Making Decisions for the Ever Changing Weather

The weather is often the first topic of conversation when we meet friends in the street or when shopping in town. Many of us have to endure the natural elements which can affect us all at some point in our lives. Rob Harrison looks at the UK climate to explain why it can be so varied – and how technology at the Met Office is helping the commercial world to use weather forecasts to manage risks, plan operations and ensure health and safety.

The climate across the UK is one that invariably presents a wide range of weather types. What makes the weather even more remarkable in this country are the changes we see over a relatively short period of time.

As the UK's national weather service, the Met Office provides a wide range of weather and climate information to the public, government and businesses including the financial world, energy industry, airline companies and rail networks.

So why does the weather change so often in the UK?

Textbook descriptions of our long term weather describe the climate as temperate. This is one where the summers are cool rather than very warm or hot - winters milder rather than cold.

The geographical position of the British Isles puts them very much at the 'crossroads' for different weather patterns. Just to the south and east, there is the land mass of continental Europe, while to the west the world's second largest ocean provides a vast supply of moisture when winds blow in off the Atlantic.

Add to the mix, the fact we are a small island nation - introduces further local effects on our climate, with the seas and ocean helping to influence what weather we actually get.

Across north western parts of Europe, the winds usually blow from a south westerly direction. As this moist air, in the form of cloud, rain or showers, reaches our shores from the west, it is these areas that receive the highest rainfall totals.

Predominate south westerly winds that affect the UK is ultimately caused by the differential heating of the Earth's surface by the Sun. This establishes a global circulation of the atmosphere, with warmer air from the tropics heading North Pole in the northern hemisphere. The direction of this flow is deflected to the right by the rotation of the Earth.

Clearly, the persistence of south westerly winds does vary as the fluid nature of the atmosphere fluctuates through the seasons. What are referred to as 'blocking' weather patterns occur from time to time - steering Atlantic weather systems around the UK.

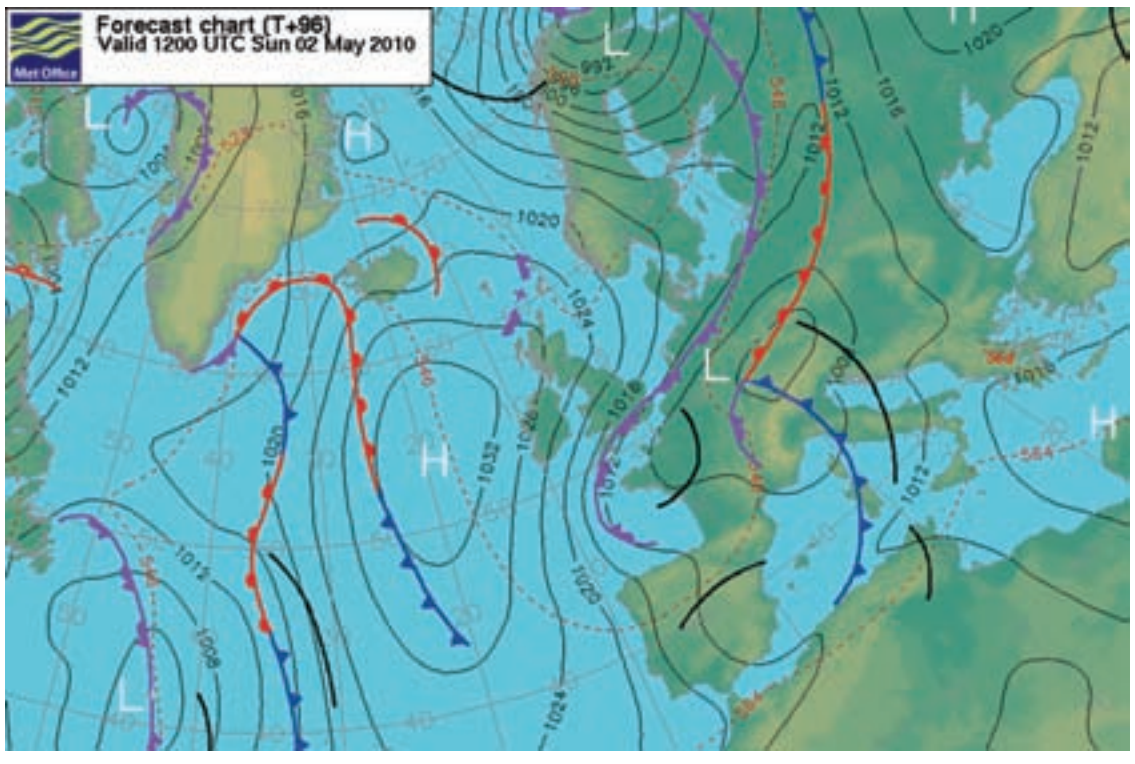


Figure 1: synoptic chart

Weather patterns are displayed on maps called synoptic charts, which illustrate:

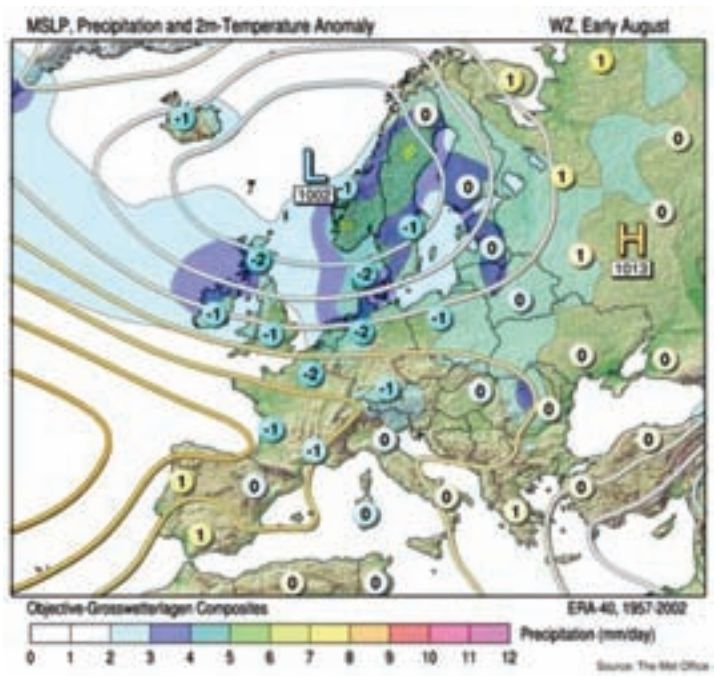
- Areas of equal air pressure are represented by black lines called isobars and are measured in millibars or hecto-pascals. The closer these lines are together, the stronger the wind will be – and vice versa
- Low Pressure – associated with unsettled and windy conditions with cloud, rain and showers. The lower pressure in the atmosphere allows air to ascend, cool and condense into clouds that produce wet weather.
- High Pressure – associated with settled and drier weather. The higher pressure forces air to descend, warm and lose moisture, but still with some cloud at times.
- Troughs – lines where showers become prolonged and heavy and associated with areas where the air is ascending.
- Warm Front – shown by red semi circles, as the name implies introduces warmer/milder air.
- Cold Front – shown by blue triangles introduces a clearer and often showery weather with a fall in temperatures.
- Occluded Front – shown by a combination of red semi circles and blue triangles. This front occurs when a cold front reaches a warm front as part of the life cycle of a low pressure system.

In the northern hemisphere, the wind blows around areas of Low pressure in an anti-clockwise direction. Conversely, the wind blows in a clockwise direction around areas of High pressure.

The direction of the wind over the UK brings with it a particular type of weather – or air mass. The British Isles are affected by six main types of air mass as shown in Table 1.

Air Mass	Description
Tropical Maritime	Winds blowing from this direction (south west or west) are the most common across the UK. The air mass will usually bring mild, moist air (since its source is from over the Atlantic Ocean) as well as cloud and rain – or sometimes in winter, snow. Strong winds can also be a feature of this air mass, as deep areas of Low pressure move in from the west.
Tropical Continental	Mild or warm air from Europe means that this air mass is much drier, since it has been brought in over land rather than the sea. During the summer we record our highest temperatures with this type of air but during winter brings very mild weather.
Arctic Maritime	As the name implies, this air is brought to us straight from the north. As this cold air travels over the sea, snow showers often develop and affect regions exposed to the north.
Polar Maritime	Cold air normally blows in from the Atlantic Ocean from a north westerly direction picking up moisture from the water. This often brings an unsettled mix to the UK weather with bands of rain and showers, wintry at times especially in the north.
Returning Polar Maritime	An air mass that originated in Polar regions but has travelled long distances over the Atlantic Ocean. This means that the relatively warm ocean waters modify the air and it becomes less cold by the time it reaches our shores.
Polar Continental	This air mass brings the UK its coldest air as it sweeps in generally from an easterly direction in the winter. On rare occasions, the source of this can be as far east as Siberia. UK temperatures fell very low in some places at the beginning of the year because this air mass was over the country.

Table 1: Air masses which affect the UK weather



Forecasting the weather

The changes we constantly see in the UK weather make the task of predicting it a challenging one. Ever evolving technology helps the Met Office to gain both a fuller understanding in how the fluid dynamics of the atmosphere work and in processing vast amounts of data used in making today's weather forecast.

These advances have revolutionised how observations are received from remote locations through to the way weather forecasts are presented on the growing number of media outlets.

Observations are vital to the process of creating forecasts. Data sources are always changing and improving and now include observations of the atmosphere taken from over 36,000 kilometres above the Earth, and of the ocean taken from 2,000 metres below sea level. Sources of observations also include: balloon profiles, surface data, aircraft observations which provide a range of detail, such as temperature, air pressure, wind speed and direction, humidity and many other properties to provide the starting conditions of our weather forecast model. These vast quantities of observations arrive from sites around the world, measured using World Meteorological Organisation (WMO) standard equipment.

Images of observation equipment

The supply of observational data is absorbed by the increases in supercomputer capacity, which allows vast quantities of data to be assimilated. Around 5 - 10 million pieces of observed information are fed into the Met Office supercomputer each day. It is perhaps thanks mostly to the revolutionary advances made in satellite technology that has had the biggest single impact on how a weather forecast is produced.

All of this information is fed into the supercomputer which uses Numerical Weather Prediction (NWP) models to produce weather forecasts.

A forecast can be deterministic – which is a simple statement about a particular type of weather occurring or not - or probabilistic, which is a statement that asses the risk and is usually expressed in percentage terms as to the likelihood of it happening.

The VisualEyes™ system makes use of short-term and long-term numerical forecasts as well as our probabilistic models to provide alerts based on specific requirements. It also allows real-time as well as forecast weather to be viewed.

Detailed forecasts from VisualEyes™ project site-specific alerts for wind farms shown on a web-based map viewer to allow operators to easily monitor conditions across several sites. These alerts are probabilistic in nature so the operator can determine the appropriate thresholds for their sites for different weather parameters, such as lightning, wind speed, rain, temperature and visibility. These are flagged up clearly on the map when an alert is given.

Medium range weather forecasting

Accuracy continues to improve as better technology becomes available. However, beyond 5 days a probabilistic forecast generally provides a better interpretation of the weather than a deterministic forecast. This is because of increased uncertainty the longer the forecast period is (see graph in Figure 2).

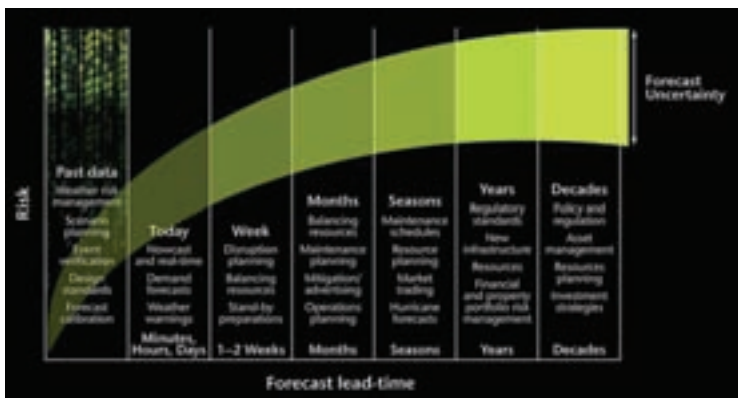


Figure 2: Uncertainty graph

Looking to a month ahead, different methods are used to forecast the weather. One fairly recent development is the use of weather regimes in medium-range weather forecasts.

Decider™ was developed by the Met Office to present medium-range forecasts of 3 to 30 days over Europe. It displays data, temperature, pressure, rainfall, cloud cover, wind speed and wind direction on a map and table format. This makes it easy to view likely upcoming weather and its impacts on the industries such, renewable and energy.

The product summarises a range of forecast outputs and condenses large volumes of information using a synoptic classification known as "weather regimes".

Each weather regime has a specific set of weather characteristics that accompanies them. Decider™ and its unique objective analysis method acts like a key to enable understanding of local weather patterns embedded within larger scale weather. It has already proved to be highly successful across the energy sector. It is also useful in commodities trading.

Graham Ford, Utilities Business Manager added, "Initially customers were concerned that you needed good meteorological skills to get the best from it. It's really not that difficult and our scientists have become very adept at explaining it in a simple way that is relevant to the user".

Forecasts beyond a month take us to climate prediction and the same numerical models used for short range forecasts are used for climate models. Despite the variable nature of weather, evidence shows that the global climate is warming up. Natural variability means that we will always have some cold winters and some hot summers. However, research at the Met Office Hadley Centre shows that for the UK, winters are likely to become milder and wetter. During summer months, temperatures like those seen in 2003 are likely to become a more regular feature of our climate as we head through the 21st century.

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