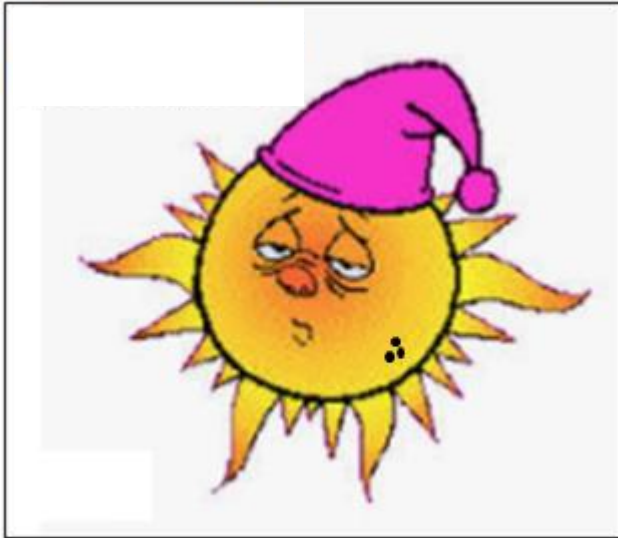


Get Ready for Worldwide Propagation on 15m, 12m and 10m



Cycle 25 is waking up

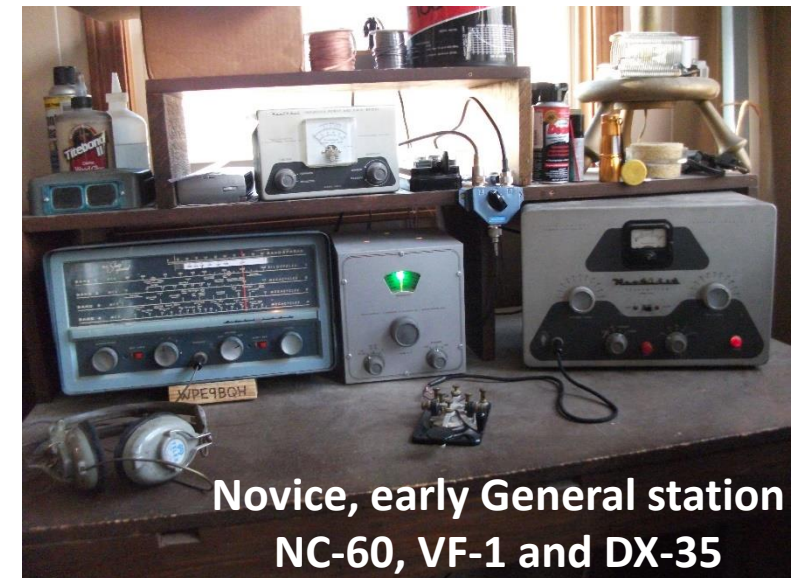
Carl Luetzelschwab K9LA

E-mail: k9la@arri.net

Website: <https://k9la.us>

Who Is K9LA?

- Novice in October 1961
 - General in May 1962, Extra in 1977
- Enjoy
 - Solar and propagation topics
 - Playing with antennas
 - DXing
 - Contesting (mostly casual now)
 - Fixing and using vintage equipment
 - Traveling to hamfests and conventions
- Purdue graduate (electrical engineer)
- RF design engineer by profession (now retired)
 - Motorola in Schaumburg, IL and Ft Worth, TX
 - Magnavox/Raytheon when we moved back north in 1988
- Wife is Vicky AE9YL (first licensed as KB5EAM in 1987)



Novice, early General station
NC-60, VF-1 and DX-35

What We'll Cover

- Cycle 25 update
- The importance of solar cycles
- HF propagation fundamentals
- Space weather and propagation
- Antennas for the higher HF bands

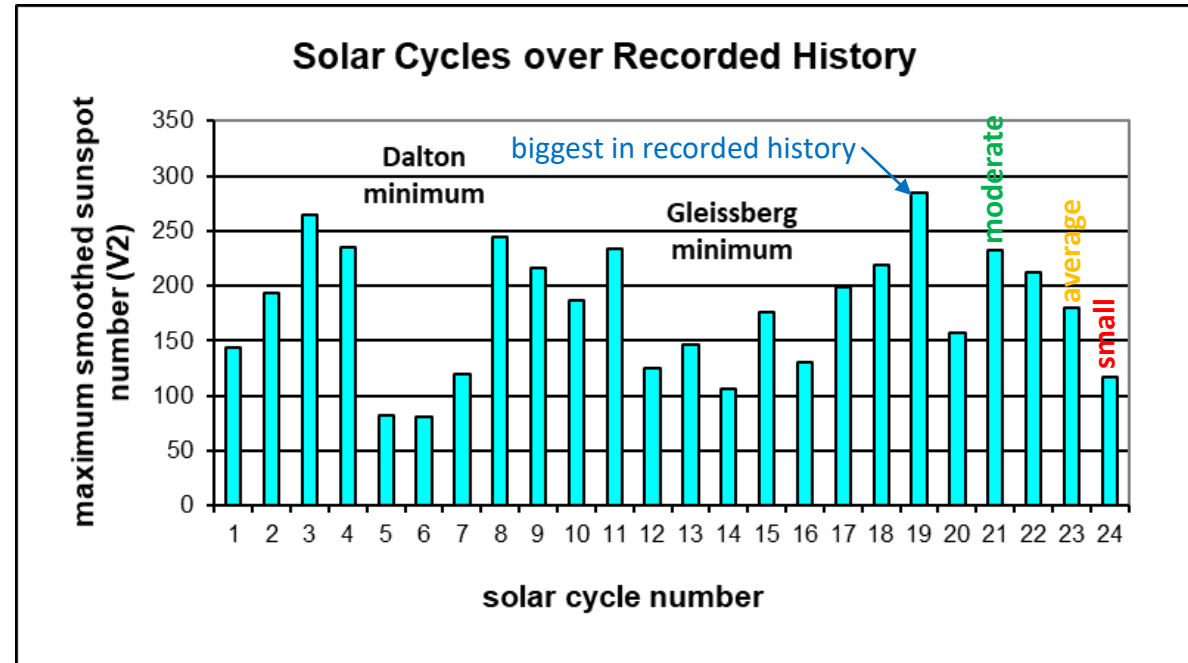


Whew! A lot of stuff!

Cycle 25 Update

Recorded History

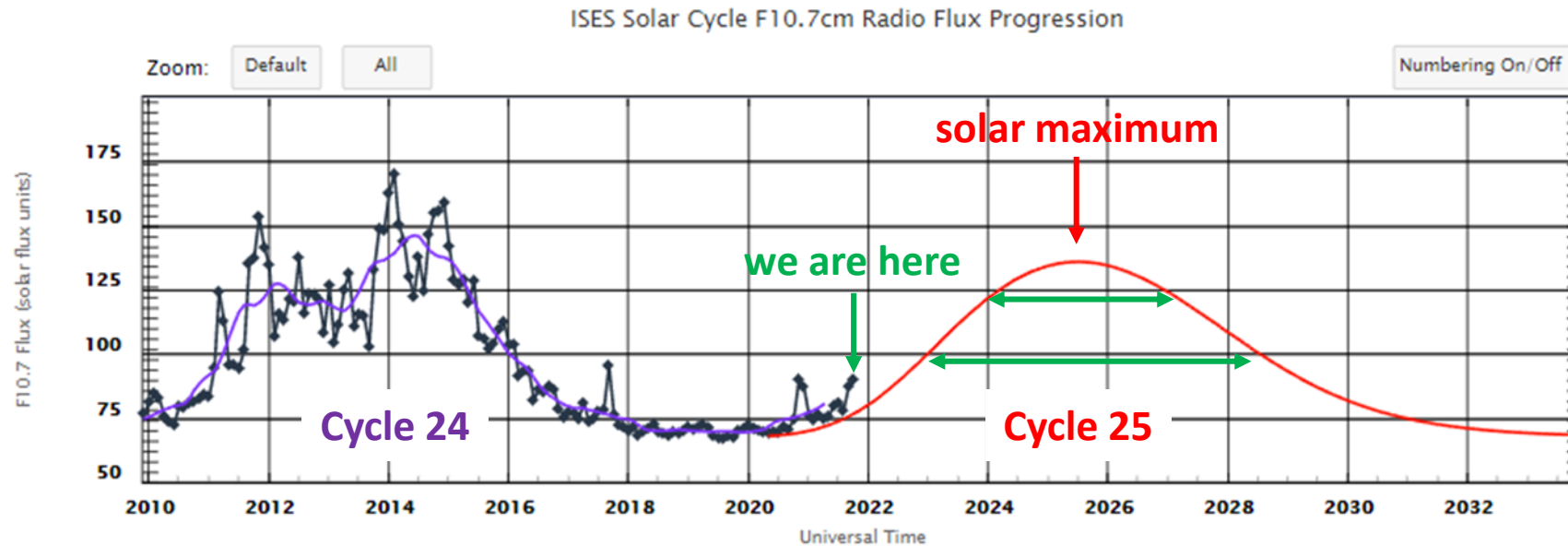
- Cycle 1 began in 1755
 - Maunder Minimum occurred from 1645-1715 with few sunspots
- We've gone through 3 periods of big solar cycles and 2 periods of small solar cycles
 - We appear to be in a third period of small solar cycles



Will Cycle 25 get us out of this third period of small solar cycles?

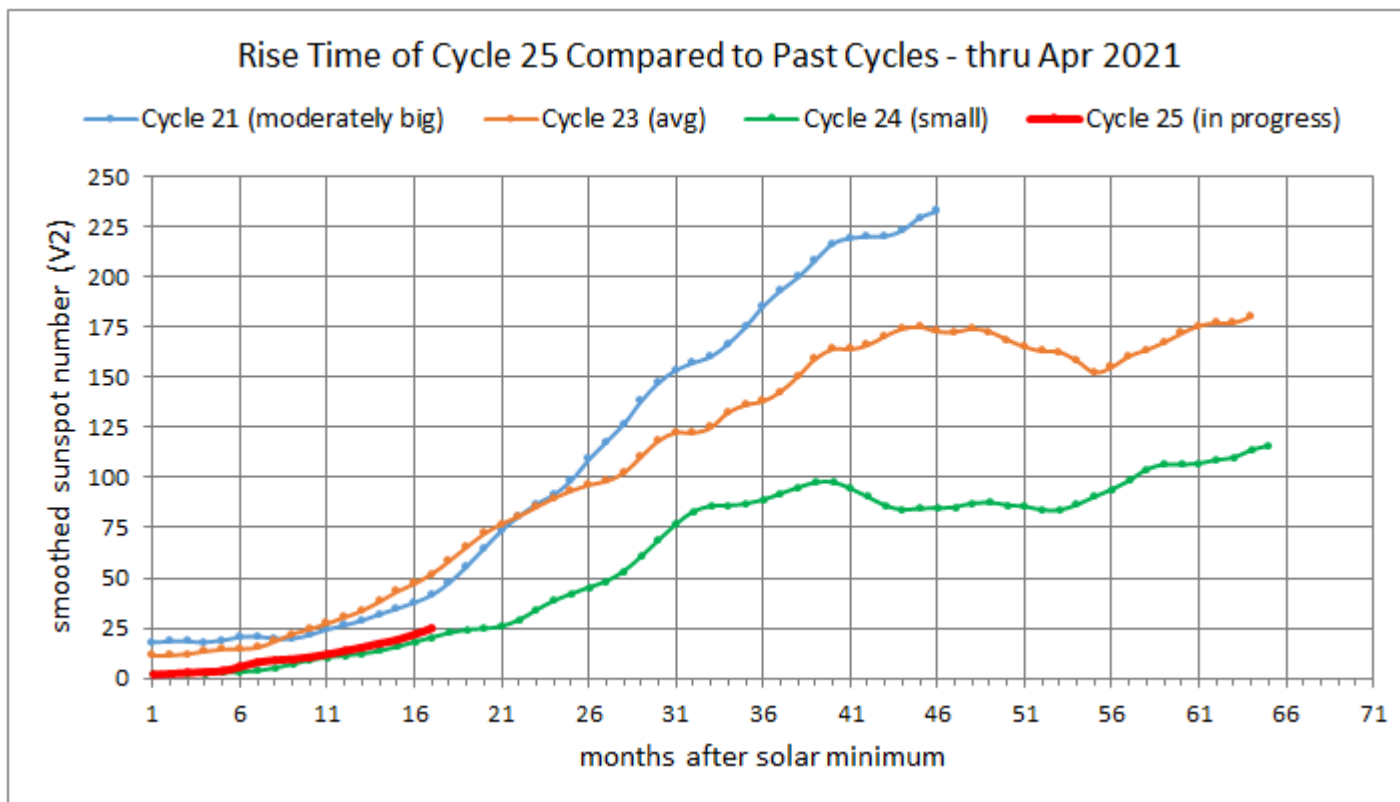
Prediction from NOAA/NASA

- Here's the prediction from the Solar Cycle 25 Prediction Panel



- This is one of many predictions (50 of 56 = 89%) that predicts a Cycle 25 similar to or smaller than Cycle 24
- Four predictions (4 of 56) are for an average cycle (similar to Cycle 23)
- Two predictions (2 of 56) are for a moderate cycle (similar to Cycle 21)

How Is Cycle 25 Doing?



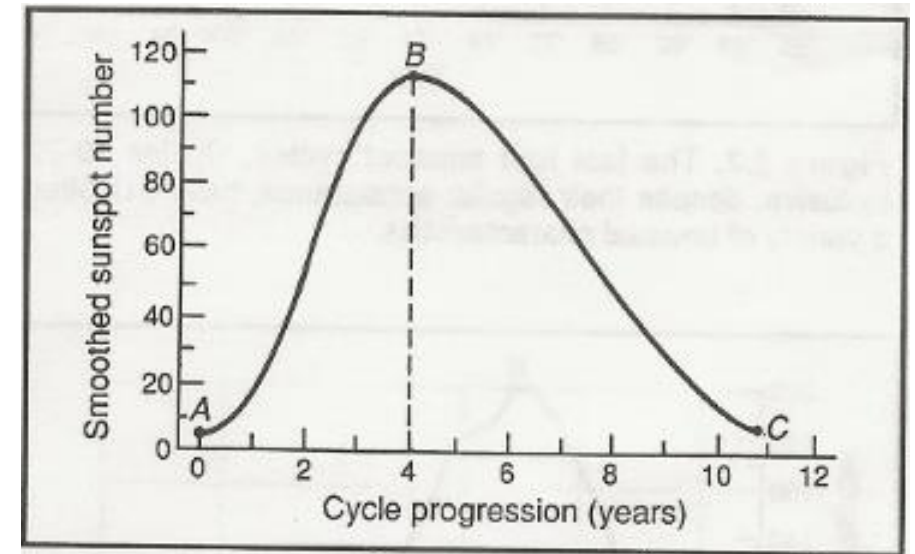
Historical data indicates big solar cycles rise faster than small solar cycles

- Cycle 25 is starting its ascent – kind of slow right now
- Will it continue to follow the small Cycle 24 (green)?
- 6 to 12 more months of data may give us a better clue as to where it's headed

The Importance of Solar Cycles

What Is a Solar Cycle?

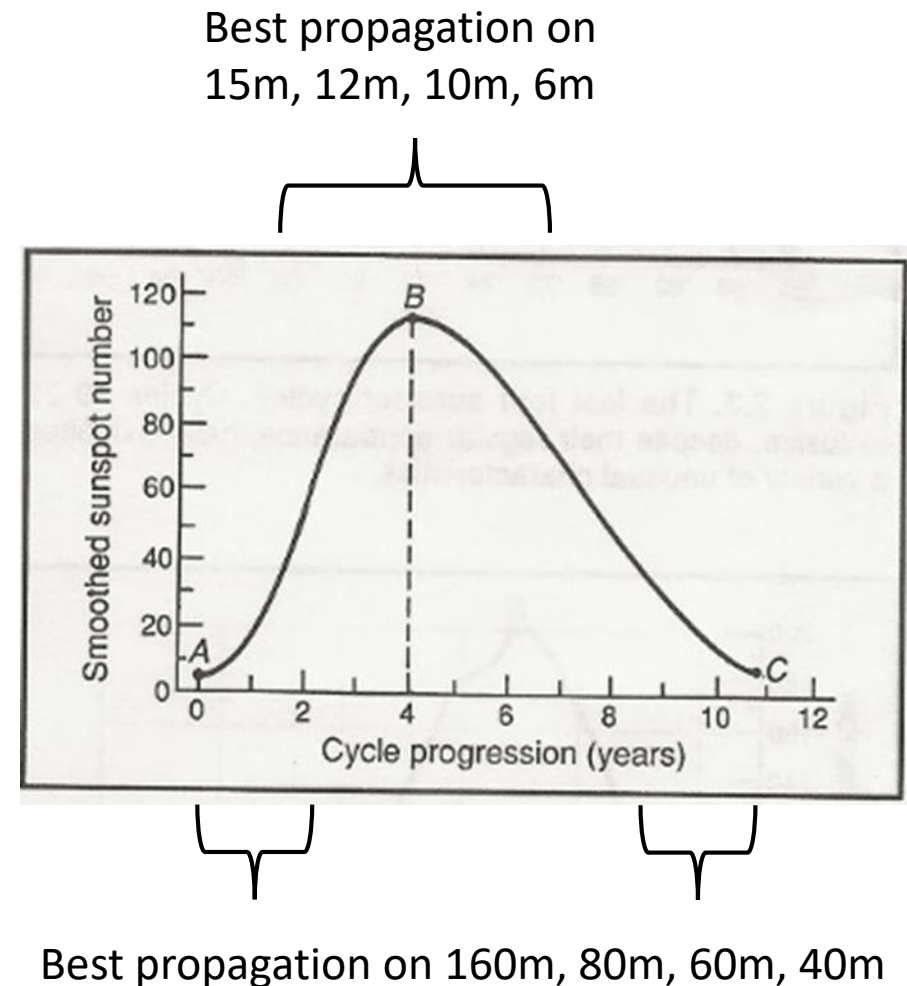
- Also known as a sunspot cycle
- It's the time period from a very low number of sunspots on the sun (solar minimum) through a maximum number of sunspots (solar maximum) and then back down to a very low number of sunspots
 - A to B to C in the plot on the right
- It's an approximate 11 year cycle
- On average
 - Rise time = 4 years
 - Descent time = 7 years



If you make a prediction at solar minimum, it could take about 4 years to validate

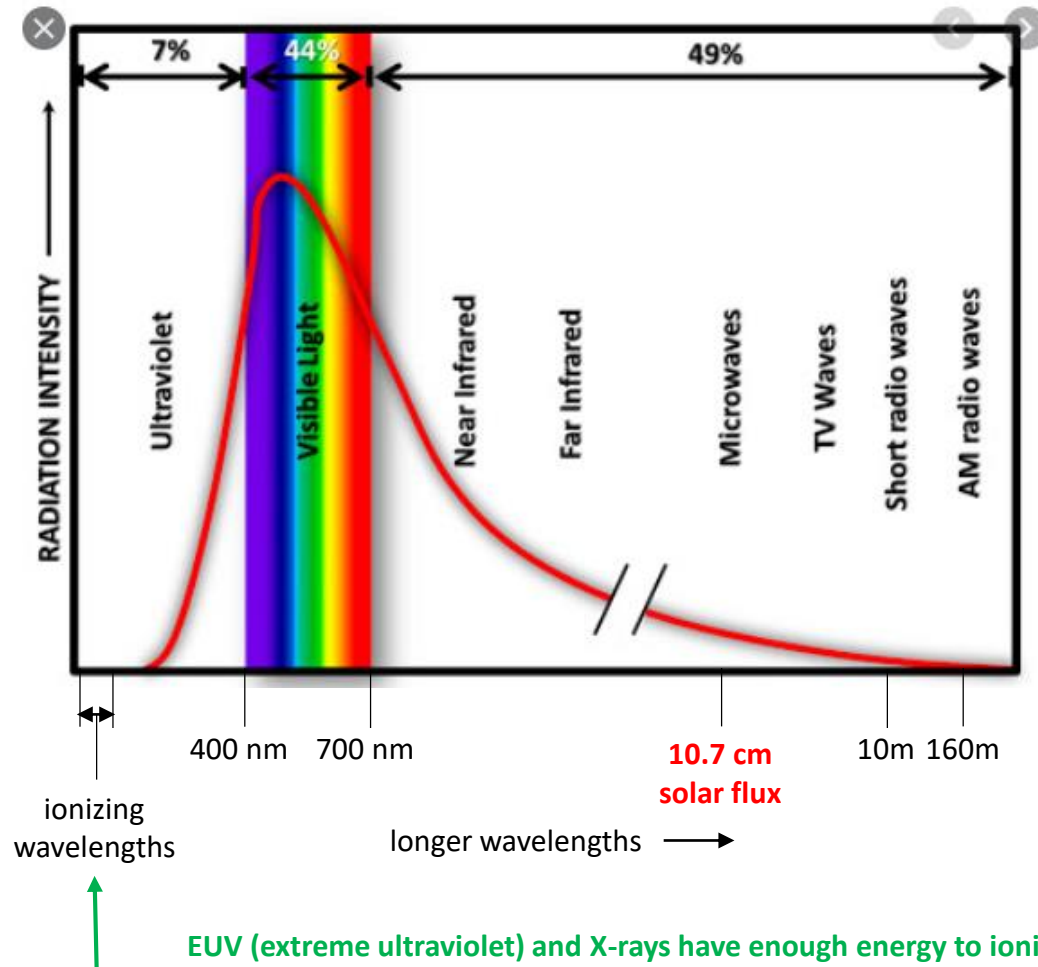
Why Are Solar Cycles Important?

- They are important for the higher HF bands
 - 15m, 12m, 10m (and 6m)
 - The area around sunspots emits EUV (extreme ultrultraviolet) radiation that ionizes the F₂ region
 - The F₂ region is responsible for most of our long-distance (DX) contacts on HF
 - More sunspots = more EUV = more ionization = a higher MUF (maximum useable frequency) = best propagation on the higher HF bands
- They are important for 160m and the lower HF bands
 - 160m, 80m, 60m, 40m
 - Few sunspots = less ionospheric absorption and less disturbances to propagation = best propagation on the lower bands



HF Propagation Fundamentals

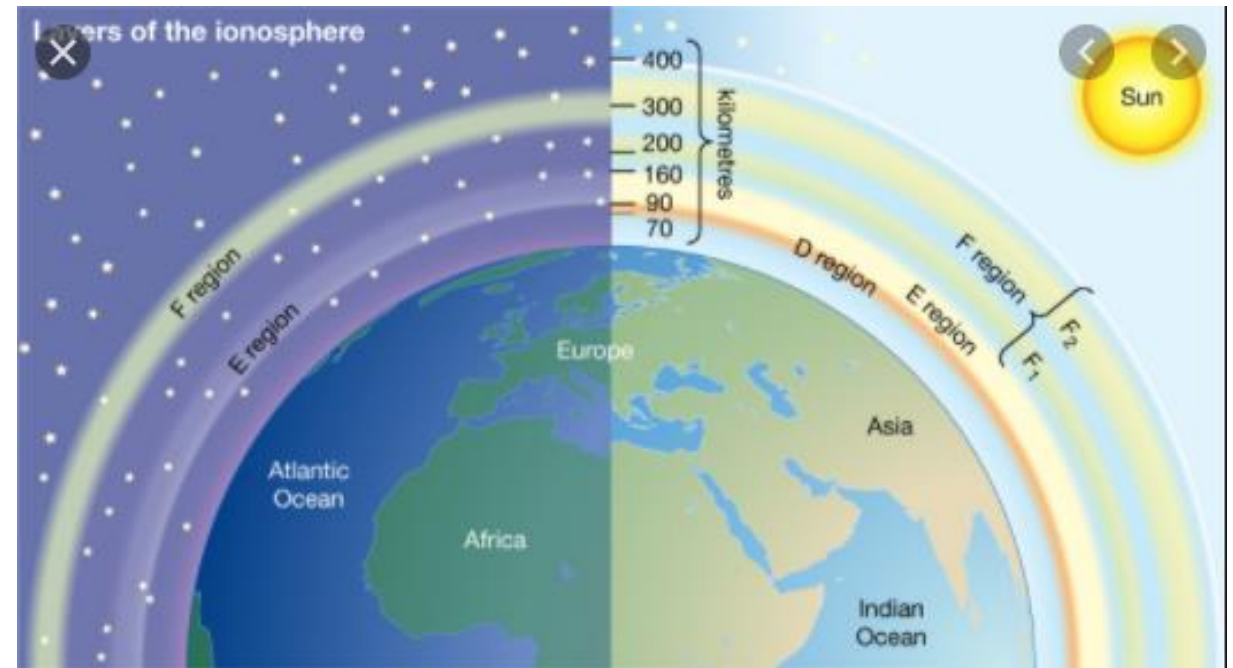
Solar Radiation



- The sun emits electromagnetic radiation at many wavelengths
- Most intense radiation is at visible light wavelengths (400-700 nm)
- Energy of a photon is inversely proportional to its wavelength
 - Shortest wavelengths are highest in energy
- The important range of radiation for our Amateur Radio HF endeavors is very short wavelengths (ionizing wavelengths)

Regions (Layers) of the Ionosphere

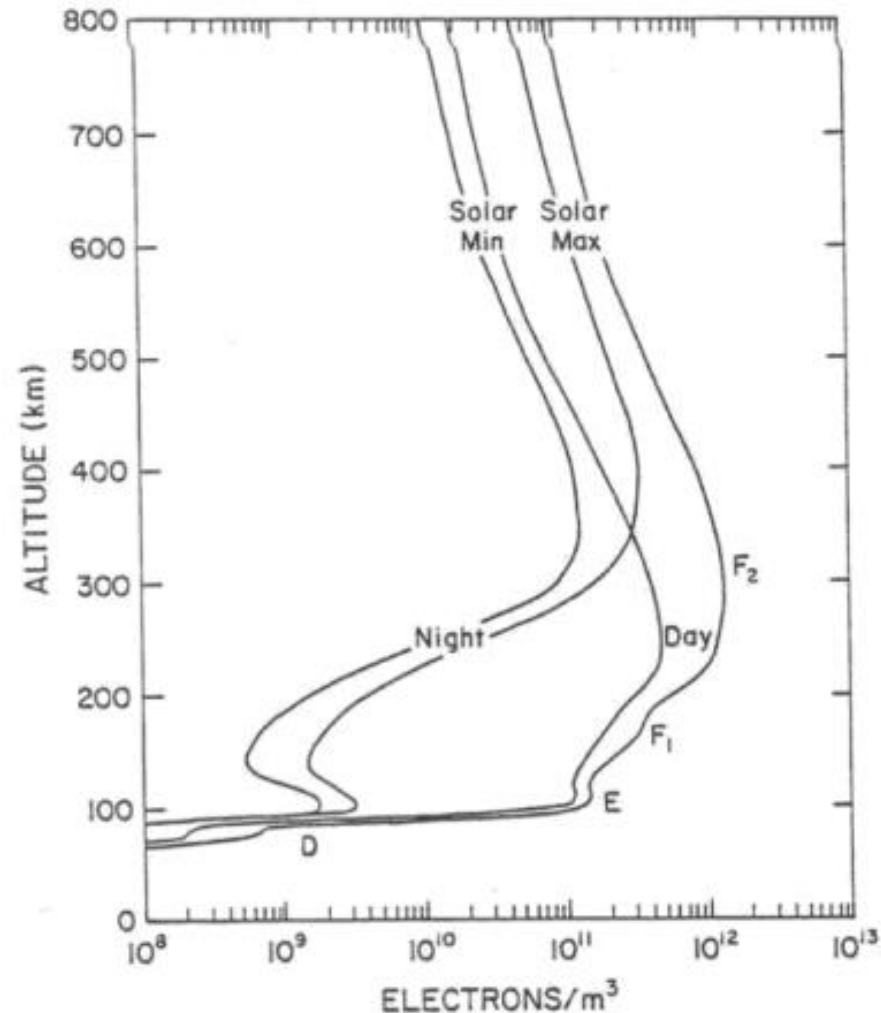
- Ionizing radiation creates regions of ionization in the atmosphere
 - Dependent on wavelength of radiation and number of neutral atmospheric constituents vs altitude
- EUV (extreme ultraviolet) results in the F₂ region
 - EUV is the true ionizing radiation of the F₂ region
- X-rays result in the E region
- Even shorter X-rays and the Lyman- α spectral line of hydrogen result in the D region



Free electrons (electrons stripped from a neutral atoms and/or molecules during the ionization process) are what is important for skywave propagation

Why We Should Call Them Regions

- The picture on the last slide suggests 'layers'
 - For example, it appears that there is nothing in between the E layer and the F₁ layer
- But the ionosphere is really a continuous electron density profile as in the picture on the right

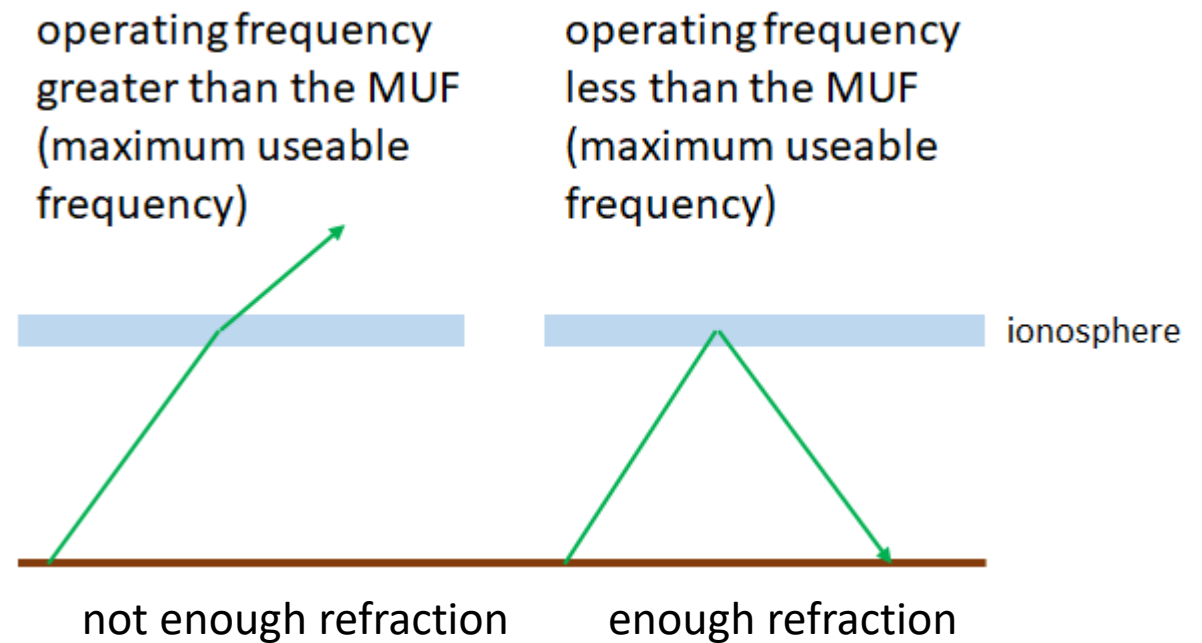


General Characteristics of the Regions

- F region (roughly 150-400 km)
 - F region splits into F_1 and F_2 region during the daytime
 - F_1 is mostly an inflection point, not a major peak, in the electron density
 - Highest in altitude – gives the longest hops
 - F_2 region has the highest electron densities – best for the higher bands (15m, 12m, 10m)
 - F_2 region is the most important for our long distance QSOs
- E region (roughly 90-150 km) – peak around 105 km
 - Shorter hops due to lower altitude
 - Can block signals from getting to the F region
 - Sporadic-E in the summer really helps 10m and 6m
- D region (roughly 60-90 km) – inflection point
 - A detriment to propagation due to absorption (loss)

Ionosondes Measure the Ionosphere

- Ionosondes are for all intents and purposes radars looking straight up
- They measure maximum electron densities in the E, F₁ and F₂ regions
 - These are converted to a 'critical frequency' for each region
- Spherical geometry converts critical frequencies to oblique MUFs (maximum useable frequencies) at lower elevation angles
- The lower the elevation angle, the higher the MUF

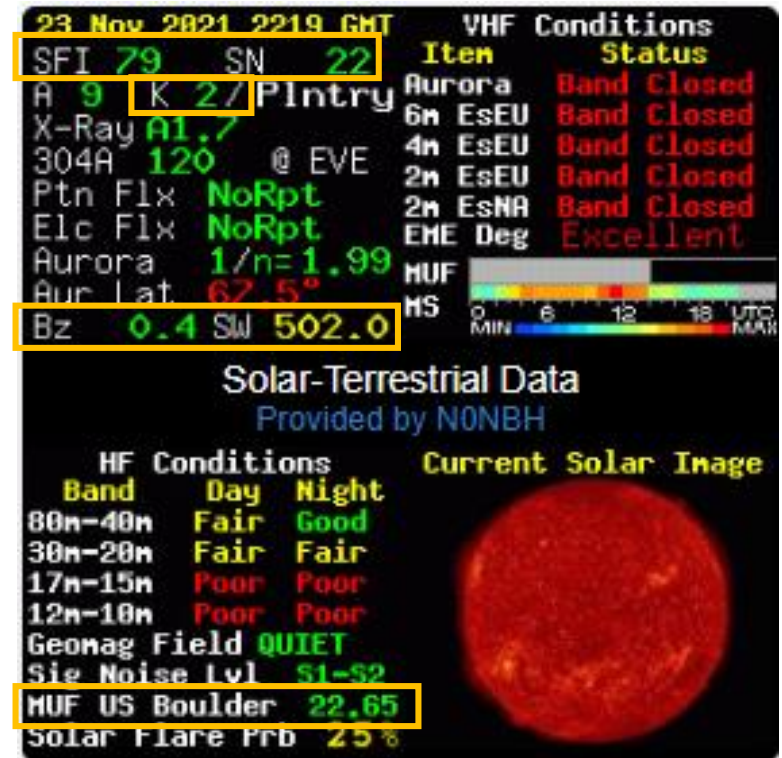


Space Weather and Propagation

Caution – we're going to make
simple statements about very
complicated processes

Parameters to Monitor – NØNBH Banner

- These parameters tell us which bands may be open (MUF may be high enough)
 - SFI – 10.7 cm solar flux – varies from 65 to over 245
 - SN – sunspot number – varies from 0 to over 286
 - SFI and SN are proxies for the true ionizing radiation of the F₂ region – EUV
 - Note ‘MUF US Boulder’ on the NØNBH banner
- These parameters tell us if the F₂ region of the ionosphere may be adversely impacted
 - K index – 3-hr measurement of the activity of the Earth’s magnetic field – varies from 0 to 9 (logarithmic scale)
 - Bz – magnitude and direction of IMF – varies from +50 to -100
 - Perpendicular to the ecliptic
 - SW – solar wind speed – varies from 300 to 2000 km/s



NØNBH banner at www.qrz.com

What We Generally Desire

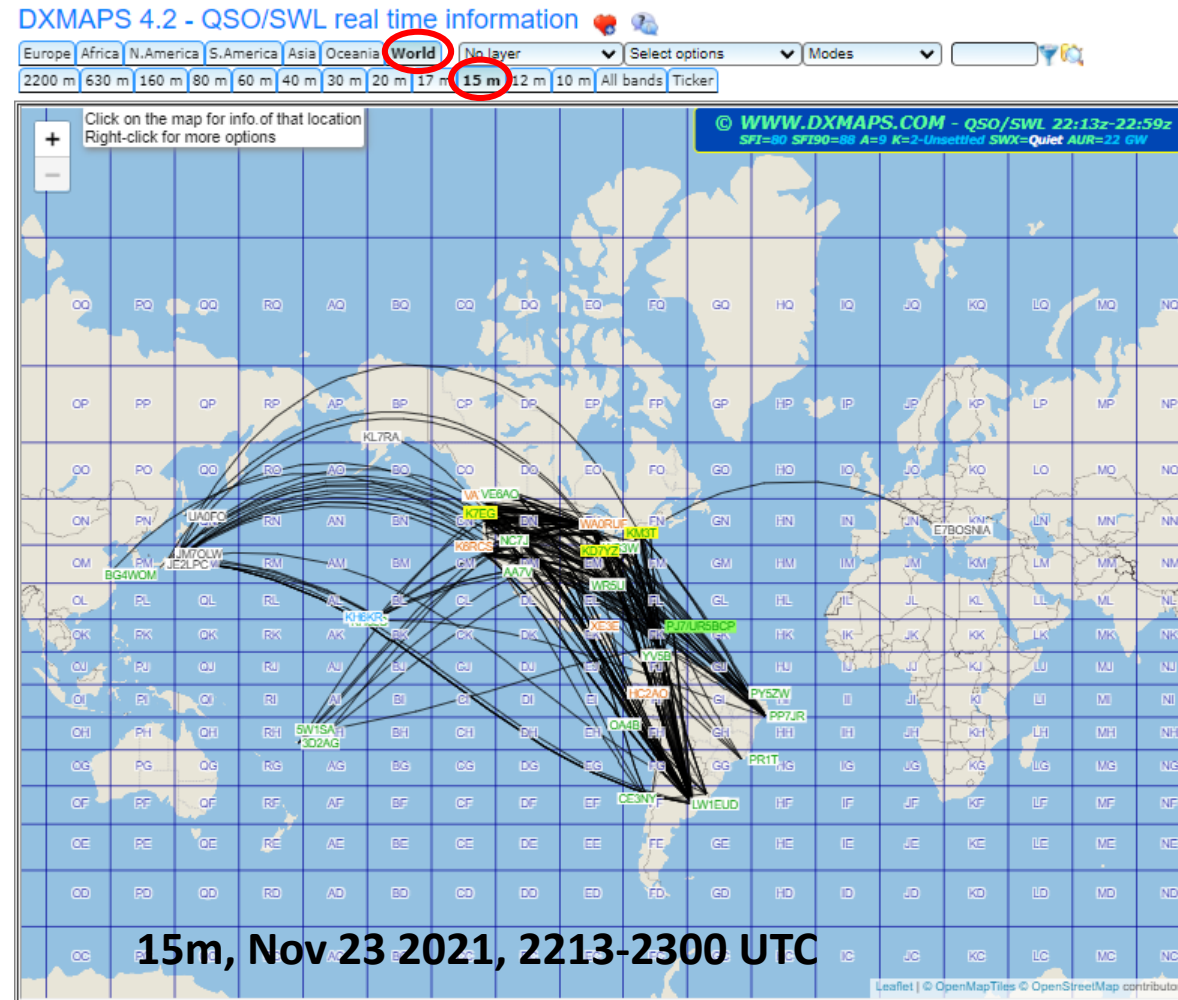
- High SFI and SN
 - The chart to the right gives an indication which bands may be open
- A high value of 'MUF US Boulder'
- K index ≤ 3
- Bz positive or very slightly negative
- SW not too much greater than 400

Smoothed SFI	Smoothed SN	Similar to ...	Monthly median MUF
65	0	Solar min	20 MHz
130	115	Cycle 24	33 MHz
170	179	Cycle 23	38 MHz
195	215	Cycle 22	41 MHz
245	286	Cycle 19	46 MHz

- Smoothed values are monthly means that are averaged over 12 months
- Monthly median MUF (50% probability) is for F₂ propagation in a fall/winter month in the afternoon on a mid-latitude path (there is a distribution about the median)

To See What's Happening Right Now

- If you don't want to bother with all those numbers on the previous two slides . . .
- Go to dxmaps.com
- Select a map
- Select a band
- Other methods
 - PSKreporter
 - WSPRnet
 - Reverse Beacon Network
 - IARU/NCDXF beacons



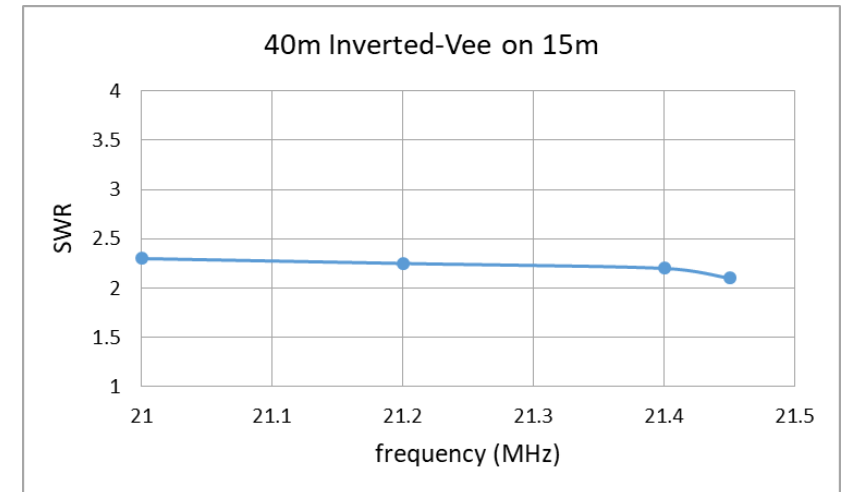
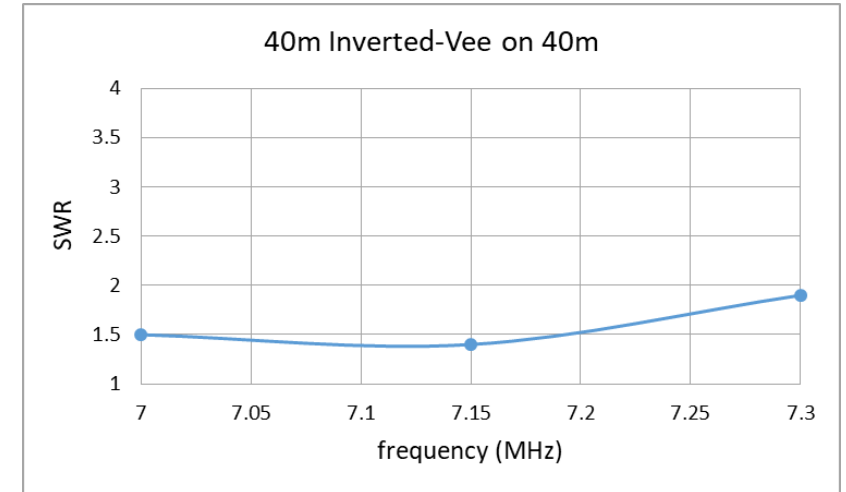
The Bands Right Now

- The higher bands are showing signs of life for three reasons
 - Cycle 25 is rising
 - We moved into fall and winter in the northern hemisphere
 - DXpedition activity is finally picking up (S9OK, J5T, 3DAØRU, 7P8RU)
 - DXpeditions can show us that the bands are open more than we think
- Digital modes offer more opportunities due to their signal-to-noise ratio advantage
 - FT8/FT4 offers more opportunities than CW, CW offers more than SSB
- The low bands (160m, 80m, 60m, 40m) are good at night around solar min
- 30m, 20m, 17m are generally good throughout a solar cycle

*Antennas for the Higher HF Bands
(15m, 12m, 10m)*

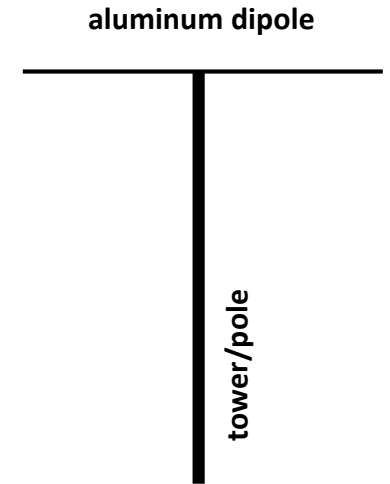
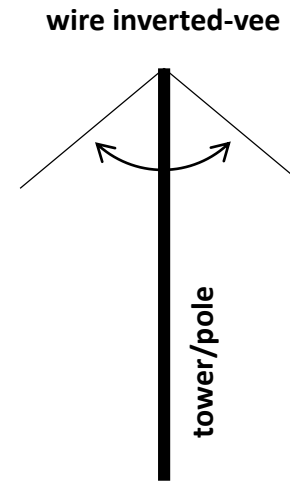
Antennas for 15m

- Use your 40m dipole/inverted-vee
 - Works as a 3/2-wavelength antenna
 - A bit of gain in some directions
 - Lowest SWR on 15m may be above 21.450 MHz
 - Probably need to use a tuner – either your rig’s internal tuner or an external tuner
- Vertical with four elevated radials
 - I have a Hustler 4BTV – gives decent results
- 15m dipole/inverted-vee
 - Overall length about 22 feet (11 ft each side)
 - Put it up at 20 feet
- 2-element Yagi
 - 6 foot boom, 22 foot elements



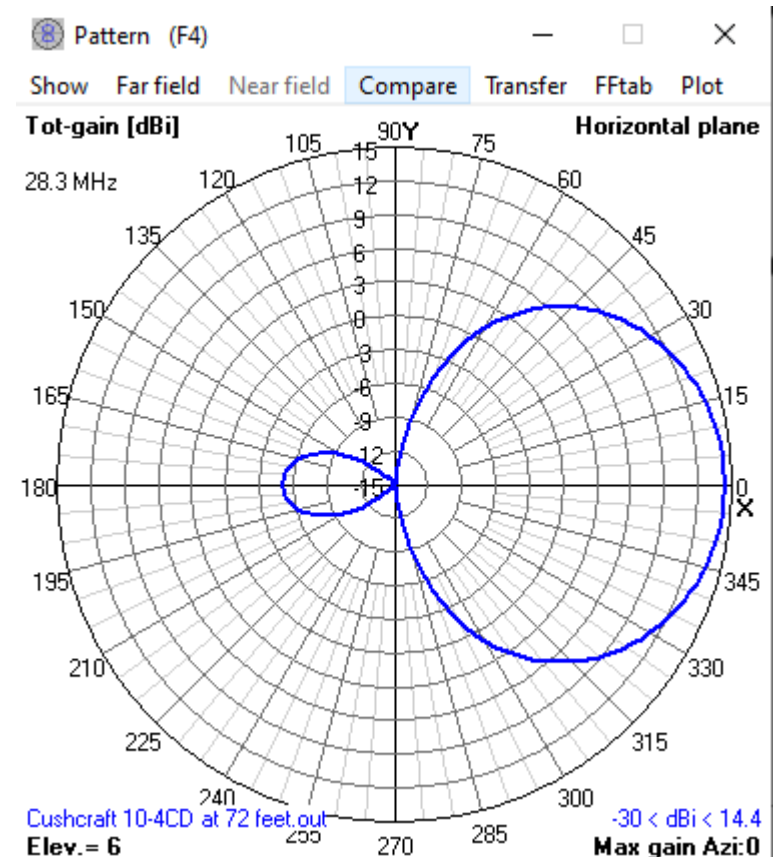
Antennas for 12m

- Inverted-vee
 - Each side about 9.25 feet
 - Keep angle > 90 degrees
- Dipole made with aluminum tubing
 - About 18.5 feet from tip-to-tip
- 2-element Yagi
 - A bit smaller than a 15m Yagi
- 3-element Yagi
 - More gain
 - Better F/B ratio



Antennas for 10m

- Dipole (made of aluminum) is relatively small
 - About 16.5 feet tip-to-tip
 - It will give great results at 15-20 feet high
- Multi-element Yagis are quite reasonable
 - I have a 4-element Cushcraft 10m Yagi
 - 16 foot boom, elements about 17 feet tip-to-tip
 - Used it to work many stations with my homebrew QRP (250 milliwatts) 10m DSB transceiver during big Cycle 22



Some References to Start With

- Propagation
 - Propagation chapters of the ARRL Antenna Book and the ARRL Handbook
 - “The Little Pistol’s Guide to HF Propagation” by Bob Brown NM7M (SK)
 - Available for free on my website at <https://k9la.us> - 15Mb file
 - The CQ Shortwave Propagation Handbook – 4th Edition (updated in 2021)
- Antennas
 - ARRL Antenna Book
 - Low-Band DXing (Fifth Edition) by ON4UN (SK)
- Solar info
 - Lots of data on the internet
 - <https://spaceweather.com/>, <https://www.swpc.noaa.gov/>,
<https://www.solarham.net/>, NØNBH banner at <https://www.qrz.com/>,
<https://www.spaceweatherwoman.com/>

Summary

- Cycle 25 is beginning its ascent
- Most forecast a below average Cycle 25 – a few forecast a big Cycle 25
 - Even if it's small, it will offer great worldwide propagation around solar maximum with modest antennas and 100 W
 - All we can do is wait to see what happens
- Don't forget sporadic-E on 6 meters during the summer and in December
 - Sporadic-E happens regardless of where we are in a solar cycle
- Antennas are of a reasonable size on 15m, 12m and 10m
- Use the digital modes for their advantage over SSB and CW

Get radio-active on HF!