Technician License Course
Chapter 4

Lesson Plan Module 8 - Propagation

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Radio Wave Propagation

Radio wave propagation is a complicated and mostly empirical science based on observations. Some prediction is possible.

Radio waves propagate in many ways. We will discuss three basic mechanisms:

- Line of sight
- Ground wave
- Sky wave

Line-of-Sight Propagation

Line-of-Sight means that the transmitter and receiver can see each other.

- Line-of-Sight is the primary propagation mode for VHF and UHF signals.
- There is some attenuation of the signal as the radio wave travels.
- Visual Horizon – the farthest point you can see.
- Radio Horizon – slightly more than Visual due to the ground bending the wave. About 10% more
- Height of antennas at transmitter and receiver determines Line of Sight distance.

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Ground Wave Propagation

Low Frequency (LF) and Medium Frequency (MF) waves are bent along the earth's surface because the lower edge of the wave is slowed.

- These waves will travel beyond the range of line-of-sight.
- Ground Wave signals can be useable for a hundred miles or more in daytime.
- This mode is used by AM Broadcasting.

Sky Wave Propagation

Medium Frequency (MF) and High Frequency (HF) waves can be bent back to earth by the Ionosphere.

- These sky waves will travel beyond the range of line-of-sight.
- Sky Wave signals can propagate around the earth.
- But sometimes they are absorbed or not returned.
- There is usually a “skipped” distance between the ground wave and sky wave.
- We’ll discuss the Ionosphere later.

VHF and UHF Propagation

VHF & UHF propagation is principally line of sight.

UHF signals may work better inside buildings because of the shorter wavelengths which are better able to pass through openings.

Buildings may block line of sight, but reflections may help get past obstructions. Try moving your location just a few feet or aiming the antenna at a sharp edge.

Reflected waves interfering with the Direct wave can distort the signal. Airplanes can cause signal to “flutter”.

Reflections from a transmitter that is moving cause multi-path which results in rapid fading of signal – “picket-fencing”.

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VHF and UHF Propagation

VHF & UHF propagation may exceed Line of Sight due to unusual conditions.

Tropospheric propagation is caused by weather fronts. Wave is scattered in new directions.

Ducting is caused by temperature inversions. Wave travels between the air layers up to hundreds of miles.

Knife-edge bending is caused by diffraction around buildings or mountains. Creates “shadows”.

Auroral and Meteor Scatter propagation are brief.

The Ionospheric E-Layer sometimes reflects longer VHF wavelengths. Six meter band has summertime “openings” .

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Ionosphere

Radiation from the Sun will strip electrons away from the atoms in the upper reaches of the atmosphere. This creates ions and electrons.

- The region where ionization occurs is called the ionosphere.
- Height is 30 to 260 miles.

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Sunspots and the Ionosphere

Earth's Ionosphere is divided into several layers of ionized gases.

- The level of ionization depends on the UV radiation intensity of the Sun.
- Radiation from the Sun is related to the number of sunspots on the Sun's surface.
- High number of sunspots means more ionizing radiation emitted from the Sun.
- Sunspot activity follows an 11-year cycle.
- Last minimum was in 2008. Maximum may have been August 2013.

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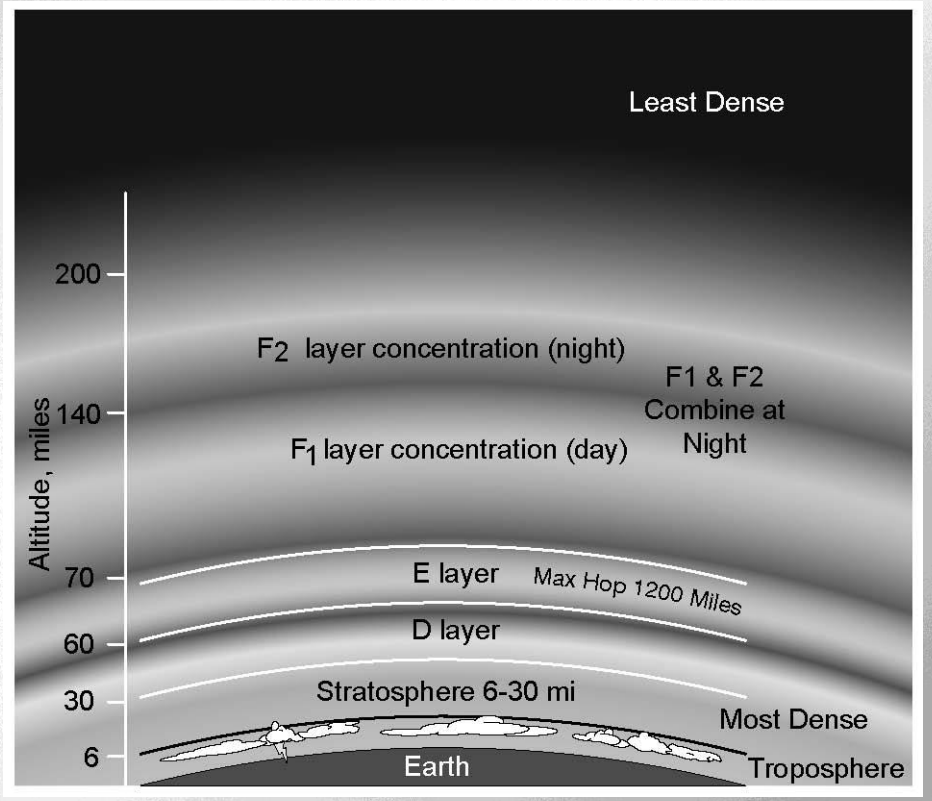
Levels of the Ionosphere

Density of the atmosphere affects:

- The intensity of the radiation that can penetrate to that level.
- The amount of ionization that occurs.
- How quickly the electrons recombine with the nucleus.



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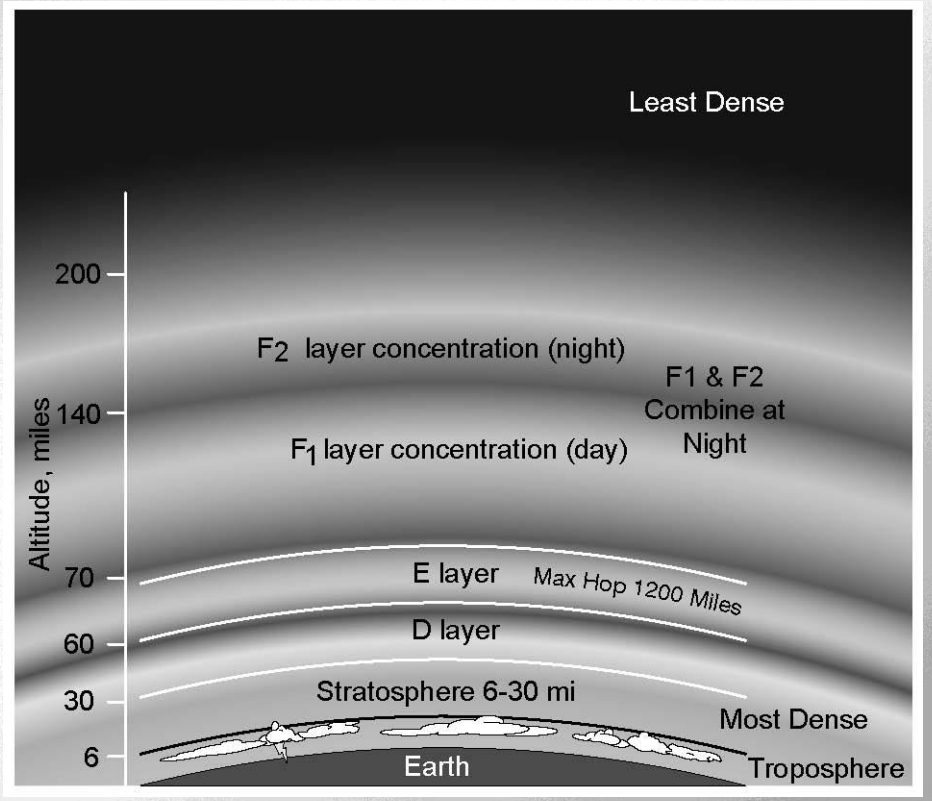
Levels of the Ionosphere

Layers have different effects.

- F Layers cause longer reflected paths.
- E Layer is sporadic but reflects shorter wavelengths.
- D Layer is dense with electrons which absorb energy and create radio noise during daytime.
- Layer to layer reflections occur.



The Ionosphere – An RF Mirror

The ionized layers of the atmosphere actually act as an RF mirror that reflect some frequencies back to earth.

Sky-wave propagation is responsible for most long-range, over the horizon communication in the HF bands.

Reflection depends on frequency and angle of incidence. Shorter wavelengths at high angles may not be reflected.

For any distance on a given day, there is a Lowest Useable Frequency and a Maximum Useable Frequency. No propagation if LUF is higher than MUF.

Conditions are similar every 28 days because of the rotation of the sun.

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Other types of Over the Horizon Radio

Sporadic-E

- Early summer and mid-winter
- Long distances on 10, 6, and 2 meters.

Aurora – Northern Lights

- Results from particles ejected from the sun.
- Particles spiral towards the poles
- Reflected signals usually fading and distorted

Meteor Trails

- Last for several seconds
- Good “Pings” on 6 Meters up to 1500 miles
- August is a good month for the Leonids.

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