NVIS Operation

Near Vertical Incidence Sky -Wave operation Near vertical incidence skywave, or NVIS, is a skywave radio-wave propagation path that provides usable signals in the distances range - usually 0—650 km (0 - 400 miles). It is used for military communications, broadcasting, especially in the tropics, and by radio amateurs for nearby contacts circumventing line-of-sight barriers. The radio waves travel near-vertically upwards into the ionosphere, where they are refracted back down and can be received within a circular region up to 650 km (400 miles) from the transmitter.

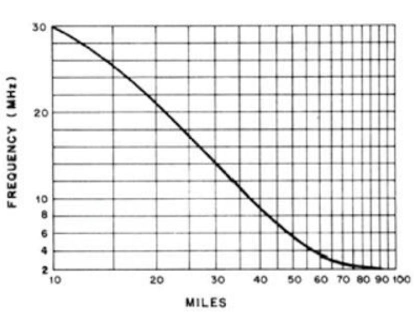
Basic Radio Wave propagation

Line of Sight

Where a radio waves travel directly from the transmitting antenna to the receiving antenna. It does not necessarily require a clear line of sight path as lower frequencies can pass through buildings and other obstructions. Generally used for VHF and above.

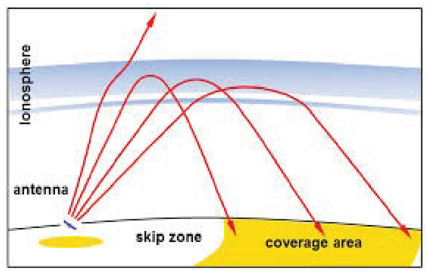
Surface Modes

At lower frequencies vertically polarised radio waves can travel as surface waves following the contour of the Earth - this is referred to as ground wave propagation. Since the ground is not a perfect conductor the ground wave becomes attenuated over distance. Attenuation is proportional to frequency. This would mean that lower frequency wave would travel a further distance. The graph below shows the relation ship of frequency and distance travelled



Ionospheric Propagation (Skywave)

At medium and shortwave frequencies radio frequencies can refract from a layer of charged particles (ions) high in the atmosphere, the ionosphere. This means that radio waves transmitted at an angle towards the ionosphere will return to Earth beyond the horizon and over great distances. The lower the angle the greater the distance. At too high of an angle the radio wave may pass through the ionosphere



Factors that determine the refraction of the signal back to Earth would be the density of the Ionosphere and the frequency of the signal. The level of ionisation will vary at different times of day and seasonal cycle.

Critical Frequency

As the frequency is increased a point is reached where the radio signal will pass through the ionospheric layer and into space. This is the critical frequency.

Maximum Usable Frequency

The highest radio frequency that can be used for transmission between two points via reflection from the ionosphere at a specific time of day.

Lowest Usable Frequency

This is the frequency below which communication cannot be maintained between two stations over a given distance. The lower the frequency the greater the absorption of the signal. The reason why 80 metre does not offer the opportunity for DX during the daytime.

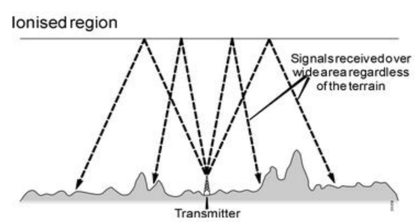
Why NVIS Propagation

The point at which ground wave fades out to obscurity and the signa returns to Earth may be a considerable distance and this area is known as the skip zone. No signal is received in this area. This may be an area of some 400 - 500 miles. NVIS propagation is particularly useful where radio communications coverage is required in regions where the ground is mountainous, falls within the skip or dead zone, and impossible to reach via VHF.

What is NVIS Propagation

NVIS propagation requires a high angle or near vertical signal to be transmitted towards the ionosphere. This must be at a frequency that is below the critical frequency, i.e. the maximum frequency at which a vertically incident signal is "reflected" by the ionosphere. Typically it is just below the critical frequency for the ionospheric layer or region that is to be used.

The critical frequency varies according to ionisation density in the relevant ionospheric layer or region which in itself is dependent upon the radiation received from the Sun. Accordingly it is dependent upon the sunspot cycle, time of day, season and a variety of other factors.

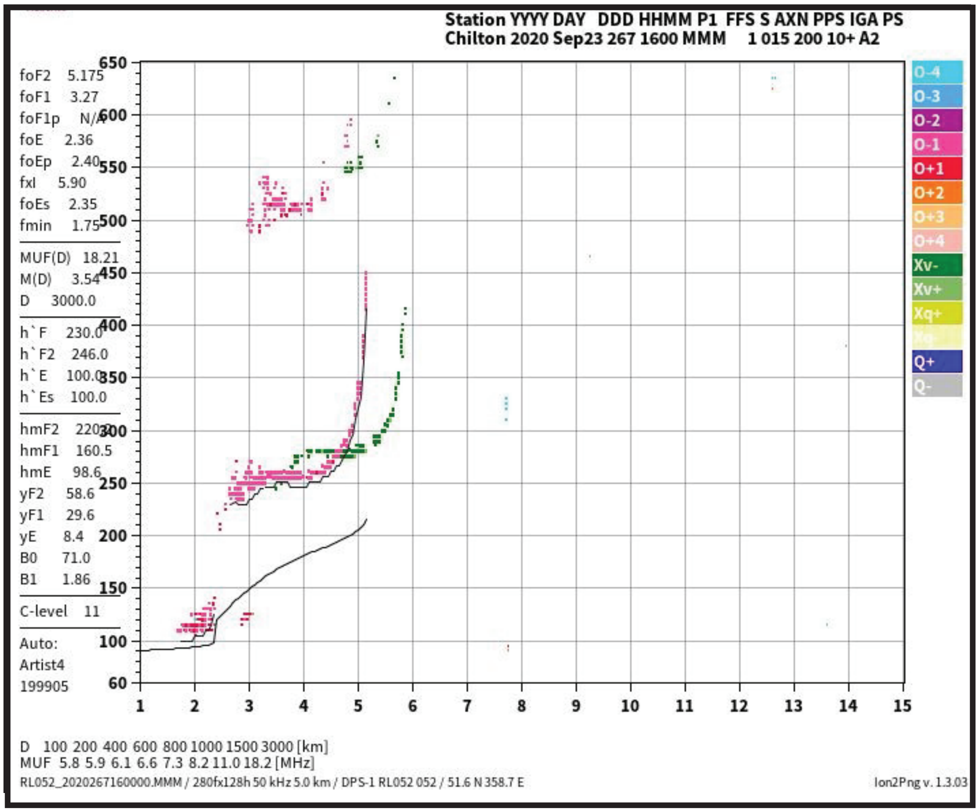


Near Vertical Incidence Skywave, NVIS propagation

When a signal is radiated at a high angle the near vertical incident signal is reflected by the ionosphere and returned to Earth over an area of many miles either side of the transmitter. Unlike the idea for DX chasing, NVIS relies totally on an antenna capable of transmitting High angle radiation rather than low angles.

Try squirting water at varying angles at a ceiling. The higher the angle, the more localised the water return from the ceiling will be. Try several different angles from vertical and it will be noted that the shallower the angle the greater distance from the return to ground

From the experiment, anything from vertical to 75 degrees will give the ideal coverage area. From this we deduce that a high angle radiation from the antenna is essential. Any shallower angle will result in longer distances covered.



Frequency consideration

The frequency selection is normally a balance between reducing D-Layer losses and achieving a high angle of radiation. Too low a frequency may result in greater D-Layer attenuation and too high a frequency will result in the signal passing through the F-Layers.

During the daytime, 40 metres is the highest frequency band used, by afternoon and evening a middle band such as 60 metres, and a lower frequency such as 80 metres would be used at night. 160 metres could be used in the winter months during the night. The Critical Frequency, Fo, is the key to the successful operation of NVIS. Ideally, a frequency of 10% than the Critical Frequency should be used. The Ionogram can be checked for a suitable choice of Frequency. The FoF2 should be noted (Critical frequency of the F2 Layer).

There are a number of aids to assist with the choice of frequency. The Ionogram is always the first choice as it will show real time criteria.

Looking at the Ionogram, the figures on the bottom row reveal the possible distance D for a given MUF. In this Ionogram above, the use of 5MHz will give approximately 200 Km but using 7 MHz it would be possible to cover approximately 600 Km. There is plenty of information here. D-layer Absorption is present from 1MHz to 2MHz. E-Layer MUF is 2.36 MHz and the MUF of the F2 Layer is 5.175MHz as far as NVIS is concerned. Our Natural choice of band would be 5MHz for NVIS. Using a lower angle of Radiation the MUF would be 18.2MHz for a path around 1,500 Km. Taking a look at the Ionogram everyday will reveal the state of the Ionosphere. Forget the gimmicky Ham-clocks and other Ham-Prop programs. The Ionogram is what the professionals use!

Choice of Antenna

The antenna can be a dipole, an Inverted Vee, or a pair of phased dipoles (Shirley Antenna) located at no more than 1/4 wavelength above ground. Better again try the G4 HOL Loop antenna featured in the 2019 Journal. All of the above will work well and can be enhanced with a counterpoise of 5% longer placed beneath them if the Earth conductivity is poor.

Dipole: A dipole can be useful if positioned 0.1 to 0.25 wavelengths above ground. As the dipole is brought close to the ground the angle of radiation increases at the expense of lower angle radiation.

Inverted Vee

The inverted vee is a handy antennas it is easy to support and can be suspended from a lower height if the apex is kept to 120 degrees or greater it will work for NVIS communications

Counterpoises

The high angle of radiation may be enhanced by placing a counterpoise beneath the antenna. The length of the counterpoise should be 5% longer than the antenna and ideally distance is 0.15 of a wavelength beneath the antenna.

Mobile operation

The military often mount a resonant antenna drawn diagonally across the roof of the vehicle which tends to increase the angle of radiation.

Barrett Communications supply an interesting roof rack mounted antenna which tunes across a wide band of frequencies. The roof rack itself provides the Earth plane. The Barrett antenna is priced at around £2000.00 so one would really want to be enthusiastic on HF mobile operation. Many overseas aid convoys utilise the Barret system for communication over a wide localised area to maintain communications with their bases..

Conclusion

It is plain to see why the fellow with the high antenna gets the DX, whilst the fellow with the antenna strung close to ground is getting into the IRTS news way better. Naturally, NVIS is the only way to get a HF signal efficiently around the country for Emergency operations on a national basis. 5Mhz is the band of choice for NVIS operation, and national coverage, during the daytime, whilst 80 metres is chosen after darkness.

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