CAIE Geography Pre-U

1B: The Atmospheric Environment

Essential Notes

Definitions, classification and distribution

What is climate classification?

The formalisation of systems that recognise, clarify and simplify climatic similarities and differences between geographical areas.

Climate types

- Equatorial
- Semi-arid tropical
- Arid tropical
- Semi-arid temperate/warm temperate west coast
- Semi-arid temperate/cool temperate continental
- Humid temperate/warm temperate east coast
- Humid temperate/cool temperate west coast
- Boreal
- Arctic

Processes in the atmospheric environment

Atmospheric systems

The atmospheric system consists of **inputs, stores, processes and outputs.** Ecosystems are examples of **open systems** with matter and energy flowing in and out. The Earth is a **closed system** with energy entering and exiting the system.

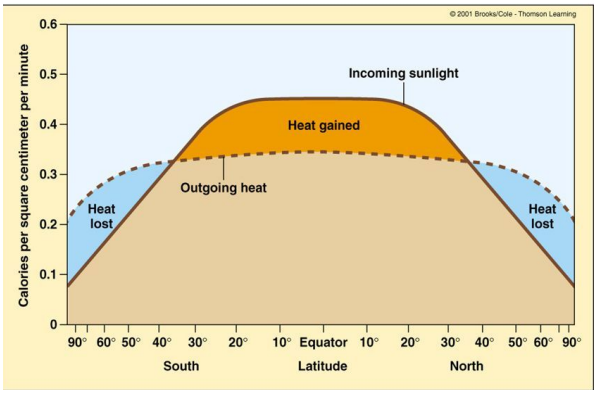
Atmospheric systems also undergo **two types of feedback**:

- Positive feedback
- Negative feedback

The Earth's atmospheric system consists of **four layers**:

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere

The vertical energy budget



http://slideplayer.com/slide/10011173/

Inputs to the vertical energy budget are in the form of **short-wave solar radiation**, commonly known as **insolation**. There are four factors that affect the level of insolation that enters our atmospheric system:

- **Solar constant**
- **Eccentric orbit** causes different **distances from the sun**.
- **Altitude of the sun in the sky**
- The length of night and day can vary

Vertical heat **transfers** occur when the energy is entering or exiting the system. There are three types of vertical energy transfers:

- **Absorption**
- **Reflection**
- **Scattering**

Ozone, gases and buildings can also store heat energy.

Outputs are in the form of long-wave radiation. They can occur in four ways:

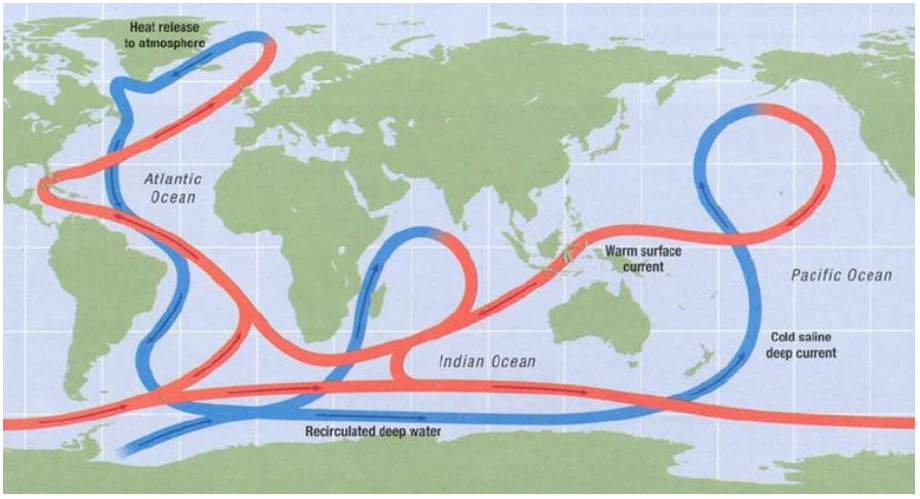
- **Radiation**
- **Conduction**
- **Convection**
- **Latent heat**

The ratio between incoming radiation and the amount reflected is known as the **albedo** and varies according to the surface.

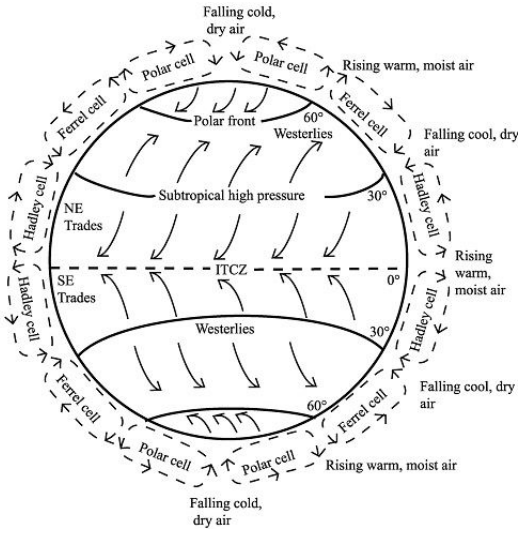
Horizontal energy budget

Due to the vertical energy budget, the equator receives more energy than the poles, this means that in order to stop the equator from continuing to warm and the poles continuing to cool, transfers need to take place. These are known as **horizontal heat transfers.**

Oceanic energy transfers: Due to the uneven heating of the surface of the oceans, convection currents between high and low latitudes are formed. Intense sun at the equator warms the water up. This water becomes less dense so travels along the surface towards the poles. As there is less insolation at the poles the water is colder and denser. It, therefore, travels along the sea bed towards the equator. These convection currents are started by the wind that moves over the surface and starts to drag the water. *Source: www.researchgate.net*



Atmospheric energy transfers: The main way this occurs is shown by **the tri-cellular model** shown below which also shows the movement of winds from high pressure to low pressure zones.
https://physics.stackexchange.com/questions/73450/why-does-the-wind-direction-vary-locally



The ITCZ is the **inter-tropical convergence zone** which is the meeting of the trade winds in the equatorial region. This can move north and south depending on the position of the sun and is involved in the monsoon of the Indian subcontinent.

The tri-cellular model is formed due to the influence of the **Coriolis force**.

Determinants of climate

- **Latitude**
- **Maritime or continental**
- **Altitude**
- **Position in relation to the tri-cellular model**
- **Aspect**

Short term changes and their impact

Characteristics of Cool temperate western maritime climate

Cool temperate western maritime (CTWM) climates are located between 40° and 60° within the **Ferrel cell** and on the **boundary with the polar cell**. They are **close to the ocean** which moderates the temperature. As they are located on the **west side** of the continent they are influenced by warm ocean currents which travel along the west coast. CTWM climates experience heavy cloud cover and prolonged periods of rain, drizzle and fog. CTWM climates can vary greatly in the short term due to the influence of the polar front, various air masses and the influence of both high and low pressure.

Jet streams

Jet streams are narrow zones of **high-speed winds** that are found high up in the atmosphere. They are formed through significant differences in temperature. The **polar front jet stream (PFJS)** is formed through the meeting of **subtropical and subpolar air** that also form a boundary called the polar front. The polar front jet stream meanders around the globe, these meandering waves are called **Rossby waves**. The jet stream helps to transfer energy and controls the location of air masses.

Air masses

Air masses are parcels of air which have the **same temperature, humidity and lapse rate**. Air masses have different characteristics depending on where their source was located and the characteristics of the surface over which it travelled. The UK is affected by 5 air masses:

- **Arctic maritime**
- **Polar continental**
- **Tropical continental**
- **Tropical maritime**
- **Polar maritime**

Polar front

The polar front is the transition boundary between tropical maritime air and polar maritime air. When the PFJS moves northwards, the UK experiences warm weather as the overlying air mass is tropical maritime. If the PFJS moves southwards the UK will experience cold, wet weather. There are three types of front:

- A **warm front** which is where warm air is advancing and being forced to override the cold air.
- A **cold front** is where advancing cold air undercuts the body of warm air.
- **Occluded front** is formed as a result of a cold front catching up with a warm front.

Depressions

Depressions are areas of low pressure and mostly occur at mid-latitudes. A depression cycle undergoes three stages:

- The **embryonic stage** is when warm, moist tropical maritime air meets colder drier polar maritime air. The warm air is forced to rise and so there is less air at the surface, resulting in low pressure.
- The **mature stage** is when the pressure continues to fall as more warm air is forced to rise. As there is less air in this area, winds blow into this area and as pressure continues to decrease, these winds increase in strength.
- The final stage is known as the **decaying stage.** This is where the cold front catches up with the warm front to form an occluded front. There is no longer any warm sector at ground level and pressure gradually rises to lead to decreased wind speeds.

In the summer low-pressure weather creates prolonged rainfall and flooding, although nice weather can be experienced in-between weather fronts. In the winter heavy rainfall and snowfall can occur and stormy conditions also occur.

Anticyclones

Anticyclones are areas of high pressure formed by falling air. In the summer, warm, dry weather is created and heatwaves and droughts can occur. In the winter, high-pressure zones experience cold, dry, frosty days.

Blocking anticyclones are areas of high pressure which remain stationary for long periods of time. This distorts the usual eastward progression of pressure systems and often are the cause of heatwaves.

Impacts and management of high-pressure and low-pressure systems

	Low pressure	High pressure
Summer positives	Good irrigation for plant growth. Increase in sale of waterproofs and warm clothes.	Increase flight demands. More plant growth. More vitamin D. Increase in moods. Increased tourism. Infrastructure can be built.
Summer negatives	Trees are blown down. Damage to infrastructure. Crops damaged. Flooding.	Restriction on train speeds. Forest fires. Low rivers. Drought. Hyperthermia.
Summer management	Planning, Irrigation/drainage. Flood measures. NHS strategies.	Irrigation. Hosepipe bans. Health information.
Winter positives	More public transport used. Increase in winter sports. Increased trade abroad. Increase in online shopping.	Increase in indoor leisure activities. Increased online shopping.
Winter negatives	Road travel difficult. Rural settlements isolated. Agricultural production halted. Increase in illness. People unable to get to work.	Travel and transport disrupted. Old and very young vulnerable to serious colds. Damage to water pipes.
Winter management	Contingency planning. Gritters for the roads. NHS strategies.	Warnings of weather on the internet, radio, news etc. Health information provided.

Seasonal changes and their impacts

The monsoon is the seasonal reversal in winds and the subsequent change in precipitation.

Summer monsoon

The sun appears to move northwards bringing with it the **ITCZ**. Heat increases over the Indian subcontinent as **insolation increases** and creates a large area of **low pressure**. As a result of this, **warm, moist air is drawn northward**. The rainfall totals are accentuated as the air is forced to rise, because of the **Himalayas**, by both **orographic and convectional uplift**.
Impacts of the summer monsoon include:

- Extreme flooding
- Damage to crops
- Lots of water for irrigation
- Infrastructure and tourism damaged
- Compromise of water purification facilities

Winter monsoon

The sun and the **ITCZ** both **move southwards**. The land experiences **intense cooling** which creates a very large **high-pressure zone**. The air moving over the land is dry because it originated in a semi-desert area and they become warmer and drier as they **descend from the Himalayas**.
Impacts of the winter monsoon include:

- Allows the rice to ripen, be harvested and be planted
- Low amounts of water are available for irrigation
- Drought

Changes in the monsoon

Due to climate change and possibly other unknown factors, the monsoon is becoming more **unreliable**. The amount of rainfall each year and when it arrives varies considerably and this makes it difficult for farmers to predict when to plant their crops.

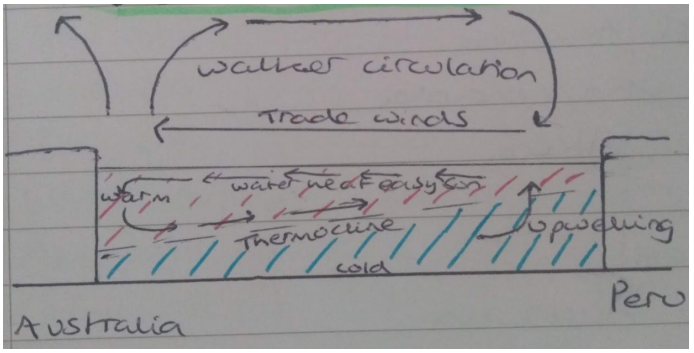
Management

- **Holiyas** are simple holes dug in the ground lined with plastic piping and can contain storage below. They allow excess water to be collected during the summer monsoon so flooding does not occur and then the collected water can be used during the winter.
- **Drought and flood-resistant crops**
- The government and charities are improving **forecasting and early warning systems** to alert farmers when the rains will come
- **Water distribution** improvement programme and **seed banks**.

Cyclical changes and their impacts

The **El Nino Southern Oscillation (ENSO)** is the irregular periods of changing wind speeds and the resulting change in the ocean currents in the Pacific Ocean. There are three different periods of ENSO: El Nino, La Nina and neutral conditions.

Neutral conditions

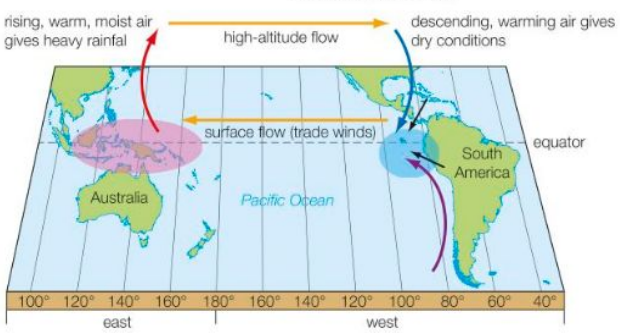


Upwelling of cold water off the coast of South America gives productive fishing due to nutrient-rich waters.

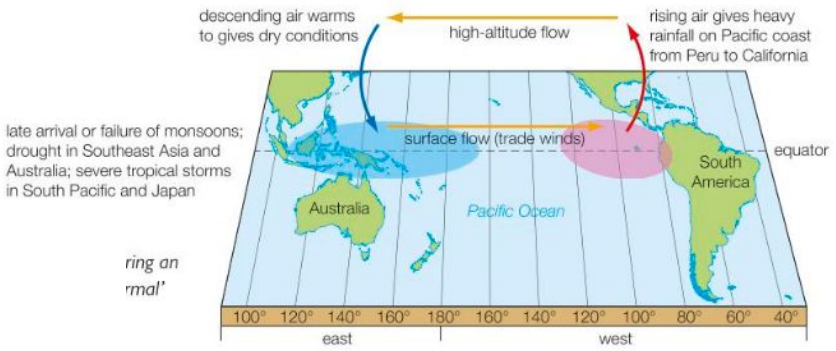
El Nino Southern Oscillation

El Nino is the **change** in water body patterns within the Southern hemisphere, leading to unusual weather conditions. The causes of El Nino aren't fully understood.

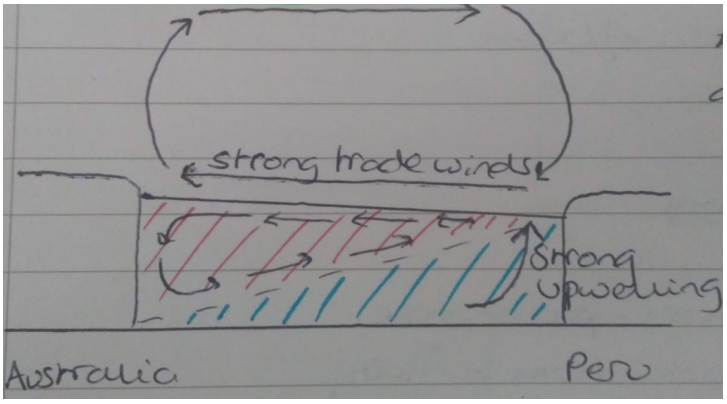
- Normally cool water is found along the Peruvian coast, and warm waters are found around Australia.
- ENSO causes this to switch (Peru gets warm waters, whereas Australia get cold water) and usually occurs every 3 to 7 years, generally lasting for 18 months.
- Peruvians can determine ENSOs occurrence based on their **anchovy** harvest - anchovies prefer cold waters, therefore as the water warms up (due to El Nino) the anchovies will migrate away, causing a reduction in Peruvian harvest.
  - ENSO can also trigger **extremely dry conditions** in areas South & South-East Asia, Eastern Australia and North-East Brazil. In South Asia, ENSO can **weaken the annual monsoon**.



The conditions before and during El Nino



La Nina



The atmospheric pressure differences are large so the trade winds are strong. This gives very productive fishing in Peru. Australia experiences increased rainfall, whereas South America experiences drier conditions.

Management of ENSO

ENSO can be monitored through **buoys** in the sea that can measure temperature. The **height of the ocean** can be measured by **buoys and by satellites**.
If these monitoring systems can detect whether an El Nino year or La Nina year is about to occur then **planning** can be put in place. **Drought/flood-resistant crops** can be planted and extra **seeds stored**. The government can issue **advice** to citizens and make sure that emergency services are prepared and drills carried out.

Long term changes and their impact

Causes

The earth's climate has been changing throughout all of history. The earth can undergo **global warming** as a result of natural and/or human causes. Natural causes of global warming include:

- **Astronomical forcing**
- The amount of **energy emitted by the sun can vary** due to sunspots.
- **Eruption of volcanoes**.
- **Natural greenhouse gases**.

Humans have increased the levels of greenhouse gases in the atmosphere, this is known as the **enhanced greenhouse effect** and it is as a result of increased levels of pollution and carbon dioxide due to **industrialisation, deforestation** and large scale, **commercialised agriculture**,

Impacts

Global warming affects both humans and animals across the world. Here are just some examples of the possible impacts:

- More storms in Britain
- Flooding by the sea in Bangladesh and India
- Many Pacific Islands being submerged by the sea
- The seas by Canada becoming too warm for salmon and trout
- In Britain there will be 30% more rain in winter and 30% less rain in summer by 2080.
- Increased coral bleaching
- Extinction of many animals

- Increased levels of malnutrition and famine
- Vectors of diseases such as the mosquito that carries malaria will be able to breed in higher latitudes and so the distribution will increase
- Cereal production in high latitudes will increase but in low latitudes will decrease

Management

Management of climate change can either be **mitigation** or **adaptation.** Mitigation is trying to stop climate change by using **renewable energy** sources such as wind and solar, setting targets to **reduce GHG emissions** and **capturing carbon emissions**. Adapting is making changes so that we can live with the effects of climate change. This will include **planting drought-resistant crops**, **managing coastline retreat** and investing in **better freshwater provision**.

Views on climate change

Evidence for and against climate change:

- July 2016 was the 379th consecutive month with global temperatures above the 20th-century average.
- Over the last 11 year solar cycle, solar output has been lower than it has since the mid 20th century so global warming cannot be as a result of this.
- There have been many periods hundreds of thousands of years ago where the temperature is at about the same level as today and the earth's temperature has been constantly under flux.
- In less than 100 years the levels of CO_2 have been constantly increasing and are around double the previous maximum. Although correlation between rising CO_2 and rising temperatures does not necessarily mean causation.
- The oceans are becoming more acidic due to harmful gases which have been released by humans being absorbed by the oceans.
- The glaciers and the polar ice is shrinking.
- Not enough historical data available to confirm if temperatures are increasing and some scientists say that there has been no significant increase in global temperatures since 1997.
- Models used to predict future impacts of climate change are flawed and give false predictions.