Amateur Radio
Technician Class Training

Slideset created by Alan Wolke, W2AEW
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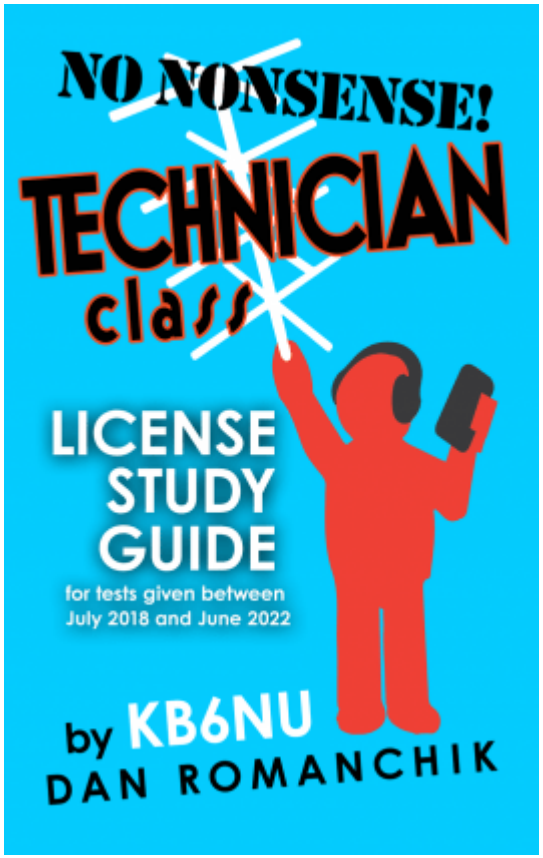
Based on the No-Nonsense Technician Class Study Guide by Dan Romanchik, KB6NU

Updates by Rebecca Mercuri, Ph.D., K3RPM

Agenda – Session 1

- **Introduction**
- **Radio Wave Characteristics (RWC)**
- Electronic Components and Circuits (ECCD)
- Electrical Principles (EP)
- Antennas and Feed Lines (AFL)
- Amateur Radio Signals (ARS)
- Electrical Safety (ES)
- Radio Practices and Station Setup (RPSS)
- Station Equipment (SE)
- Operating Procedures (OP)
- Rules and Regulations (RR)



Welcome to the MORE Project!

- The Make Amateur Radio Easier (MORE) Project was proposed by Dr. Rebecca Mercuri, K3RPM to help increase the participation of under-represented groups (particularly youth and non-males) in Amateur Radio
- The Project was funded by the ARDC and is managed by the Institute of Electrical and Electronics Engineers, Princeton / Central Jersey Section, Broadcast Technology Chapter (IEEE PCJS BTC)
- Students (of all ages and genders) who successfully complete the training classes, and pass the Technician exam, will receive a hand-held radio and training on its proper use, so that they can Get On The Air

Introductions

Let's BRIEFLY get to know each other!

- Teachers (Name, Callsign, License Class)
  - How you got involved with Ham radio
- Students (First and Last Name, Nickname)
  - Why are you interested in amateur radio?
- Special Guests & Visitors (Name, Callsign)
  - Why are you here today?

Characteristics of a Good Ham
Also of a Good Student!

- Eager to learn and experience new things
- Courteous and polite
  - Listen before you talk; keep comments short
- Asks questions
  - Use the raise hand feature in Zoom (try it now!)
  - Type questions and comments into the chat
- Able to follow rules and instructions
- Spends time studying (review 1 hour each day)
- Helps others

Course Materials

- Each of you should have received a link to our resource list when you enrolled in this class
- You can also find this list via the MORE Project website at: http://n2re.org/m-o-r-e-project
- Instructions on how to obtain the lecture slides and other course materials will be provided via email
- We will be following the No Nonsense! Technician Class License Study Guide, 2022-2026 Edition
- Download the Study Guide and slidesets for each class – use for review and practice between classes

What is Amateur Radio?

- Hobby
- Service
- STEM Field
- Way to Meet People
- Fun!

- It's what YOU make of it!

Communicate, Experiment, Serve, Interact, Compete

- Ham Radio is:
  - Regulated, but non-commercial
  - Experimentation (allowed & encouraged)
  - Community service
  - Technical learning & discovery
  - Contests & challenges
  - *Something for everyone!*

Cool things to do ...

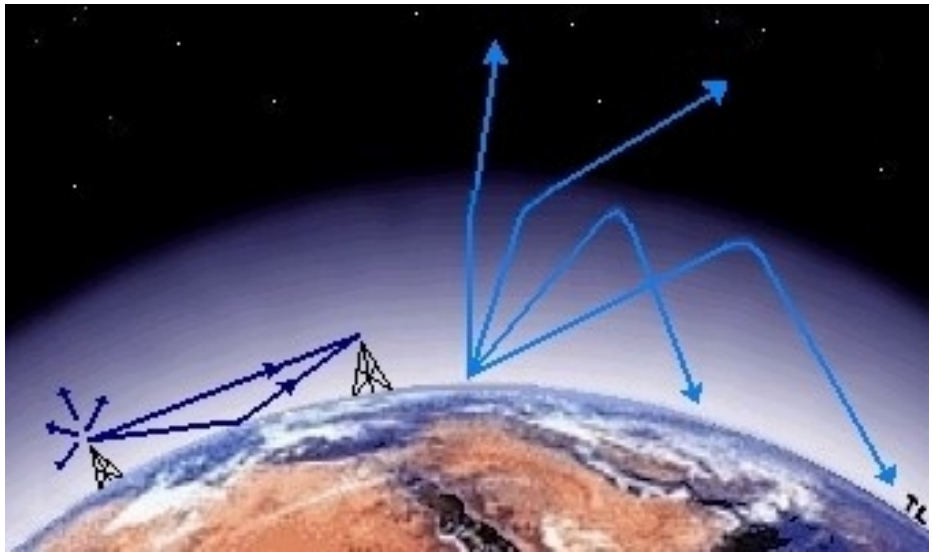
End of Introduction

Questions?

Radio Wave Characteristics (RWC)

- Frequency, Wavelength
- Radio Wave Properties
- HF Propagation

Radio Wave Characteristics (RWC)

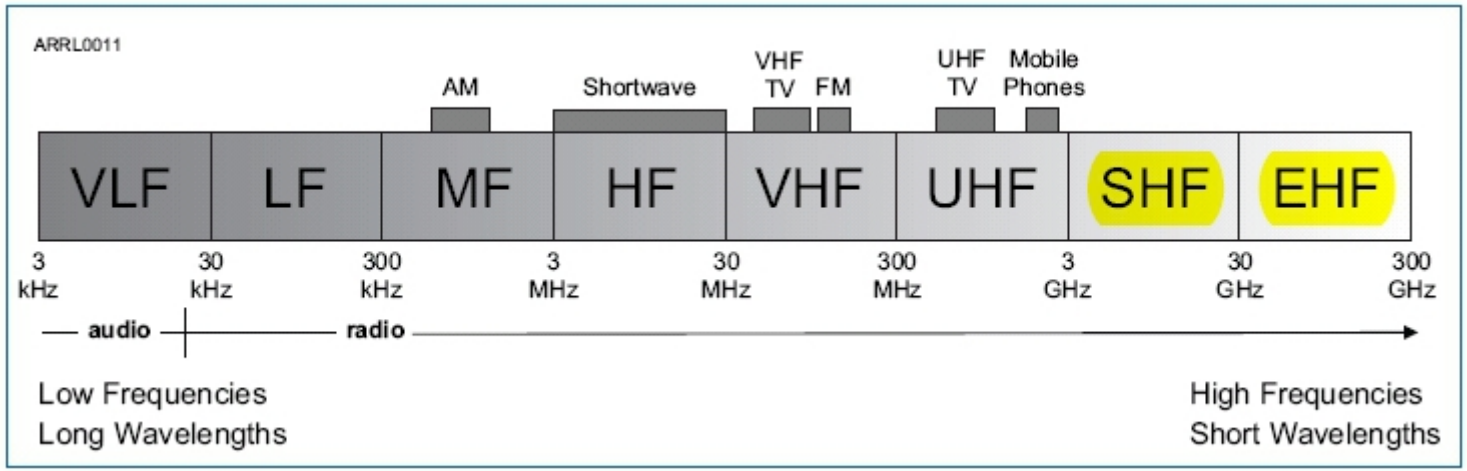


Frequency

Wavelength

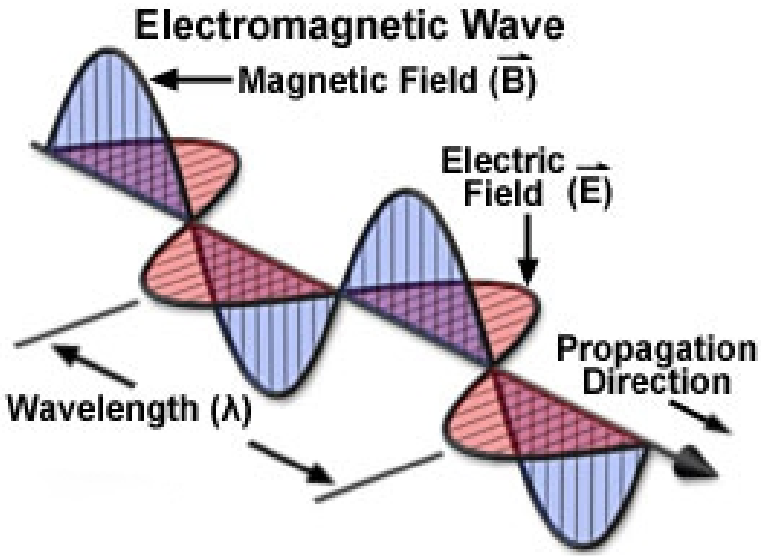
Spectrum

Propagation



Radio Waves

- Radio waves are **Electromagnetic**
- Have *electric* and *magnetic* field components
- *Radio waves* travel through space and they carry signals from transmitter to receiver

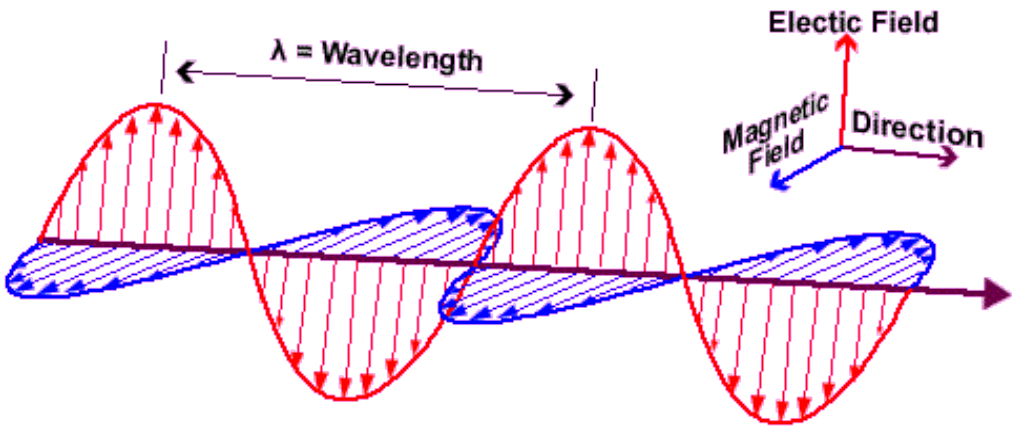


Frequency and Wavelength

Frequency: number of times per second the signal repeats (cycles) {exam may say reverses…}

Frequency measured in **Hertz** (cycles/second)

Wavelength: how far the wave travels during one cycle



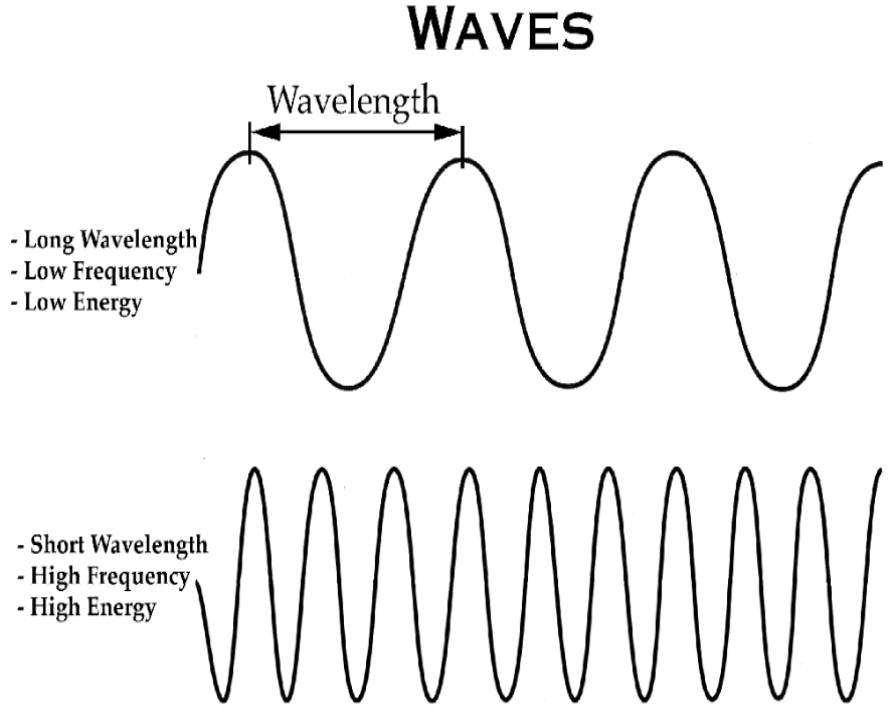
Radio Wave Facts

- Travels at *speed of light* in free space

  …about **300,000,000 meters per second**!

  …regardless of frequency

- Wavelength gets *shorter* as frequency *increases*
- *Wavelength in meters is equal to 300 / frequency in MHz*



Radio Frequency Bands

- The **approximate wavelength** of radio waves is used to identify different bands
- Examples:

  The 2m band spans 144 - 148MHz

  The 40m band spans 7.000 – 7.300MHz

It's not always "exact"…

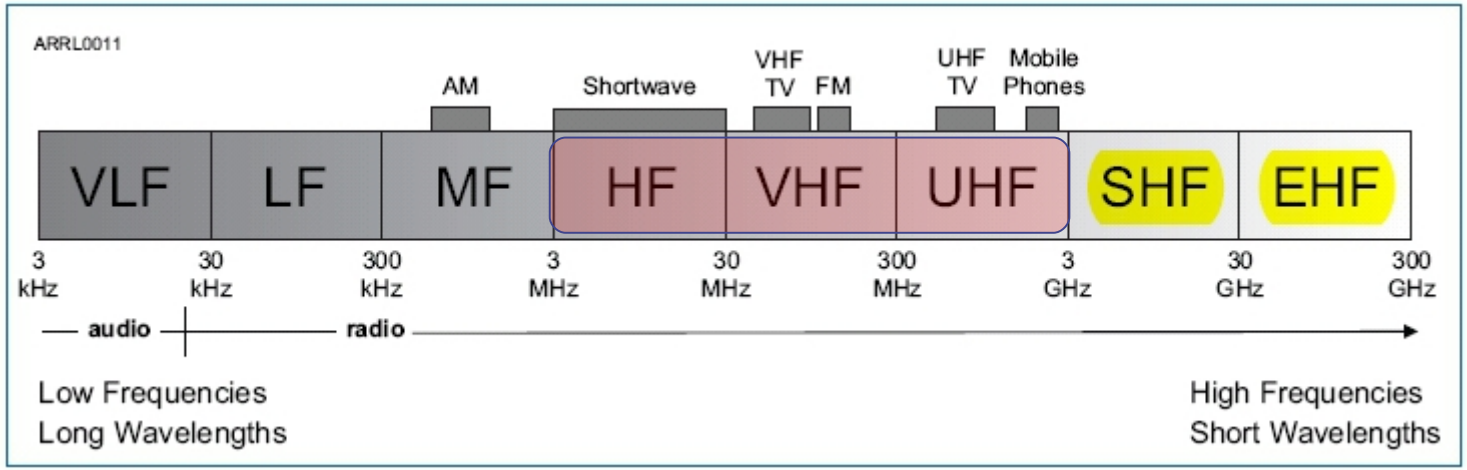
The RF Spectrum

RF = Radio Frequency

The full range of frequencies are divided into sub-ranges for convenience

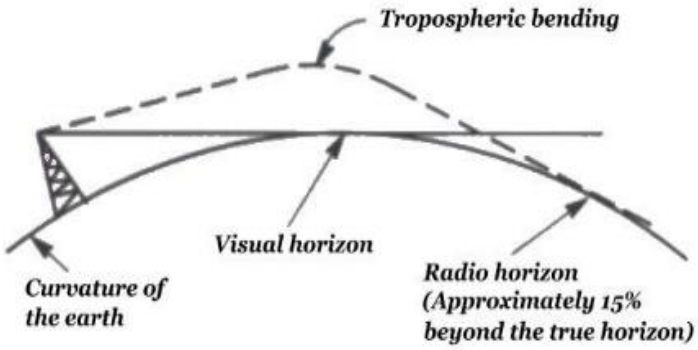
Most common for Amateur Radio: **HF**, **VHF** & **UHF**

HF 3-30MHz *VHF 30-300MHz* *UHF 300-3000MHz*



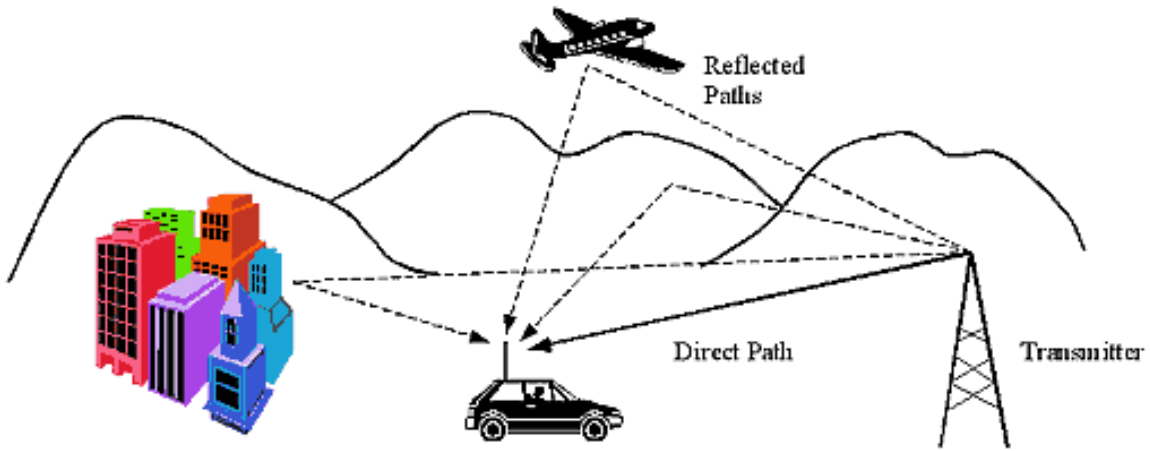
Frequency Band Properties

- Different bands have different propagation properties – thus different use cases
- **VHF & UHF** are typically **line-of-sight**
  Not reflected off of the ionosphere
  Rarely heard outside of local area
- *Radio horizon* is where the radio signals are blocked by the curvature of the earth
  Although earth "seems" slightly less curved to RF, so the radio horizon is usually a little greater than the visual horizon



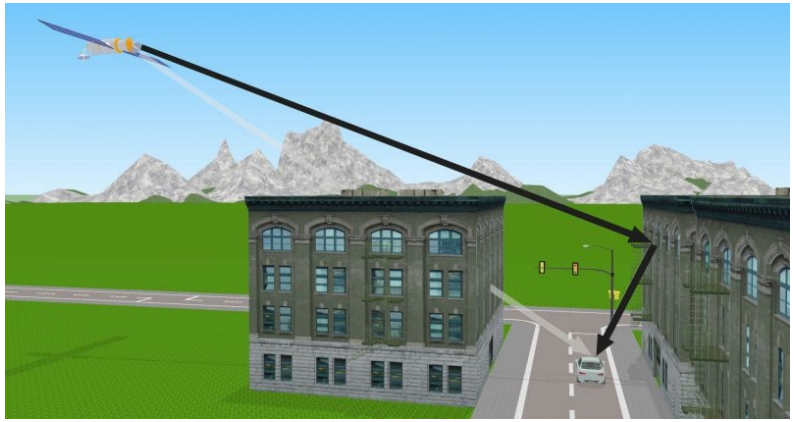
Multipath

- VHF & UHF often affected by **Multipath**
- Signals from different paths may be in or out of phase
  - They can add to each other, or cancel each other out
- If you're affected by *multipath, try moving a few feet!*
- Multipath can affect digital signal *error rates*



Signal Reflections

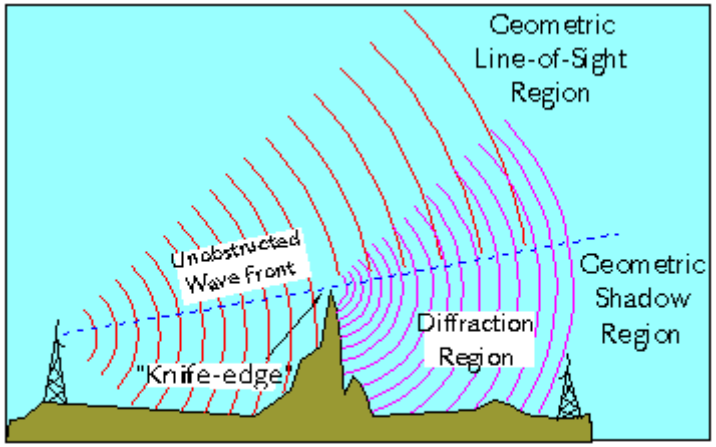
- If you can't reach a VHF / UHF station, try directing your antenna to a reflecting path if the direct path is blocked



- Multiple / changing reflections due to being in a moving vehicle can often cause rapid fading or fluttering known as **"Picket Fencing"**

More on VHF and UHF

- **UHF** is better at penetrating building structures than VHF – so is better suited for use inside or around buildings
- *Knife Edge* diffraction helps radio waves "bend" around "sharp" objects
- Range is better in Winter, less *absorption by vegetation*



knife-edge effect

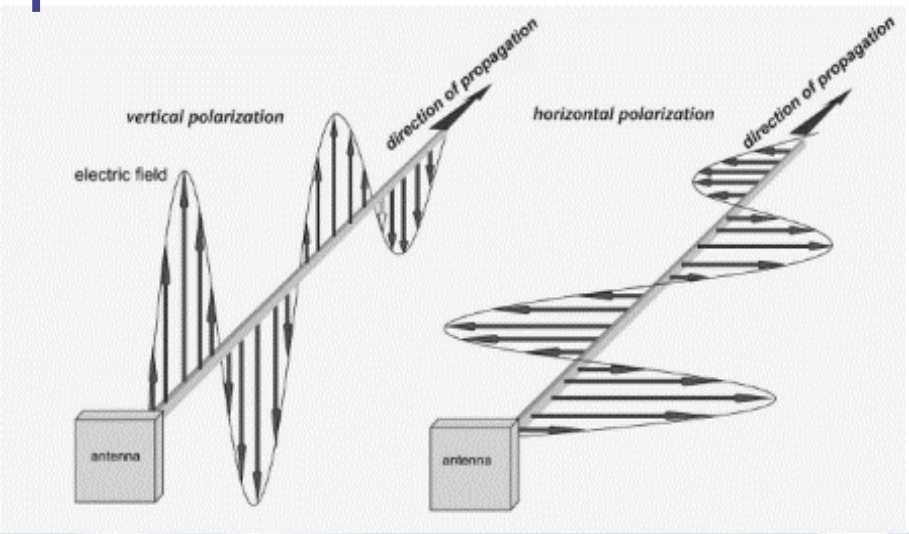
Signal Polarization

- **Polarization** is important for VHF / UHF

  Vertical polarization often used for repeaters
  - Handheld radio has vertical antenna

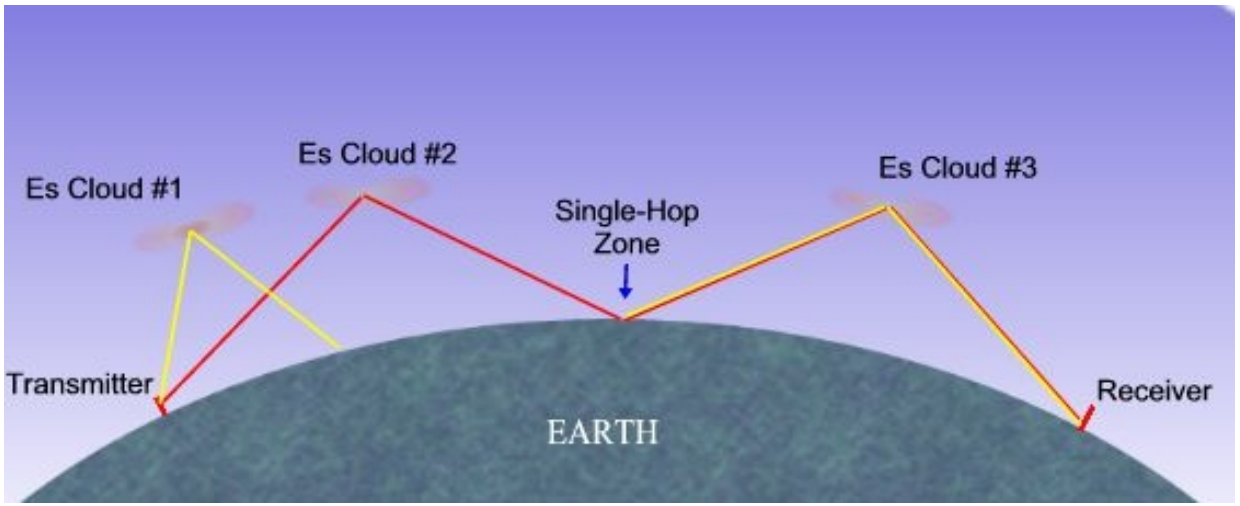
  Horizontal often used for weak-signal operation
  - Beam antenna is aimed horizontally

- Signals will be much *weaker* if you don't use the same polarization at both ends



Long Distance VHF: Sporadic-E

- Sometimes signals are refracted by the E-Layer of the ionosphere – this is called **Sporadic-E**
- Results in strong over-the-horizon signals on 10m, 6m and 2m



More Long Distance VHF

- Note that Fog and Rain have little effect on 10m and 6m signals
- Other long distance phenomenon (not in the exam):

Auroral reflected signals often have a lot of fluctuations in strength and sound distorted

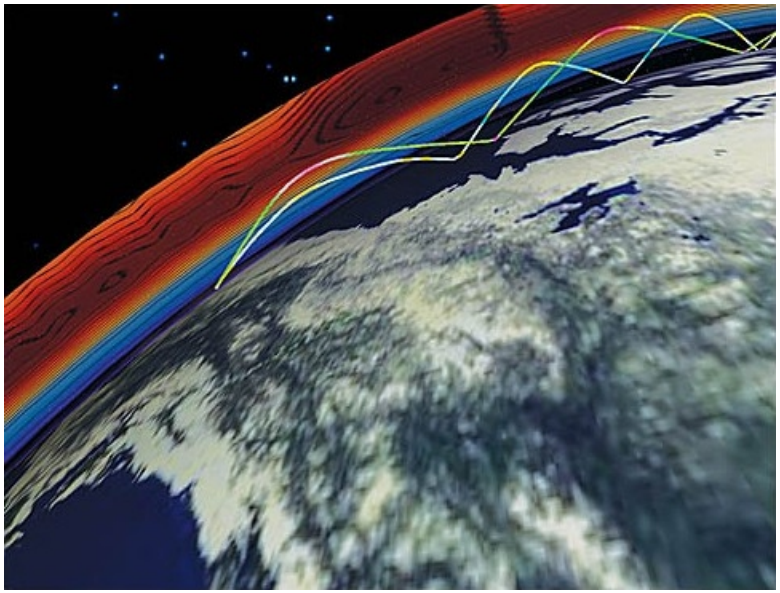
Meteor Scatter is popular on 6m

Tropospheric scatter results in VHF/UHF propagation up to 300 miles

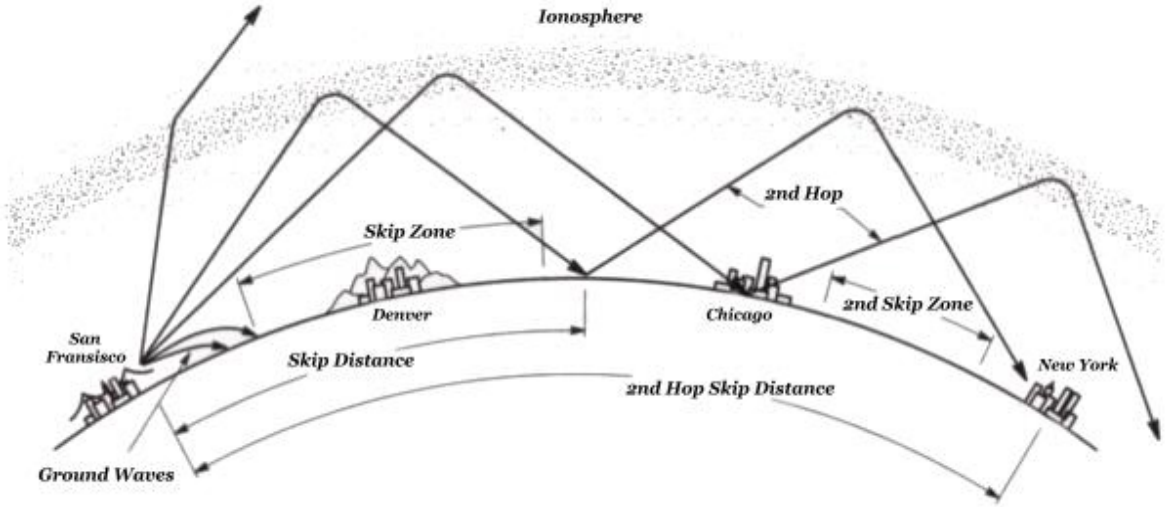
Temperature inversions result in **Tropospheric Ducting** – VHF propagation for hundreds of miles

HF Propagation

- HF signals can be reflected by the ionosphere
- The **ionosphere** is what enables worldwide radio propagation



Ionospheric Skip



- *Fading* is common, due to random combinations of signals arriving from different path lengths
- *Polarization* is not so important, the signal gets *randomized* by the reflection

Variations in Ionosphere

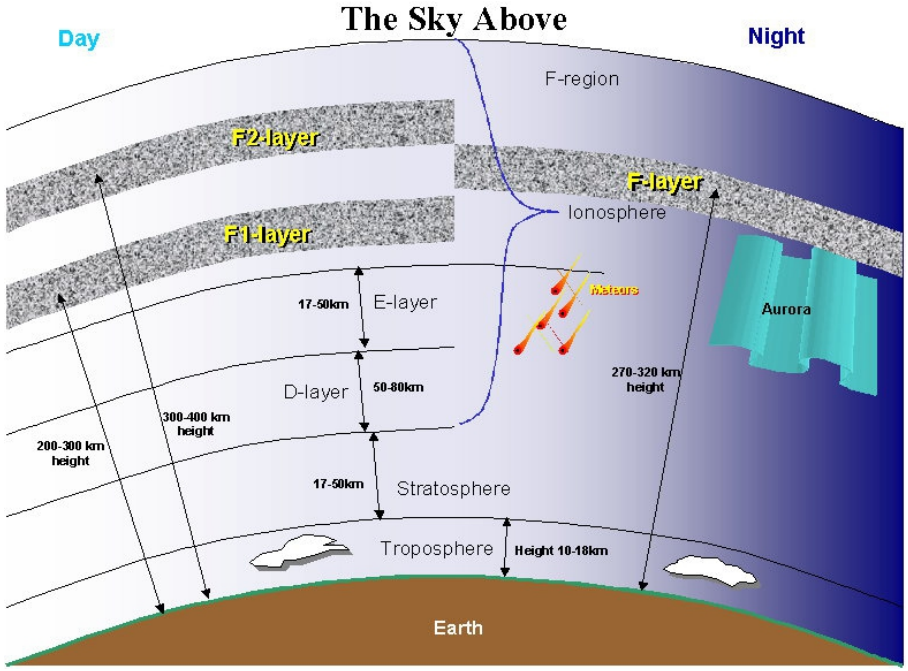
- Daily variations:

  Higher bands like 10m, 15m, and 20m better during day

  Lower bands like 40m, 80m, 160m better at night

- 11 year sunspot cycle affects ionization – thus propagation

- At *peak* of the 11yr cycle, *6m and 10m* bands provide long distance communication



Radio Wave Characteristics
Chapter End

Questions?

Let's Practice for the Exam!