Geog 1000 - Lecture 35

Climate Change

http://scholar.ulethbridge.ca/chasmer/classes/

Today's Lecture (Pgs 240-248)

1. Hand back assignment 4
2. Review Questions
3. Assignment 4 answers

4. What is climate change?
5. Global mean temperature trends
6. The Greenhouse Effect
7. 1000 years of (paleo)climatology
8. Natural vs. Human induced influences on climate
9. Effects of extreme temperatures
10. Indicators of climate change
11. Climate change: Do the Math
12. 10 things to know about climate change
13. Sources and sinks of greenhouse gas fluxes in Canada

Assignment 4

Average = 28/30!! ☺ ☺

A) Within the Introduction, why is Canada's Boreal forest, specifically waterways and wetlands, important (4 marks)? B) What do they mean by "ecosystem services"? (1 mark) and give 3 examples of the benefits that they provide (refer to an additional reference of your choice for this definition and provide website) (3 marks); C) How many wetlands have been lost in the Prairies over the last two decades (1 mark), and how much money is the US spending to restore river systems (1 mark)? (Total = 10 marks).

a) Provide important ecosystem services at local, provincial, national, international levels

- Have low levels of pollutants
- They stabilize climate
- Feed productivity of oceans

Assignment 4

b) Ecosystem services are the ways in which people benefit from ecosystems (1 mark)

Any 3 of the following, but if they add others and they sound reasonable then that is fine too (3 Marks, 1 mark per item):

- Clean drinking water
- Decomposition of waste
- Production of ecosystem services: nutrient dispersal/cycling, seed dispersal, primary production
- Provisioning (or products) from ecosystems: food, raw materials, genetic resources, water minerals, medicinal, energy, jewelry
- Regulating services: C sequestration, climate regulation, waste decomposition, detoxification, purification of air or water, pest disease control
- Cultural services: e.g. spiritual enrichment, cognitive development, spiritual/historical, recreation, science education

C) 70% = 1 mark

D) $14 to 15 billion = 1 mark

Assignment 4

2. In section Climate Change and Threats to Boreal Freshwater: A) Why is the Boreal forest highly sensitive to changes caused by climate change and/or industry? (2 marks) B) How much is the air temperature expected to increase by within the Canadian boreal forest by 2100 (at both latitudes)? (1 mark); C) List two already observed impacts of climate change on the Boreal forest (2 marks); and D) describe what might happen in the future to precipitation and lake/pond/river water (3 marks). E) What might be one result of decreased water movement in rivers (2 marks). Total = 10 marks.

*a)*Annual precipitation is only slightly higher than the amount of runoff. Therefore any change in climate or other disturbance, whereby the environment becomes warmer, might result in more water lost than replenished.(= 2 marks)

b) 5 degrees at 50 deg N; 8.75 (or ~9) deg C at 80 deg N. (1 mark – 0.5 of a mark each) → Or percentages.

c) They might repeat some of this in part C and part D, but in part D they will add more information than in C. For c = 2 marks; 1 mark per answer, also use discretion if they add something else that makes sense then that is ok too.

- Longer growing seasons
- permafrost warming

Assignment 4

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C) or d) decrease in pond water by up to 31%, disappearance

C) or d)- rivers with shorter periods of ice cover, greater year to year variability → unpredictable ecosystem effects

c) or d) ponds may start to accumulate salts, losses of aquatic ecosystems

- higher winter flows of water, lower spring/summer flows. Changes to peak flow could cause problems for some species that require high water levels for spawning.

e) decreased flow in rivers would reduce movement of nutrients to lakes. This could affect food webs and might decrease movement of food to other species. May also reduce input of organic matter into lakes – these protect lakes from solar radiation.

Assignment 4

3. A) Why might fish and other aquatic organisms be sensitive to climate change? (2 mark); B) What could happen to these species? (2 marks); C) Using an additional (cited) reference, what are "peatlands" and what might happen to them under increased air temperatures (4 marks)? D) Describe the characteristics of Boreal forest waterways and wetlands which would allow them to be resilient to climate change (2 marks). Total = 10 marks

a) Fish are highly sensitive to increases in water temperature, which might result from increased air temperatures. Water could become too warm for some species. Other examples: Eutrophication, increased acidity/pollution from glacial melt, etc.

b) These species could either die, or they would move to cooler water. This would change the species composition where some would move to cooler waters, some would die, and others would move in. Other examples also fine.

c) Peatlands are made up of organic materials, accumulating peat, saturated. The amount and quality of the peatland habitats are likely to decrease in range and abundance; could release large amounts of methane and CO2 (exacerbate global warming). Other reasonable examples ok too.

d) Large, pristine waterways and wetlands that are intact and aren't fragmented could provide the best environment for adaptation. This would also help species to weather climate change

What is Climate Change?

We expect climate to remain fairly constant over time

Climate change = when climate doesn't remain constant

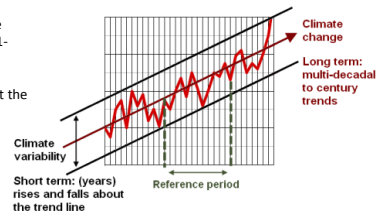
What is a significant change in climate?
Depends on underlying climate variability

What is the difference between climate change and climate variability?

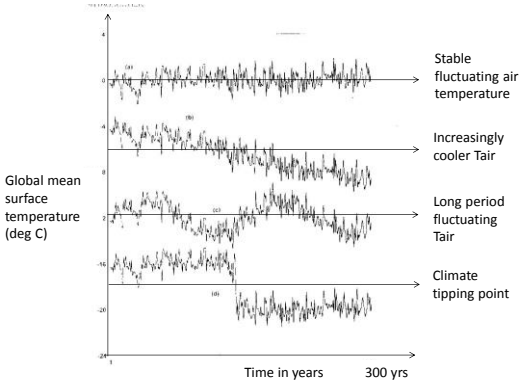
Climate variability → 3 decade long reference point (e.g. 1961-1990).

→ Short-term variability about the mean

→ Change = prolonged trend

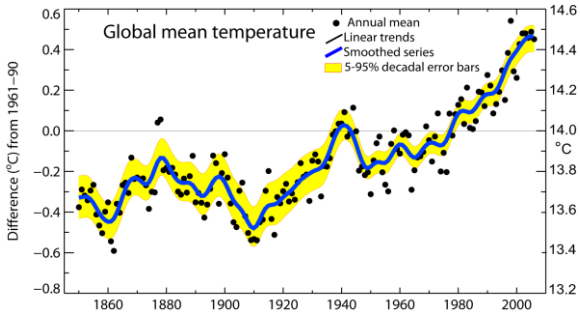


Climate Change Tipping Points



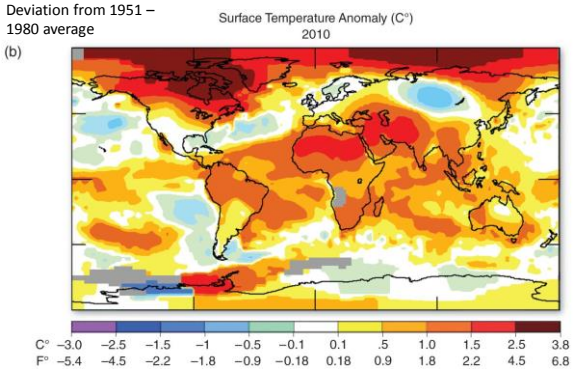
Global Mean Temperature Trends

Warmest 12 years on record: 1998, 2005, 2002, 2004, 2006, 2001, 1997, 1995, 1999, 1990, 2000



Global Mean Temperature Trends

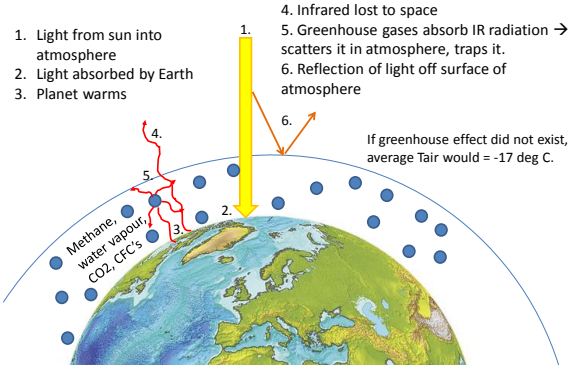
Deviation from 1951 – 1980 average



The Greenhouse Effect

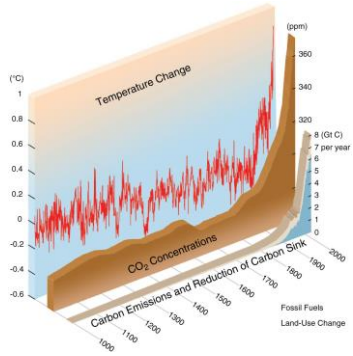
Climate change: any change in net energy

1. Light from sun into atmosphere
2. Light absorbed by Earth
3. Planet warms
4. Infrared lost to space
5. Greenhouse gases absorb IR radiation → scatters it in atmosphere, traps it.
6. Reflection of light off surface of atmosphere



If greenhouse effect did not exist, average Tair would = -17 deg C.

1000 years of increasing air temperature and atmospheric CO_2



Paleo-climate record: Atmospheric CO2 has never been above 300 ppm (800,000 years)

AND

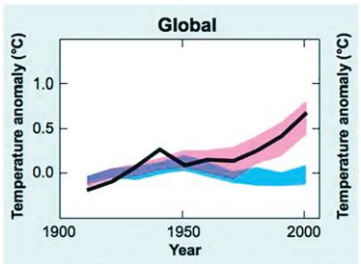
Change never > 30 ppm in less than 1000 years.

Seeing > 30 ppm change in last 12 years (!!)

1000 years of increasing air temperature and atmospheric CO_2

Increase in Temperature *very likely* anthropogenic → > 90% statistical confidence.

95% of climate scientists, atmospheric physicists, etc. agree



Blue line = air temp. with astronomical, solar, volcanic activity

Pink line = anthropogenic forcing.

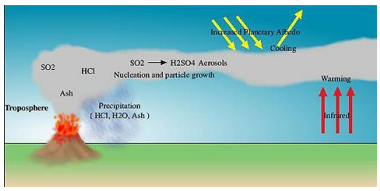
Natural Causes of Climate Change

1. Volcanic Activity → Short term influence

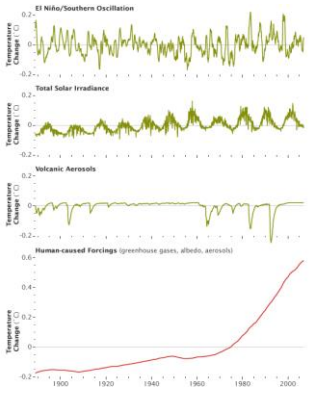
2. Astronomical variations → very long temporal scales

3. Changes in solar output (e.g. maxima)

** Climate effects of increases in greenhouse gases since Industrial Revolution is 10 x greater than changes in Sun's output (ec.gc.ca).



Major Natural Influences on Temperature Change



El Nino, solar variability, volcanic aerosols = greatest natural influence in short term

Influences = +/- 0.2 deg C (ave = 0)

Human influences = + 0.8 deg C since 1889.

(http://earthobservatory.nasa.gov/Features/GlobalWarming/page4.php)

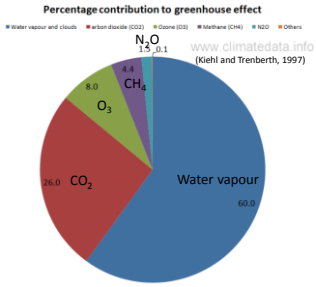
Human Causes of Climate Change

1. *Burning fossil fuels* → CO_2 – major output
2. *Land conversion – Forest to agriculture*

→ Influence amount of energy input and output from the atmosphere

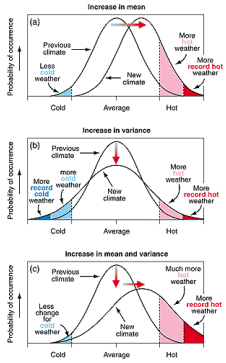
- Gases absorb heat = warmer air and Earth.

Water vapour is largest contributor to Greenhouse Effect.



Effects on Extreme Temperatures

IPCC – Intergovernmental Panel on Climate Change

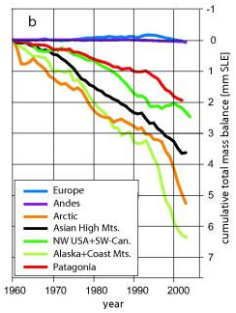


1. A shift in average warmer climates
→ More periods of hot weather

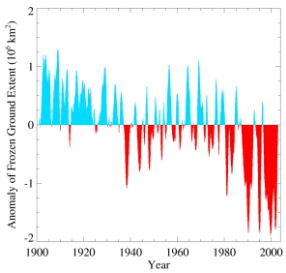
2. An increase in the variability of hot and cold periods, equally

3. An increase in the variability and a shift to warmer weather = much greater percentage of hot weather.

Indicators of Climate Change

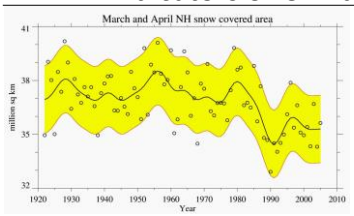


Increased glacial retreat since early 1990's



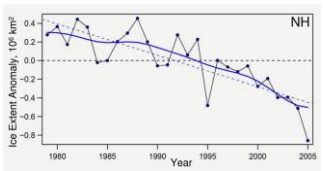
Area of seasonally frozen ground in NH has reduced by ~7% from 1901 to 2002

Indicators of Climate Change

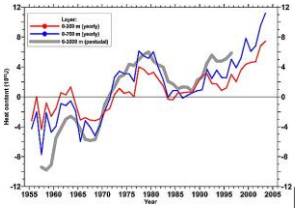


Area of spring snow cover has dropped during 1980's (tipping point)

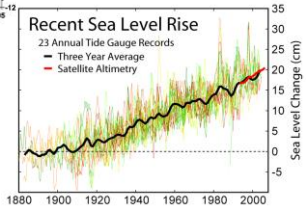
Arctic sea ice area has decreased 2.7% per decade



Indicators of Climate Change



Heat content of oceans have increased



Sea level has steadily increased.

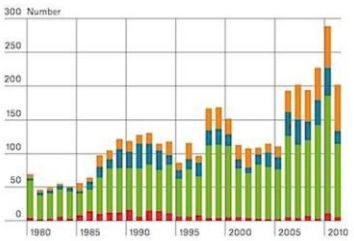
Indicators of Climate Change

http://www.huffingtonpost.com/2012/10/29/hurricane-sandy-climate-change_n_2038859.html

Natural catastrophes in North America 1980 to 2011: Numbers of events

- Geophysical
- Meteorological
- Hydrological
- Climatological

Source: Munich Re, NatCatService



Economy of Climate Change

Dr. James Byrne, Uleth!

10 things to know about Climate Change

1. *Climate Change = long term shift in climate*
2. *Natural processes have driven periods of climate change* → Past climates have been variable. Only solar activity and volcanoes relevant for this.
3. *Human activity now main cause of recent climate change* → Warming over last century due to burning fossil fuels, land use changes.
4. *Global warming: Enhanced greenhouse effect*
5. *Ozone hole* → Not a cause of climate change, but linked. Ozone depletion = very slight cooling.
6. *Climate Change* → warming trend, not just warming cycle.

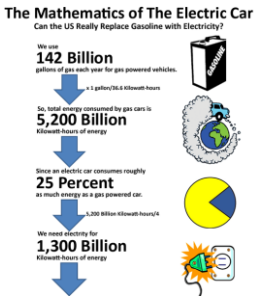
10 things to know about Climate Change

7. *Climate change affects many* → Changes in averages & changes in extreme weather.

8. *People and organisations can make a difference* → Reducing gas emissions will slow rate of change.

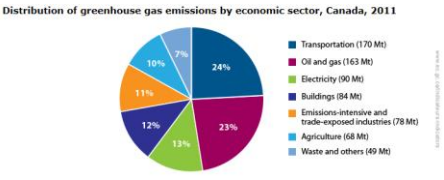
9. Expected GHG levels to be 734 megatonnes (Mt) in Canada by 2020 (128 Mt lower than no action.

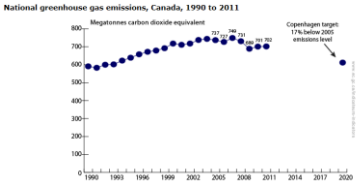
10. Canada → $1.2 billion to reduce emissions, adaptation.



Greenhouse gas sources:

In Canada:



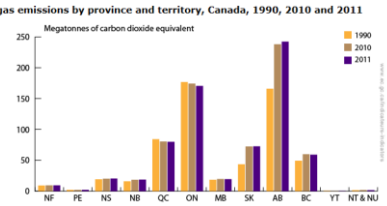


Increases: Oil and gas sectors, transportation.

Decreases: Reduced emissions from electricity, manufacturing

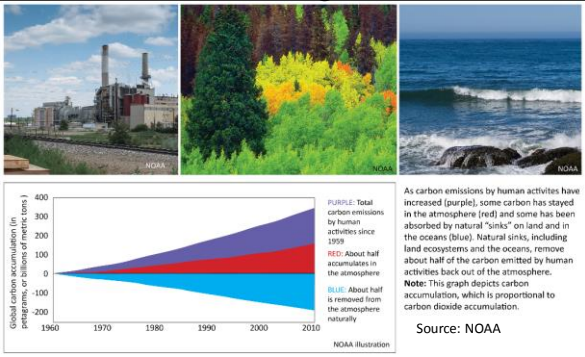
Greenhouse gas sources:

In Canada:



Alberta, Ontario, Quebec, Saskatchewan, BC → almost 90% of emissions

Greenhouse gas sinks:



Source: NOAA

Oceans and forests = greatest sink for CO2; not yet reached capacity. Sequester ~50% emitted.