8. PROPAGATION – AI6JB

Chapter 8 Propagation

ARRL General Class
Section 8.1 – The Ionosphere

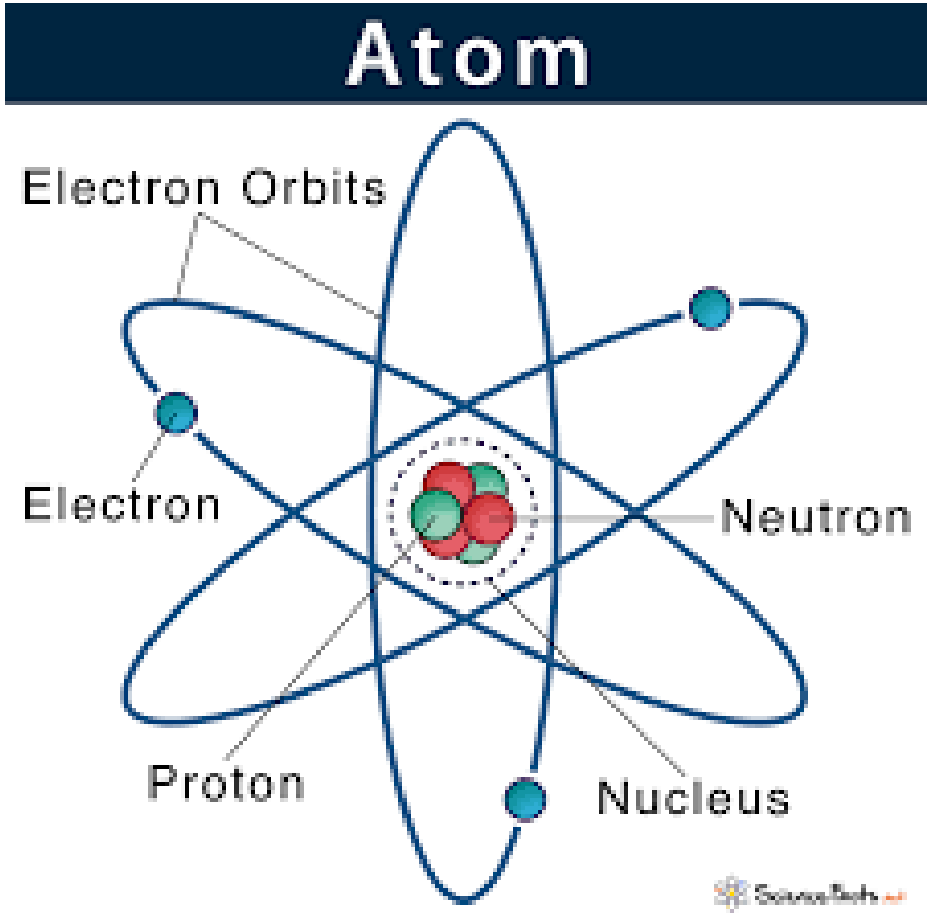
The Ionosphere

Upper reaches of atmosphere gets thinner with distance

Beginning at about 30 miles, remaining gas is thin enough for ionization to occur

Ultraviolet (UV) Radiation Ionizes the atoms

Creating positive and negative ions



The Ionosphere

This region of the atmosphere becomes a very weak conductor

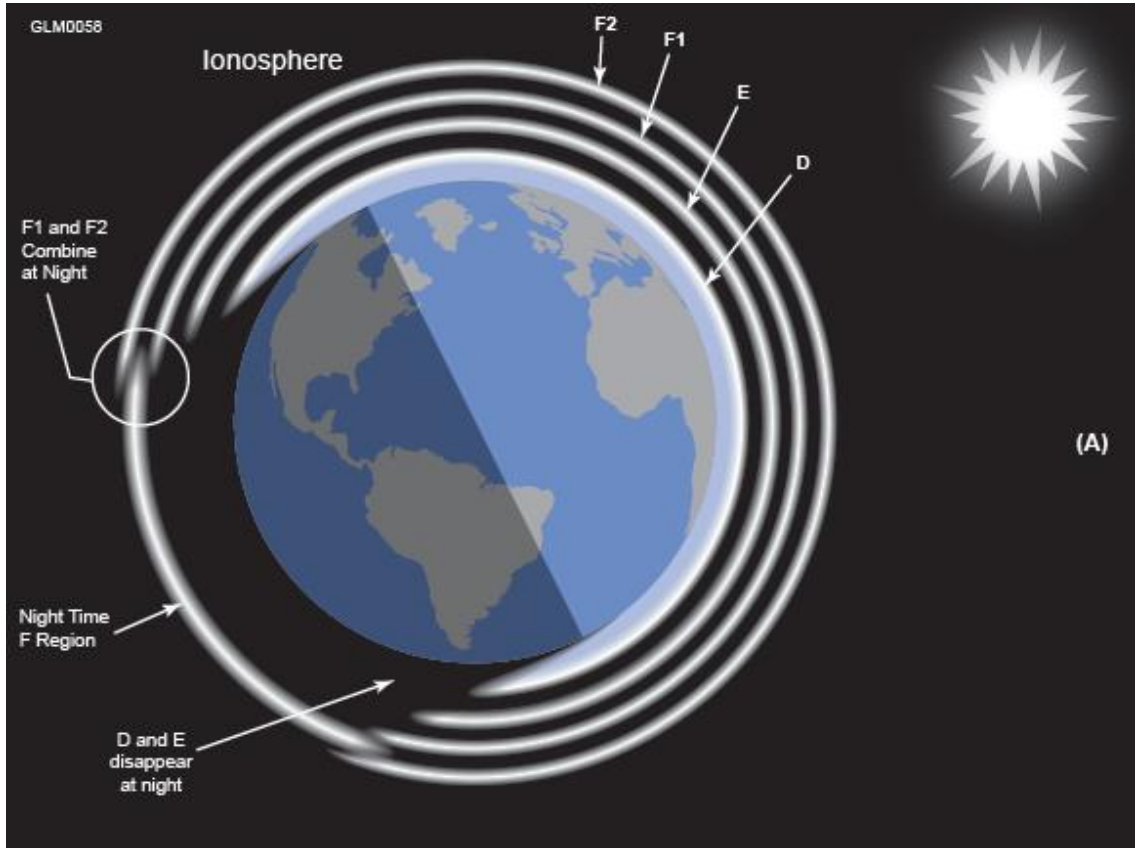
Extends about 300 miles above the earth

Ionization only occurs when the Sun Shines

The ionized atmosphere divides into layers

Layers D through F
- D Layer – 30 to 60 miles
- E Layer – 60 to 70 miles
- F Layer – 100 to 300 miles

F Layer divides into two layers: F1 & F2



Ionosphere

D layer (30 to 60 miles in altitude) is only present when illuminated by the sun

Disappears at night because ions and free electrons are close enough together to recombine quickly when no UV is present, returning to a neutral condition

At night, the D and E regions disappear and the F1 and F2 regions combine to form a single F region

Longer wavelengths and lower frequencies are easily absorbed in the D layer

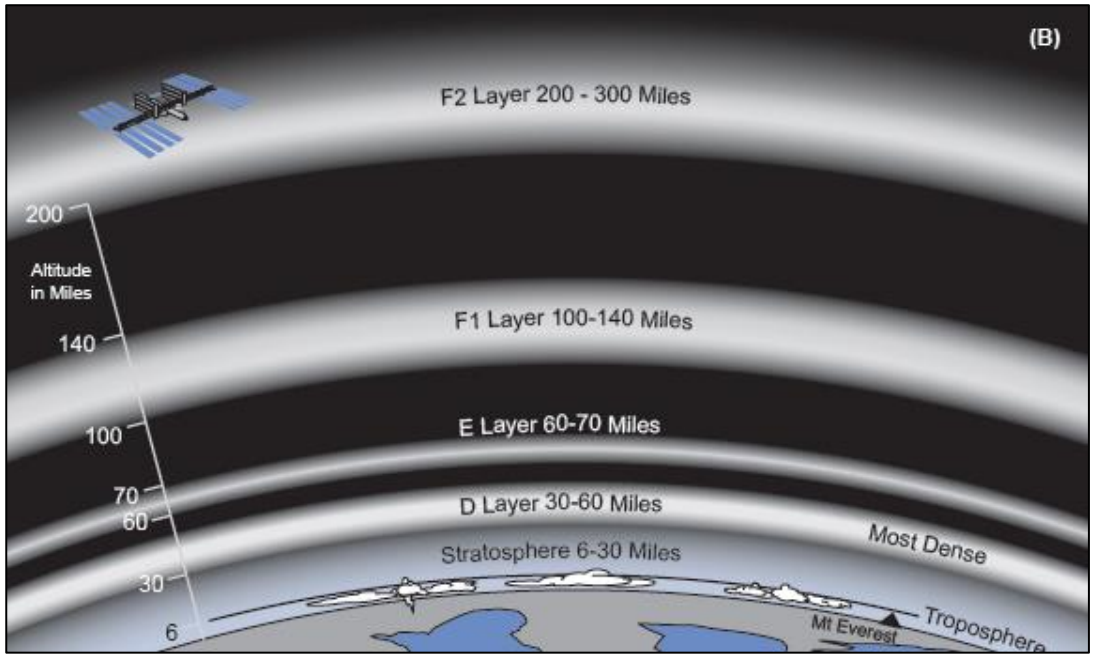


Figure 8.1 — The ionosphere consists of several regions of ionized particles at different heights above the Earth.

Ionosphere (cont.)

E layer (60 to 70 miles in altitude) acts similarly to D

- Higher and less dense than D region, enables it to last longer after sunset

Longer wavelengths and lower frequencies are also absorbed in the E layer

Sporadic E Propagation

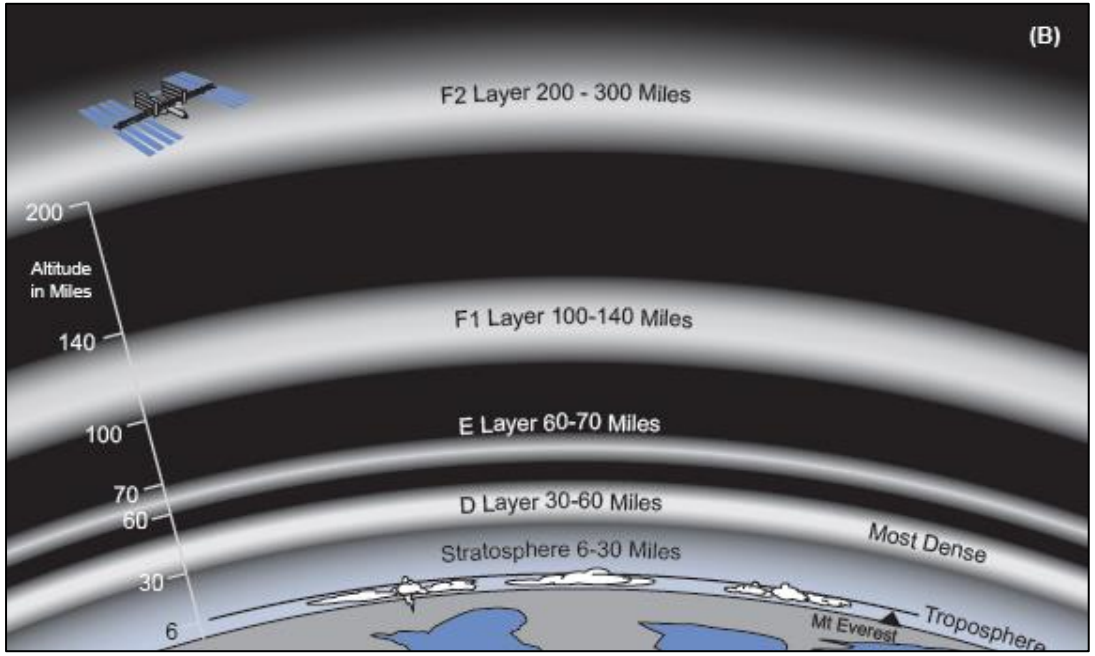


Figure 8.1 — The ionosphere consists of several regions of ionized particles at different heights above the Earth.

Ionosphere (cont.)

F layer (100 to 300 miles in altitude), least dense of the three

- Remains partially ionized at night
- During the day, F region splits into F1 and F2
- Height of the F region varies quite a bit with local time, season, latitude, and solar activity
- At any particular location, the stronger the illumination from the sun, the higher the F2 layer will be, so its maximum height is reached at noon when the sun is overhead

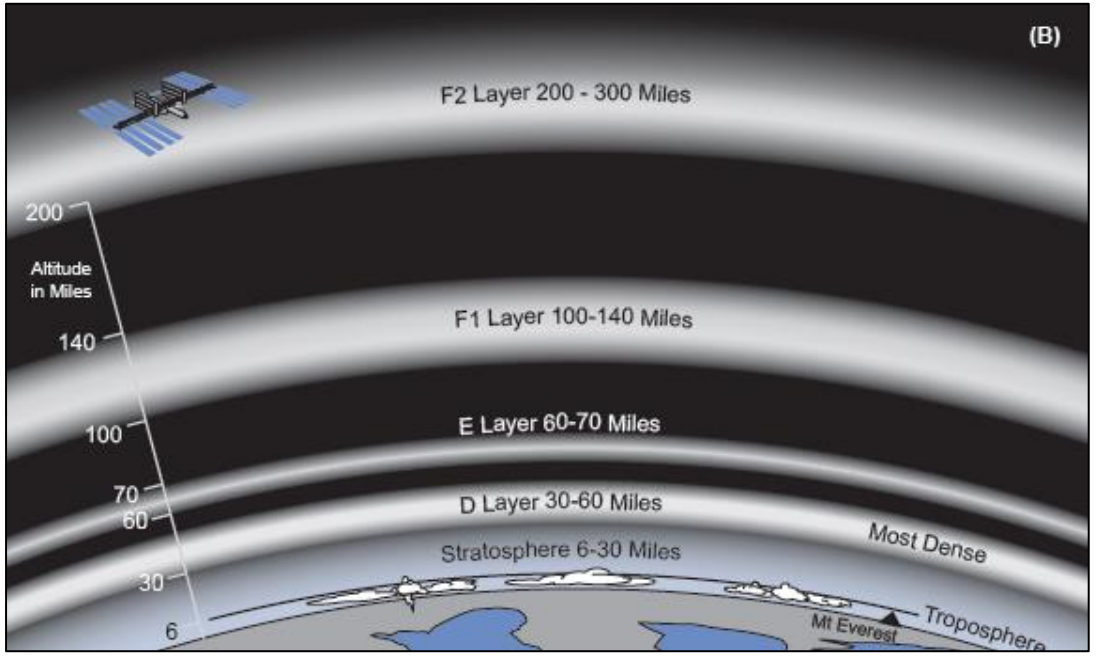


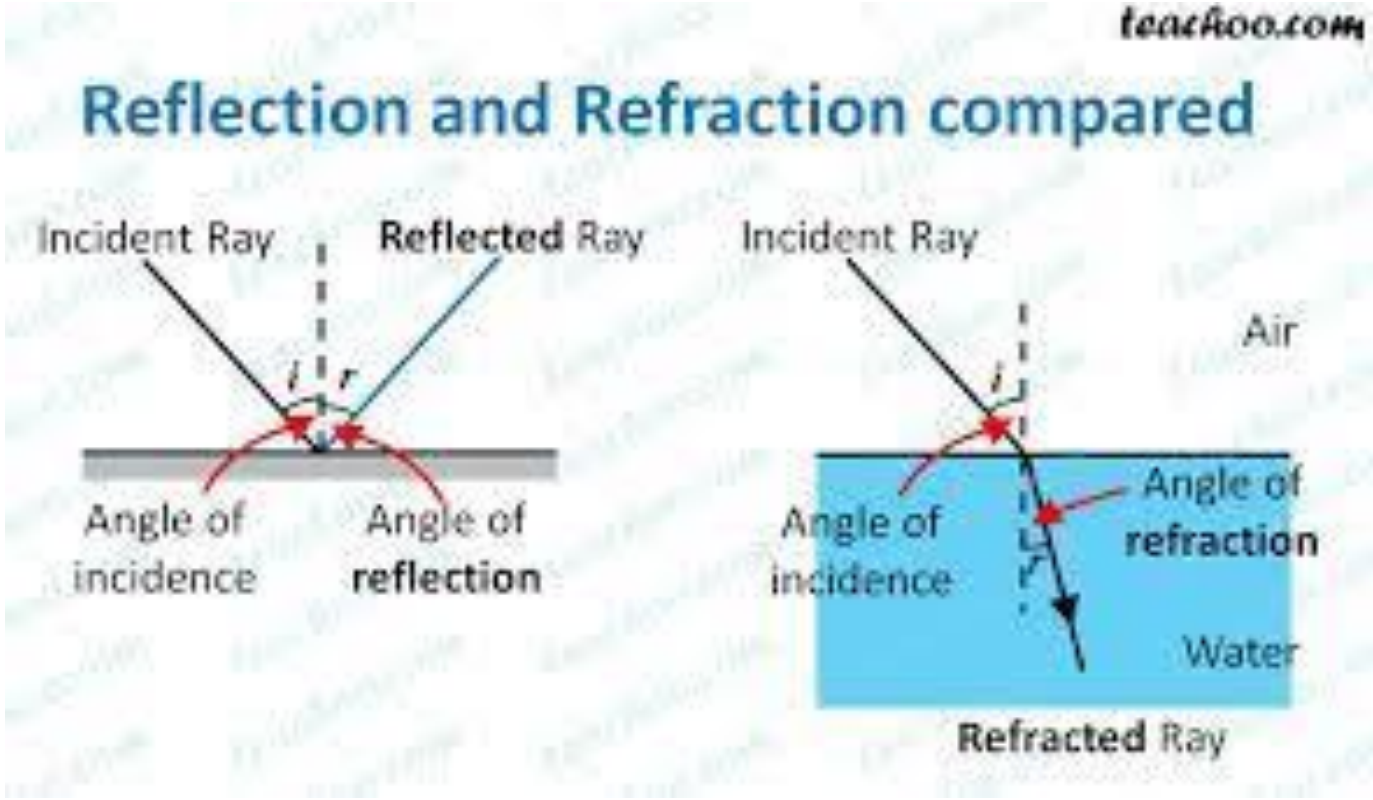
Figure 8.1 — The ionosphere consists of several regions of ionized particles at different heights above the Earth.

Reflection

Reflection versus Refraction
- Reflection Bounces
- Refraction Bends

The ability of the Ionosphere to refract allows international HF or “DX”

The greater the ionization, the greater the refraction



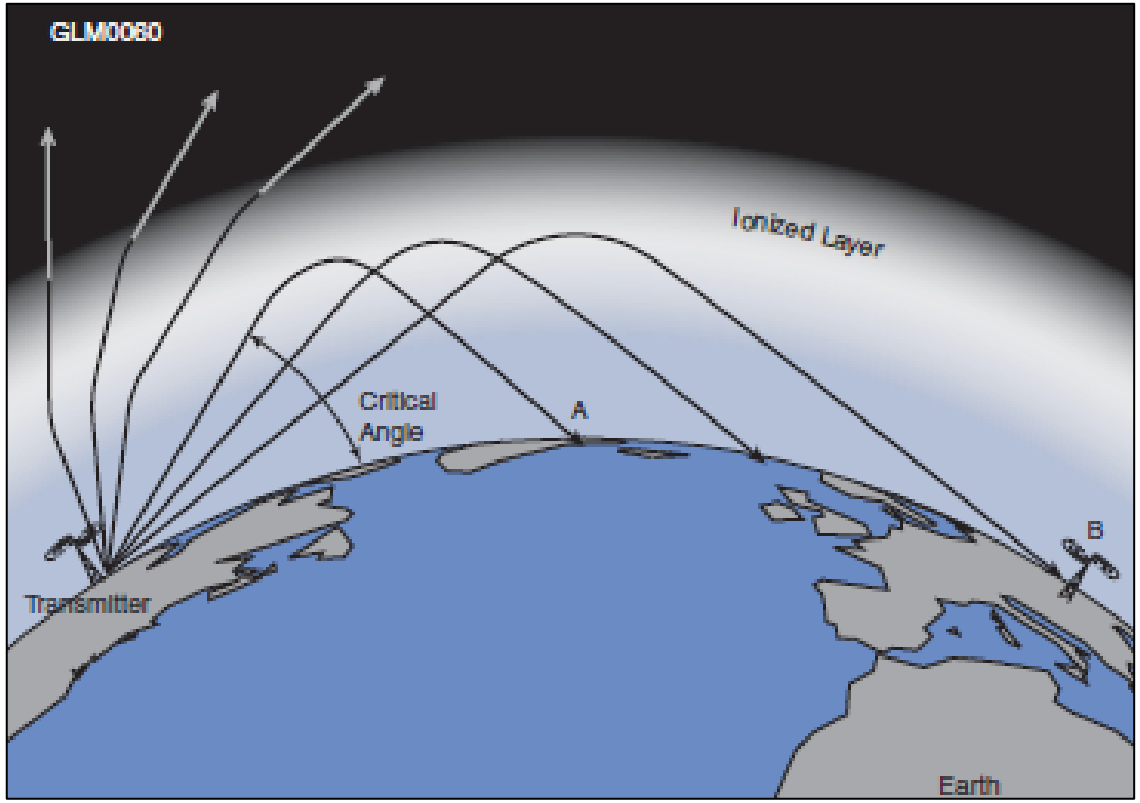
Reflection

Ionosphere refracts radio waves
(it's a weak conductor)

- Refraction amount depends on amount of ionization and wave frequency
  - The HIGHER the IONIZATION, the more the refraction
  - The LOWER the FREQUENCY, the more the refraction
  - HF signals … relatively good refraction … reflected back to the Earth's surface
  - VHF & UHF signals … essentially no refraction

Each reflection is a hop; allows signal to be received hundreds or thousands of miles away

Skywave, Skip, or Ionospheric Wave Propagation are mean the same thing

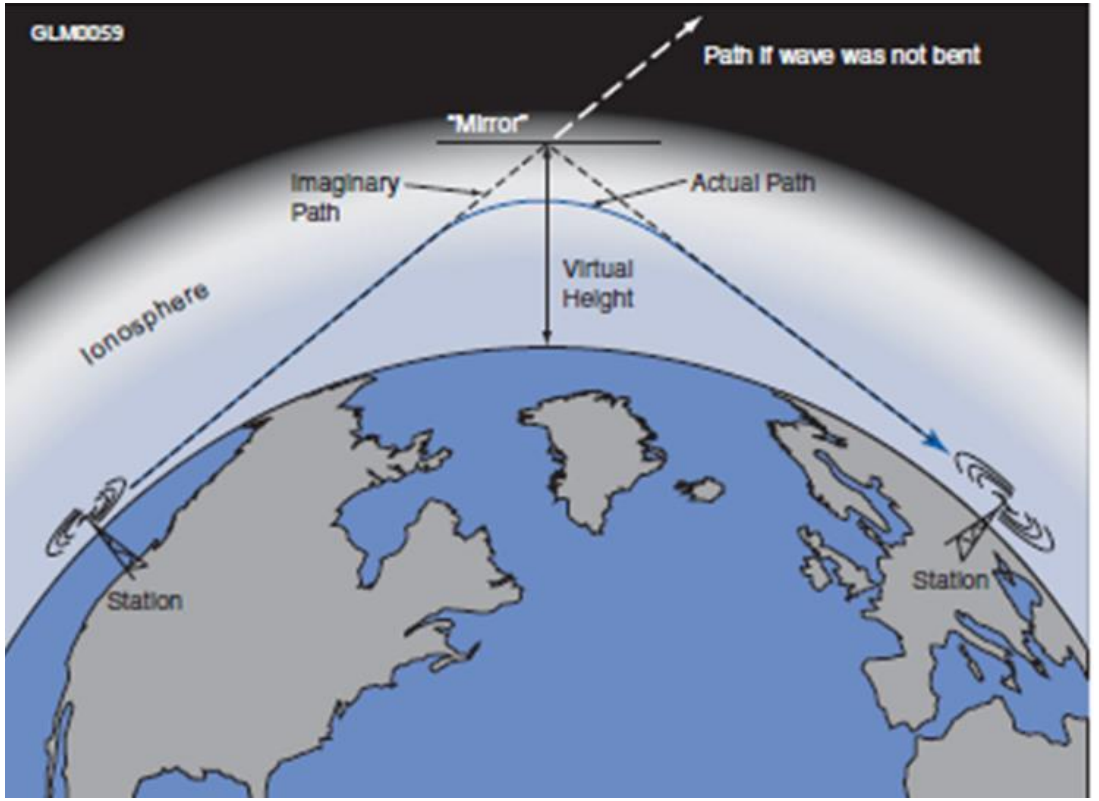


Reflection

The higher the region from which the reflection takes place, the longer the hop

Waves reflected from F2 layer travel up to 2,500 miles before returning to ground

Hops from E layer are shorter, up to 1,200 miles, because of lower reflecting height



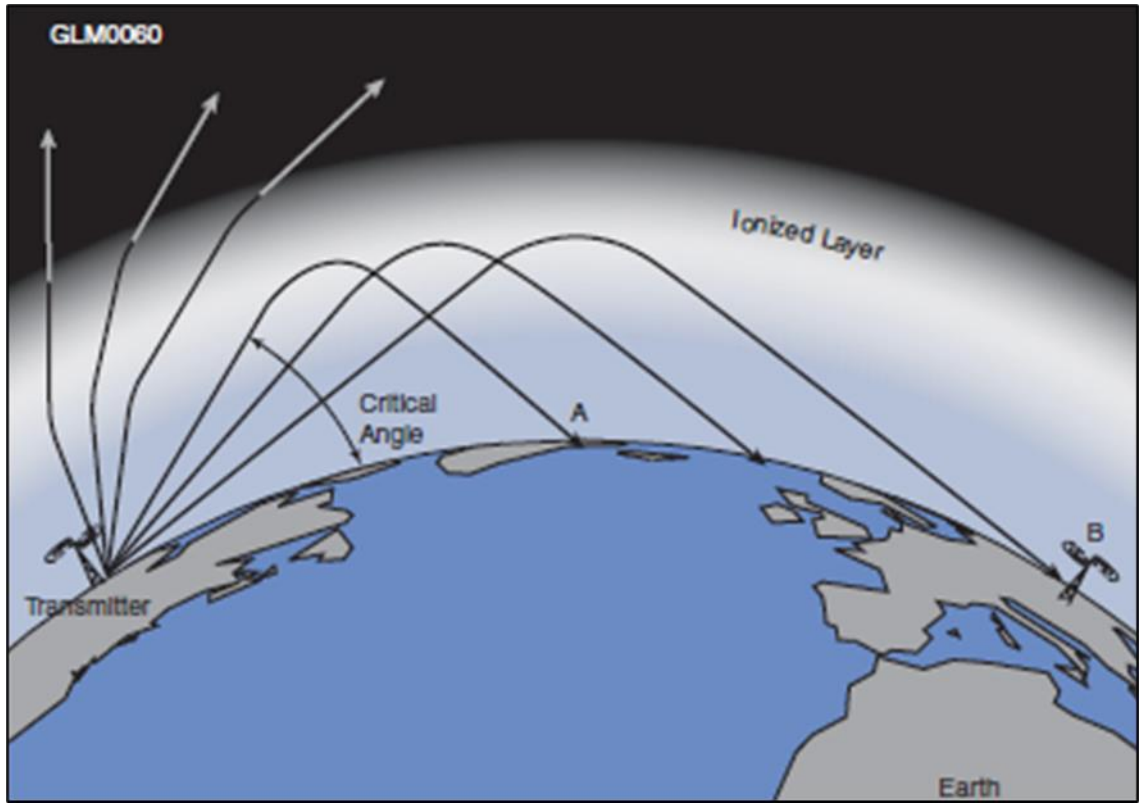
Reflection

Critical Angle of Attack

- Highest takeoff angle at which a wave can be returned to Earth is the critical angle
- Critical angle depends on ionospheric conditions and frequency

Critical Frequency

- The highest frequency on which a wave transmitted straight up will be returned to Earth
- What for the acronym MUF, Maximum Usable Frequency



Absorption

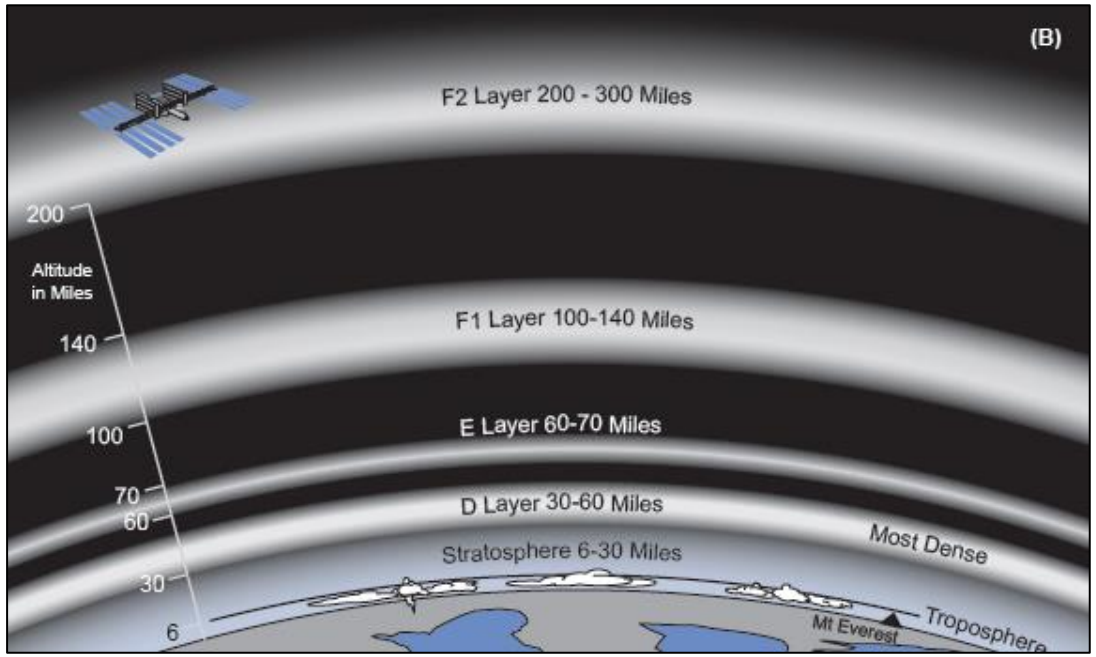
Enemy of propagation is absorption

- In D and E regions, waves passing through the denser gas are partially absorbed (D region is not very good at refraction)

In HF bands below 10 MHz, AM broadcast bands, and at lower frequencies, the D region completely absorbs radio waves during the day, preventing those waves from returning to Earth

Absorption increases in daytime and when solar UV is more intense

- QUESTION: When is the best time to transmit on HF below 10 MHz?



Answer: At night!

Noise

Noise is another enemy of propagation (covers up weak signals)

Stronger at frequencies below VHF (due to atmospheric disturbances)

Lower you go in frequency, the stronger the noise or static

Varies seasonally

Most noticeable on lower frequency HF bands in the summer when atmospheric noise is strongest

Long Path and Short Path

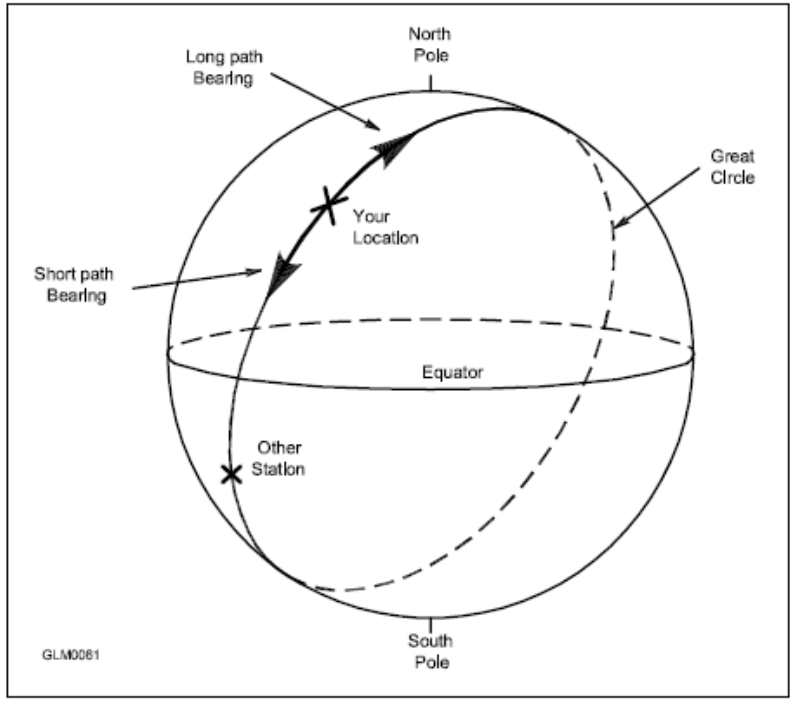
When ionosphere along short path does not support propagation, sometimes long path will

Occasionally, propagation over both long and short paths will be supported (at same time)

Unless the paths are almost equal there will be an echo (delayed signal arrives a fraction of a second later)

Round-the-world propagation: you can hear your own signal coming all the way around to your location about 1/7 of a second later!

- 25,000 miles divided by 186,000 miles/sec



This sketch of the Earth shows both great circle paths drawn between two stations. The bearings for the *short path* and the *long path* are shown from the Northern Hemisphere station.

QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview