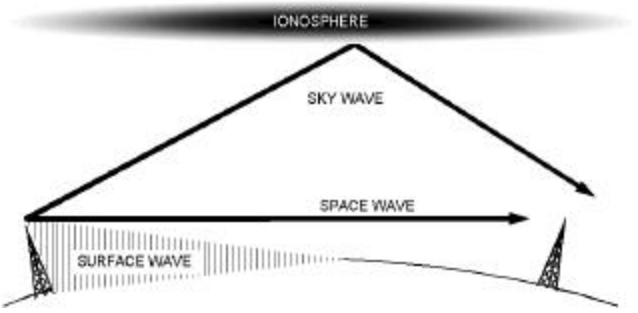
Commo Brief: Radio Wave Transmission

Radio Wave Transmission

There are two principle methods in which radio waves travel from a transmitting antenna to a receiving antenna. One method is by the ground wave, and the other is by the sky wave. Ground waves, as their name might suggest, travel along or slightly above the ground. Sky waves are those waves which are reflected back to the earth by the ionosphere.

Ground Waves

The ground wave is comprised of two separate waves known as the surface wave and the space wave. A surface wave travels along the surface of the earth and is affected by surface features, obstructions, and soil conductivity. The space wave travels above the surface and relies on a line-of-sight path between the transmitting and receiving antennas. The following figure illustrates the differences between sky waves and the two types of ground waves.



Surface Waves

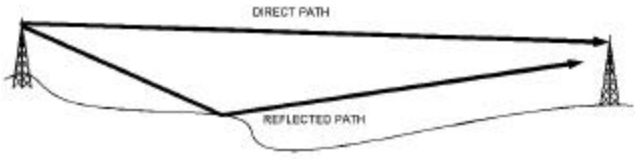
A surface wave is able to generally follow the contours of the Earth due to diffraction. When a surface wave encounters an object, terrain feature, or other obstruction, the wave tends to curve or bend around the object if the wavelength exceeds the dimensions of the object. For this reason, longer wavelengths such as those found on High Frequency (HF) bands perform better as surface waves than Very High Frequencies (VHF), which tend to be absorbed by the object.

As a surface wave passes over the ground, the wave induces a voltage in the Earth, which weakens (attenuates) the signal. The level of attenuation depends on a number of factors, including the electrical characteristics of the terrain. The ground with the best electrical conductivity, such as that found near water or loamy soil, minimizes attenuation. Electrical conductivity is poor in desert or rocky terrain and results in increased attenuation.

Because waves with shorter wavelengths are more readily absorbed in the surface wave, long-range VHF communications are impractical using the surface wave.

Space Waves

Space waves travel through free space just above the Earth's surface. Because they travel close to the surface, space waves often are reflected off the ground, buildings, or mountains, creating multiple paths to a receiving antenna.



This multi-path characteristic of space waves makes them susceptible to fading. Fading of a signal occurs when the two component waves (direct path and reflected path) arrive at the receiving antenna out of phase and cancel each other out. When they arrive in phase, they reinforce each other and result in a stronger signal.

In VHF communications we are concerned with line-of-sight distances. In other words, we want the two antennas to be visible to each other above the horizon to take advantage of the direct path component of the space wave.

Sky Waves

The sky wave, also known as the ionospheric wave, is radiated upward and returned to the Earth at some distant location after being refracted by the ionosphere. This type of propagation is unaffected by the Earth's surface and is capable of literally sending signals around the world. Short wave stations heard around the world, for example, are often heard by sky wave.

HF frequencies (under 30 MHz) are used for sky wave propagation, and can sometimes "bounce" several times between the ionosphere and the ground to create multiple hops to the far side of the Earth. Sky wave propagation is affected by factors such as solar activity, seasons, the frequency in use, and the time of day.

The ionosphere rarely refracts VHF signals, and generally only during periods of intense solar storms when the ionosphere is particularly active. Such conditions do not lend themselves to dependable operation, and operators should not rely on openings to conduct communications.

Solar activity is the predominate factor affecting the ionosphere, and significantly determines the paths open between various locations. Calculations, which consider the factors above, can determine the best operating frequencies and the best time of day to operate between two locations. Working long distances consistently becomes a matter of understanding the effects of propagation and the limitations of a given radio station.