



1

Is the Climate Changing?

2

Yes!

...But Earth's climate is always changing!

A History of the Earth's Climate

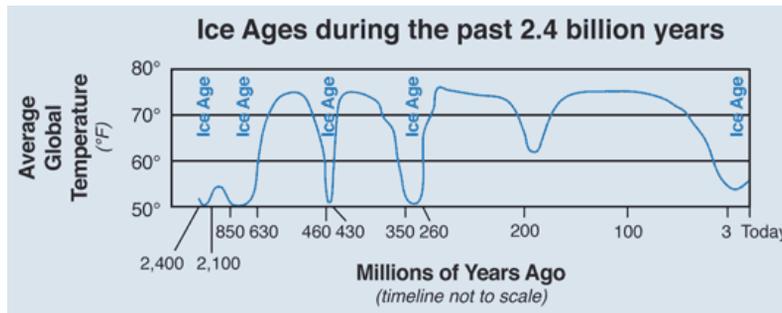
http://www.youtube.com/watch?v=dC_2WXyORGA

2

Is the Climate Changing?

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- Throughout its 4.5 billion year history, Earth's climate has alternated between periods of warmth and relative cold, each lasting for tens to hundreds of millions of years.



3

Is the Climate Changing?

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- However, the current rate of change has never been proven before!
- Humans are causing the climate to change faster than it ever has before!



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How do we know this?

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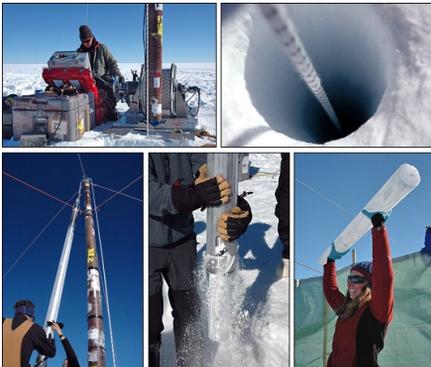
- Scientists study past temperature records by analyzing rocks, fossils, pollen grains, and ice.



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Ice Cores

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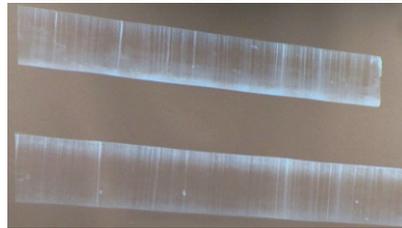
- Samples from ice fields show layers created by snowfall, which alternate with summer deposits of pollen and dust.
- These layers provide physical timelines of glacial cycles.

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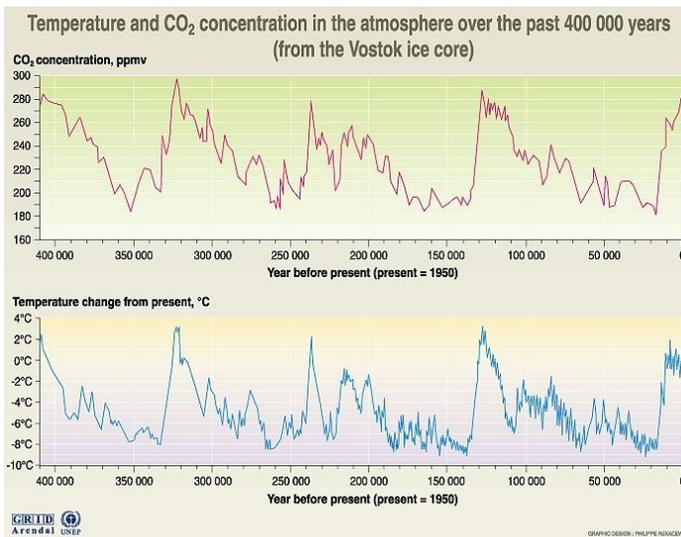
Ice Cores

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- Air bubbles in the ice can help measure atmospheric CO₂ levels at the time the ice was laid down.
- Increased CO₂ levels relate to increased atmospheric temperature.

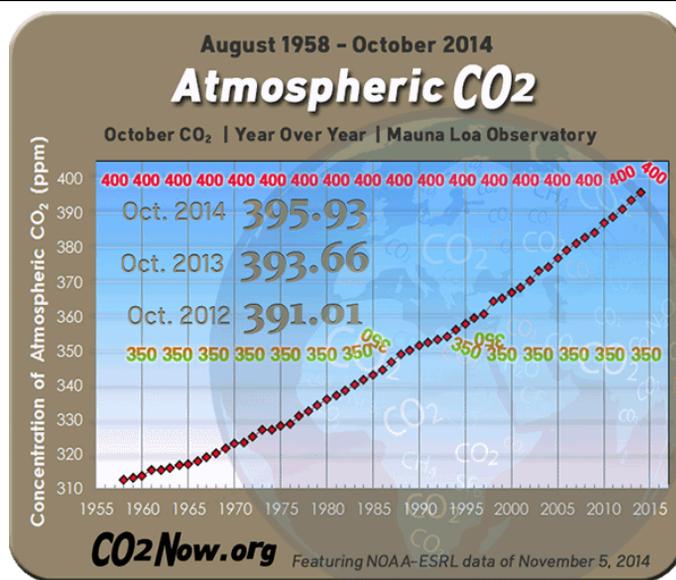


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Ice cores show that atmospheric CO₂ levels have never exceeded 300 ppm in the last 650,000 years.

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- Today's atmospheric CO₂ level is 404 ppm!
= the highest level in human history

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Increasing CO₂ levels

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- Scientists believe the increase in CO₂ levels is caused by human activities such as:

- ▣ Burning fossil fuels
- ▣ Deforestation
- ▣ Agricultural practices
- ▣ Industrial processes



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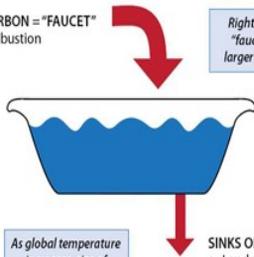
Increasing CO₂ levels

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The Carbon 'Bathtub' and its Components

SOURCES OF CARBON = "FAUCET"

- Fossil fuel combustion
- Deforestation



Right now, size of "faucet" is much larger than "drain."

SINKS OF CARBON = "DRAIN"

- Land uptake
- Ocean uptake

As global temperature increases, size of "drain" decreases.

- Some of the excess CO₂ ends up in carbon sinks such as oceans and forests.
- However, about half ends up in the atmosphere!

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Anthropogenic Greenhouse Effect

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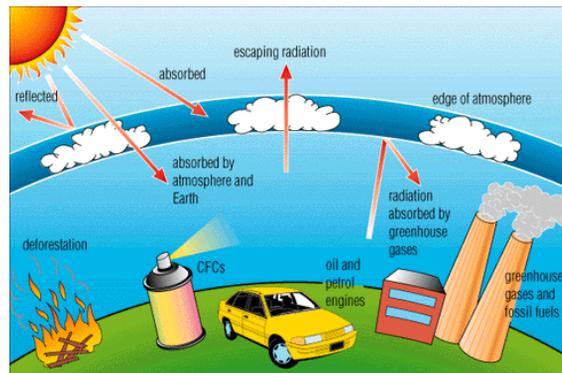
- As the concentration of CO₂ and other greenhouse gases (GHGs) increase, more energy is trapped and absorbed by the atmosphere.
- This process is called the anthropogenic greenhouse effect.

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Anthropogenic Greenhouse Effect

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- Involves the same processes as the natural greenhouse effect but as human release more GHGs Earth's NRG balance changes

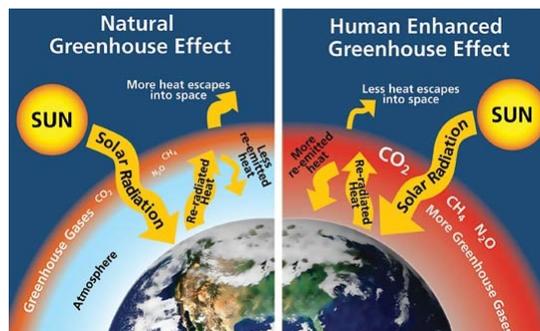


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Anthropogenic Greenhouse Effect

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- More thermal energy is trapped inside the atmosphere, raising temperatures beyond what they would be from the natural effect alone



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Anthropogenic Greenhouse Effect

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Main Greenhouse Gases

Greenhouse Gas	Chemical formula	Anthropogenic sources (examples)	Atmospheric Lifetime (years)	GWP (100 year time horizon)
Carbon Dioxide	CO ₂	Fossil fuel combustion, deforestation, cement production	50-200	1
Methane	CH ₄	fossil fuels, landfills, animal husbandry	12	21
Nitrous Oxide	N ₂ O	fertilizer, fossil fuel combustion	120	310
Fluorinated Gases	various	industrial processes	various	various

Global Warming Potential (GWP) is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the gas to that of the same mass of carbon dioxide (whose GWP is by convention equal to 1).

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Anthropogenic Greenhouse Effect

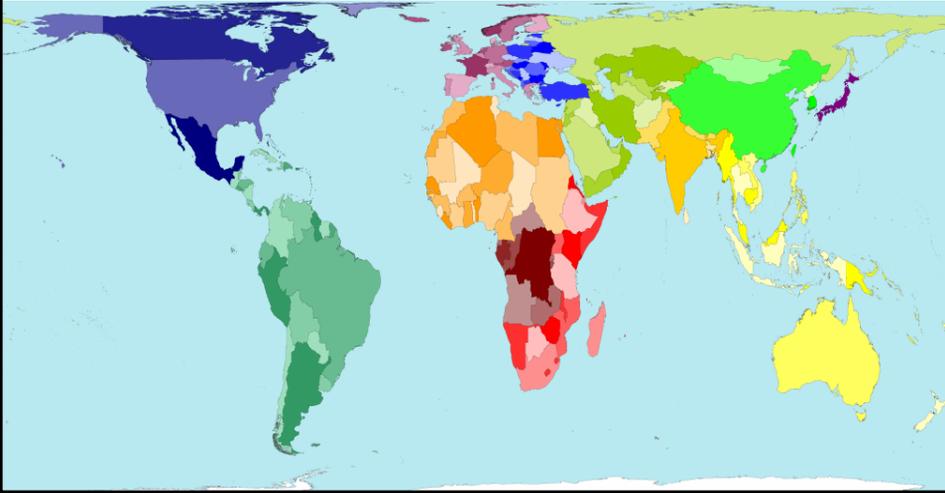
- Canada's Emissions
 - Canada ranks 15th out of 17 countries for greenhouse gas (GHG) emissions per capita and earns a "D" grade.

REPORT CARD		
GHG Emissions	1990s	2000s
Australia	D	D
Austria	A	A
Belgium	B	B
Canada	D	D
Denmark	B	B
Finland	B	B
France	A	A
Germany	B	B
Ireland	C	C
Italy	A	A
Japan	A	A
Netherlands	B	B
Norway	A	A
Sweden	A	A
Switzerland	A	A
U.K.	B	A
U.S.	D	D

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Anthropogenic Greenhouse Effect

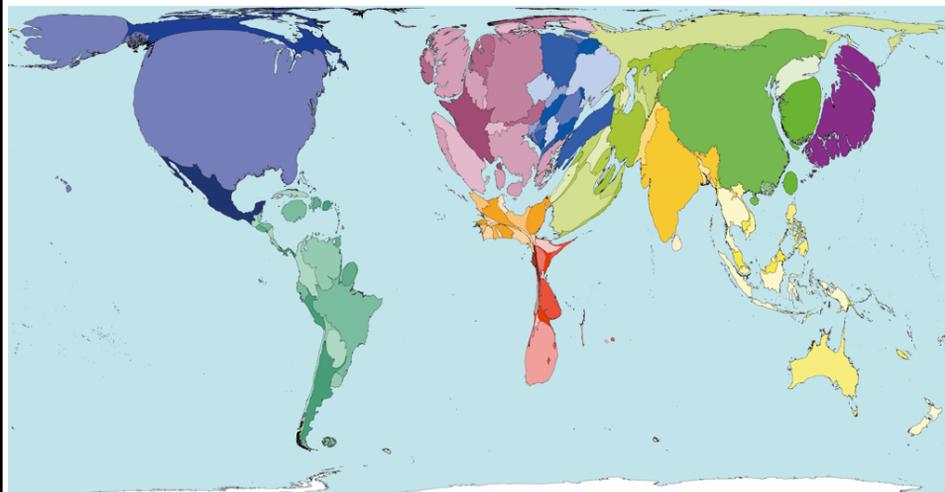
Regular World Map by Land Area



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Anthropogenic Greenhouse Effect

Distorted World Map Showing GHG emissions



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Climate Change

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- The result is climate change!



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Climate Change

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- Occurs when long-term weather patterns (i.e. temperature, precipitation, extreme events) are altered

Columbia Icefields, Jasper National Park

1906



M. Schäfer © Whyte Museum of the Canadian Rockies

1998



© B.H. Luckman

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Is Climate Change Real?

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- Global warming is one measure of climate change, and is a rise in the average global temperature.
- Click on the link below and try the Climate Time Machine to see predictions for all 5 factors

https://climate.nasa.gov/climate_resources/25/interactive-climate-time-machine/

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<http://www.youtube.com/watch?v=M2Jxs7IR8Z>

↓

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Top 5 Things That Could/Are Happening Because of Climate Change...

23

5. Everything is confused.

- meaning that self-regulating systems are now acting up (i.e. rain falling a few weeks later than it usually would)

4. The World Wide Redistribution of Growing Conditions & Fresh Water

- meaning that as the earth continues to warm, there will be an increase in poor growing conditions and drought (which leads to famine and war)

3. Displacement & Extinctions due to Sea Level Rise

- meaning that polar ice caps are melting which would flood low-lying communities and ecosystems

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Top 5 Things That Could/Are Happening Because of Climate Change...

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2. Ocean Acidification

- meaning that as oceans soak up CO₂ the pH of the water lowers, resulting in mass extinctions of oceanic species

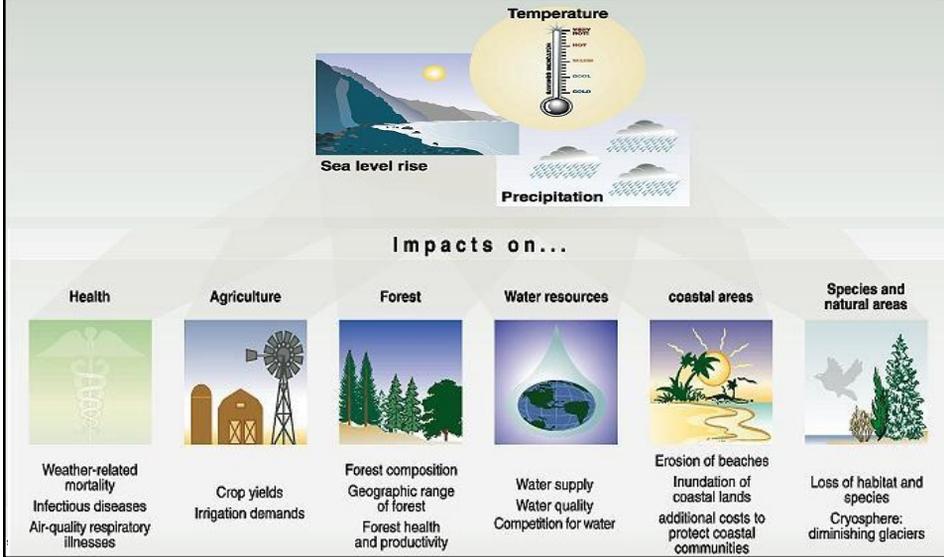
1. Shutdown of the Global Conveyor Belt

- meaning that thermohaline circulation would shut down resulting in:
 - a change in or stopping of global weather,
 - oceans would become a stagnant puddle,
 - and there would be an explosion in anaerobic bacteria that would fill the air with hydrogen sulfide

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Potential Effects of Climate Change

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