

Cycle 25, 10m Long Path, 6m F2, Are the Bands Open Now?

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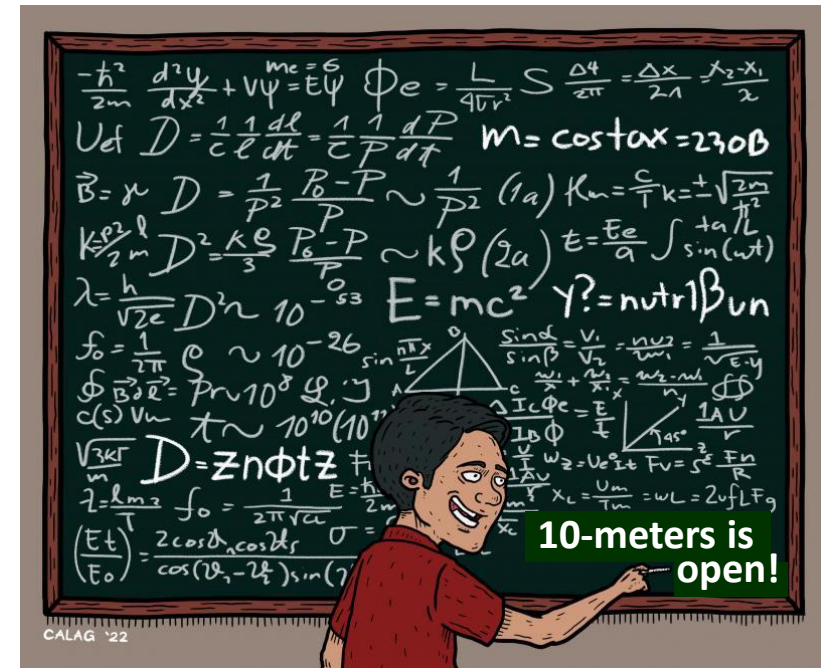


spiral aurora over Tromso, Norway
December 11, 2022

Purpose of This Presentation

- *Review solar, space weather, ionosphere and propagation issues*
- *Just as important, to encourage you to get on the air on the higher HF bands to take advantage of the great worldwide propagation on these bands*

FCC part 97.1 (e) Continuation and extension of the amateur's unique ability to enhance international goodwill.

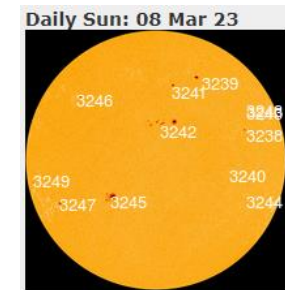


Agenda

- Cycle 25
 - Predictions and real data
- 10-Meter long path
 - Add some spice to your operating time this spring through fall
 - Should apply to 15m and 12m, too
- 6m F2 propagation
 - We've already had some
 - Should be more this fall/winter
- Are the bands open now?
 - Propagation predictions
 - Space weather
 - Real-time data

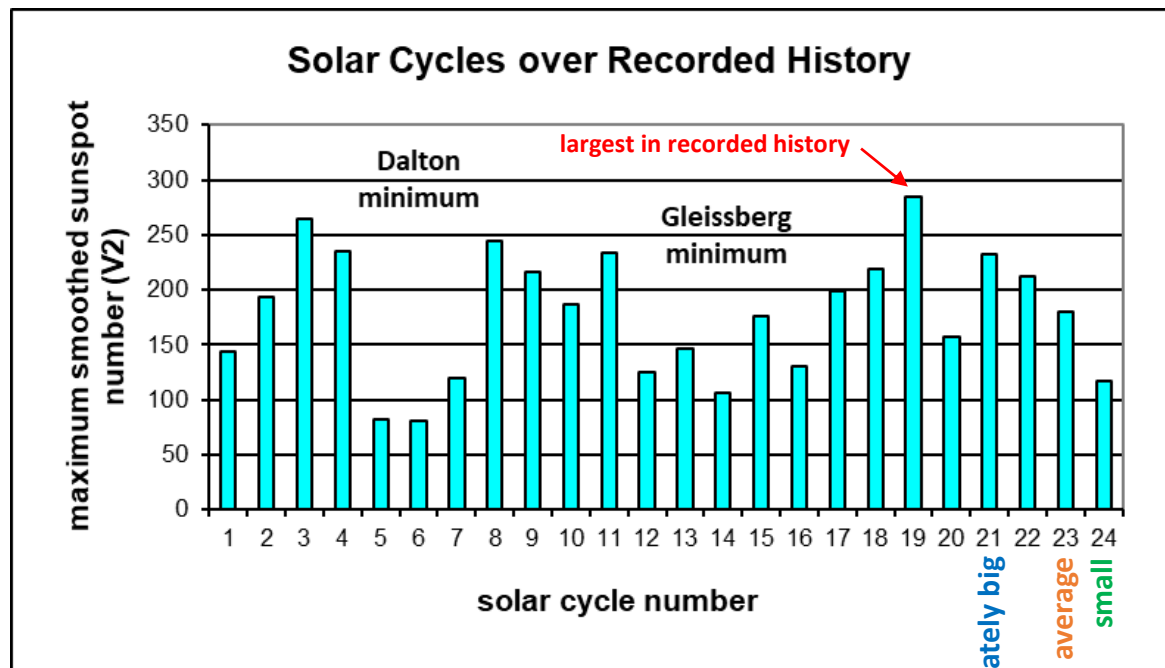


Cycle 25



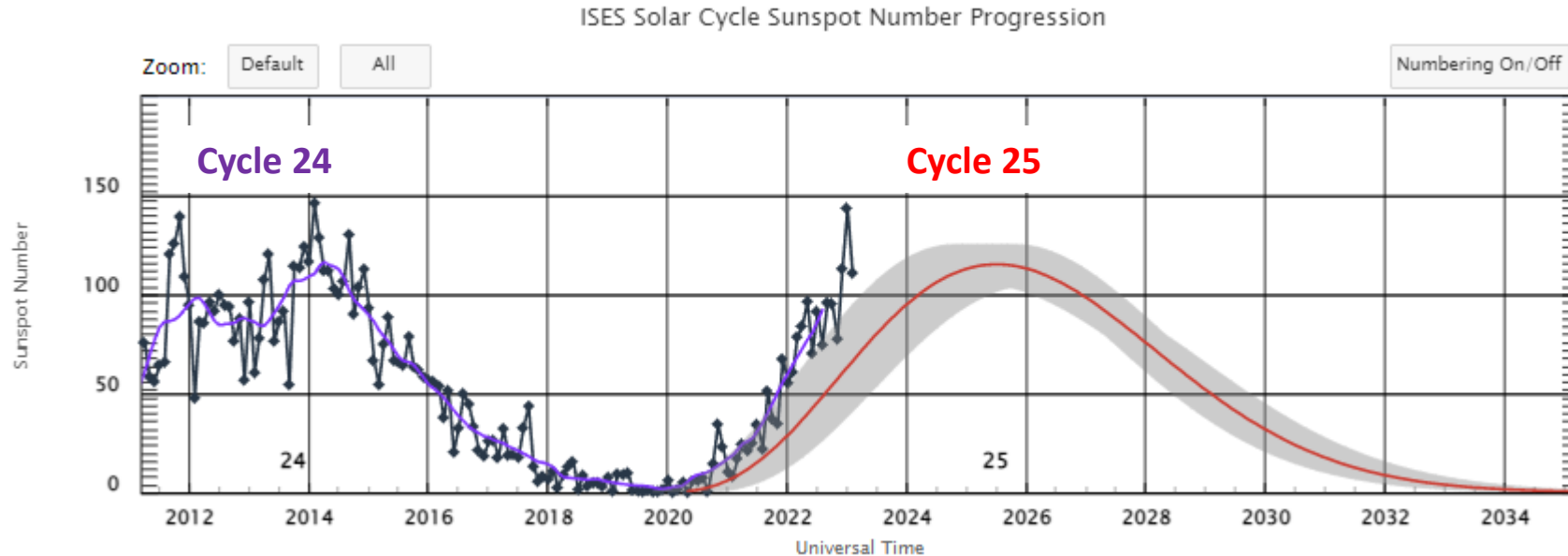
Historical Look at All 24 Cycles

- Cycle 1 began in 1755
 - No, I wasn't around back then
- We've gone through 3 periods of 'big' solar cycles
 - Cycles 1-4, 8-11, 17-23
- We've gone through 2 periods of 'small' solar cycles
 - Cycles 5-7, 12-16
- With Cycle 24, we appear to have entered a third period of small solar cycles



- *Will Cycle 25 get us out of this possible third period of small cycles?*
- *Will this minimum period have bigger cycles than the last minimum period?*

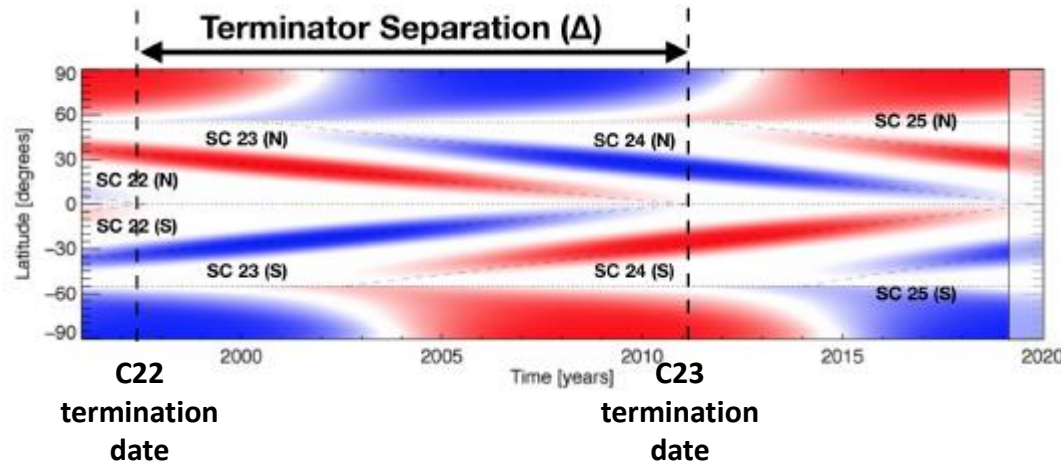
NOAA/NASA/ISES Prediction



- From the Solar Cycle Prediction Panel representing NOAA, NASA and the International Space Environmental Services (ISES)
- Their prediction (red line) for Cycle 25 starts in May 2020
- Cycle 25 actually started in December 2019
- If you move the red prediction line 5 months to the left . . .

Prediction from McIntosh and Colleagues

- They identify “termination” events
 - Points in time marking the start and end of sunspot and magnetic field cycles on the Sun



Cycle 22 termination date = April 1998

Cycle 23 termination date = January 2011

Δ correlates to the size of the next cycle

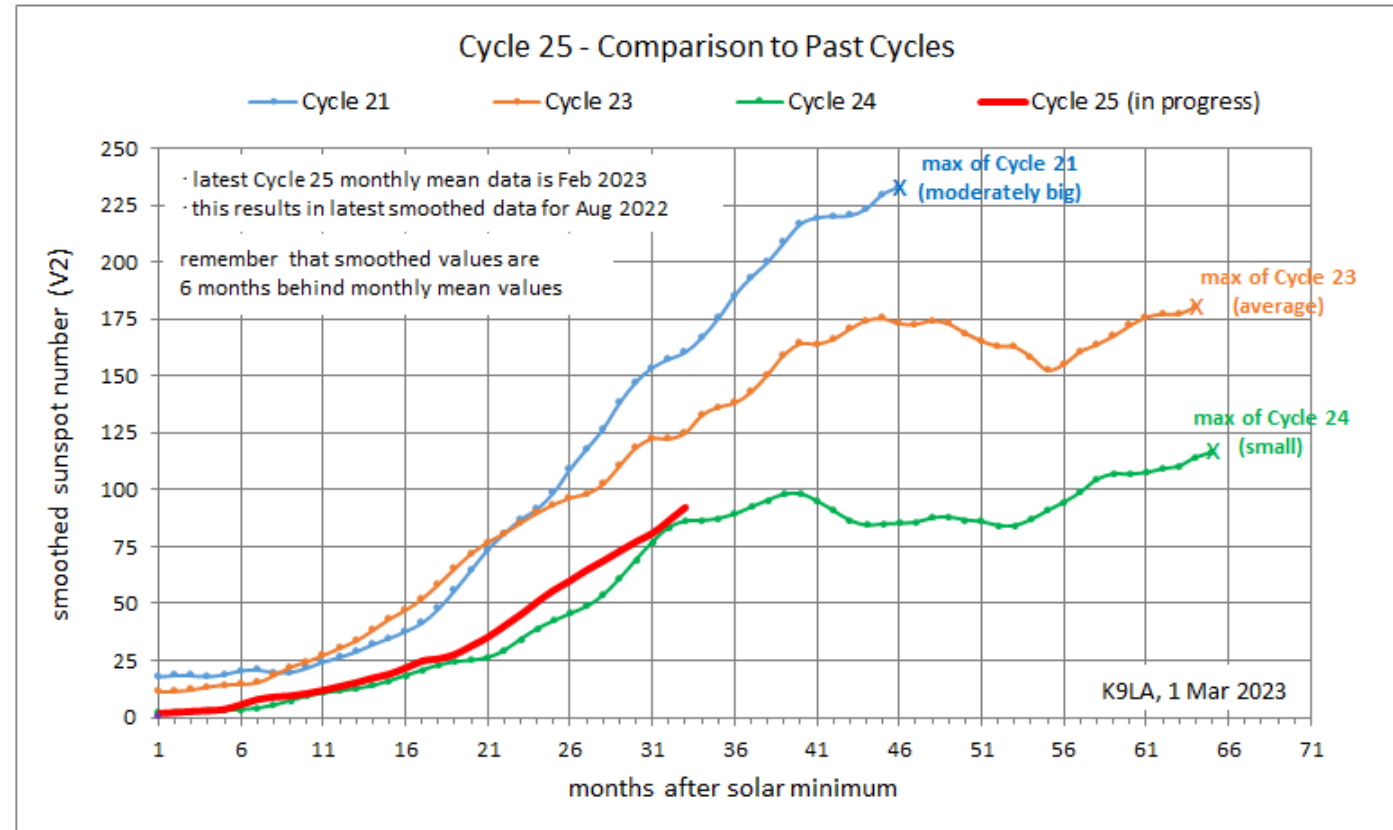
Shorter Δ says a bigger cycle

$\Delta = 12.83$ years \implies Cycle 24 \sim 130 (actual 120)

- Initial prediction for Cycle 24 termination date was May 2020 ($\Delta = 9.3$ years)
 - Resulted in Cycle 25 prediction to be similar to Cycle 21 (moderately big)
 - $233 \pm 29/-21$ at 68% confidence - <https://arxiv.org/abs/2006.15263>
- Cycle 24 termination date was actually December 2021 ($\Delta = 10.9$ years)
 - Resulted in revised prediction for Cycle 25 – now similar to Cycle 23 (average)
 - 190 ± 20 – visit the March 1, 2022 issue of <https://spaceweather.com/>

Enough Predictions – What Does the Data Say?

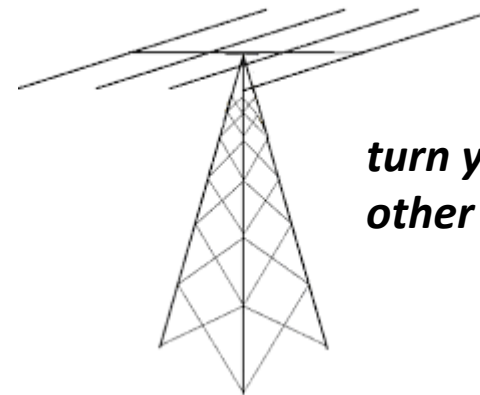
- As noted earlier, solar minimum was in December 2019
- We currently have 33 months of smoothed sunspot number data since solar minimum
- So far, we appear to be tracking the small Cycle 24
- But we have enough EUV (extreme ultra-violet) radiation for 15m, 12m and 10m
 - EUV is the true ionizing radiation for the F2 region of the ionosphere
 - Sunspots and 10.7 cm solar flux are proxies for EUV



Hopefully Cycle 25 will continue to move up to an 'average' cycle

10-Meter Long Path

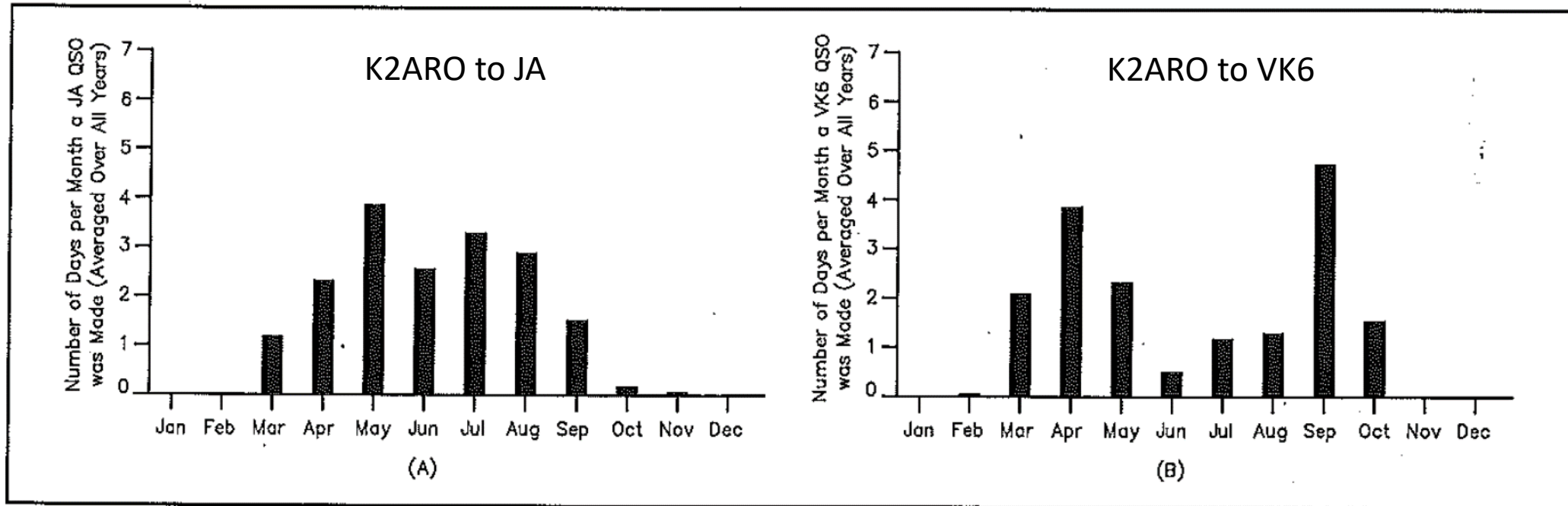
- *My interest in 10-meter long path started with CQ WW DX PH in 1986*
- *Worked VS6DO (Hong Kong – now VR2) pointing southeast at 8 AM when we lived in the Dallas-Ft Worth area*



turn your antenna the other way around

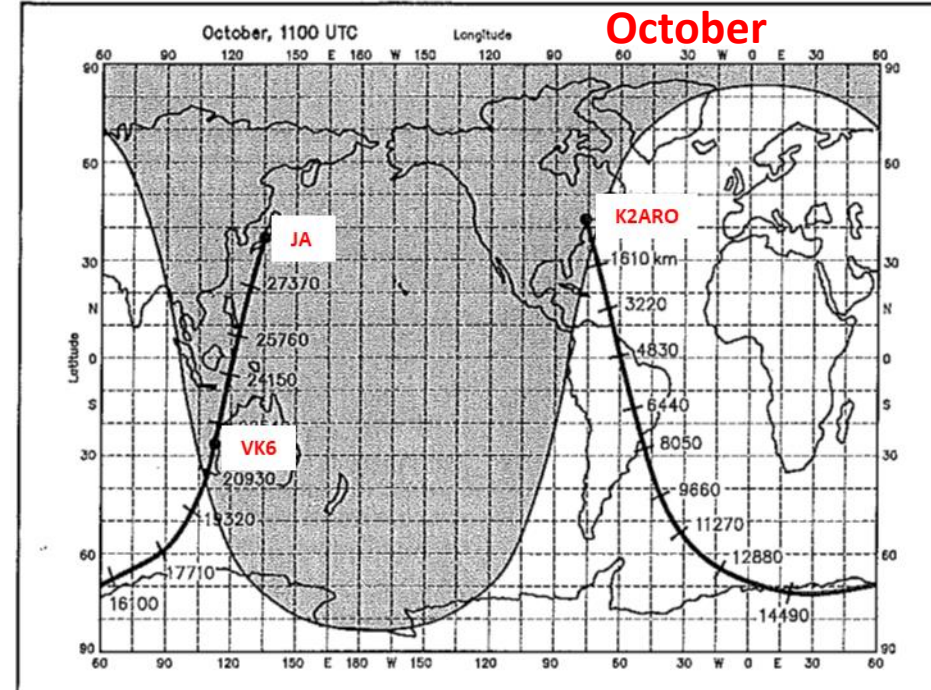
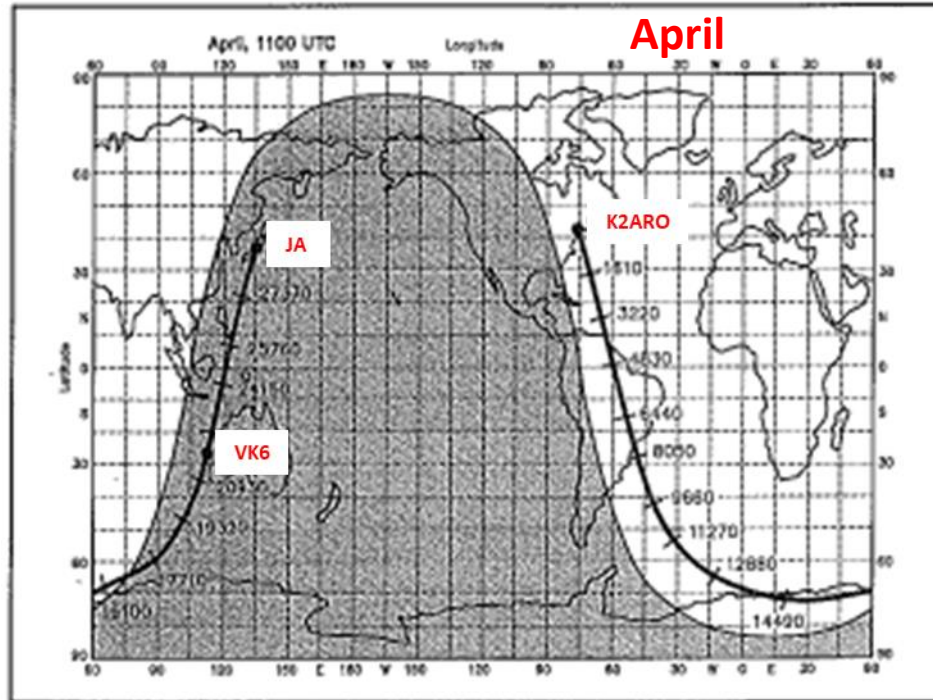
K2ARO Data

Data from Jan 1979 through Dec 1993 (Cycles 21 and 22)



- 10m long path available from March thru October
- Needed conditions
 - East end of path – at or a bit after sunrise
 - West end of the path – not too many hours after sunset
 - Someone on the other end

Typical Long Path



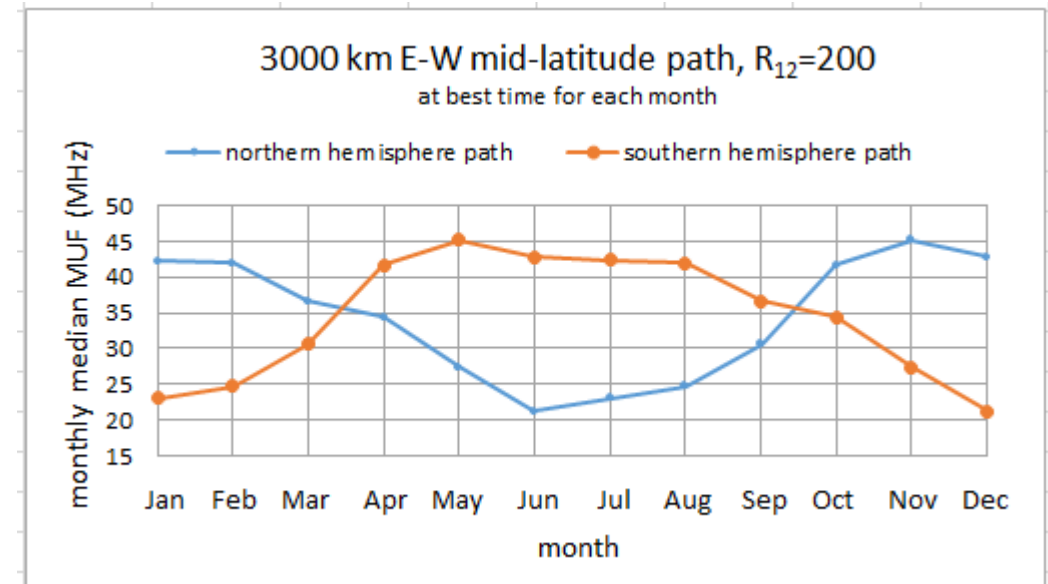
- 10m long path not necessarily a grayline path*
- Mar 22nd to Sep 22nd most productive
 - 90% of JA QSOs, 77% of VK6 QSOs
- Before Mar 21st and after Sep 23rd
 - 10% of JA QSOs, 23% of VK6 QSOs

* A grayline path is when the entire path aligns with or is very near the terminator

May evening have TEP into JA

Why March thru October?

- Oxygen atoms (O) are good for electron production
- Molecular nitrogen (N₂) is good for recombination
- Thus we'd like a high O/N₂ ratio
 - Many more electrons being produced than being recombined
- The highest O/N₂ ratio is in the fall and winter months for each hemisphere
- 10m long path is mostly in the southern hemisphere (see slide 11)



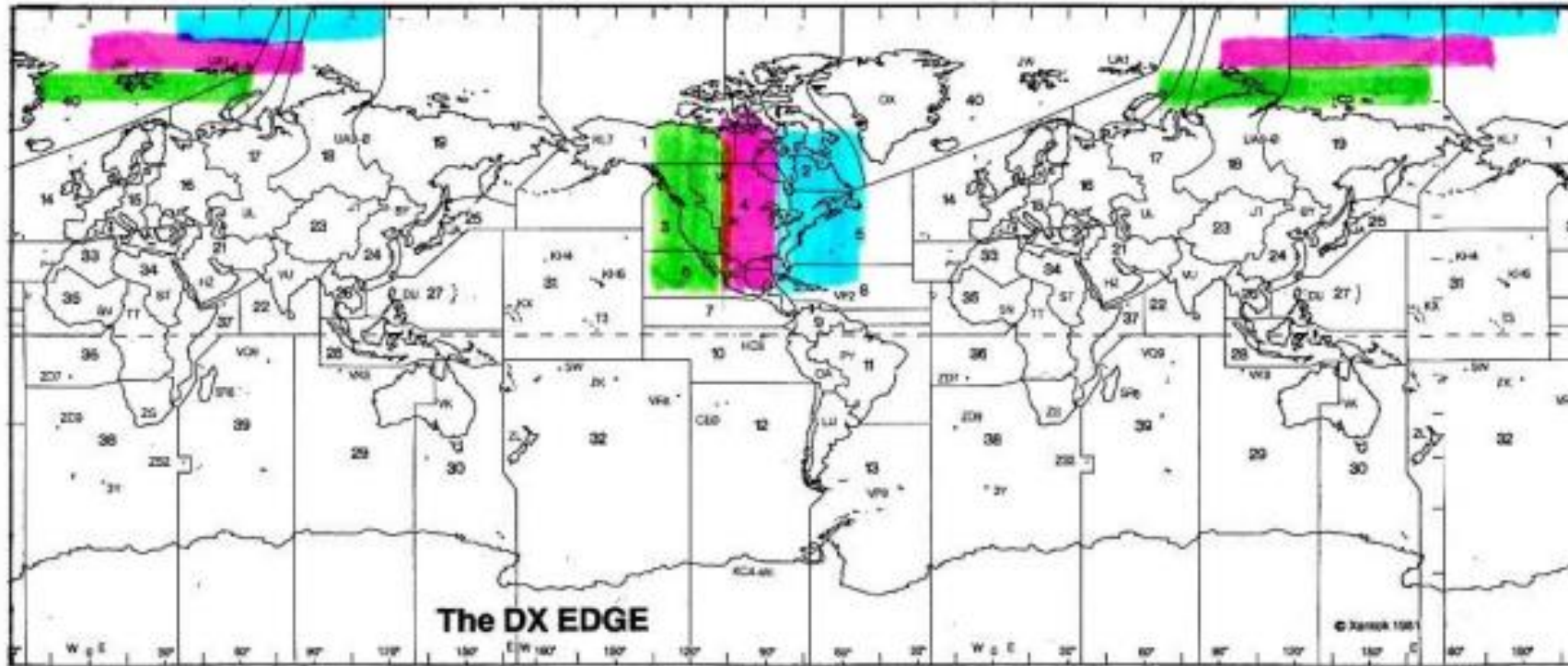
- *Northern hemisphere fall and winter is October thru February*
- *Southern hemisphere fall and winter is March thru September*

The Big Picture

**North America
evening long path**

Note the color of where you are in the US. For morning long path, the colored horizontal bars in the upper right depict your longitude opportunities. Ditto for the evening long path in the upper left.

**North America
morning long path**



The real question - is anyone on the other end?

For more details: [https://k9la.us/A Refresher on 10m Long Path.pdf](https://k9la.us/A%20Refresher%20on%2010m%20Long%20Path.pdf)

Data from logs from K2ARO, N6AV (SK), NT5C (SK) and skeds with JH3DPB (SK)

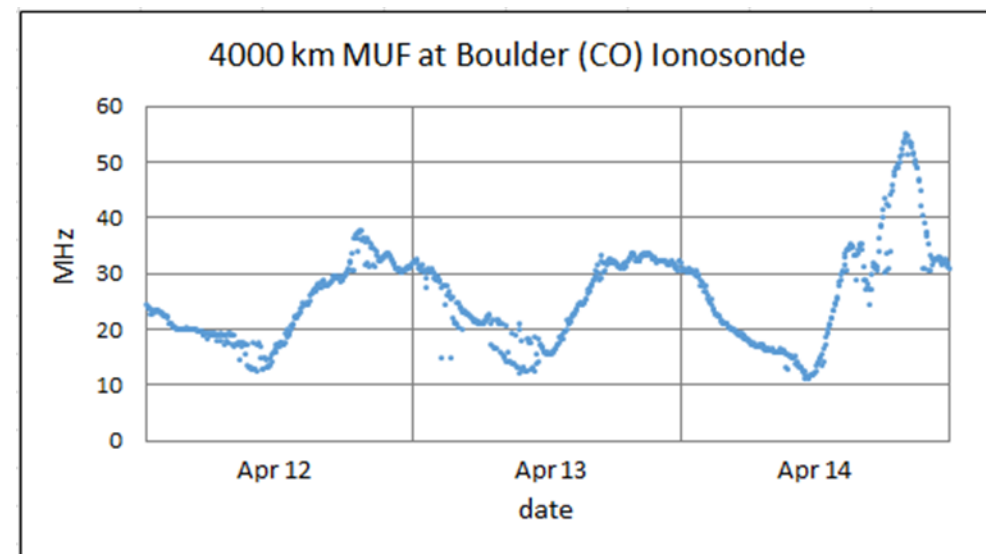
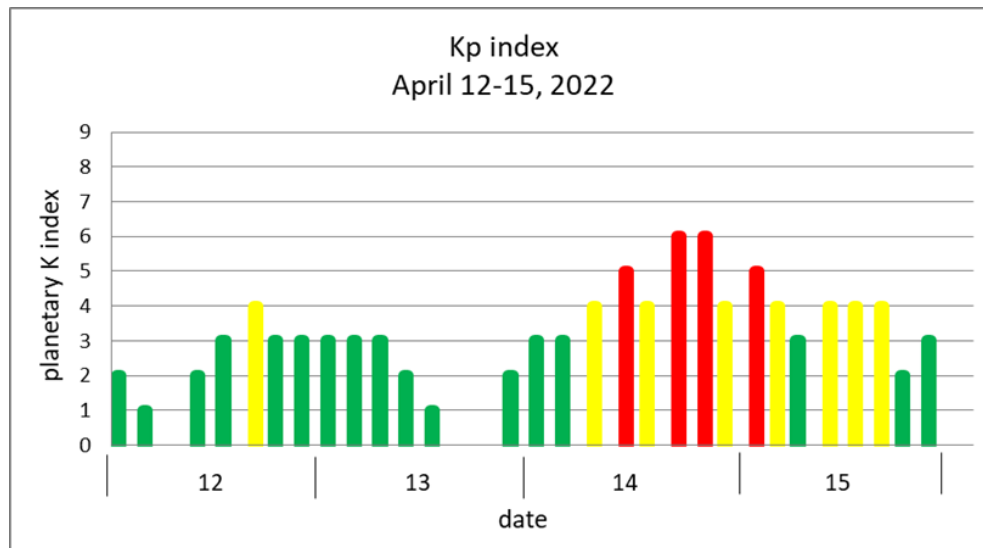
6-Meter F2 Propagation

*We've come a long way since
the Heathkit Sixer days*



April 14, 2022

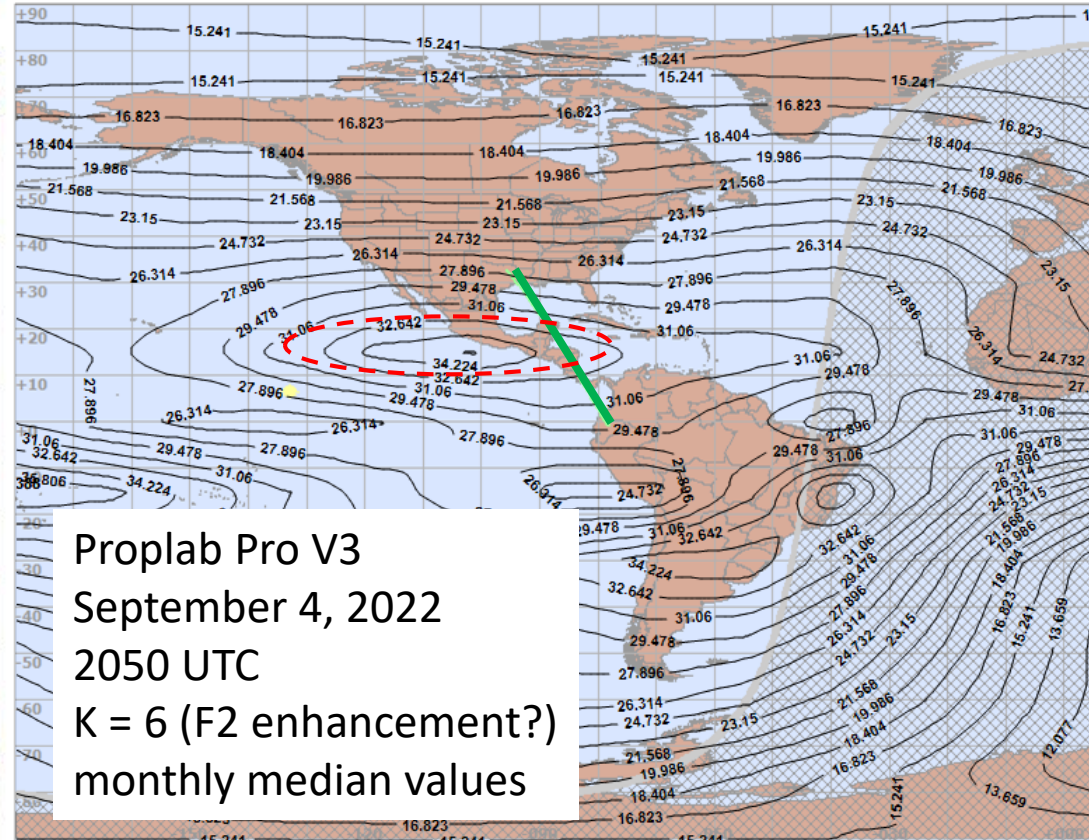
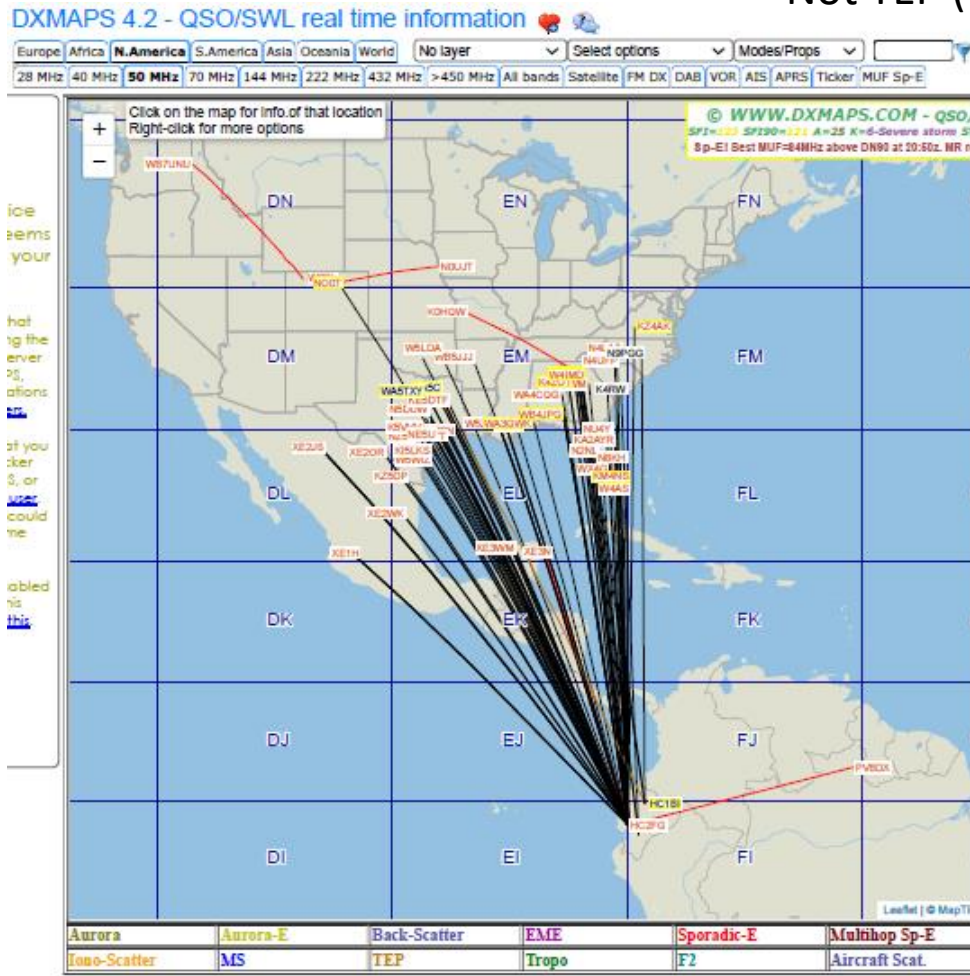
- 10.7 cm solar flux was 99 – not enough for 6-meter F2 propagation (need around 200 and above)
- Help from the K index – it spiked up to 5 and 6 on April 14
- Boulder ionosonde showed F2 region enhancement on April 14
- Lots of continental QSOs



- Austin (TX) and Eglin AFB (FL) ionosondes showed similar F2 region enhancements
- Take-away – watch for 6-meter F2 propagation when the K index spikes up

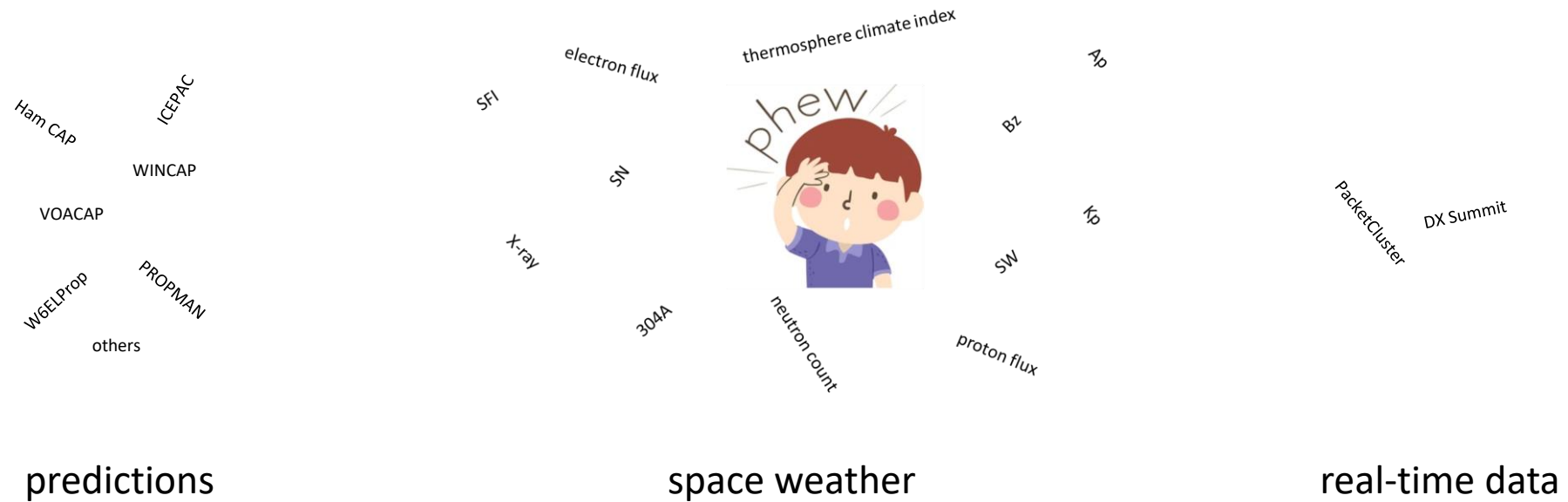
September 4, 2022 around 2050 UTC

Not TEP (Trans-Equatorial Propagation)



Note location of the northern crest of the equatorial ionosphere (dashed red line) – did that help, too?

Are the Bands Open Now?



Propagation Predictions

- Scientists recorded solar data and ionosphere data
- The result they desired was a correlation between a daily solar parameter (sunspots or 10.7 cm solar flux) and what the ionosphere was doing today
- That correlation didn't happen – the correlation was poor
 - For example, SFI 90 yesterday and SFI 100 today – but the MUF today is lower
- Why? Because there are three sources of variability of the ionosphere and we only fully understand two of them
 - Solar radiation – sunspots, 10.7 cm solar flux, EUV (and MUF US Boulder – more on this later)
 - Geomagnetic field activity – K index, A index, Bz and solar wind
 - Events in the lower atmosphere coupling up to the ionosphere – no parameters (yet)
- Tough to make a daily model with data from only 2 of the 3 sources

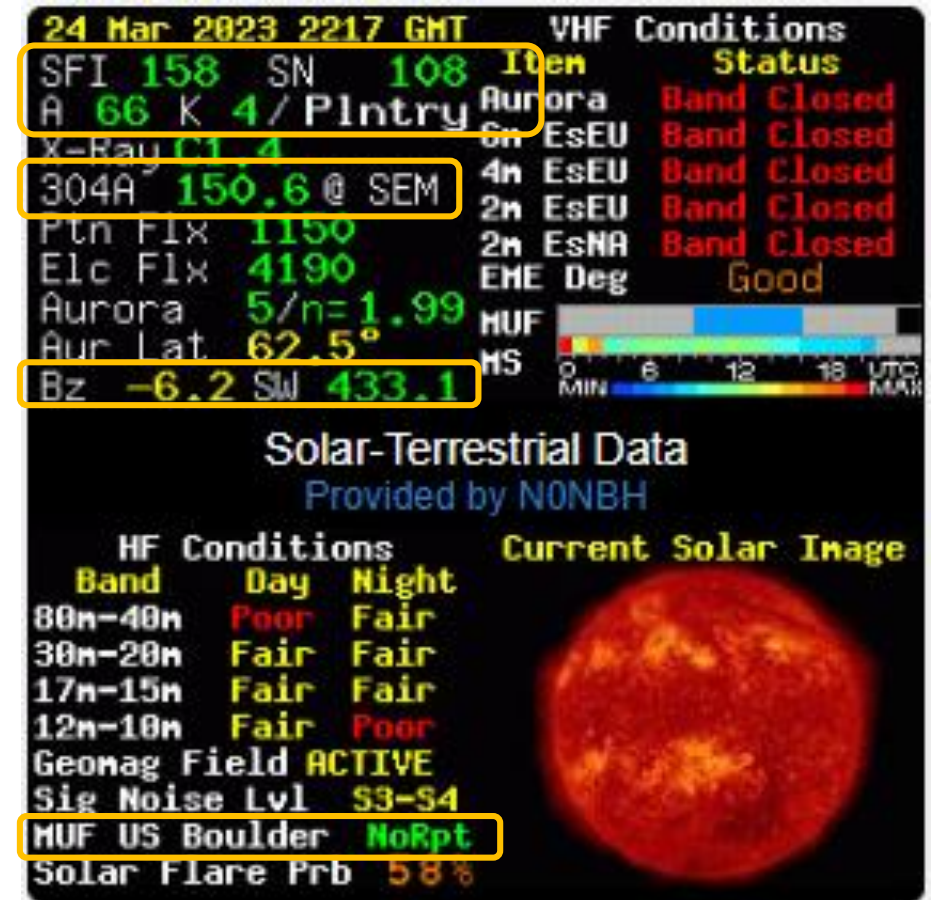
Here's What We Ended Up With

- A monthly median model of the ionosphere
 - Median implies 50% probability
 - Correlated to a smoothed solar parameter (long-term average of daily data)
 - Our understanding of the ionosphere is statistical over a month's time frame
- Our propagation predictions give monthly median MUF and signal strength
 - There's a distribution about these median values
 - The MUF on any given day in the month could be somewhat higher to much lower than the median
 - The signal strength on any given day in the month could be somewhat higher to much lower than the median
 - Unfortunately this doesn't tell us which are the 'good' days and which are the 'not so good' days
 - Plugging in the daily 10.7 cm solar flux and the current K index won't make the predictions more accurate

Our predictions are probabilities

Space Weather Parameters

- Slide 18 mentioned SN, SFI, EUV, K, A, Bz and solar wind
- One place to get them is from the NØNBH banner at www.qrz.com or from K7RA's weekly report or many other places
- Let's review SN, SFI, EUV, K, A, Bz and solar wind
- Note 'MUF US Boulder' at the bottom
 - This is a real-time indicator when there is data



Descriptions of These Parameters

- **SFI** – 10.7 cm solar flux – from 65 to 350
 - SN – sunspot number – from 0 to 450
 - EUV – extreme ultra-violet radiation – from 100 to 400
 - MUF US Boulder – MUF when Boulder is midpoint of 3000 km path
- general correlation
- **K** – 3-hr index of the activity of the Earth’s magnetic field – from 0 to 9 (logarithmic)
 - A – avg of the eight daily K indices – from 0 to 400 (linear)
 - Bz – north/south component of the IMF* – from +50 to -100
 - SW – solar wind speed – average for quiet time is 400 km/s – from 350 km/s to 2000 km/s
- general correlation

*We'll focus on the parameters in **green***

** IMF is Interplanetary Magnetic Field (Sun's magnetic field)*

What We Desire for SFI and K

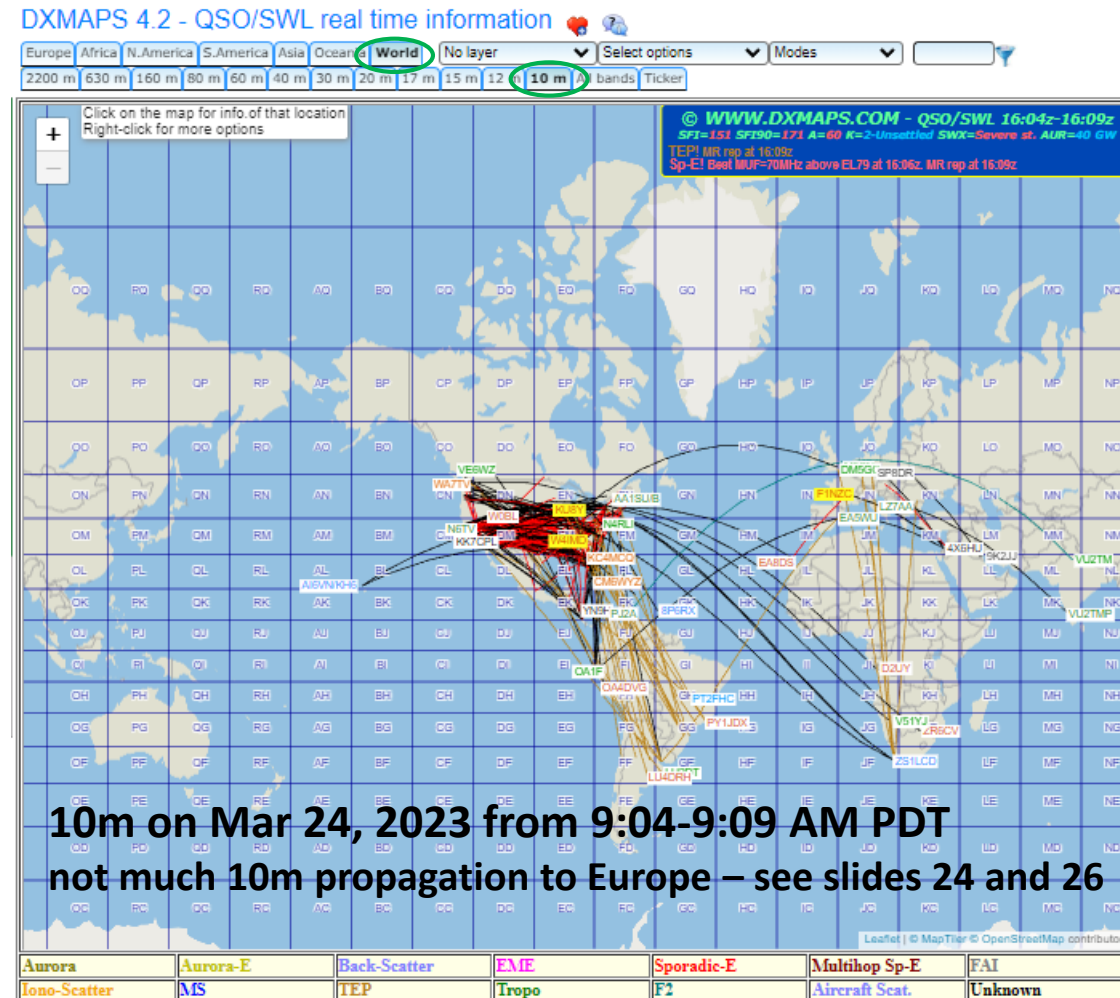
- We need two conditions for a QSO to occur
 - Enough ionization (MUF) to refract the signal back to Earth
 - Low enough loss (absorption, FSPL, antenna gains, transmitter power, receiver MDS, ground reflection loss, local noise) to make signal readable (or detectable)
- What we desire
 - Generally $K \leq 3$ (caveat – a single K index is not sufficient)
 - When $K > 3$, the MUF could be decreased
 - OTOH, VHF types like high K indices for propagation via aurora
 - SFI for the higher HF bands (15m, 12m, 10m)
 - 15m: need smoothed SFI > 90
 - 10m: need smoothed SFI > 100
- Where we are right now
 - Smoothed SFI ~120
 - If the smoothed SFI (or SN) is high, the MUF could be depressed due to high K indices

***Space weather parameters only give us
a general idea of what's happening***

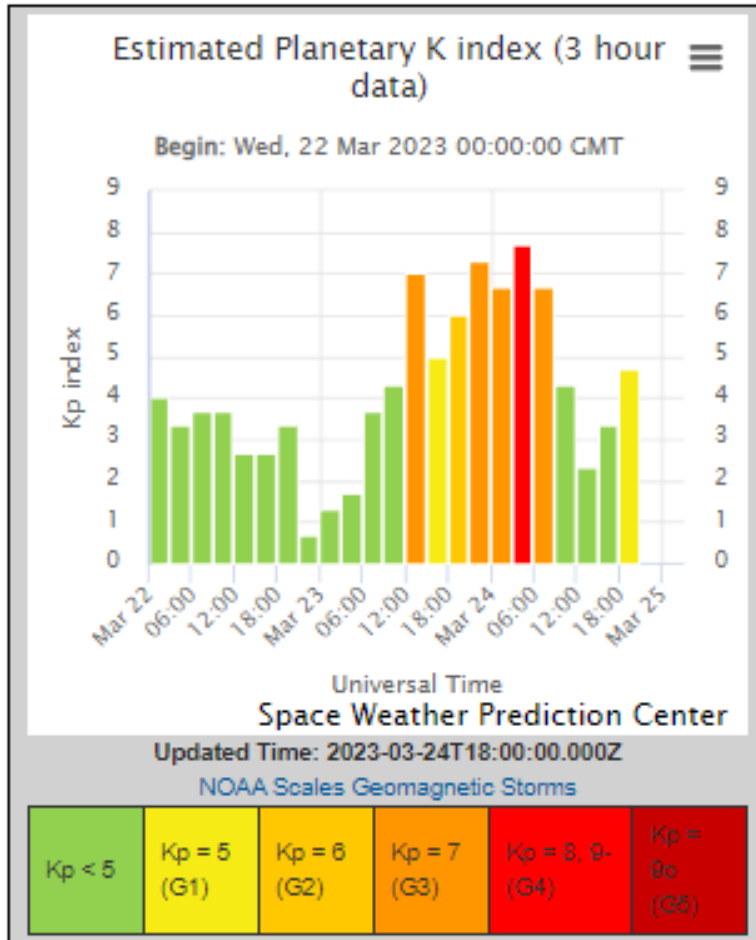
Real-Time Data

- If you don't want to mess with propagation predictions or with all those space weather parameters, go to dxmaps.com
- Select a view (World, NA, . . .)
- Select a band
- Other methods
 - KC2G MUF map (next slide)
 - PSKreporter
 - WSPRnet
 - Reverse Beacon Network
 - IARU/NCDXF beacons

*These sites give
real-time data*



Kp – Yesterday and Today



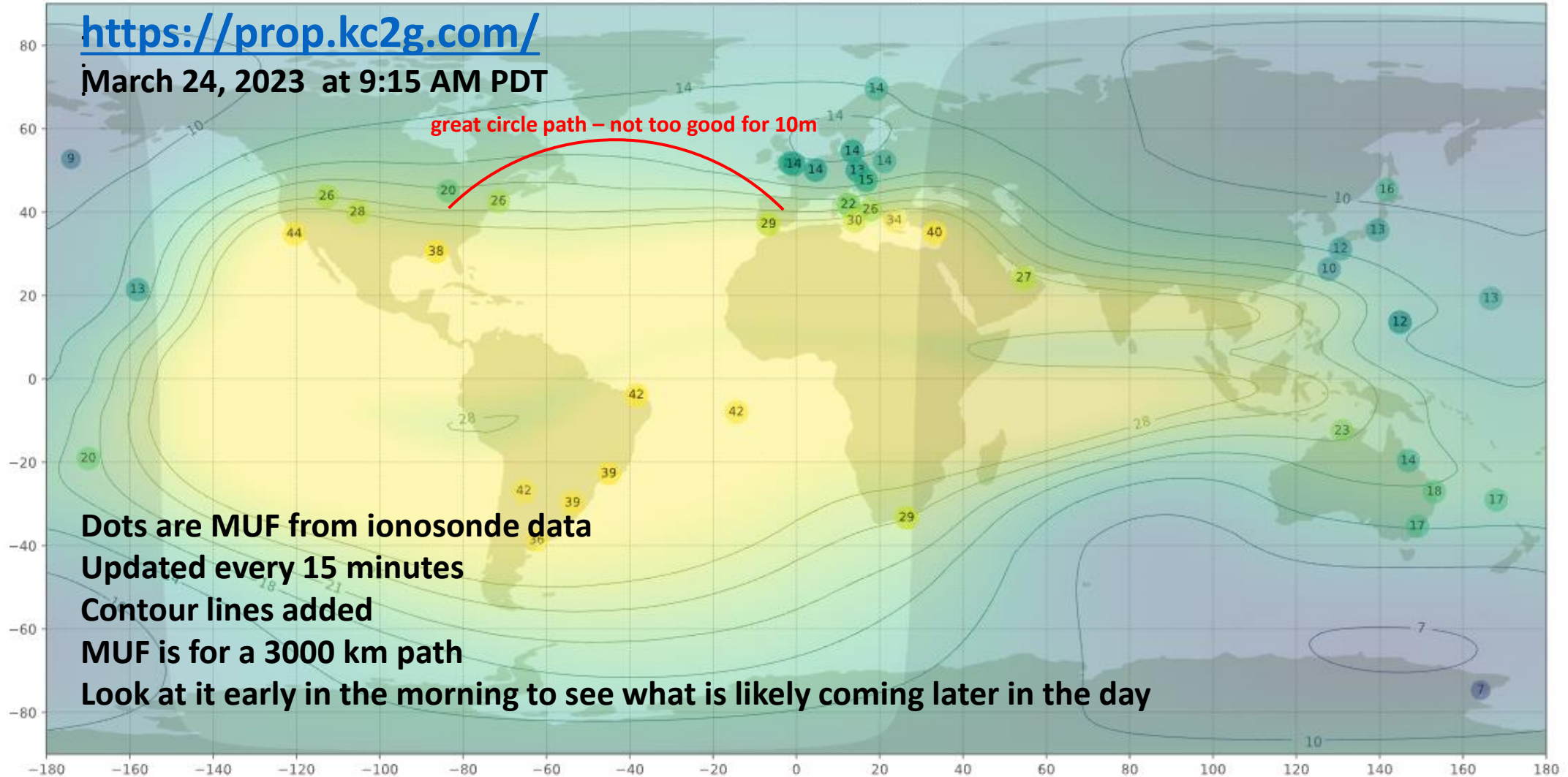
- Pretty high K indices about 24 hours ago
- WPX SSB will be affected

Real-Time Assessment of the Bands

url's for websites on slide 23

- dxmaps.com
- KC2G MUF map – <https://prop.kc2g.com/>
- PSKreporter - <https://pskreporter.info/pskmap.html>
- WSPRnet - <https://www.wsprnet.org/drupal/wsprnet/map>
- Reverse Beacon Network - <https://www.reversebeacon.net/>
- IARU/NCDXF beacons - <https://www.ncdxf.org/beacon/>

What's the MUF Doing Right Now?



Summary

- Cycle 25 is awake and is in its ascent
 - Solar maximum around 2024/2025
 - Even if it is a small cycle, now and around solar maximum will offer worldwide propagation with modest power (100W) and simple antennas (vertical or dipole) on 15m, 12m and 10m
- Should have more 6m F2 propagation this fall/winter
 - Additional openings to be analyzed at the 6m BBQ at W6JKV's ranch near Austin, TX in late September
- Real-time data (slide 25) is best way to tell if a band is open
- The digital modes offer an advantage over CW and SSB

Get radio-active !!!