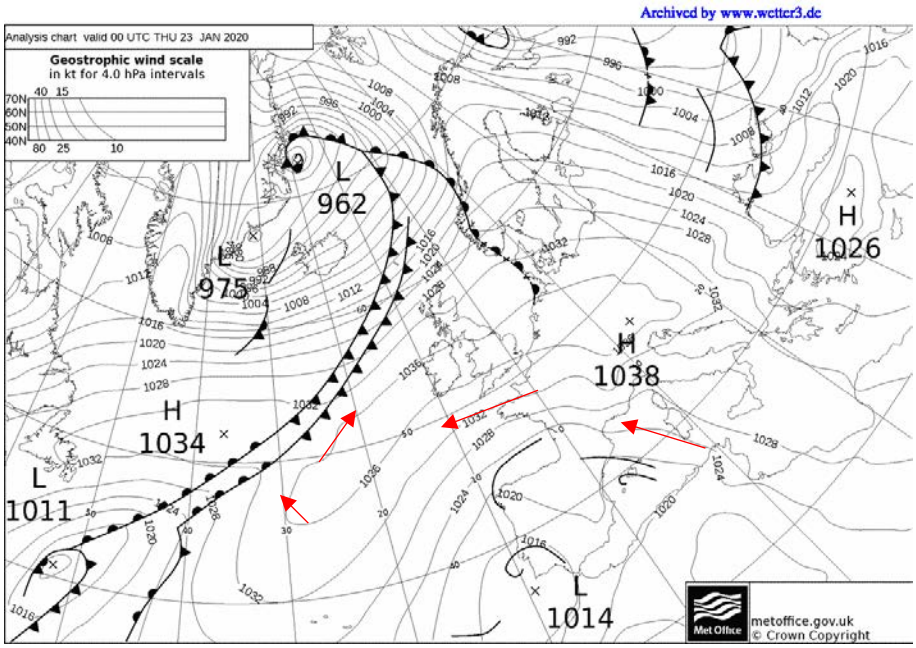
MetLink
Royal Meteorological Society

Air Masses

Background Information for Teachers

Polar, Arctic, Tropical, Maritime and Continental

Air masses are a nice, simple way to start thinking about where our air has come from, what has happened to it before it reaches us and what that means for our weather. However, it can be easily oversimplified and bear little relation to the current situation where pressure systems and fronts are probably having a far greater impact on what is happening outside the window. For example, on the day shown in the image below, tropical air is covering all of the UK – but the High pressure is actually contributing more significantly to the clear skies seen by some and the significant fog experienced by others.



An air mass is a large body of air with relatively uniform characteristics such as temperature and humidity. Air masses are classified according to their source region and track. The source regions tend to be semi-permanent anticyclones (associated with the sinking regions of the global atmospheric circulation) in the sub-tropics and polar regions ('tropical' or 'polar' air). Air masses acquire their characteristics by contact with the underlying surface in the source region and the surface they pass over before reaching the UK.

Fronts mark the boundary between two distinct air masses.

When High pressure sits over the UK, there is usually very little air movement into the area, and air masses are less relevant.

Teaching about air masses usually starts with this diagram, showing that air can approach the UK from pretty much any direction, and that the characteristics of the air depend on where it has come from:

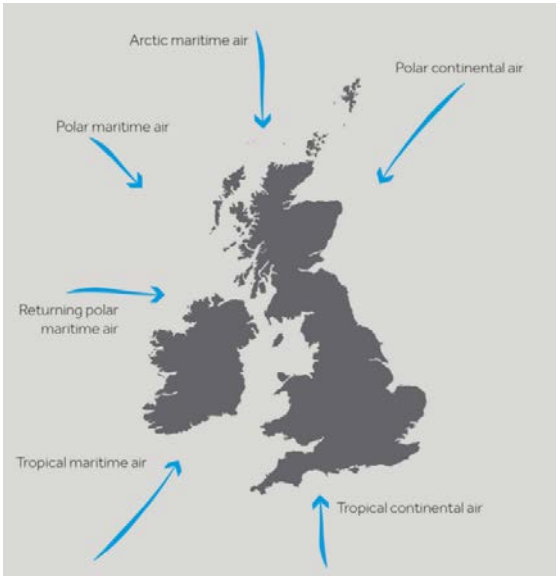
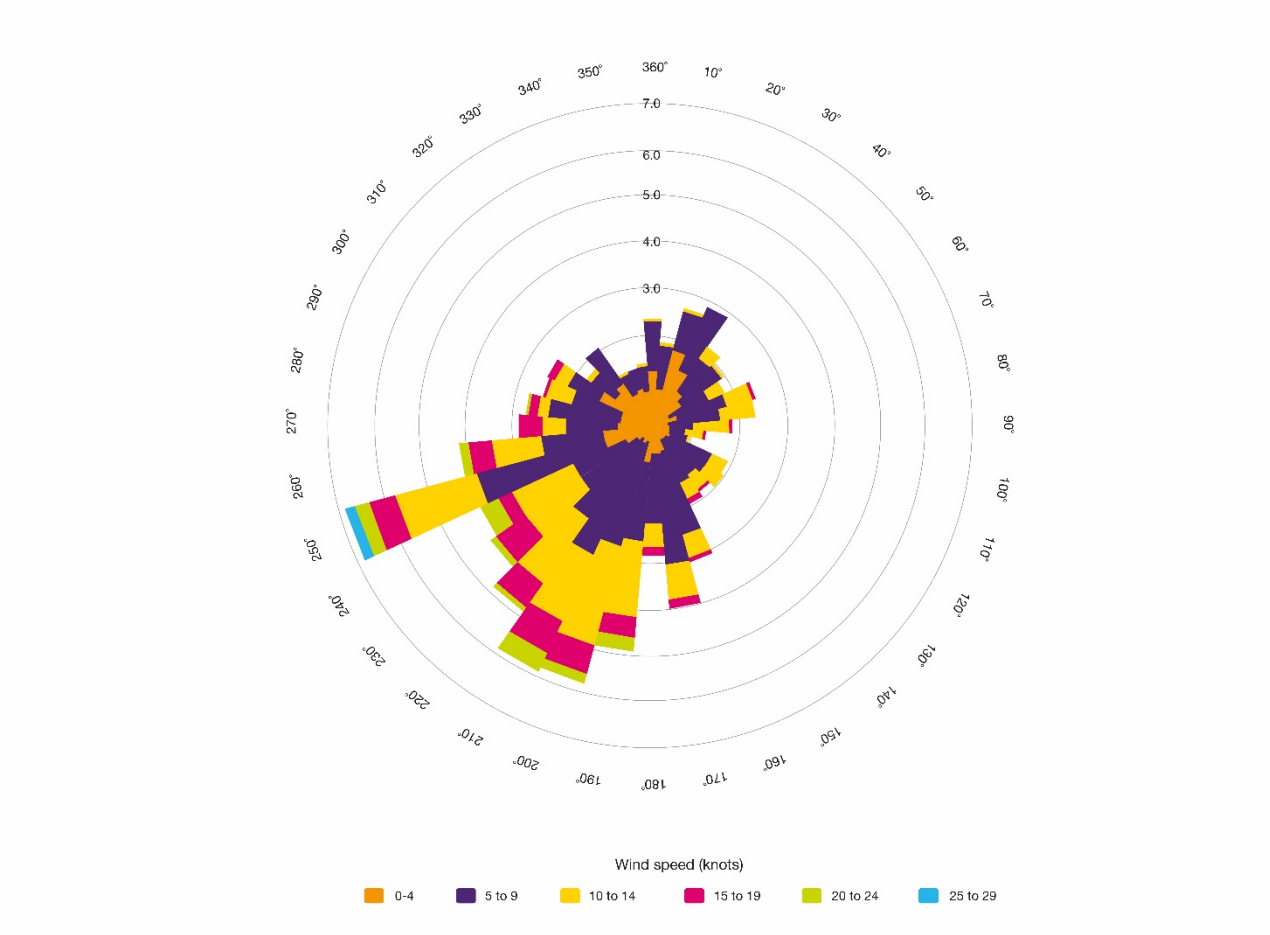


Image copyright University of Reading

There are six air masses which can affect the weather in the UK – **Polar Maritime** is the most common, but we can also experience **Tropical Maritime**, **Polar Continental**, **Tropical Continental** and **Returning Polar Maritime** air. The UK sometimes also gets **Arctic Maritime** air which has travelled straight south from the Arctic. **Returning Polar Maritime** air is polar air which changed direction over the Atlantic, hitting the UK from the west or even south of west, but still polar in nature.

A note of caution about the above figure – it can be misinterpreted as showing that the NE of the UK always experiences Polar Continental air, the south always Tropical Continental air etc. In fact, unless there is a front in the way, we would expect one air mass to be affecting the whole country. The weather it delivers may be different in different places, more on this below, but, on the whole, the cause – the type of air mass, will be the same.

This wind rose (from Heathrow Airport) is typical for the UK, showing that our most common air masses are Polar or Returning Polar Maritime and Tropical Maritime. Arctic Maritime and Tropical Continental air are very rare.



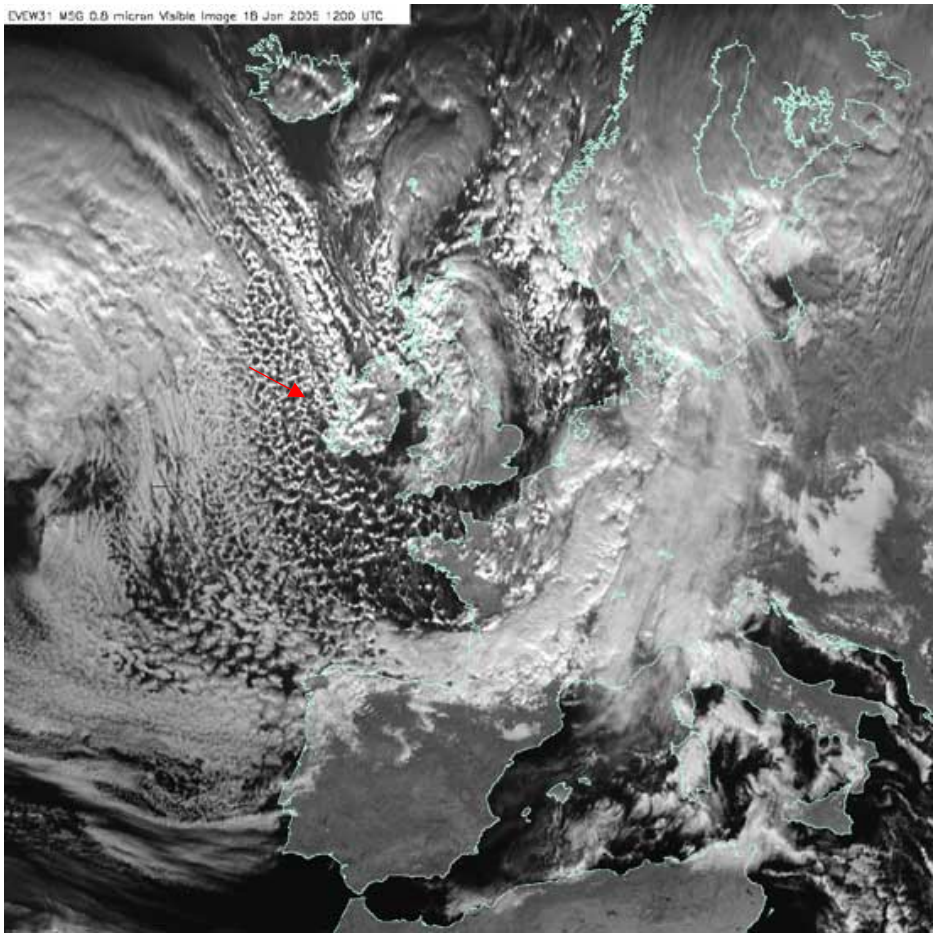
A very helpful way to think about air masses and the weather they produce is to go through the following table.

	Source Air temperature	Direction of Travel	Humidity increasing or not?	Temperature increasing or decreasing?	Convection?	Rainfall?
Polar Maritime	Cold	South East	Yes	Increasing	Yes	Yes – typically in showers.
Polar Continental	Cold	South West	No	Increasing	Yes	No – it depends on how much of the North Sea the air has crossed.
Tropical Maritime	Warm	North East	Yes	Decreasing	No	Maybe light drizzle – layer cloud can form as the air travels polewards and cools.
Tropical Continental	Warm	North West	No	Decreasing	Not generally	Sometimes there can be thunderstorms if localised convection begins over warm land surface.

Starting with **Polar Maritime** (Pm) air – this is air that has flowed out of a High pressure area in the Arctic to the northwest of the UK, and arrives at our west coast from around the west. As the air started off in the Arctic, it was initially cold, but then warmed as it travelled south over increasingly warm waters – as the air temperature rises, you would

expect it to have a greater tendency to rise – so you would expect to see convection (warm air rising). The clouds we associate with convection are cumulus clouds – the puffy clouds in which you can often watch the rising air currents changing the cloud's shape on a fine day. As the air passes over the ocean, it picks up water vapour, so there will be cloud and rainfall out at sea – and over the first bit of land the wind meets – the west coast.

This satellite image is typical for Pm air. The puffy cumulus clouds to the west of the UK, with a more solid bank of cloud over the west coast.



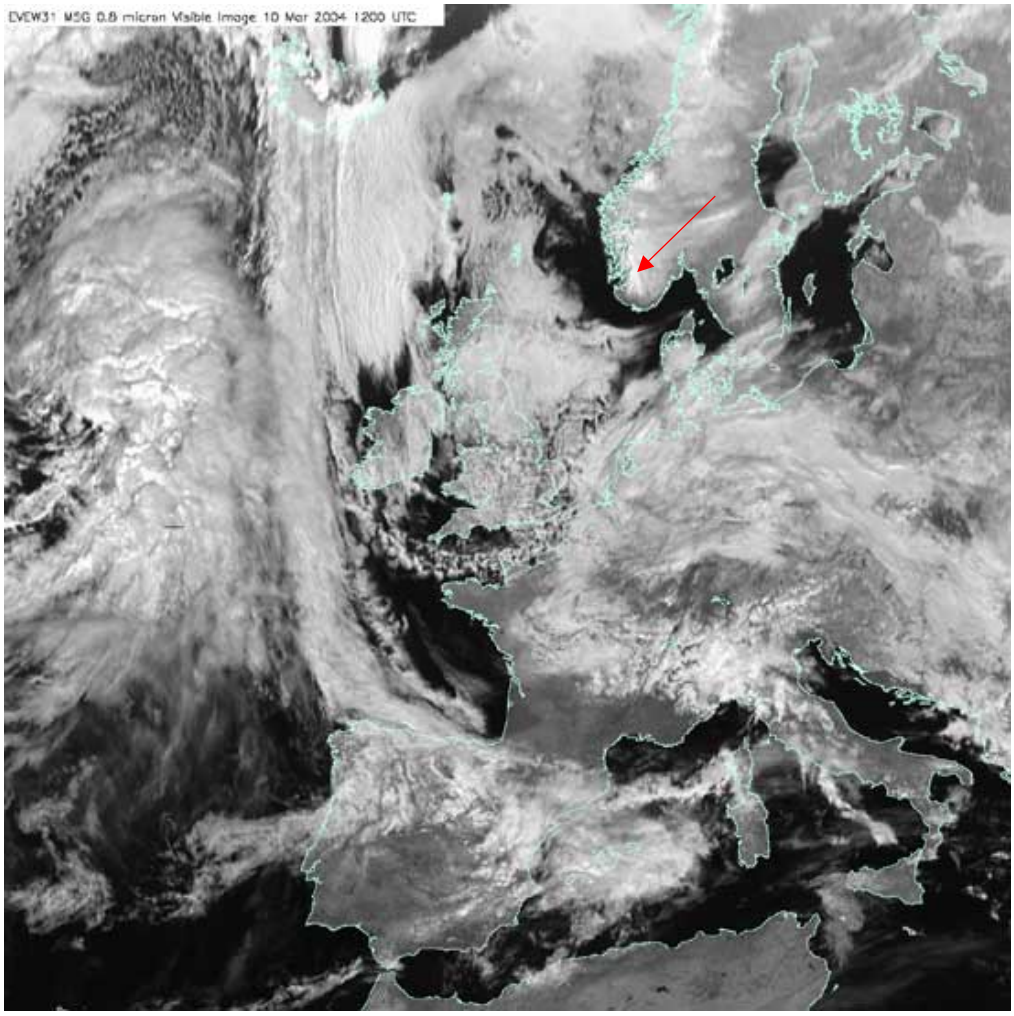
All satellite images courtesy University of Dundee Satellite Receiving Station

In the summer, when land surfaces are warmer than the sea, PM can actually bring most rainfall to eastern counties as the air is warmed as it passes over the land, triggering convection.

Returning Polar Maritime (rPm) air is air which originated in the North Atlantic, but which was diverted before hitting the UK – so may approach from south of west. However, its characteristics are polar, not tropical. Using the isobars (pressure contours) to trace the path of the air reaching the UK would identify it as polar in origin. The further south the air approaches from, the less convection there will be as the air crosses the UK.

Arctic Maritime Air (Am) brings localised snow showers across the UK in winter, predominantly in the North. As the air moves south across the country it is warmed by the ground underneath and the local topography can trigger clouds and snowfall.

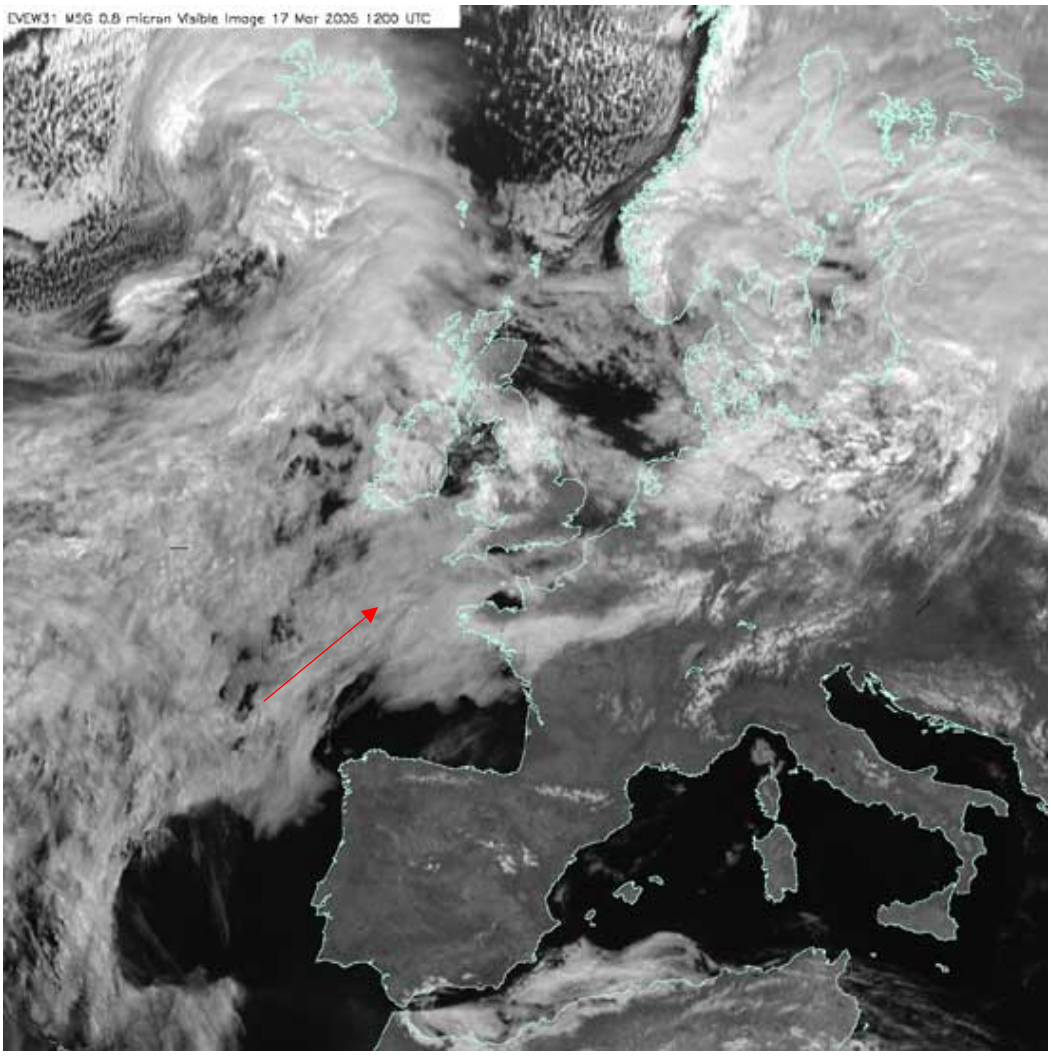
Polar Continental (Pc) air will similarly be cold to start with and get progressively warmer as it moves south, so you would also expect convection. However, the air will be very dry as it passes over continental Europe, so little cloud will form. The UK is a set of islands though and to reach us, the air must pass over the North Sea, picking up water vapour as it does so. The cloud and precipitation (typically snow in winter) it brings therefore primarily affect the east coast. This satellite image is typical for Pc air – you can see the cloud free areas immediately to the west of the land masses, with cloud forming further east.



The '**Beast from the East'** in 2018 was an example of a polar continental air mass meeting a depression (storm Emma) – resulting in widespread snow.

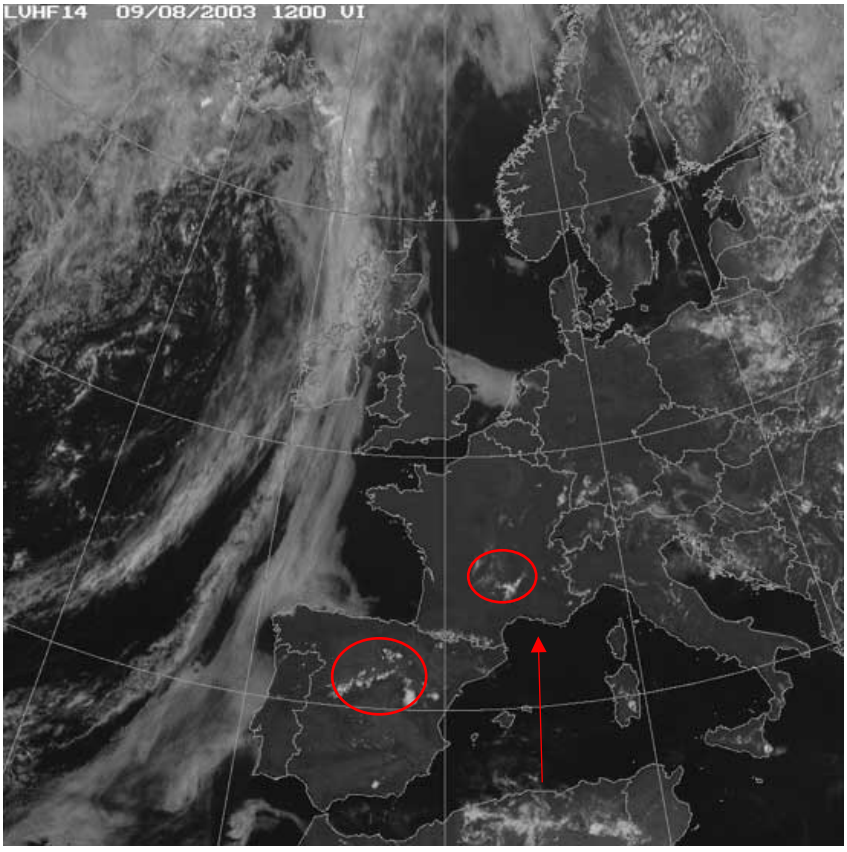
The processes at work in **Tropical Maritime** (Tm) air are a bit different. This is warm air, which is being cooled from below as it moves north. You therefore wouldn't expect any convection with air rising, cooling and forming cloud. However, the air is being cooled just by moving north and so eventually may reach the temperature at which cloud forms – flat, featureless sheets of stratus cloud because, on the whole, the air is staying at the same level. As it is maritime air, there is plenty of water vapour available to form cloud droplets. The processes which give us big, fat raindrops are mainly associated with the vertical air motions and circulations in cumulus clouds. So Tm air at best gives a

persistent drizzle. The satellite image below shows the extensive sheet of stratus cloud over the Atlantic associated with Tm air.



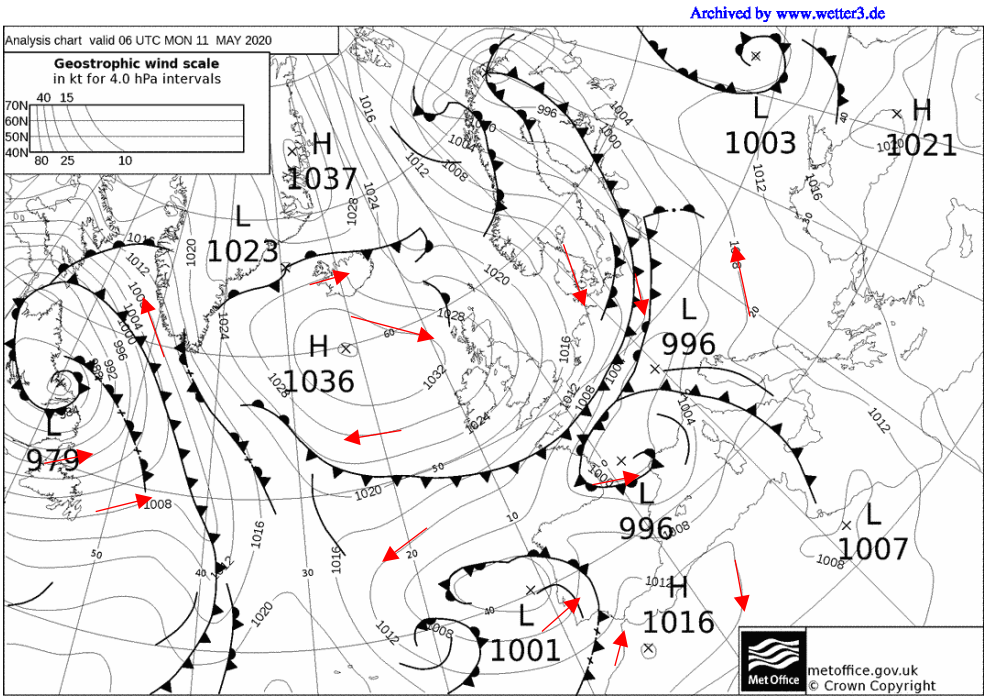
In the UK, the weather fronts associated with depressions usually separate polar and tropical maritime air.

We rarely experience **Tropical Continental** (Tc) air – air that flows up from the Sahara over continental Europe. If we do, it can bring Saharan dust with it. This is the warmest and driest air we can get – any moisture picked up over the Mediterranean will be rained out before it reaches us. Tc air gives clear skies – in the summer, this can mean that some areas get particularly warm – maybe because of their colour (dark) or aspect (facing the Sun) – giving rise to late afternoon localised thunderstorms – ringed in the following image:



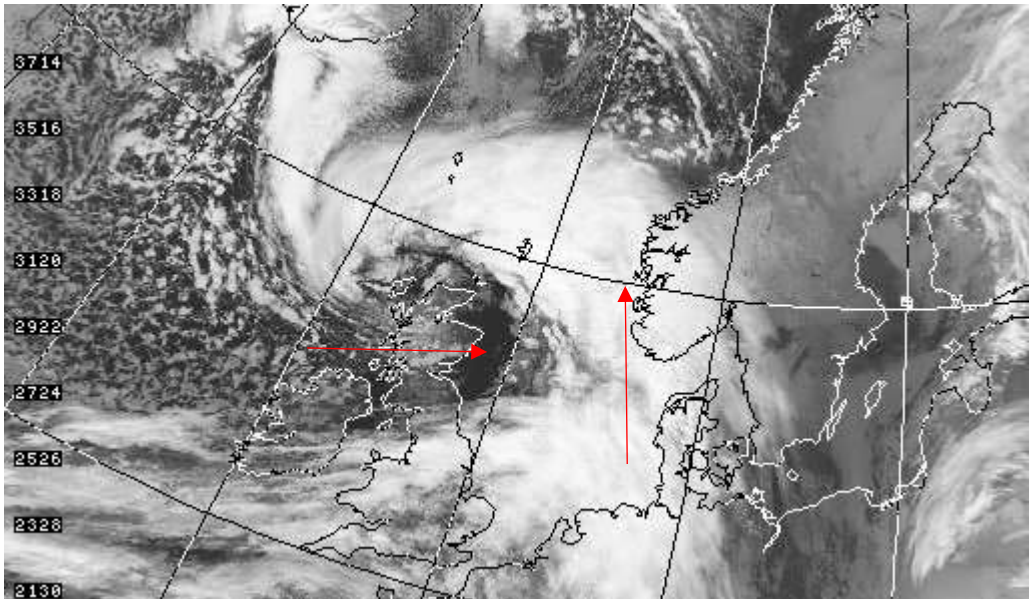
In the winter, the oceans are warmer than the land, giving rise to more convection over the ocean. In winter there is also much less diurnal variation in temperature than in the summer when the land is warmer – so snowfall, for example, is equally likely by day or by night.

Using a synoptic chart, it should be possible to work out the wind direction and therefore the air mass. Bearing in mind that air blows along the isobars, then the task is simply to work out which way the wind is following the contours around the map. It shouldn't matter which pressure system you consider – the wind should be able to blow around the Low pressure systems in an anticlockwise direction and the High pressure systems in a clockwise direction. Consider the map below, where arrows have been added to indicate the wind flow, and ignore the fronts – following each pressure contour, the wind should blow along the contour from one side of the map to another.



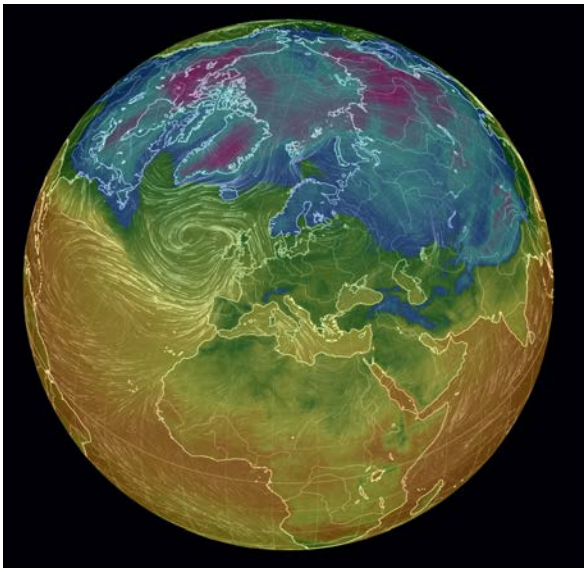
Of course, the characteristics of the air masses can be very different in the summer and the winter. Siberia, for example, is extremely cold in winter but relatively warm in summer – so a polar continental air mass can bring us bitterly cold weather and heavy snowfall (for eastern counties) in the winter, but much warmer weather in the summer.

Fronts mark the boundary between two air masses: the image below is typical for a mid-latitude depression, with a swathe of tropical maritime cloud caught between the warm and cold fronts, and the isolated cumulus clouds typical for polar maritime air evident both to the NE and the west of the UK.

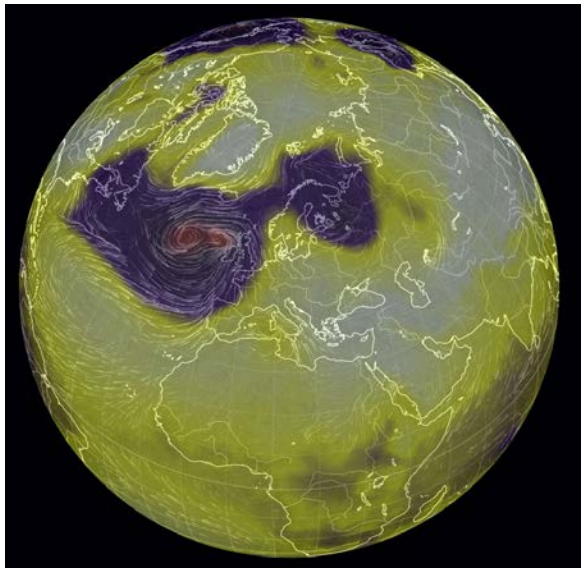


Sources of Information

Earth.nullschool.net can be used to great effect to investigate the current air mass – showing both the current air flow, the surface temperature and the mean sea level pressure – again note how the air flow is along the pressure contours.



Wind Speed and Surface Temp



Wind Speed and Mean Sea Level Pressure