Cycle 25 Update
and more

Cycle 25 is very alive!

Carl Luetzelschwab K9LA

e-mail: k9la@arrl.net

website: https://k9la.us

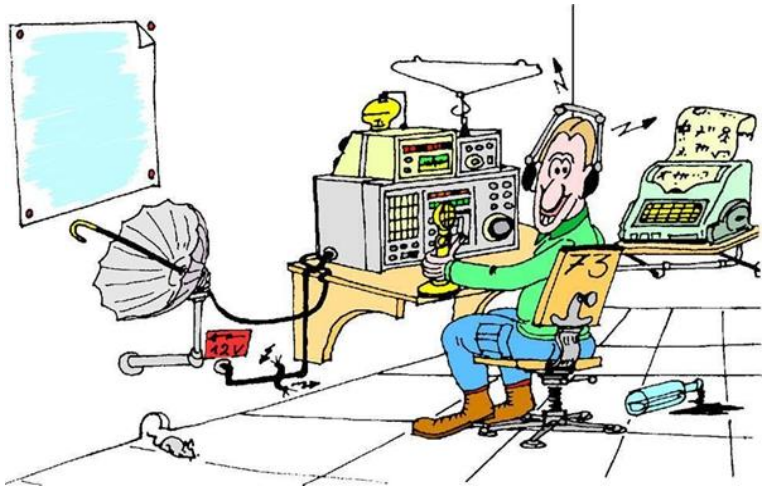
Madison (WI) DX Club Presentation

- "Improve DXing during the Solar Maximum" by Frank Donavan - W3LPL
- On Tuesday June 11, 2024

- Video and pdf at this link
  - https://www.madisondxclub.org/MDXC_Programs.html
- Many other presentation at that link

What We'll Cover

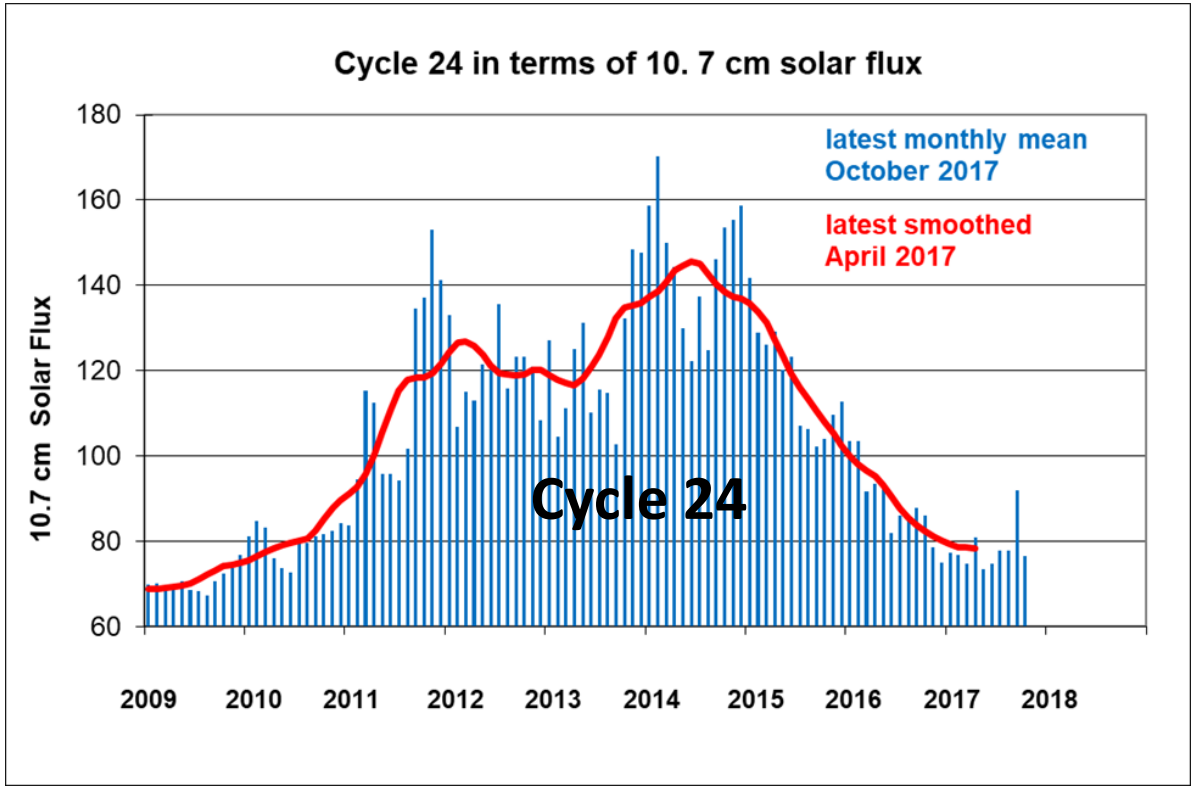
- My previous presentations to the Arkansas DX Assn
- Latest data on Cycle 25
- General knowledge
- An interesting early May
- Guidelines for the next several years
- Summary



My Previous Presentations to the Arkansas DX Association

Back in December 2017

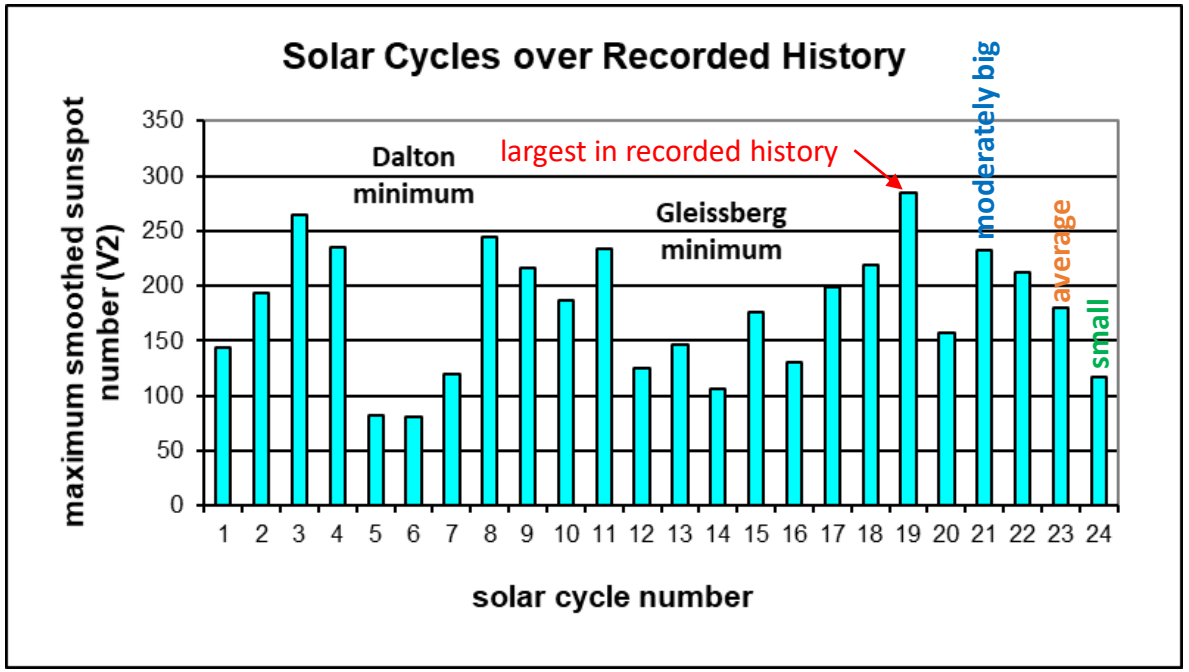
- In-person
  - Solar Topics and Propagation
  - Disturbances to Propagation
- We had not yet reached solar minimum between Cycles 24 and 25
- What has happened in 7 years?



We did go through solar minimum in December 2019

Review - All Previous Solar Cycles

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

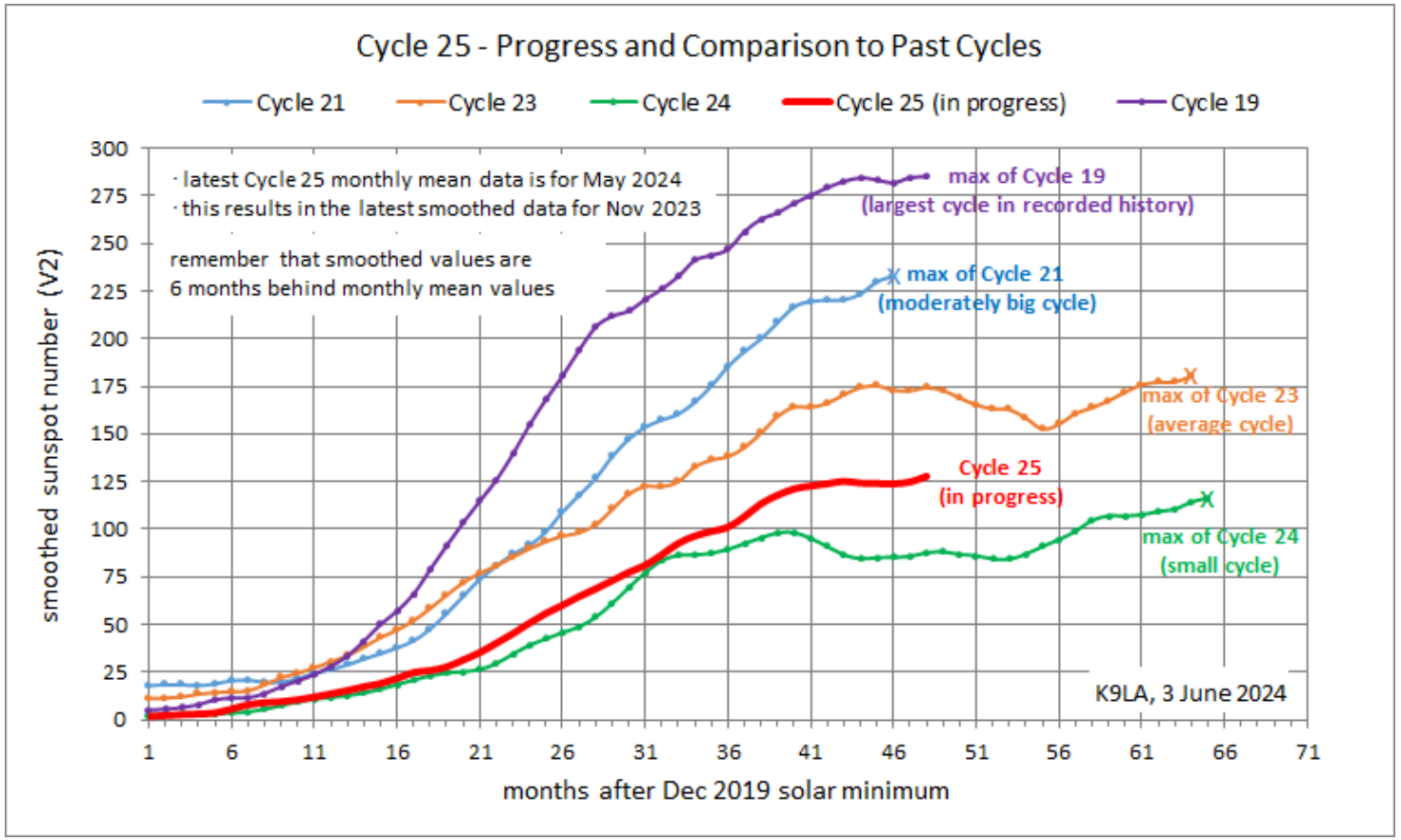


Will Cycle 25 keep us in a third period of small solar cycles?

Latest Data on Cycle 25

The Latest Cycle 25 Data

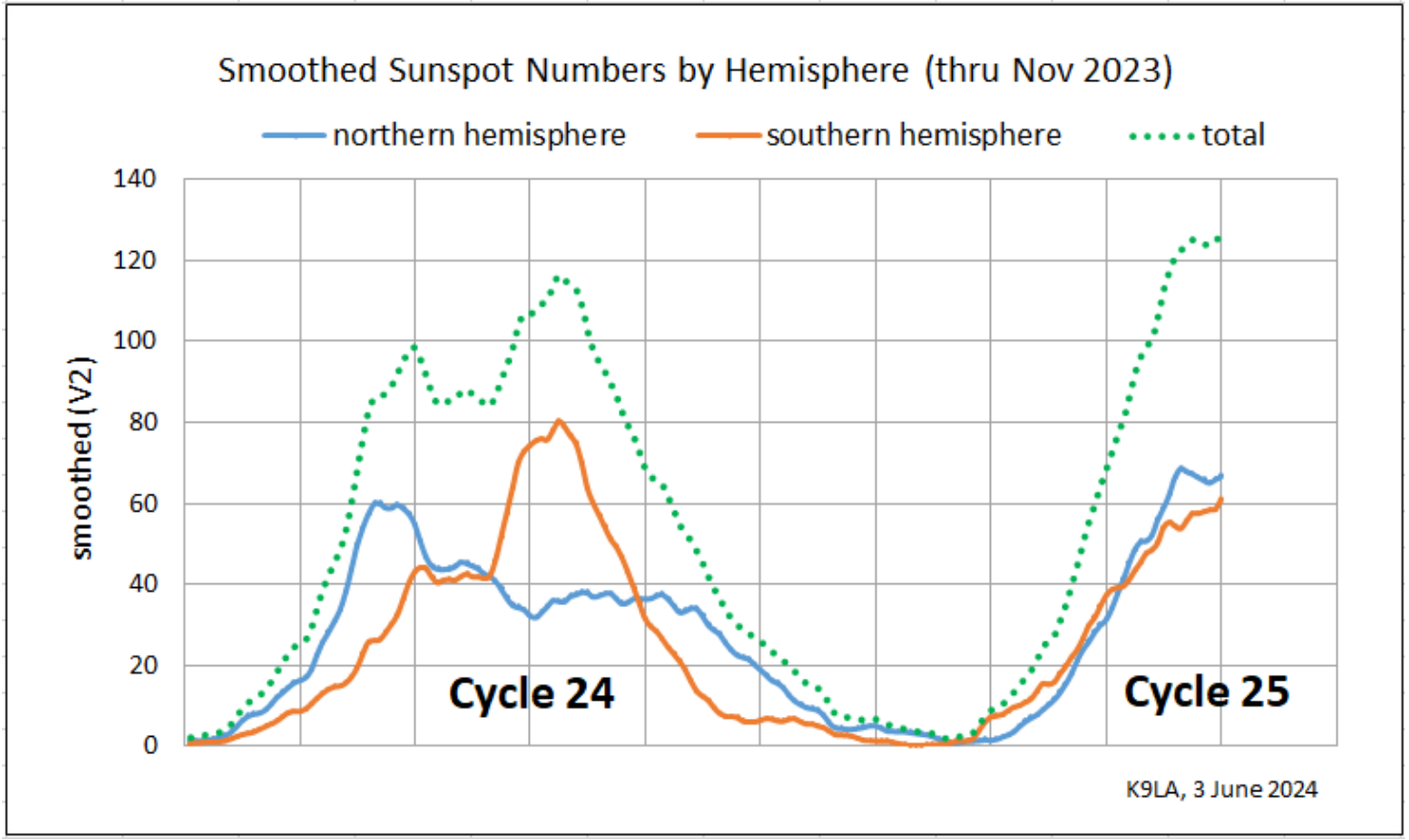
with comparisons to other solar cycles



Big cycles rise faster, big cycles generally starts higher

- Cycle 25 has surpassed Cycle 24 – but not by much so far
- Will it make it up to an average cycle like Cycle 23?
  - Perhaps

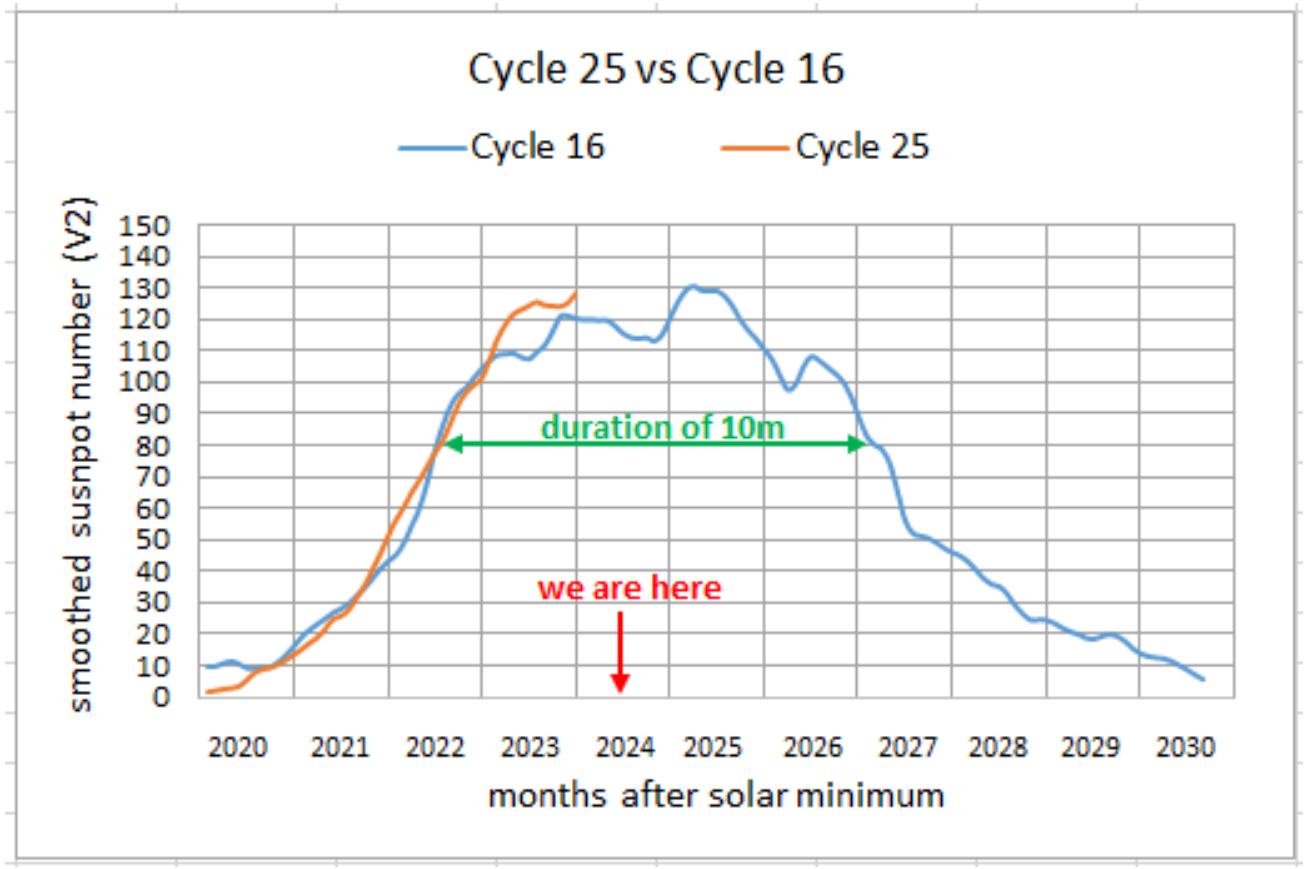
Cycle 25 – One Peak or Two Peaks?



- Cycle 24 (and Cycles 22 and 23) had two peaks
- Best guess right now is one peak for Cycle 25 due to the two solar hemispheres working together
- We'll see what happens in the next several months with respect to the two hemispheres

Perhaps both solar hemispheres will become more active

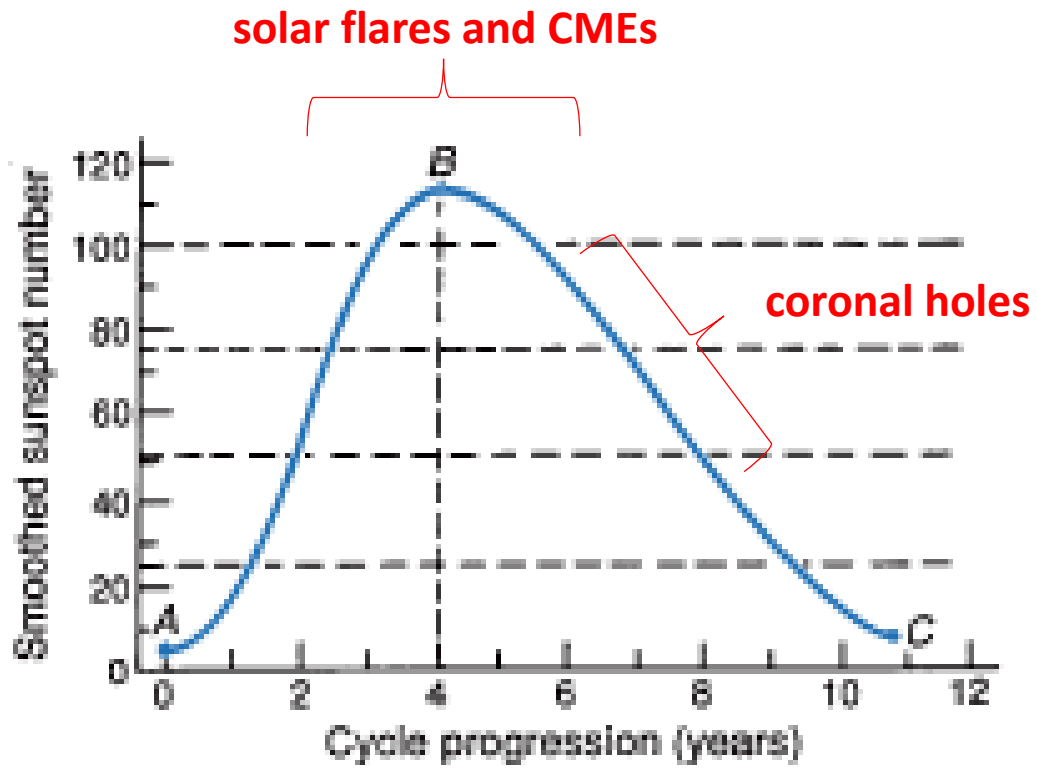
The Coming Years



- Cycle 25 is similar to Cycle 16
- We need a long-term sunspot number greater than 80 for consistent worldwide 10m propagation
- We should have great worldwide 10m propagation in the fall and winter up to 2027

General Knowledge

A Typical Solar Cycle

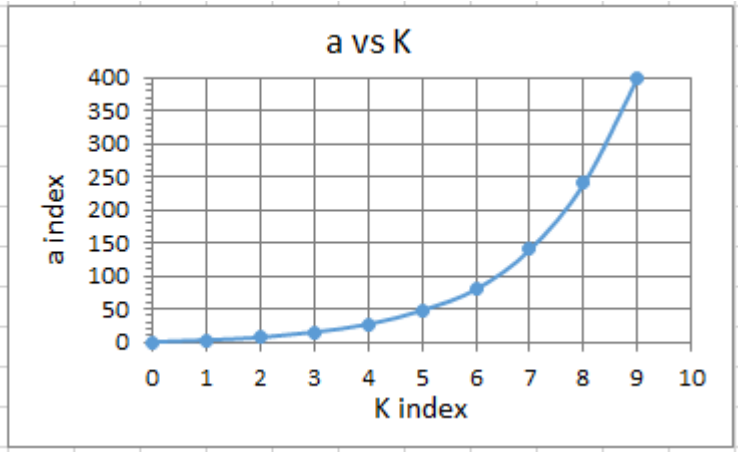


- Average length (A to C) is 11 years
  - Schwabe cycle
- Average rise (A to B) is 4 years
- Average decline (B to C) is 7 years
- Other cycles
  - Hale cycle ~ 22 years
  - Gleissberg cycle ~ 88-90 years
  - De Vries cycle ~ 205 years
  - Halstatt cycle ~ 2300 years

K and A Indices

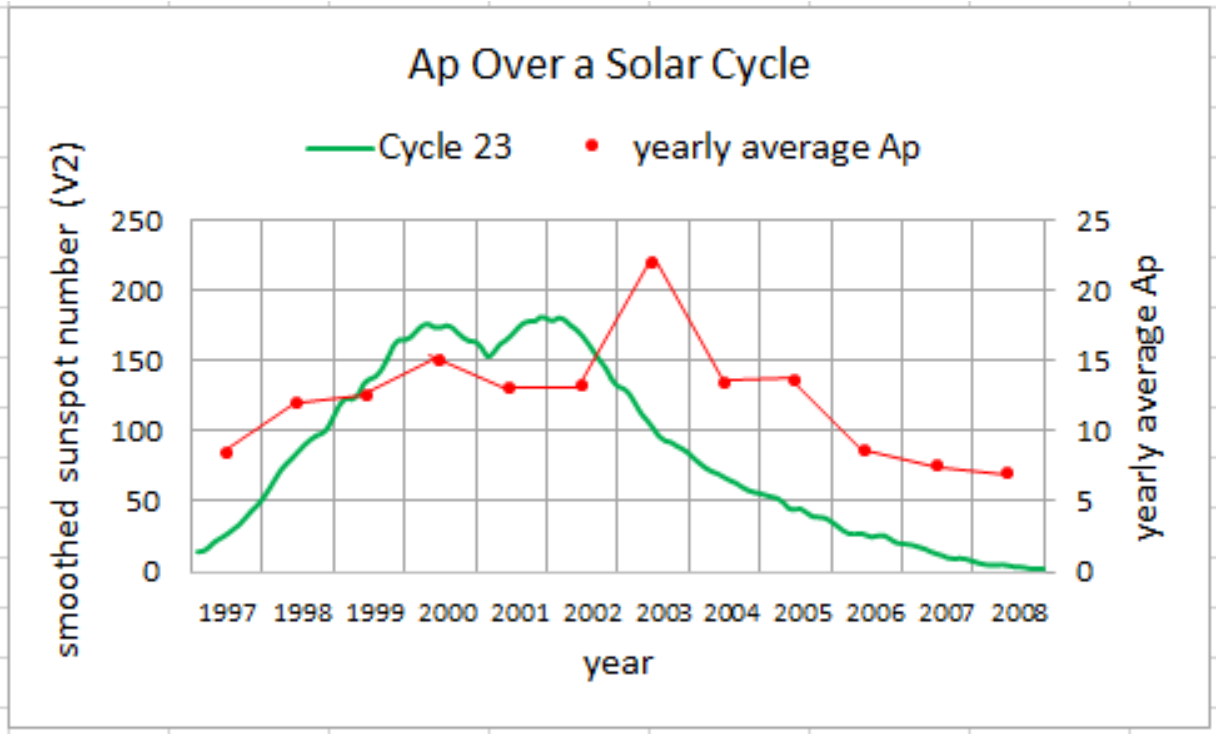
- The K index is a logarithmic 3-hour index – it is reported every 3 hours
  - It is the maximum deviation of the Earth's magnetic field in the eight 3-hour periods – 00-03z, 03-06z, 06-09z, 09-12z, 12-15z, 15-18z, 18-21z, 21-00z
  - K goes from 0 (quiet magnetic field) to 9 (extremely disturbed magnetic field)
- The A index is a linear daily index – it's the average of the eight K indices
  - A goes from 0 (quiet magnetic field) to 400 (extremely disturbed magnetic field)

K	a
0	0
1	3
2	7
3	15
4	27
5	48
6	80
7	140
8	240
9	400



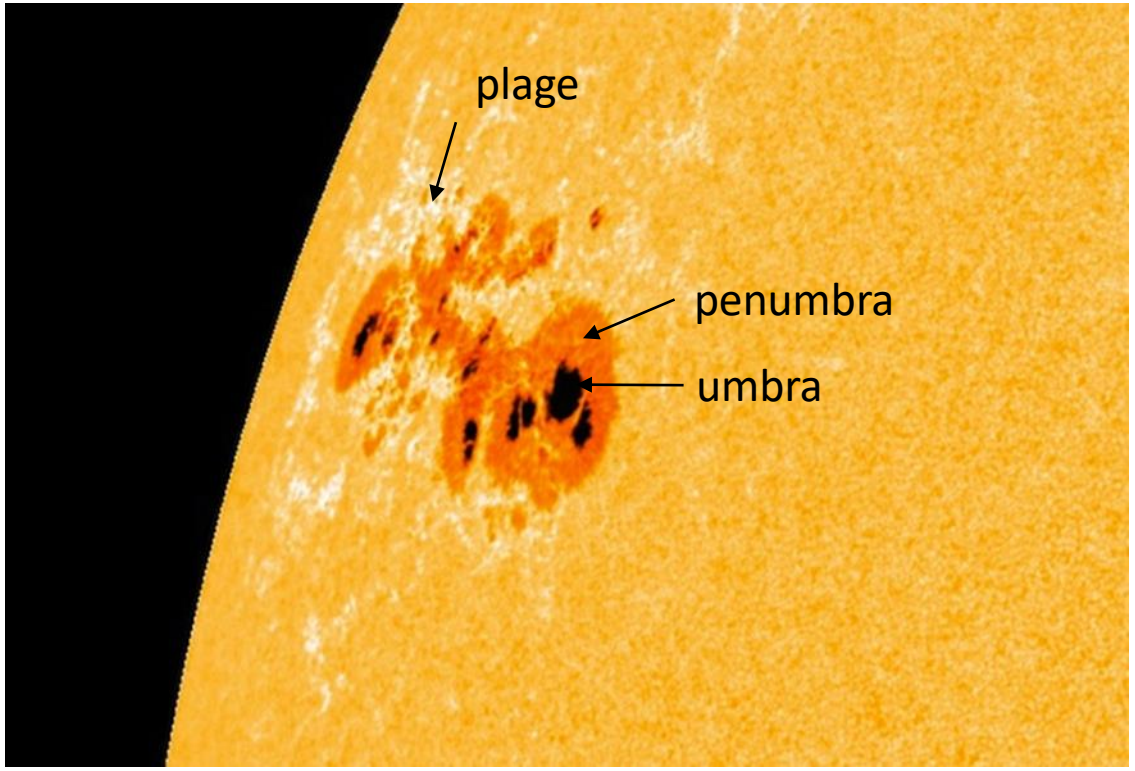
- When the K and A indices are very high, ionization in the F2 region can be significantly reduced
- When the K index is ≤ 3 (A index ≤ 15), the F2 region is generally considered to be 'normal'

Disturbances Over a Solar Cycle



- Solar flares are most prevalent around solar maximum – where we are now – they don't contribute to elevated K indices
- CMEs (Coronal Mass Ejections) are also most prevalent around solar maximum
- Coronal holes are most prevalent during the decline of a solar cycle
- Coronal holes are more detrimental than CMEs

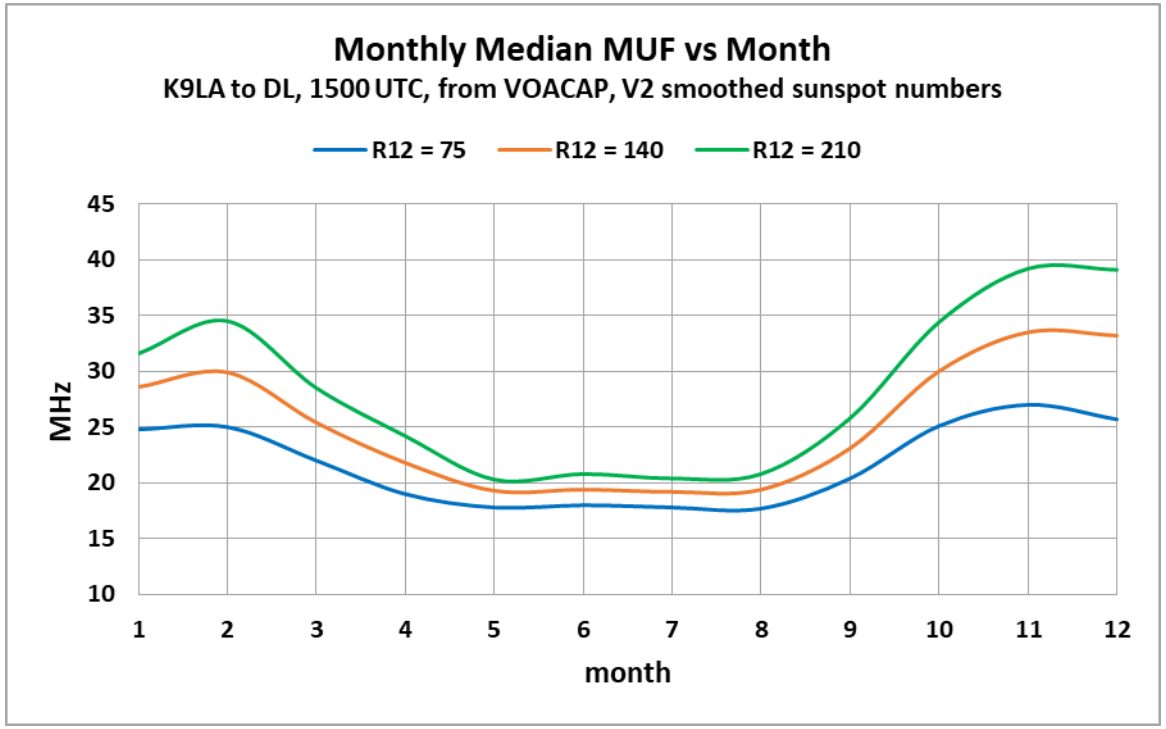
Why Are Sunspots Important?



The white area around a sunspot is called a plage (French for ‘beach’)

- Plage areas emit EUV (extreme ultra-violet) radiation
- EUV radiation ionizes the atmosphere at F2 region altitudes
  - Sunspots themselves do not ionize anything - nor does 10.7 cm solar flux
- F2 region is responsible for most of our long distance QSOs
  - And most QSOs at night

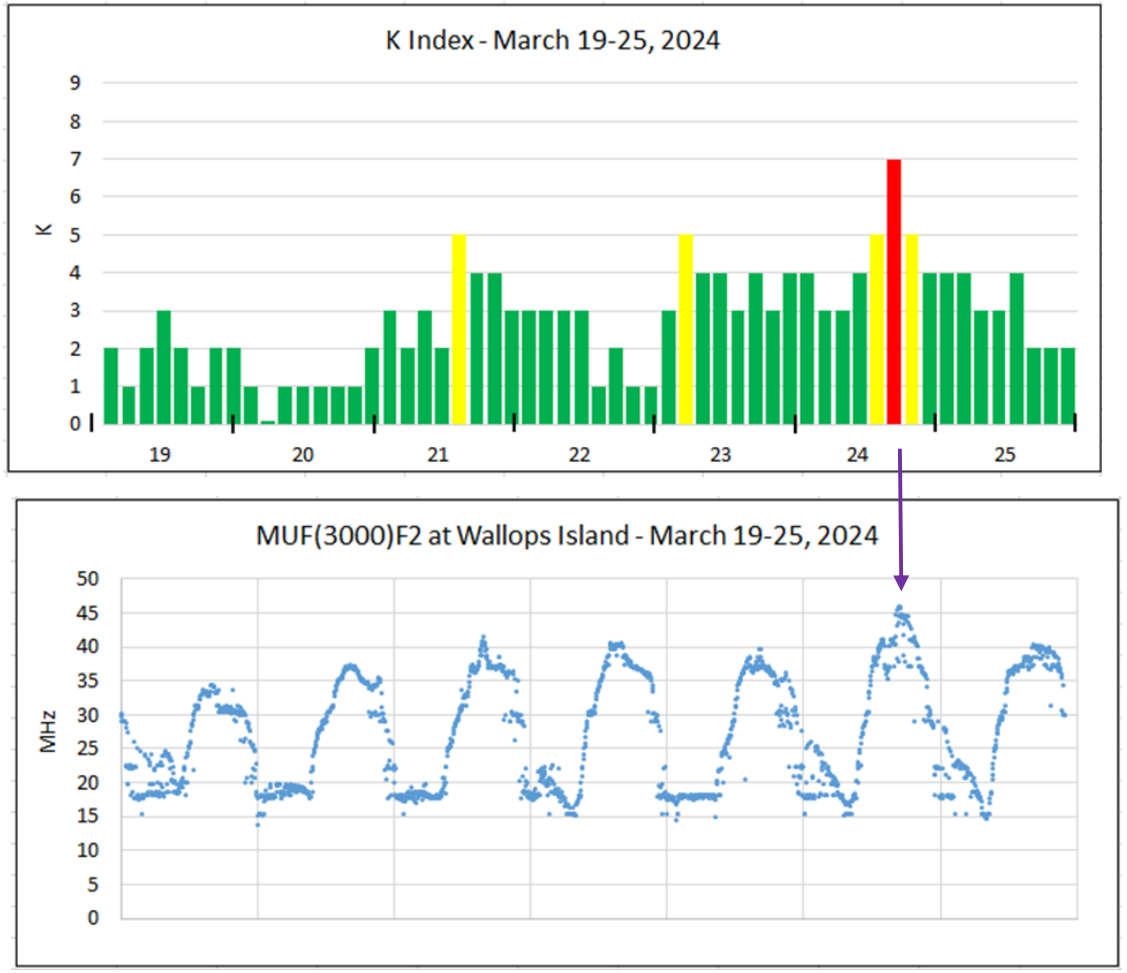
MUF vs Month



- Lowest MUFs in the summer
  - IARU, FD, state QSO parties
- Highest MUFs in the fall/winter
  - Major DX contests
- This is due to a change in the composition of the atmosphere throughout the year
- Sporadic-E helps in the summer (if it occurs!)

Short-Term Enhancements

- Check the higher HF bands and 6m when there is a moderate spike in the K index
- We had one of these on Sunday March 24, 2024
- Note what happened to the MUF on March 24
- Fall months are good to keep an eye on, too

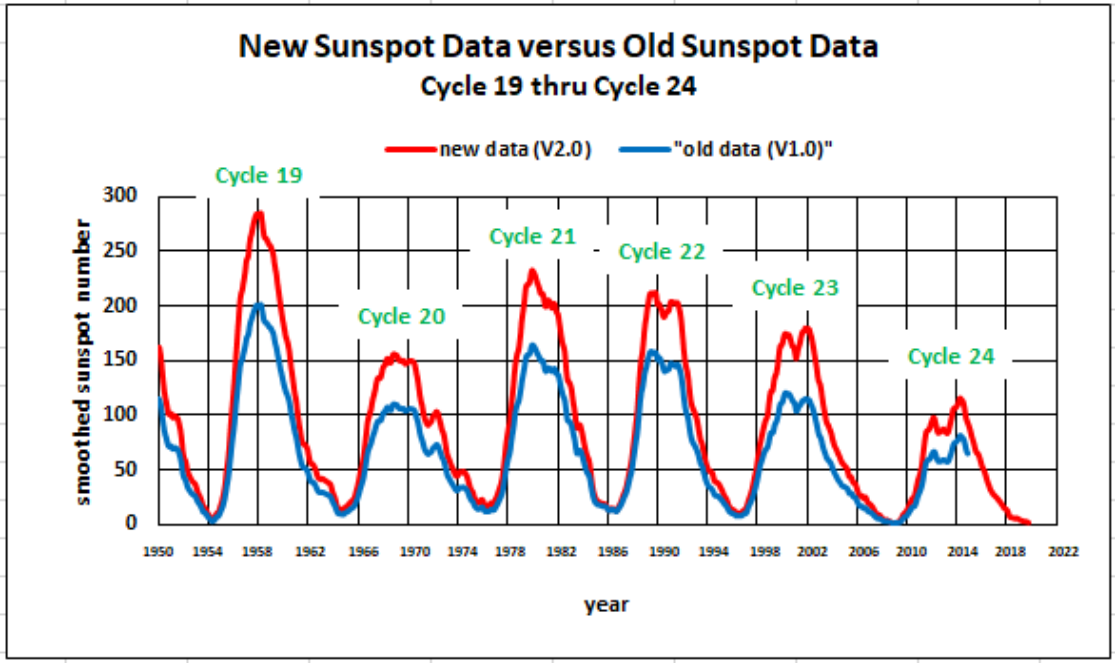


Why Does Our Sunspot Record Start in 1749?

- Our sunspot record begins with Cycle 1 in 1755
  - We actually have data starting in July 1749
- The Chinese were observing sunspots way before 1749
- Why does our data start in 1749?
- Rudolf Wolf reviewed sunspot data back to 1610, and determined that there was enough good data beginning in 1749
  - Remember the Maunder Minimum was 1645-1715 (few sunspots)
- R. Wolf also developed the daily sunspot number formula
  - R = k(10g + s) where R is the sunspot number, g is the number of sunspot groups, s is the total number of sunspots (groups and individuals) and k is a factor to bring the counts of different observers into agreement

V1 and V2 Sunspot Record

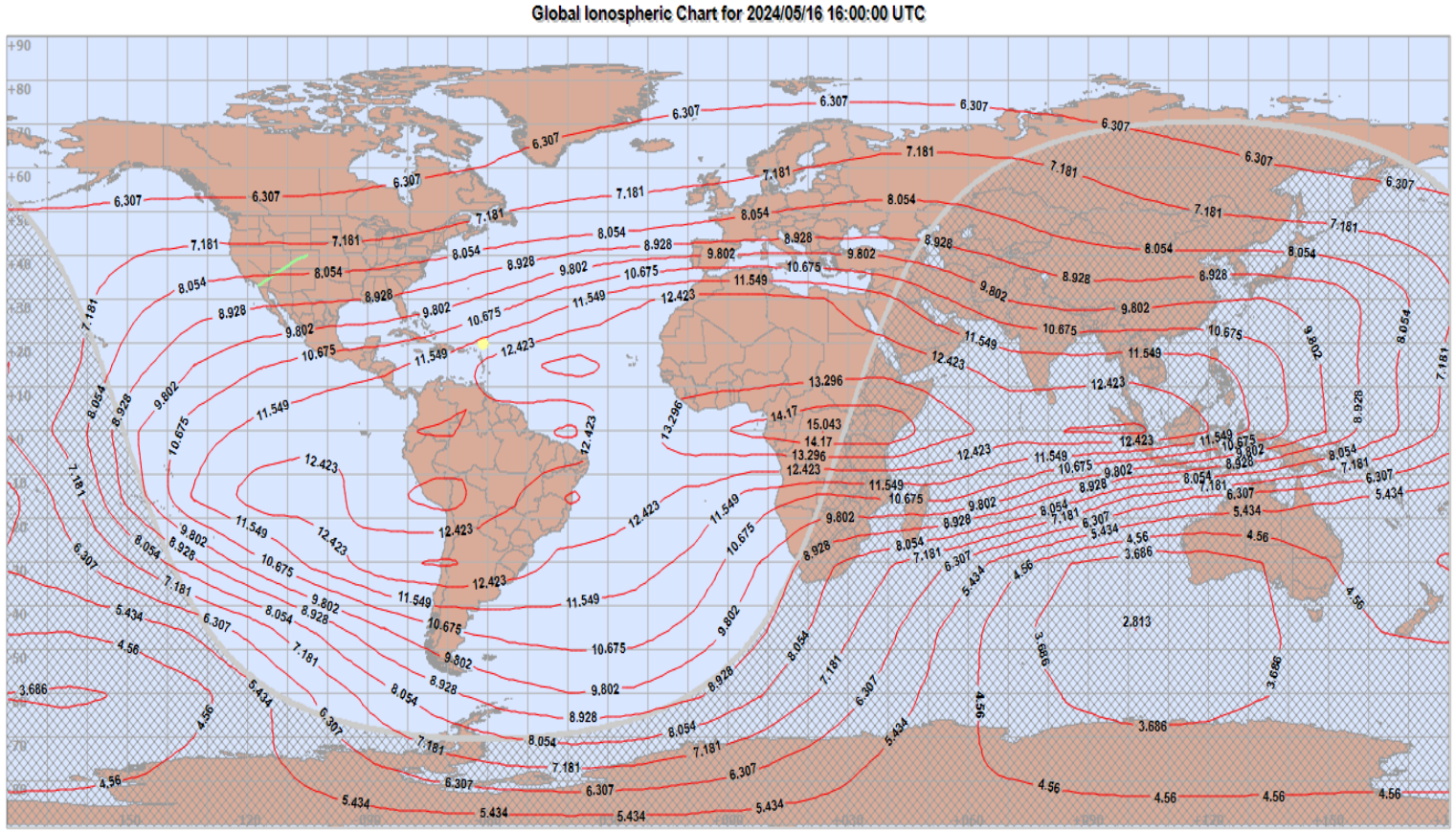
- In the mid 1990s, concern arose about the accuracy of the sunspot record
- Four Workshops were held to review the old data (2011, 2012, 2013, 2014)
- The end result of these Workshops generated a new sunspot record that is considered to be more accurate than the old one
- V1 is old version, V2 is new version
- Biggest issue was when A. Wolfer took over from R. Wolf in 1876
- Wolfer had to multiply his count by 0.6 to agree with Wolf



- After much analysis, the 0.6 factor was backed out, and that makes V2 values higher than V1 values
- V2 record also goes back to 1755
- Note – our propagation predictions are based on V1 sunspot numbers

Worldwide Ionosphere

- Equatorial region is the most robust area of the ionosphere – highest MUFs
- Farther north or south results in lower MUFs
- This results in an advantage for hams in the southern states



- Red lines are values of critical frequency of the F2 region (amount of ionization)
- Highest values are in the equatorial region

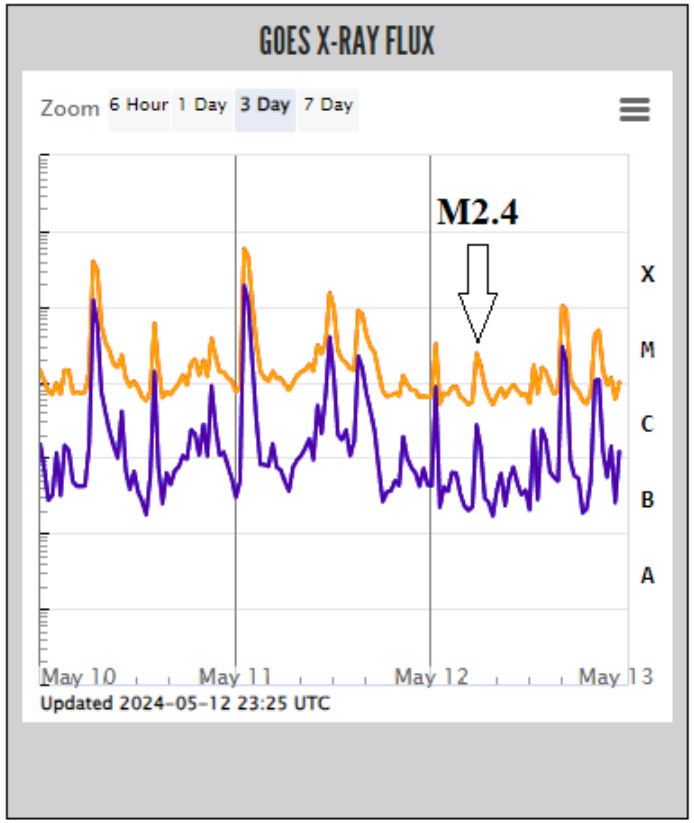
An Interesting Early May

Early May

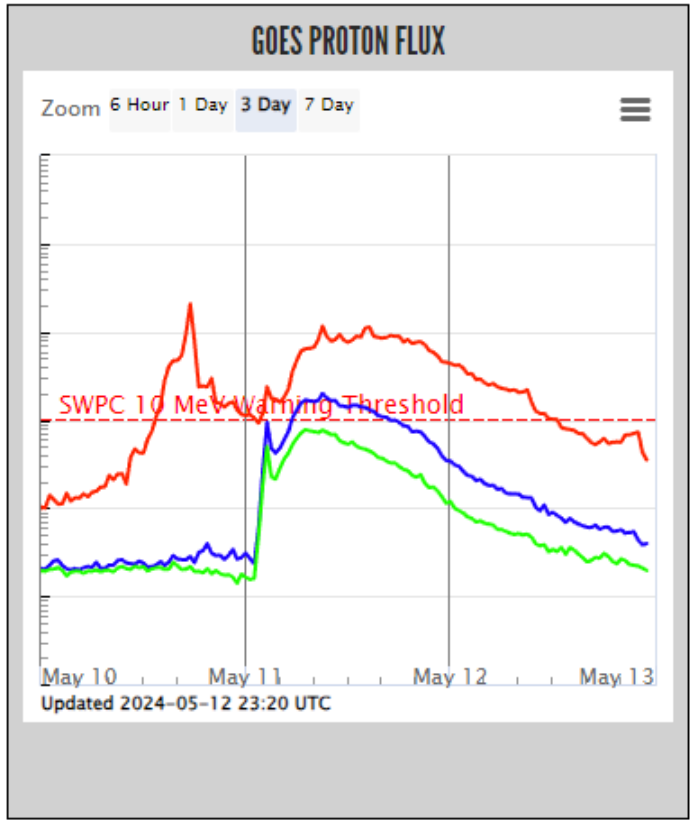
- We had some interesting (not necessarily good) propagation in early May (10th, 11th, 12th)
- Started with two big sunspots
  - AR3663 (northern solar hemisphere)
  - AR3664 (southern solar hemisphere)
- Many solar flares from both regions
- Several CMEs (Coronal Mass Ejections) from AR3664
- Resulted in all three categories of disturbances to propagation
  - **Radio blackout** due to solar flares – signals go away
  - **Solar radiation storm** due to solar flares – affects paths across the polar caps
  - **Geomagnetic storm** due to CMEs – elevates the K indices

AR is Active Region

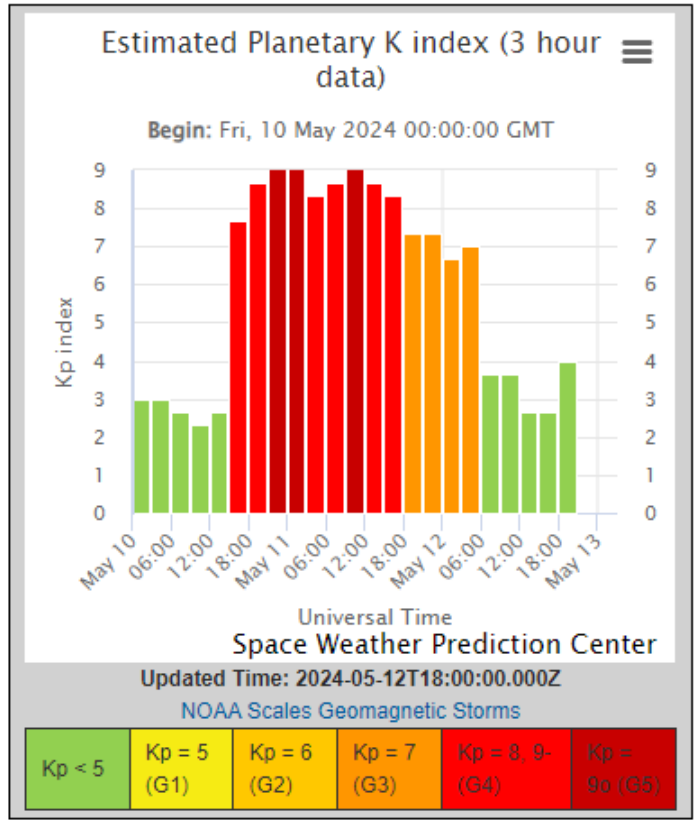
The Data at https://www.swpc.noaa.gov/



x-ray radiation from solar flares – can cause a radio blackout – short duration

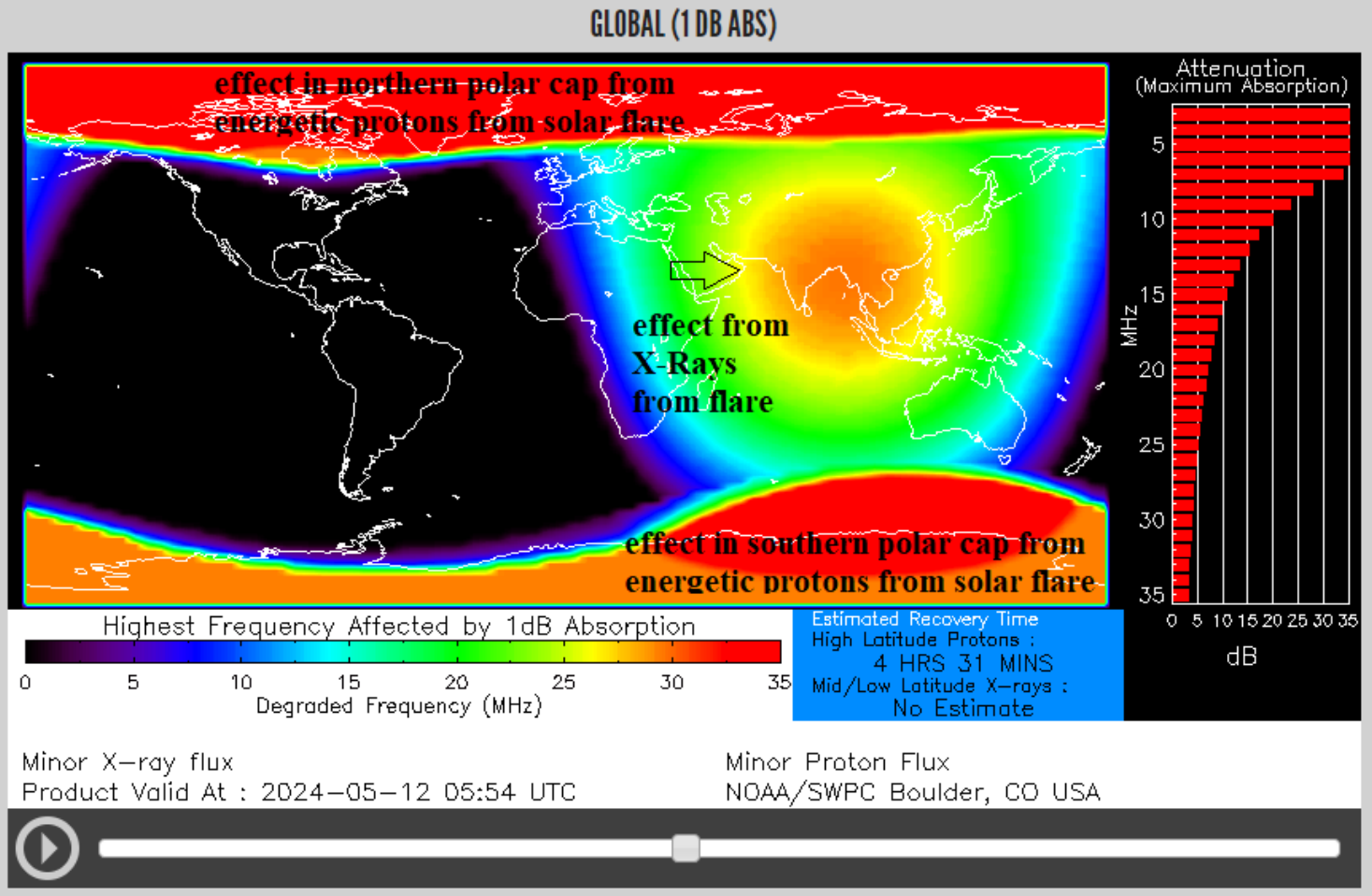


energetic protons from solar flares/CMEs – can cause a solar radiation storm – it can last a while



K indices from CMEs – can cause a geomagnetic storm – can last several days

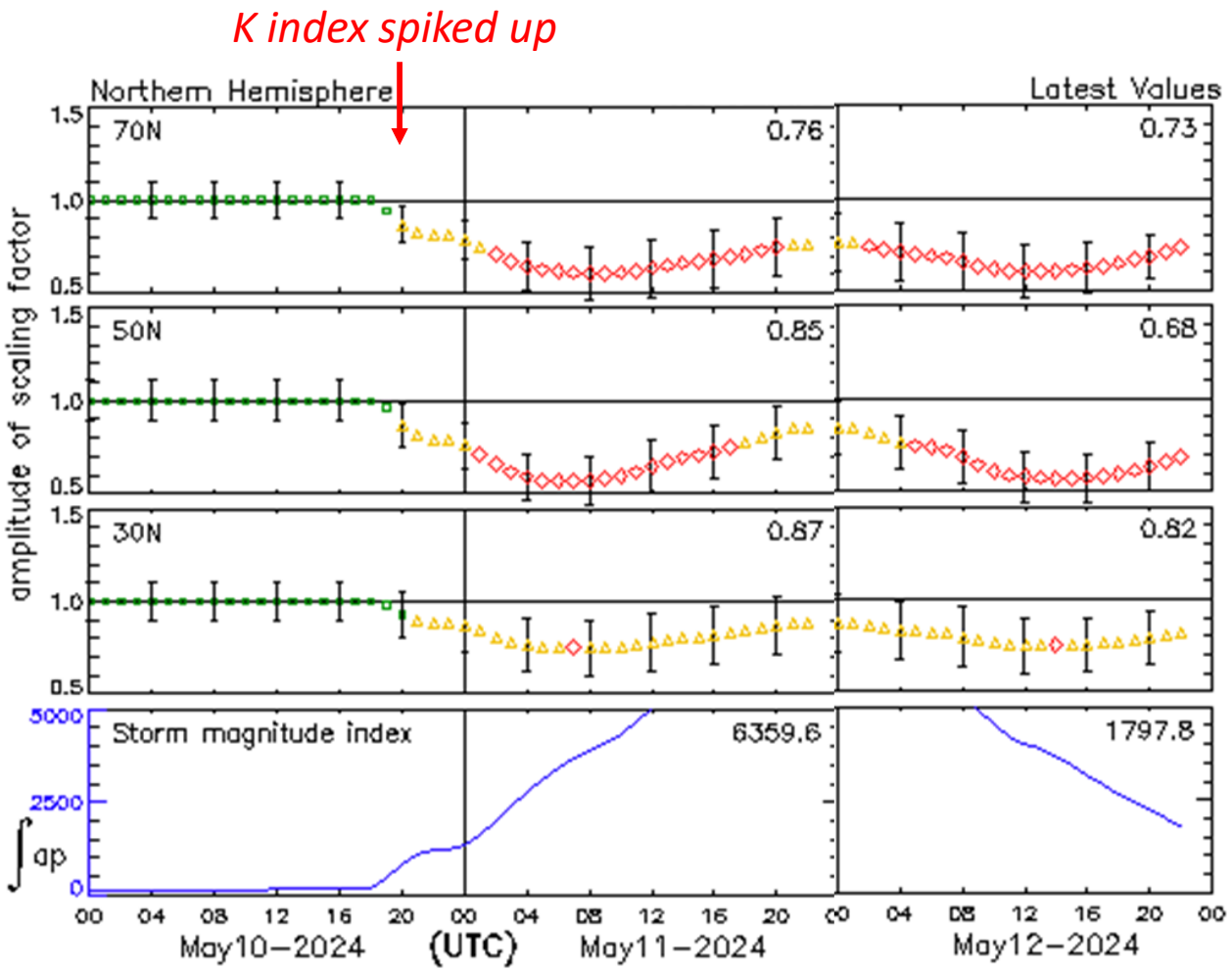
Radio Blackout & Solar Radiation Storm



- Radio blackout - more D region absorption under overhead Sun due to x-ray radiation from M-2.4 solar flare
- Solar radiation storm - more D region absorption in the polar caps due to energetic protons from solar flares (CMEs could be involved)

https://www.swpc.noaa.gov/products/d-region-absorption-predictions-d-rap

Geomagnetic Storm – Worst of the 3



- K index from 0 (quiet magnetic field) to 9 (extremely disturbed magnetic field)
- K index was ≥ 7 for almost two days
- Resulted in F2 region losing electrons
- When the MUF decreases, lose the higher HF bands

https://www.swpc.noaa.gov/products/storm-time-empirical-ionospheric-correction

Guidelines for the Next Several Years

What to Expect

- Parameters that determine if a QSO takes place
  - D region absorption and F2 region ionization
- 160m, 80m
  - D region absorption is critical – amount of F_2 region ionization is usually high enough
  - Best around solar minimum
  - Good at night for DX contacts – thunderstorms don't help ☹
  - Keep an eye on sunrise and sunset – in my experience, sunrise on the east end of a path is better than sunset on the west end of a path
  - General consensus seems to be that 160m isn't as good as it used to be

What to Expect

- Transition bands – 40m, 30m, 20m, 17m
  - These bands are transitioning from D region absorption being critical (40m not as bad as 160m) to the amount of F2 region ionization being critical (17m not as bad as 10m)
  - Generally good over a solar cycle
  - 40m, 30m - nighttime
  - 20m, 17m - daytime
- 15m, 12m, 10m, 6m
  - Amount of F_2 region ionization is critical – D region absorption is minimal
  - Best around solar maximum
  - Great worldwide propagation during the fall and winter months
  - Lower MUFs during the summer months – sporadic-E can help mitigate this ☺

Summary

- Cycle 25 has leveled off – will it go higher?
- So far, Cycle 25 kind of looks like another small-ish cycle
- If we're in this third period of small cycles, Cycle 26 could be small
- The digital modes offer an advantage over CW and SSB
  - Can decode a signal farther down in the noise
    - How much farther down depends on which digital mode
  - This is a significant advantage on 10m and 6m
- Take advantage of the summer E_s season on 10m and 6m
- There are tools on the internet to determine what the bands are doing right now
  - For example, dxmaps.com, PSKreporter, WSPRnet, RBN, etc