Kemnal Keys GCSE Topic 2 Weather hazards and climate change

Detailed Content	Core Knowledge & Understanding	Keywords
*The features of the **global atmospheric circulation***	Wind is caused by differences in atmospheric pressure – air moves from high pressure to low pressure – the greater the difference in pressure, the stronger the winds. Towards the poles, the Sun's energy spreads over a large area, resulting in low temperatures and high pressure. At the equator, the Sun's energy is concentrated over a small area, resulting in high temperatures and low pressure. The further one moves away from the equator towards the poles (low latitudes to higher latitudes) the less of the Sun's heat energy is concentrated on a smaller area. The difference in air pressure on the Earth's surface causes global patterns of air circulation (cells) from areas of high pressure to areas of low pressure. **The Tri-cellular model of Global Atmospheric Circulation** 1) Warm air rises from the equator, creating a belt of low pressure. As the air rises, it cools. 2) The resulting condensation creates clouds and rain that move north and south of the equator. 3) The **ITCZ** (Inter-tropical convergence zone) is a band of low pressure around the Earth which generally lies near to the equator. The trade winds of the northern and southern hemispheres come together here, which leads to the development of frequent thunderstorms and heavy rain. 4) At 30° north and south of the equator, the cold, dry air sinks, creating high pressure and clear skies **(Hadley Cell).** 5) When the sinking air reaches the Earth's surface, it moves either back to the equator or towards the poles. 6) At 60° north and south of the equator, the surface air meets colder air from the poles, which causes it to rise, creating a belt of low pressure (Ferrel Cell). 7) The air rises and cools. At a high level, this moves either back to the equator or towards the poles. 8) At the poles, the cool air sinks to the Earth's surface, creating high pressure. The air them moves back towards the Equator (Polar Cell).	Air Atmosphere Wind Air pressure Global Circulation Angle of incidence Tri-Cellular model Equator Inter-Tropical Convergence Zone (ITCZ) hemisphere Latitude Longitude Hadley cell Ferrel Cell Polar cell
*How **circulation cells** and **ocean currents** transfer and redistribute heat energy across the Earth.*	**Ocean currents** are large scale movements of water that transfer heat energy from warmer to cooler regions. Surface currents are caused by winds and help transfer heat away from the equator. The **Gulf Stream** is an example of surface ocean movements from the Caribbean to the UK. Deep ocean currents, known as **Global Thermohaline Circulation**, also transfer heat from the equator to the poles but are driven by differences in water density. When water freezes at the poles, the surrounding water gets saltier, increasing its density. As it gets denser it sinks, causing warmer water to in at the surface – creating a current. This warmer water is cooled and sinks, continuing the cycle. The **Humboldt Current** brings cold water back from the poles to the equator, where it is heated.	Ocean currents Surface currents Gulf Stream Global Thermohaline Circulation Humboldt current Density Salt
*How **climate** has changed in the past over different time scales: glacial and interglacial periods during the Quaternary period.*	The average climatic conditions of the Earth change naturally over time, creating both warmer and colder periods. The Quaternary Period is the most recent geological time period from 2.6 million years ago to the present day and includes the whole of human history. **Before** the Quaternary, global temperatures were warmer and quite stable. **During** the Quaternary global temperatures have shifted between cold glacial periods that last for around 100,000 years, and warmer interglacial periods that last for around 10 000 years.	Climate Geological time Quaternary Glacial Interglacial

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Causes *(Milankovitch cycles, solar variation, volcanism) and evidence (ice cores, pollen records, tree rings, historical sources) for natural climate change.*	These variations were caused by natural events: **Milankovitch Cycles** - Earth's orbit changes approx. every 100 000 years from a circular orbit (warmer) to a more elliptical orbit (colder) **(Eccentricity)** - Roughly every 40 000 years the Earth's tilt varies = greater angle of tilt = hotter summers and colder winters **(Axial tilt)** - The Earth 'wobbles' on its axis roughly every 24 000 years resulting in differences between seasons. **(Precession)** **Solar variation** Lower solar radiation output levels result in glacial periods, higher solar radiation output levels result in interglacial periods. **Tectonic activity** Large-scale volcanic eruptions can eject ash and dust into the atmosphere blocking out solar radiation causing temperatures to fall **Evidence** **Historical sources** such as diaries and painting **Ice Cores** trap volcanic bubbles, revealing information on climate when the ice is formed **Tree rings** show climate conditions by the size of their growth – thick rings mean warm, wet conditions **Pollen records** provides evidence on warm and cold growing conditions	Variations Milankovitch Cycles Eccentricity Axial tilt Precession Circular orbit Elliptical orbit Seasons Solar radiation Tectonic Volcanic eruptions Evidence Historical sources Ice cores Tree rings Pollen
How ***human activities*** *(industry, transport, energy, farming) produce greenhouse gases (carbon dioxide, methane) that cause the enhanced greenhouse effect.*	**The Greenhouse Effect** – how the atmosphere keeps the Earth warm and sustains life on Earth. Heat energy (insolation) passes through the atmosphere and heats the Earth's surface and oceans. Heat is radiated back into space from the Earth. Greenhouse gases such as CO_2, H_2O, and CH_4 trap some of the heat in the Earth's atmosphere. **Enhanced Greenhouse effect** **Human activities** have increased the levels of greenhouse gases and therefore increased temperatures since the Industrial Revolution through: - **Industry** – production of consumer goods using fossil fuel energy releases greenhouse gases. Cement made from limestone contains carbon which is released when cement is produced. Industrial waste releases methane through waste decay - **Transport** – most transport runs on fossil fuels. Increased car ownership increases greenhouse gas emissions. Residential and business properties rely on fossil fuels for electricity and heating - **Agriculture** including rice production and livestock produce lots of CH_4. Deforestation for agriculture reduces the amount of CO_2 trees absorb and store.	Greenhouse effect Insolation Atmosphere Radiated Enhanced Greenhouse effect Greenhouse gases Industrial Revolution Industry Consumer Fossil fuels Waste decay Transport Residential Agriculture Livestock
Negative effects that ***climate change*** *is having on the environment and people (changing patterns of crop yield, rising sea levels and retreating glaciers).*	**Negative effects** **Environment** - melting ice sheets, retreating glaciers = sea level rise = coastal flooding = contamination with salt causing plants to die. - Arctic melting could change the Gulf Stream bringing colder temperatures in Western Europe. **People** - Changes in climates near the equator e.g. The Sahel means longer periods of drought so lower crop yields. - Many low-lying islands like the Maldives face greater flood risk from rising sea levels.	
Climate of the ***UK*** *today and changes over the last 1000 years*	UK climate has varied a lot over the last 1000 years. **Medieval Warm Period** - between 900 and 1300 **Little Ice Age** - cooling followed the Medieval Warm period	Medieval
Spatial variations in temperature, prevailing wind and rainfall within the UK.	North and west are generally cooler and wetter than the south and east The prevailing wind is from the south west, across the Atlantic Ocean	Cardinal points Prevailing wind
The significance of the UK's geographic location in relation to its climate.	**Prevailing winds** from the south west bring warm moist air across the Atlantic Ocean resulting in higher rainfall in the west Higher elevation tends to have higher areas of rainfall (orographic rainfall)	Elevation Orographic

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*How the global circulation of the atmosphere leads to **tropical cyclones** (hurricanes and typhoons) in source areas and the sequence of their formation*	**Tropical cyclones** develop in a band of low pressure and warm temperatures between 5° and 30° north and south of the equator through global atmospheric circulation Sea temperature = 26°C or higher Water depth = 60-70m Low wind shear Warm, moist air rises, leading to condensation and low air pressure, increasing surface winds. Easterly trade winds move tropical storms to the west near the equator. Coriolis effect (Earth's rotation) makes storms spin. Energy increases over warmer water, loses strength over land. Majority of storms occur in northern hemisphere **1)** Warm, moist, unstable air above the ocean rises, creating an area of low pressure below **2)** Surrounding cooler air is drawn into the area of low pressure, causing winds **3)** The cool drawn-in air warms up and takes on moisture, causing it to rise **4)** The large mass of rising, warm air cools and condenses, forming large cumulonimbus clouds and heavy rain **5)** Latent heat released during condensation helps to power the storm **6)** As more air is drawn in the area of low pressure, the Earth's rotation causes wind to spiral in the storm's centre, or eye (**Coriolis effect**) **7)** Colder, drier air sinks in the eye of the storm, creating calm conditions. Prevailing winds then push the storm inland **8)** The storm continues to get bigger and stronger until it reaches land or colder seas. Landfall and friction slow the storm down. The centre is called the **eye** – descending air, low pressure light winds, no rain, high temperature **Eye wall** – spiralling rising air, very strong winds, storm clouds, torrential rain, low temperatures **Edge** – lower wind speed, smaller clouds, scattered rain, temperature increases	Tropical cyclones Latitude Wind hear Moist Trade winds Coriolis effect Rotation Hemisphere Evaporation Condensation Precipitation Cumulonimbus clouds Spiral Vortex Landfall Friction Eye Eye wall Edge
Characteristics, frequency and geographical distribution of tropical cyclones and how these change over time	**Names and locations** - Hurricanes = Atlantic Ocean - Typhoons = Pacific Ocean - Cyclones = Indian Ocean June – November = northern tropics November – April = southern tropics Circular in shape, hundreds of kilometres wide, lasting 7-14 days, spin anti-clockwise in the north and clockwise in the south Increased frequency and intensity due to the enhanced greenhouse as a result of increased greenhouse gases released into the atmosphere through human activities	Hurricanes Typhoons Cyclones Clockwise Anti-clockwise Frequency Intensity
Reasons why tropical cyclones are natural weather hazards (high winds, intense rainfall, storm surges, coastal flooding and landslides).	Measured using the **Saffir-Simpson Scale** – Cat 5 is the strongest **High winds** – up to 250 km/h **Rainfall** – trillions of litres of water per day **Storm surges** – rise in sea level through low pressure and high winds **Coastal flooding** - result of storm surges **Landslides** – rainfall makes hills unstable	Saffir-Simpson scale Storm surges

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Different social, economic and environmental impacts that tropical cyclones can have on a ***named developed* and a named emerging* or developing* country***	**Case Study Developed and developing country** **What:** Hurricane Irma, Category 5 **When:** 8th to 11th September 2017 **Where:** Gulf of Mexico **Who:** Barbuda, Caribbean Islands (developing), Florida, USA (developed) **Why/How: Causes** - Tropical depression formed in the Atlantic Ocean. Spinning vortex of winds as heat energy is evaporated from the ocean to fill gap of very low air pressure. Sea temperatures 32˚C in Gulf of Mexico. Air pressure 915mb. Trade winds blowing away from the Equator. **Impacts Caribbean – Barbuda (developing)** Up to 185mph winds 600 students had to go to school on other islands 90% properties damaged 68 sq. miles covered by Category 5 hurricane No water or communications – island considered uninhabitable 3 deaths Most people evacuated from Barbuda to Antigua $250 million in damages = 12% of islands GDP 1,800 residents evacuated 3m storm surge causing significant flooding	Tropical depression Developed country Developing country Uninhabitable Evacuated Significant Tourism Colony
Different social, economic and environmental impacts that tropical cyclones can have on a named developed and a named emerging* or developing* country*	**Impacts USA – Florida Keys (developed)** 7 direct deaths in USA 85 indirect deaths of which 80 were in Florida 77,000 people in shelters 6.5 million ordered to evacuate 70% buildings built before 1994 6.9 million homes left without power 2 – 3 m storm surge causing significant flooding 250 to 300mm rainfall an hour $62.5 million in damages Loss of tourism trade	
Different responses to tropical cyclones of individuals, organisations and governments in a named developed and a named emerging or developing country	**Responses Caribbean – Barbuda (developing)** 60 tons of relief supplies sent by USA and British Aid Agencies British military troops sent to support restoration of electricity Many NGO's remain in situ to provide relief Antiguan and Barbudan government trying to force people to leave, stating the land they share as 'common land' should be bought and developed. Locals resisting 'disaster capitalism' **Responses USA – Florida Keys (developed)** The five living former US presidents have raised more than $31m (£23.5m) for victims in the US. Various aid agencies remain involved in providing support	Relief supplies NGO's - Non-Government Organisations Disaster capitalism

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*Characteristics of **arid environments** compared to the extreme weather conditions associated with drought*	**Arid** environments are places which normally have very low rainfall e.g. deserts. Many are also hot, causing water to evaporate before it can be replaced by rain **Characteristics of arid environments** - plant growth is sparse short, low shrubs, few trees - soil is shallow and not very fertile as there is hardly any leaf litter **Characteristics of droughts** - severe shortage of water over an extended period of time for a particular location - water supplies become depleted as they are not replenished with rainfall but still used often - high temperatures which increases evaporation rates	Arid Desert Characteristics Sparse Leaf litter Drought Depleted Replenished
*Different causes of the weather hazard of **drought**: meteorological, hydrological, and human (agricultural, dam building, deforestation).*	**Causes of droughts** **- Meteorological changes in atmospheric circulation (see Milankovitch cycles)** El Niño can slow down the trade winds in the Pacific Ocean from east to west, resulting in less warm water reaching Australia Blocking high pressure systems can stop depressions that cause rain moving across the Atlantic Ocean to the UK - **Hydrological** Lack of water in rivers, lakes, reservoirs and aquifers (stores) mean abstraction without replenishment Water evaporates quicker in high temperatures meaning stores are depleted quicker **- Human** Irrigation for farming uses large volumes of water Building dams to create reservoirs limits water supply downstream Deforestation reduces water held in the soil and reduces transpiration back into the atmosphere	Meteorological El Niño High pressure systems Depressions (low pressure systems) Hydrological Aquifers Abstraction Replenishment Depletion Irrigation Dam Reservoir Deforestation
Why the global circulation makes some locations more vulnerable to drought as a natural hazard than others and how this changes over time.	**Vulnerability** Most severe droughts found at 30° north and south of the equator Pattern is caused by cool, dry air sinking, creating belt of high pressure with very little rainfall (between Hadley and Ferrel cells) Drought pattern is spreading to larger areas as a result of climate change	
Reasons why droughts are hazardous	**Hazards** Low water levels causing animals and plants to die Stagnant water unable to flush out waste materials leading to water-borne disease such as cholera Lack of food supplies leads to malnutrition, famine and death Soil exposed to wind erosion Soil hardens so when the rains do come it is unable to infiltrate, leading to flooding Wildfires	

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How the impacts of drought on people and ecosystems can vary for a ***named developed* and a named emerging or developing country****	**Case Study Australia Early 21st Century (developed)** **What:** Severe, long-term drought **Where:** South-east Australia **When:** 2001 to 2009 **Who:** Murray-Darling Basin – known as the 'Big Dry' **Impacts on people** - water levels in rivers and lakes fell so water supplies greatly reduced - crop yields fell – increased food prices - livestock died - farmers' income fell - 100000 people lost jobs **Impacts on ecosystems** - dust storms in land - wildfires – over 30000km² of land burned Impacts on ecosystems - vegetation loss and soil erosion - toxic algae - river and marshlands dried up - plants and animals died - some invertebrates need floods to breed – some near extinction - wildfires destroyed habitats	Crop yields Livestock Income Dust storm Vegetation Toxic algae Marshlands Invertebrates Extinction Habitats Pasture Cattle Migration Food insecurity Malnutrition Starvation Desertification
How the impacts of drought on people and ecosystems can vary for a named developed and a named emerging or developing country	**Case Study Ethiopia 2016 (developing)** **What:** Severe, almost continuous, long-term drought **Where:** Ethiopia, Horn of Africa **When:** Continued decline in precipitation since 1980's but most severe in 2016 **Who:** 85% of people in Ethiopia depend on agriculture as their main income **Impacts on people** - farmers in some regions lost 50-90% of their crops - lack of pasture for animals - 2 million cattle died, reducing milk production - migration to urban areas for work - food insecurity and malnutrition - 70000 people at risk of starvation. In 2017 7.8 million people needed emergency assistance to meet their basic needs **Impacts on ecosystems** - water sources dried up and plants died - loss of vegetation damaged habitats for wildlife - vulnerable to wildfires, flooding, wind erosion and desertification	

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Different responses to drought from individuals, organisations and governments in a named developed and a named emerging or developing country	**Case Study Australia Early 21st Century (developed)** **Responses** **Individuals** - water saving measures such as re-using grey water and using water-efficient showers - farmers using drip-irrigation - diversifying farming incomes **Organisations** - media campaigns in schools and on TV to encourage reducing water usage - CSIRO (research institute) to developed and breed drought-tolerant types of wheat **Government** - water conservation measures through reduction in water allocation - desalination plants built - income support to 23000 rural families and 1500 small businesses - improved investment in forecasting and preparing for droughts	Grey water Water-efficient Drip-irrigation Diversify Drought-tolerant Conservation Desalination Investment Forecasting Livelihoods Humanitarian aid Great Green Wall Semi-arid Rural-to-urban migration
	Case Study Ethiopia 2016 (developing) **Responses** **Individuals** **-** migration to new livelihoods in urban areas - farmers switched from growing cereal crops to a more resistant crop called chat **Organisations** - charities and international organisation provided humanitarian aid - FAO of the UN requested US$20 million for seeds and to reduce pests - FAO treated livestock and humanely slaughtered those too ill to survive to prevent disease - the Great Green Wall, in conjunction with other nations in The Sahel, are planting a wall of trees in the semi-arid region to increase transpiration and then precipitation **Governments** - Ethiopian Government distributed food from its national food reserve through the Productive Safety Net Program, in which people work on public building projects in return for food or money - provided permanent housing to rural-to-urban migrants near to sources of water	