

Name: \_\_\_\_\_

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Class: \_\_\_\_\_

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## IB ESS

# 7.2 Climate Change – Causes and Impacts

### Significant ideas:

Climate change has been a normal feature of the Earth's history, but human activity has contributed to recent changes.

There has been significant debate about the causes of climate change.

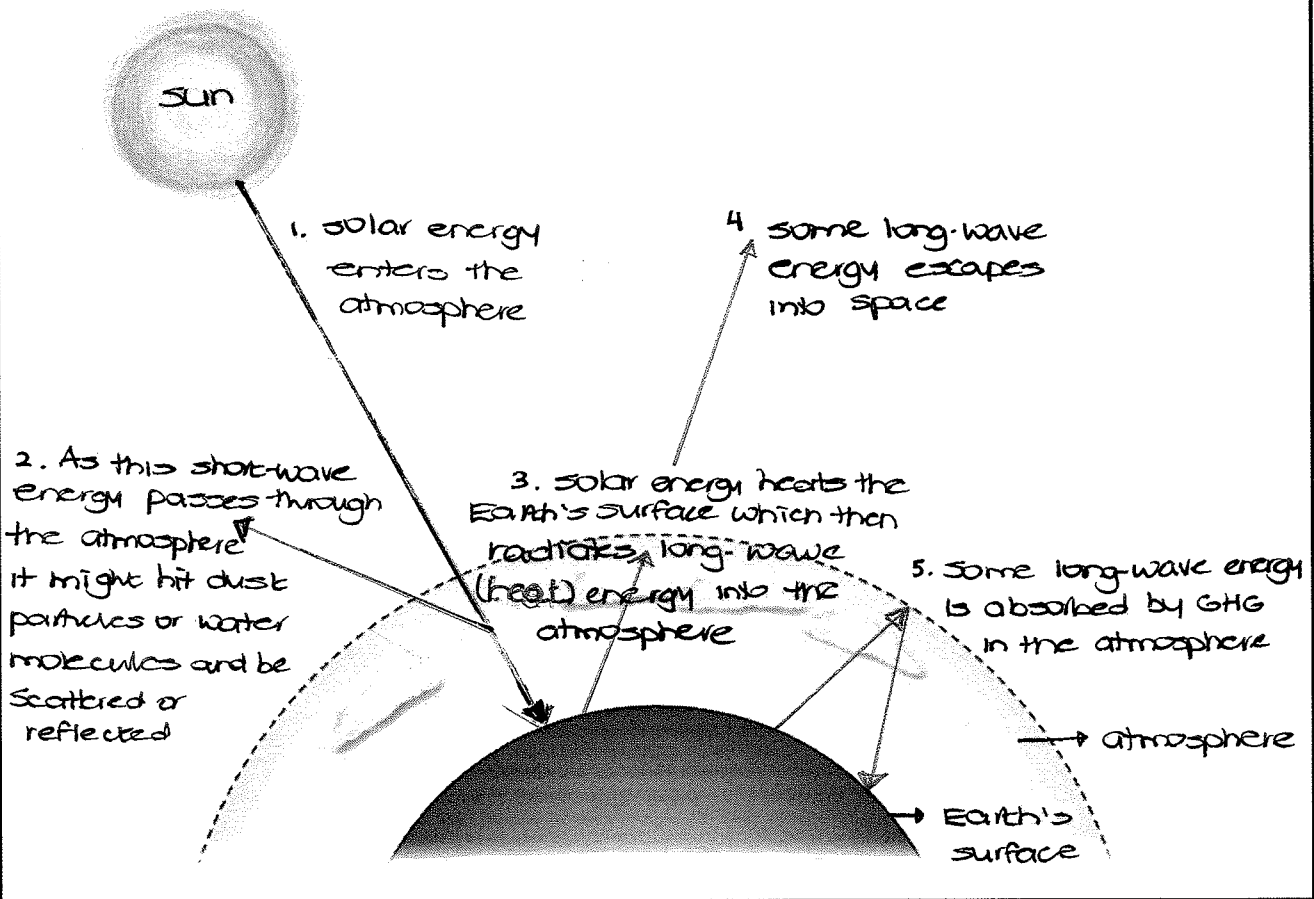
Climate change causes widespread and significant impacts.



# The Greenhouse Effect

1. Complete the diagram below to describe the greenhouse effect. Include the following labels (notice that some phrases are present twice):

longwave radiation      shortwave radiation      reflected      reflected      absorbed  
 re-emitted      atmosphere      Earth's surface      Sun



## Climate Change and Greenhouse Gases

1. Compare "greenhouse effect" and "global warming".

The greenhouse effect is a natural process that traps some outgoing longwave radiation and enables life on Earth. Global warming - or the enhanced greenhouse effect - is the process in which humans have increased the GHG in the atmosphere leading to increased trapping + heat

2.

a) List the human activities that are increasing levels of greenhouse gases.

Burning of fossil fuels, agriculture, livestock, landfills, use of refrigeration and air conditioning systems.

b) Using the headings as a guide, outline the potential effects of increased greenhouse gas levels

Global mean temperature

Global average/mean temperature has increased by about  $0.95^{\circ}\text{C}$  since 1880 most of that since 1980.

Extreme weather

More heat means more energy in the climate and so the weather will be more violent and sporadic with bigger storms and more severe drought.

Long term climate change

Increasing risk of dangerous feedbacks and abrupt large-scale shifts in the climate system.

Sea level

Melting of polar ice caps and glaciers will increase sea levels causing coastal flooding.



3. Compare "weather" and "climate"

Climate describes how the atmosphere behaves over relatively long periods of time whereas weather describes the conditions in the atmosphere over a short period of time.

4.

a) Outline the potential impacts of global climate change, using the headings to guide your answer.

Biomes

Biomes will shift further north/south from the equator (latitudinal) or up slopes as on mountains (altitudinal)

Crop-growing land

Changes: in the location of crop-growing areas with movements north and south from the equator. Some land may become unavailable e.g. wheat-growing region of the US

Biodiversity

Reduction in biodiversity as species change their distribution in response to change in climate. High altitude and high latitude species are more endangered as they have fewer options for migration.

Ecosystem services

The services provided (eg. primary productivity, pollination, flood control, climate regulation, provision of lumber) are all at risk

Coastal flooding

A rise in sea level cause flooding in low-lying areas such as the Netherlands, Egypt and Bangladesh - 200 million people could be displaced

Ocean acidification

Decrease in ocean pH is caused by the oceans absorbing human carbon dioxide emissions - the  $\text{CO}_2$  dissolves in seawater and forms carbonic acid.

Damage to human health

Heatwaves can cause death. Insect disease vectors will spread to more regions as they will not be killed off in winter. Malaria, yellow fever and dengue fever could spread to higher latitudes



b) Many of the points listed above are negative. However, some of the factors may be positive. State and explain which factors may be beneficial in some way.

As biomes shift towards the poles, significant changes in the location of crop growing areas are likely as the cultivation possibilities increase in previously peripheral areas. Vine cultivation will spread northwards in Europe, along with arable lands in general. Countries with restricted growing season, like Russia, will benefit from an extended growing season.



# Feedback Mechanisms

1. Define:

see Booklet 1.2

i) Negative feedback

tends to reduce, neutralize or counteract any deviation from an equilibrium and promote stability  
e.g. predator-prey relationships

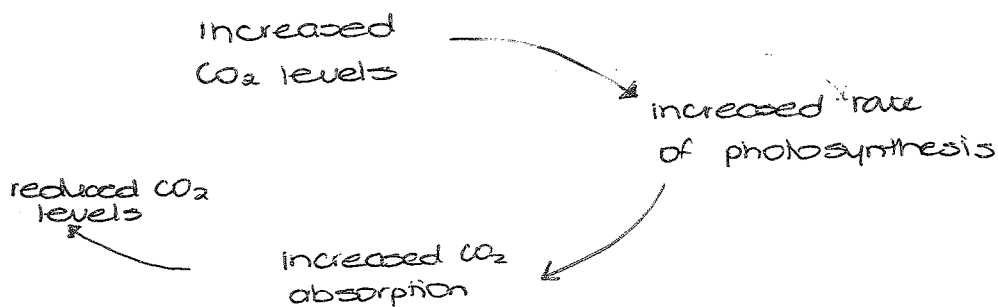
ii) Positive feedback

amplifies or increases change; it leads to exponential deviation away from equilibrium. Drives the system to a tipping point where a new equilibrium is adopted.

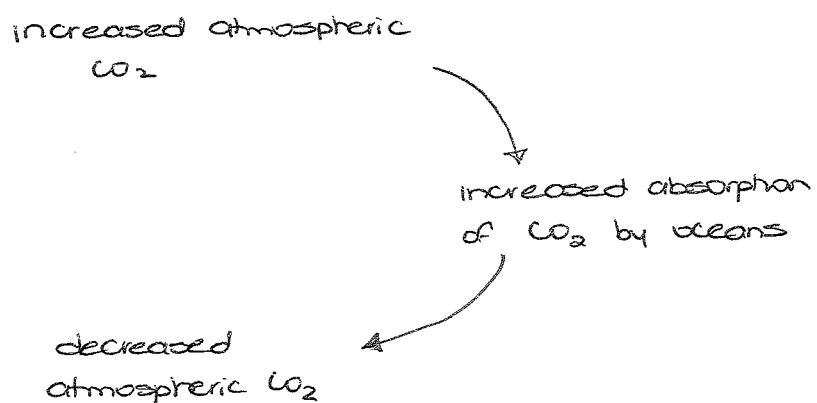
2. Draw flow diagrams (or similar) to represent these feedback mechanisms.

## NEGATIVE FEEDBACK MECHANISMS

i) Rates of photosynthesis may increase in response to increased  $\text{CO}_2$  levels

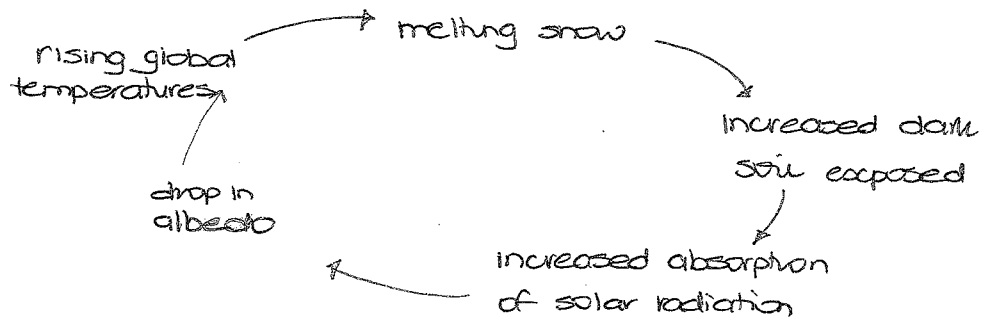


ii) Increased atmospheric  $\text{CO}_2$  will result in increased absorption by the oceans (Le Chatelier's principle)

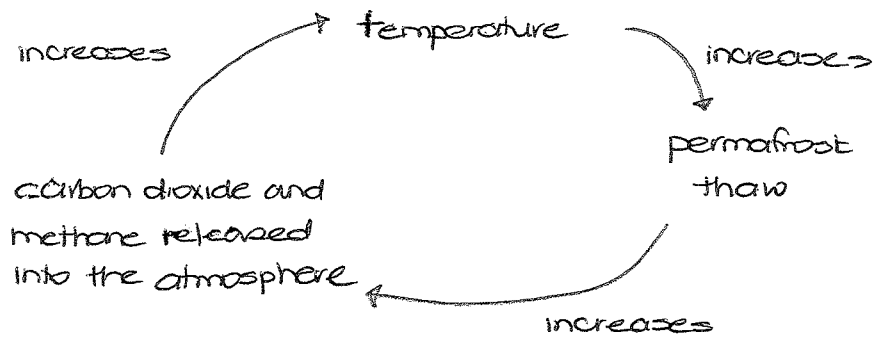


## POSITIVE FEEDBACK MECHANISMS

i) Increased snow melt reduces the Earth's albedo.



ii) Increased melting of permafrost releases methane, a greenhouse gas.



## Climate Modeling

1. Explain how improvements in technology have improved our ability to predict the future weather and climate

We have improved our modelling of climate change. Simple models of the climate system have been developed to predict change. These models have improved over the past 30 years and now include more factors.

2. Climate models, known as AOGCMs, are an essential tool in predicting future changes in the climate

a) What does AOGCM stand for?

Atmosphere-ocean-general-circulation models

b) What evidence is there to suggest that AOGCMs are reliable?

The latest AOGCM model quite accurately reflect past climate change so they will likely predict changes with various GHG concentrations accurately.

c) Climate models are **not** completely accurate. Give reasons for this.

Climate models need to use approximations to solve the complex equations involved. With climate models having both high and low estimates there is considerable uncertainty.





## Opinions on Climate Change

1. How might a person's environmental value system influence their opinion on the issue of global climate change? Consider whether or not they believe it is happening, and what they feel we should do about it.

All main EVS would acknowledge that global climate change is real, but would disagree on the cause and action needed.

Eco-centric: Global climate change is caused by human actions, more education is needed and a change in personal behaviour.

Anthropocentric: Climate change is part of natural cycle and we should manage the Earth's  $\text{CO}_2$  by taxation and legislation.

Technocentric: humans can reduce carbon emissions with engineering and developing alternate energy sources.

2. Do research to find two differing opinions on global climate change, one viewpoint that claims humans activities are causing global climate change, and one that believes this is not true. You can focus on the opinions of two individual people, or use media examples, such as documentaries that present a viewpoint.

(Help: if you don't know where to find appropriate examples, you could use the documentaries, "An Inconvenient Truth" and "The Great Global Warming Swindle". These are available via Youtube)

**TASK: Evaluate these contrasting viewpoints.**

(Remember to provide citations where relevant)

Al Gore won the 2007 Nobel Peace Prize for efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change.

Quote from a hearing before the committee on environment and public works in the United States Senate (<http://govinfo.gov/content/pkg/CHRG-110shrg55923/html/CHRG-110shrg55923.html>).

'Global warming is real and human activity is the main cause'

In 1938 there were about 300 parts per million of  $\text{CO}_2$  in the air. Today it is 338 parts per million. Even though Earth has gone through all these big swings in natural cycles, the  $\text{CO}_2$  content never went above 300 ppm in all that time.

We are putting 70 million tons every day of this global warming pollution into the Earth's atmosphere. Where the atmosphere is concerned, that extra  $\text{CO}_2$  is retaining in the atmosphere much more of the outgoing infrared than normally escapes back into space. It is real, we are



causing it, at least a majority of it.

An opposing view is shared by Martin Durkin in the Great Global Warming Swindle in which he claims that the chief cause of climate change is not human activity but changes in radiation from the sun.

'If we look at climate from the geological timeframe, we would never suspect CO<sub>2</sub> as a major climate driver. None of the major climate changes in the last 1000 years can be explained by CO<sub>2</sub>.

This point of view is based on a somewhat limited and more simplistic interpretation of the scientific data whereas Al Gore is using science to support his view.

3. Your opinion: Do you believe global climate change has occurred over recent years and will continue to do so as a result of human activities? Justify your answer.

Answers will vary

