General License Course
Chapter 4.4

Reactance

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Reactance

Definition: The resistance to the flow of ***alternating*** current (AC) caused by capacitance or inductance is called ***reactance*** and is denoted by the symbol X.

It is measured in ohms, like resistance.

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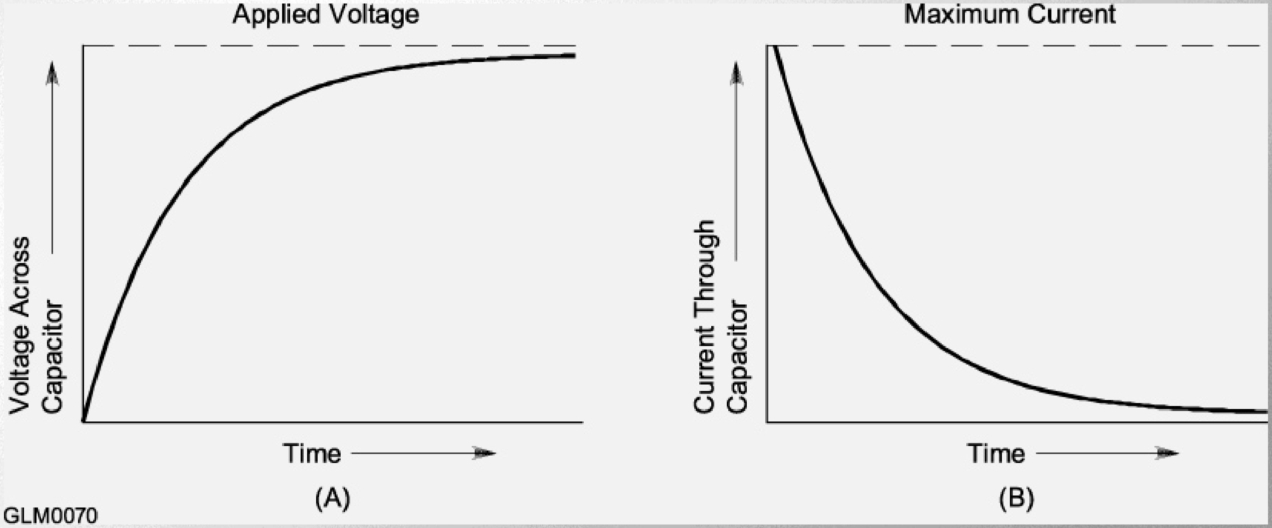
Capacitive Reactance

The opposition to alternating current flow from the stored electrostatic energy in a capacitor is called capacitive reactance (X_C)

As the frequency of the applied signal increases, X_C decreases and vice versa

$$X_C = 1 \div [2 \pi f C]$$



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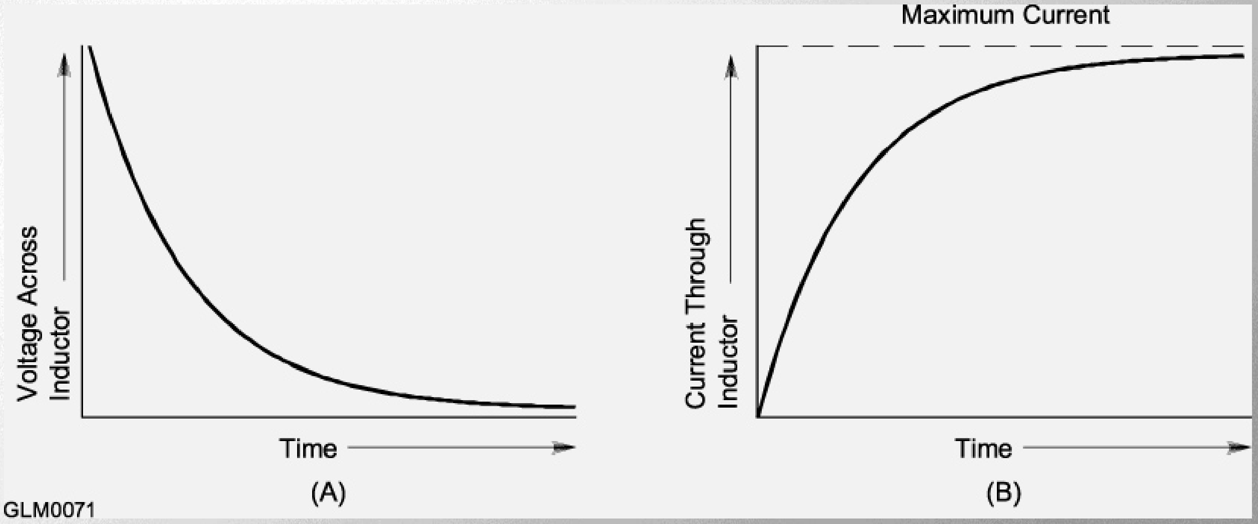
Inductive Reactance

The opposition to alternating current flow from the stored electromagnetic energy in a inductor (X_L)

As the frequency of the applied signal increases, X_L increases and visa versa

$$X_L = 2 \pi f L$$



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Parasitic Reactance

- An unwanted characteristic resulting from the components physical construction
  - wire-wound resistor on a ceramic form
  - Inter-lead capacitance/inductance
- Placing a wire-wound resistor in an RF circuit can make circuit performance unpredictable (fine for DC or low frequency)
- RF circuits normally use carbon composition, carbon film, or metal oxide resistors which have very low inductance

Take Quiz 1

G5A02 What is reactance?

A. Opposition to the flow of direct current caused by resistance

B. Opposition to the flow of alternating current caused by capacitance or inductance

C. Reinforcement of the flow of direct current caused by resistance

D. Reinforcement of the flow of alternating current caused by capacitance or inductance

G5A02 What is reactance?

A. Opposition to the flow of direct current caused by resistance

B. Opposition to the flow of alternating current caused by capacitance or inductance

C. Reinforcement of the flow of direct current caused by resistance

D. Reinforcement of the flow of alternating current caused by capacitance or inductance

G5A03 - Which of the following is opposition to the flow of alternating current in an inductor?

A. Conductance

B. Reluctance

C. Admittance

D. Reactance

G5A03 - Which of the following is opposition to the flow of alternating current in an inductor?

A. Conductance

B. Reluctance

C. Admittance

D. Reactance

G5A04 - Which of the following is opposition to the flow of alternating current in a capacitor?

A. Conductance

B. Reluctance

C. Reactance

D. Admittance

G5A04 - Which of the following is opposition to the flow of alternating current in a capacitor?

A. Conductance

B. Reluctance

C. Reactance

D. Admittance

G5A05 - How does an inductor react to AC?

A. As the frequency of the applied AC increases, the reactance decreases

B. As the amplitude of the applied AC increases, the reactance increases

C. As the amplitude of the applied AC increases, the reactance decreases

D. As the frequency of the applied AC increases, the reactance increases

G5A05 - How does an inductor react to AC?

A. As the frequency of the applied AC increases, the reactance decreases

B. As the amplitude of the applied AC increases, the reactance increases

C. As the amplitude of the applied AC increases, the reactance decreases

D. As the frequency of the applied AC increases, the reactance increases

G5A06 - How does a capacitor react to AC?

A. As the frequency of the applied AC increases, the reactance decreases

B. As the frequency of the applied AC increases, the reactance increases

C. As the amplitude of the applied AC increases, the reactance increases

D. As the amplitude of the applied AC increases, the reactance decreases

G5A06 - How does a capacitor react to AC?

A. As the frequency of the applied AC increases, the reactance decreases

B. As the frequency of the applied AC increases, the reactance increases

C. As the amplitude of the applied AC increases, the reactance increases

D. As the amplitude of the applied AC increases, the reactance decreases

G5A09 - What unit is used to measure reactance?

A. Farad

B. Ohm

C. Ampere

D. Siemens

G5A09 - What unit is used to measure reactance?

A. Farad

B. Ohm

C. Ampere

D. Siemens

G6A06 - Why should wire-wound resistors not be used in RF circuits?

A. The resistor's tolerance value would not be adequate

B. The resistor's inductance could make circuit performance unpredictable

C. The resistor could overheat

D. The resistor's internal capacitance would detune the circuit

G6A06 - Why should wire-wound resistors not be used in RF circuits?

A. The resistor's tolerance value would not be adequate

B. The resistor's inductance could make circuit performance unpredictable

C. The resistor could overheat

D. The resistor's internal capacitance would detune the circuit

General License Course
Chapter 4.4

Impedance and Resonance

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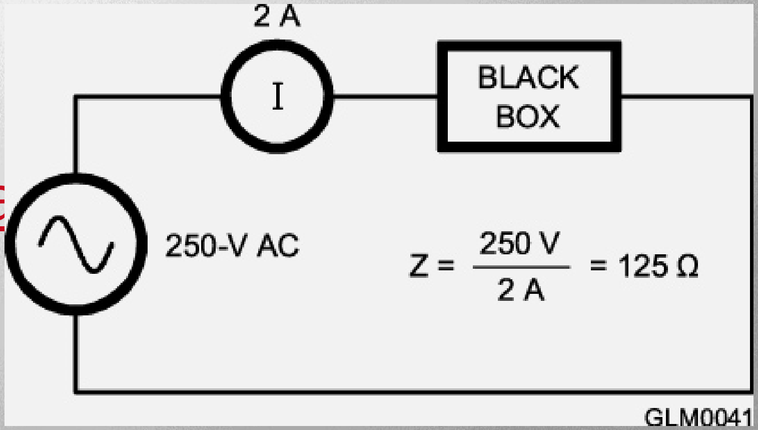
Impedance

- Impedance - opposition to current flow in an ac circuit
  - Denoted by “Z” and measured in ohms (Ω)
  - Equal to voltage divided by current: Z = E/I (aka <u>the ratio of voltage to current</u>)
  - Includes the effects of R, X_L *and* X_C
  - The Inverse of impedance is admitta

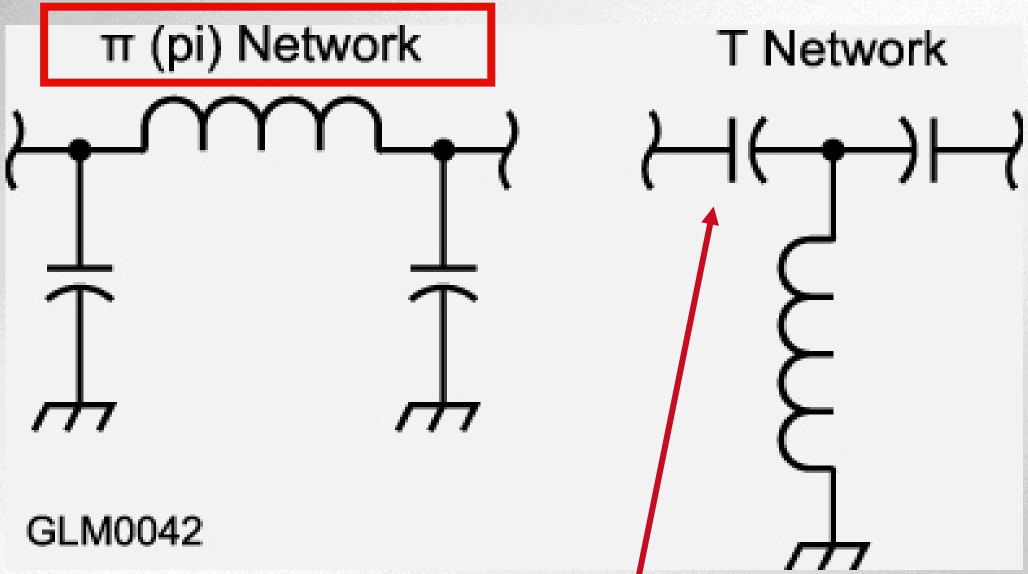


Impedance Matching

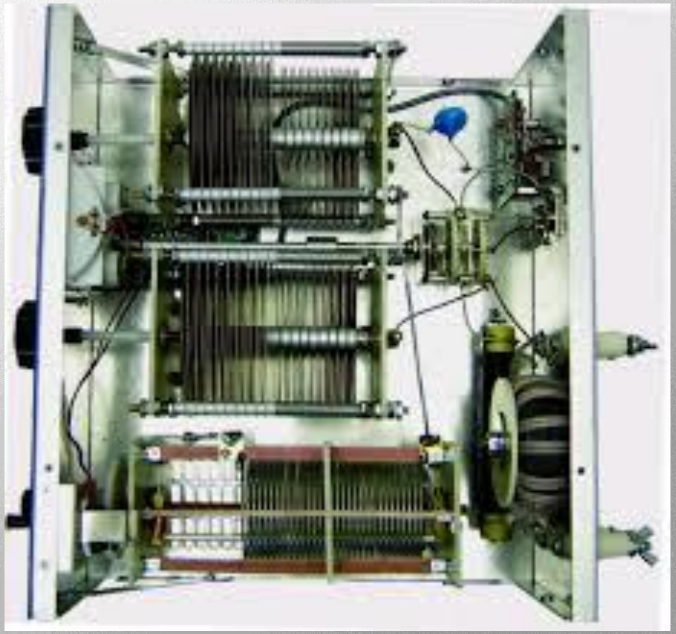
- Maximum power transfer occurs when the source and load impedances are equal
- Most Amateur radio transmitting equipment is designed to have a 50 Ω output impedance
- Most antennas are designed to have a feed point impedance of 50 Ω but rarely present that impedance over their entire frequency range
- An impedance-matching circuit changes that variable impedance to the desired value

Impedance Matching

- Method 1 - Many impedance matching circuits are LC networks employing inductors and capacitors (a Pi Network, for instance)



(most antenna "tuners")



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Impedance Matching

- Method 2 - Special RF impedance-matching <u>transformers</u> are often used to equalize impedances between the source and load to maximize the transfer of power to the load

- Method 3 - Special <u>lengths of transmission line</u> can also be used to match impedances

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Three methods - all correct...

More on Transformers

- Using a transformer to match ***impedances:*** The turn ratio between the primary and secondary is the ***square root*** of the ratio between the two impedances to be matched.
- **Example:** The turns ratio of a transformer used to match an antenna's 600-ohm feed point impedance to a 50-ohm coaxial cable is 3.5 to 1. (not 1 to 3.5)

NP = turns on the primary
NS = turns on the secondary

$$\frac{NP}{NS} = \sqrt{\frac{ZP}{ZS}}$$

ZP = primary impedance
ZS = secondary impedance

$$= \sqrt{\frac{600}{50}} = \sqrt{12} = \mathbf{3.46}$$

(Round to 3.5)

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Reactance

REVIEW: The resistance to the flow of ***alternating*** current (AC) caused by capacitance or inductance is called ***reactance*** and is denoted by the symbol X.

It is measured in ohms, like resistance.

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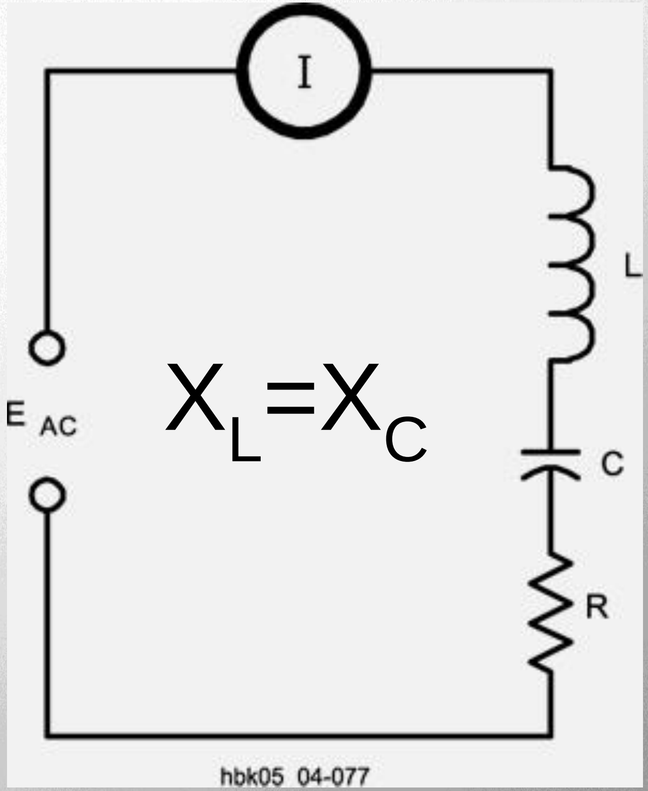
Resonance

- Resonance in a circuit or antenna occurs when capacitive and inductive reactance are equal
- In a resonant series circuit the reactances of the L and C cancel each other, forming a short circuit, leaving only the resistance, R, as the circuit's impedance
- Resonance is used in filters or tuned circuits to pass or reject specific frequencies

Series – Short Circuit

Parallel – Open Circuit



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Self-Resonance

- Occurs when a single components reactance equals the value of its parasitic reactance of the opposite type
- Above its self-resonant frequency, a components reactance switches type, making an inductor capacitive (and vice versa).

Take Quiz 2

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G5A01 - What happens when inductive and capacitive reactance are equal in a series LC circuit?

A. Resonance causes impedance to be very high

B. Impedance is equal to the geometric mean of the inductance and capacitance

C. Resonance causes impedance to be very low

D. Impedance is equal to the arithmetic mean of the inductance and capacitance

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G5A07 - What is the term for the inverse of impedance?

A. Conductance

B. Susceptance

C. Reluctance

D. Admittance

G5A07 - What is the term for the inverse of impedance?

A. Conductance

B. Susceptance

C. Reluctance

D. Admittance

G5A08 What is impedance?

A. The ratio of current to voltage

B. The product of current and voltage

C. The ratio of voltage to current

D. The product of current and reactance

G5A08 What is impedance?

A. The ratio of current to voltage

B. The product of current and voltage

C. The ratio of voltage to current

D. The product of current and reactance

G5A10 - Which of the following devices can be used for impedance matching at radio frequencies?

A. A transformer

B. A Pi-network

C. A length of transmission line

D. All these choices are correct

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G5A10 - Which of the following devices can be used for impedance matching at radio frequencies?

A. A transformer

B. A Pi-network

C. A length of transmission line

D. All these choices are correct

G5A11 - What letter is used to represent reactance?

A. Z

B. X

C. B

D. Y

G5A11 - What letter is used to represent reactance?

A. Z

B. X

C. B

D. Y

G5A12 - What occurs in an LC circuit at resonance?

A. Current and voltage are equal

B. Resistance is cancelled

C. The circuit radiates all its energy in the form of radio waves

D. Inductive reactance and capacitive reactance cancel

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C. The circuit radiates all its energy in the form of radio waves

D. Inductive reactance and capacitive reactance cancel

G5C07 - What transformer turns ratio matches an antenna's 600-ohm feed point impedance to a 50-ohm coaxial cable?

A. 3.5 to 1

B. 12 to 1

C. 24 to 1

D. 144 to 1

G5C07 - What transformer turns ratio matches an antenna's 600-ohm feed point impedance to a 50-ohm coaxial cable?

A. 3.5 to 1

B. 12 to 1

C. 24 to 1

D. 144 to 1

G6A11 - What happens when an inductor is operated above its self-resonant frequency?

A. Its reactance increases

B. Harmonics are generated

C. It becomes capacitive

D. Catastrophic failure is likely

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G7C03 - What is one reason to use an impedance matching transformer at a transmitter output?

A. To minimize transmitter power output

B. To present the desired impedance to the transmitter and feed line

C. To reduce power supply ripple

D. To minimize radiation resistance

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General License Course
Chapter 8.1

The Ionosphere

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The Ionosphere

- **Ionosphere** – region beginning about 30 miles above the Earth and extending to about 300 miles
- The air is thin enough that ultraviolet (UV) radiation from the sun can break the molecules of gas into individual atoms and then knock electrons away from them (the gas is ionized by the loss of an electron)
- That layer of charged ions and free electrons refract electromagnetic waves back toward Earth

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Ionospheric Regions

- The main regions of the ionosphere are the D, E, F layers
- D Layer: 30 – 60 miles in altitude (closest)
  - Only present when illuminated by the Sun – recombines quickly
- Disappears at night when no UV rays are present
- E Layer: 60 – 70 miles in altitude
  - Acts similarly to the D layer but recombines more slowly
- Disappears later- at night

Ionospheric Regions

- F Layer: 100 – 300 miles above Earth
  - During the day it breaks into F1 and F2 layers
  - At night it combines into a single F layer - the ions and electrons don't recombine easily because the gas atoms are so spread out
  - The F1 and F2 layers vary with the local time, season, latitude and solar activity
  - The stronger the Sun's illumination, the higher the F2 layer will be (maximum height occurs when the Sun is overhead)

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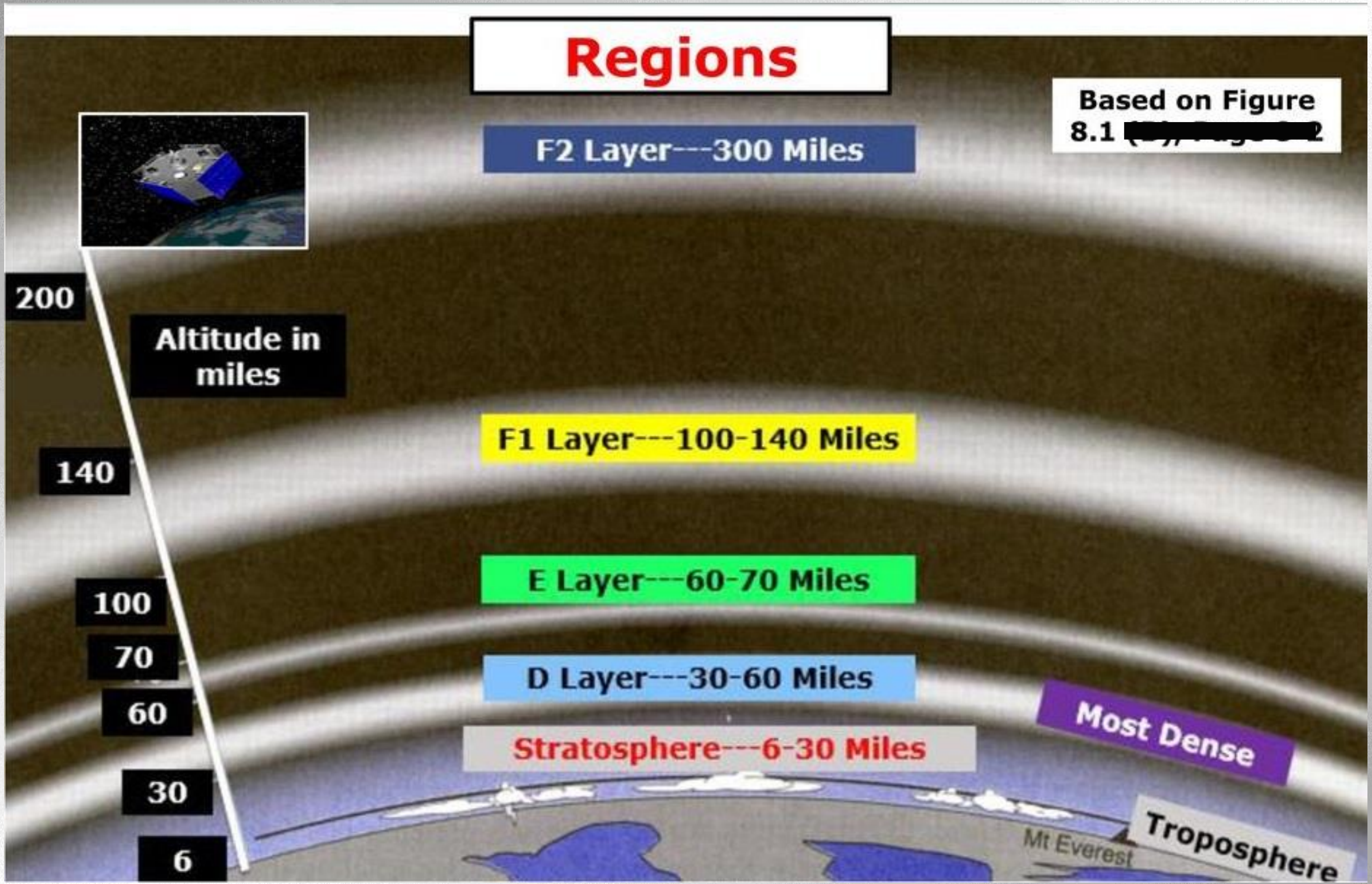
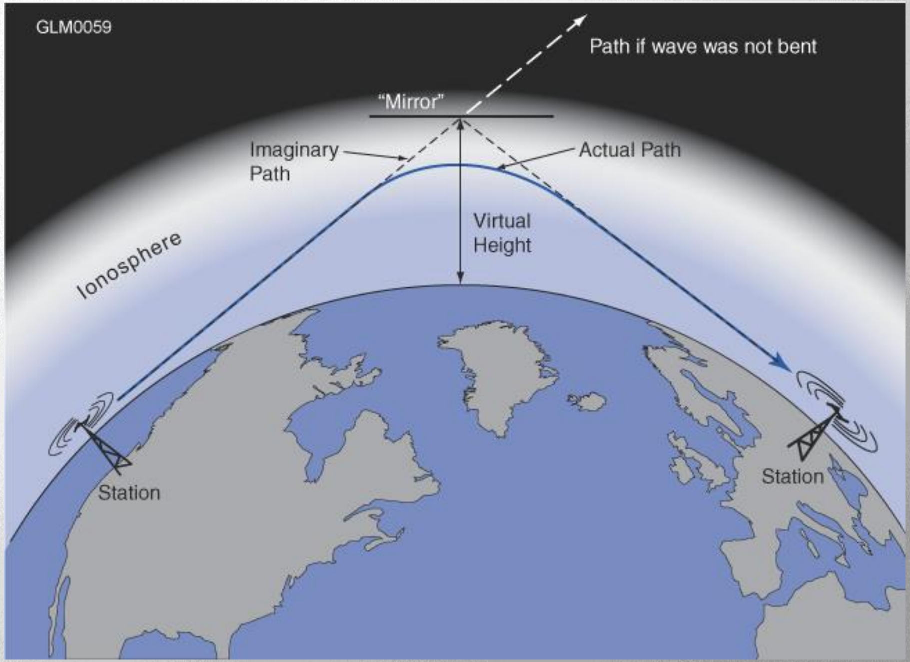

Regions
Based on Figure
8.1 [redacted]
F2 Layer---300 Miles
200
Altitude in
miles
F1 Layer---100-140 Miles
140
E Layer---60-70 Miles
100
70
D Layer---30-60 Miles
60
Most Dense
Stratosphere---6-30 Miles
30
6
Mt Everest
Troposphere

Reflection & Absorption

- The ability of the ionosphere to refract radio waves depends on how strongly the ionoshere is ionized and the frequency used

The stronger the ionization, the greater the "bending"

The higher the frequency of the wave, the less it is bent (VHF & UHF are often hardly bent)



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Reflection & Absorption

- *Critical Angle* – the highest angle at which the radio wave will be refracted back to Earth (see next page)
- *Absorption* increases in the daytime when the UV is more intense
- Below 10 MHz signals can be completely absorbed by the D layer during the daylight hours (40, 60, 80, 160 meters) leaving only ground wave signals. The D layer is the most absorbent (lossy) layer
- Lower HF frequencies typically experience high levels of atmospheric noise/static during summer months

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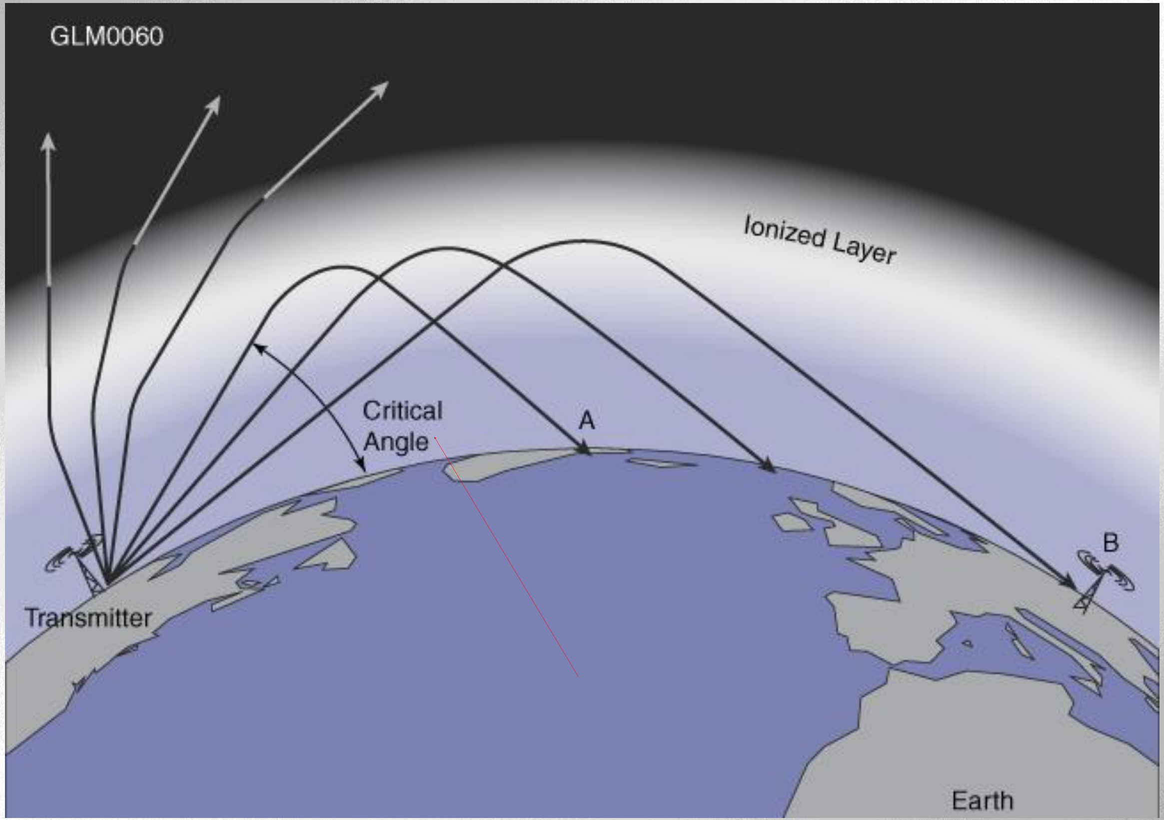
Sky-wave Propagation



Note that lower elevation angle signals travel farther on one "hop"

Sky-wave Propagation

- *Hop* – one reflection from the ionosphere
- Sky-wave (Skip) – propagation by ionospheric refraction. The higher the reflecting region, the longer the hop
- F2 layer hops can be up to <u>2500 miles</u> (highest layer, longest hops), E layer hops can be up to <u>1200 miles</u>
- MUF (Maximum Usable Frequency) – highest frequency at which sky-wave is available between two points. Also known as the Critical Frequency (the highest frequency which is refracted back to earth)
- LUF (Lowest Usable Frequency) – frequency below which there is too much absorption for communication
- Signals above the LUF but below the MUF will be bent back to earth by the ionosphere

Long Path & Short Path

- *Long path* – signals that travel the long way around the world from point to point (180 deg from short path) – point directional antennas accordingly
- *Short path* – most HF contacts are made via short path or the most direct route
- Round-the-world propagation – occasionally you can hear your own signal coming all the way around the world (1/7 second delay echo)

A slightly-delayed echo may be heard if a sky-wave signal arrives from both short and long path directions

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Long Path AND Short Path - Echo

C:\Users\ai2n\Videos\General Course - Videos\er4dx 10m multipath echo - 12_09 utc 4_12_2013.wmv

ER4DX (Moldova) on 10 meters

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Take Quiz 3

G2D06 - How is a directional antenna pointed when making a "long-path" contact with another station?

A. Toward the rising sun

B. Along the gray line

C. 180 degrees from the station's short-path heading

D. Toward the north

G2D06 - How is a directional antenna pointed when making a "long-path" contact with another station?

A. Toward the rising sun

B. Along the gray line

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G3B01 - What is a characteristic of skywave signals arriving at your location by both short-path and long-path propagation?

A. Periodic fading approximately every 10 seconds

B. Signal strength increased by 3 dB

C. The signal might be cancelled causing severe attenuation

D. A slightly delayed echo might be heard

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G3B01 - What is a characteristic of skywave signals arriving at your location by both short-path and long-path propagation?

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B. Signal strength increased by 3 dB

C. The signal might be cancelled causing severe attenuation

D. A slightly delayed echo might be heard

G3B09 - What is the approximate maximum distance along the Earth's surface normally covered in one hop using the F2 region?

A. 180 miles

B. 1,200 miles

C. 2,500 miles

D. 12,000 miles

G3B09 - What is the approximate maximum distance along the Earth's surface normally covered in one hop using the F2 region?

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B. 1,200 miles

C. 2,500 miles

D. 12,000 miles

G3B10 - What is the approximate maximum distance along the Earth's surface normally covered in one hop using the E region?

A. 180 miles

B. 1,200 miles

C. 2,500 miles

D. 12,000 miles

G3B10 - What is the approximate maximum distance along the Earth's surface normally covered in one hop using the E region?

A. 180 miles

B. 1,200 miles

C. 2,500 miles

D. 12,000 miles

G3C01 - Which ionospheric region is closest to the surface of Earth?

A. The D region

B. The E region

C. The F1 region

D. The F2 region

G3C01 - Which ionospheric region is closest to the surface of Earth?

A. The D region

B. The E region

C. The F1 region

D. The F2 region

G3C02 - What is meant by the term "critical frequency" at a given incidence angle?

A. The highest frequency which is refracted back to Earth

B. The lowest frequency which is refracted back to Earth

C. The frequency at which the signal-to-noise ratio approaches unity

D. The frequency at which the signal-to-noise ratio is 6 dB

G3C02 - What is meant by the term "critical frequency" at a given incidence angle?

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B. The lowest frequency which is refracted back to Earth

C. The frequency at which the signal-to-noise ratio approaches unity

D. The frequency at which the signal-to-noise ratio is 6 dB

G3C03 - Why is skip propagation via the F2 region longer than that via the other ionospheric regions?

A. Because it is the densest

B. Because of the Doppler effect

C. Because it is the highest

D. Because of temperature inversions

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A. Because it is the densest

B. Because of the Doppler effect

C. Because it is the highest

D. Because of temperature inversions

G3C04 - What does the term "critical angle" mean, as applied to radio wave propagation?

A. The long path azimuth of a distant station

B. The short path azimuth of a distant station

C. The lowest takeoff angle that will return a radio wave to Earth under specific ionospheric conditions

D. The highest takeoff angle that will return a radio wave to Earth under specific ionospheric conditions

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G3C04 - What does the term "critical angle" mean, as applied to radio wave propagation?

A. The long path azimuth of a distant station

B. The short path azimuth of a distant station

C. The lowest takeoff angle that will return a radio wave to Earth under specific ionospheric conditions

D. The highest takeoff angle that will return a radio wave to Earth under specific ionospheric conditions

G3C05 - Why is long-distance communication on the 40-, 60-, 80-, and 160-meter bands more difficult during the day?

A. The F region absorbs signals at these frequencies during daylight hours

B. The F region is unstable during daylight hours

C. The D region absorbs signals at these frequencies during daylight hours

D. The E region is unstable during daylight hours

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C. The D region absorbs signals at these frequencies during daylight hours

D. The E region is unstable during daylight hours

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G3C11 - Which ionospheric region is the most absorbent of signals below 10 MHz during daylight hours?

A. The F2 region

B. The F1 region

C. The E region

D. The D region

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G3C11 - Which ionospheric region is the most absorbent of signals below 10 MHz during daylight hours?

A. The F2 region

B. The F1 region

C. The E region

D. The D region

General License Course
Chapter 8.2

The Sun

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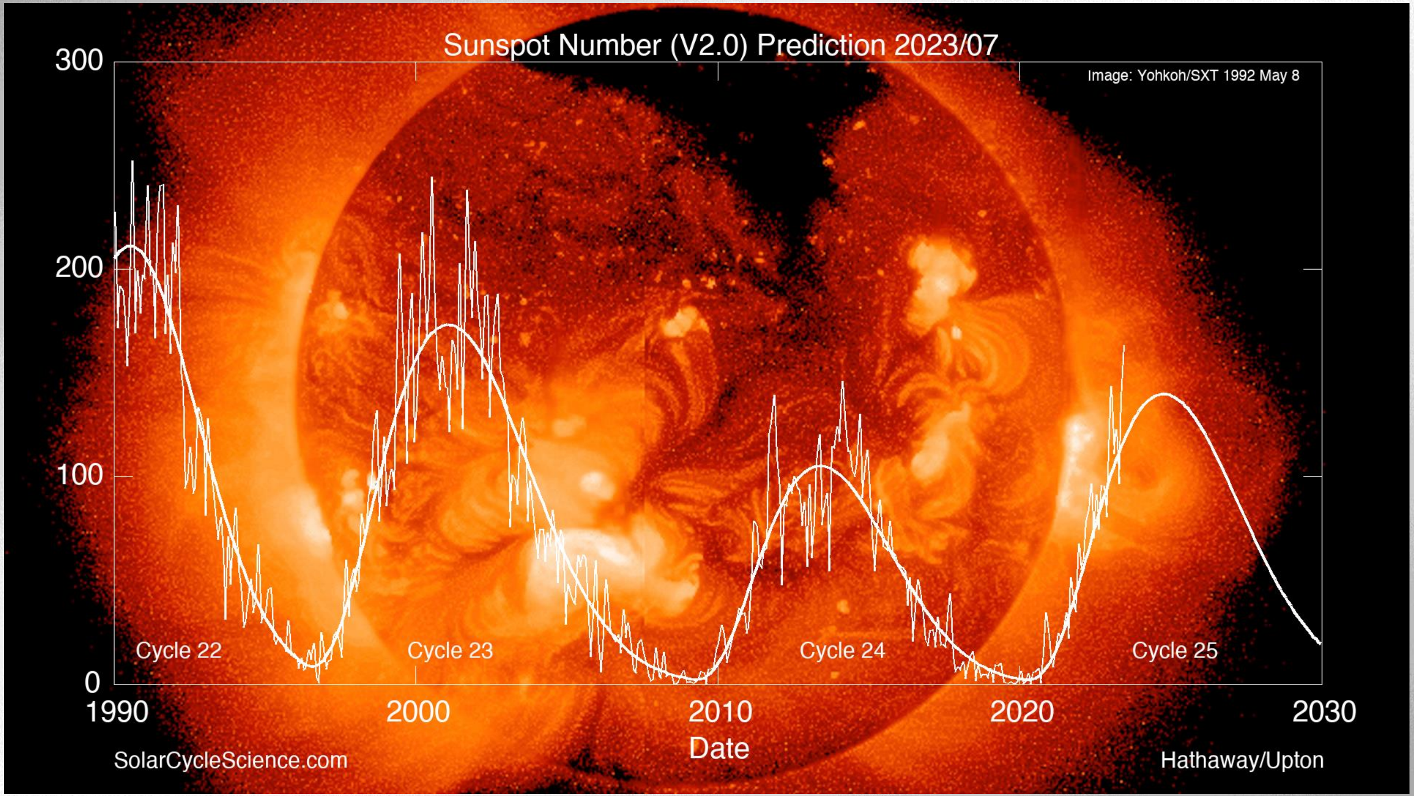
The Sun

- Sunspot or Solar Cycle – approximately an 11-year cycle
- Sunspot number represents the number of sunspots and groups present at a given time
- Sunspot numbers are useful in assessing the overall solar activity
- More sunspots result in more UV energy, creating more ionization and (generally) improving propagation conditions on the higher frequency HF bands and possibly into the lower VHF range

Solar Activity

- High sunspot numbers mean poor daytime conditions on 80 & 40 meters (increased absorption)
- Low sunspot numbers means 15, 12, & 10 meter bands are often closed (no sky-wave)
- 20 meter band is usually good regardless of sunspot number during daylight hours
- The Sun’s surface layers rotate every 26-28 days causing sunspots to reappear if still present - HF propagation tends to repeat, as well

Measuring Solar Activity



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Measuring Solar Activity

- Solar-Flux Index (SFI) – a measure of 2800 MHz (*<u>10.7 cm</u> wavelength*) energy from the Sun
- K index (0-9) – the short-term stability of the Earth's geomagnetic field
  - 0 is quiet, 9 is extreme storm
- A index (0-400) – long-term geomagnetic field stability around the world
  - Values 0 (stable) to 400 (greatly disturbed)

A is long-term, K is short-term

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Assessing Propagation

- MUF – Maximum Usable Frequency - highest frequency for propagation between two points *(higher than MUF will not be refracted enough to get back to Earth)*
- LUF – Lowest Usable Frequency - lowest frequency for propagation between two points - lower frequencies will be absorbed
- Maximum Usable Frequency is affected by:
  - path distance and location
  - time of day and season
  - solar radiation and ionospheric disturbances
    - *(all three choices are correct)*

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Assessing Propagation

Signals with frequencies below the MUF and above the LUF are bent back to Earth from the ionosphere - Signals just below the MUF will have the least amount of attenuation

Signals with frequencies below the LUF are completely attenuated before reaching the intended destination. High levels of noise or static are typical on the lower HF frequencies in summer

Signals with frequencies above the MUF are not refracted enough to return to Earth: they proceed into space

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Solar Disturbances

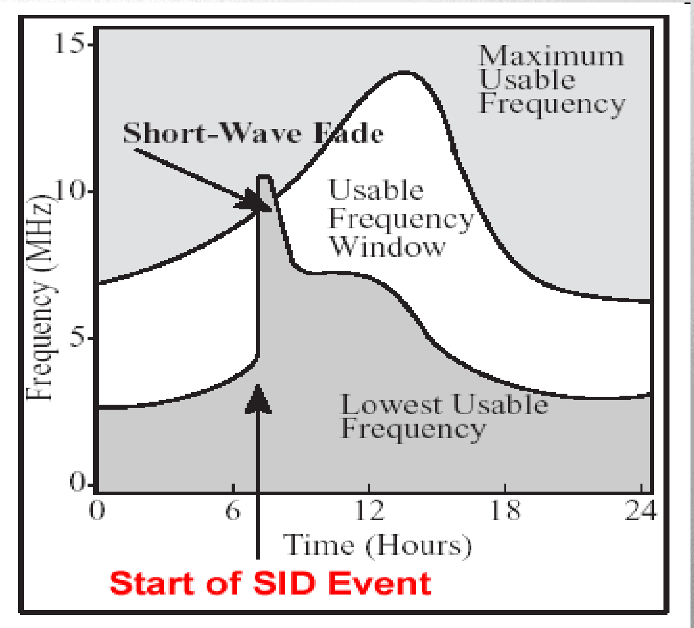
- Solar flares emit UV & X-ray *radiation* that travels at the speed of light and reaches the Earth's ionosphere in about 8 minutes - it can cause a Sudden Ionospheric Disturbance (SID)
- Increases D layer ionization and absorption dramatically, possibly causing a radio blackout that can last from seconds to several hours
- Affects lower bands more than higher bands
- SID only impacts the sunny side of the Earth so dark side may be relatively unaffected

Assessing Propagation

- If LUF rises above MUF, no ordinary sky-wave propagation is possible between those two points

Sudden Ionospheric Disturbance (SID)

Disrupts low frequencies more than higher frequencies



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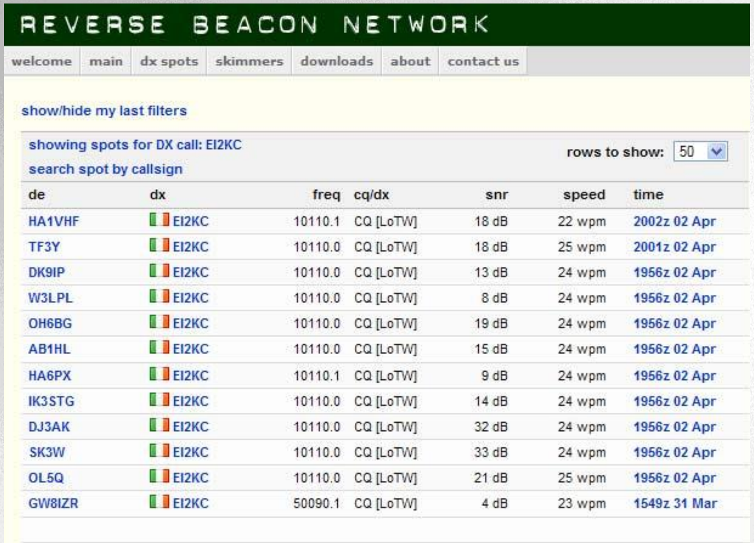
Assessing Propagation

- Automated receiving stations linked to the internet can allow you to see where your transmissions are being received. (Reverse Beacon Network, PSK Reporter, etc.)


REVERSE BEACON NETWORK

welcome | main | dx spots | skimmers | downloads | about | contact us

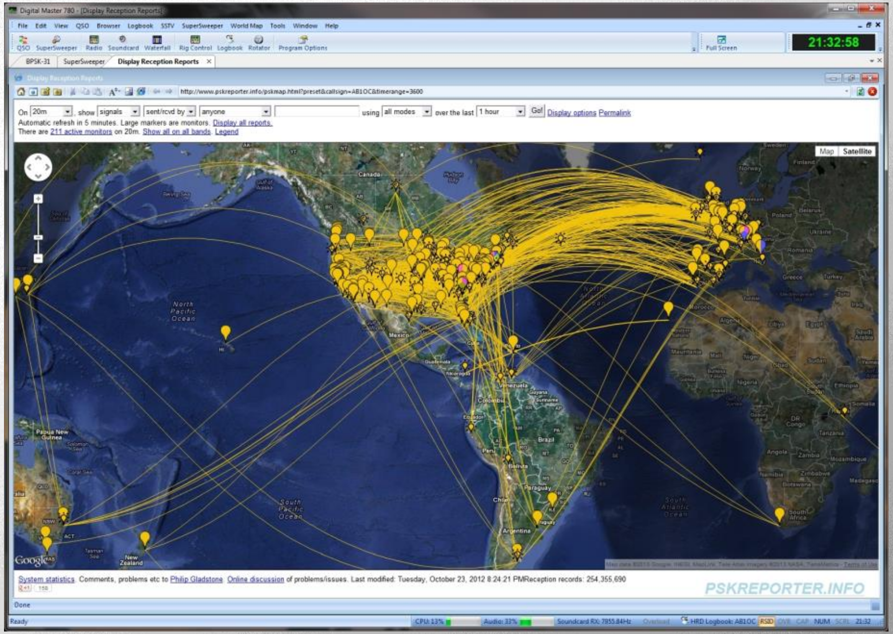
show/hide my last filters

showing spots for DX call: EI2KC

search spot by callsign

rows to show: 50

de	dx	freq	cq/dx	snr	speed	time
HA1VHF	EI2KC	10110.1	CQ [LoTW]	18 dB	22 wpm	2002z 02 Apr
TF3Y	EI2KC	10110.0	CQ [LoTW]	18 dB	25 wpm	2001z 02 Apr
DK9IP	EI2KC	10110.0	CQ [LoTW]	13 dB	24 wpm	1956z 02 Apr
W3LPL	EI2KC	10110.0	CQ [LoTW]	8 dB	24 wpm	1956z 02 Apr
OH6BG	EI2KC	10110.0	CQ [LoTW]	19 dB	24 wpm	1956z 02 Apr
AB1HL	EI2KC	10110.0	CQ [LoTW]	15 dB	24 wpm	1956z 02 Apr
HA6PX	EI2KC	10110.1	CQ [LoTW]	9 dB	24 wpm	1956z 02 Apr
IK3STG	EI2KC	10110.0	CQ [LoTW]	14 dB	24 wpm	1956z 02 Apr
DJ3AK	EI2KC	10110.0	CQ [LoTW]	32 dB	24 wpm	1956z 02 Apr
SK3W	EI2KC	10110.0	CQ [LoTW]	33 dB	24 wpm	1956z 02 Apr
OL5Q	EI2KC	10110.0	CQ [LoTW]	21 dB	25 wpm	1956z 02 Apr
GW8IZR	EI2KC	50090.1	CQ [LoTW]	4 dB	23 wpm	1549z 31 Mar



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Solar Disturbances

- Solar flare – a large eruption of energy and solar material on the surface of the Sun
- Corona - The extended outer atmosphere of the Sun
- Coronal hole – a weak area in the Sun's outer layer where ionized gas and charged particles escape the Sun's magnetic field
- Coronal mass ejection (CME) – an ejection of large amounts of material from the corona
  - CME may be directed in a narrow stream or wide spray (usually disruptive to HF radio communications)

Solar Disturbances

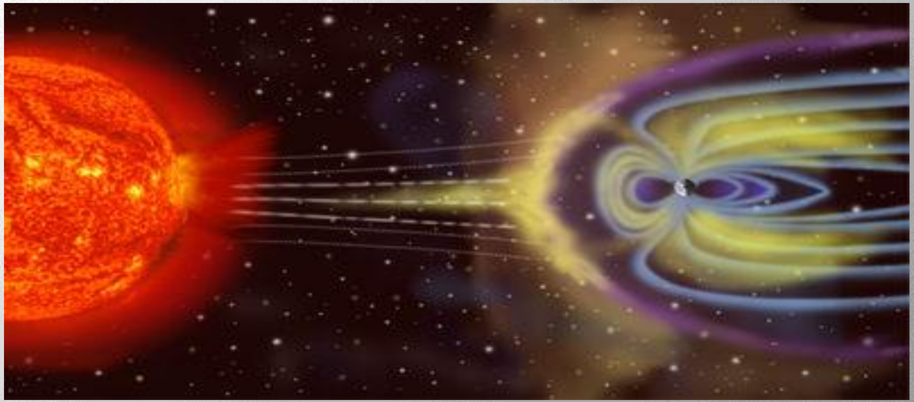
- Geomagnetic Disturbances
  - The Sun gives off a stream of particles called *solar wind*
  - These can cause a *Geomagnetic Storm,* a temporary disturbance in the Earth's geomagnetic field (next slide)
  - Charged *particles* from coronal holes and CMEs take from 15 hours to several days to reach the Earth
  - Particles increase ionization in the E region
  - Causes auroral displays and geomagnetic storms

Solar Disturbances

- Sudden changes in the geomagnetic field disrupts the upper ionosphere, causing long-distance paths *at high latitudes* near the magnetic poles to be wiped out for a period of hours to days

- Auroras are actually gases ionized by the incoming charged particles as they flow vertically down into the atmosphere, guided by the intense magnetic field near the magnetic poles

- Auroras can reflect VHF signals - Auroral propagation is strongest on 6 and 2 meters (signals will hiss or buzz)



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VE3EN 6m SSB AURORA

(note the slow, deliberate, speech to enhance intelligibility)

Take Quiz 4

G3A01 - How does a higher sunspot number affect HF propagation?

A. Higher sunspot numbers generally indicate a greater probability of good propagation at higher frequencies

B. Lower sunspot numbers generally indicate greater probability of sporadic E propagation

C. A zero sunspot number indicates that radio propagation is not possible on any band

D. A zero sunspot number indicates undisturbed conditions

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G3A04 - Which of the following are the least reliable bands for long-distance communications during periods of low solar activity?

A. 80 meters and 160 meters

B. 60 meters and 40 meters

C. 30 meters and 20 meters

D. 15 meters, 12 meters, and 10 meters

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G3A05 - What is the solar flux index?

A. A measure of the highest frequency that is useful for ionospheric propagation between two points on Earth

B. A count of sunspots that is adjusted for solar emissions

C. Another name for the American sunspot number

D. A measure of solar radiation with a wavelength of 10.7 centimeters

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G3A07 - At what point in the solar cycle does the 20-meter band usually support worldwide propagation during daylight hours?

A. At the summer solstice

B. Only at the maximum point

C. Only at the minimum point

D. At any point

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G3A10 - What causes HF propagation conditions to vary periodically in a 26- to 28-day cycle?

A. Long term oscillations in the upper atmosphere

B. Cyclic variation in Earth's radiation belts

C. Rotation of the Sun's surface layers around its axis

D. The position of the Moon in its orbit

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G3A12 - What does the K-index measure?

A. The relative position of sunspots on the surface of the Sun

B. The short-term stability of Earth's geomagnetic field

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D. The solar radio flux at Boulder, Colorado

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G3A13 - What does the A-index measure?

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B. The amount of polarization of the Sun's electric field

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G3B12 - Which of the following is typical of the lower HF frequencies during the summer?

A. Poor propagation at any time of day

B. World-wide propagation during daylight hours

C. Heavy distortion on signals due to photon absorption

D. High levels of atmospheric noise or static

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G3A02 - What effect does a sudden ionospheric disturbance have on the daytime ionospheric propagation?

A. It enhances propagation on all HF frequencies

B. It disrupts signals on lower frequencies more than those on higher frequencies

C. It disrupts communications via satellite more than direct communications

D. None, because only areas on the night side of the Earth are affected

G3A02 - What effect does a sudden ionospheric disturbance have on the daytime ionospheric propagation?

A. It enhances propagation on all HF frequencies

B. It disrupts signals on lower frequencies more than those on higher frequencies

C. It disrupts communications via satellite more than direct communications

D. None, because only areas on the night side of the Earth are affected

G3A03 - Approximately how long does it take the increased ultraviolet and X-ray radiation from a solar flare to affect radio propagation on Earth?

A. 28 days

B. 1 to 2 hours

C. 8 minutes

D. 20 to 40 hours

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D. 20 to 40 hours

G3A06 - What is a geomagnetic storm?

A. A sudden drop in the solar flux index

B. A thunderstorm that affects radio propagation

C. Ripples in the geomagnetic force

D. A temporary disturbance in Earth's geomagnetic field

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B. A thunderstorm that affects radio propagation

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D. A temporary disturbance in Earth's geomagnetic field

G3A08 - How can a geomagnetic storm affect HF propagation?

A. Improve high-latitude HF propagation

B. Degrade ground wave propagation

C. Improve ground wave propagation

D. Degrade high-latitude HF propagation

G3A08 - How can a geomagnetic storm affect HF propagation?

A. Improve high-latitude HF propagation

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G3A09 - How can high geomagnetic activity benefit radio communications?

A. Creates auroras that can reflect VHF signals

B. Increases signal strength for HF signals passing through the polar regions

C. Improve HF long path propagation

D. Reduce long delayed echoes

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G3A09 - How can high geomagnetic activity benefit radio communications?

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C. Improve HF long path propagation

D. Reduce long delayed echoes

G3A11 - How long does it take a coronal mass ejection to affect radio propagation on Earth?

A. 28 days

B. 14 days

C. 4 to 8 minutes

D. 15 hours to several days

G3A11 - How long does it take a coronal mass ejection to affect radio propagation on Earth?

A. 28 days

B. 14 days

C. 4 to 8 minutes

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G3A14 - How is long distance radio communication usually affected by the charged particles that reach Earth from solar coronal holes?

A. HF communication is improved

B. HF communication is disturbed

C. VHF/UHF ducting is improved

D. VHF/UHF ducting is disturbed

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G3B02 - What factors affect the MUF?

A. Path distance and location

B. Time of day and season

C. Solar radiation and ionospheric disturbances

D. All these choices are correct

G3B02 - What factors affect the MUF?

A. Path distance and location

B. Time of day and season

C. Solar radiation and ionospheric disturbances

D. All these choices are correct

G3B03 - Which frequency will have the least attenuation for long-distance skip propagation?

A. Just below the MUF

B. Just above the LUF

C. Just below the critical frequency

D. Just above the critical frequency

G3B03 - Which frequency will have the least attenuation for long-distance skip propagation?

A. Just below the MUF

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D. Just above the critical frequency

G3B04 - Which of the following is a way to determine current propagation on a desired band from your station?

A. Use a network of automated receiving stations on the internet to see where your transmissions are being received

B. Check the A-index

C. Send a series of dots and listen for echoes

D. All these choices are correct

G3B04 - Which of the following is a way to determine current propagation on a desired band from your station?

A. Use a network of automated receiving stations on the internet to see where your transmissions are being received

B. Check the A-index

C. Send a series of dots and listen for echoes

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G3B05 - How does the ionosphere affect radio waves with frequencies below the MUF and above the LUF?

A. They are refracted back to Earth

B. They pass through the ionosphere

C. They are amplified by interaction with the ionosphere

D. They are refracted and trapped in the ionosphere to circle Earth

G3B05 - How does the ionosphere affect radio waves with frequencies below the MUF and above the LUF?

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G3B06 - What usually happens to radio waves with frequencies below the LUF?

A. They are refracted back to Earth

B. They pass through the ionosphere

C. They are attenuated before reaching the destination

D. They are refracted and trapped in the ionosphere to circle Earth

G3B06 - What usually happens to radio waves with frequencies below the LUF?

A. They are refracted back to Earth

B. They pass through the ionosphere

C. They are attenuated before reaching the destination

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G3B07 - What does LUF stand for?

A. The Lowest Usable Frequency for communications between two specific points

B. Lowest Usable Frequency for communications to any point outside a 100-mile radius

C. The Lowest Usable Frequency during a 24-hour period

D. Lowest Usable Frequency during the past 60 minutes

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G3B08 - What does MUF stand for?

A. The Minimum Usable Frequency for communications between two points

B. The Maximum Usable Frequency for communications between two points

C. The Minimum Usable Frequency during a 24-hour period

D. The Maximum Usable Frequency during a 24-hour period

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G3B11 What happens to HF propagation when the LUF exceeds the MUF?

A. Propagation via ordinary skywave communications is not possible over that path

B. HF communications over the path are enhanced

C. Double-hop propagation along the path is more common

D. Propagation over the path on all HF frequencies is enhanced

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General License Course
Chapter 8.3

Scatter Modes

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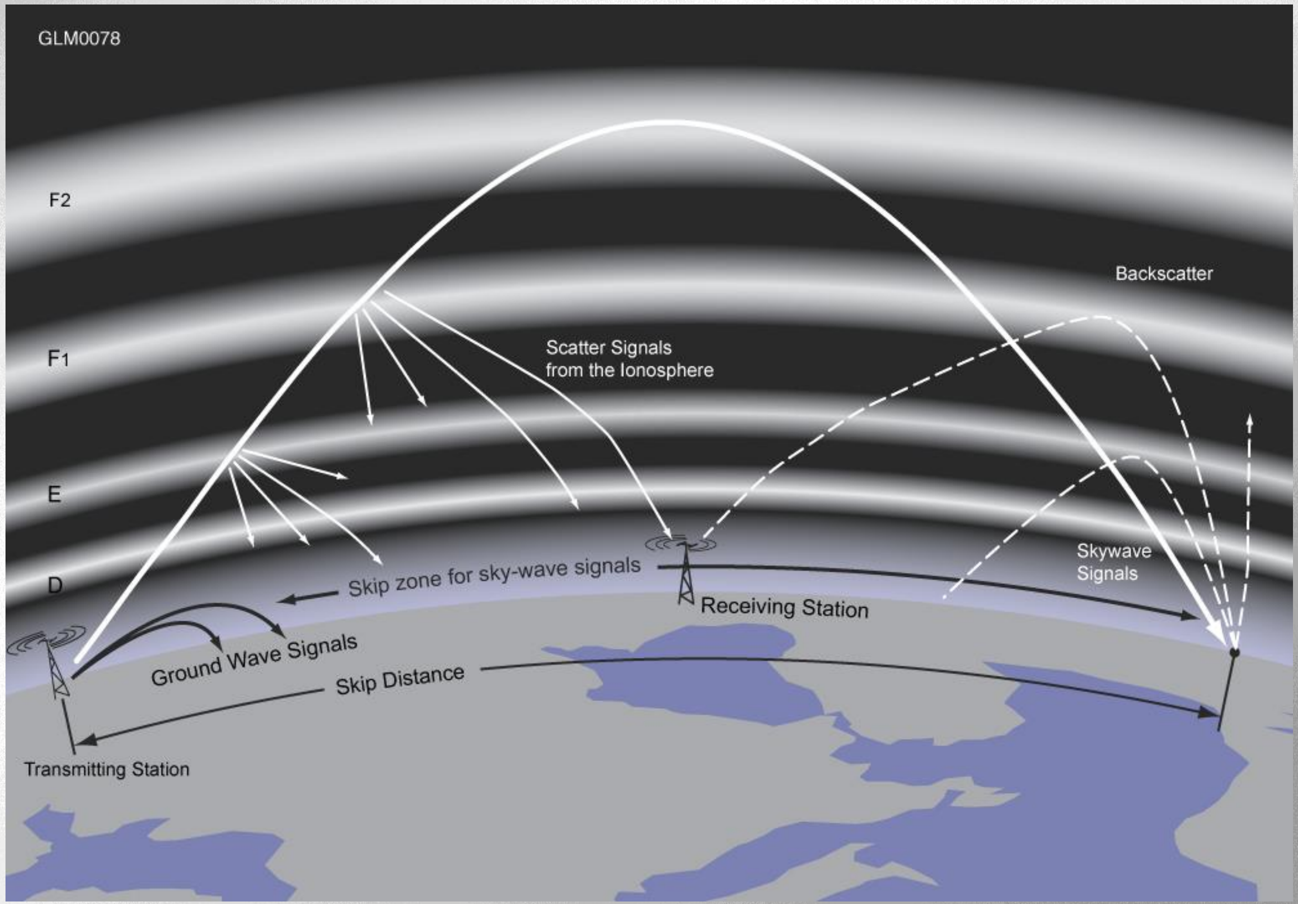
Ionospheric Reflections

Scatter



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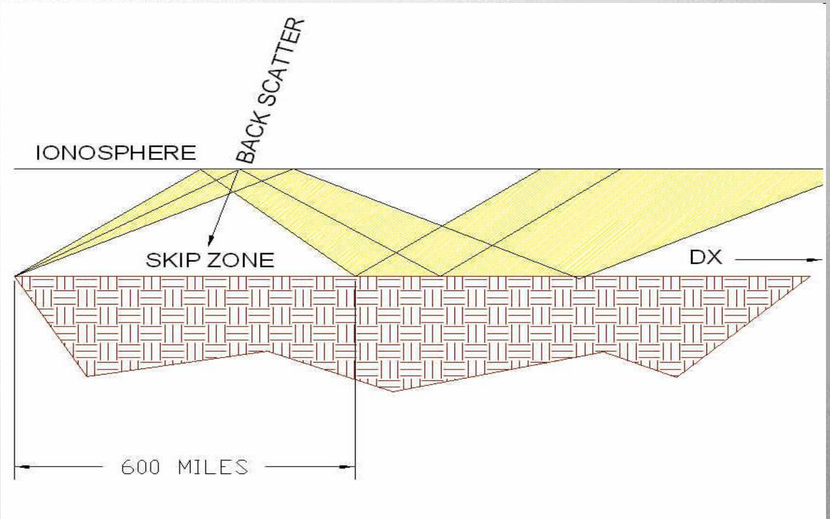
Scatter Modes

- Scatter Characteristics
  - HF scatter signals in the skip zone are usually <u>weak</u> because only a small part of the signal energy is scattered into the skip zone
  - Signals typically have a <u>fluttering</u> or wavering sound
  - HF Scatter signals often sound <u>distorted</u> because their signal energy is scattered into the skip zone through several different radio wave paths
  - An indication that a signal heard is being received via <u>scatter</u> propagation is that the signal is heard on a frequency <u>above</u> the Maximum Usable Frequency for that path, in what would usually be considered the skip zone

Scatter Modes

- Scatter Characteristics
  - Signals can be heard from stations that are too far away to be received via ground wave but too near for normal sky-wave propagation (above MUF)
  - Back scatter reflects signals back toward the transmitter. Back scatter helps fill in the skip zone where signals would otherwise not be heard



Scatter Modes

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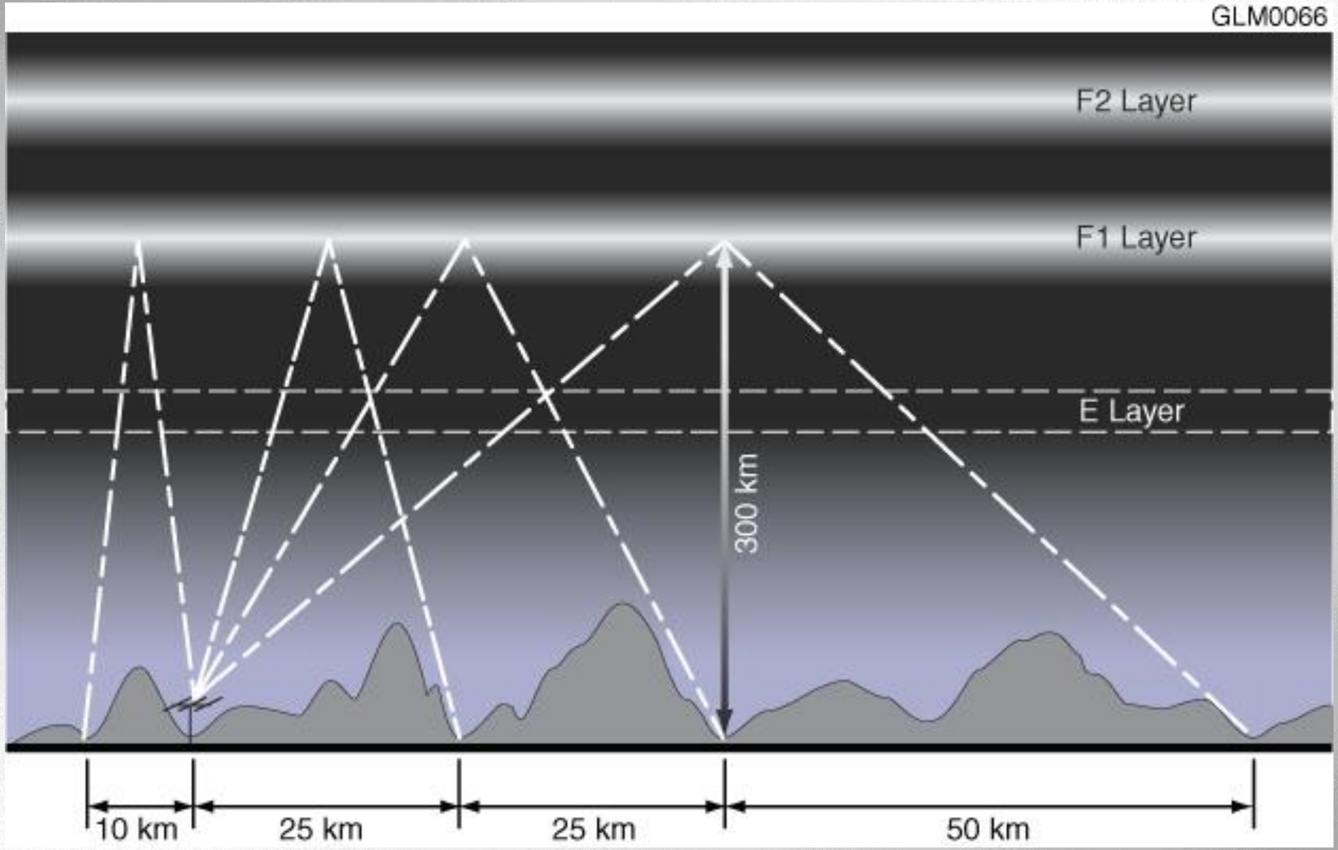
W1AW/8 in Ohio - 15m CW

Scatter Modes - NVIS

- NVIS = Near Vertical Incidence Sky-wave, which enables short distance MF or HF propagation using high elevation angles.
- Reflections from a signal radiating vertically are returned to Earth over a 200-300 mile range around the transmitting station
- Horizontal dipoles placed close to the ground (⅛ to ¼ wavelength high) have an omnidirectional pattern at very high angles - good for regional daytime communications on 160-40 meters
- NVIS works best at 40 meters and lower-frequency bands

NVIS Reflections



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Take Quiz 5

G3C06 - What is a characteristic of HF scatter?

A. Phone signals have high intelligibility

B. Signals have a fluttering sound

C. There are very large, sudden swings in signal strength

D. Scatter propagation occurs only at night

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G3C07 - What makes HF scatter signals often sound distorted?

A. The ionospheric region involved is unstable

B. Ground waves are absorbing much of the signal

C. The E region is not present

D. Energy is scattered into the skip zone through several different paths

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G3C08 - Why are HF scatter signals in the skip zone usually weak?

A. Only a small part of the signal energy is scattered into the skip zone

B. Signals are scattered from the magnetosphere, which is not a good reflector

C. Propagation is via ground waves, which absorb most of the signal energy

D. Propagation is via ducts in the F region, which absorb most of the energy

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G3C09 - What type of propagation allows signals to be heard in the transmitting station's skip zone?

A. Faraday rotation

B. Scatter

C. Chordal hop

D. Short-path

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A. Faraday rotation

B. Scatter

C. Chordal hop

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G3C10 - What is near vertical incidence skywave (NVIS) propagation?

A. Propagation near the MUF

B. Short distance MF or HF propagation at high elevation angles

C. Long path HF propagation at sunrise and sunset

D. Double hop propagation near the LUF

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Next Week
Chapters 4.5-4.7

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