Here Comes Solar Cycle 25!

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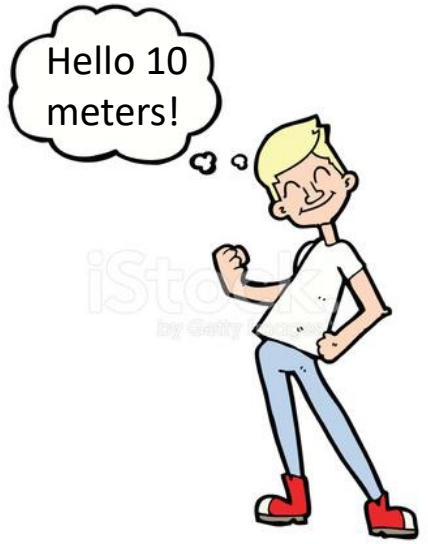


Some Comments about K9LA

- Novice in October 1961
- I enjoy
  - Learning about the sun and propagation
  - DXing
  - Contesting – mostly casual these days
  - Playing around with antennas
    - And modeling them, too
  - Fixing and using vintage equipment
    - More in queue than I'd like to admit
- My wife Vicky AE9YL and I live in Fort Wayne, IN
- Vicky and I enjoy traveling
  - Club meetings, conventions, hamfests
- ARRL Central Division Vice Director

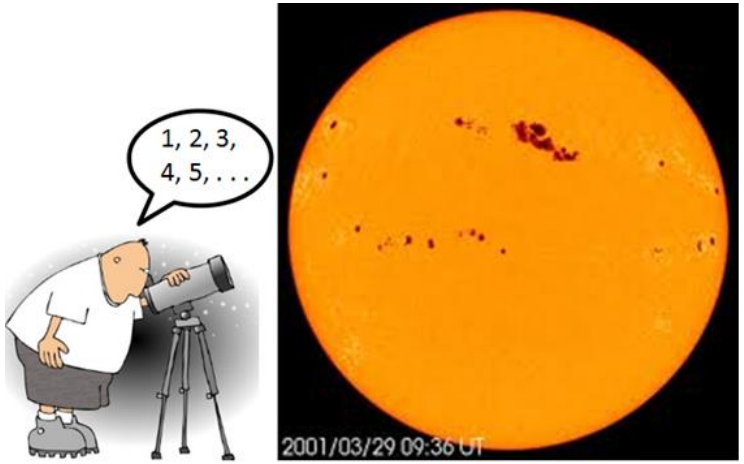
Ranger II and Drake 2-B

What I'll Talk About

- Why solar cycles are important
- Space weather and propagation
- Current propagation conditions
- Status of Cycle 25
- Simple antennas for the higher bands (15m, 12m, 10m and 6m)

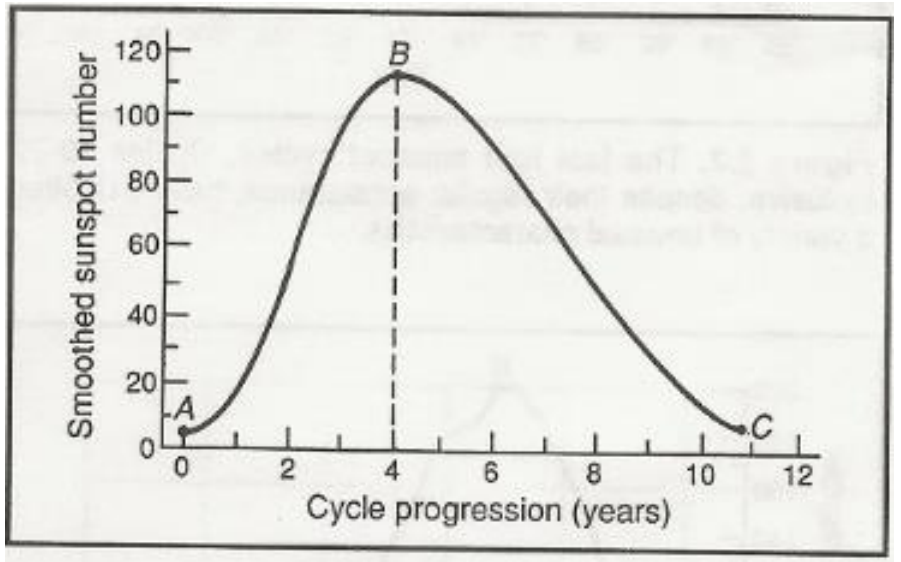
All of this in about 40 minutes !!!

Why Solar Cycles Are Important



What Is a Solar Cycle?

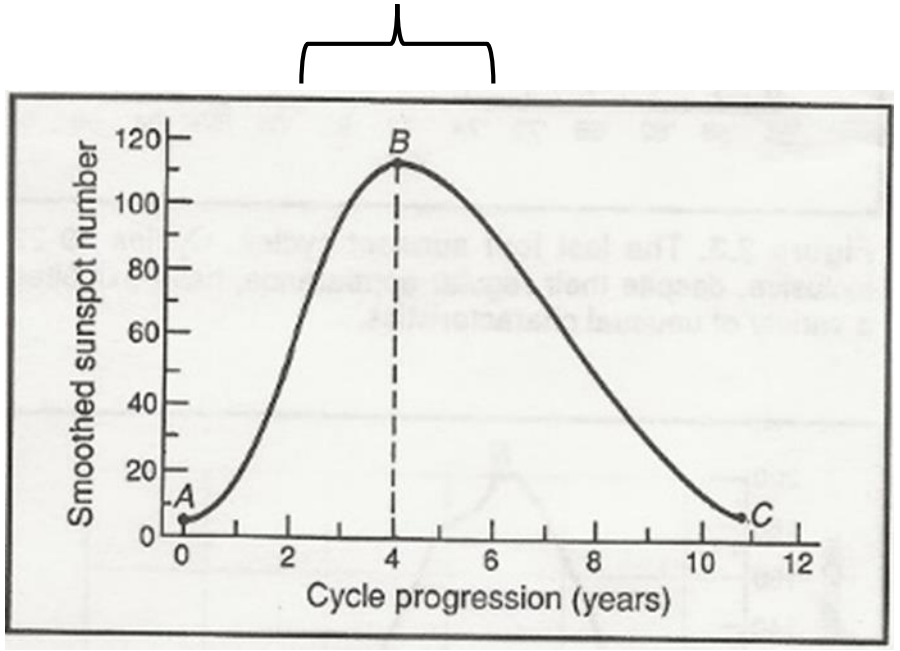
- Also known as a sunspot cycle
- It's the time period from a very low number of sunspots on the sun (solar minimum) through a maximum number of sunspots on the sun (solar maximum) and then back down to a very low number of sunspots
  - A to B to C in the plot on the right
- All 24 previous solar cycles
  - On average – an approximate 11 year cycle
  - On average – 4 year rise time (A to B)
  - On average – 7 year descent time (B to C)



Why Are Solar Cycles Important?

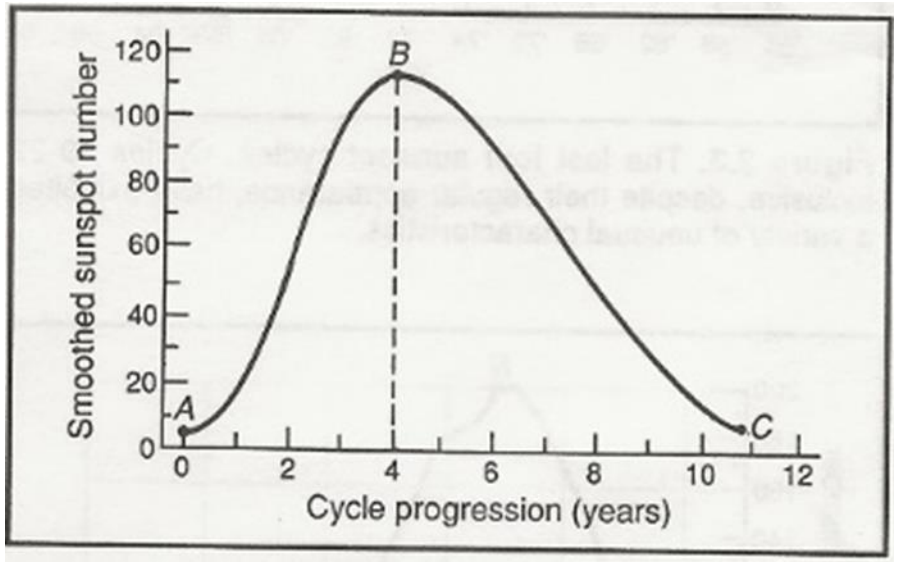
- They are important for the higher HF bands
  - 15m, 12m, 10m (and 6m)
  - The area around sunspots emits EUV (extreme ultraviolet) radiation
    - EUV is the true ionizing radiation for the F2 region
    - The F2 region is responsible for most of our long-distance (DX) contacts on HF
  - More sunspots = more EUV = higher electron density = more refraction (bending)
- More sunspots results in the best propagation on the higher HF bands – especially around solar maximum

Best propagation on
15m, 12m, 10m, 6m



Why Are Solar Cycles Important?

- They are important for the lower bands
  - 160m, 80m, 60m, 40m
  - Less sunspots = less electrons in the D region = less ionospheric absorption
  - Less sunspots = less disturbances to propagation
- Less sunspots results in the best propagation on the lower bands – especially around solar minimum
- 30m, 20m, 17m are generally good throughout an entire solar cycle



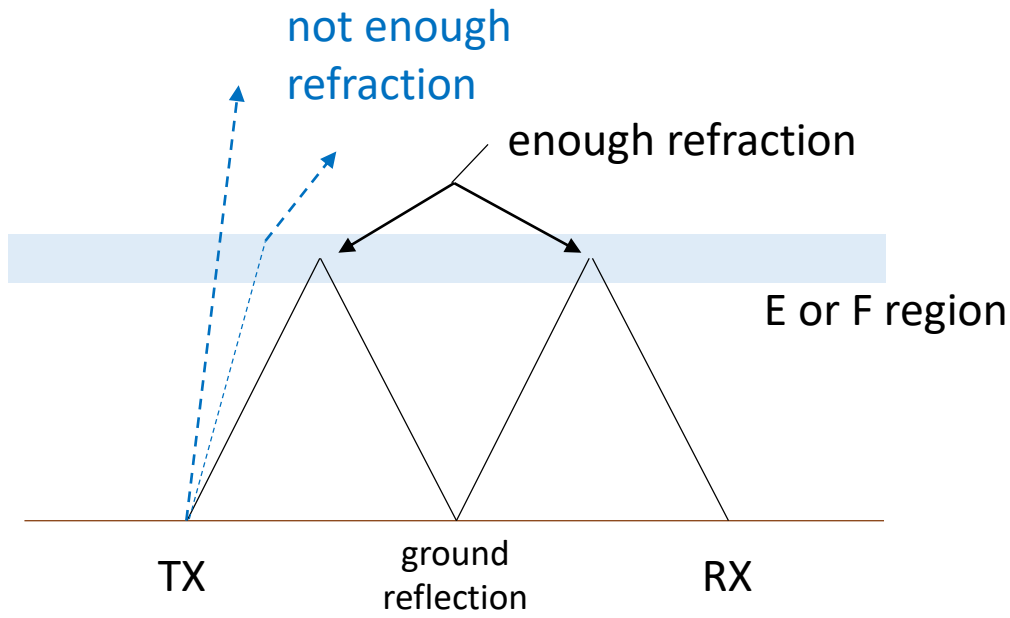
Best propagation on
160m, 80m, 60m, 40m

HF Propagation Modes

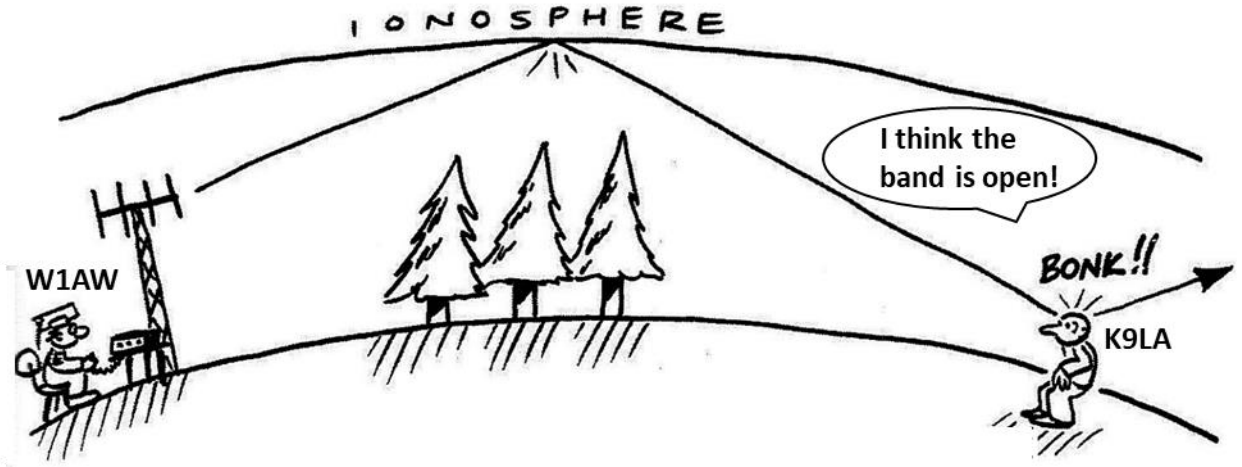
- Many modes – multi-hop, sporadic-E, trans-equatorial (TEP), ionosphere-ionosphere, scatter, ground wave, short path, long path, auroral-E, skewed paths, gray line, drifting patches of enhanced F2 region ionization in the polar cap, etc.

Many of these modes can create excitement if you're in the right place at the right time

- Multi-hop is the most prevalent
  - Occurs with both the E and F regions



Space Weather and Propagation



The Two Issues We'll Focus On

- From slide 6, is there enough ionization in the F2 region to refract our signals back to Earth?
- From slide 7, are there any disturbances to propagation that could degrade the F2 region?
- There is a third issue – ionospheric absorption – how much your signal strength is reduced by the D region
  - In general, lower bands best at night, higher bands best during the day

Caution – what we're trying to do is take extremely complicated atmospheric/ionospheric processes and make some simple statements tying HF propagation to space weather

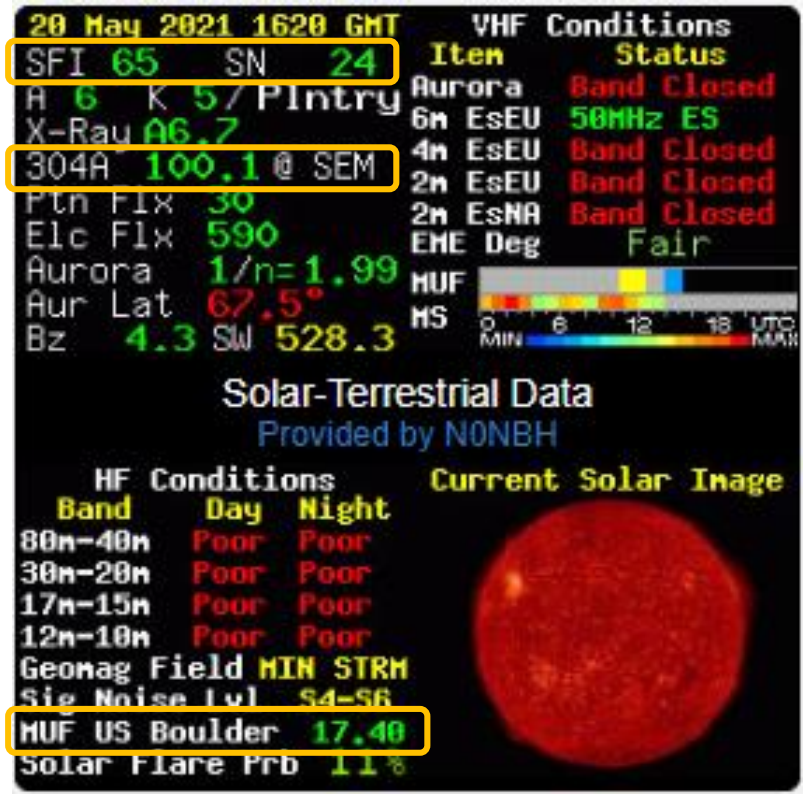
Enough Ionization

- At solar minimum, when the 10.7 cm solar flux (SFI) bottoms out between 65-70 and the number of sunspots (SN) can be zero, 20m (and 17m to a bit lesser extent) can be open worldwide during the daytime and early evening

- That's because there is still enough EUV to refract 14 MHz (and 18 MHz on many days) back to Earth during the day and early evening

- Thus SFI and SN can give us an indication if the higher HF bands (15m, 12m, 10m, 6m) might be open

Enough Ionization



MUF US Boulder is a real-time assessment of the F2 region

- The NØNBH banner – this is daily data
  - At www.qrz.com, for example
- Our understanding of the ionosphere is based on the correlation between monthly median values of MUF/signal strength and smoothed 10.7 cm solar flux (or smoothed sunspot number or smoothed 304A EUV)
  - We do not have daily predictions
- To provide consistent daily worldwide openings, the following values are needed for many weeks

	SFI value for many weeks	SN (V2) value for many weeks	EUV value for many weeks
15m	90	50	140
10m	105	70	200
6m	145	140	300

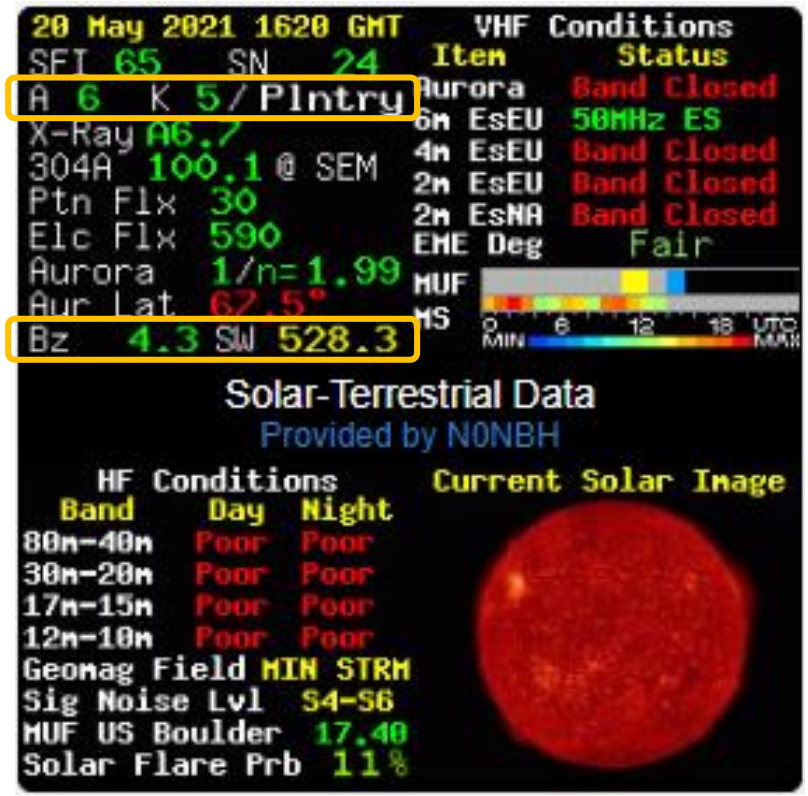
Just because the SFI, SN, EUV are high enough doesn't mean there's enough ionization – are there disturbances to propagation that cause problems?

Disturbances to Propagation

NOAA has defined disturbances to propagation as follows

- Geomagnetic storms (G) – earth-directed CMEs (coronal mass ejections) and CHs (coronal holes) can disturb the Earth's magnetic field
  - Result is higher K indices and a degraded F2 region
- Solar radiation storms (S) – a big (M- and X-Class) solar flare can emit energetic protons that funnel into the polar cap
  - Increased absorption at D region altitudes – degraded over-the-pole paths
- Radio blackouts (R) – a big (M- and X-Class) solar flare can emit radiation at x-ray wavelengths
  - Increased absorption in the D region on the daylight side of Earth

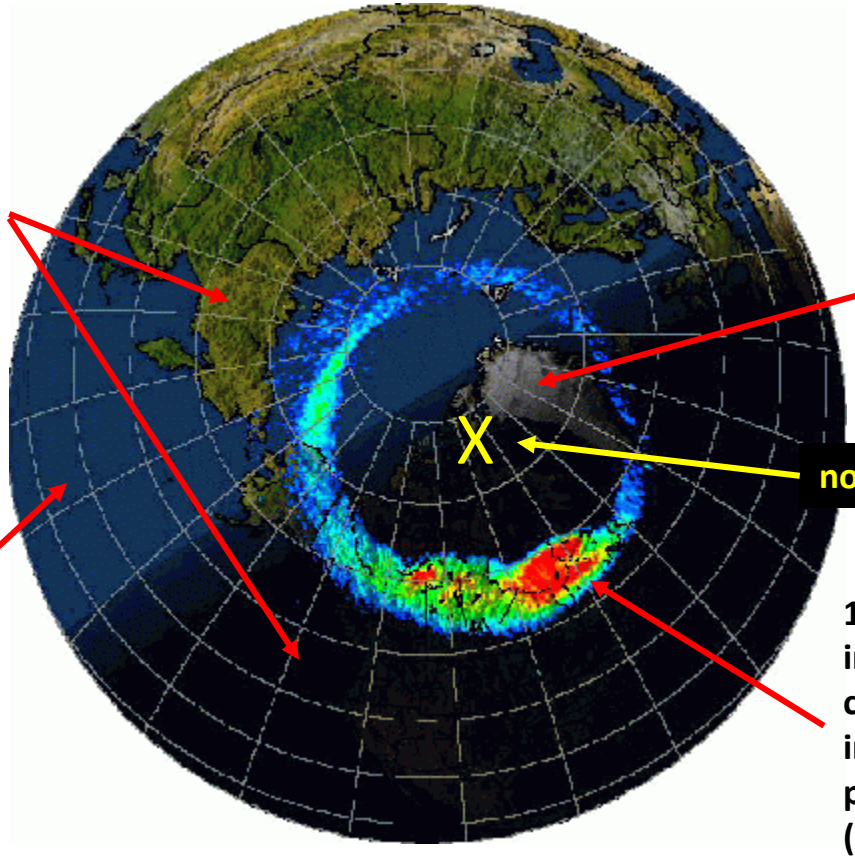
Disturbances to Propagation



We desire
- K ≤ 3 (A ≤ 15)
- Bz positive or slightly negative
- SW not too much > 400

- K index – 3-hr indicator of fluctuation of the Earth's magnetic field from quiet-time value
  - From magnetometer data
  - From 0 (quiet) to 9 (very active) – logarithmic scale
  - Higher values mean a more disturbed F2 region
- A index – average of the eight daily K indices
  - From 0 to 400 – linear scale
- Bz – direction (+/-) and magnitude of the interplanetary magnetic field
  - About +50 to -100
- SW – solar wind speed
  - Quiet-time about 400 km/sec, up to 2000

The Big Picture for Disturbances



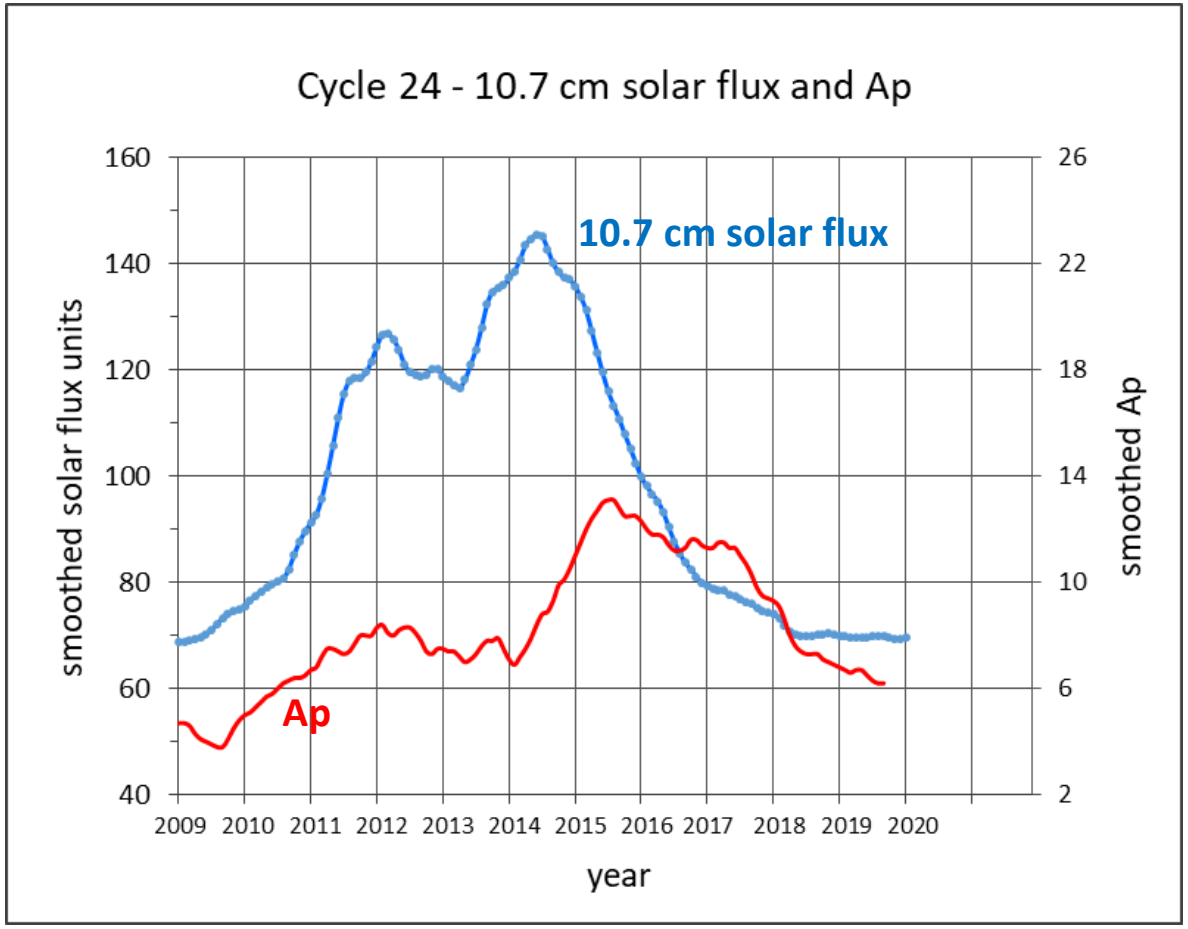
1a) Geomagnetic storm – decreased F2 region MUFs at high/mid latitudes, and possible enhanced F2 region MUFs at low latitudes, affects both day and night ionosphere

2) Solar radiation storm – increased D region absorption at HF in the polar cap both day and night, southern polar cap may not be affected the same

3) Radio blackout – increased absorption at HF on daylight side of Earth, max at sub-solar point, frequency dependent (lower frequencies worse)

1b) Geomagnetic storm – increased auroral ionization causing possible VHF paths, increased absorption and possible horizontal refraction (skewed paths) on HF

Disturbances Throughout a Solar Cycle



- The higher the Ap, the more disturbed the F2 region can be
- Ap peaks around solar max
  - Due mostly to CMEs
- Ap peaks even higher during the decline of solar cycle
  - Due mostly to coronal holes
- Quietest time is around solar minimum and during the initial ascent of a solar cycle
- A disturbed F2 region is the price we pay for lots of sunspots for great propagation on the higher HF bands

Current Propagation Conditions

The Bands Right Now

- We're still around solar min – in other words, Cycle 25 is rising slowly
  - And remember it takes a solar cycle about 4 years to hit its peak
- 17m and lower frequencies offer great opportunities
- 15m offers decent worldwide propagation on a few days of the month
- 12m is kind of quiet
  - Occasional openings to the south and to VK/ZL
- 10m is mostly noise
  - Very occasional openings to the south and to VK/ZL
- *Very important – the digital modes offer better opportunities due to their signal-to-noise ratio advantage over SSB and CW*
  - Last several days – East Coast to Europe on 6m via sporadic-E with FT8

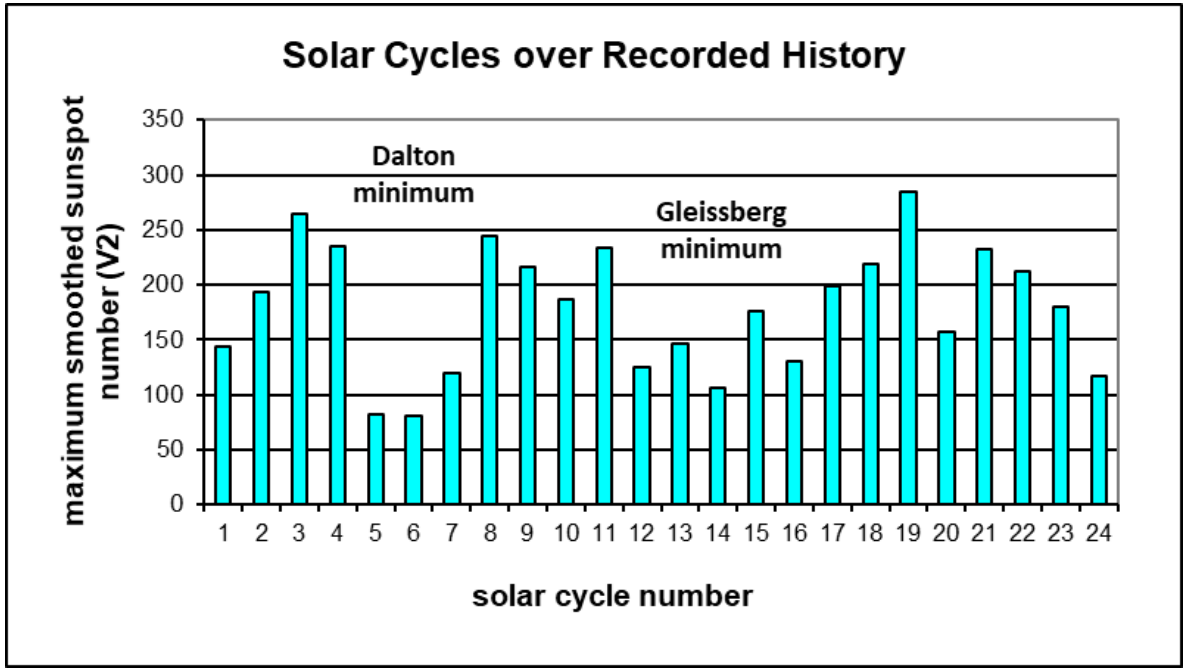
Status of Cycle 25

If you've only been licensed for several years, you may be asking "what's so great about 15m, 12m and 10m?" as most of the time there is only noise and not many signals on those bands

All I can say is "wait a couple years and you'll be amazed what those bands can do around solar maximum with modest power and modest antennas"

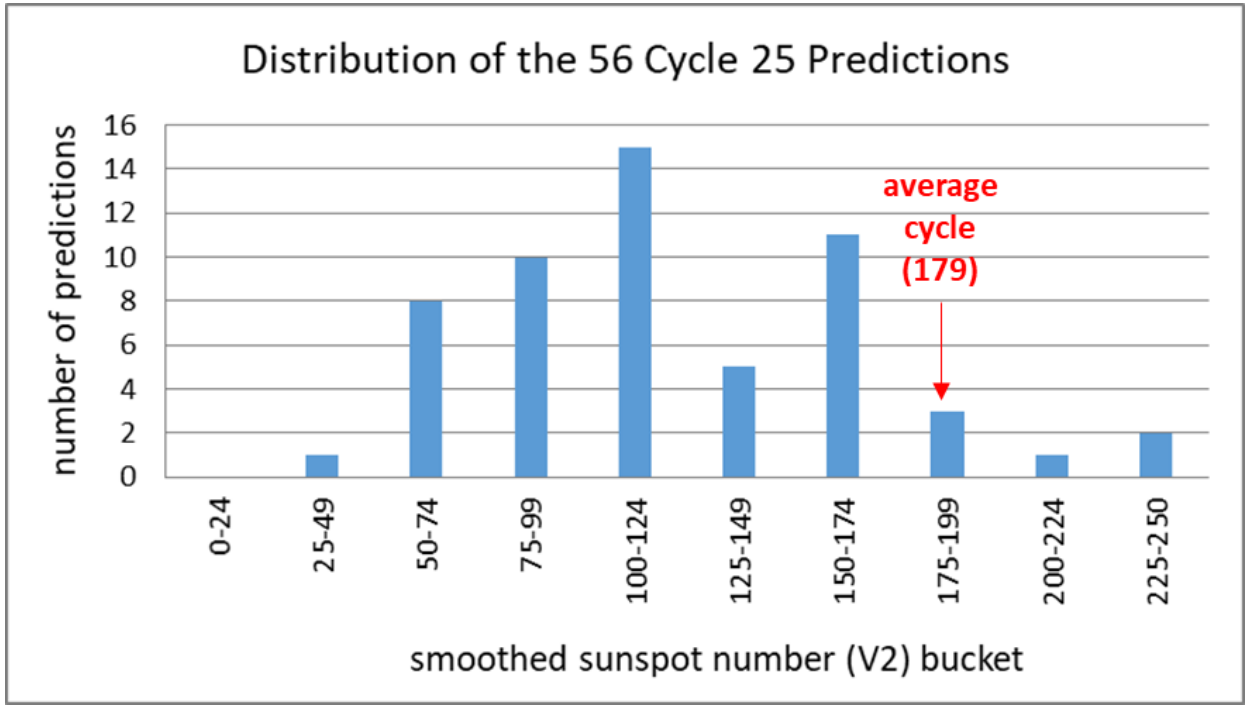
Recorded History

- Cycle 1 began in 1755
  - Maunder Minimum occurred from 1645-1715 with few sunspots
- We've gone through 3 periods of big cycles and 2 periods of small cycles
  - We appear to be in a third period of small cycles
- Cycle 24 has ended
- Cycle 25 has started its rise
  - But it's a <u>slow</u> rise so far



The critical question – will Cycle 25 get us out of this third small-cycle period?

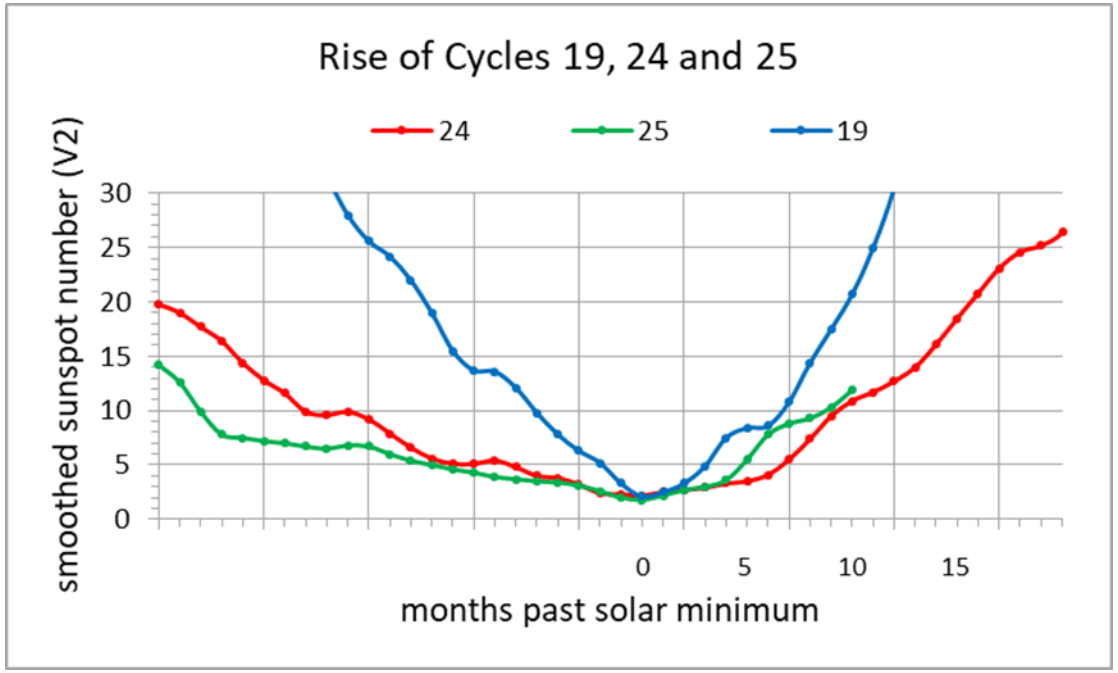
I'm Aware of 56 Predictions for Cycle 25



- 50 of the 56 (89%) are for a below average cycle (like Cycle 24)
- 3 are for an average cycle (like Cycle 23)
- 3 are for a big cycle (like cycles 21 and 22)

Cycle 25 Progress

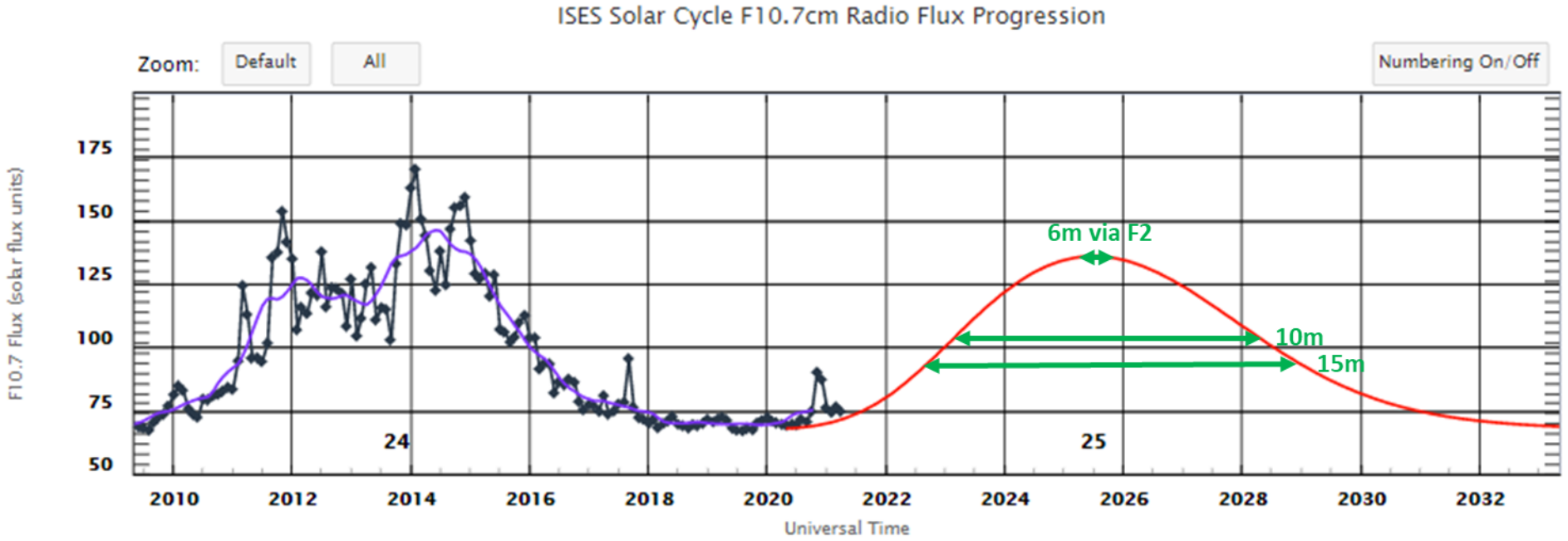
- Historical data shows that big cycles rise faster than small cycles



- After 10 months of data, Cycle 25 is rising a bit faster than Cycle 24
- Too early to tell with any confidence what Cycle 25 is going to do

If Cycle 25 is Similar to Cycle 24

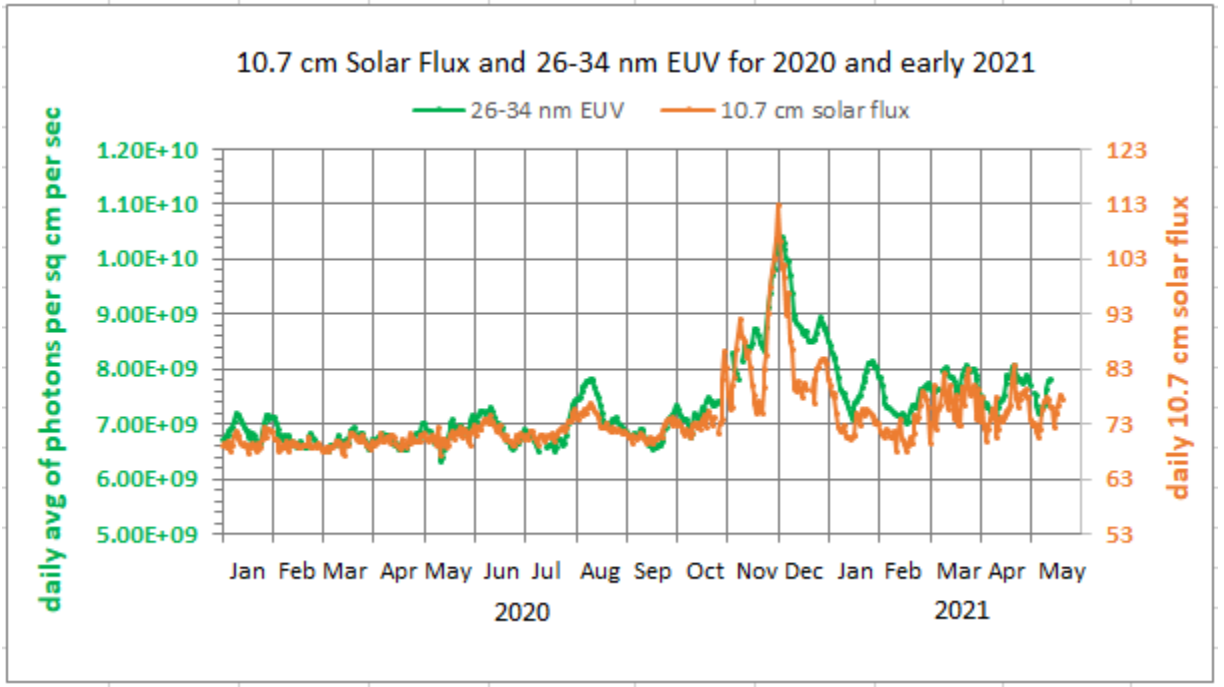
- Here's the forecast from the Solar Cycle 25 Prediction Panel



- Green solar flux values are from slide 12 for consistent daily worldwide openings
- If Cycle 25 is bigger than Cycle 24, the higher bands will be open earlier than and later than the dates suggested above

When the Sun Hiccups

- We have a way to go before 10m opens up consistently on a daily basis
- But sometimes the Sun hiccups

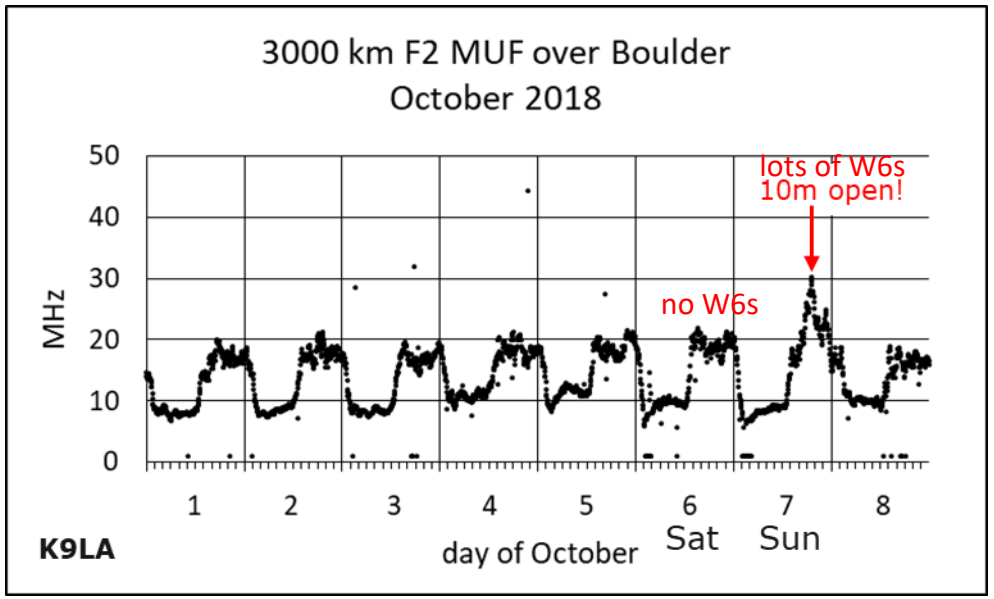


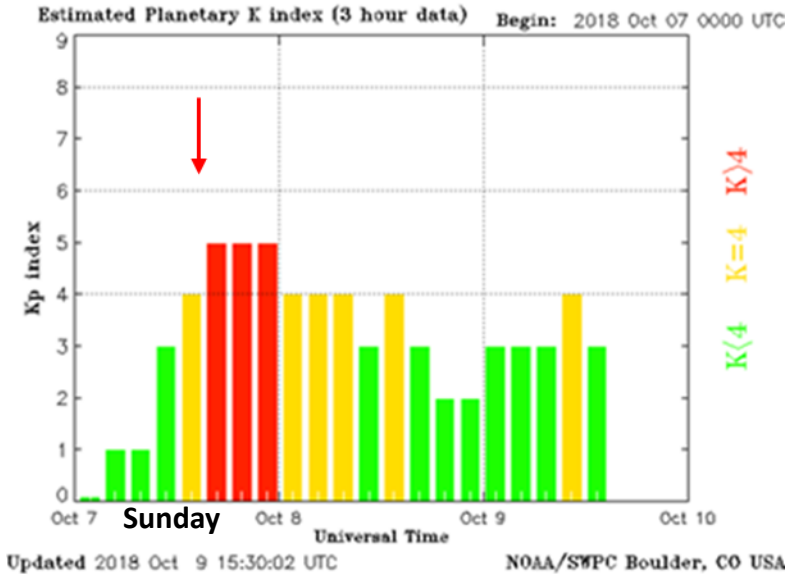
- Nice spike in EUV in late 2020, but it settled back down to solar minimum levels in early 2021
- EUV now showing a small increase

- Late 2020 was a great look into the good things to come on the higher bands with Cycle 25

2018 California QSO Party

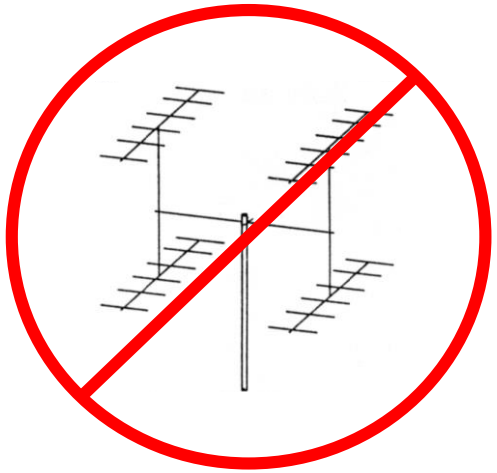
- No W6s heard on 10m in the Midwest on Saturday





- Lots of W6s on 10m on Sunday after the K index spiked up to cause an enhanced mid-latitude F2 region
- Check the higher bands if the K index spikes up

Simple Antennas for the Higher HF Bands



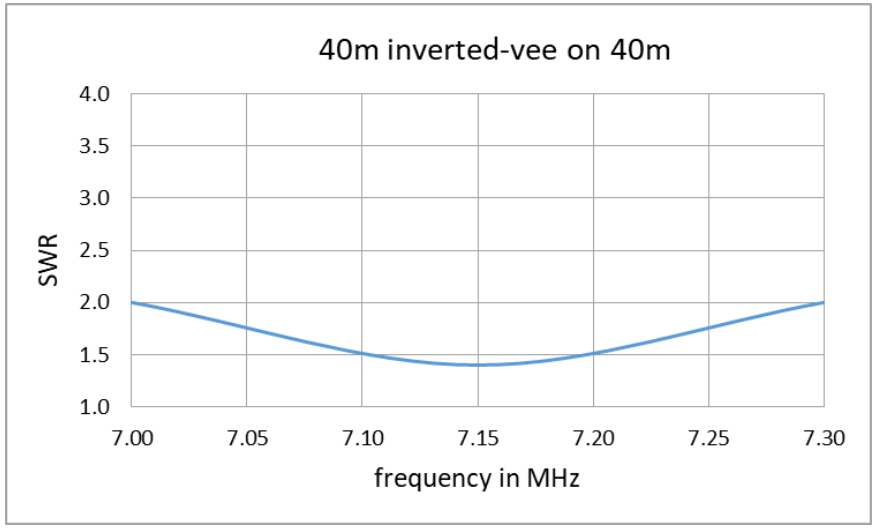
Tech and General Privileges on the Higher Bands

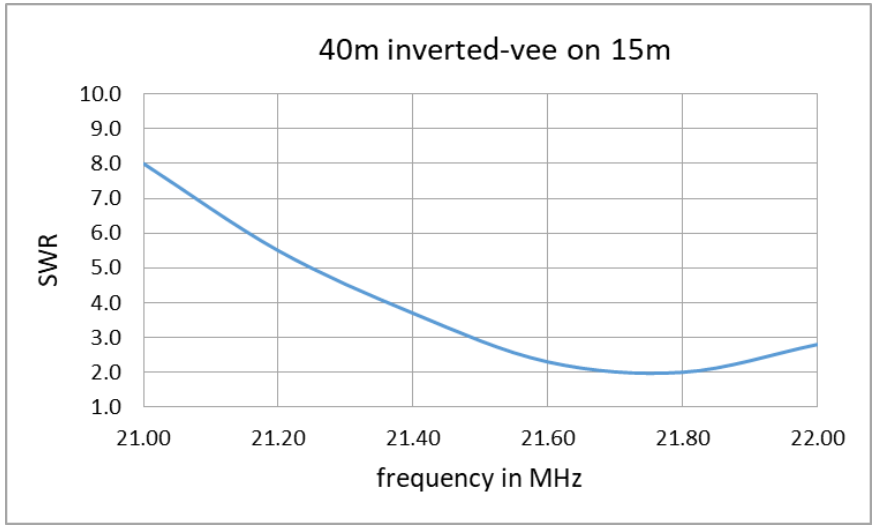
- Technician (and Novice)
  - 15m
    - 21.025-21.200, CW only, 200 W
  - 12m
    - No privileges
  - 10m
    - 28.000-28.300, RTTY and data, 200 W
    - 28.300-28.500, SSB phone, 200 W
- General
  - 15m
    - 21.025-21.200, RTTY and data
    - 21.275-21.450, phone and image
  - 12m
    - 24.890-24.930, RTTY and data
    - 24.930-24.990, phone and image
  - 10m
    - 28.000-28.300, RTTY and data
    - 28.300-29.700, phone and image

RM-11828 Technician Class Enhancement – 75m SSB, 40m SSB, 15m SSB privileges

Antennas for 15m

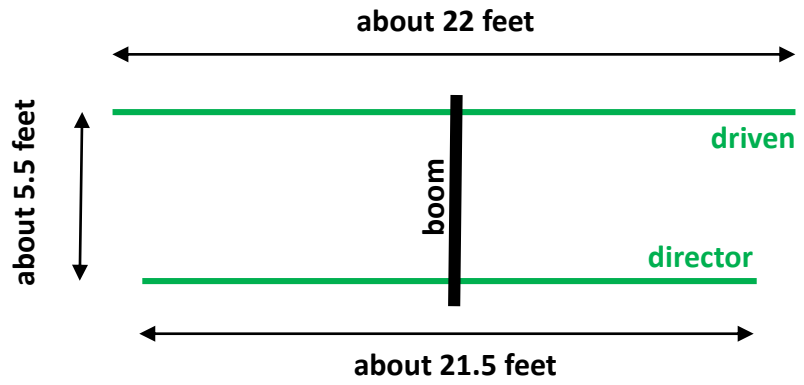
- Use your 40m dipole/inverted-vee
  - Works as a 3/2-wavelength antenna
    - A bit of gain in some directions
  - If your 40m dipole/inverted-vee is cut for 7.150 MHz, the lowest SWR on 15m will be up around 21.800 MHz
    - Need to use a tuner – either your rig's internal tuner or an external tuner
- Vertical with four elevated radials
  - I have a Hustler 4BTV – gives decent results
- 15m dipole/inverted-vee
  - Overall length about 22 feet

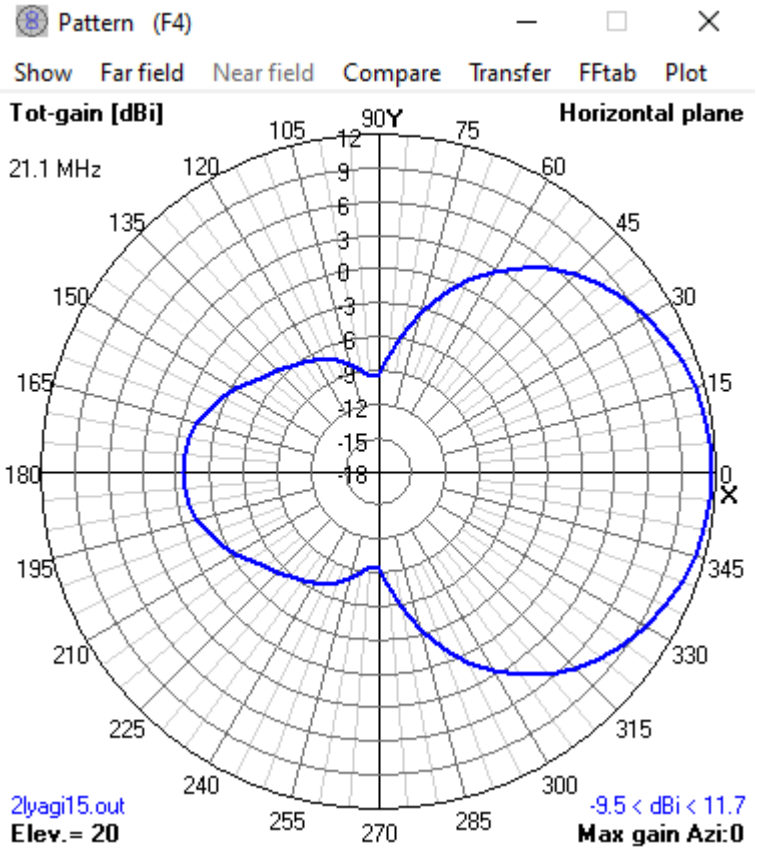




Another Antenna for 15m

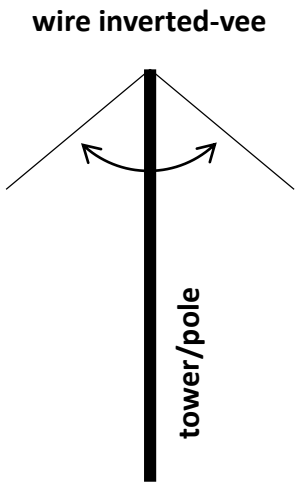
- 2-element Yagi
  - Driven element and director
  - Aluminum tubing
  - About 5dB gain over a dipole
  - A rotator is required due to F/B and F/S ratios
- A height of 30 feet would work very well

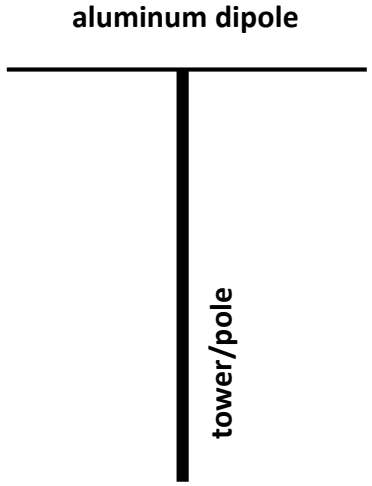




Antennas for 12m

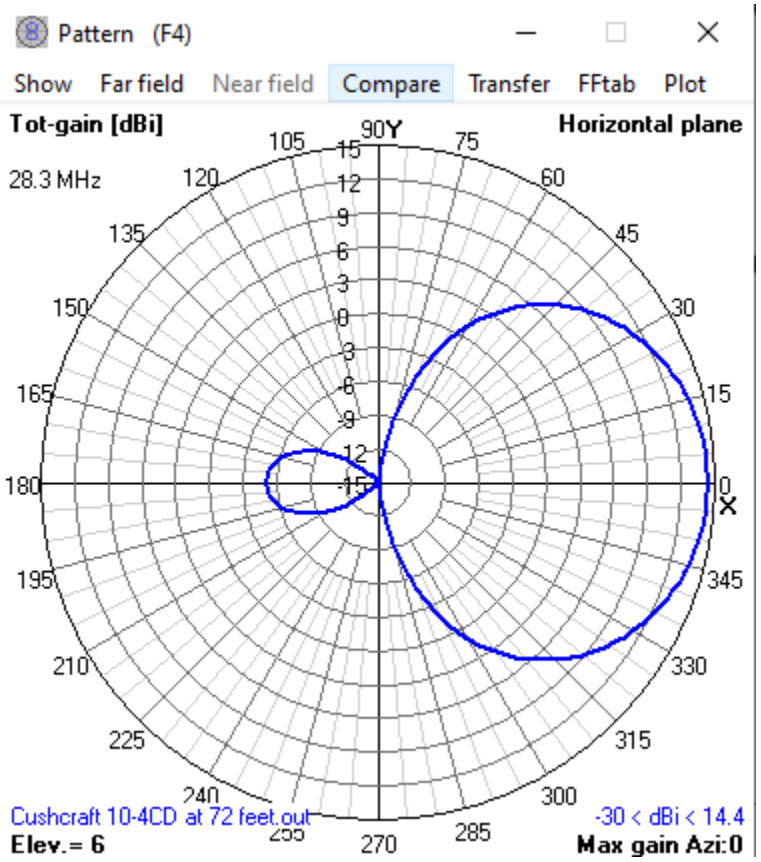
- Inverted-vee
  - Each side about 9.25 feet
  - Keep angle > 90 degrees
- Dipole made with aluminum tubing
  - About 18.5 feet from tip-to-tip
- 2-element Yagi
  - A bit smaller than the 15m Yagi
  - Scale it from the approximate dimensions on slide 29
- 3-element Yagi





Antennas for 10m

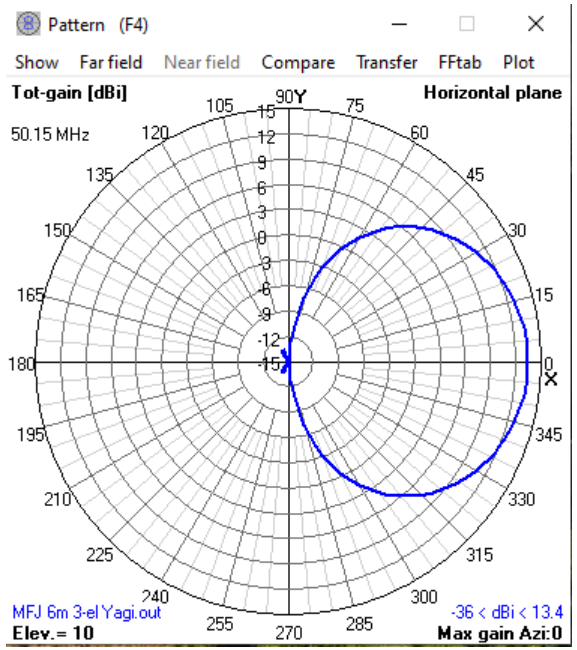
- Aluminum dipole is relatively small
  - About 16.5 feet tip-to-tip
- Multi-element Yagis are quite reasonable
- I have a 4-element Cushcraft 10m Yagi
  - 16 foot boom, elements about 17 feet tip-to-tip
  - Used it to work many stations with my homebrew QRP (250 milliwatts) 10m transceiver
- Use vertical (ground plane) for omni-directional pattern for local work
  - Dipole would mostly do okay, too
  - Best if everyone has the same polarization



Antennas for 6m

- A multi-element Yagi is very doable – even for small property lots
  - Small and lightweight
- I have an MFJ-1762 3-element 6m Yagi
  - 9 foot elements, 6 foot boom, about 3 pounds
  - Great F/B – but what do you do when E_s is open in more than one direction?
- When a good E_s opening is available, just about any antenna will work that has a reasonable SWR on 6m
  - I've used my 40m inverted-vee

MFJ-1762



Summary

- Cycle 24 is over, Cycle 25 is beginning its ascent
- Most forecast a below average, a few forecast a big cycle
  - All we can do is wait and see what happens
- http://prop.kc2g.com/ – real-time worldwide MUFs (maximum useable frequencies)
- dxmaps.com – see who is working what now
  - Similar sites: PSKReporter, WSPRnet, Reverse Beacon Network, IARU/NCDXF beacons
- Get ready for the higher bands as Cycle 25 rises
  - Antennas are of a reasonable size on 15m, 12m, 10m, 6m

Get radio-active on HF!