PROPAGATION OF RADIO WAVES

Lon M. Lease, PE

NL7LE

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AGENDA

Fundamentals of Radio Waves

Sky Wave Propagation and the Sun

MUF Predictions

Propagation in the Troposphere

Sunspot Cycles

NVIS

Carrington Event

FUNDAMENTALS OF PROPAGATION

Velocity

Free Space Attenuation and Absorption

Refraction

Scattering

Reflection

Diffraction

Ground Waves

VELOCITY

Radio is a part of the Electromagnetic spectrum- infrared, ultraviolet, heat, X rays

Electromagnetic Waves travel near speed of light in a vacuum

Slower in mediums- wire 95%, slower in other mediums

$c=f*\lambda$ c= speed of light 300,000,000 meters /sec

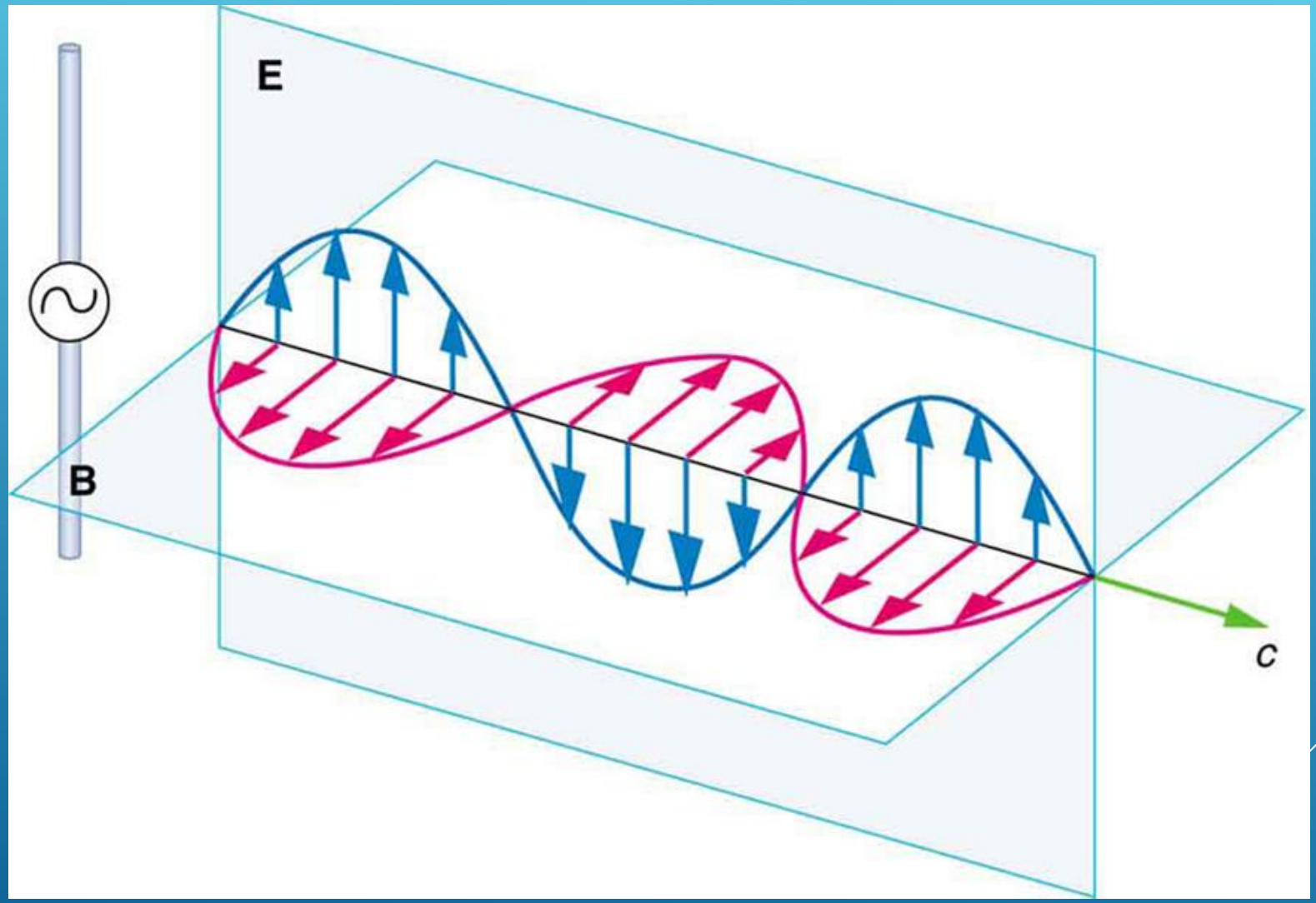
f= frequency in hertz

λ= wavelength in meters

OR

λ= 300/f in Mhz

ELECTRIC AND MAGNETIC WAVES



ABSORBTION AND SCATTERING

Free Space Loss

L = 20logd + 20logf

L= free space loss in dB

d = distance in Km

f = frequency in Mhz

Loss can be calculated for any path

REFRACTION

Caused by change in velocity when passing between medium

Direction changes because speed changes across boundary

Like light and water

SCATTERING

Changes direction and decreases in intensity

If they are organized when scattered they produce a pattern

Garden hose spraying water.

REFLECTION

Above 30Mhz signals can reflect off objects like airplanes, water towers, and hills

Range is limited by line of sight distance between stations

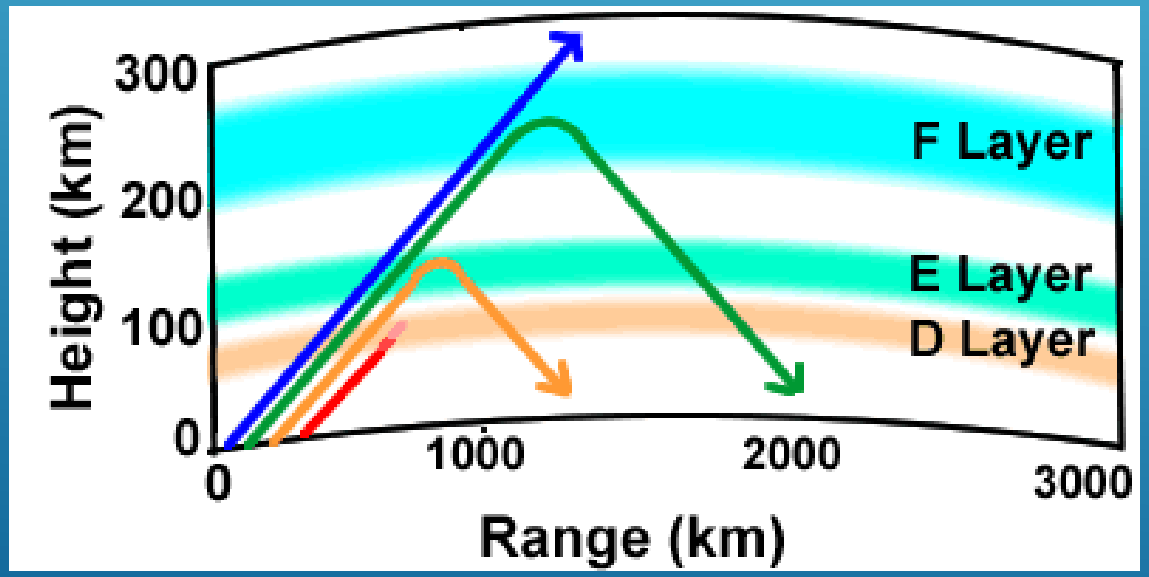
DIFFRACTION

Signals can appear behind objects when they pass along an edge

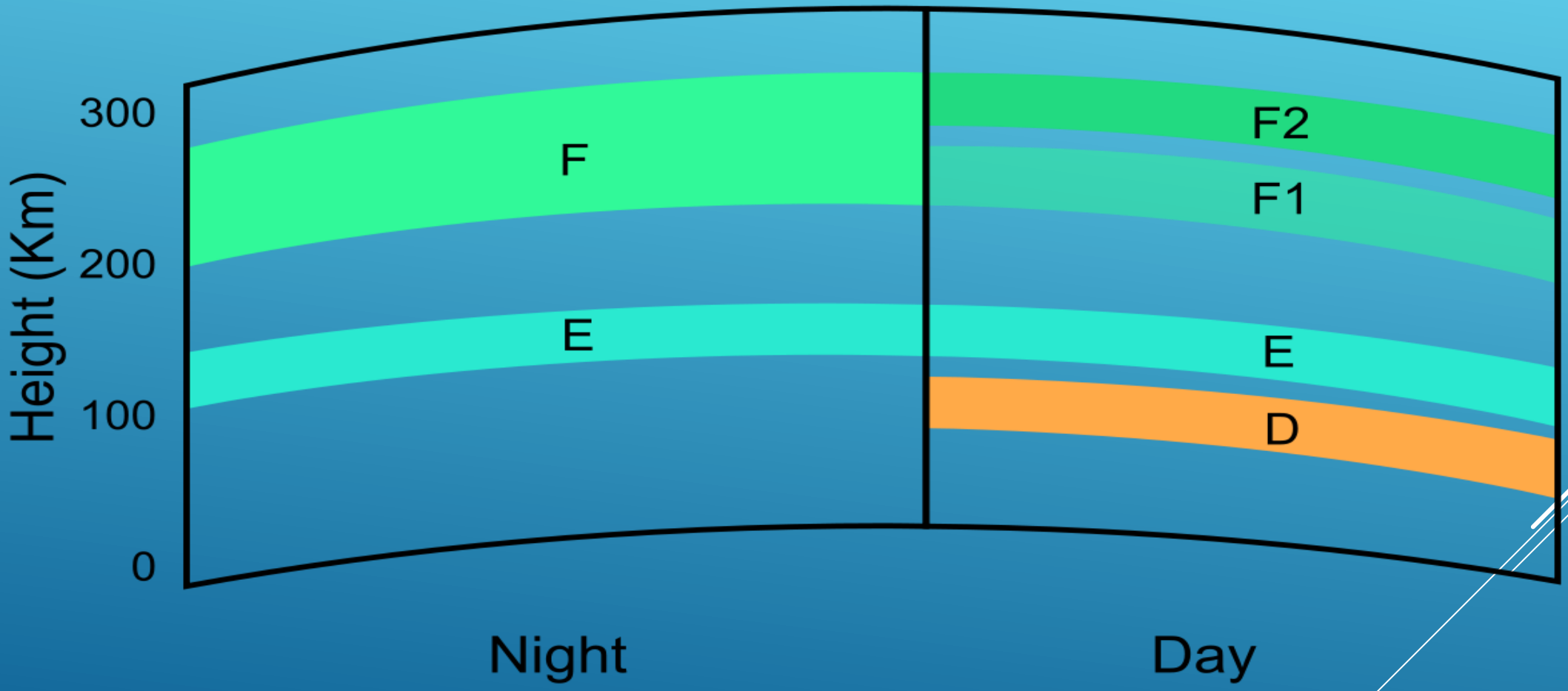
They form patterns of increased signal and areas of absence as they reinforce (inphase) and cancel (out of phase)

SKYWAVE PROPAGATION AND THE SUN

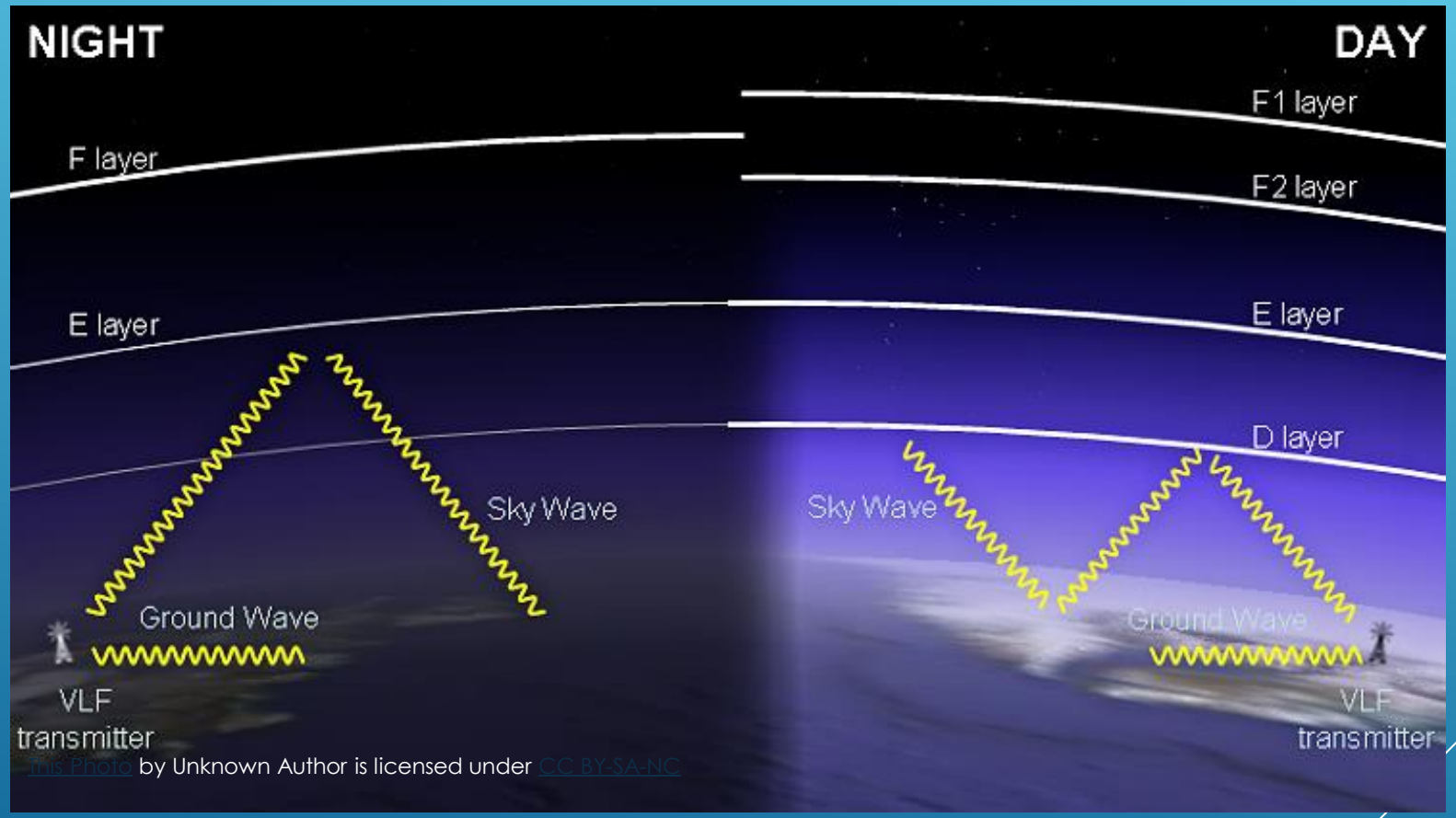
- Structure of Atmosphere and Ionosphere
- Ionospheric Reflection
- Maximum and Lowest Usable Frequencies



IONOSPHERE LAYERS



IONOSPHERIC REFLECTION

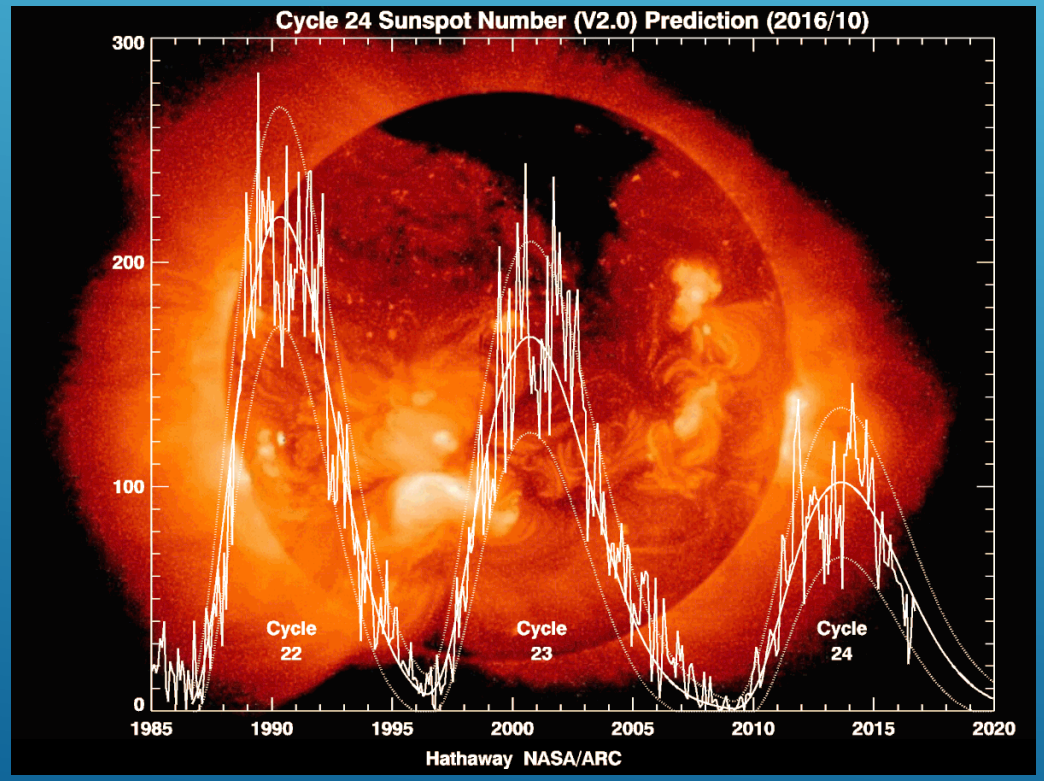


MAXIMUM AND LOWEST USABLE FREQUENCIES

- When the frequency of a vertical incident wave is raised above the critical frequency, the ionosphere can not reflect the wave and it escapes
- Also dependent on angle of incidence
- These define a maximum and lowest usable frequencies
- Can be as low as 3Mhz and as high as 30Mhz

SUNSPOT CYCLES

- Sun activity peaks every 11 years
- 2010 was last peak
- Just reaching Cycle 24
- Sunspot activity effects Ionosphere layers by exciting ions



NEAR VERTICAL INCIDENCE SYKWAVE

- Invented in WW2 by Germans to communicate between tanks
- Place an antenna .1 wavelength to ground.
- Propagates up and reflects off ionosphere and covers 800 miles

CARRINGTON EVENT

- Coronal Mass Ejection directly towards earth
- First observed by Carrington 1859 while studying sun
- Caused fires in telegraph offices in US
- Caught one last week arrived at earth Oct 11 as G1/G2 Geostorm
- Increases Ion activity and aurora activity

NEXT TIME

- Effects of each Ionosphere Layers
- UHF/VHF
- Space Communications

PRACTICAL EXERCISE

- Safe use of OEM power supply
- E = I X R
- P = I x E
- Fuse Protection and Grounding