DX University
Visalia, California – 2013

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Propagation for Working DX

Carl Luetzelschwab K9LA

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Carl Luetzelschwab K9LA received his Novice license WN9AVT in October 1961. He upgraded to General in May 1962. In 1977 he selected K9LA.

Carl enjoys propagation, DXing, contesting (he was the Editor of The National Contest Journal from 2002-2007), antennas, and vintage rigs. He received a BSEE and MSEE from Purdue, and professionally he is an RF design engineer with Raytheon (formerly Magnavox). Retirement is on the horizon.

Carl's primary expertise for DXU is propagation. Carl is a DXCC Card Checker with the ARRL, is at the Top of the Honor Roll, and enjoys viewing extremely old QSLs (especially from deleted entities).

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What We'll Cover

- **Cycle 24 update**
- **What to expect on the bands in the next couple years**
- **Mitigation for disturbances to propagation**
- **Propagation predictions**
- **Real-time assessment of the bands**

- **References at the end**

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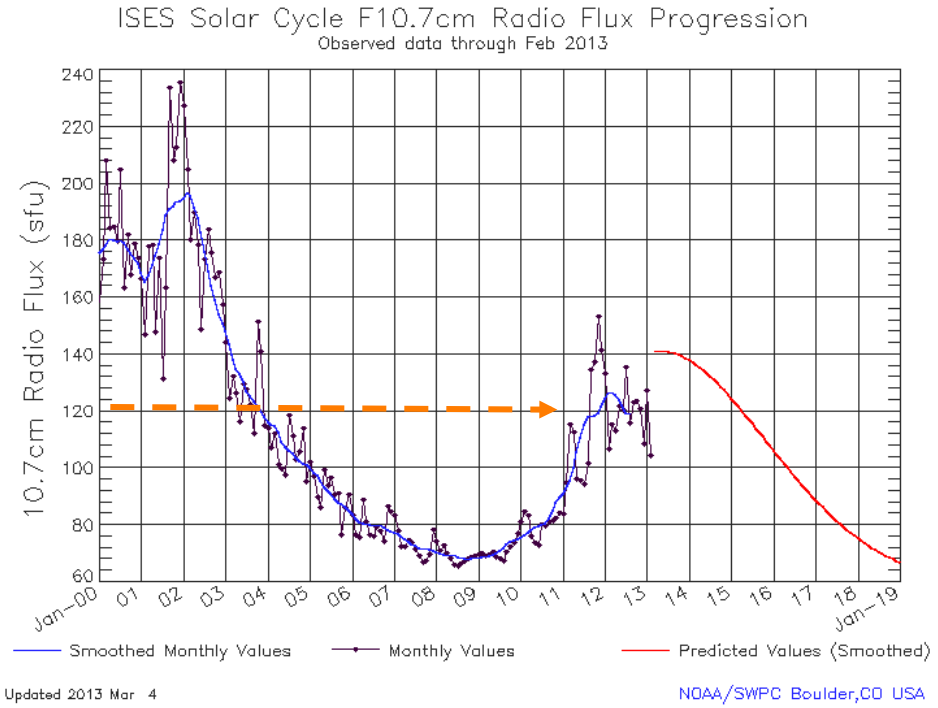
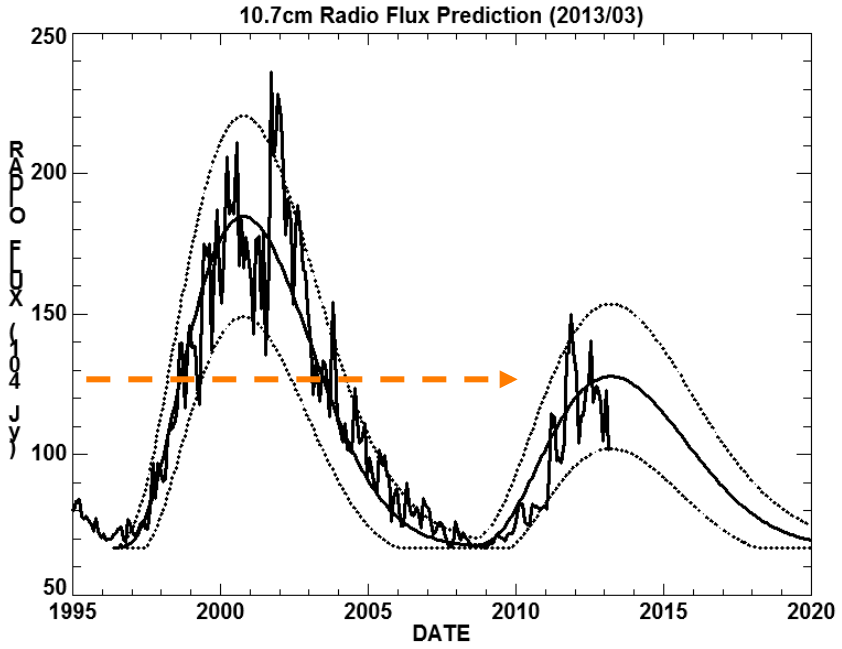
ISES and MSFC Predictions

ISES on the left, MSFC on the right





http://www.swpc.noaa.gov/SolarCycle/

http://solarscience.msfc.nasa.gov/images/f107_predict.gif

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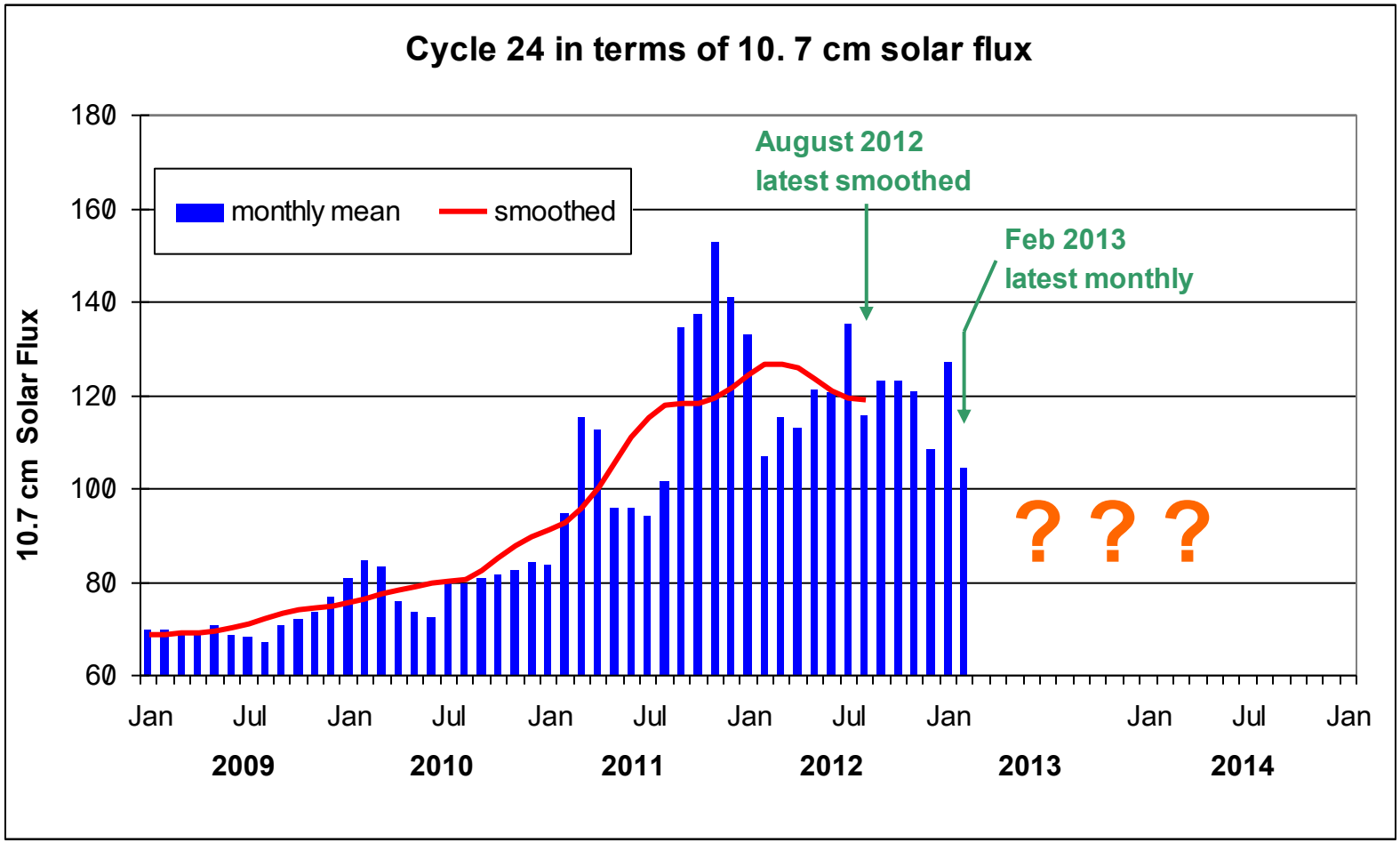
Cycle 24 Actuals



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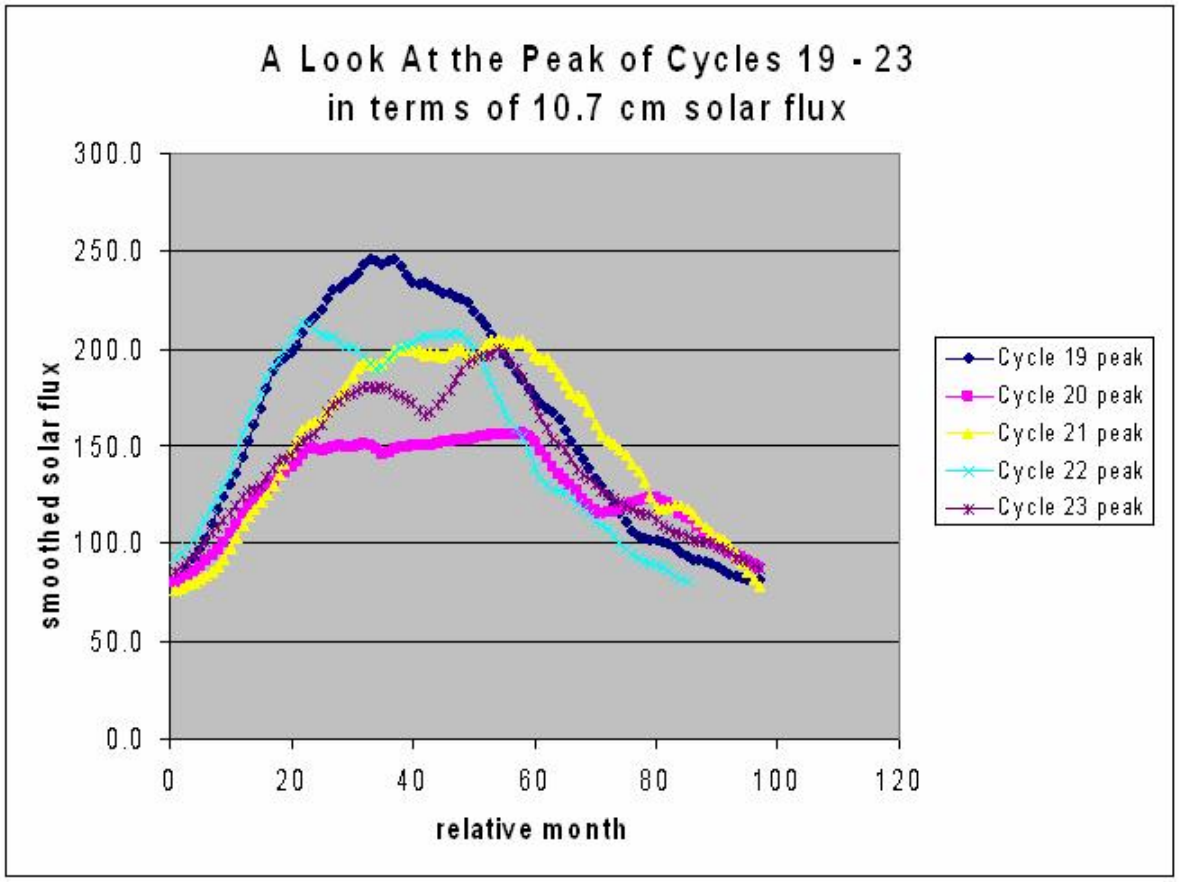
Two Peaks?

- **Dr. Dean Pesnell (Goddard Space Flight Center) believes we'll have a second peak**
- **Last two solar cycles had double peaks**
- **Some earlier ones did, too**
- **But not a lot of data on which to base a guess**



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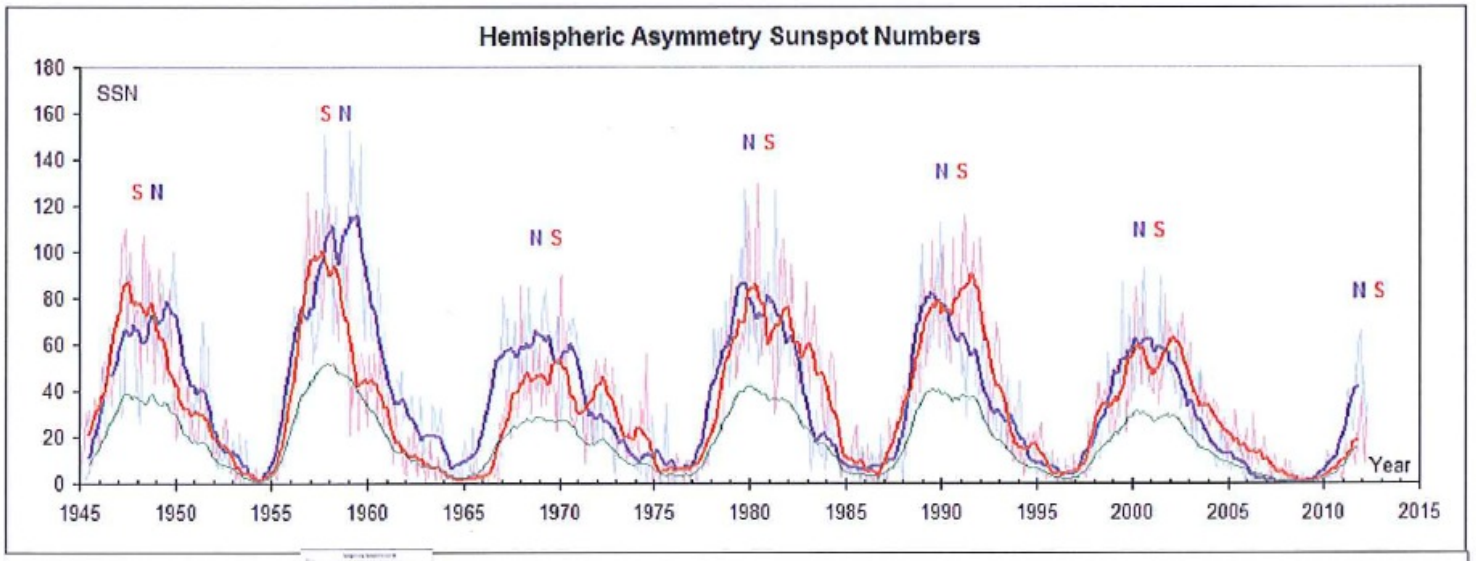
Hemisphere Asymmetry

- **Northern hemisphere has dominated Cycle 24 so far**
- **Southern hemisphere responsible for Cycle 22 and 23 double peaks**
- **If the southern hemisphere gets going . . . .**



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15m, 12m, 10m, 6m

- **6m**
  - **F2 openings few and far between away from the equatorial ionosphere**
  - **Expect TEP across the magnetic equator**
  - **Expect sporadic E**
    - **Summer – late morning, early evening**
    - **December – early evening**
- **10m, 12m, 15m**
  - **Next fall should still be decent**
    - **Fall is the best season for MUFs**
  - **After that, it depends on a second peak**

160m, 80m, 40m

- **Supposed to be best at solar minimum**
- **Still lots of DX to be worked at solar maximum**
  - **For example, W8JI worked over 200 countries and all 40 zones on 160m around the peak of Cycle 23**
  - **But most are enjoying strong signals on the higher bands**
- **General consensus that 160-Meters wasn't as good during this solar min as it was during the last solar min**
  - **NM7M's (SK) hypothesis is the effect of galactic cosmic rays on ducting on 160-Meters**

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30m, 20m, 17m

- **Bread and butter bands during an entire solar cycle**
- **Put up the best antenna you can for 20m**
  - **Preferably a Yagi**
- **Or put up the best antenna you can for 17m**
  - **Again, preferably a Yagi**
- **Or try a simple wire antenna on 30m**
  - **Inverted-Vee is approximately 24 feet on a side**
    - **Should do ok on 10m, too (similar to 40m dipole working on 15m)**

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If Cycle 24 Has 2 Peaks

- **Contribution likely from the southern solar hemisphere**
- **Possibility of F2 on 6m**
  - **Similar to the second peak of Cycle 23 in Nov 2001**
- **Interesting topic – second peak had a lower sunspot number but a higher 10.7 cm solar flux – something unusual started going on with the Sun around the peak of Cycle 23**
- **15m, 12m, 10m openings should be extended a couple years**
  - **Regardless, now's the time to think about DXCC, WAS and WAZ on these bands**

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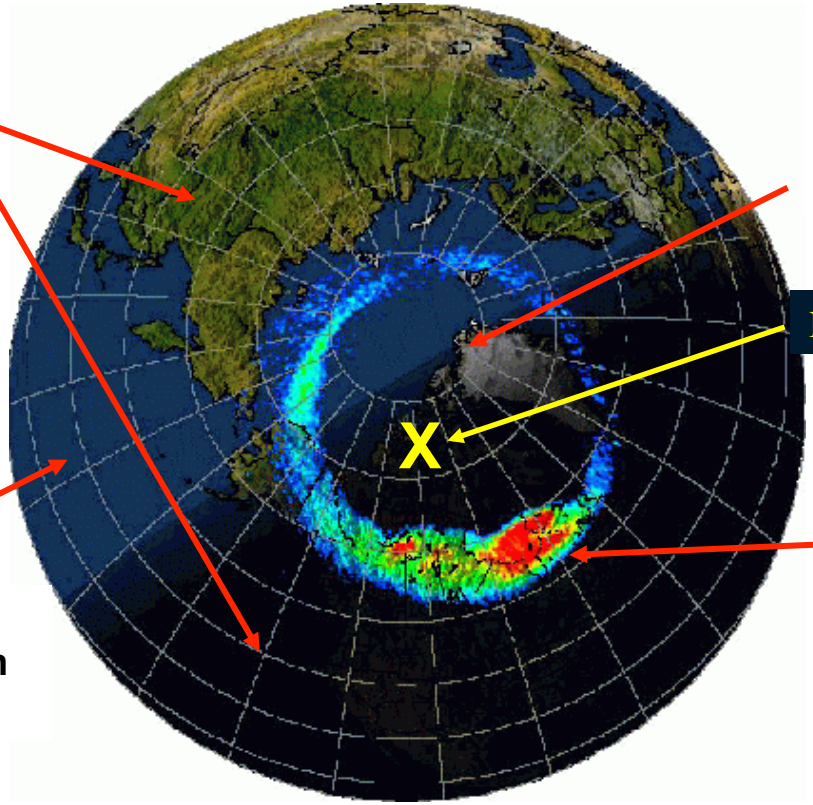
Mitigation for Disturbances to Propagation

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



2) Solar radiation storm - increased D region absorption in the polar cap

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

3) Radio blackout – increased absorption on daylight side of Earth

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Geomagnetic Storms

- **Cause**
  - **CME or coronal hole disturbs the Earth's magnetic field**
    - **Ionization rearrangement in F2 region at all latitudes**
    - **Electron precipitation into the auroral zones**
      - **Impact similar in both auroral zones (north and south)**
  - **Can last for several days**

- **Mitigation**
  - **VHF - check for auroral propagation**
  - **MF - check for skewed paths on 160-Meters**
  - **HF**
    - **Paths across mid and high latitudes – move down in frequency**
    - **Look for enhanced low latitude paths**
      - **for example, southern USA to VK/ZL)**

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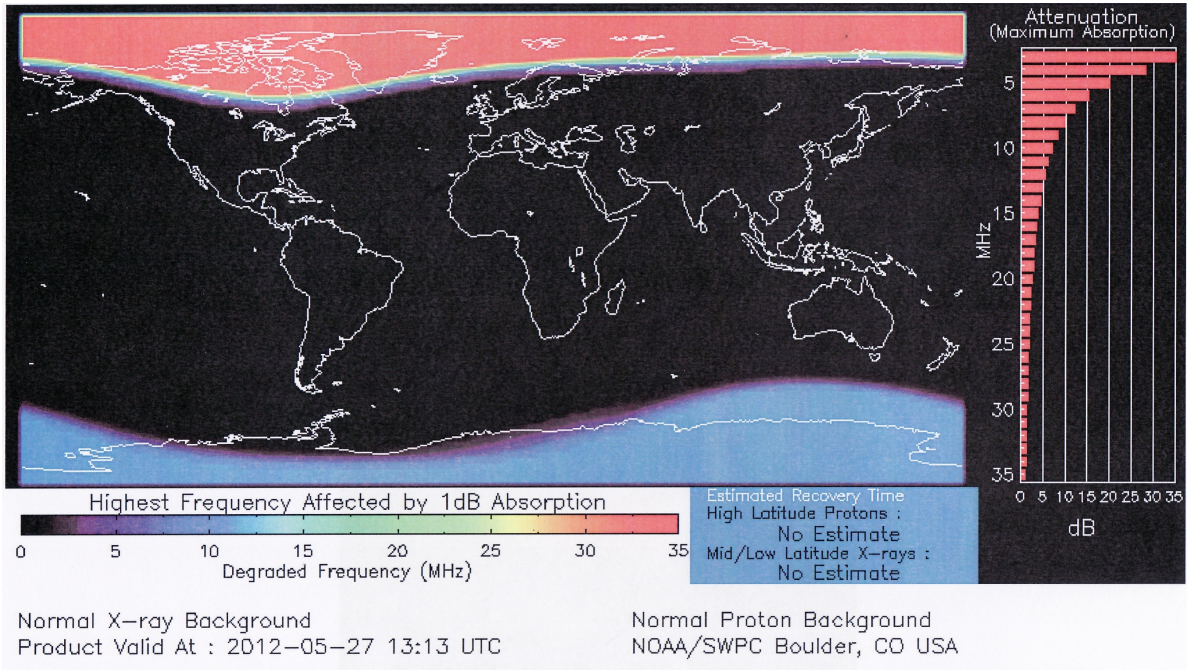
Solar Radiation Storms

- **Cause**
  - **Energetic protons from big solar flares**
  - **Funnel into the polar cap**
  - **Can last for a couple days**



http://www.swpc.noaa.gov/drap/dregion_absorption_documentation.html

- **Mitigation**
  - **Effect not necessarily similar in the polar caps**
  - **For paths over the poles**
    - **Try long path if the short path is degraded**
    - **Try short path if the long path is degraded**

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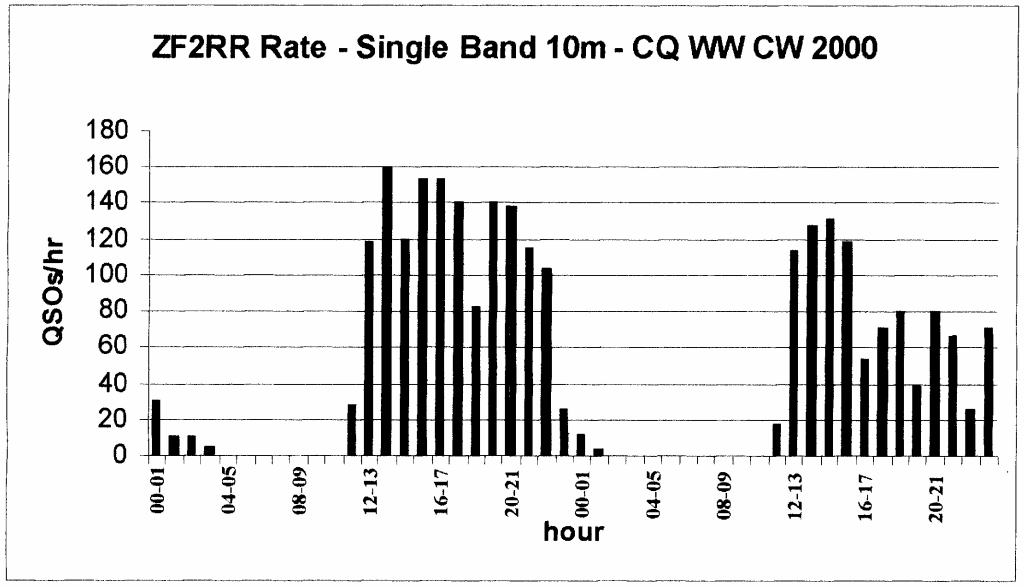
Radio Blackouts

- **Cause**
  - **Electromagnetic radiation at X-ray wavelengths from big solar flares**
  - **Last about an hour on the higher bands, longer on the lower bands**
- **Mitigation**
  - **Try the higher frequencies**
  - **Look for paths that are in darkness**



- **18-19 UTC 1st day – X1.9 flare**
- **16-17 UTC 2nd day – X4.0 flare**
- **19-20 and 22-23 UTC 2nd day – hunting for mults**

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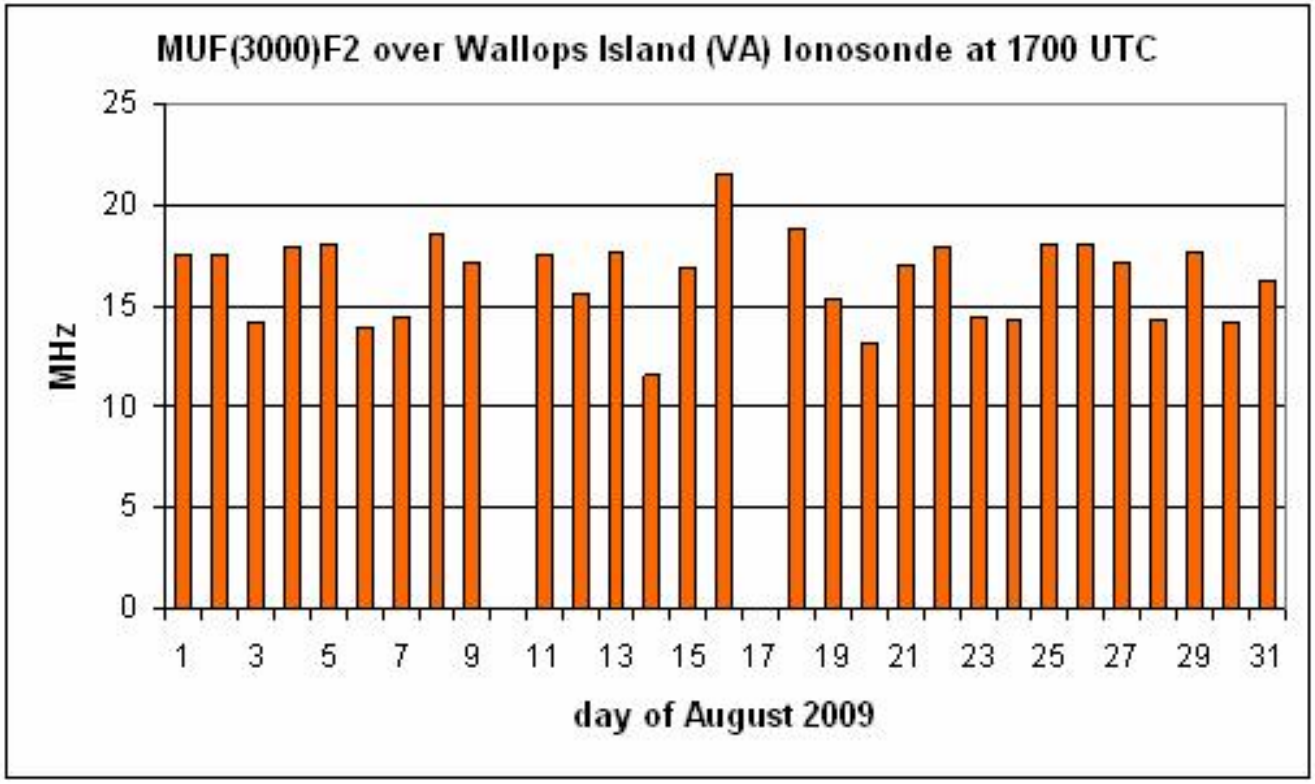
Modeling the Ionosphere



Simple task – correlate the MUFs each day to the 10.7 cm solar flux each day

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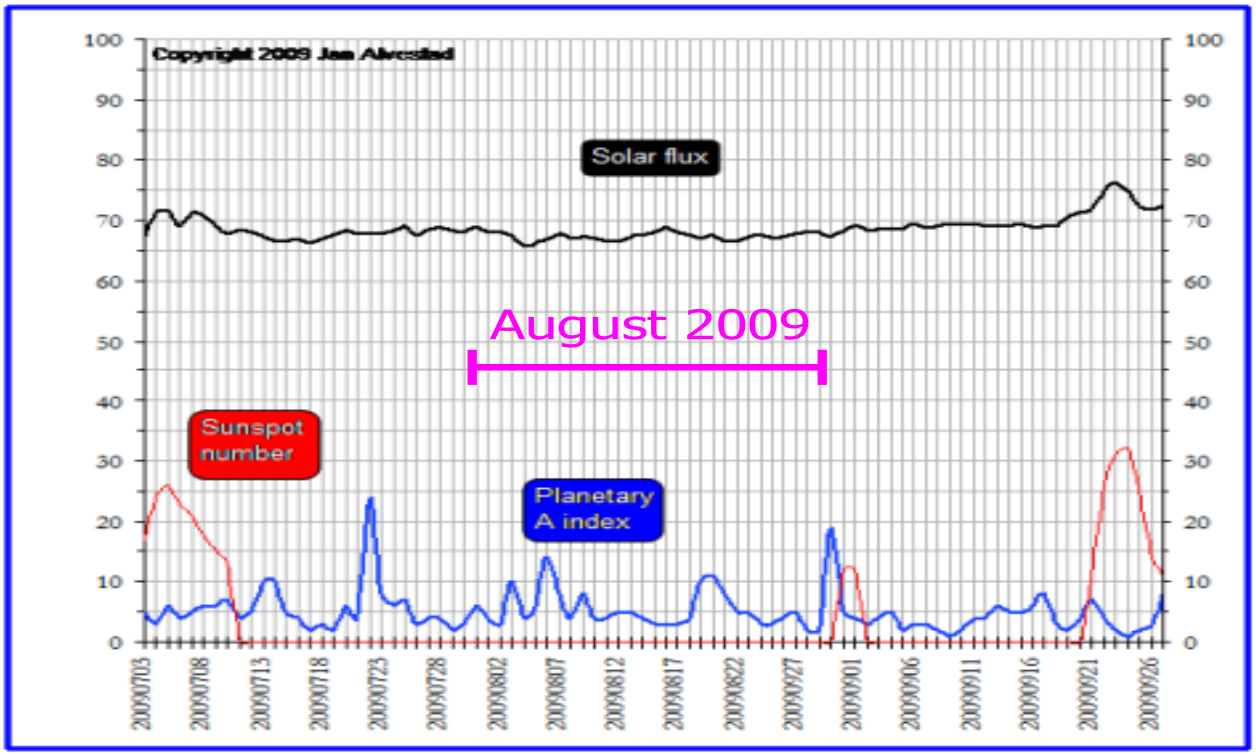
August 2009 Space Weather



- **Houston, we have a problem – zero sunspots and constant 10.7 cm solar flux**
- **How do you correlate MUF to 10.7 cm solar flux?**

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Factors Affecting Ionization

- **There appears to be two other factors that determine electron density**
  - **Solar ionizing radiation instigates the process**
- **Geomagnetic field activity**
  - **More complicated than a single K index**
- **Events in the lower atmosphere coupling up to the ionosphere**
  - **Gravity waves can result in short-term cyclic nature to propagation**

Bottom Line

- **We don't have a daily model of the ionosphere**
  - **In other words, a given 10.7 cm solar flux does not map to a unique MUF**
- **We have a monthly model**
  - **Statistical over a month's time frame using monthly median values and a smoothed solar index**
- **Interesting experiment**
  - **Listen to a higher frequency station (WWV, for example, on 20 MHz) every day for a month at the same time**
  - **Try to correlate your MUF and signal strength observations to the daily 10.7 cm solar flux**

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Real-Time Assessment

- **How do we know what the bands doing right now?**
- **Use the following for an assessment**
  - **NCDXF beacons**
  - **DX Summit**
  - **DX Sherlock (and other similar sites)**
  - **Remote RX**
  - **RBN**

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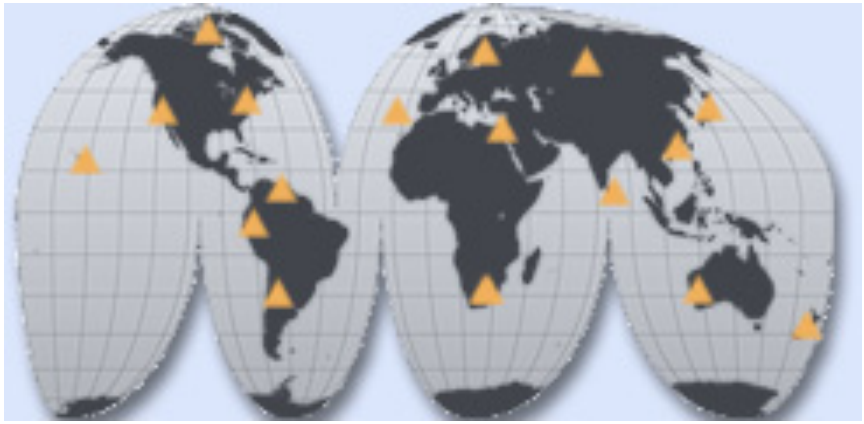
NCDXF Beacons



- 18 worldwide beacons
- 20m, 17m, 15m, 12m, 10m
- Each beacon transmits for 10 seconds
  - ID and then dashes at 100W, 10W, 1W, 0.1 W
- Good picture of what's happening worldwide
- www.ncdxf.org/pages/beacons.html

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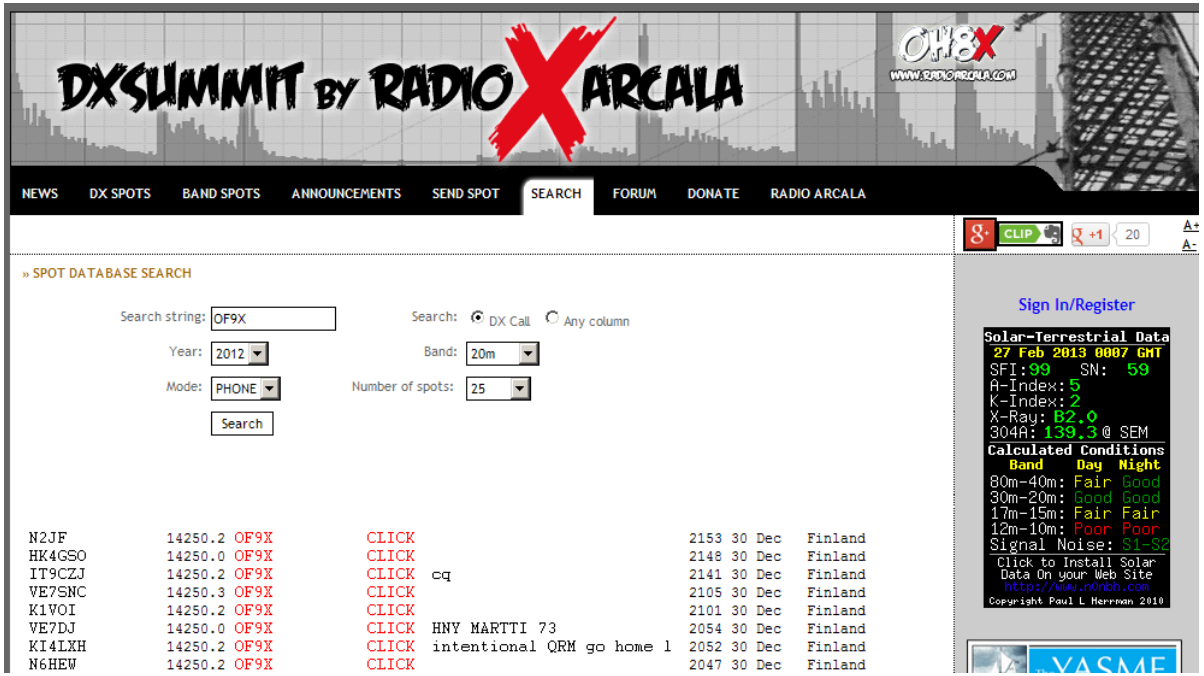
DX Summit

Searchable data base of PacketCluster spots



http://www.dxsummit.fi/Search.aspx

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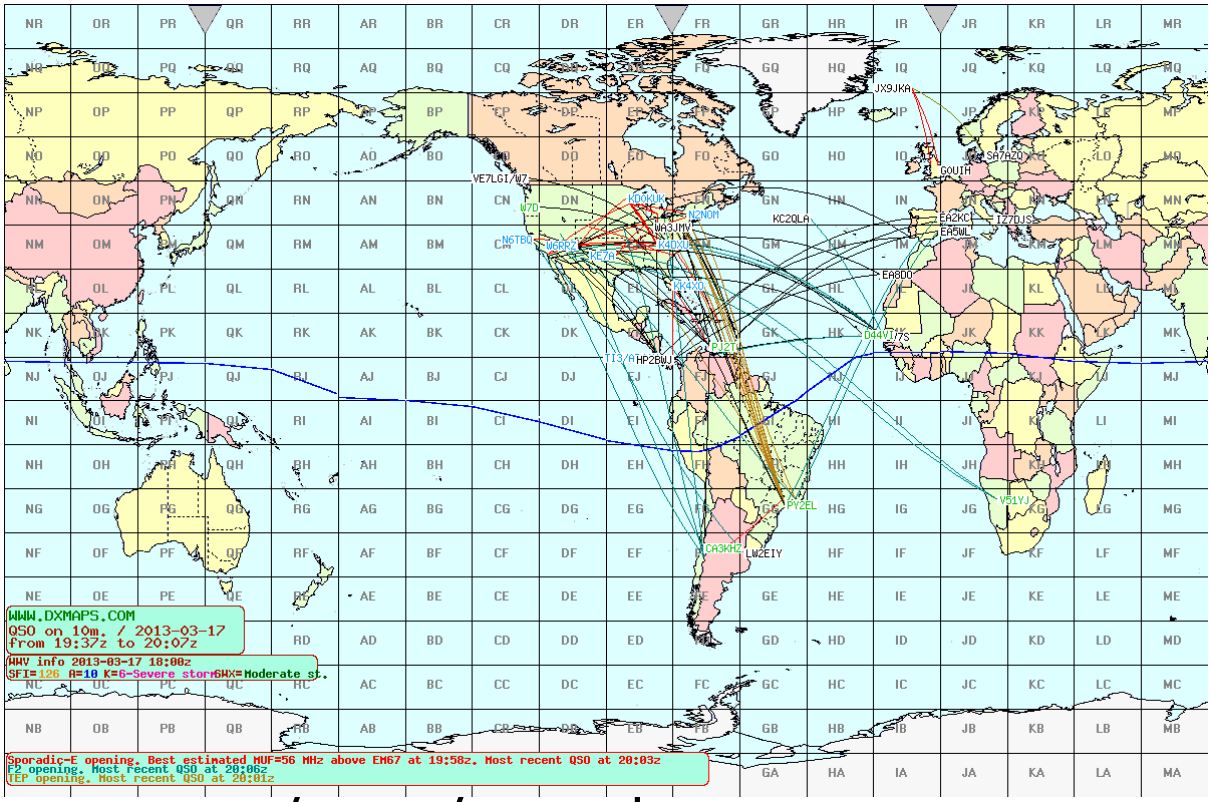
DX Sherlock and Others

- Makes a map with current spots
- Select area of world and band



- http://www.dxmaps.com/spots/map.php

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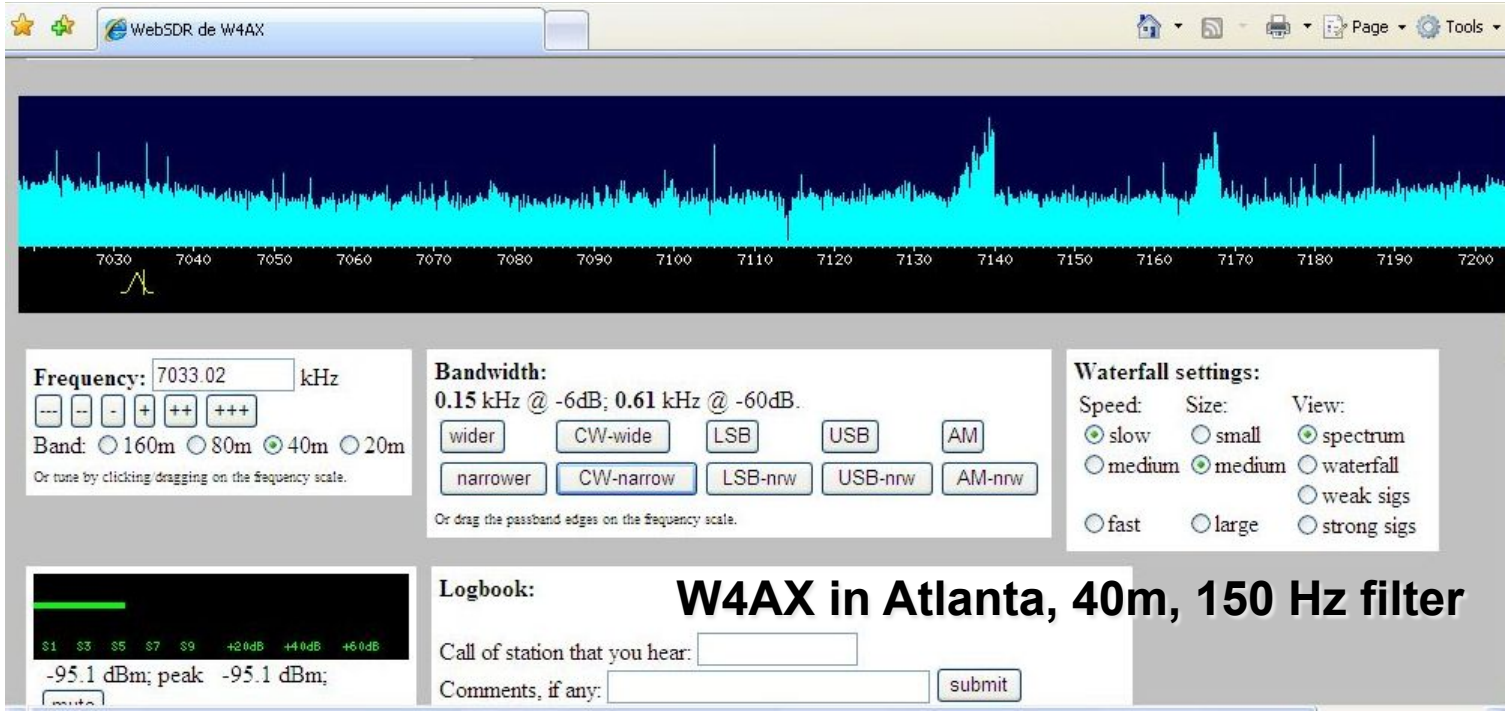
Remote RX

- SDR (Software Defined Radio) connected to Internet
- http://www.websdr.org



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Remote RX

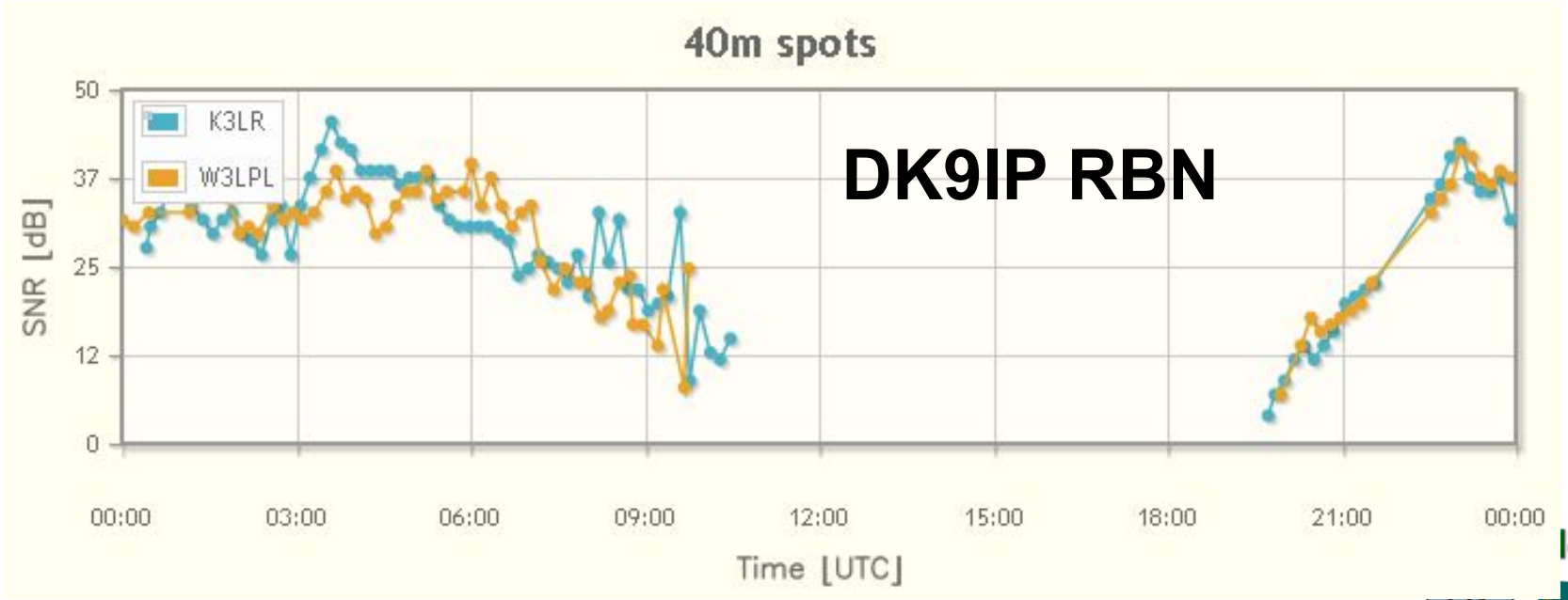
- Noise is -95 dBm in 150 Hz
- I tuned the SDR to 7033.2
- Transmitted 100W to inverted-vee at 55 ft
- My signal measured -90 dBm
- Conclusions
  - Path is open
  - How good is it?
    - 5 dB SNR for my 100W and inv-vee

RBN

- Reverse Beacon Network
- SDR decodes the CW, records the calls, measures the signal level and frequency, saves all this data
- http://www.reversebeacon.net
- Transmit to see where you're spotted
  - Transmit discretely, of course

RBN

- Station comparisons
- Example: W3LPL vs K3LR during first day of 2011 ARRL DX CW contest



Summary

- Cycle 24 is an underachiever – take advantage of the higher bands now
- Work around disturbances to propagation
- Understand that it's really tough to predict what the ionosphere will do tomorrow
- Use many available web-based tools for a real-time assessment

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References

- **The Little Pistol's Guide to HF Propagation (Brown NM7M SK, WorldRadio Books, 1996)**

- **http://myplace.frontier.com/~k9la (Little Pistol is there)**

- **The ARRL Handbook (2013 Edition, Chapter 19 Propagation)**

- **The NEW Short Wave Propagation Handbook (W3ASK-N4XX-K6GKU, CQ, 1995)**

- **Radio Amateurs Guide to the Ionosphere (McNamara, Krieger Publishing, 1994)**

- **Ionospheric Radio (Davies, Peter Peregrinus Ltd, 1990)**