



Anticyclones, depressions, hot & drought, cold & snow

Learning Objectives:

To describe and explain the weather associated with high and low pressure systems and their links to extreme weather, the hazards associated with this extreme weather and its impacts on various sectors of the community.

Curriculum Links:

OCR Advanced GCE in Geography H483

The study of high and low pressure systems and air masses to illustrate:

- The formation of these hazards, i.e. heavy snowfall, frost drought
- How they represent hazards to people through blizzards, cold spells, heat waves and droughts.
- The impacts associated with these weather features for named areas at the local, regional and global scale, including impacts on:
 - Transport
 - Agriculture and forestry
 - Health
 - Economic activity

AQA Advanced GCE in Geography Unit 3 GEOG3

- Air masses affecting the British Isles
- Origin and nature of depressions. Weather changes associated with the passage of a depression.
- Origin and nature of anticyclones. Associated weather conditions in winter and summer.

Edexcel Advanced Subsidiary GCE in Geography Unit 2 6GE02

- Defining the nature and distribution of different types of extreme weather such as... blizzards, winter weather, heat waves and droughts.

Materials: Figures 3 & 4, coloured pens and plain A4 paper. World and European Maps

Suggested activities:

Following PowerPoint:

Starter - What am I describing? **Students guess using more detailed clues.** - Heat wave

-Introduce global atmospheric circulation with use of YouTube video and/or animation

Students could draw circulation cells onto a globe map and add their own explanation.

-Use PowerPoint to give an overview of cyclonic and anti-cyclonic weather systems. An animation is included which helps explain the Coriolis effect.

-Use PowerPoint to introduce the three types of front. Each comes with a diagram and link to an online animation.

Word-close notes available as a worksheet in figure 3.

Heat waves

Map activity - On a map of Europe, student's sketch where they think an anticyclone would be positioned in summer to give the UK hot weather.

Mind map graffiti - Students gather into groups of 3-4. Each uses a different colour pen. Give them two minutes to mind map all of the social, economic and environmental issues associated with heat waves. When time is up, students pass their answers to the next group. Then give them 30s to add to the other group's answers - these may be answers they have already written on their own sheet or others which they think of after looking at the new mind map. Keep passing the sheets around and giving them 30s until they have their own answers back with corrections/additions. There are suggested answers on the PowerPoint.

The 2003 European Heat wave - Case study given with statistics and images. Students could be set homework to write this up or research an African drought to provide a comparison.

Cold spells (cold waves)

Map activity - On a map of Europe, student's sketch where they think an anticyclone would be positioned in winter to give the UK cold weather. Explanation of the formation of frosts and blizzards follows.

Individual mind maps, mind map graffiti, group discussions or research task to determine the social, economic and environmental issues associated with cold spells. Examples given on following slides.

The 2010 severe UK winter - Case study given with statistics and images. Students could be set homework to write this up or research alternative event.

Student complete table in figure 4 - Suggested answers but the list is not comprehensive.

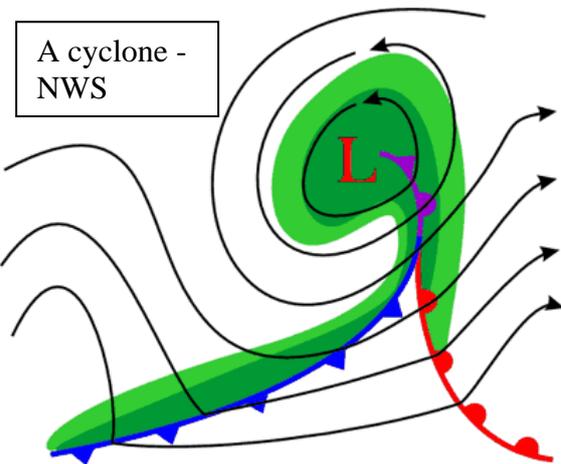
Plenary - Bingo. Students choose 4 words and write them in the back of their books. Teacher asks the class questions, the answers to which are on the list on the slide. The answers could be discussed as you go along or the first student to shout bingo could discuss the questions and answers.

Figure 3 - Notes on cyclones, anticyclones & weather fronts

Anticyclones, Depressions & Weather Fronts

Weather is driven by the _____ heating of the Earth's surface. Air heated strongly at the equator becomes less dense and _____, reaching the top of the troposphere (10-15km) and spreading outwards to both _____. When it reaches the Polar Regions, it sinks and through continuity flows back to the _____. This closed cell of circulation creates a low pressure at the surface where air is _____ (i.e. at the equator) and a high pressure where air is _____ (Polar Regions). However, due to the Earth's rotation, the circulation is more complex and actually results in three separate circulations. Adding further to the complexity is the non-uniform nature of the Earth's surface (sea, land, mountains, ice etc).

Anticyclone - A large area of high atmospheric pressure, characterised by outward-spiralling winds - a "high". Winds are _____ in the Northern Hemisphere and _____ in the Southern (Source: BBC). Anticyclones are masses of sinking air, creating a high pressure (>1013mbars) at the surface. Horizontal pressure gradients (how much pressure changes with distance) are often small and so the surface wind speeds are usually _____. The sinking air inhibits convection and therefore cloud formation so _____, dry, sunny days usually accompany high pressure systems in summer and _____, _____ days in winter.



Cyclone - A large area of low atmospheric pressure, characterised by inward-spiralling winds - a "low" - also called a "_____". Winds are anticlockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere (Source: BBC). Cyclones consist of _____ air, creating the low pressure (<1013mbars) at the surface. Horizontal pressure gradients can be very steep and so the surface wind speeds are often _____ and sometimes

extreme. The rising air promotes convection and cloud formation and therefore precipitation (rain, snow, hail etc). Weather _____ (the boundary between different air masses) are formed with cyclones.

Cold Front - The boundary between cold and warm air, where _____ air is undercutting the _____ air (because it is denser). This lifts the warm air, possibly to a level where it can rise by itself (_____) due to instability in the atmosphere, resulting in clouds and _____. Cold fronts often bring heavy rain, cooler air, and a clockwise shift in wind direction (veering wind). Draw the symbol for a cold front on a weather map:

Warm Front - The boundary between cold and warm air, where _____ air is overriding the _____ air (because it is less dense). This air rises steadily, but again may result in convection occurring. As warm fronts pass through a location they bring _____ air, cloud, rain and a veering of the wind. Draw the symbol for a warm front on a weather map:

Occluded front - These occur when a cold front catches up a warm front and undercuts it. Various types of weather can be associated with an occluded front including thunderstorms, rain, cloud or very little apparent change. Normally the air at the surface becomes _____.

Figure 4a - Complete the table to show the impacts of these weather features on a local, regional and global scale. ANSWERS

Heat wave & droughts

| | Local | Regional | Global |
|--------------------------|---|---|---|
| Transport | Train speeds restricted. Too hot to walk far. | Train speeds restricted. Roads busy with holiday makers. | Increase demand for flights from holiday makers. |
| Agriculture and forestry | Vegetable patches damaged. Hosepipe bans. Animals need monitoring | Crops damaged. Rivers running low. Animals need monitoring | Large wild fires. Food supply limited by drought |
| Health | Need to check on vulnerable neighbours. Difficulty sleeping | Hospitals and doctors put under pressure. | Health service and mortuaries under pressure to cope in affected countries. |
| Economic activity | Increased electricity bills with air conditioning use. BBQ sales & other outdoor activities | Supermarket sales up. Cinema and indoor events suffer. | Food prices increase with reduced supply of crops. |

Cold spells and blizzards

| | Local | Regional | Global |
|--------------------------|---|---|---|
| Transport | Road and rail supplies severely disrupted. Pavements dangerous. | Road, rail and air transport severely disrupted. | Air transport to, from and through affected countries severely affected. Shipping may be halted at ports. |
| Agriculture and forestry | Trees fallen may block roads. Winter crops buried. | Most agriculture activities halted. Animals need continual monitoring. | Certain food supplies low due to cold and dry conditions. |
| Health | Old and very young vulnerable to cold. Need to check family and neighbours. | Hospitals and doctors surgeries under increased demand. | Surge in influenza levels and other illnesses in affected countries. |
| Economic activity | Increased demand for winter clothes and salt. | Transport disruption prevents people getting to work. Electricity and gas companies profit. | Air and ship transport disruption affects trade. Oil exporting countries see rise in demand. |

Figure 4b - Complete the table to show the impacts of these weather features on a local, regional and global scale.



Heat wave & droughts



| | Local | Regional | Global |
|--------------------------|-------|----------|--------|
| Transport | | | |
| Agriculture and forestry | | | |
| Health | | | |
| Economic activity | | | |



Cold spells and blizzards



| | Local | Regional | Global |
|--------------------------|-------|----------|--------|
| Transport | | | |
| Agriculture and forestry | | | |
| Health | | | |
| Economic activity | | | |

Background Information:

Weather is driven by the unequal heating of the Earth's surface. Air heated strongly at the equator becomes less dense and rises, reaching the top of the troposphere (10-15km) and then it spreads outwards to both poles. When it reaches the Polar Regions, it sinks and through continuity flows back to the equator. This closed cell of circulation creates a low pressure at the surface where air is rising (i.e. at the equator) and a high pressure where air is sinking (Polar Regions). However, due to the Earth's rotation, the

circulation is more complex and actually results in three separate circulations (see

figure 1). Adding further to the complexity is the non-uniform nature of the Earth's surface (sea, land, mountains, ice etc). This model of circulation is therefore only a guide to the average conditions and day-to-day conditions are likely to differ considerably.

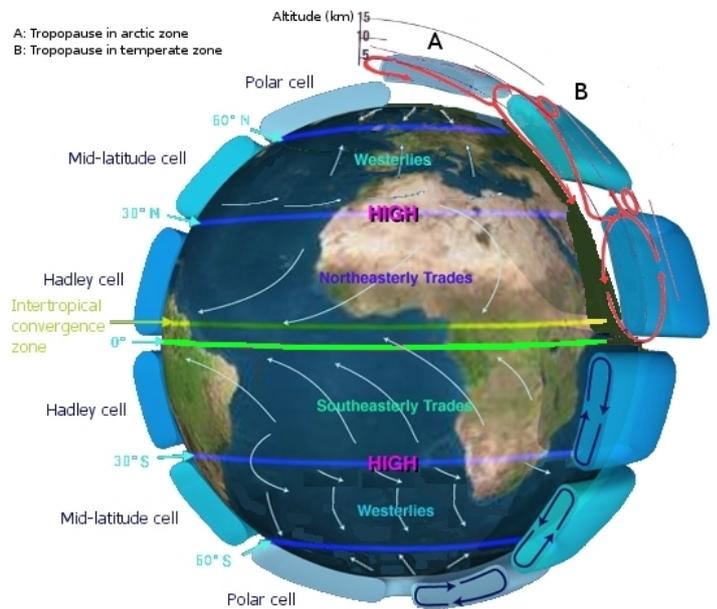
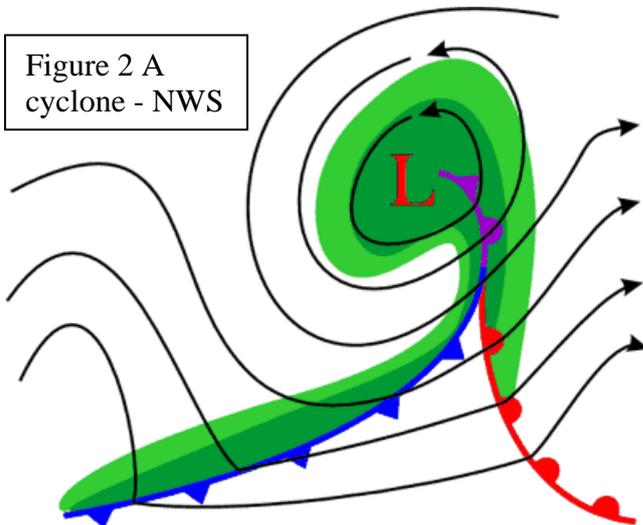


Figure 1 - The three cell model of global air circulation - NASA

Anticyclone - A large area of high atmospheric pressure, characterised by outward-spiralling winds - a "high". Winds are clockwise in the Northern Hemisphere and anticlockwise in the Southern (Source: BBC). Anticyclones are masses of sinking air, creating a high pressure (>1013mbars) at the surface. Horizontal pressure gradients (how much pressure changes with distance) are often small and so the surface wind speeds are usually low. The sinking air inhibits convection and therefore cloud formation so hot, dry, sunny days usually accompany high pressure systems in summer and cold, dry days in winter.

Figure 2 A
cyclone - NWS



Cyclone - A large area of low atmospheric pressure, characterised by inward-spiralling winds - a "low" - also called a "depression". Winds are anticlockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere (Source: BBC). Cyclones consist of rising air, creating the low pressure (<1013mbars) at the surface. Horizontal pressure gradients can be very steep and so the surface wind speeds are often high and sometimes extreme. The rising air promotes convection and cloud formation and therefore precipitation (rain, snow, hail etc). Weather fronts (the boundary between different air masses) accompany cyclones.

Cold Front - The boundary between cold and warm air, where cold air is undercutting the warm air (because it is denser). This lifts the warm air, possibly to a level where it can rise by itself (convection) due to instability in the atmosphere, resulting in clouds and rainfall. Cold fronts often bring heavy rain, cooler air, and a clockwise shift in wind direction (veering wind).

Symbol for a cold front on a weather map:



Warm Front - The boundary between cold and warm air, where warm air is overriding the cold air (because it is less dense). This air rises steadily, but again may result in convection occurring. As warm fronts pass through a location they bring warmer air, cloud, rain and a veering of the wind.

Symbol for a warm front on a weather map:



Occluded front - These occur when a cold front catches up a warm front and undercuts it. Various types of weather can be associated with an occluded front including thunderstorms, rain, cloud or very little apparent change. Normally the air at the surface becomes drier.

Symbol for a cold front on a weather map:



Heat waves - Heat waves are periods of hot weather which are unusual for an area. They are usually associated with an anticyclone which has become stationary over an area. Heat waves lead to problems such as hyperthermia (heat stroke), heat rash, heat cramps and heat exhaustion. Heat waves results in more deaths than any other weather type with the very young and old most at risk. Prolonged heat waves can also lead to drought conditions (due to lack of rainfall and evaporation from the Earth's surface) causing death, crop failures, and wild fires.

Cold spells (cold wave) - Cold spells are periods of cold weather which are unusual for an area. They are often associated with anticyclones in winter but a nearby cyclone is usually required to bring fronts with their associated precipitation (often snow). Cold spells can cause hypothermia if people cannot remain warm and death to animals through starvation if the ground is covered in snow. Weather systems with heavy snow and strong winds are known as blizzards. They represent a major hazard to humans, from blocking roads and other transport networks, to cutting electricity supplies and making all aspects of life difficult.

References:

- 1) The Met Office - <http://www.metoffice.gov.uk>
- 2) The National Weather Service - <http://www.nws.noaa.gov>
- 3) Atmospheric global circulation video - <http://www.youtube.com/watch?v=DHrapzHPCSA>
- 4) Atmospheric global circulation animation -
http://www.nodvin.net/snhu/SCI219/demos/Chapter_7/Chapter_07/Present/animations/50_1_2_1.html
- 5) Coriolis effect animation -
<http://upload.wikimedia.org/wikipedia/commons/b/b6/Corioliskraftanimation.gif>
- 6) Animation of a cold and warm front -
http://www.classzone.com/books/earth_science/terc/content/visualizations/es2002/es2002page01.cfm?chapter_no=visualization
- 7) Animation of an occluded front -
http://www.uwsp.edu/geo/faculty/ritter/images/atmosphere/weather/cold_occlusion.gif
- 8) Video of economic impacts of a heat wave -
http://www.dailymotion.com/video/xe3wse_the-economic-effects-of-the-heat-wave_news
- 9) UNEP - United Nation Environment Programme - European heat wave review -
http://www.grid.unep.ch/product/publication/download/ew_heat_wave.en.pdf
- 10) Met Office Heat-Health Watch (only available 1st June to 15th September) -
<http://www.metoffice.gov.uk/weather/uk/heathealth/>
- 11) South Dakota blizzard news report - <http://www.youtube.com/watch?v=UTNgL7noiyQ>
- 12) UK cold spell ITN report -
<http://www.youtube.com/watch?v=BpFeaOLOf8s&feature=related>
- 13) Formation of a cyclone - <http://www.srh.weather.gov/srh/jetstream/synoptic/cyclone.htm>

Images:

Figure 1 - NASA - <http://sealevel.jpl.nasa.gov/overview/images/6-cell-model.jpg>

Figure 2 - NWS - <http://www.srh.weather.gov/srh/jetstream/synoptic/cyclone.htm>

Figure 3 - Author

Figure 4 - Author

Weather front diagrams -Wikipedia - http://en.wikipedia.org/wiki/File:Cold_front_symbol.svg

http://en.wikipedia.org/wiki/File:Warm_front_symbol.svg

http://en.wikipedia.org/wiki/File:Occluded_front_symbol.svg

Book:

Meteorology Today - C Donald Ahrens