Climate Models

A climate model is a simulation of the factors that could affect Earth's climate.

It helps us see what might happen to Earth.

Factors that don't change: elevation, latitude

Factors that do change: air pollution, volcanic eruptions, etc.

With a climate model, we can manipulate variables and safely and easily see their effects.

We know they are accurate because we use info gathered from old trees, ice cores, NASA satellites, and human record-keeping to verify the effects.

Predictions can suggest how to mitigate the worst effects of climate change and help decision-makers prioritize environmental issues based on scientific evidence.

Climate models have the ability to advance the way we plan our cities and even influence business opportunites.

What Happens to the Bonds in Greenhouse Gases?

When the greenhouse gases absorb long wave radiation, the wave's energy causes the bonds to vibrate.

The bonds will stretch and bend as a result of this energy input.

The molecules have a change in dipole moment and may even change their angle temporarily.

The incoming energy, used to vibrate the bonds, is then released back into the atmosphere over time as a slightly longer IR wavelength than it was when it was absorbed.

Vibrations of H20:	Vibrations of CO2:
asymmetrical stretching (IR active)	asymmetrical stretching (IR active)

What Happens to the Bonds in Greenhouse Gases? (cont)

symmetrical stretching (IR active)	symmetrical stretching (not IR active)
symmetrical bending (IR active)	symmetrical bending (IR active)

When a molecule is not IR active, it is because there is no change in net molecular dipole.

Aerosols

Definition: tiny particles in the air that can be produced when we burn different types of fossil fuels.

Can also be called an **atmospheric particulate**.

In the 80s and 90s the word aerosol was used by the media to refer to the spray cans that released CFCs.

Most aerosols cool down the Earth. We need them in low levels, just like greenhouse gases.

Common aerosols include: organic carbon (warming), pure sulfates and nitrates (cooling), and soot (cooling).

Soot holds onto radiation energy and does not reflect it back, so cooling the global temperatures. In addition, it acts as a shade to UV light entering the atmosphere, cooling the surface.

Carbon Capture

Carbon capture involves capturing CO2 at its source (factories, etc.) and transporting it to a suitable location where it is stored underground.

This prevents it from entering the atmosphere.

This mimics how nature has stored oil, gas, and CO2 for millions of years.

The 2018 Paris Agreement

The goal was to achieve 0 net carbon pollution by the end of the century.

In order to do this, we must limit the human practices that create greenhouse gas emissions.

We can reverse the effect of those practices by reducing the amount of carbon in the atmosphere.

Bonded Pair Shapes

# of Bonded Pairs:	Shape Name:	Angle(s) (in degrees):	Example:
2	Linear	180	Carbon Dioxide
3	Trigonal Planar	120	Boron Trifluorid
4	Tetrahedral	109.5	Methane
5	Trigonal Bipyramidal	120, 90, 180	Phospho Pentachloride
6	Octahedral	90, 120	Sulphur Hexafluoride

These bonded pairs only happen with non-metals forming covalent bonds.
If there are lone pairs, they can cause a molecule to become **bent**. This means that the bond angle becomes reduced by 2.5 degrees.
Polar molecules have lone pairs.

The Best Way to Measure Climate Change

The temperature of the oceans.
WHY?
They are less erratic than air temperatures and thus more reliable. It also takes longer for ocean temperature to change than air temperature.



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The Best Way to Measure Climate Change (cont)

FINDINGS
- warming water expands, causing sea levels to rise
- resulting in more powerful storms and greater downpours, therefore stronger flooding
- causing a reduction in sea life, a loss of coral reef, and a displacement of people

Rise in Sea Levels

Warmer water expands, causing a rise in the sea levels.

This results in more powerful storms and greater downpours.

Destruction of Coral Reefs

Increasing carbon dioxide in oceans causes carbonic acid to form.

This increases the acidity of the oceans.

Resulting in the destruction of coral reefs.

Which in turn displaces large amounts of marine life.

UV Radiation

UV light is a wave that forms part of the electromagnetic spectrum. It has a higher frequency and shorter wavelength than visible light.

SPF: Sun Protection Factor

It is measured in how long the sun's radiation would take to redden your skin compared to without sunscreen

Common ingredients in sunscreen include titanium dioxide and zinc oxide.

UVA	UVB
longer wavelength	shorter wavelength
ages the skin	burns the skin
exposure causes genetic damage to the cells on the innermost part of the top layer of skin	penetrates and damages the outermost layer of your skin
can penetrate glass	cannot penetrate glass

UV Radiation (cont)

UN 2018 Warnings

Without urgent action, global temperatures will rise above 3 degrees celcius by the end of the century

This will cause entire cities to be swallowed by the ocean and plants and animals will face extinction due to extreme droughts

Increasing Greenhouse Gases & Their Effect

In recent years there has been an increase in the amount of greenhouse gases due to human activity such as **burning fossil fuels, deforestation, and modern farming practices**. The increase in greenhouse gases absorbs more of the outgoing long wave radiation, which **slows the release of energy into space** even more than normal. This increased amount of energy in the atmosphere results in **an increase in Earth's temperature**.

Why do we Need Greenhouse Gases?

In short, **to maintain Earth's temperature**. The Earth's temperature remains reasonably constant because greenhouse gases will absorb some of the long wave radiation (IR radiation) which slows the process of the energy being released into space.

Is it a Greenhouse Gas?

Greenhouse gases in the atmosphere can absorb infrared radiation. *A greenhouse gas must have a polar bond, but doesn't necessarily have to be a polar molecule.* In order to have a polar bond, there must be a difference in the **electronegativity** values between the atoms in the bond.

What is electronegativity?
- A measure of the tendancy of an atom to attract a bonding pair of electrons.
- The Pauling scale is commonly used
- e.g. F=4.0, which is the highest electronegativity value

What is Climate Change?

The term climate change is used to describe a long-term change in global temperatures and weather patterns. It describes the effects of global warming that have occurred as a result of human activity following the industrial revolution.

The Alcohol Family (CnH2n+1OH)

Methanol	CH3OH
Ethanol	CH3Ch2OH
Propan-1-ol	CH3CH2CH2OH
Butan-1-ol	CH3CH2Ch2CH2OH
Butan-2-ol	CH3CH2CHOHCH3

The Alkane Family (CnH2n+2)

Methane	CH4 (g)
Ethane	C2H6 (g)
Propane	C3H8 (g)
Butane	C4H10 (g)
Pentane	C5H15 (g)
Hectane	
Heptane	



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The Alkane Family (CnH2n+2) (cont)

Octane

Nonane

Decane

IPCC Findings

The nternational Panel on Climate Change, a UN body of climate scientists found that atmospheric carbon dioxide concentration had risen by 40% since the industrial revolution, resulting in Earth's 1 degree celcius temperature increase.

Effects of Increasing CO2 in Oceans

Carbonic acid ($H_2CO_3(aq)$) forms in the seawater resulting in an increase in acidity of the oceans.

Calcium carbonate + carbonic acid -> calcium hydrogen carbonate + carbon dioxide + water

$CaCO_3 (s) + H_2CO_3 (aq) \rightarrow CaHCO_3 (s) + CO_2 (g) + H_2O (l)$

Effects of Increasing Carbon Dioxide Levels in Water

-rising ocean temperatures

-makes it hard for shellfish to build the shells they need for protection

-algae bloom, causing *eutrophication*

-fish lose their sense of smell and are unable to detect predators

Eutrophication - excessive nutrients in a body of water; causes excessive plant growth and death of animal life due to lack of oxygen

What Makes a Greenhouse Gas Effective?

- Concentrations in the atmosphere (AKA Abundance)
- Ability to absorb infrared radiation

These two factors make a greenhouse gas contribute to global warming. However, a gas does not have to have high amounts of both factors to make a large impact. For example, Carbon Dioxide has a very high abundance in the atmosphere, but a low IR absorption ability, and it is still one of of the highest contributors to global warming.

Weather vs. Climate

Weather	Climate
occur locally	regionally or globally
short periods of time	over seasons, years, or decades
rain, snow, etc.	average of temperature, humidity, and rainfall patters

How Do CO2 Emissions Change the Global Climate?

CO_2 emissions may cause the Earth's atmosphere to trap more heat.

The CO_2 molecules absorb long-wave radiation.

Bonds will vibrate by bending to stretching.

Change in dipole and change in angle.

Transmission of long-wave radiation occurs into the atmosphere.

Thus raising the global temperatures.

this is the exact structure that my teacher wants, and may not work for everyone

Naturally Maintaining Earth's Temperature

The mean average of temperature of the Earth's temperature is regulated by a **steady state equilibrium** whihc exists between the energy reaching the Earth from the Sun and the energy being transmitted by the Earth back into space. The incoming radiation is **shortwave ultraviolet and visible radiation.** Some is reflected back into space and some is absorbed by the atmosphere before it reaches the surface.

The energy released back from the Earth's surface is **infrared radiation** which is longer in wavelength than UV or visible light. However, this means not all the radiation escapes and hence the Earth's temperature is warm enough to sustain life.



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