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AIR MASSES AFFECTING THE BRITISH ISLES AND THEIR IMPACTS

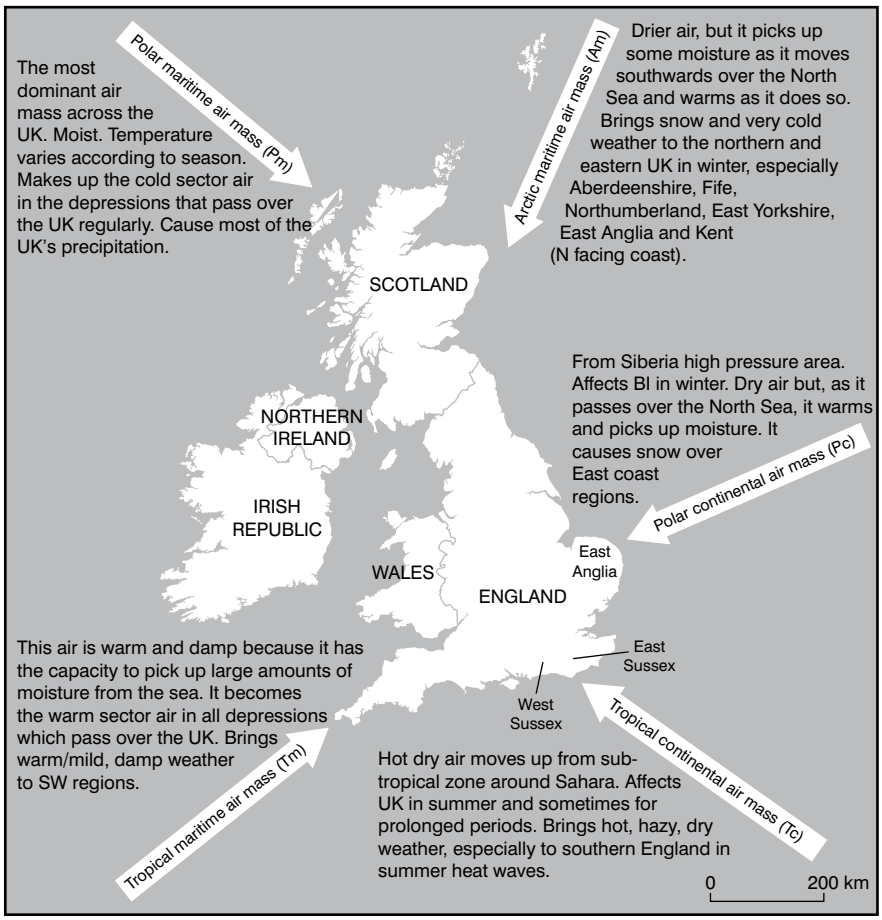
Introduction

The British are well-known for their obsession with the weather; we have a reputation for it across Europe and, no doubt, further afield. There is a genuine reason for this, the fact that our weather changes so rapidly. Within a single day we can have quite a variety of weather events which affect our daily lives and how we carry out the tasks we have to accomplish. We are both encouraged and limited by our weather. We listen to weather forecasts relentlessly and set great store by them. If they prove inaccurate we become irritated.

The main source of weather data in the UK is the Meteorological Office, from whom other agencies giving weather forecasts, such as the BBC, other TV and radio stations, newspapers and internet road and travel sites like the RAC and the AA, get their information. Weather forecasts are given on various scales into the future, and the greater the length of time involved, the less accurate the forecasts are likely to be. Day-to-day forecasts are usually quite accurate, but the seasonal ones are much less so. Summer 2009 was predicted to be a 'barbecue summer', with fine hot weather, yet turned out to be rather poor, and people were disappointed. It was announced in early March 2010 that the Meteorological Office would no longer give long-term forecasts for periods more than one month ahead.

The key explanation for the huge variability in the weather of the British Isles is the variety of the air masses that affect it. Our location in the mid-latitudes on the west coast of Europe leads to our cool temperate western margin climate. Five air masses dominate our climate (Figure 1). Low pressure systems tend to come from the west, over the ocean, moving quickly and bringing changeable weather. Those from the east are generally high pressure, giving more settled weather with greater stability over a longer period of time. These latter weather systems are easier for weather forecasters to predict; the westerly low pressure airstreams not only bring more variable weather, but they tend to move at less predictable speeds, usually resulting in the correct sequence of weather events being predicted, but not necessarily at the times stated in the forecasts.

Figure 1: The five main air masses affecting the British Isles



The key air masses affecting the British Isles

Figure 1 shows the five air masses that dominate British climate. The two dominant air masses are connected with low pressure weather systems and move towards us over the sea, making them relatively moist:

- polar maritime
- tropical maritime.

The less frequently occurring air masses are high pressure systems, moving towards us over land, making them drier:

- polar continental
- tropical continental.

The **Arctic maritime** air mass approaches from the north, over the ocean, but comes from the higher pressure zone within the polar region. It is cold and therefore contains limited moisture.

Typical weather brought by the five air masses

The **polar maritime** and **tropical maritime** air masses affect the UK for a greater proportion of the year than any of the others. Moving from Canada across the North Atlantic, polar maritime air makes up the **cold sector** of a **depression**. Depressions (low pressure systems) dominate the British climate and the cold sector, first and second parts (Figure 2(a)), is usually by far the larger section of the depression as the system passes over the country. Northern Britain,

i.e. Scotland, Northern Ireland and northern England, are affected by this air mass the bulk of the time.

The characteristics of air masses are strongly influenced by two factors:

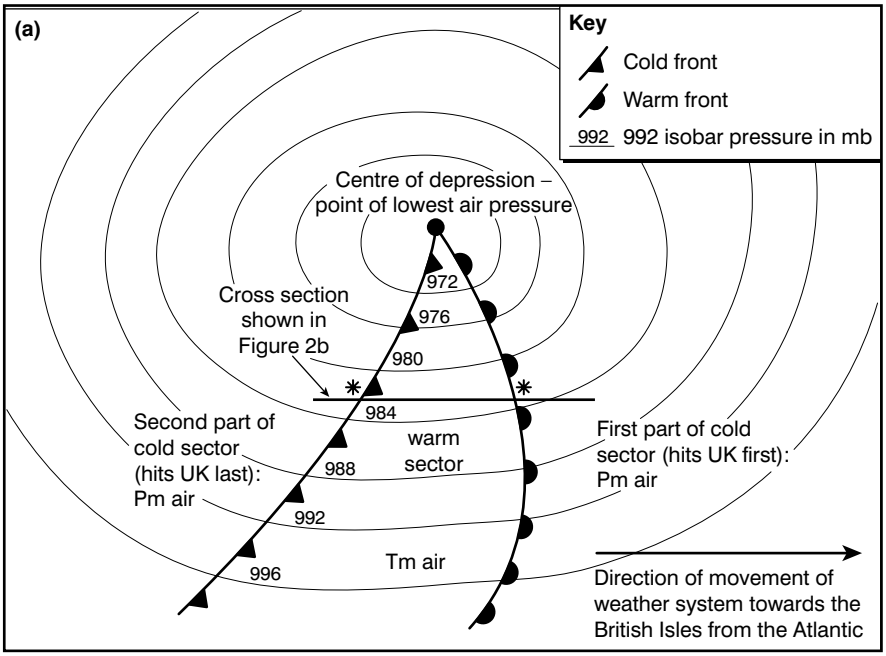
- the characteristics of their source region
- the nature of the earth's surface over which they pass.

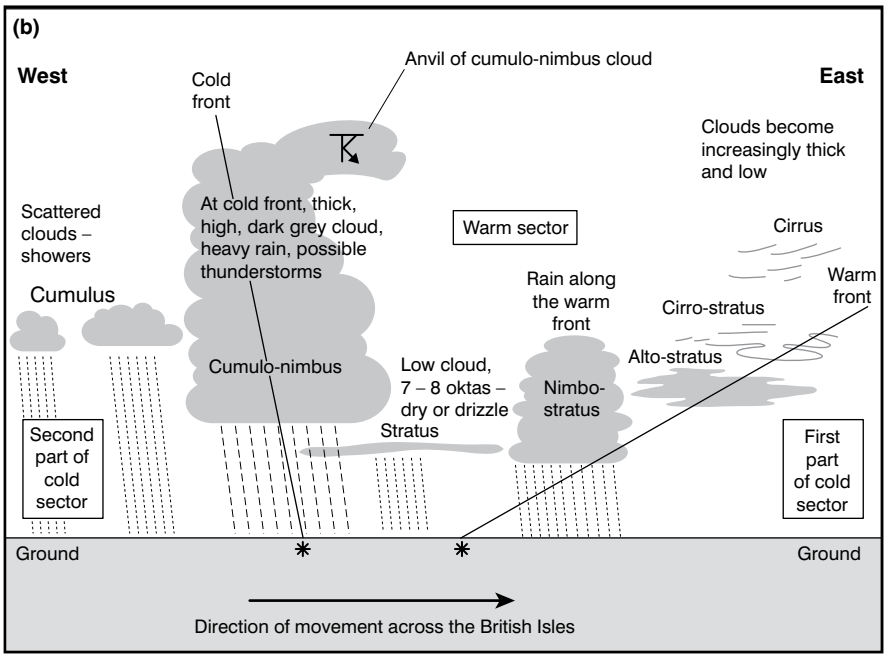
Polar maritime air begins in northern Canada, so is relatively cold and dry. However, as it moves over the North Atlantic in an east south easterly direction, it warms up, enabling it to absorb more moisture by evaporation from the ocean. On meeting tropical maritime air along the polar front, the two air masses do not mix, due to their differing temperatures and pressures; each stays as a distinct body of air. However, at the junction of the two air masses their interaction results in activity causing key aspects of British weather (Figure 2(a)).

Tropical maritime air has moved north eastwards across the Atlantic from the subtropical latitudes. It often includes air which has previously been part of tropical storms, or even hurricanes, in the Caribbean. Its higher temperature allows it to evaporate large amounts of moisture from the ocean. On meeting the polar maritime air it rises, as it is warmer and therefore lighter. Rising air always cools, causing condensation and cloud formation along the **front** (junction line) between them (Figure 2(b)). This frontal precipitation accounts for most of the UK's rain and some of its snowfall.

It is the junction between the polar maritime and tropical maritime air which brings the most changeable weather to the British Isles. As a rule, **fronts bring rain**. A depression moves across the British Isles from west to east, so it is the eastern end which arrives first. The first signs are high, wispy cirrus clouds, which look like fair weather clouds, almost the opposite of the weather of which they are a precursor. The clouds become lower and denser, through cirro-stratus and alto-stratus. As the warm front approaches the clouds are nimbo-stratus, which bring moderate rain. As the warm front passes over, temperature rises as dominant ait mass changes from polar maritime to tropical maritime,

Figure 2: (a) Synoptic map, showing generalised depression, with polar maritime (Pm) and tropical maritime (Tm) air, with (b) cross-section through the depression, showing weather brought to the UK





cold sector to warm sector. Air pressure rises, as the centre of the depression approaches and wind changes direction from south westerly to westerly. Cloud cover is now 7–8 oktas, low stratus, possibly bringing drizzle, though it may be dull and dry. At the passage of the cold front, tall cumulo-nimbus clouds bring heavier rain, with possible thunderstorms, a drop in temperature, a rise in pressure and change to scattered cumulus clouds with showers in the second part of the cold sector. Wind direction changes to north westerly. In winter the cold sector (polar maritime air) brings chilly, wet weather, possibly with sleet or wet snow, and in summer it is cooler and damper than the ideal. Milder wet winter weather occurs in the warm sector (tropical maritime air), but in summer it is usually warm and showery.

Arctic maritime air does not affect the UK for very long, and it is generally in winter. Eastern Scotland and England (especially East Anglia and Kent) experience it most. Very cold air from the Arctic is pulled southwards by high pressure systems. Strong northerly winds dump snow across these coastal regions, as far inland as East Sussex.

It usually lasts several days and the wind chill factor is at its most extreme.

Polar continental air brings the UK some of its worst weather. Anticyclones sitting over northern Europe force very cold air across the UK from the east. A slight warming and increase in moisture occurs over the North Sea can bring heavy snow to the east side of the country, as in the winter of 2009–10 (see case study below for the potentially dramatic consequences of this air mass).

The tropical continental air mass is the one many people favour most. Hot and dry, and moving over continental Europe in summer, it brings the UK's real heat waves. Being associated with high pressure, it tends to stay for many days at a time. In 1976, 1989 and 2003, this air mass was responsible for severe drought conditions. The only rainfall occurring is convectional, which can, of course, mean thunderstorms. Visibility may be limited, due to heat haze.

Case study: the UK freeze of January 2010

Wind systems exist not only close to the earth's surface but also in the upper atmosphere. Known as **jet streams**, the upper atmosphere winds, which were less well known, were first discovered in the First World War, when Zeppelin airships were blown off course as they rose higher. These upper level winds are extremely rapid and can exceed 230 km/hr. The **polar front jet streams**, active between 40 and 60 degrees N and S, form the division between the Ferrel and Polar cells of air movement. The position varies from year to year, possibly partly due to the sun's activity. To put it simply, the polar front jet steam controls which air masses most influence weather in the middle latitudes, which includes the UK. In the winter of 2009–10 the jet stream was positioned so that the polar continental air mass pulled extremely cold air from Northern Europe and Siberia over the British Isles throughout much of December, January and February. Much of the UK experienced significant snowfall prior to Christmas 2009, but the main falls came in the New Year. Remember that, although basically a dry air mass, the polar continental body can warm up a little as it passes over the North Sea (warmed slightly by North Atlantic Drift waters), enabling it to pick up enough moisture to be able to dump a good deal of snow over eastern England and Scotland. Aberdeenshire, Fife, East Anglia, Kent, Sussex and Surrey were particularly badly hit in the early months of 2010 (Figure 3).

Figure 3: BBC internet weather report, 6 January 2010

Schools closed and travellers hit as snow continues

Thousands of schools are closed and travellers have been hit by major disruption after new heavy snowfalls hit large parts of the UK.

Parts of Scotland and northern England have had more snow, which has also spread to southern areas of the UK.

Up to 5,000 homes in Sussex are without electricity after heavy snow brought down power lines to several villages.

Some rail firms have reduced services, many roads are badly affected and flights have been delayed or cancelled.

The worst hit areas have been central southern England and parts of the South West and south Wales.

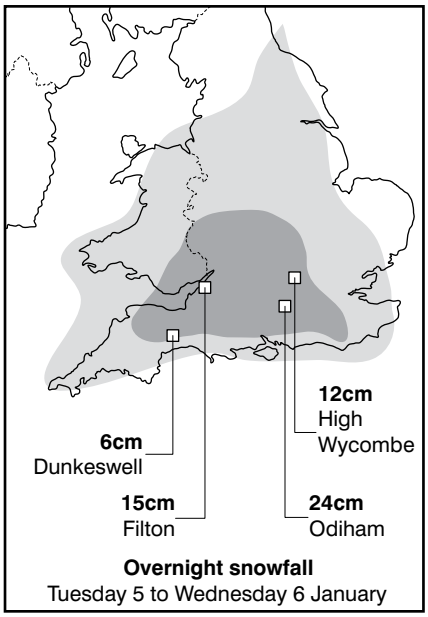
Counties most affected include Surrey, Hampshire, Wiltshire, Dorset, Berkshire and parts of Gloucestershire and Buckinghanshire.

Source: Adapted from www.news.bbc.co.uk

For most people, the school term began around Monday/Tuesday 4/5 January, for the beginning of the winter public examination period. By Wednesday 6 January many were unable to attend school, either because they could not physically get there or because schools had closed. Figure 4 shows the snow forecast for that day and Figure 5 a photograph taken on that day in the High Weald of East Sussex, where 30–40 cm of snow brought nearly everything and everyone was at a standstill. The situation was made worse by the failure to grit roads by some local authorities, despite weather forecasts which were, in fact, close to accurate. Low stocks of salt and grit were blamed.

The freezing January weather lasted longer than usual – for some regions, well into February and even March.

Figure 4: Expected snowfall, Wednesday 6 January 2010



Source: Based on www.news.bbc.co.uk/ Met Office

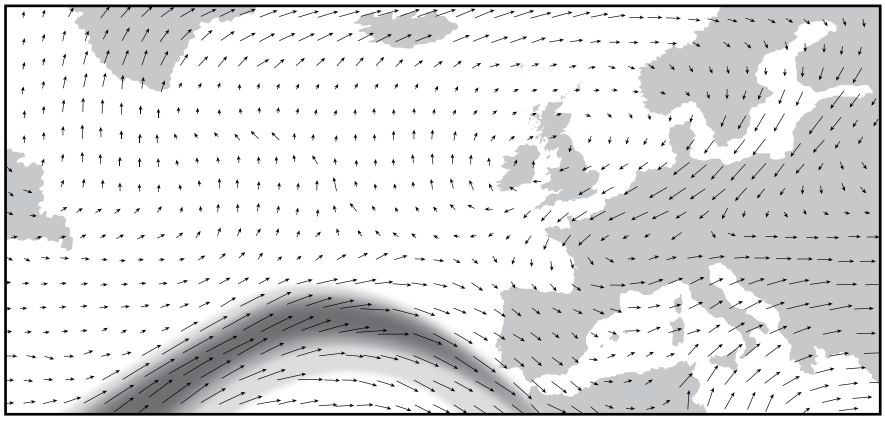
Figure 5: Impact of January 2010 snow in the High Weald of East Sussex

In the Scottish Highlands a move was made to extend the deer hunting season so that animals suffering in the dire conditions could be shot, rather than die a slow death without grazing which had been covered by feet of snow for several weeks (Box 1).

Impacts of the winter 2009–10 beyond the UK

The UK was not alone in having unusual weather conditions in the early months of 2010. Other parts of Europe and North America were also hit hard. Locations further

Figure 6: Position of the polar jet stream at midnight on Sunday 7 March 2010. Airstreams were moving toward the UK, especially the South East, from continental Europe. The longer the arrows, the stronger the flow. The day was bright and clear, but very cold.



Source: Based on www.metcheck.com

south within Europe suffered unseasonably heavy rain. On 20 February 2010, Madeira was shattered by a ferocious storm which caused massive flash floods, mudslides and landslides. Homes were simply washed away. Some people had no chance – at least 43 died and hundreds of buildings were wrecked (www.timesonline.co.uk/tol/news/weather/artice7042986.ece). The Canary Islands, much of North Africa and Southern Europe were also hit with unusual, destructive weather.

In France, 45 people were killed by storm-related events, mostly hit by collapsing buildings and trees, plus another five in Spain and Portugal. Over 1 million households across France lost their power in late February/early March, as storms crossed the country, especially in the Vendee and Charente-Maritime regions of the west coast, where people had to be rescued from their own roofs by emergency services helicopters. Huge waves and strong gusts battered many coastal towns. President Nicolas Sarkozy visited the stricken area, promising increased coastal flood protection in the near future. Belgium and Germany experienced heavy rain and high winds subsequently.

These events were all because the jet stream veered further south than usual over Western Europe and the Eastern USA. Washington DC seized up due to snow. Usually, this region is too far south for such extreme cold weather events, and it is fair to say they are far from prepared.

Websites for further reading

http://news.bbc.co.uk/1/hi/uk/8440601.stm
Article plus short video on January 2010 weather crisis in the UK: Greater Manchester, Scotland, SW England – also has links to associated websites for more information.

www.bbc.co.uk/weather/features/.../jetstreams_uk.shtml
General information on jet streams and their influence on UK weather patterns.

http://ecosystem-preservation.suite101.com/article.cfm/call-for-extended-deer-cull-in-...
http://www.telegraph.co.uk/earth/wildlife/7256377/Freezing-winter-has-left-Scotlands...
http://www.shootinguk.co.uk/news/443053/Scotlands_icy_weather_puts_deer_...
Deer culling caused by bad weather in Scotland, 2009–10.

www.timesonline.co.uk/tol/news/weather/artice7042986.ece
abcnews/go.com/International/...flashfloods-mudslides-madeira-9907207
Video of Madeira floods, February 2010.

http:/newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/1/hi/world/Europe/...
France storms, February 2010.

http://articles.latimes.com/2010/feb/10/nation/la-na-snow-washington11-2010feb11
Snow in Washington DC, February 2010, paralysing the city.

Any of the above websites can also be found via Google.

Box 1: Wildlife crisis in Scotland, winter 2009–10

'The winter or 2009–10 has provisionally been recognised by the Meteorological Office as the coldest since 1978–79 ... In Scotland the weather was particularly harsh, with temperatures in the Highlands falling as low as minus 22.3 degrees C ... Such sustained periods of cold weather have ... led to problems for wildlife ... Long-term snow coverage reduces food supplies for herbivores and, as these die off or move elsewhere, the creatures which prey on them also go hungry. In response, the Scottish Wildlife Trust has called for culling of red deer in Scotland to be extended.'
http://ecosystem-preservation.suite101.com/article.cfm/call-for-extended-deer-cull-in...

'Thousands of red and roe deer have been left suffering after weeks of snow and ice have made it difficult for them to find food.

The authorities in Scotland have also warned walkers that it is likely they will stumble across the distressing sight of dead or dying animals in the coming weeks.'

http://www.telegraph.co.uk/earth/wildlife/7256377/Freezing-winter-has-left-Scotlands...

Focus Questions

1. The British are sometimes considered to be obsessed by the weather. Use detail from this **Geofile** to explain the reasons behind this assertion.

2. This **Geofile** includes a detailed case study of the winter weather of 2009–10 resulting from polar continental air. Research equivalent weather events for tropical continental air in previous years (there are some suggested years in the text). How was the UK affected uncharacteristically, and how did people try to cope?