SNC 2D
Grade 10 Science, Academic
Unit: Earth and Space Science: Climate Change

The Big Ideas:

- Earth's climate is dynamic and is the result of interacting systems and processes.
- Global climate change is influenced by both natural and human factors.
- Climate change affects living things and natural systems in a variety of ways.
- People have the responsibility to assess their impact on climate change and to identify effective courses of action to reduce this impact

Some tips on using this manual:

1. Put this manual in your binder, then remove the staple. As you work on a lesson on any given day, just remove those sheets from your binder to work on them.
2. This manual is available on the class moodle. All links are live links from the moodle.
3. Write dates beside the Lessons on the table of contents.
4. Cross off Days as they are completed. That way, should you miss a lesson, you can easily refer to which lesson you have to make up.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Table of contents page

Lesson 1 Using explanatory models 4

Homework - If you are able to, bring a laptop to class tomorrow. 6

Lesson 2 Climate zones 7

Homework 10

Finish handouts 10

Read page 319-321, Do page 321 #5, 6, 8, 9. Read page 322-323, Do page 323 #2, 3, 5 10

If you are able to, bring a laptop to class tomorrow. 10

Lesson 3 Graphing historical data 11

Lesson 4 Graphing historical data (cont) 11

Lesson 5 The Story of Stuff 12

Lesson 6 Components of the Earth's Climate System 12

Homework 14

Finish all handouts from class 14

Read 8.4 + take notes 14

Do pg 335 #3 and 4 14

Read 8.8 + take notes 14

Lesson 7 Energy Transfer Around the Earth 15

Homework – finish previous day`s homework 18

Lesson 8 The Greenhouse Effect and Anthropogenic Greenhouse Gases 19

Homework 23

Finish all handouts from class 23

Read 8.6 and take notes 23

greenhouse effect animation 23

Read 9.4 and take notes 23

Do page 342 #1,5. Page 389 #2, 3 23

Lesson 9 Feedback loops 24

Homework 27

Do page 357 # 3, 7 27

Lesson 10 Studying Clues to Past Climate 28

Finish handouts from class if not done - required viewing: http://www.science.gc.ca/default.asp?lang=en&n=D4359403-1 30

Read 8.11 and take any additional notes as needed 30

Optional reading: Ice Cores Handout 30

Study for quiz ..... **Error! Bookmark not defined.**
Bring laptop next class if possible 30
Lesson 11 9.2 - Analyzing sea ice extent for evidence of climate change 31
Homework 31
pg 381 #a, b, c, e, f, h, j, k (to complete k, you need to visit http://www.capefarewellcanada.ca/ 31
Prelab for Tuesday 31
Lesson 12 Climate Change Lab 31
Lesson 13 Evidence of changing climate 31
Homework 33
Bring laptop tomorrow if possible 33
Page 378 #2, 3, 7 33
Lesson 14 How Are Humans Working to Mitigate Climate Change? 34
Homework 34
Complete handout - including skimming through chapter 10 34
Read page 354 about Lake Agassiz 34
Check out www.takepart.com 34
Watch http://www.cbc.ca/player/Shows/Shows/Doc+Zone/2010-11/ID/1664956266/ 34
If you are able to, bring a laptop to class tomorrow. 34
Lesson 15 Mitigating Climate Change (cont) 36
Lesson 16 Mitigating Climate Change (cont) 36
Homework 36
Study for unit test 36

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 1 Using explanatory models

Using an explanatory model to explain phenomena, concepts or events is a powerful tool. Scientists use this tool often in all areas of study (think of the Bohr-Rutherford model of the atom). A strong first draft of an explanatory model is one that describes an event or a process, and what causes that event to take place. It prompts the creator of the model to identify gaps in their understanding of the process, and to consider what steps/actions/experiments they could do to fill in these gaps. It should be easy to modify or add to the explanatory model.

An explanatory model will make use of pictures as well as explanations to convey the author's understanding of an event. The model should be able to show the progression of time (think of "before, during, after"). Below in an example of an explanatory model showing what happens during a chemical reaction:

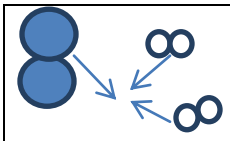
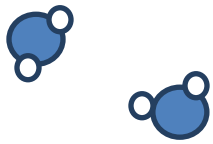
		
At first, there are 3 molecules, with a total of 6 atoms. These molecules collide.	After they have collided, all the initial bonds break apart, or disappear.	Later, new bonds have formed, making new compounds. These new compounds, called products, would have their own physical and chemical properties.

Figure 1: Explanatory model of a chemical reaction (1st draft)

This model would be suitable for explaining chemical reactions to students who don't know much about reactions (a student who has finished grade 9, for example). However, it leaves a lot of unanswered questions.

1. **Reason** *(individually)* After looking at this explanatory model, come up with 3 questions that you feel are not answered by this model regarding chemical reactions.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

2. **Communicate** *(as a group)* Compare your questions with your group members. Choose 2 of the questions you came up with. On your whiteboard, write the question, as well as <u>what steps you would need to take to answer the question</u>. That is, what data would you need to answer the question and how do you think you would get that data.

After taking some lessons in chemistry, the author of the model was able to revise the mode:

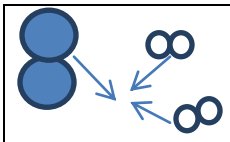
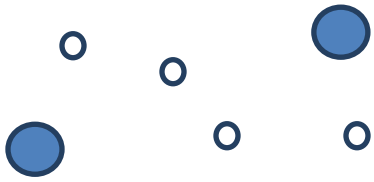
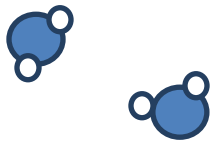
		
At first, there are 3 molecules, with a total of 6 atoms. ~~These molecules collide.~~ Molecules are constantly in motion. This is part of the kinetic molecular theory. Because of this, molecules sometimes collide with one another.	~~After they have collided, all the initial bonds break apart, or disappear.~~ If molecules collide under the right conditions (say, with enough speed), this can cause initial bonds to break. One way to increase the chances of a collision resulting in breaking of bonds would to be increase the temperature of the substances.	Later, new bonds have formed, making new compounds. These new compounds, called products, would have their own physical and chemical properties.

Figure 2: Explanatory model of a chemical reaction (2nd draft)

The question that might have sparked this revision could have been, “why do molecules collide?” or “do all collisions result in chemical reactions?”. In order to get information to answer this question, a student might have conducted several reactions using the same reactants at different temperatures to see if they all produced the same results.

Practice modelling

3. **Explain** (*individually)* Choose a process that you are very familiar with (ex: ice melting, digestion, how a switch in a circuit completes the circuit, other) and represent the process using a model. Complete your model in the space below.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

4. **Interpret** (*as a group)* Show your model to your group members. Have them consider your model as an explanation for your process. Ask your group members to come up with one question each about your process that isn't answered by your model. Record these in the table below.
5. **Reason** (*as a group)* For each question, consider what steps you could take to get an answer to the question. This might be: conduct an experiment, review a lesson, etc. **Do not simply answer the question**.

Questions	Steps to answer questions

6. **Observe** (*as a group)* Watch/listen these two clips about the polar vortex:

http://www.cbc.ca/player/News/TV+Shows/Mansbridge+One+on+One/ID/2429505866/ (22:28)

http://www.cbc.ca/player/Shows/Shows/22+Minutes/Clips/ID/2430064128/?page=7 (0:56)

Applying models to climate change

7. **Explain***(individually)* On separate sheet of 8.5"x11" paper, construct a draft explanatory model that explains:

   How does global warming affect the polar vortex?

   As a starting point, if you don't know how to related these two topics (global warming and the polar vortex), you could create an explanatory model for either one of them).
8. **Revise***(as a group)* compare your model with those of your group members. Look for similarities and differences. Get a piece of chart paper and construct a group explanatory model. This model will be revisited throughout the unit. It is not expected to be complete at this time.
9. **Reflect***(as a group)* review your model and look for gaps in your understanding. Come up with 3-6 questions you have about global warming or the polar vortex that you hope to have answered by the end of this unit. Write them below

Homework - If you are able to, bring a laptop to class tomorrow.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 2 Climate zones

Looking for order and organization in our world is a big part of what scientists do. One way that climatologists organize areas of the world is through *climate zones*.

Challenge 1 – Climate zones

1. **Predict***(as a group)* Without looking up the definition, define the term climate zone.

Visit http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/welcome.html and click on the Climate Zones link on the right hand column.

2. **Research** *(individually)* There are several different climate zones in Canada. Each group member is to read about one and summarize the key characteristics of that climate zone in the space below.

3. **Communicate** *(as a group)* Share your summary with your group members.

4. **Refine** *(as a group)* After seeing the characteristics of each of the climate zones in Canada, go back to your definition above of a climate zone and make any modifications you think are appropriate.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Challenge 2 – are the effects of the Polar Vortex weather or climate?

Weather is a set of daily atmospheric conditions for a particular area. An example could be, "today it is raining, with a high of 15°C, and a light breeze coming from the east". Climate can be thought of as the weather of an area averaged out over a long period of time. An example could be, "in Vancouver, it tends to be mild year-round, with a lot of precipitation, mostly as rain".

5. **Predict** *(as a group)* On your whiteboard, select two different cities that you know of in Canada, that are in two different climate zones. Based on the descriptions of the climate zone, predict what you think the weather was like in February and in August of 2014.

The Weather Network (http://www.theweathernetwork.com/) provides a lot of interesting data. Under the *Forecasts & Reports* heading, the options *Historical Weather* and *Statistics* can be found.

6. **Verify** Visit the statistics link on The Weather Network and look up the two cities you chose. Use this information to refine your prediction on your whiteboard as needed.

7. Visit http://www.theweathernetwork.com/news/articles/researchers-link-extreme-weather-events-to-global-warming-in-new-study/34133/, and read the (lengthy) article.

The jet stream is a fast-moving "river" of winds. There are four of them around the globe, two in the northern hemisphere and two in the southern hemisphere. All of them flow west to east (called an easterly wind) and arise from a combination of: a) difference in air pressure and b) the Coriolis Effect. The polar jet stream in the northern hemisphere generally acts as the southern boundary for the polar vortex.

Literacy corner: When reading a text, comprehension questions can be broken up into 3 types:

Directly stated: Look for the information written in the body of the text

Indirectly stated: answer is located between the lines – you have to combine your background knowledge with one or more pieces of information from the text.

Connection: think about how what you've read relates to something you're already familiar with.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

8. Where is the polar vortex usually found *(directly stated)*? What climate zone does this correspond to *(indirectly stated)*?

9. Describe the usual behaviour of the jet stream *(directly stated)*.

10. What causes the usual behaviour of the jet stream? *(directly stated)*

11. **Predict** What happens to the jet stream as the difference between the temperature at the equator and the polar region increases? *(indirectly stated)*

12. Visit the Historical Weather page at www.theweathernetwork.com for the two cities **you chose in question 4.** Examine the daily weather for Feb and Aug for 2014. Are there any anomalies which could possibly be attributed to the polar vortex? *(connection)*

    ***To complete this, you will likely want to divide the work up amongst your group members – 2 people/month, one researches 1st-15th, the other the remaining dates.*

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

13. **Design** *(as a group)* If you were to find any anomalies, how could you verify if they were in fact due to the polar vortex? What additional data would you need?

Summary

14. What have you learned today that could be added to your explanatory model which details how global warming affects the polar vortex. *(connection)*

Homework

Finish handouts

Read page 319-321, Do page 321 #5, 6, 8, 9. Read page 322-323, Do page 323 #2, 3, 5

If you are able to, bring a laptop to class tomorrow.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 3 Graphing historical data

Please visit the class website to down load the files needed for this assignment. You will need to access these files:

Climate Change Graphing Assignment.xls

Compiled Precipitation Data.xlsx

Assignment due date:_____

You are to submit the file by uploading it to moodle. The link to do this is under the daily outline for climate change. The file name must be

Section - Lastname Firstname - graphing assignment.xls

As a checklist for your assignment, you should be handing in:

- ☐ 1 excel file
- ☐ The file should have a different worksheet (or tab near the bottom) for each graph.
- ☐ Don't delete the worksheet with your data in it. If you do, the data will likely also be deleted from your graphs.

If you are able to, bring a laptop to class tomorrow.

Lesson 4 Graphing historical data (cont)

Continue working on the graphing assignment

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 5 The Story of Stuff

By the end of this lesson, you will have a greater understanding of materials economy, and greater appreciation for what goes into manufacturing a product.

The video that will be used for this lesson is available at http://storyofstuff.org/

Lesson 6 Components of the Earth's Climate System

In grade 9 science, Ecology is a unit of study. During that unit, students learn about food chains and food webs, and that everything in a certain area - the living things (biotic factors) and non-living things (abiotic factors) – all interact to form an ecosystem.

Another method of classification that scientists/climatologists use is the Earth's Climate System. There are 4 components to the Earth's climate system: the hydrosphere, lithosphere, atmosphere and biosphere. In any given area on Earth, these four components interact to define the climate of that area, or the climate zone.

1. **Discuss** *(as a group)* Discuss what you think each of the components of the Earth's climate system refers to. Then, try to group the given terms according to which component you think they belong to (just rewrite the **bolded** word).

Table 1: Examples of components of the Earth's climate system

The Earth's **mantle**	A **person**	**Mountains**	Where **weather** happens	**Seaweed**	The **polar vortex**
Prevailing **wind** patterns	Warm **ocean current** from the gulf of Mexico	A big, **oak tree** standing 25 m tall	**Pollution** billowing out of a factory's smoke stack	The **jet stream**	**Toxic run-off** that leaches into the water table
The **ozone layer**	The **Grand Canyon**	**Mould** growing on an old sandwich	The **troposphere**	**Tectonic plates**	**The Stratosphere**

Table 2: Components of the Earth's Climate System

Hydrosphere	Lithosphere	Atmosphere	Biosphere

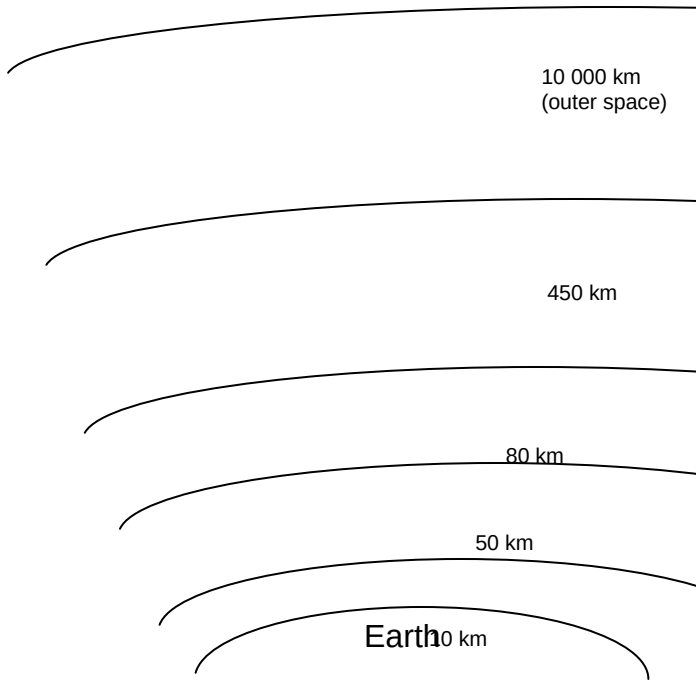
Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

One of the components of the Earth's climate system, *the atmosphere*, can be further broken down spheres, or layers.

2. **Predict** *(as a group)* Etymology is the study of the origins of words. Below are the names for the 5 layers of the atmosphere (the origins of the names) and what is found in each layer. Place the names of the layers in order on the diagram

Mesosphere (meso = middle). Meteors that enter Earth's atmosphere burn up here.
Stratosphere (strato = layered). Contains the ozone layer.
Troposphere (tropo = turning, or ever-changing). Contains people and weather.
Exosphere – (exo = outer). Contains human-made satellites in orbit.
Thermosphere (thermo = heat). A very hot layer. Many chemical reactions occur easily here.



An interesting point about the layers of the atmosphere is that, depending on what chemicals are found in the layer, the temperature either gets warmer or colder as altitude increases (as you get higher). For example, ozone absorbs UV light from the sun. As altitude in the stratosphere increases, the concentration of ozone increases.

3. **Explain** (*as a group)* As you travel from the bottom of the stratosphere to the top of the stratosphere, would the temperature increase or decrease? Why.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

The layers of the atmosphere (troposphere, stratosphere, mesosphere, thermosphere, exosphere) are categorized primarily by altitude and temperature. These two factors also affect what chemicals are found in each layer. However, when considering a boundary between two layers, it is more like they blend into one another, as opposed to a hard transition at a given altitude. Also, chemicals can be found in multiple layers of the atmosphere. For example, ozone is actually found in both the stratosphere and troposphere. When found in the stratosphere, it is good for people, as it absorbs harmful ultraviolet rays from the sun. Yet, when found in the troposphere, it can combine with other chemicals and form pollution. This pollution can irritate the respiratory system of people.

Summary

When asked about where the polar vortex is found, Isaac replied, "the polar vortex is found on Earth". Isaac's group member Marie responded, "Isaac, that answer is much too vague. The polar vortex is found..."

4. **Summarize** (*individually)* Complete Marie's response to where the polar vortex is found. Be sure to be as exact and precise as possible. Avoid using lengthy sentences, but be sure to use as much vocabulary from the unit as possible.

<u>Vocab to include</u>
Climate zone
Polar region
Arctic circle
Atmosphere
Troposphere
Stratosphere
Wind

Homework

Finish all handouts from class

Read 8.4 + take notes

Do pg 335 #3 and 4

Read 8.8 + take notes

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 7 Energy Transfer Around the Earth

Almost all of the Energy found on Earth comes from the Sun. The sun emits many types of energy: thermal energy, visible light, ultraviolet light to name a few. It is the high-energy ultraviolet light that is the main source of energy on Earth.

Challenge 1 – how is energy transferred?

1. **Define** *(as a group)* For each definition below, identify the type of energy transfer as radiation, conduction or convection.

_____ Energy is transferred through the direct contact of particles. As energy is absorbed by one particle, it starts to move back and forth more quickly, bumping into other particles near it. When energy is transferred through a solid, it usually does so by this method.

_____ In science, the term vacuum means there is nothing present (no particles are present). Space is an example of a vacuum. All forms of electromagnetic waves can travel through a vacuum. When they do so, they use this method of energy transfer. No medium is needed to transfer the energy.

_____ A fluid is either a liquid or a gas. When a molecule in a fluid absorbs energy, it is free to move around and take that energy to another location.

2. **Identify** *(as a group)* For each example below, identify the method of energy transfer.
   a. A pot is sitting on the stove and the handle got hot. The handle heated up due to_____
   b. Radio waves can leave 88.1 FM (located in Liberty Village) and go to the antenna in your radio due to _____
   c. After a few minutes at a cafe, my half-filled coffee got cold, so the server came by and filled it with hot coffee. As a result, the cup of coffee was warmed due to _____
   d. The sun's high-energy, ultraviolet electromagnetic rays travel to the Earth due to _____
   e. Ocean currents in the hydrosphere and wind currents in the atmosphere can take energy from near the equator and distribute it around the world through _____
   f. The Earth's surface is warm, it emits low energy infrared electromagnetic rays into the atmosphere through _____

Challenge 2 – the role of pressure

Pressure is an amazing thing. Under regular, atmospheric pressure (what we all experience every day), we know that water boils around 100°C. However, if you were to decrease the atmospheric pressure (say, by going to the top of a really high mountain), water boils at a much lower temperature. In a high-pressure situation, water will not boil until a higher temperature

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

has been reached.

Pressure can also be used in the carbonation of drinks. Carbon dioxide wants to be in a gaseous state. However, under high pressure (such as when a pop bottle is sealed in a factory), the carbon dioxide will stay dissolved in the liquid. Once the bottle is open the pressure inside the bottle will equalize with the pressure outside the bottle and the carbon dioxide will start to form bubbles and rise to the top of your drink!

3. **Draw + Explain** *(as a group)* Sketch a pop bottle before being opened and after. Identify any areas of high or low pressure, and indicate which direction the air molecules will move.

Challenge 3 - Energy transfer around the Earth

The sun's UV rays hit the Earth most directly near the equator. The Earth will absorb these UV rays and warm up. The Earth will then heat up the air directly above it.

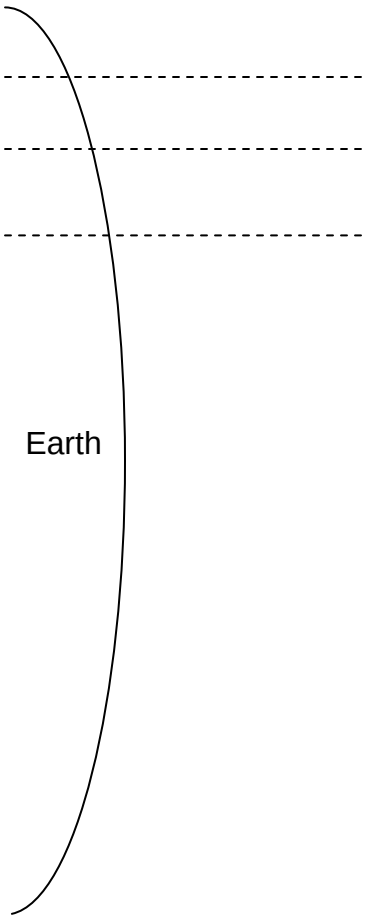
4. **Review** *(individually)* What direction does warm air move?

As a group, review what is meant by up, down, north, south, east and west. It is important that we use these terms correctly when describing the movement of air molecules around the Earth.

In class, Albert explained that, "Canada geese fly down to Florida for the winter."

5. **Reason** *(individually)* Correct Albert's statement

6. **Represent** *(as a group)* Copy the diagram shown here onto your whiteboard. Indicate the equator and the movement of air molecules at the equator that have been warmed by the ground below them.



Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Once air molecules get up into the atmosphere, they can travel north or south, as they do so they, cool, and eventually come back to Earth. This usually happens around 30° latitude.

7. **Represent** *(as a group)* On the diagram, label the line of latitude which represents 30° N, and indicate the movement of cool air molecules around that location.

Near the equator, air molecules are rising into the atmosphere, and around 30°, they are falling towards Earth. This will create areas of different pressure.

8. **Represent** *(as a group)* Label either HP or LP at the equator and at 30°, depending on if you think there is a high pressure area or low pressure area.

As a group, you should have just developed how a convection loop forms between the equator and 30°. A similar convection loop forms between 30° and 60°, and a third one forms between 60° and 90° (the north pole). These convection loops are largely due to differences in pressure, and are always present. The same situation arises in the southern hemisphere.

9. **Represent** *(as a group)* Complete your diagram by putting a LP label at the equator, HP at 30°, LP at 60° and HP at the pole. Do all three convection loops circulate in the same direction? Why or why not?

10. **Verify** *(as a group)* Show your whiteboard to your teacher for evaluation. Copy the correct version into your notes

These convection loops are continuous loops that surround the globe. They are responsible for distributing energy from the equator to other areas of the Earth. They can be thought of as having a lower half, which is down at ground level, and an upper half, which is high up in the atmosphere. The lower half of the convection loops are felt by people, and are called "prevailing winds".

Challenge 4 – the Jet Stream

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

At the centre of each convection loop is a pressurized region. The equatorial convection loop has the highest pressure inside it, while the polar convection loop has the lowest pressure inside it.

11. What direction will air molecules near the centre of the convection loops in the northern hemisphere tend to move?

Gaspard-Gustave, a new classmate from France, described the Coriolis Effect as *the change in direction of motion of an object when viewed in a rotating frame of reference*. No one in the class knew what he meant, so he went on to explain...

An air molecule moves from high pressure to low pressure. At 30°N, there is an area of high pressure and at the equator is an area of low pressure. So, air moves directly to the equator. But we humans are on the Earth, which is rotating. So, we don't see the air moving straight down (say, from Texas around 30°N south to Colombia near the equator). We in fact see it moving south, as well as west. If air molecules were moving north, they would move north and to the east.

12. **Explain** *(as a group)* Two jet streams form in the northern hemisphere. Explain how they form which should include what direction they flow and approximately where they are located.

Summary

13. **Reflect** *(individually)* How does the information in this lesson relate to your understanding of how the polar vortex forms? Consider the role of convection loops and the polar jet stream.

Homework – finish previous day`s homework

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

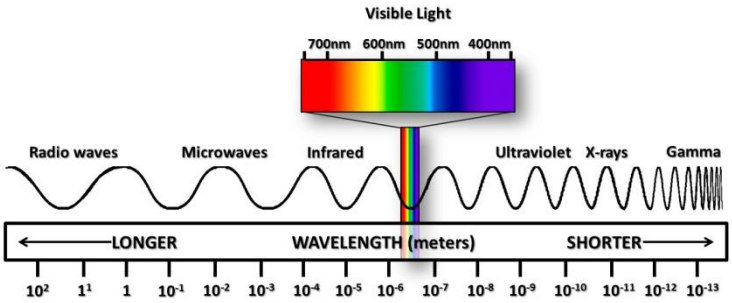
Lesson 8 The Greenhouse Effect and Anthropogenic Greenhouse Gases

Why is the greenhouse effect called *the greenhouse effect*? This term draws on what a greenhouse does. A greenhouse is used for growing plants. It lets solar radiation in through the glass panels, but the result is that the inside of the greenhouse heats up – why? This can also be observed on any bright, sunny day – if a car is parked in the sun, and someone enters the car, the temperature inside the car is noticeable warmer than outside the car. The same principals apply in both cases.

Challenge 1 – defining the greenhouse effect

1. **Describe***(as a group) Solar* radiation is a concern for people. What type of radiation does the sun primarily emit? *(hint – what does sunscreen protect against?)*

The electromagnetic spectrum is used to classify different types of radiation. As seen in this figure, ultraviolet radiation has a shorter wavelength (which means higher energy), while infrared radiation has a longer wavelength (which means lower energy).



Go up to the front of the class where there is a UV light and an incandescent bulb. Both of these light sources emit visible light, but the UV light also emits ultraviolet radiation while the incandescent bulb emits infrared radiation.

2. **Observe** *(individually)* Feel the air around each bulb. Around which bulb does the air feel warmer?

Due to the chemical properties of the gases in the atmosphere, individual gas molecules have a difficult time absorbing UV radiation, but can readily absorb infrared radiation. However, the hydrosphere, lithosphere and biosphere are all able to absorb UV light. In fact, plants need UV light in order to perform photosynthesis. When all parts of the climate system absorb UV radiation, they typically get warmer and radiate some of the energy back as infrared radiation.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

3. **Conclude** *(as a group)* On your whiteboard, answer the question – Explain the process by which the sun indirectly heats our atmosphere.

It is called *the greenhouse effect* because, like a greenhouse, high energy solar radiation is allowed to pass through the atmosphere, but then that energy is absorbed by Earth and re-emitted as low-energy infrared radiation, which is not allowed to leave the atmosphere because it is absorbed by atmospheric gases

Challenge 2 – Greenhouse gases

4. **Predict** *(as a group)* Identify which gases you think make up our atmosphere.

5. **Predict** *(as a group)* On your whiteboard, write the gases you listed in what you think is the order of most concentrated or abundant (at the top) to least concentrated (at the bottom).

The greenhouse effect can be categorized into 2 groups – the **anthropogenic greenhouse effect** and the **natural greenhouse effect**. Due to the natural greenhouse effect, the temperature of the atmosphere around Earth has risen since our planet was "born". This is because naturally occurring greenhouse gases exist in the atmosphere. This is beneficial – without this natural warming, life as we know it would not exist on Earth. The anthropogenic greenhouse effect causes the temperature of the atmosphere to rise above the level it would be found under natural conditions. The anthropogenic greenhouse effect is present because humans have released unusually high concentrations of greenhouse gases.

Not all atmospheric gases are greenhouse gases.

6. **Predict** (*as a group)* On your whiteboard, circle all the gases that you have heard referred to as greenhouse gases.

A gas is considered a greenhouse gas if it easily absorbs infrared radiation. The shape of the molecule of a gas particle dictates how good it is at absorbing infrared radiation. The more linear the molecule, the worse it is at absorbing IR radiation. If a gas is made up of a diatomic

Name: _____ Partner 1:_____

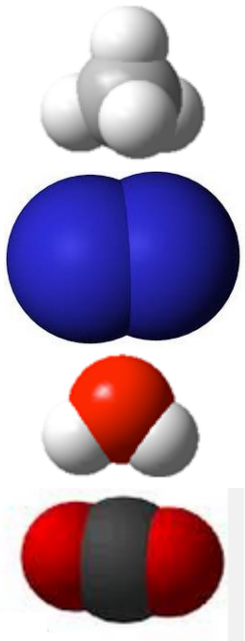
Partner 2: _____ Partner 3:_____

molecule, or a single atom, it is really bad at absorbing IR radiation.

7. **Test** *(as a group)* Compare your predictions above with the pie charts found at the end of this lesson. Record the correct responses to #4-6 on your papers.

8. **Analyze** *(as a group)* Use a line to match the following shapes of molecules to the gas it represents. Then, indicate the strength of the gas as a greenhouse gas (some gases have the same or similar shapes)

Shape



Gas	**Strength of greenhouse gas**		
	Not a GHG	**Weak GHG**	**Strong GHG**
Ozone (O_3)			
Water vapour ($H_2O_{(g)}$)			
Methane (CH_4)			
Nitrogen (N_2)			
Carbon dioxide (CO_2)			
Oxygen (O_2)			
Nitrous oxide (N_2O)			

9. **Reason** *(as a group)* The two greenhouse gases (anthropogenic or natural) that are of the most concern to climatologists would be carbon dioxide and methane, each for a different reason. Explain why.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Challenge 3 – Sources of greenhouse gases

10. **Reason** *(individually)* During a lesson in class, sources of greenhouse gases were being identified as either natural or anthropogenic. Below each of the following statements, identify if you agree with the person. If you disagree with them, state why. If you agree with them, identify where you have heard that information before (which, presumably) is why you agree with them.

Marie said, "When considering carbon dioxide, it is useful to consider carbon sinks and carbon sources. A carbon sink is anything that takes carbon dioxide out of the air and stores it in another form, like when a plant uses carbon dioxide in photosynthesis. Carbon sources can be divided into two types: natural and anthropogenic sources. A natural source could be naturally occurring combustion – for example, if lightning strikes a tree, causing a forest fire; or when a volcano erupts. Anthropogenic sources could be from combustion in factories, cars, or deforestation. "

Isaac said, *"Methane is a really bad greenhouse gas. It is much stronger than carbon dioxide. It can come from natural sources like decomposition in a swamp, but it can also come from anthropogenic causes, like cattle farming.*

Albert said, "*Nitrous oxide comes from naturally occurring sources. They occur in the food farmers give to animals, the waste that comes out of the animal's digestive tract, and in fertilizers. All these things occur naturally, so it is not an anthropogenic source.*

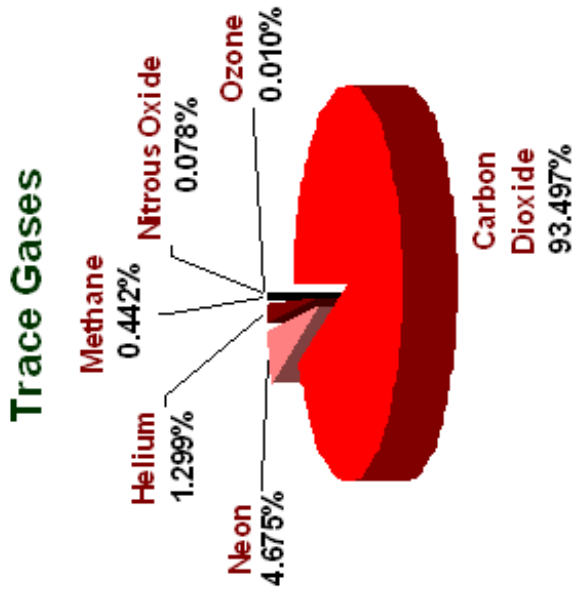
Summary

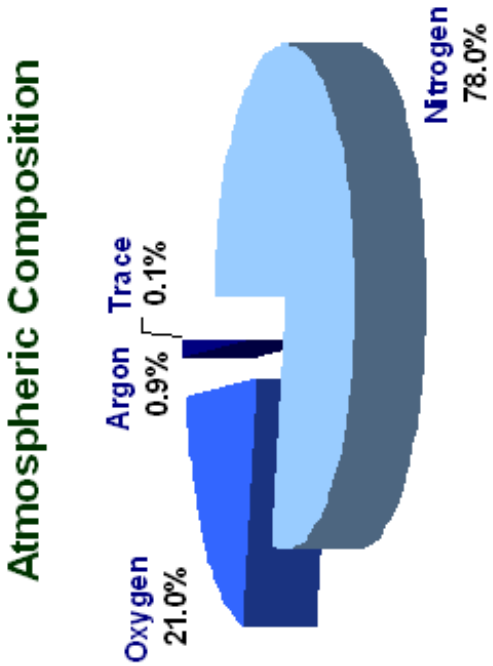
11. *(individually)* After concluding today's lesson, write one well-thought out question relating to the greenhouse effect and greenhouse gasses.

Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____

Data taken from the University of North Carolina (http://www.nc-climate.ncsu.edu/edu/k12/.AtmComposition) shows the atmospheric composition in these two graphs





Homework

Finish all handouts from class

Read 8.6 and take notes

greenhouse effect animation

Read 9.4 and take notes

Do page 342 #1,5. Page 389 #2, 3

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 9 Feedback loops

Challenge 1 – philosopher's corner

One can being to examine feedback loops in general by looking the phrase *money begets money*. This phrase has been used in a variety of contexts throughout history. Depending on the situation, it can be interpreted literally or figuratively.

1. **Interpret** *(individually)* When you read the phrase *money begets money*, what context comes to mind? Do you think of it literally that money gets more money? If so, how? Do you think of figuratively, in the context of a society? Again, how?

2. **Compare** *(as a group)* Have a read through each other's interpretations of this phrase.

3. **Relate** *(as a group)* Money begets money is actually a proverb (a short saying that states advice or a general truth). Proverbs exist in many languages. On your whiteboard, write out a few proverbs in the languages of your group members (if you all speak English, that is fine).

Challenge 2 – examining a situation

One interpretation of *money begets money* is to say *the rich get richer and the poor get poorer.* These ideas can be represented as two distinct cycles. There are processes through which a rich person would get richer.

4. **Brainstorm** *(individually)* make a list of opportunities that someone who is well-off can take advantage of, due to the fact that they are well-off.

5. **Compare** *(as a group)* Have a look at all your group members' lists. Look for similarities and look for differences. Choose an opportunity that is listed on <u>one of your partner's list and not your list</u> and explain how that opportunity can make the person richer.

6. **Brainstorm** *(individually)* make a list of opportunities that someone who doesn't have a lot of money is not able to take advantage of due to the fact that they don't have a lot of money.

 Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____

7. **Compare** *(as a group)* Have a look at all your group members' lists. Look for similarities and look for differences. Choose a lack of opportunity that is listed on <u>one of your partner's list and not your list</u> and explain how that fact that they don't have that opportunity can make the person poorer.

Challenge 3 – representing as a loop

It is possible to represent the ideas above as a cycle or a loop. Consider the simple example provided in Figure 1. Not much detail is provided about the cause and effect relationship, but it does show that, depending on where you "enter the loop", either point could be taken as either the cause or the effect..

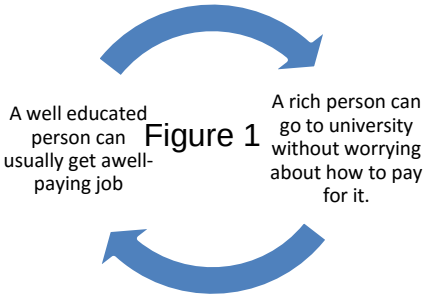


Figure 1

Now consider Figure 2. This shows a more in-depth cause and effect relationship, with more details added to the "process" of the loop.

8. *(as a group)* On your whiteboard, create a loop showing one or more cause and effect relationships you examined in Challenge 2.

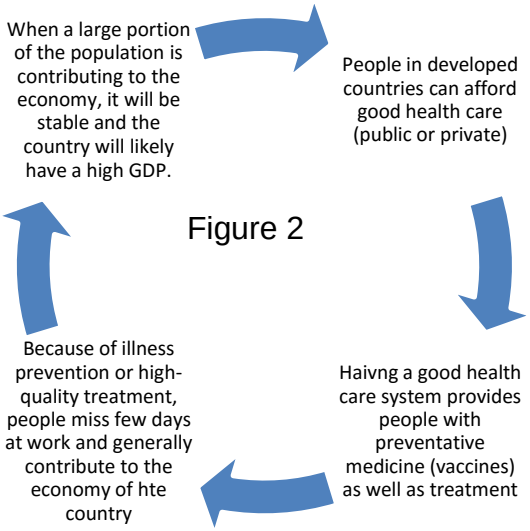


Figure 2

The idea of cause and effect is a very important one in science. However, it is not always easy to tell which is which. Climatologists have compared data for increased concentrations of carbon dioxide with increased concentration of methane over the same time period. It is unclear if one caused the other, or if there is simply a correlation.

Both Figure 1 and Figure 2, as well as any relationships you thought about in Challenge 2 are called **positive feedback loops**. It is important to note that, in this case, "positive" does not mean "good". It means that the results keep reinforcing the original cause. A **negative feedback loop** is one where a final result prohibits the initial cause from happening again.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Challenge 4 – Scavenger hunt

9. **Define** *(as a group)* Use any means in the classroom (except the teacher) to define these terms:

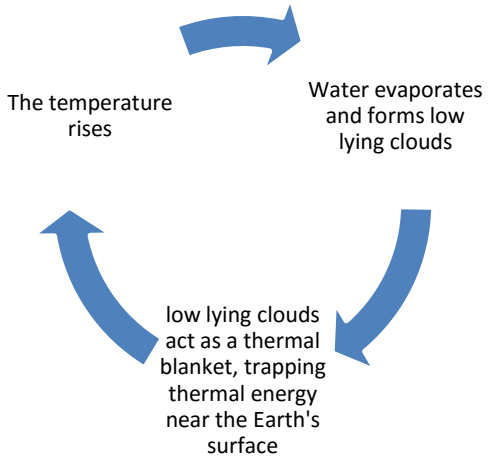
Heat capacity:

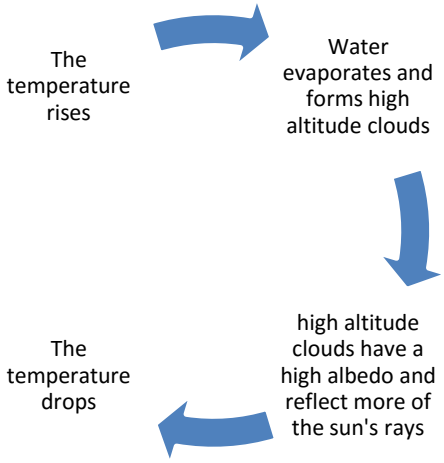
Heat sink:

Albedo (provide examples as well)

Challenge 5 – identify feedback loops in climatology

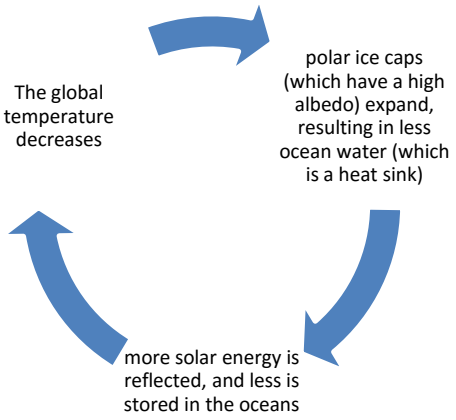
10. **Identify** *(as a group)* Read each of the following situations with your group members then decide if you think it is a positive feedback loop or a negative feedback loop

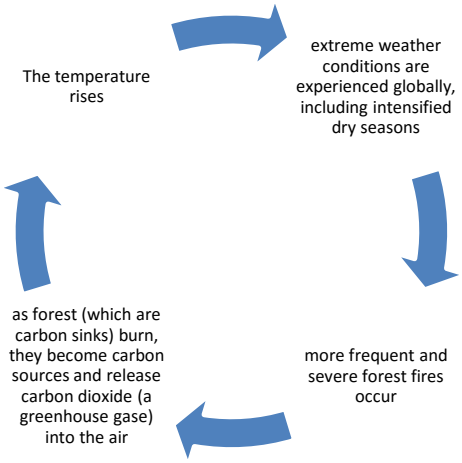




Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____





Summary – the Albedo Effect

The albedo effect is a very important feedback loop which has a direct influence on how the polar vortex behaves. The polar vortex is bound by the polar jet stream, which usually runs in a fairly straight line around 60° latitude. This is due to the fact that there is a relatively large temperature difference between the north pole and the equator. When there is any significant temperature increase in the polar region, this causes the polar vortex to behave erratically.

11. **Reason** *(individually)* Based on the information provided in the examples, predict what the albedo effect feedback loop might look like. *(hint – it starts off with the temperature near the poles rising, and it relates to ice, oceans, albedo and heat sink)*.

Homework

Do page 357 # 3, 7

Name: _____ Partner 1:_____

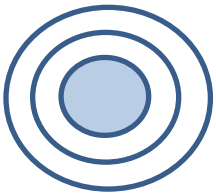
Partner 2: _____ Partner 3:_____

Lesson 10 Studying Clues to Past Climate

Climatologists study the climate – this includes current and past climate in order to make predictions about what is to come. Data has been collected through direct records for over a hundred years – measurements have been made and tabulated and examined for trends. Climatologists are also able to make use of naturally occurring records called **proxy records**. They can look at the molecular composition of tree rings, ocean sediment, and ice cores that have been around for a long time and draw conclusions about the climatic conditions during that time.

Challenge 1 – defining isotopes

1. **Represent** *(individually)* Use the diagram to the right (nucleus and 2 orbitals) to draw the Bohr-Rutherford model of an oxygen atom.

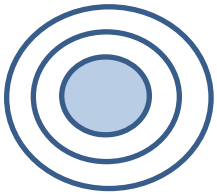


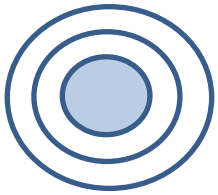
2. **Reason** *(as a group)* What part of the atom is responsible for the mass of an atom? (be as specific as possible)

3. **Reason** *(as a group)* What part of the atom is responsible for the charge on an atom?

An **isotope** is an atom of an element that has the same chemical properties (specifically, ionic charge) as another atom, but different physical properties (specifically, different mass) than another atom of that same element.

4. **Discuss** *(as a group)* What would you have to change (either add or take away) from the oxygen atom above to change its mass without changing its chemical properties?
5. **Represent** *(individually)* Draw two Bohr-Rutherford diagrams below for oxygen – one has an atomic mass of 16 (called oxygen-16 and written as ^{16}O), one has an atomic mass of 18 (called oxygen-18 and written as ^{18}O). What is different about these two diagrams?





 Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____

Challenge 2 – using isotopes

6. **Conclude** *(individually)* Water can be formed either with ^{16}O or ^{18}O. Which one would be called "heavy water" and which one would be called "water"?

Heavy water =

Water =

Scientists have performed experiments to see how the physical properties of water are affected by its molecular weight. They found that the melting point and boiling point was affected, as shown in Figure 1.

7. **Interpret** *(as a group)* Even without a numbered scale on the thermometer, what can you conclude about the properties of heavy water compared to the properties of water?

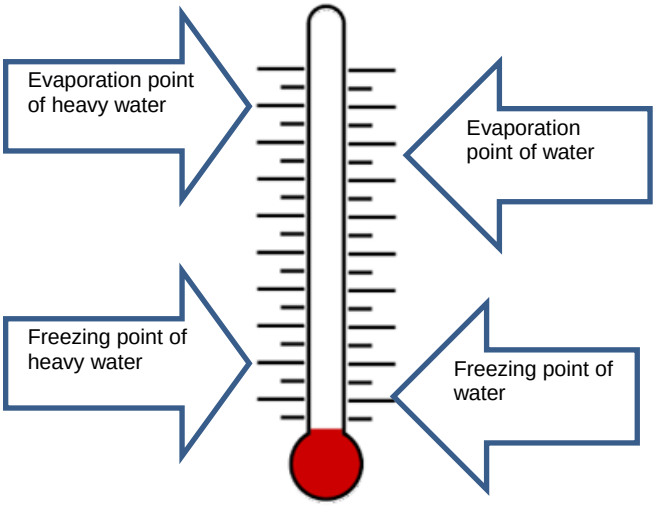


Figure 1

In the world, there is a naturally occurring amount of heavy water and water. This can be expressed as a ratio of ^{18}O:^{16}O found in water and also as a ratio found in ice. As ice forms, these ratios change.

8. **Reason** *(individually)* As global temperatures cool, what will freeze first – heavy water or water?

Math corner – a ratio can be expressed as either A:B or $\frac{A}{B}$. If a ratio is increasing, either A is getting bigger or B is getting smaller. It is the same thing as saying the difference between the two values is increasing.

9. **Interpret** *(as a group)* How will this affect the ratio of ^{18}O:^{16}O in ice?

10. **Interpret** *(as a group)* How will this affect the ratio of ^{18}O:^{16}O in oceans, lakes and the atmosphere?

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

After a period of cooling, more heavy water will have frozen than water. This means that in the oceans, lakes and atmosphere, the concentration of ^{18}O will have decreased, so the ratio of ^{18}O:^{16}O will have decreased. This also means that the concentration of ^{16}O in oceans, lakes and the atmosphere will increases. If cooling trends continue and the global gets even colder, with new ice building on the older ice, it will have different concentrations of heavy water and water in it, which would be expressed as a different ratio of ^{18}O: ^{16}O.

11. **Represent** *(as a class)* draw a diagram to represent layers of ice that form at different temperatures, resulting in different ratios of ^{18}O: ^{16}O.

Further work – complete on separate paper.

12. Watch the video found at http://www.science.gc.ca/default.asp?lang=en&n=D4359403-1 (a link to this is also on the moodle). DEAD LINK
13. Research where Ellesmere Island is.
14. Describe the process by which scientists determine the concentration of different greenhouse gases in the environment at different periods in time.
15. How far back in time have scientists been able to gather data through the proxy record of ice cores?
16. Sketch the graph showing the trends scientists have found regarding global temperatures over the year, as well as any trends related to significant greenhouse gases over the same time period. (you do not need an axis showing specific measurements, just trends)

Finish handouts from class if not done

Watch https://www.youtube.com/watch?v=XeJiuWkBWzw

Watch https://www.youtube.com/watch?v=G80mIbF5yEg

Read 8.11 and take any additional notes as needed

Optional reading: Ice Cores handout (found on the moodle), https://en.wikipedia.org/wiki/Vostok_Station, http://nsidc.org/, http://www.gisp2.sr.unh.edu/

Bring laptop next class if possible

Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____

Lesson 11 9.2 - Analyzing sea ice extent for evidence of climate change

Complete section 9.2 from the textbook. To do this, you will need data from the course moodle. The data is taken from http://nsidc.org/ The file you will need from the moodle is called Sea Ice Data.xls.

Homework

pg 381 #a, b, c, e, f, h, j, k (to complete k, you need to visit http://www.capefarewellcanada.ca/

Prelab for Tuesday

Lesson 12 Climate Change Lab

Handouts will be distributed in class

Lesson 13 Evidence of changing climate

By the end of this lesson, you will have practiced your literacy skills by predicting text and confirming content.

Activity 1 – predicting text from images

Instructions – look at each of the images below. Using the picture and the description below it, predict what information the picture is trying to reveal.	Prediction about what the picture tells us

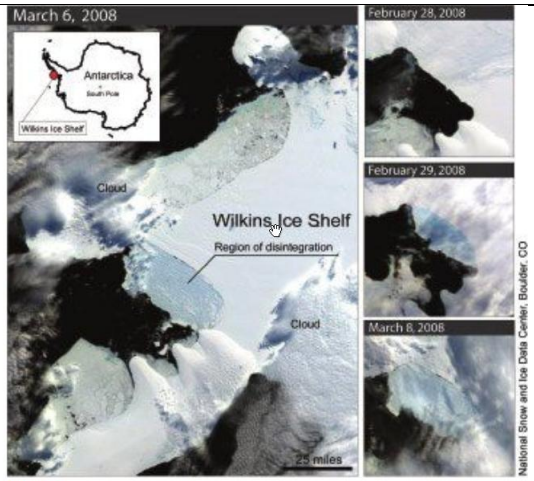


Figure 1 Between February 28 and March 6, 2008, a 405 km² section of the Wilkins Ice Shelf collapsed. The rest of the 14 000 km² ice shelf is showing signs that it could disintegrate and pull away from Antarctica.

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

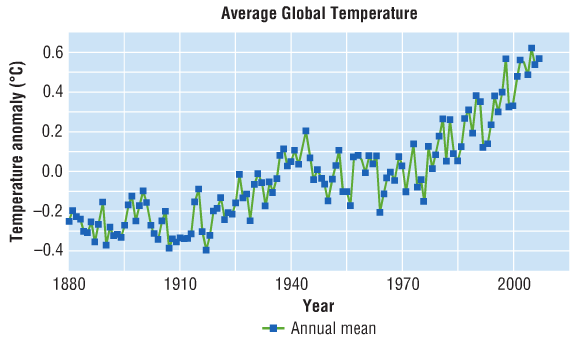


Figure 2 Earth's average temperature has generally increased from 1880 to 2006. The data were collected from all over Earth's surface.

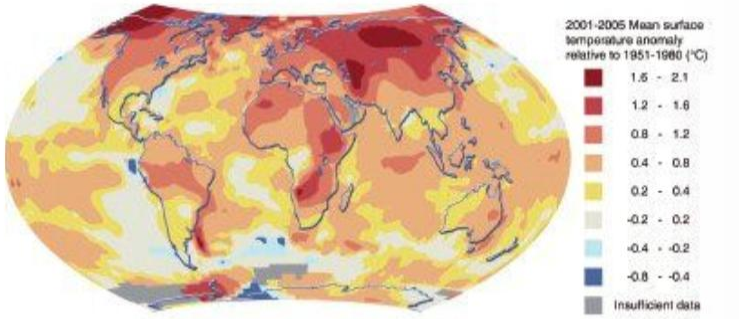


Figure 3 Global increases in average temperature for 2001 to 2005, compared with the 1951 to 1980 average. Temperatures are continuing to rise.

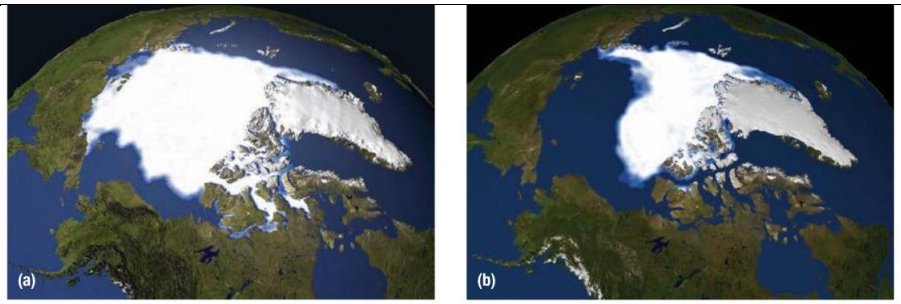


Figure 4 These satellite images show decreases in sea ice between (a) September 1979 and (b) September 2007. This month holds the record for the smallest area of sea ice in the Arctic, at the time of publication, since records were first started in 1979.

Activity 2 – predicting text from text

Instructions - Read the following captions and make a prediction about how they relate to changing climate

Melting Glaciers, Ice Sheets, and Sea Ice

Name:_____ Partner 2:_____

Partner 1:_____ Partner 3:_____

Rising Sea Levels

Changes in Severe Weather

Changes in Precipitation Patterns

Changing Seasons

Changes in Ecosystems

Now, take a look at section 9.1 – Evidence of a Changing Climate, scan through pages 373 – 376 and see if your predictions were correct. If not, add any details that were missing.

Homework

Bring laptop tomorrow if possible

Page 378 #2, 3, 7

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

Lesson 14 How Are Humans Working to Mitigate Climate Change?

Follow the PowerPoint found at https://docs.google.com/presentation/d/1Nr7eyDxESYMoqU11Eerj_w6aza-0Ag5_b4gQs6JYq8w/edit?usp=sharing

**Note - you have been given the ability to edit this power point for the purpose of signing up for a topic of interest. Please do not edit any of the other slides, or your classmates won't get all the important information.

Homework

Complete handout - including skimming through chapter 10.

Read page 354 about Lake Agassiz

Check out www.takepart.com

Watch http://www.cbc.ca/player/Shows/Shows/Doc+Zone/2010-11/ID/1664956266/

If you are able to, bring a laptop to class tomorrow.

You may find some of these links or leading questions useful as your group works through this lesson.

Answer the following:

- Why didn't Canada meet its Kyoto Protocol targets?

- What is Canada's current plan to combat Climate Change?

http://www.cbc.ca/news/politics/story/2011/12/12/pol-kent-kyoto-pullout.html

http://www.youtube.com/watch?v=zORv8wwiadQ

Page 428 #2-4

Page 433 # 1,2

http://www.ted.com/talks/david_keith_s_surprising_ideas_on_climate_change.html

What is David Keith's idea for combating Climate Change?

Do you agree with his reasoning? Why or why not?

Canada's action plan -http://www.climatechange.gc.ca/default.asp?lang=En&n=72F16A84-1

Ontario's action plan -
http://www.ene.gov.on.ca/environment/en/category/climate_change/STDPROD_078897.html

Ontario resources to examine:

Ontario's Climate Change Action Plan, Annual Report 2008-2009 (December 2009) (Downloadable file)

Climate Vision | Climate Change Progress Report (Downloadable file)

Greenhouse Gas Emissions Reductions in Ontario: A Discussion Paper

Climate Ready: Ontario's Adaptation Strategy and Action Plan 2011 - 2014 (Downloadable file)

Metrolinx Regional Transportation Plan

Green Energy Act

Canadian resources to examine:

On September 16, 2009 Parties released the first United States-Canada Clean Energy Dialogue Action Plan.

On June 21, 2012 Parties released the second United States-Canada Clean Energy Action Plan.

National Inventory Report 1990-2011: Greenhouse Gas Sources and Sinks in Canada - Executive Summary - PDF; 1.43 MB

Other countries' resources to examine:

Name: _____ Partner 1:_____

Partner 2: _____ Partner 3:_____

http://www.ipcc.ch/index.htm

http://www.fossiloftheday.com/

http://www.cop18qatar.com/

Lesson 15 Mitigating Climate Change (cont)

Continue researching and prepare for tomorrow's presentations.

Lesson 16 Mitigating Climate Change (cont)

Class presentations.

Homework

Study for unit test