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# IMPROVISED HIGH FREQUENCY TECHNOLOGIES IN MILITARY COMMUNICATION

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**Abstract**

With High Frequency communication reaching its renaissance worldwide, newer and more improvised technologies emerge, and this research paper aims to bring to light the uses of High Frequency communication technologies in empowering defenses of a country and certain theoretical/practical problems along with it.

**Keywords**:*High frequency, electromagnetic wave propagation, ionosphere, communication, electromagnetic spectrum, Wideband HF, NVIS Principles*

## INTRODUCTION

It is common knowledge that the key behind almost every success is communication and this fact does not change even in fields like the military. The military, has a lot of use for communication as it holds the military together. And an effective way of communication is needed among the personnel.

Currently, military systems all around the world use High Frequency signal propagation to communicate. High Frequency signal has 3 types of propagation methods and all have their own uses and drawbacks which I would like to state and try to assess.

1. Line of Sight (LOS)
2. Groundwave
3. Skywave (BLOS)

### 1.Line of Sight

Also known as direct wave, the signal in LOS propagate in straight lines between the transmitter and receiver and is the only most consistent HF propagation method. This is because the ability to communicate will not change when communicating between a pair of transmitter and receiver at a given location with the signals propagating in a straight line.

**Fig.1** Line of Sight propagation

LOS propagation is rarely ever used for HF frequencies. This is because, HFs have a rather lower frequency so we would require large antennae and available bandwidth for HF communication is limited. Because of this Line-of-Sight communication is mainly used with Very High Frequency or VHF

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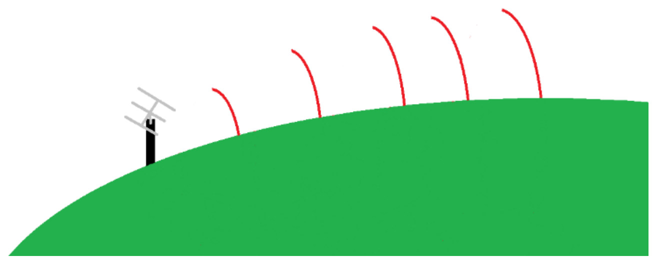
## 2. Groundwave

Groundwave, also known as surface wave, is a propagation method that uses the conductivity of the Earth's surface for communicating between transmitter and receiver. This communication technique can be used when there are no direct receivers and transmitters in a straight line of sight.**Fig.2** Groundwave propagation



This technique works by the interaction between the lower part of a signal's wavefront and Earth's surface that causes the signal waves to tilt forward and allow the signal to follow the earth's curvature well beyond line of sight.

The efficiency of this method depends on two factors: the surface conductivity and the frequency of a transmitted wave.

The ground conductivity is a measure of how conductive the soil/ground around a transmitter is, in context to a wave. This generally depends on the type of ground, with cites and Polar Regions being the least conductive, hills and forests with loamy soil having a moderate conductivity and sea water (high salt content) having the most conductivity.

In general, higher ground conductivity yields better results i.e., the signal travels a greater distance. Compared to rocky dry land, salt water has a high conductivity. So, groundwave communication can be used between ships and shores.

| Soil description | Ground quality | σ (s/m) | $\varepsilon_r$ |
|---|---|---|---|
| Cities, industrial areas | Very poor | 0.001 | 5 |
| Sandy, dry, flat, coastal | Poor | 0.002 | 10 |
| Rocky soil, steep hills, typically mountainous | Poor | 0.002 | 13 |
| Pastoral, medium hills, forestation, heavy clay soils | Good/average | 0.005 | 13 |
| Pastoral, low hills, rich soil | Very good | 0.0303 | 20 |
| Salt water | Excellent | 0.5 | 81 |

**Table.1** Ground types as used by L.B. Cebik, W4RNL.

As mentioned earlier, groundwave depends on frequencies as well. Groundwave works best with lower frequencies. This means that, in a transmitter with a set power input, it will transmit signals by groundwave propagation farther in a low frequency than high frequency.

## 3. Skywave

Skywave is the most common and also the most effective method of signal propagation. It allows for global communication techniques. It works by using the ionized particles in the upper atmosphere of the Earth. These particles are collectively known as the ionosphere. The ionosphere refracts the HF signals coming towards it back to the Earth and depends on the electron density of the ionosphere. This enables communication between transmitters and receivers that are thousands of kilometers apart.

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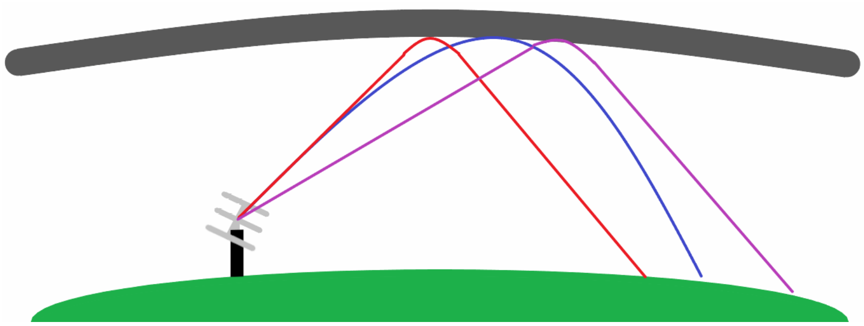
Fig.3



**Skywave Propagation**

This technique is dependent on altitudes and the density of the different layers of the ionosphere. The state of an ionosphere is affected by the sun. The ionosphere is formed when the rays of the sun strike gas molecules in the atmosphere, this detaches an electron from the molecule and forms a positive ion and a free electron that helps in HF propagation. The free electrons are held in the Earth's atmosphere by magnetic field of the earth.

**The layers in an ionosphere**

The ionosphere lies above the stratosphere and has different densities of ionization. This depends on the altitude of a particular place. Areas with a certain level of ionization are grouped into layers.

The layers which are most important for skywave propagation are the D-layer; the E-layer; and the F-layers, F1 and F2. The altitudes of these layers aren't certain because the density and the altitude of a given layer is not always constant and may change over time. However, the density and the altitude can be predicted. These layers are standardized because of the difference in which they refract/absorb HF signals.

The D-layer has the lowest electron density and is only present in daytime. It is unable to refract HF signals. The E-layer is the lowest layer of an ionosphere that is actually capable of refracting HF signals. The F1 and F2 are the highest layers and have the most effective and are most useful in short to medium distant and long distant communications respectively.

**Incidence Angle**

The incident angle is the angle at which the signal reaches the ionosphere and determines how far the signal can propagate. The angle at which a ray approaches the ionosphere is dependent on the location of the transmitting antenna and the type of antenna used. The higher an antenna is placed, the lower the incidence angle. This means that the signal will travel farther.

Due to lower incident angles, skip zones may be formed. Skip zones are regions where no HF signal can propagate either by skywave or groundwave.

The problem with HF lies that it can't be used in the skip zones. A point to note is that skip zones are most prevalent in mountainous terrains. This means that there is no Line of sight communication possible due to mountains obstructing HF signals. Groundwave communication too is not preferred in mountainous, rugged and dry terrains because of the poor ground conductivity. Regular skywave communication too would not work well because of the skip zones that are caused.

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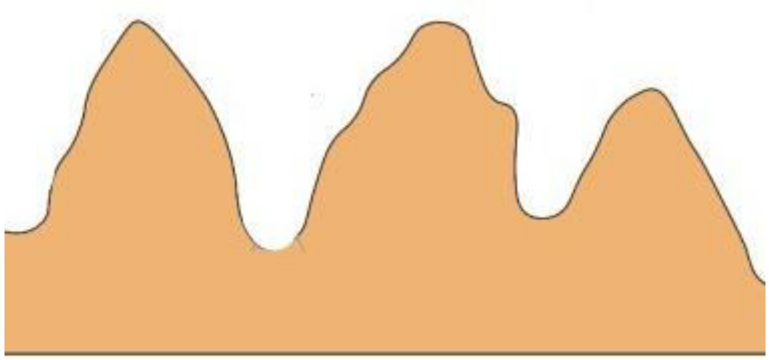
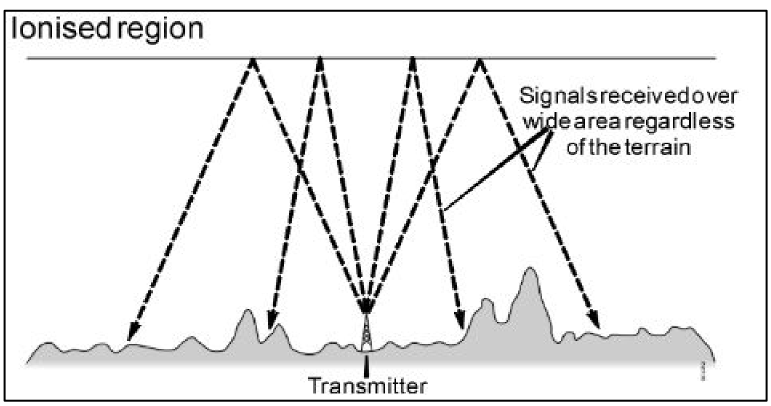


**Fig.4**Challenging terrain example

**Experimental**

Increasing the use of NVIS in military communications is a key strategy. NVIS or Near Vertical Incidence Skywave propagation. NVIS is still skywave but as the name suggests, the incidnece angle is near to being vertical. This allows for skip zones to be skipped and signals to reach receiver no matter the terrain. (See Fig.5).

**Fig.5** NVIS propagation




Due to the fact that the propagation method is still skywave we can still get all the advantages of skywave communication:

- They are ad hoc communications between a transmitter and receiver.
- Signals can propagate over thousands of kilometers rather efficently.

This can increase efficiency in communications in terrains that are not suited for groundwave and LOS communication.

**RESULT**

Recent research gives us a general idea about the rise of military use of NVIS proving the efficiency of the use of NVIS. Almost all the Tanks, ships and other military equipments use High frequency to function at their best.

## CONCLUSION

HF propagation has increased over years and can help empower defenses of a country when used for communication purposes. They may have some drawbacks but there are ways to cope with them, for example, using NVIS principles.

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## REFERENCES

1. https://hamwaves.com/ground/en/ground.a4.pdf
2. https://www.electronics-notes.com
3. https://cdn.rohde-schwarz.com/pws/campaigns/rsa/Rohde-Schwarz_Rebirth-of-HF_WhitePaper.pdf
4. https://cdn.rohde-schwarz.com/pws/campaigns/rsa/Rohde-Schwarz_Understanding-NVIS_v1.1.pdf
5. https://www.sws.bom.gov.au/Educational/5/2/2