Floating in air

Rupert Holmes explains some essential weather knowledge to help interpret forecasts on the water

Photos: Rupert Holmes

Weather forecasting has changed enormously over the past few decades – there's now a bewildering array of apps and websites that have the potential to give quite fine-grained data.

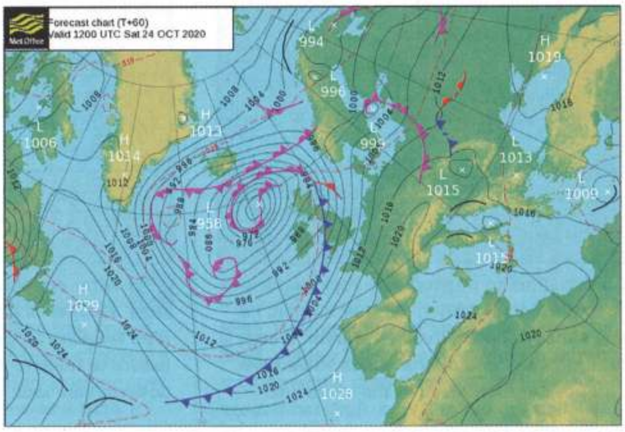
But at the same time, the way in which we receive and interact with weather data has also changed along with our expectations.

For example, despite the massive improvements in accuracy, forecasting still gets a bad press. Today's predictions for six days' time are as accurate as the 48-hour forecasts at the time of the 1979 Fastnet Race disaster and that ability continues to improve at the rate of a day per decade.

Yet interpreting what a forecast will actually mean on the water still requires some understanding of the basic elements of weather systems.

Weather is fundamentally created by the interaction between two distinct air masses with different properties: warm and wet vs dry and cold. Warm, moist air in the earth's heat engine around the equator – the tropical regions – rises, while cold, dry air at the poles falls towards earth. The boundary between them – the polar front – can be very clear at times (see synoptic chart, above).

If the polar front passes over you, some rain will typically fall. This is because the warm, moist air is cooled on contact with the polar air turning the vapour into droplets that fall as rain.



ABOVE This heavy, forbidding cloud marked the approach of an occluded front in the eastern Mediterranean, with a lot of heavy rain and wind

LEFT A polar front heads across the Atlantic

The rotation of the earth causes these bodies of warm and cold air to spin, which in turn creates a kink in the polar front. This is the seed of a new low pressure system.

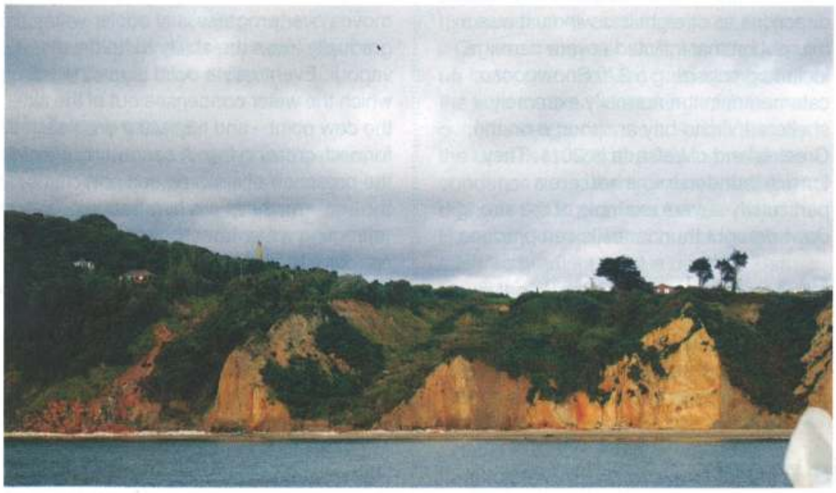
A new low pressure system will break free of the polar front and gather energy. The warm air remains separated from the cold and a great deal of energy may be dissipated as wind. This will change in strength and direction in a very predictable manner as the low pressure system moves across your location.

Typically the formation of a low pressure system will take 24-48 hours, however, some develop much faster. This is particularly true of secondary depressions, which can form quickly into a compact but devastatingly concentrated spiral of power.

Lows tend to be associated with unsettled and often unpleasant weather, but although many of their characteristics are predictable, long-range forecasts are likely to be less accurate than when high pressure dominates the picture. So when the weather is cyclonic with frontal systems passing over, it's even more important to stay in touch with updated forecasts.

Characteristically wispy cirrus clouds are an early sign of an approaching low

As a front approaches the wind will rise and the sky may clear briefly, but don't be fooled...



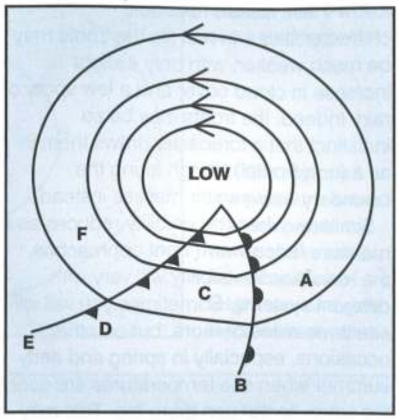
... heavier cloud will follow, bringing rain

In a textbook northern-hemisphere low-pressure system, warm and cold fronts form along the boundary between the warm and cold air masses. A warm front can be up to 100 miles across and may take several hours to pass, giving light or moderate rain as it does so. By contrast, the cold front is a more concentrated feature – a vigorous one will give maybe 15 minutes of heavy rain and strong wind, before moving away, leaving a clear sky but cold and blustery north-westerly wind in its wake.

Key elements of a low pressure system

As the depression approaches (see figure 2, above) the wind direction is likely to be south or south-easterly and increasing in strength as the centre of the low moves closer. An early sign of an approaching low is high, wispy (cirrus) cloud, with the layers of cloud progressively becoming thicker and lower, leading to rain to start as the warm front (depicted on synoptic charts with red semicircles) reaches you. As the low moves closer atmospheric

FIGURE 2 Text book low pressure system showing the warm front ahead of the cold front



pressure will fall and visibility will decrease in the rain.

As the warm front passes the wind veers, typically to a south-westerly direction and, providing the low is not continuing to deepen, it stops increasing in strength. Rain eases as the front clears away, leaving behind warmer and more

'As the cold front approaches the wind will start to increase'

humid weather, with generally overcast skies and the possibility of drizzle. This is the warm sector, formed of the moist damp air on the equatorial side of the system. Visibility will remain moderate to poor and the pressure stops falling.

The cold front (depicted on synoptic charts with blue triangles) is the most active part of most low pressure systems, with the strongest winds and heaviest rain. However it is typically no more than 30 miles across and moves faster than the warm front. It therefore passes in a much shorter time – minutes rather than hours.

As the front approaches the wind will start to increase, although the sky may briefly clear first. Don't allow this to foster a false sense of security – in a vigorous system a line of heavy, towering and forbidding cloud will follow, bringing sudden rain or hail as the front passes over.

As the cold front passes there's a marked veer in the wind direction to the north-west, accompanied by a big increase in strength and a distinct lack of visibility in the heavy rain.

When the rain stops the sky will quickly clear as the wind moderates and shifts to a cold and gusty north-westerly. Visibility should switch to crystal clear, although there may be some vigorous towering clouds around – stereotypical 'April showers' which can pack lots of rain and significantly disturb the already unsteady air flow. Atmospheric pressure will now start to rise.

Of course not all low pressure systems follow these classic textbook characteristics – in real life the fronts may be much weaker, with only a slight increase in cloud cover and a few spots of rain. Indeed, the fronts may be so indistinct that a forecaster draws them in as a (non-frontal) trough along the boundary between air masses instead.

Similarly, when the visibility reduces as a moisture-laden warm front approaches, the reduction in visibility will vary with different systems. Sometimes you will still see three miles or more, but on other occasions, especially in spring and early summer when sea temperatures are cool, the warm sector can bring fog. This may not clear until cool and dry, but unstable air arrives in the wake of the cold front.

A cold front will normally move faster than the warm front ahead of it, so eventually the two become superimposed to form an occluded front, in which warm air is drawn up to even higher levels. Occluded fronts tend to form near the centre of a depression, before moving outwards over time. They are often slow moving and have the potential to bring a lot of rain – rain for eight hours or more is often the result of an occlusion. At the same time as the occlusion forms, the cold front often trails off way out into the Atlantic, in effect becoming the new polar front, and the sequence starts again.

Microbursts and stingjets

Some storm systems include additional air streams from higher levels of the atmosphere that can wreak havoc. A dry intrusion, for instance, brings dry, cold and fast-moving air from the jet stream down from a height of 8-12km to sea level. This can create very strong winds behind the cold front.

So-called stingjets originate in a head of cloud to the north-west of the centre of low pressure, bringing very strong winds across a band 10-100km in width. They can be seen on synoptic surface pressure charts and satellite photos as tightly curved occluded fronts that form a characteristic hooked shape near the centre of the low.

We now know these were responsible for the very strong winds behind the cold front of the 1979 Fastnet Race, the October 1987 storm that wreaked havoc across southern England, the violent weather after the start of the 2008 Vendée Globe Race, plus the mid-Atlantic storm that struck the 2017 OSTAR in which four yachts were lost mid-Atlantic.

Microbursts are concentrated columns of air that descend directly downwards at speeds of up to 150mph. Once they hit the surface they fan out horizontally in all directions as straight line winds. It was a microburst that inflicted severe damage, including capsizing a 37ft Snowgoose catamaran, in the normally extremely sheltered Vlicho bay anchorage on the Greek island of Lefkada in 2011. They form in thunderstorms and are a particularly severe example of the strong downdraught thunder cells can produce.

Fog

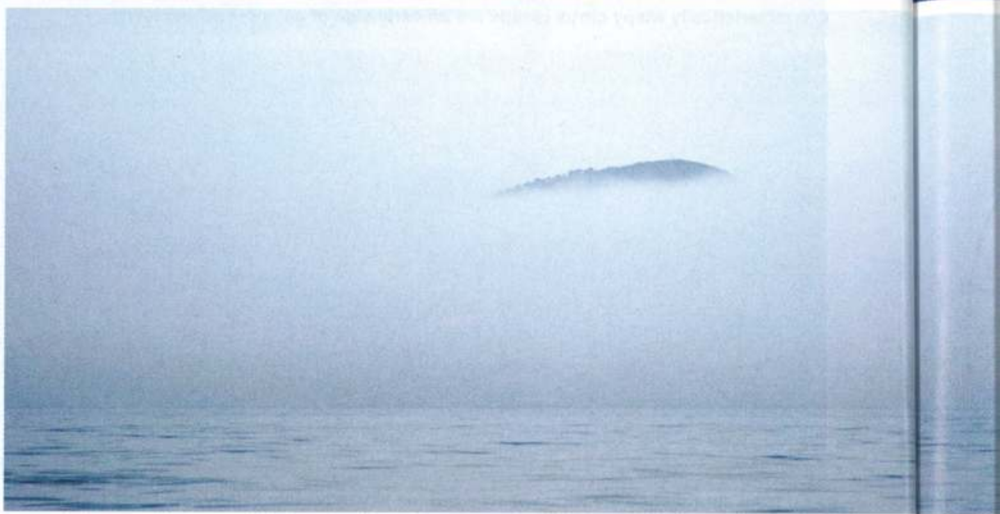
It's important for any sea-going boat to be aware of the possibility of reduced visibility. In cold and dry polar air, to the north of the polar front, visibility is normally excellent. However the warm moisture-laden air on the equatorial side of the front will always bring a reduction of visibility. We can therefore expect visibility to reduce as a low-pressure system – and particularly its warm sector – moves towards us. Fog can also persist during weather dominated by high pressure.

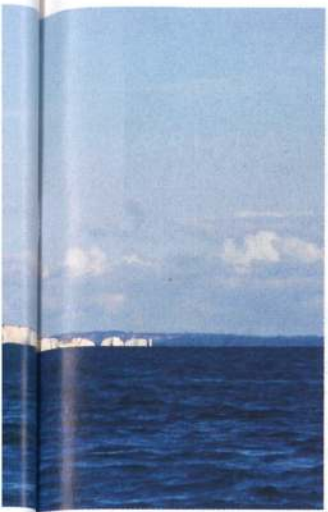
'Sea fog is most common in spring and early summer'

The extent to which visibility decreases during the passage of a low pressure system generally depends on two factors – the amount of moisture in the air and the temperature of the sea. As the warm air moves over progressively cooler water, it gradually loses the ability to hold water vapour. Eventually a point is reached at which the water condenses out of the air – the dew point – and tiny water droplets are formed, creating fog. A secondary effect is the presence of airborne salt particles over the sea – as these are hygroscopic (attracting water from the atmosphere) fog can form at higher temperatures than the theoretical dew point.

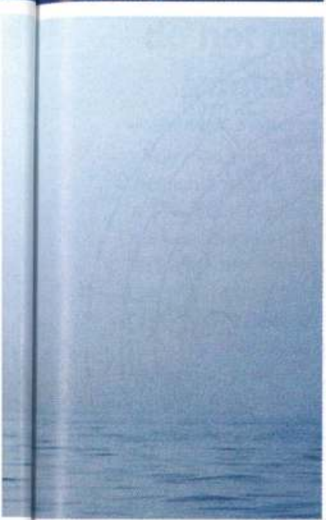
Sea fog is most common in spring and early summer as the water temperature is at its coldest, whereas by late autumn there's often minimal differential between typical air and water temperatures. Sea fog tends to cover large geographical areas, lingering until it is replaced by a new weather system, although the heat of the sun may help to thin it out in the afternoons. Thick fog can also form at the cold front where warm, moist air is rapidly cooled. However, this tends to pass quickly and after the passage of the front.

If fog forms during high pressure it's normally a more local effect as a result of a landmass cooling quickly overnight, allowing moisture-laden air to reach its dew point. The fog then spills out down valleys and estuaries and over the coast, often extending no further than a mile or two offshore. The heat from the sun usually burns it off by mid-morning. The

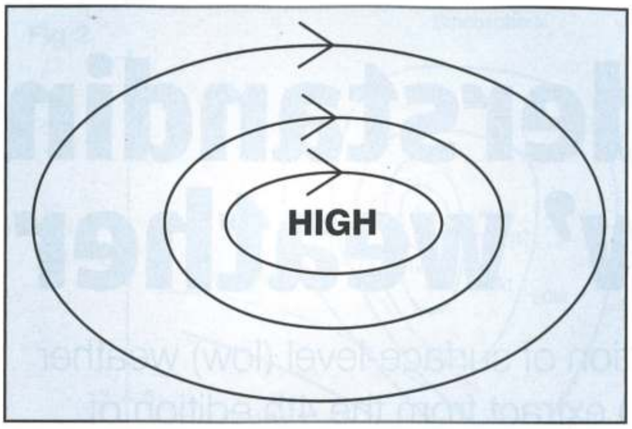




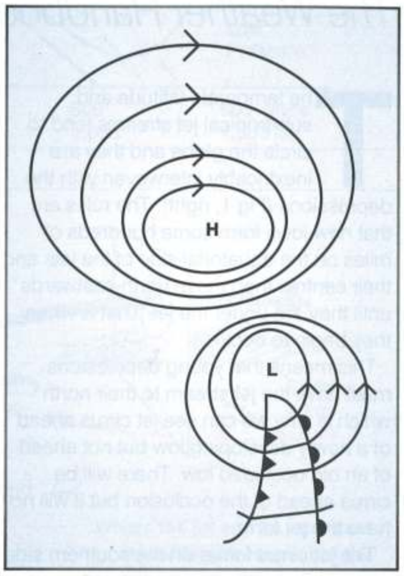
LEFT **Clouds over land are distinctive features to indicate the likelihood of sea breezes: a warm, sunny morning can bring stiffer breezes in the afternoon**



LEFT **Several factors influence the formation of fog. It can come and go quickly, or may hang around for days**



LEFT **Areas of high pressure generally bring settled weather and more accurate forecasts**



BELOW **High and low pressure areas in close proximity, which can result in a combination of bright sun and gale force easterly winds**

exception to this is in winter, when a persistent high pressure system may produce several days of fog.

High pressure

This is generally associated with settled weather, which makes medium-range forecasting easier and more accurate. In summer the clear skies provide warm sunny days, although gradient winds may be very light.

In winter a lack of cloud cover can give rise to sharp frosts, although sometimes a winter high can be associated with an accumulation of high-level cloud, giving cold, near calm overcast conditions that are not appealing for any kind of sailing.

In the British Isles and Ireland most high pressure systems are associated with the Azores high, which is typically centred a few hundred miles to the south-west of the Atlantic islands. Its position ranges somewhat to the north or south with changes in the position of the jet stream. In addition, its intensity varies, but if the Azores high is well established in summer, a ridge will extend over the UK, giving us fine weather and pushing the polar front to the north, so that we're clear of the track of low pressure systems as they move in from the Atlantic.

On the other hand, some of the poor summers of recent years have seen the Azores high unusually far south, with the result that we're right in the track of those low pressure systems.

While weather dominated by high pressure systems is generally pleasant there's one important scenario that can cause a sustained summer gale to watch out for. High and low pressure systems with centres close together have the isobars between them squeezed together. This results in stronger winds than you might expect, even if you are on the high pressure side with warm temperatures, clear skies and bright sun.

Thermal enhancement and sea breezes

The warming effect of the sun can have significant influence on the winds we experience. Perhaps the most obvious of these is the sea breeze, which is most apparent around the shores of the UK when high pressure is dominating in summer.

On warm summer days, the land heats up faster than the sea, causing the air over the land to rise and sucking in air from over the sea to replace it. As the air over the land rises it cools, allowing water to condense out to form clouds – these are a distinctive feature of sea breeze days. However, for a true sea breeze to form an offshore gradient wind is needed. This blows the air rising over the land out to sea, where it falls towards the earth and sets up a cycle.

Very often instead of a proper sea breeze we see a thermal enhancement of the gradient wind, which can increase its strength by one or two points on the Beaufort scale during the mid to late afternoon.

Whether a sea breeze or thermal enhancement, it's important to recognise that a sunny and warm morning can give way to stiff afternoon breezes. On the south coast of the UK if this is combined with spring tides these stronger winds can create dangerous conditions on the ebb at the bar of harbours such as Salcombe and Chichester. It can also give rise to challenging conditions that may overwhelm small boats in tidal races around headlands and in the Needles Channel, where a steep sea is kicked up in strong wind against tide conditions.

Sea breezes affect coastal waters up to about 20 miles offshore and maybe 30 miles inland. They generally start in late morning, with peak strength in mid/late afternoon and reach Force 4-5 maximum strength. However, a bright sunny day is not an automatic guarantee of a sea breeze. The first sunny day after a spell of wet weather often sees the heat of the sun simply evaporating surface water from the ground, which results in a cooling effect. A good sea breeze is therefore often not established until the second day of good weather.

The rotation of the earth causes a sea breeze to rotate during the day, so on the south coast a sea breeze will swing towards the south-west during the course of the afternoon. Sea breezes are a relatively shallow feature in the atmosphere, they may therefore tend to flow around, rather than over, cliffs and other obstructions, especially in the early stages.

Land breezes

At night, as air on land cools it becomes heavier and sinks, funnelling down valleys and out to sea. However, this land breeze effect is generally relatively mild compared to the strength of a well-established sea breeze, although I've encountered a very useful Force 4 breeze off the island of Ibiza at night. PBO