WEATHER - RELATED INTERFERENCE

Many people are familiar with the interference to TV and FM Radio reception that can occur during abnormal weather conditions. Doesn't it always seem to happen in the middle of Wimbledon Tennis fortnight?

In fact, the weather conditions that can cause such events do occur most commonly in the summer months so the above can often be true. It is not possible to exclude completely interference due to the weather, but the broadcasters do their planning on the basis that service areas should be clear for at least 95% of the time. There is not much that viewers and listeners can do little about this interference when it occurs. However provided they live within the service area of their transmitter and are using as good directional aerials, the problem should be kept to 5% or less most of the time.

This factsheet explains what causes this interference and what the broadcaster can do to minimise its effects. The factors which occasionally enable a distant transmitter to blot out local reception are complex, depending very much on complicated atmospheric conditions over the British Isles.

The Atmosphere

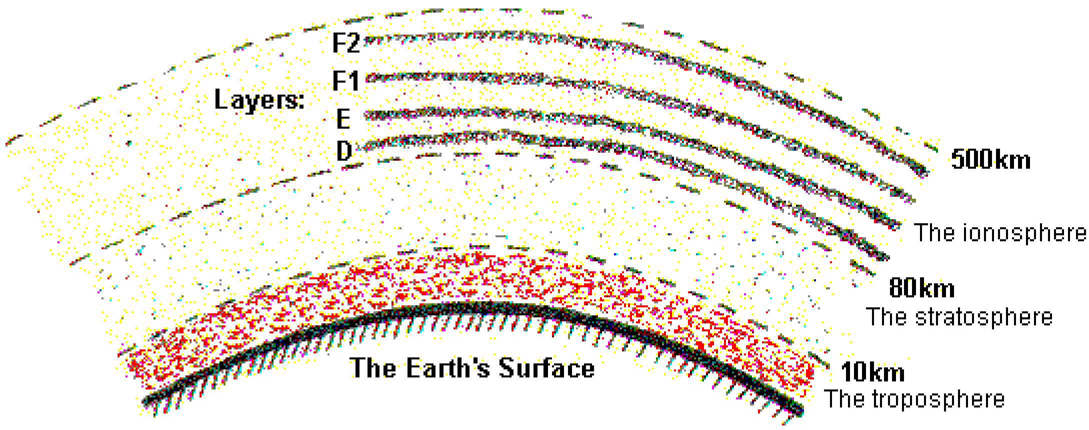

fig 1: the earth's atmosphere showing the troposphere, the stratosphere and the D, E, F1 and F2 layers of the ionosphere

The atmosphere surrounding the earth comprises a lower layer called the troposphere, which extends to a height of about 10 km above sea level; a middle layer called the stratosphere which extends to around 80 km high and an upper layer called the ionosphere which stretches about 500 km or more into space (see Fig 1). The ionosphere is usually sub - divided into layers D, E, F1 and F2. Although the ionosphere has an occasional effect on FM radio, as discussed later, the troposphere is the most important layer as far as VHF and UHF signals are concerned.

The Troposphere

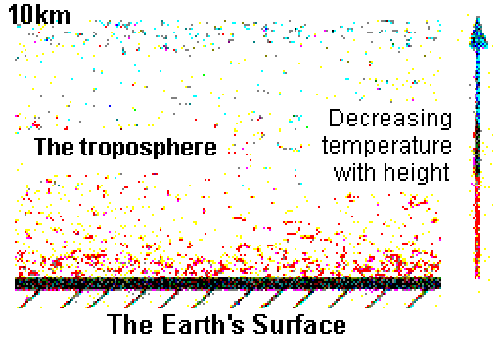

fig 2: in a normal troposphere the surface temperate decreases gradually with height

All our weather occurs in the troposphere and, during normal conditions, its temperature decreases with height as shown in Fig 2. During low pressure (cyclonic) weather, the air mass is rising gently and as it climbs, it cools and any moisture in it condenses to form clouds.

Under these conditions, the troposphere is generally well "stirred up" and unsettled. During high pressure (anticyclonic) weather, the air mass is sinking slowly and as it falls, its temperature increases to produce a warmer and drier atmosphere, very often without clouds. Under these conditions, the troposphere is generally very still and settled. Although temperature normally decreases with height, certain weather conditions can result in a layer of air being formed whose temperature remains constant or even increases with height.

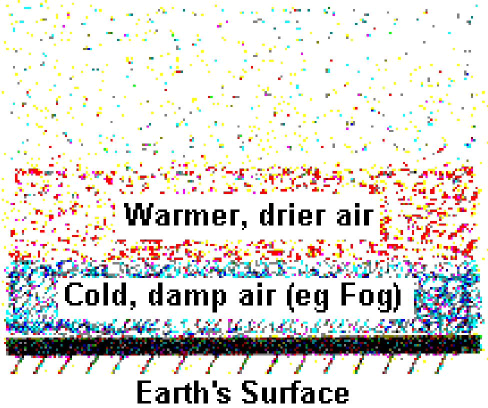

fig 3a: a temperature inversion at ground level

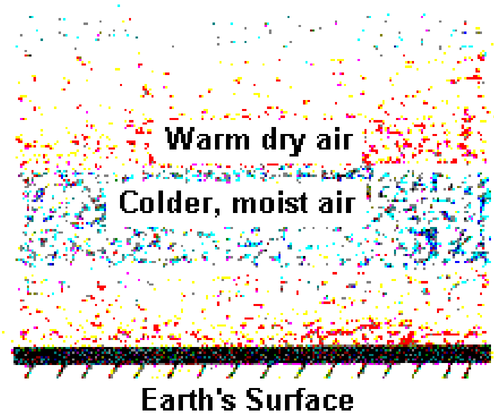

fig 3b: an elevated temperature inversion

In the United Kingdom, such a layer can occur anywhere from immediately above the earth's surface up to a height of around 3km. (see Figs 3a and 3b). This condition is known as a temperature inversion. Temperature inversions mostly occur during high pressure periods as the still air allows stratification of the atmosphere to take place. They have a pronounced effect on VHF radio and UHF television signals, particularly if there are corresponding changes in the humidity.

VHF/UHF Propagation

VHF and UHF signals normally propagate (ie travel) through the troposphere in a slightly curved path as shown in Fig 4. As a result of this bending, they are able to travel further than the geometrical horizon to a point known as the radio horizon. Beyond here, the signals attenuate rapidly and good reception is not generally possible.

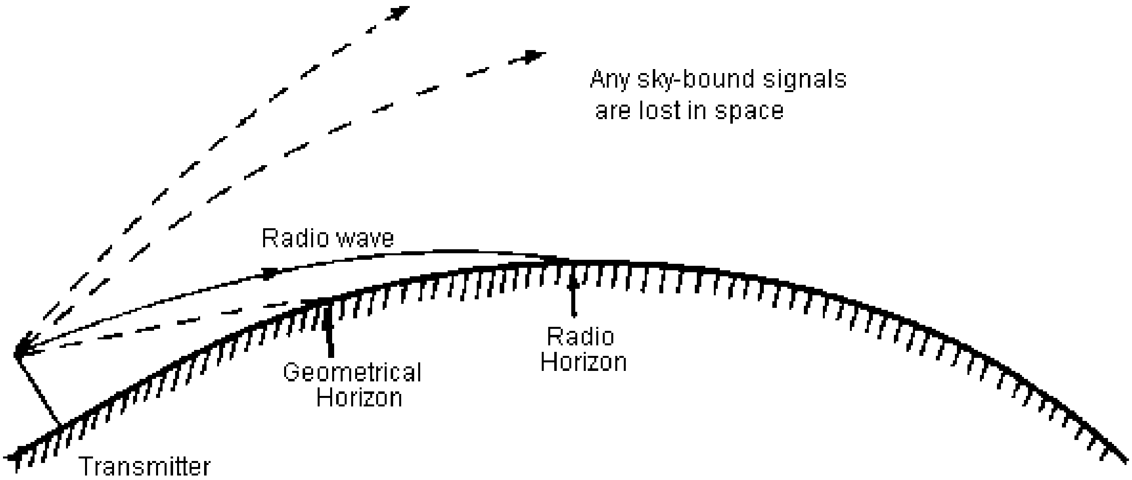

fig 4: normal propagation of a VHF or UHF signal in the troposphere

The bending of these waves is caused by refraction and the extent to which they curve depends on the refractive index of the troposphere. This in turn depends on the temperature and humidity of the air. In a normal atmosphere, the temperature (and humidity) generally decrease with height and this produces a steady fall in the refractive index with height. Under these stable conditions, the radio horizon can readily be calculated.

If a temperature inversion occurs, the refractive index can increase dramatically to produce long - range reception as shown in Fig 5.

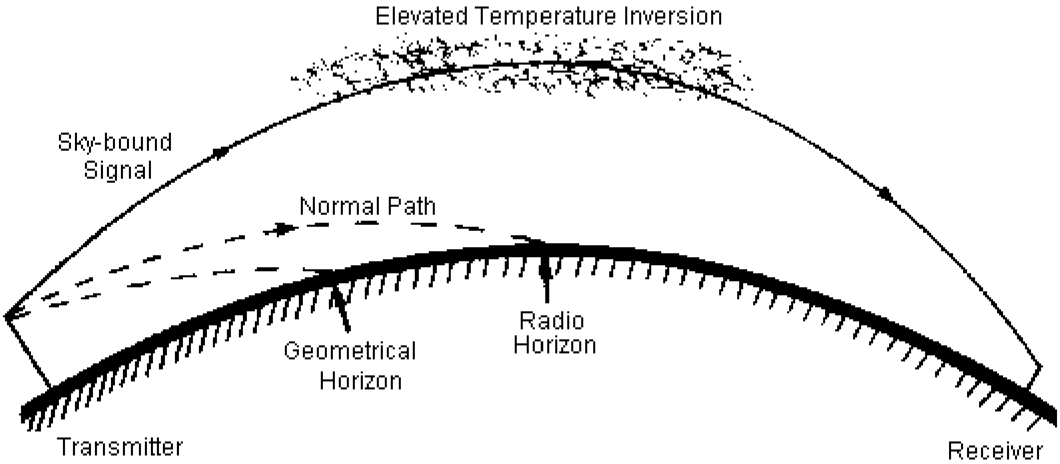

fig 5: abnormal propagation of a VHF or UHF signal by refraction from an elevated temperature inversion

In this example, a sky - bound component of the signal (which would normally be lost into space) is refracted back to earth, well beyond the normal radio horizon. This type of abnormal propagation is often described as a tropospheric opening and, to the radio amateur or DX enthusiast, it is a Godsend. However, to the ordinary viewer or FM listener, it can be a nightmare - pictures ruined by co - channel or adjacent - channel interference; FM reception wrecked by "birdie" interference (warbling, sizzling, frying - type noises in the background).

Temperature Inversions

There are four types of temperature inversion which can lead to abnormal propagation:

1. Subsidence Inversion

Tropospheric openings can occur towards the end of a stable period of high* pressure. A typical system lying over the North Sea is shown in Fig 6.

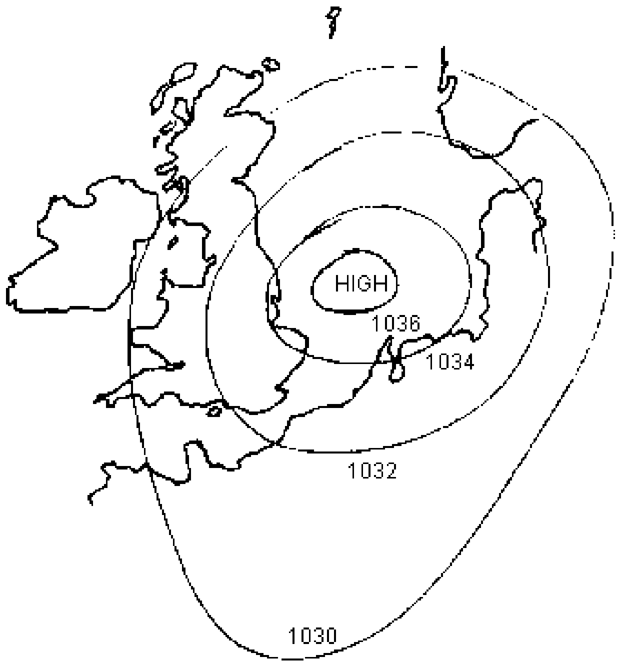

fig 6: a typical high pressure system

A large high may stay in this position for several days. If it eventually moves east, it could allow moister and cooler Atlantic air to move in near the surface - below the subsiding mass of warm, dry air associated with the high.

Note: Atmospheric pressure is often measured in millibars (mb) and, at sea level, a value of 1013 mb represents the average figure for the UK However, low and high pressure are only relative terms so that a pressure of, say, 1008 mb could be called a high - if the pressure of the surrounding air masses is considerably lower A small high like this is insignificant so far as we are concerned; the pressure at sea level would need to be 1030 mb or more to produce the large type of high which can lead to abnormal propagation over a very long path.

The sharp contrast of temperature and humidity between the two layers of air produces substantial refraction of a VHF/UHF signal and a tropospheric opening develops. Had the high moved in a different direction, an opening may not have occurred as the temperature and humidity contrast between the two layers may have been too slight.

This type of inversion can happen at any time of the year but is more common in the spring and autumn. It can produce abnormal propagation for extended periods over large distances of several hundred kilometres.

2. Advection Inversion

This type of inversion is caused by an air mass adverting (ie moving) across surfaces of differing temperature.

During many a summer, Newcastle, Norwich and London have been known to swelter in the upper 20s Centigrade for several days on end, while the residents of nearby Tynemouth, Cromer and Margate, respectively, are enshrouded in fog at around 13 to 16 degrees C. Warm dry air above the land masses was being blown over the colder sea to produce a layer of cool, foggy air immediately above the water. This large contrast in the weather has not only upset east - coast residents and holidaymakers; it has also provided the right conditions for long - range propagation over the North Sea which, at the time, would have been extensively covered by a layer of fog.

An advection inversion can also occur over the land during the winter - if warm, moist air from the sea is blown over cold, frosty or snow - covered ground to produce a surface layer of fog or mist.

3. Nocturnal Inversion

This type of inversion can occur after dark, if the land cools more rapidly than the air above it.

During the daytime, the sun heats both the ground and the air and there is a normal fall of temperature and refractive index with height. In the evening, the ground cools rapidly and the layer of air closest to it becomes colder than the layer immediately above. Around dawn, the air in contact with the ground is at its coolest and may also be very moist, resulting in fog or dew.

As in the case of the advection inversion, the sharp contrast between the two layers of air - one cool and foggy, the other warmer and drier - provides the right conditions for long range propagation of VHF/UHF signals. Nocturnal inversions occur exclusively over the land as the ground can cool much quicker after sunset, than the sea.

4. Frontal Inversion

This type of inversion occurs during low rather than high pressure weather. Associated with a low there are often warm and cold fronts as shown in Fig 7.

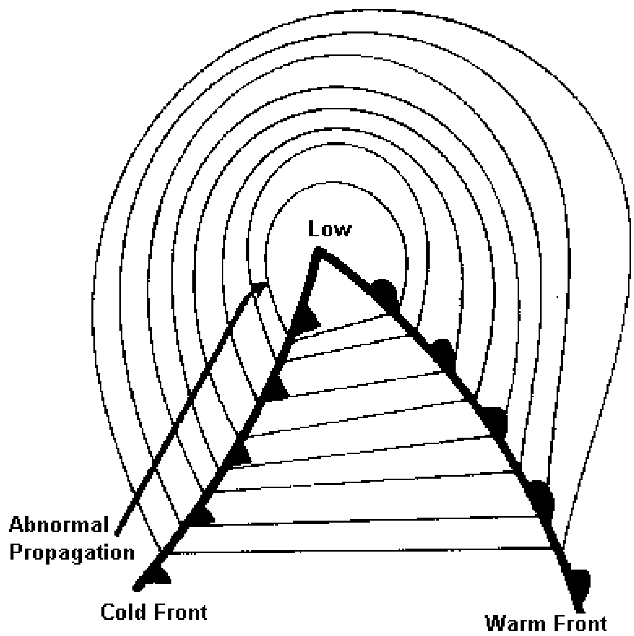

fig 7: abnormal propagation can sometimes occur behind an advancing cold front

Changes in temperature and humidity with height occur at these fronts and abnormal propagation along the advancing front may occur. These conditions generally develop only for a short time, along a limited path, and are fairly insignificant.

There are certain non-tropospheric conditions which can also affect radio and television reception. These occur in the ionosphere and deserve a brief mention.

The Ionosphere

The ionosphere plays an important part in LF, MF and HF broadcasting (ie long wave, medium wave and short wave radio) but its influence diminishes with rising frequency. In fact it has no known effect on UHF signals and only a very occasional effect on VHF Band II reception (ie FM radio). Its most pronounced effect was on VHF Band I signals - the old 405 - line television system which closed down in this country during 1985.

As mentioned earlier, the ionosphere is sub - divided into layers D, E, F1 and F2 as shown in Fig 1.

These layers have no effect on UHF propagation but under certain conditions, the E and F2 layers can act like a mirror to VHF signals, particularly at the lower frequencies, and reflect them back to earth, well beyond the normal radio horizon. For this to happen, the layer had to become heavily ionised.

In the E layer, the intensity of ionisation is seasonal, being highest in June or July. When ionisation becomes abnormally high, known as Sporadic E, VHF signals in BAND I and, to a lesser extent, BAND II can be reflected back to earth up to a maximum distance of about 2400km. In the days before UHF television, it was a major problem with television on VHF Band I.

Ionisation of the F2 layer depends not only on the season but also on sunspot activity, which reaches a maximum every 11 years. Only Band I signals are known to reflect from the F2 layer and the range covered can be extremely great. During the sunspot maximum period of 1957 - 58, the Channel 1 television transmission from Crystal Palace was received clearly in South Africa!

Network Planning

In the United Kingdom alone, there are over 4000 television transmitters sharing the 44 UHF channels available for this purpose. In Western Europe, where the same channels are used, the number of television transmitters most likely exceeds 30,000. Similar congestion occurs within Europe on VHF Band II.

It is obvious that neighbouring countries must co - ordinate their network planning such that mutual interference, even during periods of abnormal propagation, is kept to an absolute minimum. It is impossible to plan a network which is totally free of interference but broadcasters can protect their transmitter service areas for the majority of the time.

This can be achieved by carefully choosing the channel groups and aerial polarisation used at each station. Additional protection can be obtained by using directional transmission characteristics, where necessary, and by using the terrain (ie hills, mountains etc) to maximum advantage. In the case of UHF television, transmission frequencies can be "offset" slightly to minimise the subjective effects of possible interference.

Finally, network planning assumes that the viewer/listener will fit a good directional aerial to keep out unwanted signals arriving from directions other than the wanted signal.

As Sporadic E and other ionospheric abnormalities occur very rarely, they can be ignored when planning a VHF Band II or UHF network. In any case, their effects are usually felt thousands rather than hundreds of kilometres away. Successful co - ordination can only involve our closest neighbours such as Eire, France, the Benelux countries, Germany and Scandinavia. For that reason, only tropospheric abnormalities are usually considered.

As we cannot control the weather, we therefore have no influence over the occurrence of abnormal propagation through the troposphere and it is only practicable to plan a network where interference is suffered no more than 5% of the time. To improve on this figure, broadcasters would need to reduce the number of transmitters and that would have a disastrous effect on the national coverage of their services.

Unfortunately, tropospheric-type interference is never spread thinly throughout the year. It tends to happen mostly in the evenings - when television viewing and possibly FM listening are at a peak - and it often appears at the same time on consecutive days, then disappears for several months. Some years are worse than others, depending on the prevailing weather patterns. Nevertheless, when averaged over several years, viewers and FM listeners should not be troubled by weather - related interference for more than 5% of the time - provided of course that they lie within the published service area and they fit a good directional receiving aerial!

We acknowledge the valuable assistance provided by a past BBC Weatherman, Jim Bacon (a keen radio amateur).

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