Dr. Kidson

Concludes his Discussion on

The Climate of Wireless

IN our last issue Dr. Kidson, Government meteorologist, discussed atmospheric electricity and thunderstorms. This week he goes on to talk about Radio and Atmospherics.

THE ionisation in the lower atmosphere and the fine weather field are not sufficient under normal circumstances to have a very serious influence on the propagation of wireless waves, though, no doubt, they cause some attenuation. Consequently, the direct ray is the most reliable in its travel. It is less attenuated over the sea than over the land, and over smooth than rough surfaces generally. It is not very strongly affected by conditions of light or dark along its path. Short waves are more attenuated than long waves. Owing to these facts, the direct wave is used for broadcasting and for shipping, especially S.O.S. work.

The indirect ray travels to the upper conducting layers where, in the case of long-wave transmission, it is reflected downward again, and, in the case of short waves, through a process of continuously increasing refractions, it is bent downward. The beacon of the wireless aerial thus becomes visible to the eye of the wireless receiver in the case of short waves in a sort of mirage.

The descending wave will obviously combine with the direct wave and interference and resonance effects will be produced. Thus, there will be a zone at a certain distance from the aerial at which audibility will be at a minimum or fading will take place. At some further distance abnormally strong signals will be heard. The service area for broadcasting stations is that in which the direct ray is over whelmingly stronger than the indirect so that it cannot be seriously weakened by interference.

Since the service area is limited owing to attenuation, fading, and other effects, it is necessary to use the indirect ray for the greater part of the world's wireless communications. By methods developed by Appleton and others the interference between direct and indirect ray has been efficiently demonstrated and it has been possible to calculate the height from which the rays have been reflected or refracted. Long waves are reflected from a height of about 75 km. The shorter waves penetrate for some distance into the conducting medium before finally being bent back, so that at night they reach about 100 km. As Watson-Watt puts it, for the short waves the upper layers are a cloudy prism and for the long waves a dirty mirror. So cloudy is the prism in daylight that the short waves are so strongly absorbed that in broadcasting they become inaudible. The waves of the broadcast band require a concentration of 100,000 electrons per cubic centimetre to bend them back, and this concentration is found at night, usually at 100 km.

Solar radiation increases the ionic concentration in the upper atmosphere. Thus, in daylight the region of reflection or refraction is lowered. But also there are irregularities in the ionisation owing to the varying condition of the atmosphere. Consequently, there will be variations in fading phenomena. Furthermore, the increased ionisation will lead to increased absorption of short waves with consequent weakening of signal strength though the long waves will be more sharply reflected and their transmission favoured.

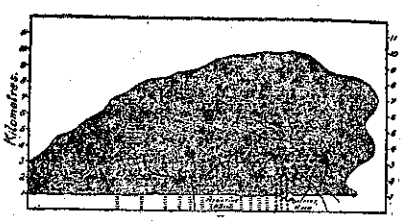

Diagram of a thunderstorm—electrical conditions.

Not only are there marked effects due to the daily illumination of the atmosphere, but the influence of the eleven-year period in solar activity, which is so clearly brought out by the number of sunspots, can also be traced. Even the disturbances sometimes associated with individual sunspots have their effects. The apparent effect of the sunspot cycle is to produce a marked intensification of the ionisation.

Atmospheric Conditions.

THE conditions in the upper atmosphere will depend not only on ionizing radiations, but on factors more directly connected with the weather. Temperature changes, for instance, will have an appreciable effect since they will influence the rate of production and re-combination of ions. The reflecting layer may be lower over a cyclone than over an anti-cyclone, and so on. Currents from Polar regions may bring a lower reflecting layer and those from equatorial regions a higher one, or vice versa.

In this connection it is interesting to note that there is more ozone above polar than above equatorial regions, and when the surface air currents over New Zealand are from the South, there is more ozone overhead than when they are from the North. This would seem to suggest that the movements at very high levels are similar to those at the surface, since it is known that the average height of the ozone in the atmosphere is 50 km.

It is probable that by the use of different wave-lengths it will be possible to explore the higher levels of the atmosphere and plot the degree of ionization in various parts. The information thus obtained would be of the utmost theoretical importance in many branches of geophysics.

It has been stated that atmospherics are almost certainly due to thunderstorms. They are more prominent on long wave-lengths than on short, in summer than in winter, in low latitudes than in high, on land than at sea. All these characteristics would fit in with the idea of a thunderstorm origin. Thunderstorms are more frequent in low than in high latitudes, and on land than on sea. There is a maximum of intensity of atmospherics throughout the year at night-time. A second maximum, prominent only in summer, occurs in the afternoon. The principal minima occur round 10 a.m.

The time of each of these maxima and minima varies throughout the year according to the time of sunrise and sunset, the morning phenomena being earlier in summer and the evening ones later. These characteristics are not confined to any one region. Atmospherics may produce disturbance in ordinary receivers at distances up to 4000 miles. Many atmospherics have been traced to the neighbourhood of thunderstorms, and many more to regions where conditions were favourable for thunderstorms, though none had been reported. The wave form of atmospherics is in agreement with the quantitative evidence found by C. T. R. Wilson regarding the field changes associated with lightning flashes.

The number of atmospherics heard accords well with the estimated number of lightning flashes as based on meteorological reports. The great majority of atmospherics come from considerable or great distances, and so can scarcely emanate from smaller local meteorological disturbances.

The Influence of Weather on Reception.

AMONGST other connections between wireless and the weather, the explanations of which are very imperfectly known, are the following:—Austin has shown that long-wave signals over distances of about 300km. are weak when the air temperature along their path is high. This is possibly an effect on the direct ray, and may be connected with variations in the state of ionisation in the surface layers, due to variations in the nature of the condensation centres in the atmosphere, many of which are heavy ions. It may be mentioned that over cities the number of these centres is frequently over 100,000, though in pure air it is very much reduced.

Sir Henry Jackson stated that the sirocco, a hot, humid wind blowing from Africa over the Mediterranean, and laden with salt and dust particles, reduced the strength of signals. He also found that signal strength decreased prior to the occurrence of atmospherics associated with thunderstorms.

It has been shown that signals are affected by those surfaces of discontinuity in the atmosphere called fronts, where cold air is under-running warm and where most of our rain is produced. It was found that—(1) surfaces of discontinuity between sender and receiver diminished the received energy, while (2) surfaces of discontinuity over the sender increased the received energy.

Duckert found that every warm mass of air passing over the receiving station impairs reception for considerable periods. The effect has certain relationships with the distribution of humidity, and is greater on short than long waves. Deflection effects in radio-direction finding have been traced to the effect of fronts between sender and receiver. Duckert refers these effects to lateral deflections produced in the lowest layers of the atmosphere.

The effects described are produced in the general air mass, and are not due to the effects of local conditions on the transmitting antennae. These have been proved to be very small. In cases of glazed frost, when ice is deposited on all objects, and in a few other exceptional cases, trouble may arise. But generally speaking, it has been shown that the effects of weather on the signal as it leaves the transmitting aerial are slight.

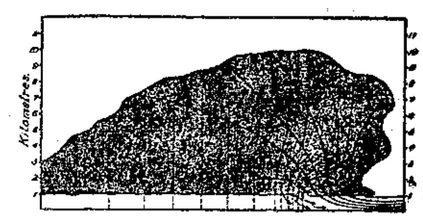

Diagram of a thunderstorm—meteorological conditions.