ice crystals.**
- As the balloon rises in the atmosphere, **data is relayed back to computers every few seconds.**

Radar:

- Radar stands for Radio Detection And Ranging.
- The Radar sends out a radio wave **and if the radio wave hits an object like an airplane the radio wave bounced back.**
- Measuring the time it took the wave to bounce back **you could calculate how far away the object was.**
- The interesting thing here is that **rain showers also caused the radar wave to bounce back.**
- Radar operators were getting "fuzzy" data **but could accurately position the rain shower!**
- Similar technology is now **used to track large rain clouds.**
- **Doppler radar** as it is sometimes called **can detect where the rain is falling and can now even tell us how much rain is falling.**
- Radar is particularly useful for **detecting and tracking thunderstorms and tornados**.

Homework: Page 219: #'s 1, 2

SRL: Page 344


Polar orbiting satellite
Height above Earth's surface
approx. 860 km
Geostationary satellite orbit
36,000 km above
Earth's surface
Direction
of rotation
of Earth

Global Weather 5

Outcome: (116-1), (117-10)

Content: Page 220-221

Weather vs. Climate:

Weather:

- Weather describes what is happening outdoors when you **look out the window.**
- Weather is the **atmospheric conditions** that happen from minute to minute.
- The weather can change a lot within a very **short time**.
- For example, it may rain for an hour and then become sunny and clear.
- Weather includes **daily changes** in precipitation, barometric pressure, temperature, and wind conditions for your area

Climate:

- Climate is the **expected weather conditions** for your area during different times of the year.
- Climate data is based on a 30-year average, which includes **average weather conditions**, regular weather patterns (like winter, spring, summer, and fall), and special weather events (like tornadoes and floods).
- Climate tells us what it's **usually like in the place where you live** at different times of the year.
- Climate data includes information such as; precipitation, temperature, humidity, sunshine, wind velocity and direction, fog, frost, and other distinct conditions for a specific area.

Factors Affecting Climate:

- The climate you receive depends entirely on where you live.

1. **Latitude**
    - Latitude measures the **distance north or south** from the equator.
    - The equator receives more **sunlight** than anywhere else on earth.
    - The further you move away from the equator the sun becomes less direct, therefore, when you move toward the north and south poles **climates tend to get cooler**.
2. **Ocean currents**
    - Ocean currents can greatly affect temperatures and weather conditions.
    - Two main ocean currents affect Newfoundland and Labrador; the **Gulf Stream** (Warm) and the **Labrador Current** (Cold).
    - What will happen when the warm moist air of the Gulf Stream passes over the cold water of the Labrador Current?
        i. **FOG**

3. Wind and air masses

- Winds that blow from the sea often bring rain to the coast because an **air mass picks up moisture as it moves over water**
- The winds blowing over the cold ocean water in summer tends to **cool the summer air**.
- During the winter the oceans are generally warmer than the winds so the winter air becomes **mild and wet** as it blows over the ocean.

4. **Elevation**
   - Elevation measures how high you are **above sea level**.
   - As you rise, **the air cools**. In fact the air cools by 6.5°C for every kilometer (1000m) you rise.
   - The higher the place is above sea level the **colder it will be**.
   - This happens because as altitude increases, air becomes thinner and is less able to absorb and hold heat.
   - This is also why you often see snow on the **top of mountains** all year round.
5. **Relief (Steepness)**
   - Mountains receive **more rainfall** than low-lying areas because the temperature on top of mountains is **lower** than the temperature at sea level due to the elevation.
   - As the warm moist wind blows into the mountainous barrier (windward side) the **air is forced to rise**.
   - As the air rises it cools and begins to **release its moisture as clouds**.
   - As the air continues to rise and cool **heavy rain develops**.
   - When the air goes over the mountain and begins to fall (leeward side) the air becomes **drier and warmer**.
   - So the amount of precipitation and the temperature depends **which way the wind is blowing and what side of the mountain you are on!**

6. **Closeness to water.**
    - If you live close to a large body of water like the ocean or a large lake, climate is affected.
    - Coastal areas are cooler and wetter than inland areas since wind blowing over the water picks up moisture and is **cooled by the body of water.**
    - In Newfoundland you may have noticed that inland communities like Gander and Grand Falls have much **warmer summer time temperatures** than areas out around the coast.
    - However, in winter, the ocean warms the coastal air so the coastal areas have **slightly warmer winter temperatures** than central areas.
7. **Human activities**
    - Human activities are now beginning to influence local climates as well as the global climate.
    - Southern Ontario (places like Toronto) now includes **smog as part of the climate data** for spring and summer.
    - The excessive pollution from cars and industry, high temperatures and high humidity combine to produce an **unhealthy atmosphere**.
    - The burning of fossil fuels in cars, industry and home heating is accused of causing **global climate change**.
    - Global warming is supposed to be responsible for **variations in climates and increased amounts of severe weather** in just about every part of the world.

Outcome: (115-2), (331-2)

Content: Page 222-225

The Atmosphere:

- The **thin layer of gases** that surround the earth
- The atmosphere is where all the **weather** happens.
- The atmosphere acts like a blanket, which controls the **temperature** of the earth.
- If there were no atmosphere, the **temperature would change dramatically.**
    - In the day, on the light side the temperature would be hot enough to boil water but at night on the dark side the temperature drops to -150^{o}C

What is the earth's atmosphere made of?

- The earth's atmosphere is a made up of **dust and a mixture of invisible gases.**
- Some of these gases include:

Gas	Amount
Nitrogen (N_2)	78%
Oxygen (O_2)	21%
Other gases: • Water vapour, argon, carbon dioxide, neon, helium, krypton, hydrogen, ozone,...	1% combined

Some of these gases have very important roles in the atmosphere.

- Nitrogen and ozone act as a protection shield that blocks out **harmful radiation from space.**

- Oxygen is essential for life. **Plants produce oxygen** and we breathe it in.
- Carbon dioxide is essential for life too. We breathe out carbon dioxide and **plants breath it in**.
- Water vapour is essential to the water cycle and **weather patterns**. Water vapour is responsible for clouds, fog, rain and snow.

Layers of the atmosphere:

- The farther we travel from the earth **the thinner** the atmosphere gets.
- About 99% of the mass of the atmosphere is below 30 km but has been measured to a height of 1000km.
- The layers of the atmosphere are classified based on their **temperature.**

1. **Troposphere**
    - We live in the troposphere and this is where all the **weather happens**.
    - This layer is the closest to the earth, which means the troposphere gets **heated** the most.
    - This heating causes **air currents** and cloud formation.
    - Also, all the dust of the atmosphere is in the troposphere.
    - Water vapour condenses on the dust particles to create **clouds and rain**.
    - The troposphere goes from the ground to about 16 km up.

2. **Stratosphere**
    - The stratosphere rises from 15 km to 50 km.

- The stratosphere has **very little amounts of water vapour** but ice crystals have been seen to form at this high altitude.
- The major gas of the stratosphere is **ozone**.
- This layer is cooler than the troposphere
- The ozone layer blocks out **radiation** from space.
- Some of the energy of ultraviolet (UV) light being blocked gets transferred to the ozone layer.

- **Jet streams** form between the troposphere and the stratosphere.
- There is not enough oxygen in the stratosphere to keep you alive. This is why the pilots of high-level aircraft need to breath oxygen from masks.

3. **Mesosphere**
    - The mesosphere has **very little atmosphere** and ranging in altitude from 50 to 80 km.
    - The temperature of the mesosphere goes as low as -80ºC!
    - This is the layer of the atmosphere where **meteorites burn up!** (Shooting stars!)
4. **Thermosphere**
    - The atmosphere in the thermosphere is very, very **thin.**
    - It is so thin that as the sun's energy hits so few molecules of air we begin to see **extreme heating**.
    - However, because there are so very few molecules the energy doesn't get transferred to other layers.

Atmospheric Pressure:

Air density:

- The atmosphere is made up of gases.
- If we warm up these molecules of gas they begin to **move faster**.
- The faster they move the more space they want to occupy, that is, the warmed gas molecules **spread out**.
- If we had this air in a container with a small hole in it some of the gas would escape and the container with the gas would get lighter then before (**less dense**).
- HOT is **LIGHTER**
- If we cooled down the air the molecules of gas would begin to **slow down.**
- When molecules slow down they need less space and begin to move closer together (contract).
- For the same container above, the gas inside would begin to **contract** and now air from the outside will move in to fill up the container.
- The container with the gas will now be heavier then before (**denser**).
- COLD is **HEAVY**

Air pressure:

- **Gravity** pulls down on all matter.
- Gases are matter and gravity pulls down on them.
- This is why the **troposphere** (layer closest to the earth) has 99% of all the gases in the atmosphere.

- As these gas molecules are being pulled down they are colliding, pushing and bumping into everything else on the surface of the earth, including you.
- All this bumping and pushing creates what we call **air pressure**.
- Have you ever put your hand out the window while you were driving in a car? That's air pressure - you are feeling the force of the air colliding with your hand!

Homework: page 225: #'s 2, 4