Technician License Course

Chapter 4

Section 4.1

Propagation

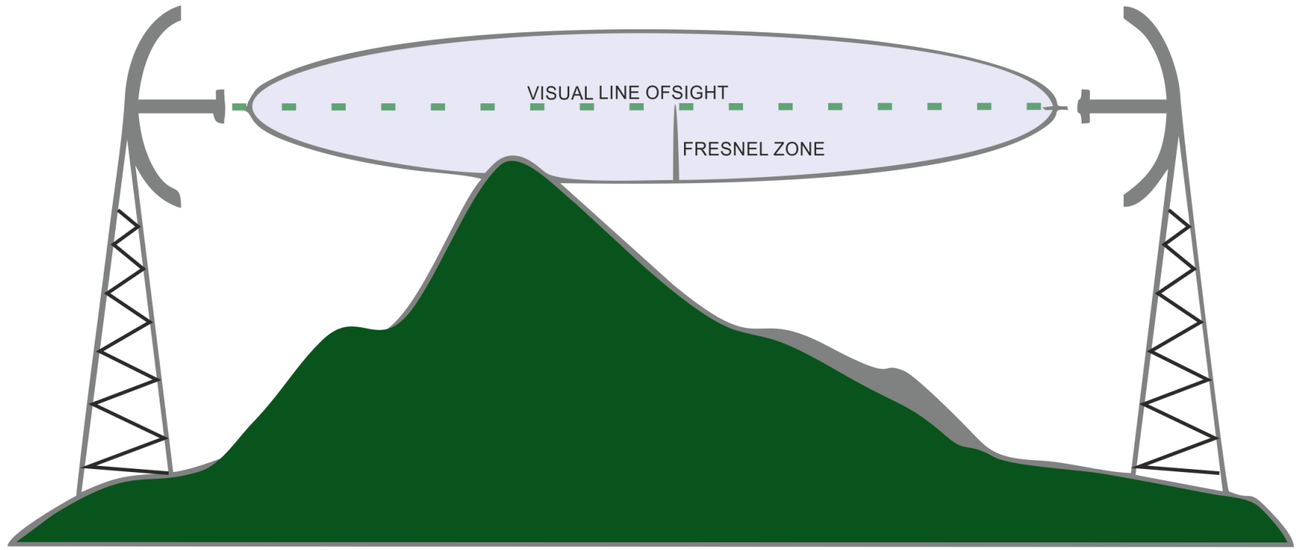
Radio Wave Propagation: Getting from Point A to Point B

Radio Wave Propagation: Getting from Point A to Point B

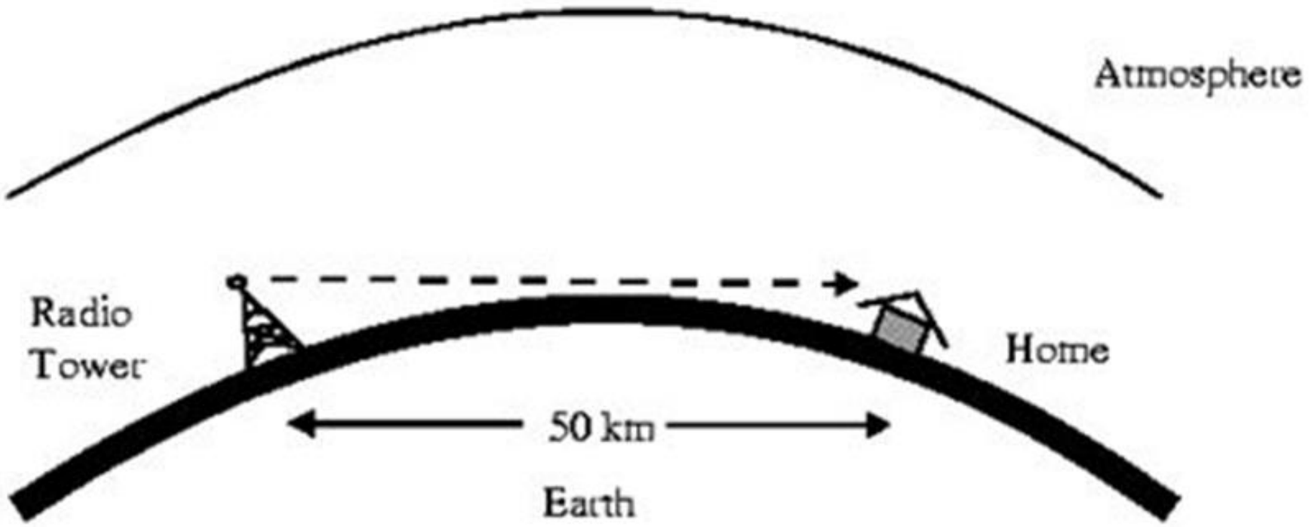
- Radio waves propagate in many ways depending on…
  - Frequency of the wave
  - Characteristics of the environment
- We will discuss three basic ways:
  - Line of sight
  - Ground wave
  - Sky wave

Line-of-Sight

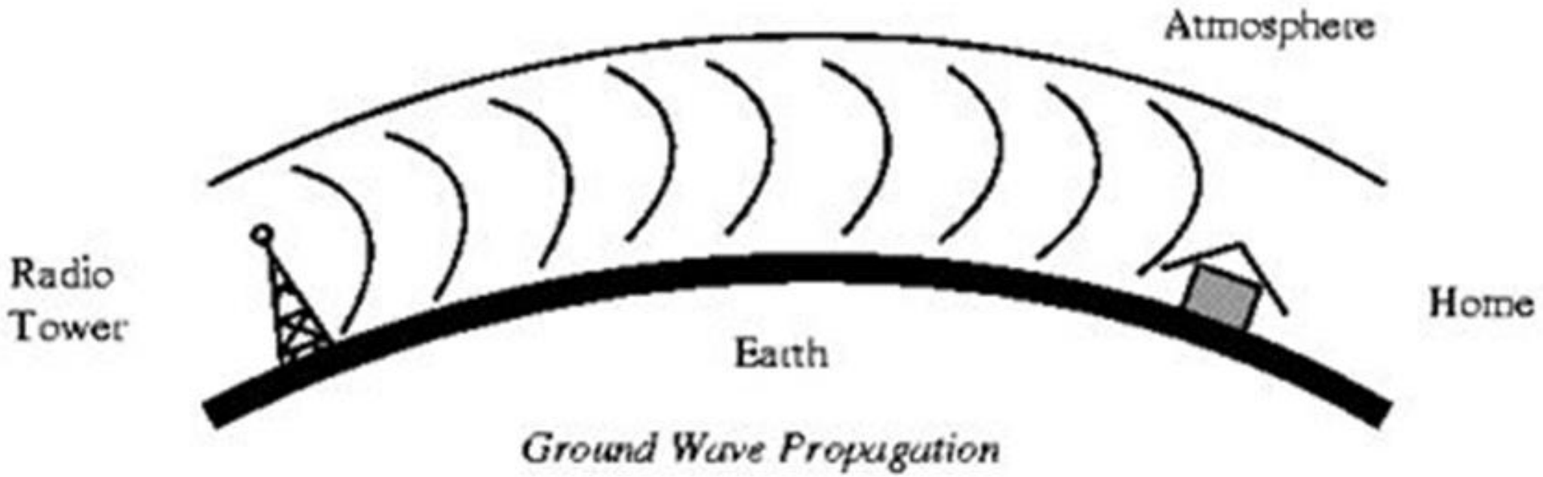
- Radio energy can travel in a straight line from a transmitting antenna to a receiving antenna – called the *direct path*
- This is the primary propagation mode for VHF and UHF signals.



Line-of-sight



Ground Wave

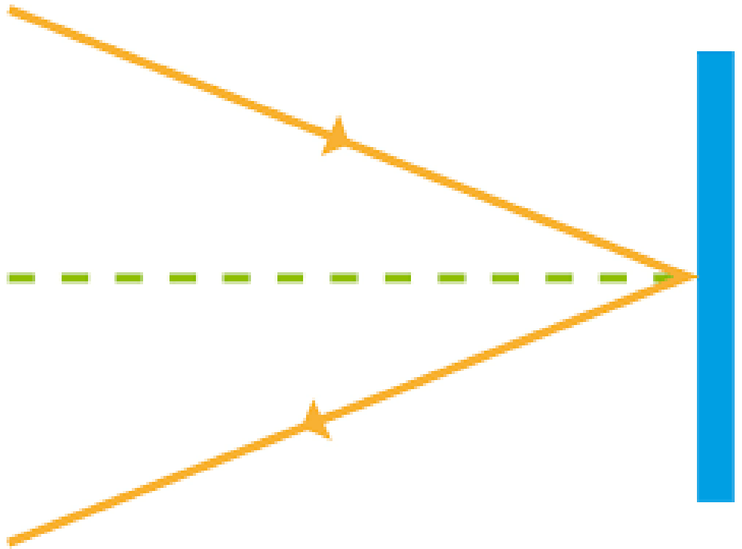

Atmosphere
Radio Tower
Home
Earth
Ground Wave Propagation

Reflect, Refract, Diffraction

Reflect, Refract, Diffraction

- Radio waves are reflected by any conductive surface
  - Ground, water, buildings

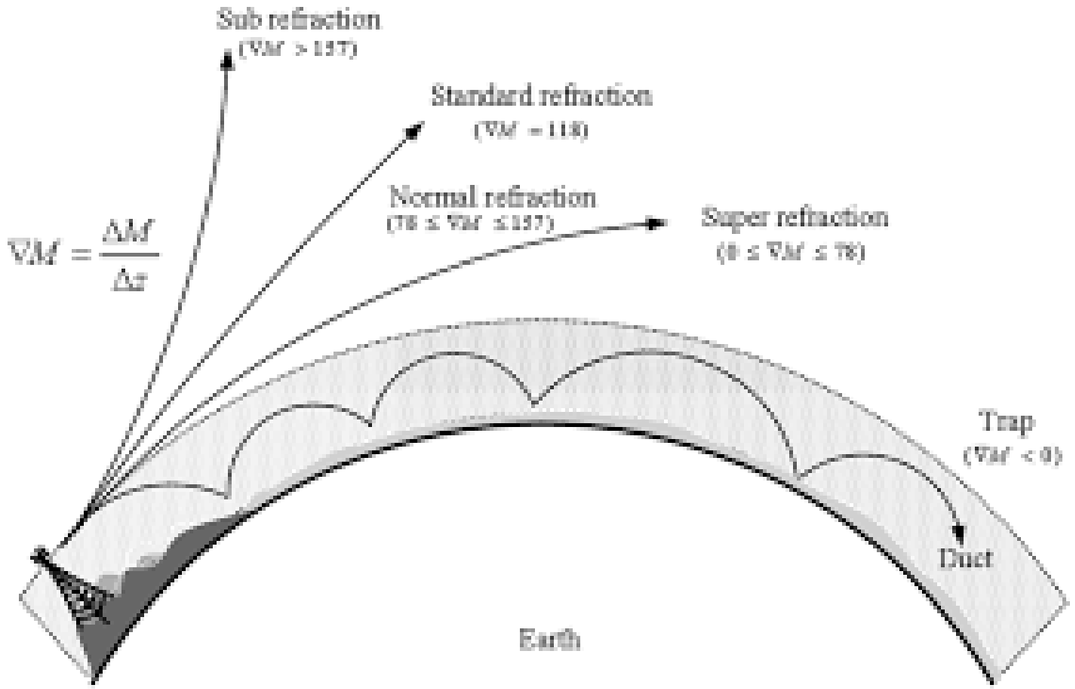
- Higher frequencies easier to reflect



Reflect, Refract, Diffraction

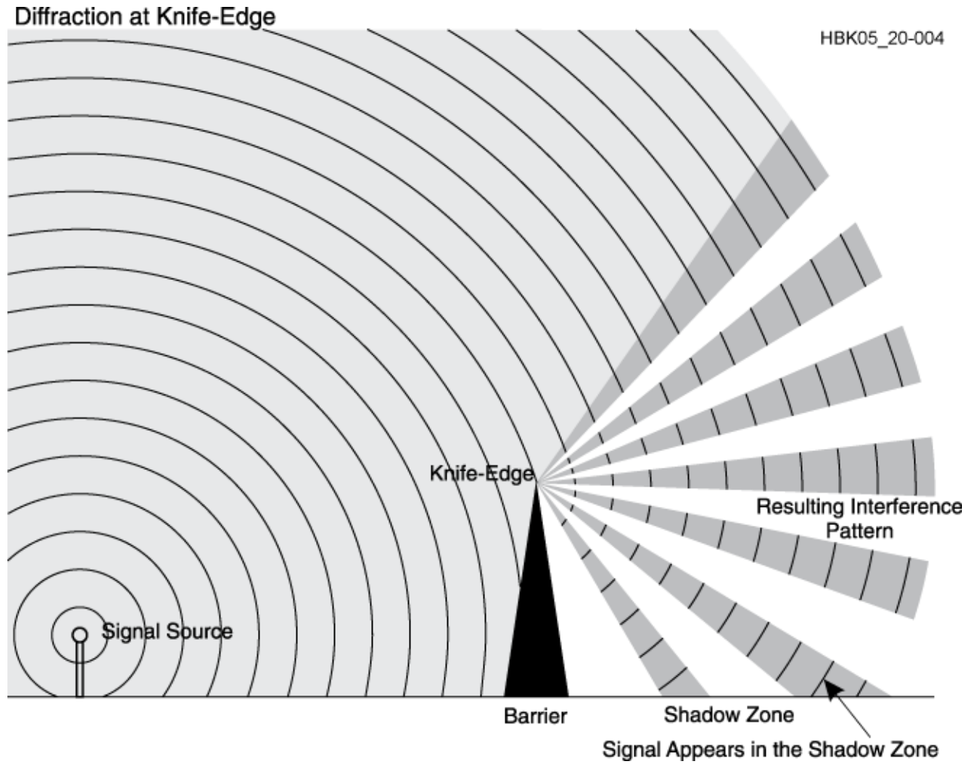
- *Refraction* or bending occurs when waves encounter a medium having a different speed of light, such as water or an electrical feed line.

- Lower frequencies refract

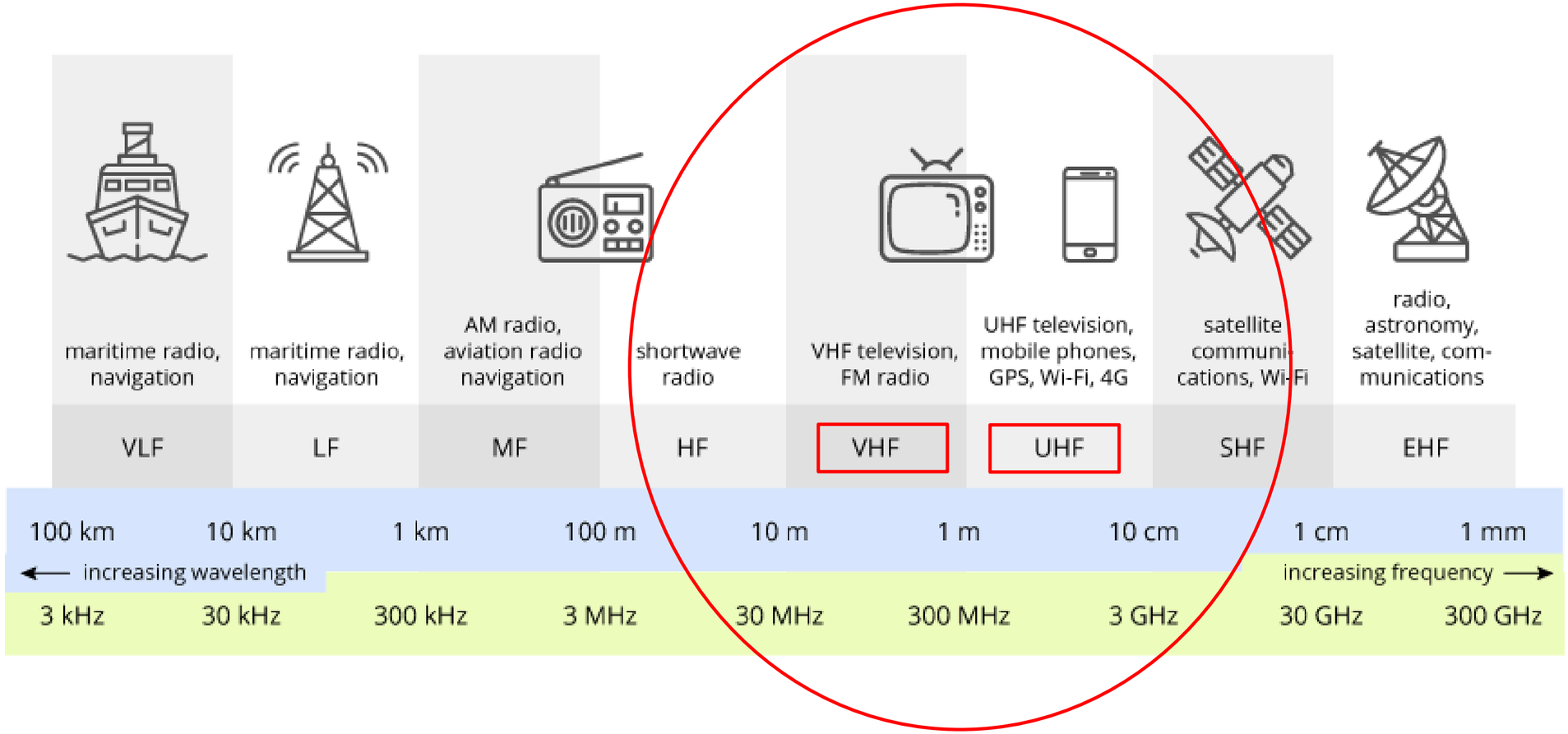


Reflect, Refract, Diffraction

- Diffraction occurs when a wave encounters a sharp edge (*knife-edge propagation*)
  - Can even hear though a barrier



VHF and UHF Propagation

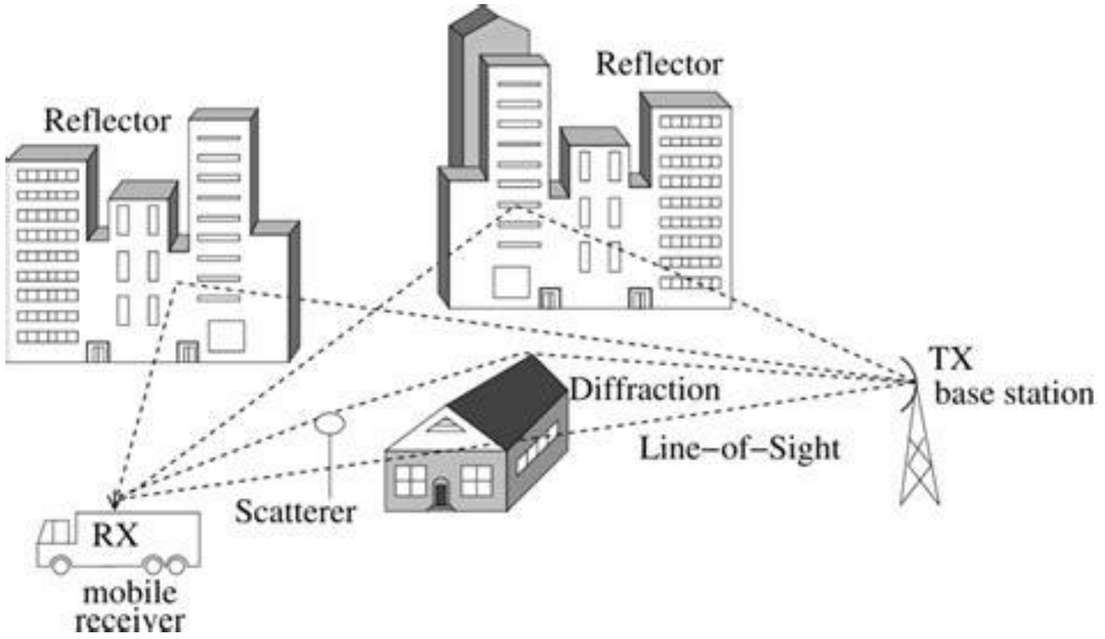


VHF and UHF Propagation

- VHF range is slightly better than visual line of sight due to gradual refraction (bending), creating the *radio horizon*.
- UHF signals penetrate buildings better than HF/VHF because of the shorter wavelength.
- Buildings may block line of sight, but reflected and diffracted waves can get around obstructions.

VHF and UHF Propagation

- ***Multi-path*** results from reflected signals arriving at the receiver by different paths and interfering with each other.
- ***Picket-fencing*** is the rapid fluttering sound of multi-path from a moving transmitter.
- On 2m, moving turning or moving a few inches can make all the difference.



VHF and UHF Propagation

- **Vegetation can absorb RF signals**, especially @ UHF frequencies
- Weather affects higher frequencies more than lower.
  - **Rain** can **reduce the range of UHF** & Microwave
  - **Rain & fog** have **little effect** on low frequencies like **6 & 10 m**

“Tropo” - Tropospheric Propagation

"Tropo" - Tropospheric Propagation

- The troposphere is the lower levels of the atmosphere – to about 30 miles high
- Radio waves can be reflected or *scattered* by clouds, rain, and density variations in the troposphere – range up to about 300 miles
- Temperature inversions and weather fronts can form *ducts* that trap and conduct VHF and UHF radio waves for hundreds of miles

The Ionosphere

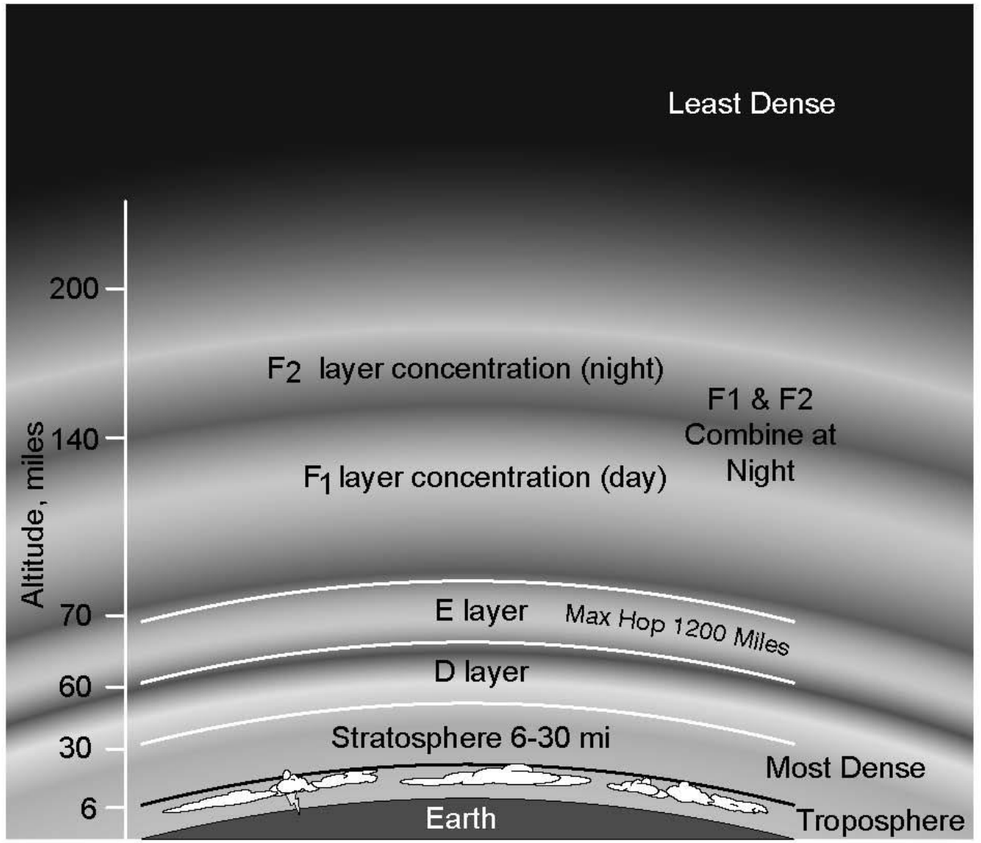
The Ionosphere

- A region from 30 to 260 miles above the surface of the Earth
- Atmosphere thin enough for atoms to be ionized by solar ultraviolet radiation
- Ions are electrically conductive
- **Enables Hams to talk to each other around the world**

Ionospheric Levels

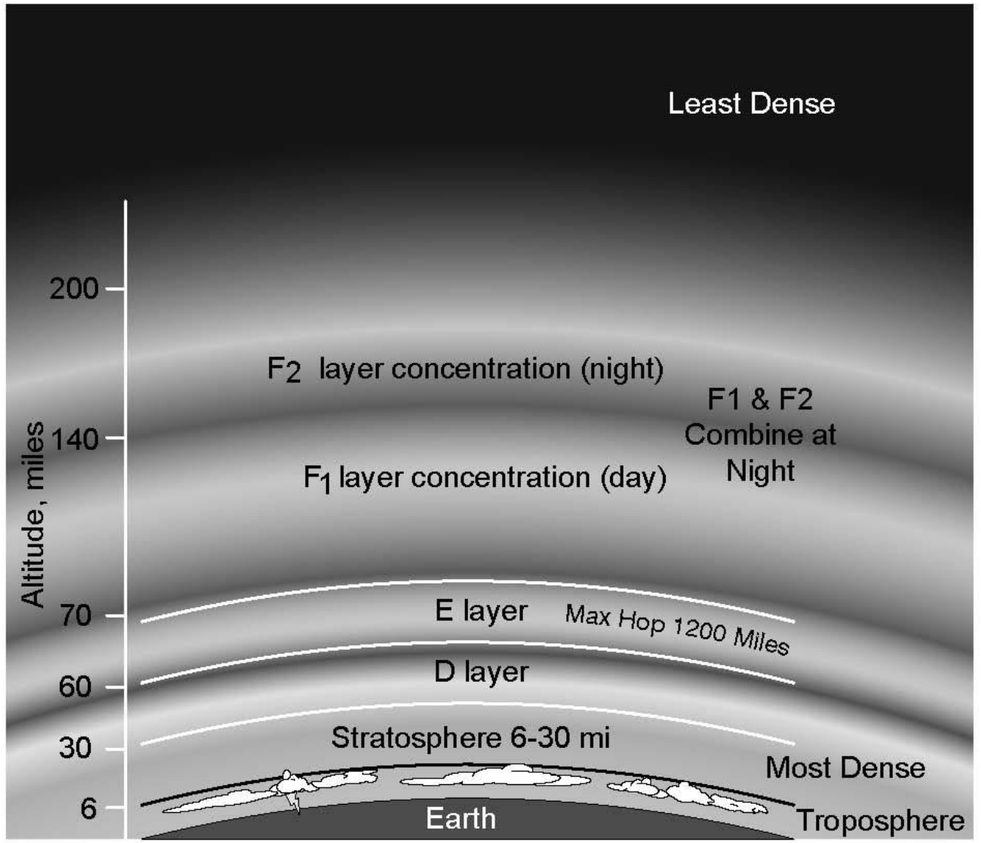
Ionospheric Levels

- Because of varying density, the ionosphere forms layers with different amounts of ionization
- Ionization varies with solar illumination (hour to hour) and intensity of solar radiation



Ionospheric Levels

- Higher ionization refracts or bends radio waves more strongly



Sunspot Cycle

Sunspot Cycle

- The level of ionization depends on the intensity of radiation from the Sun.
- Radiation from the Sun varies with the number of sunspots on the Sun's surface.
- High number of sunspots results in high levels of ionizing radiation emitted from the Sun.

-> 11-year cycle

-> 6m & 10m good DX via F layer.

The Ionosphere – An RF Mirror

The Ionosphere – An RF “mirror”

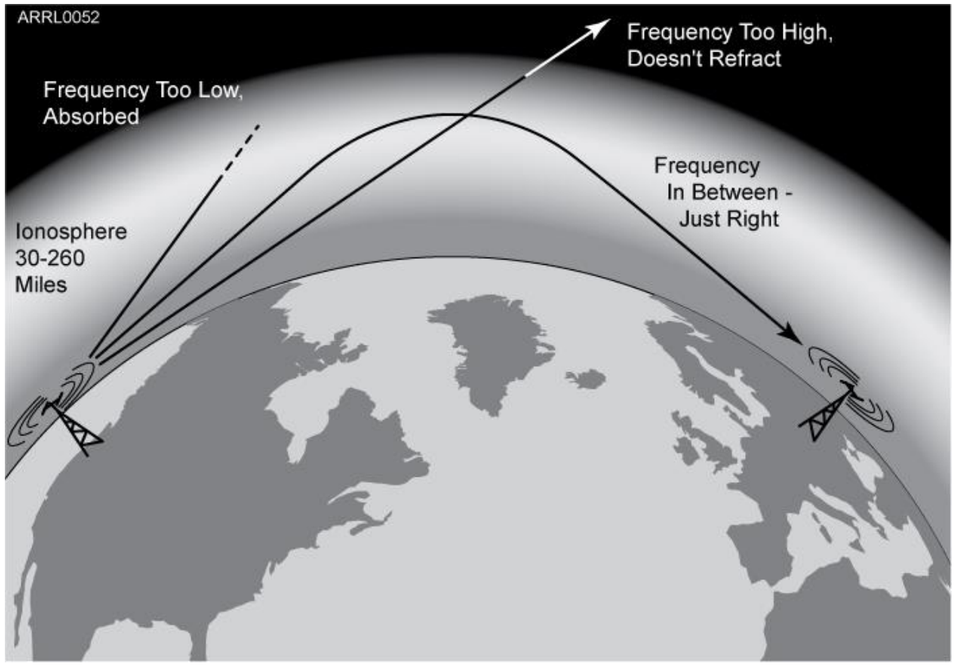
- The ionosphere can refract (bend) radio waves back to Earth

- Most refraction of amateur frequencies occurs in the F layer

The Ionosphere – An RF Mirror

- Reflection depends on frequency and angle of incidence.

- Too high a frequency or angle and the waves are lost to space.
  - **UHF are not reflected**



The Ionosphere – An RF Mirror

- Sky-wave or skip propagation is responsible for most over-the-horizon propagation on HF and low VHF (10 and 6 meters) during peaks of the sunspot cycle.
- Skip is very rare on the 144 MHz and higher UHF bands.
- Each ground-to-sky-to-ground trip is called a *hop*.
- **HF will travel farther than VHF & UHF**

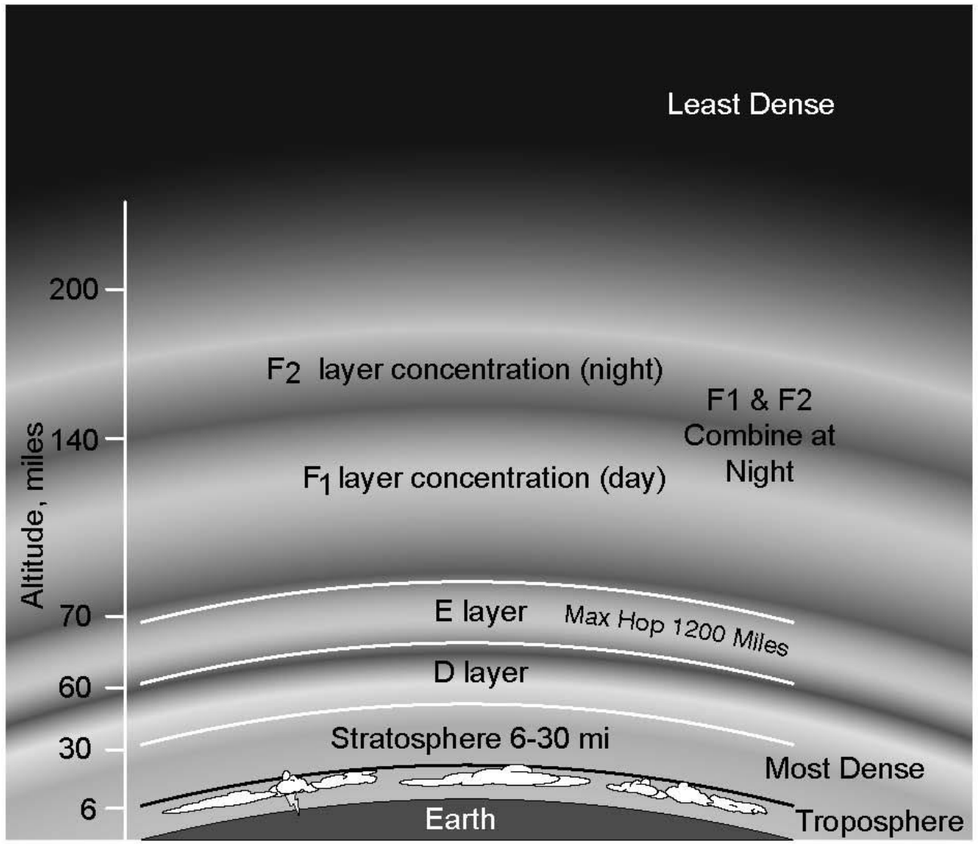
The Ionosphere – An RF Mirror

- Signals can take many paths through the ionosphere.
- Randomly combining at the receiving antenna, signals can partially cancel, creating irregular fading as the ionosphere changes.
  - **The resulting echo and flutter distort speech and CW.**
  - **Fading causes data errors for digital** signals.

Sporadic E (Es) and Aurora

Sporadic E (Es) and Aurora

- Highly ionized patches of the E layer can reflect HF and VHF signals – **best on 10, 6, and 2 meters**.
- Aurora near the north & south poles can also reflect VHF and UHF waves with a distinctive distorted sound **(rapid fluctuations of strength & sound)**



Meteor Scatter

Meteor Scatter

- Thousands of meteors enter the Earth's atmosphere every day – most are quite small.
- Meteors leave trails of highly ionized gas that last for several seconds.
- Trails can reflect radio waves – called *meteor scatter*. **The best band for this is 6 meters.**
- Mostly in the E layer, meteor scatter and sporadic E supports contacts up to about 1500 miles.

Any Questions ?