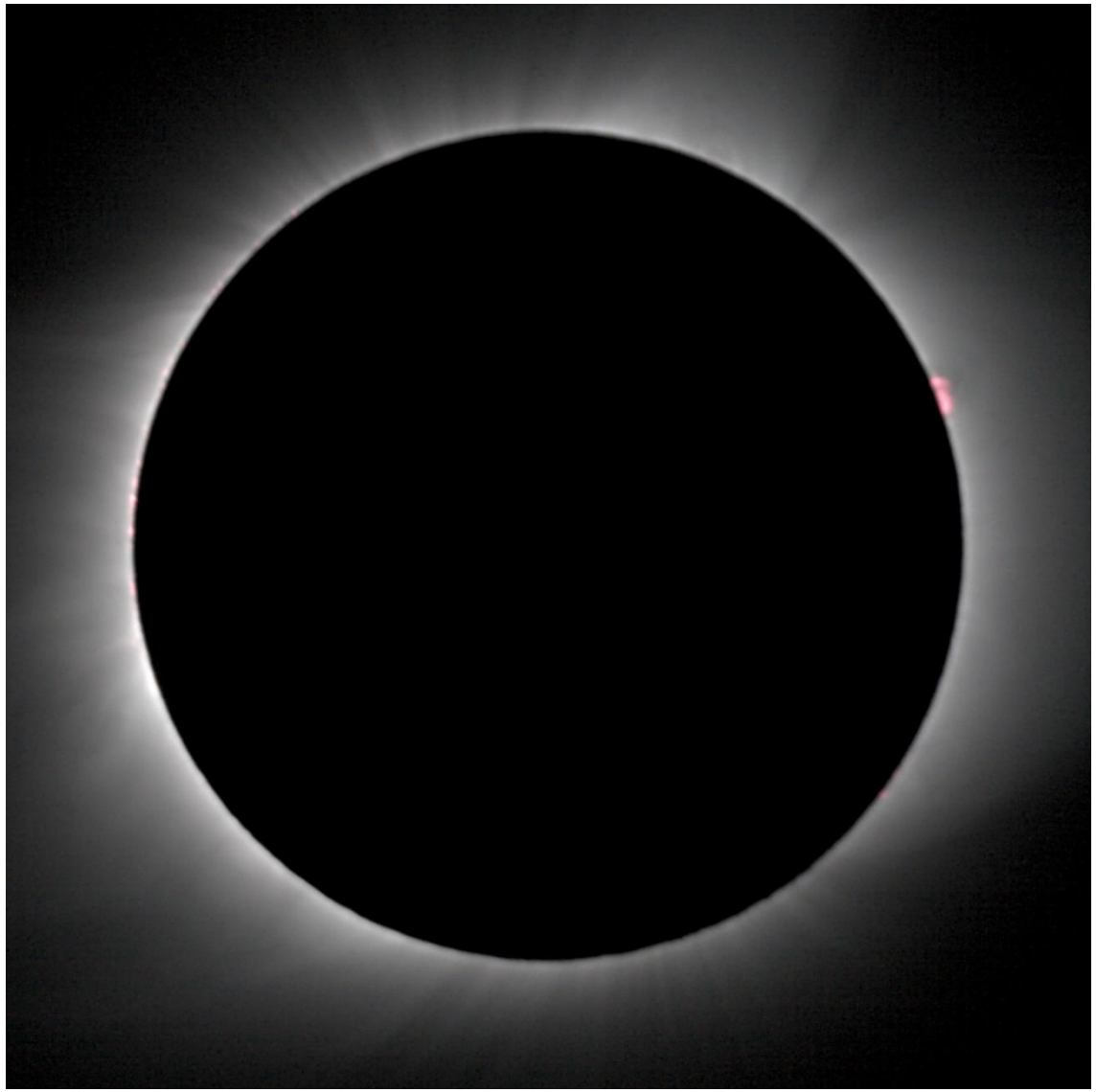
Ham Radio Activities at Marshall Space Flight Center during the 2017 Total Solar Eclipse: Transmitting Node



HamSCI Workshop

February 23-24, 2018 NJIT, Newark, NJ

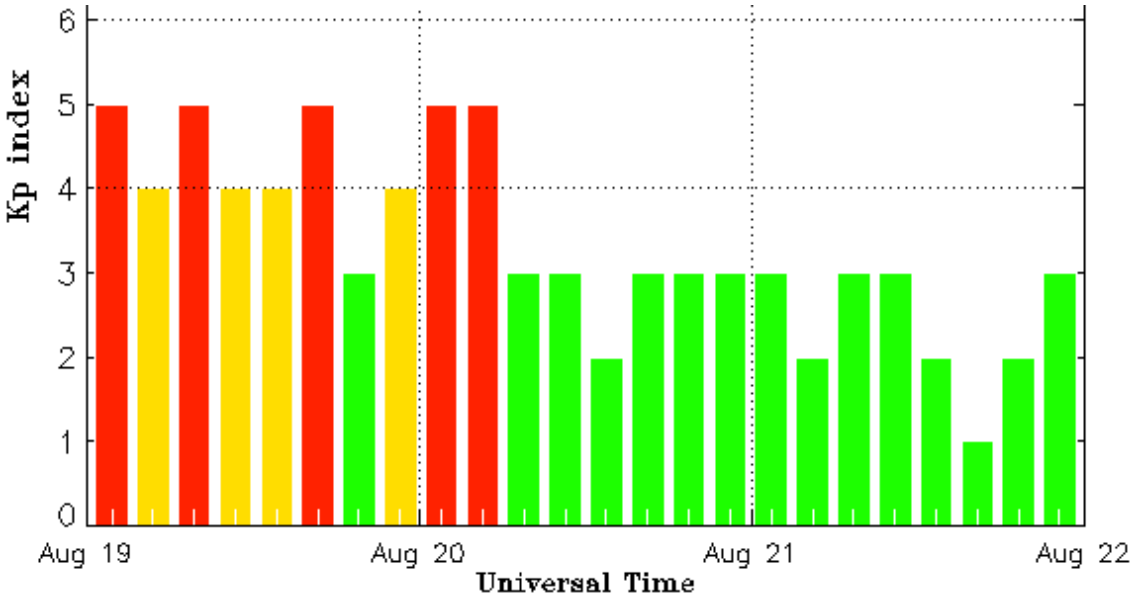
- Jesse McTernan, USRA/MSFC (KN4EZR)
- Linda Krause, MSFC (K0DRK)
- Ghee Fry, MSFC (WL7C)

Ham Radio Activities at Marshall Space Flight Center

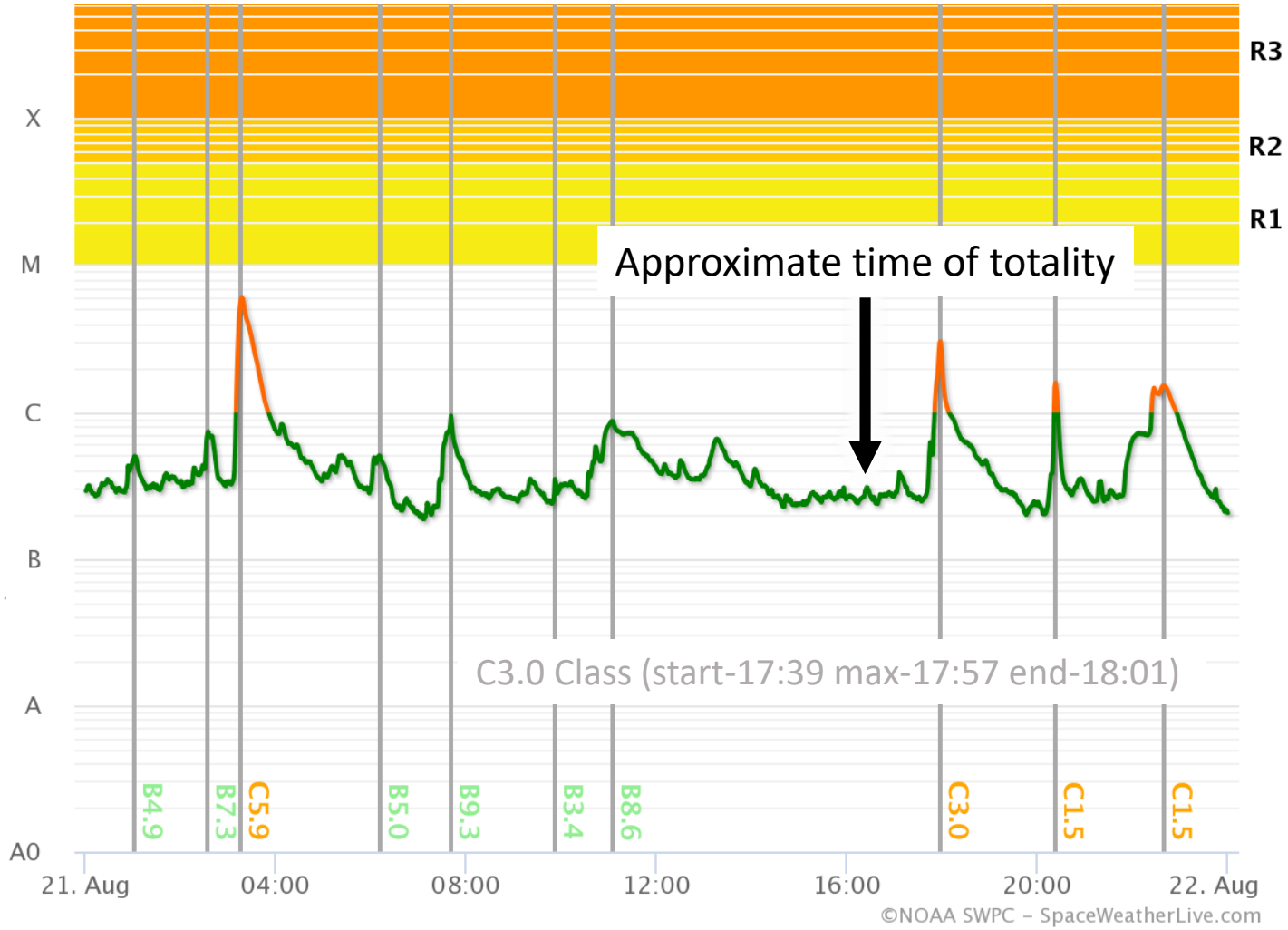
Part 2: Transmitting Node

Solar activity on Monday, 21 August 2017 was relatively quiet

Parameter	Symbol	Value	Unit
Radio Flux	F	87.1	sfu
Sun spots	R	43	
X-ray background flux	A,B,C,M,X	B2.6	(W/m^2)
K-index	Kp	1	



Space weather data from NOAA SWPC archives



X-ray activity plot from spaceweatherlive.com

Physical location and setup

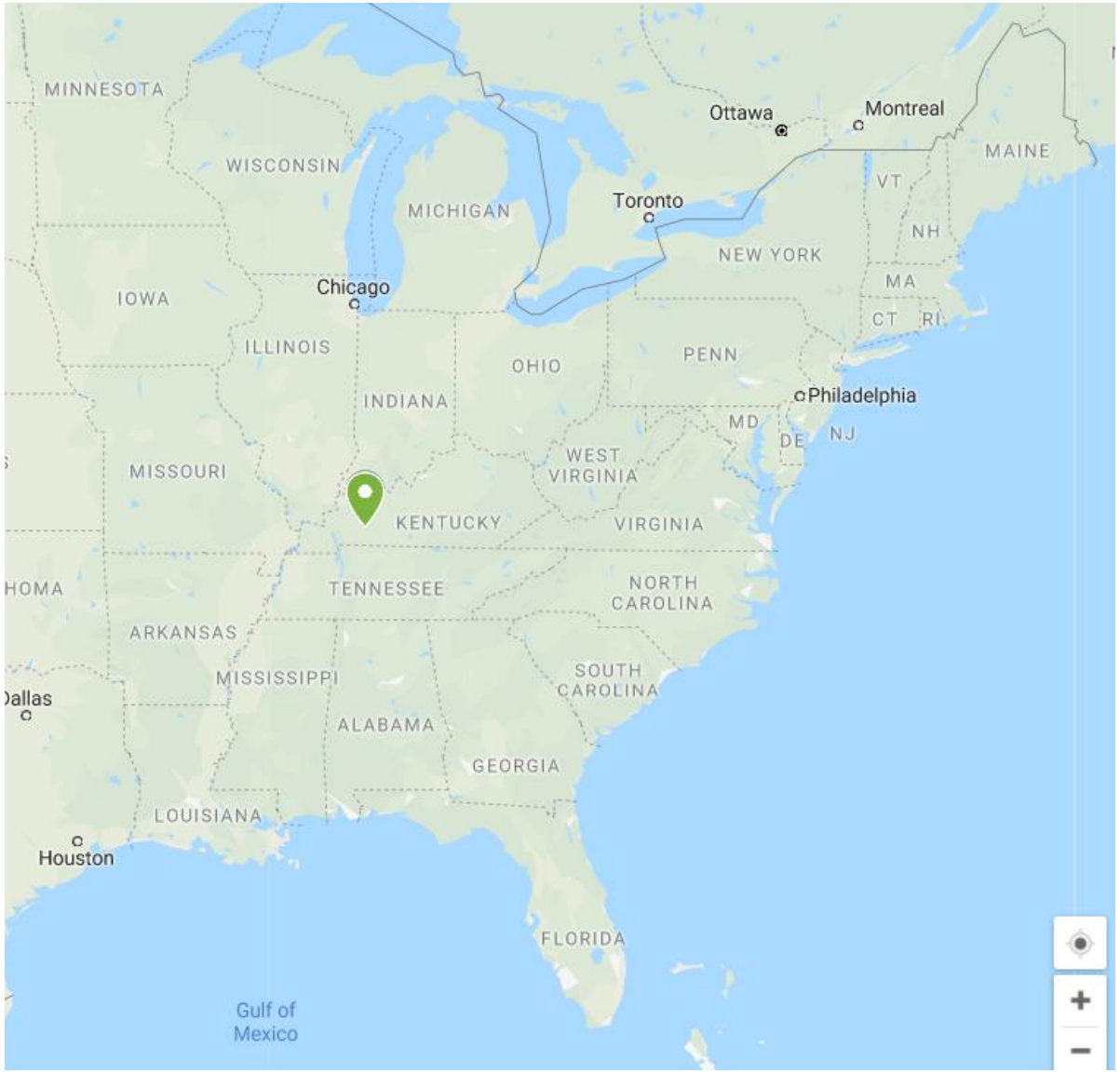


Image from Google Maps

Location

lat	lon	Maidenhead
37.035796	-87.304767	EM67ia

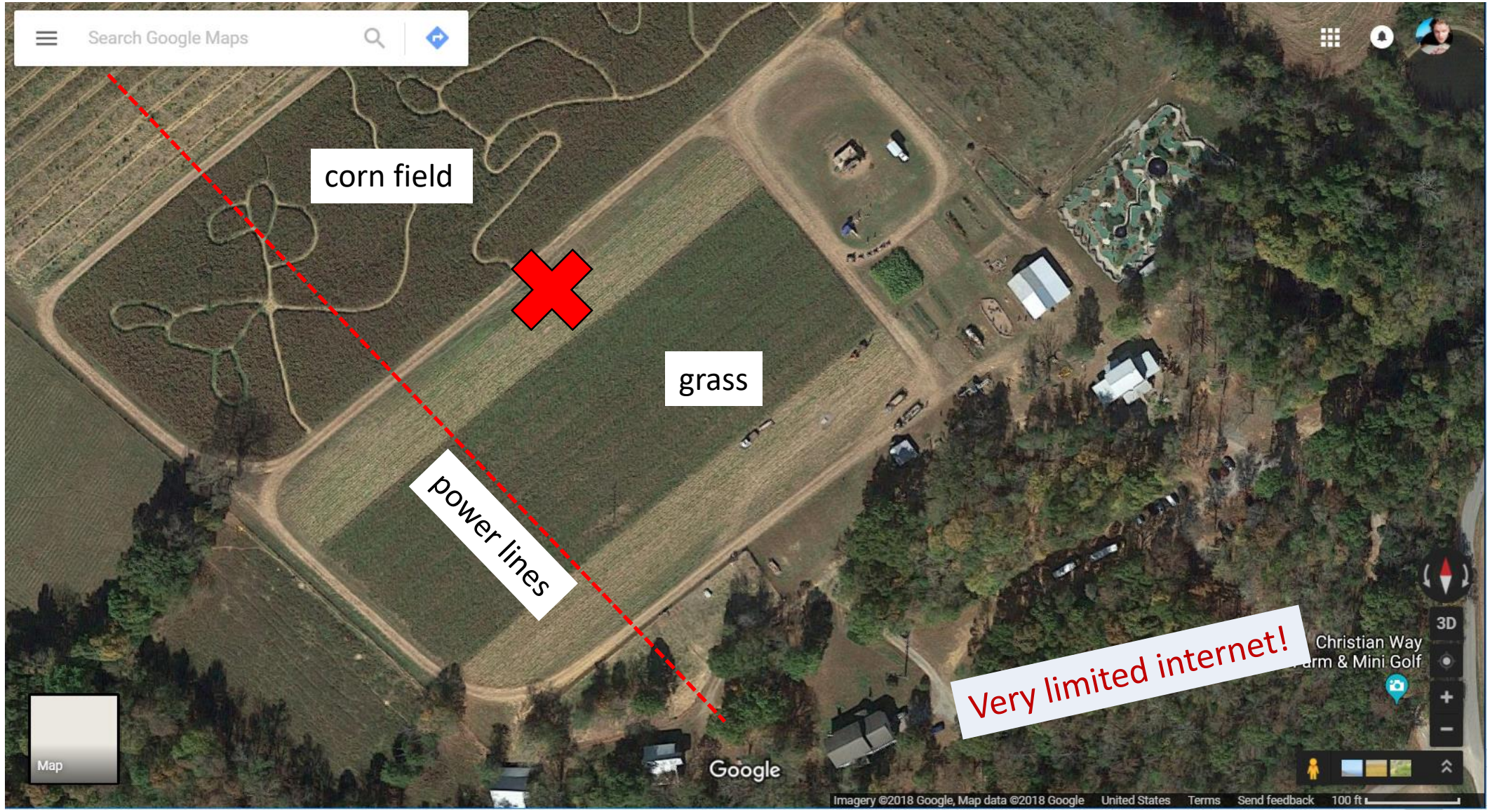
Local eclipse contact times (CDT = UTC – 5)

C1 (Begin Partial)	C2 (begin total)	C3 (end totality)	C4 (End Partial)	
11:56:48	**13:24:57**	13:27:24	14:51:43	CDT
16:56:48	**18:24:57**	18:27:24	19:51:43	UTC

Very limited internet!

Physical location and setup

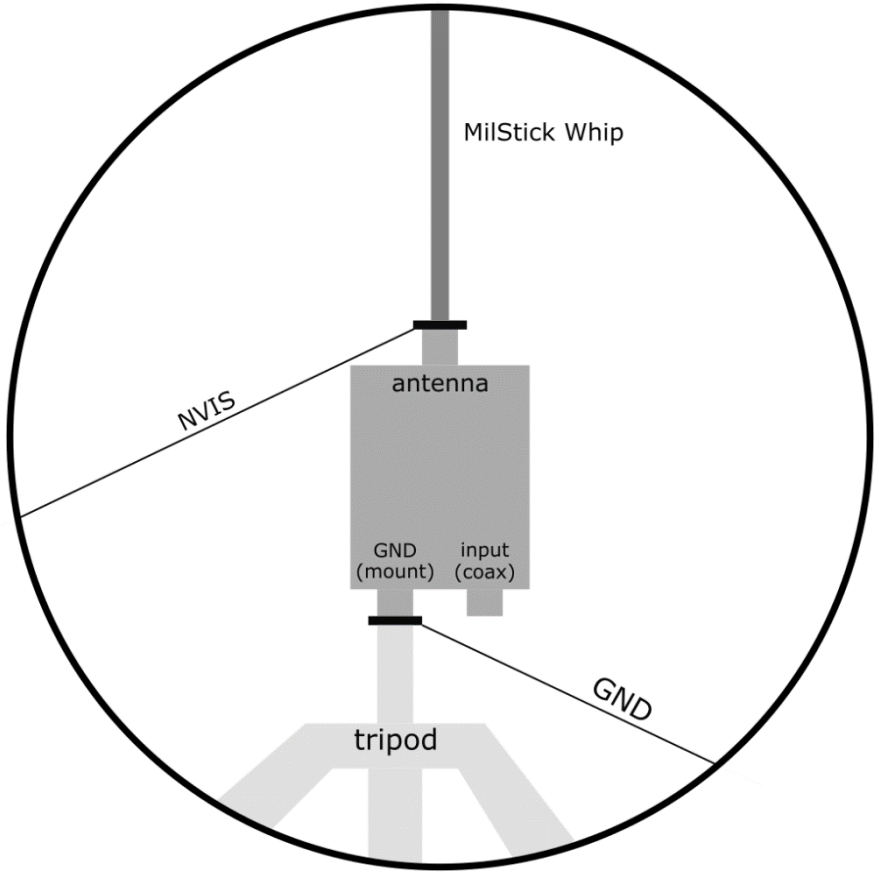
Christian Way Farm Near Hopkinsville, KY



Physical location and setup: Antenna and Radio

Alpha Antenna

6-80M complete multiband
500W portable antenna



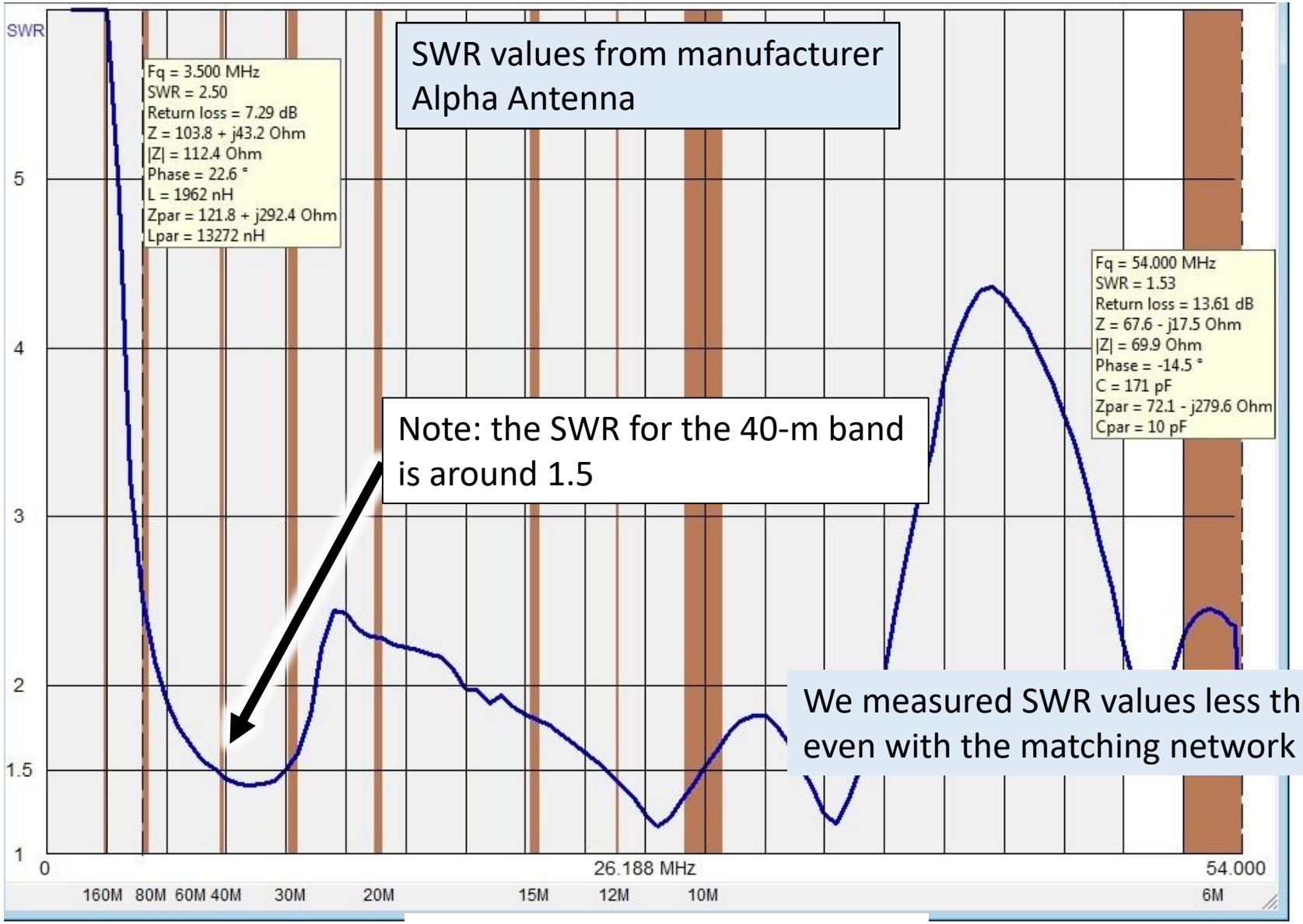
Two mistakes: didn't elevate antenna (5 feet)
Installed matching network backwards

80 Watts

Icom 7300
(image from www.icomamerica.com)

The antenna was designed to operate on multiple ham bands

SWR



We measured SWR values less than 3.0 (MFJ-226), even with the matching network installed incorrectly

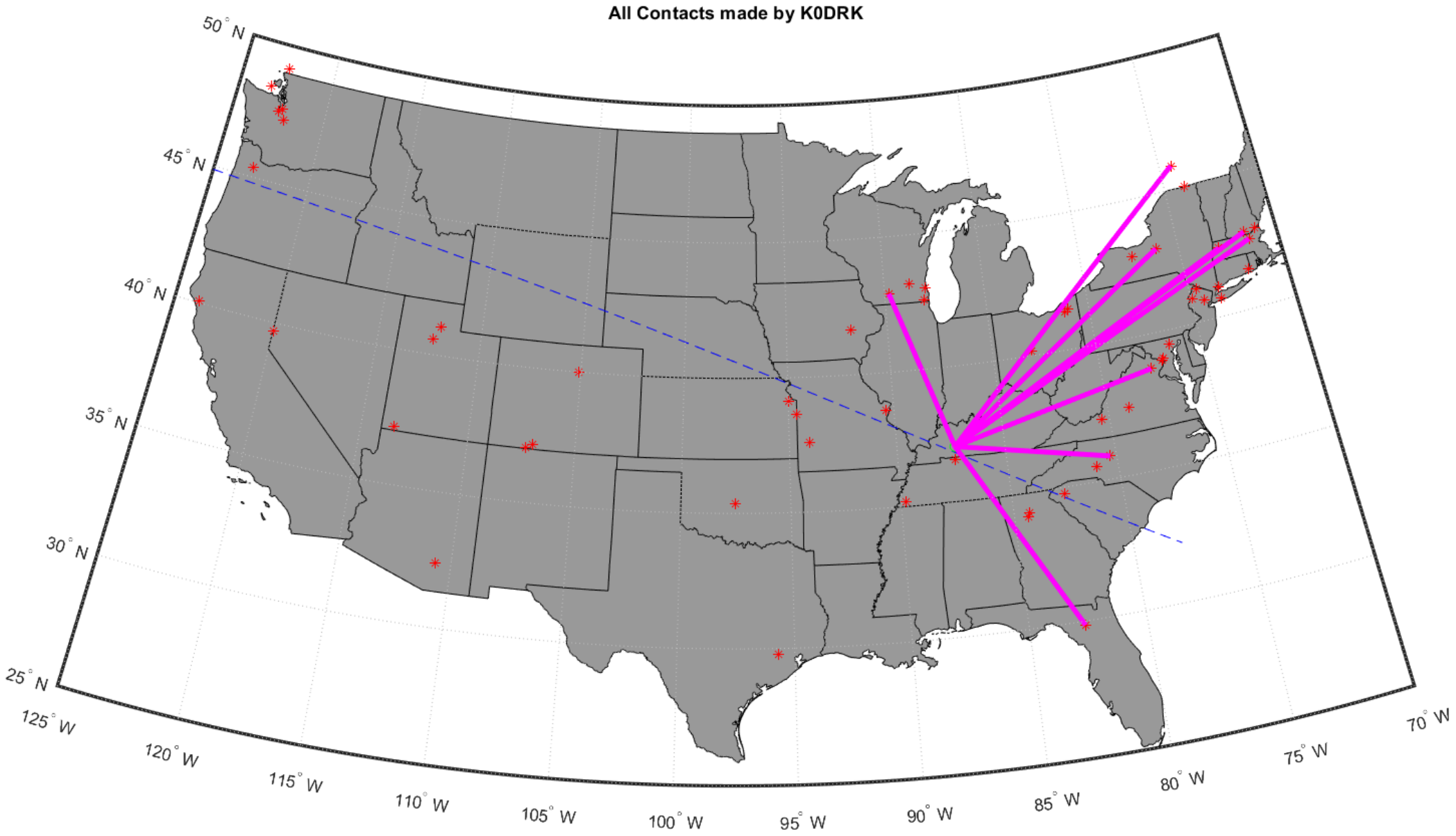
Frequency [MHz] and Band [m]

Relevant antenna characteristics

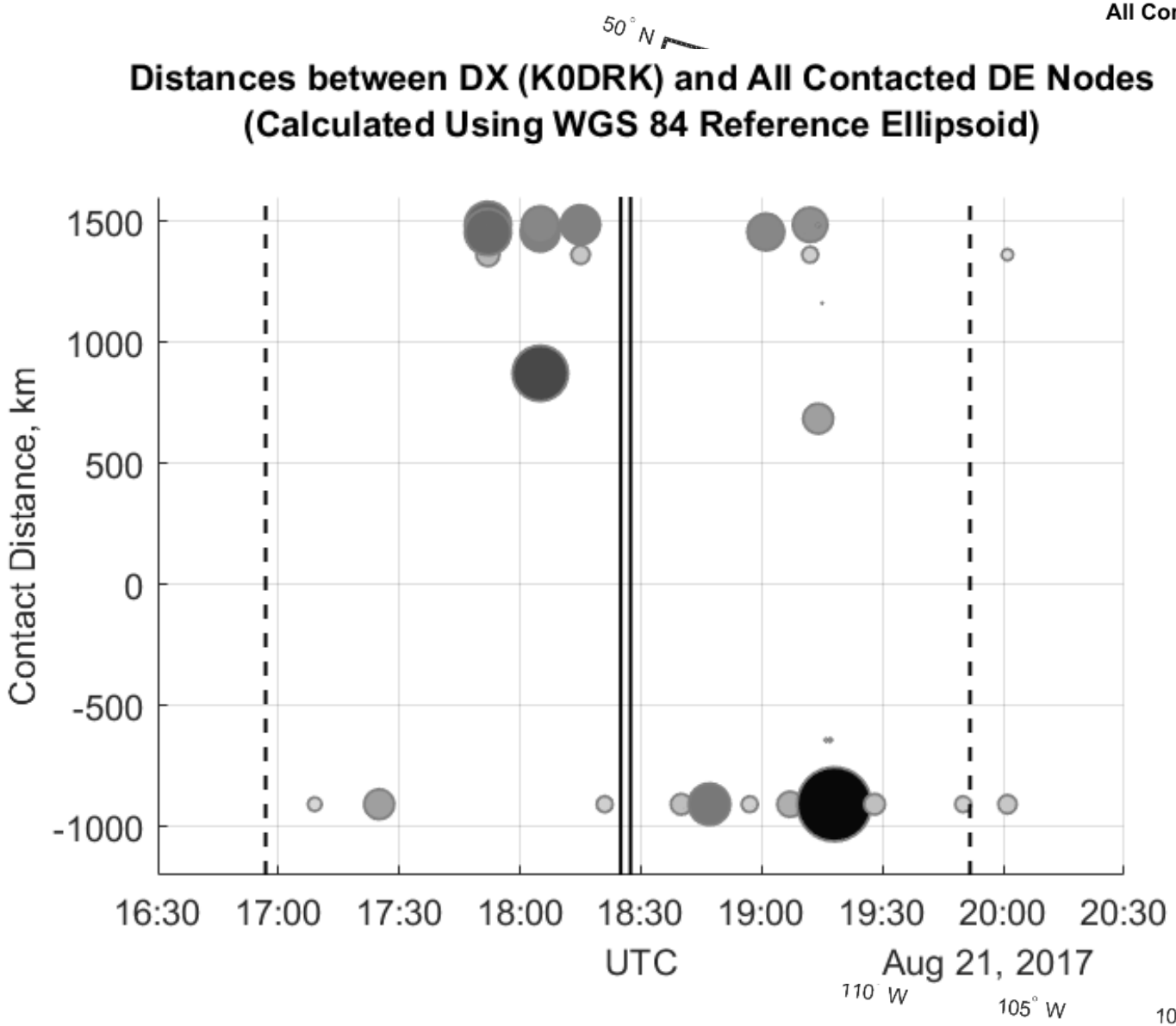
Electrical Characteristics	
Frequency range	**3.5**-29.7 MHz (**54** MHz when mounted upon an optional tripod)
Polarization	Horizontal and Vertical polarization
RF power capacity (watts)	500 PEP SSB, 250 CW, or 100 digital
Input impedance	50 ohms
Radiation Pattern:	
Azimuth	Omnidirectional/Semi-Directional
Elevation	NVIS & DX
Physical Characteristics:	
Wind and ice	MilStick survives 70 MPH wind with no ice
Maximum Height erected	13 feet when mounted on the Jaw Mount and **19 feet** when mounted upon an optional tripod
Minimum foot-print required	3 foot by 3 foot + **25 foot NVIS**-2.1
Minimum Weight	2.00 pounds (MTCH-2.1 & MLSTK-2.1.XX)

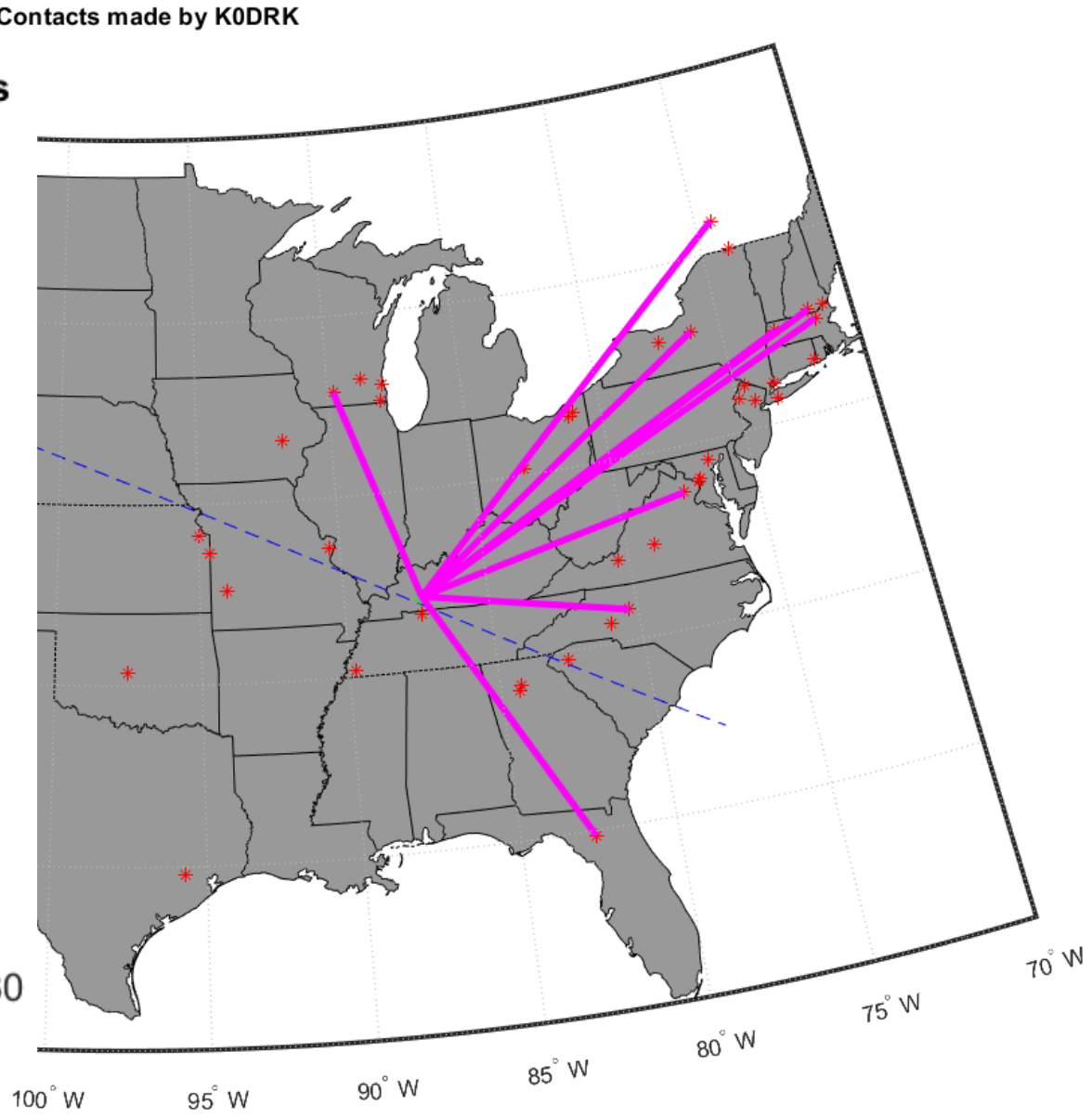
Data analysis (all contacts)

Dotted line
Asterisks
Magenta lines
Time independent

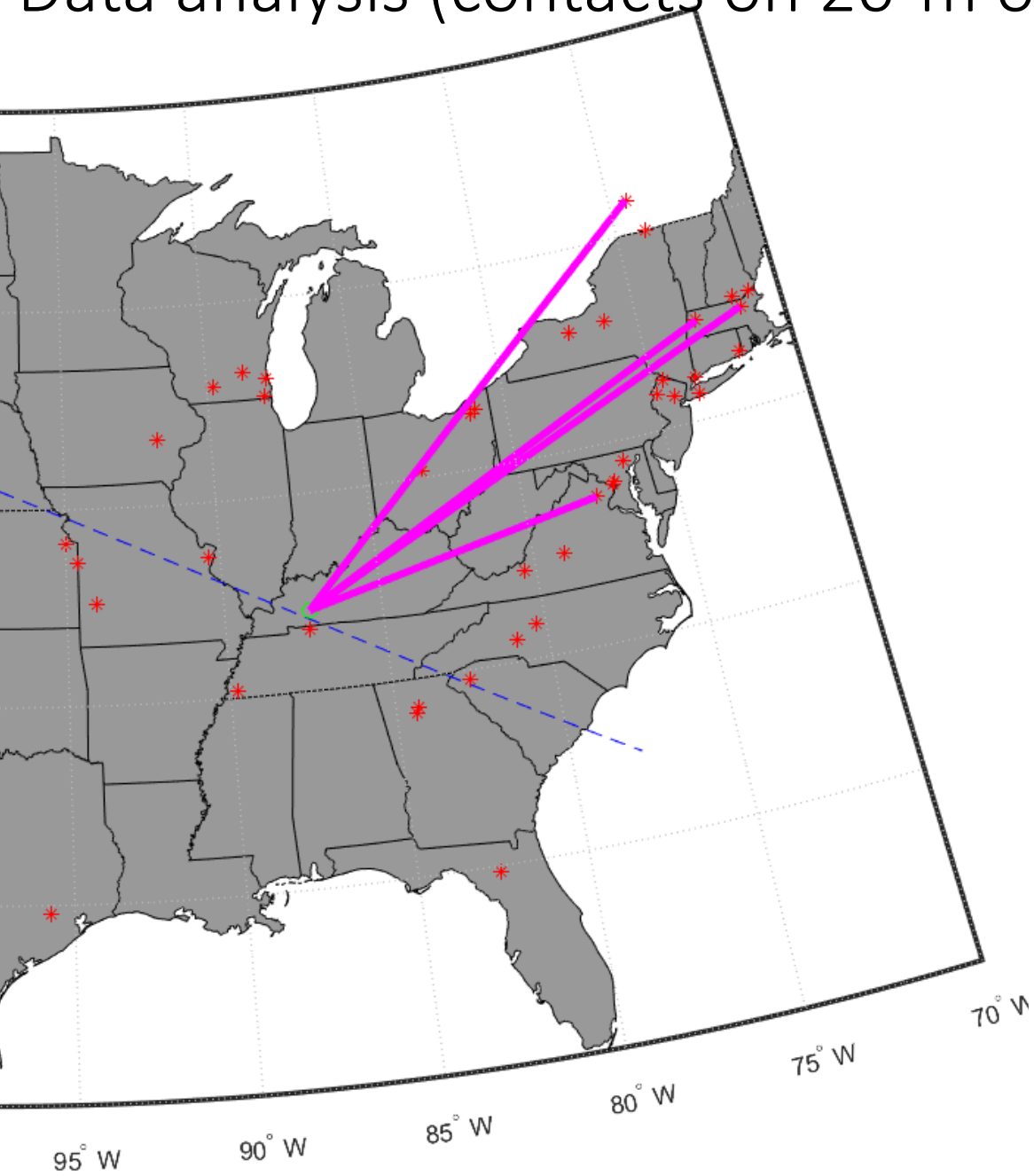


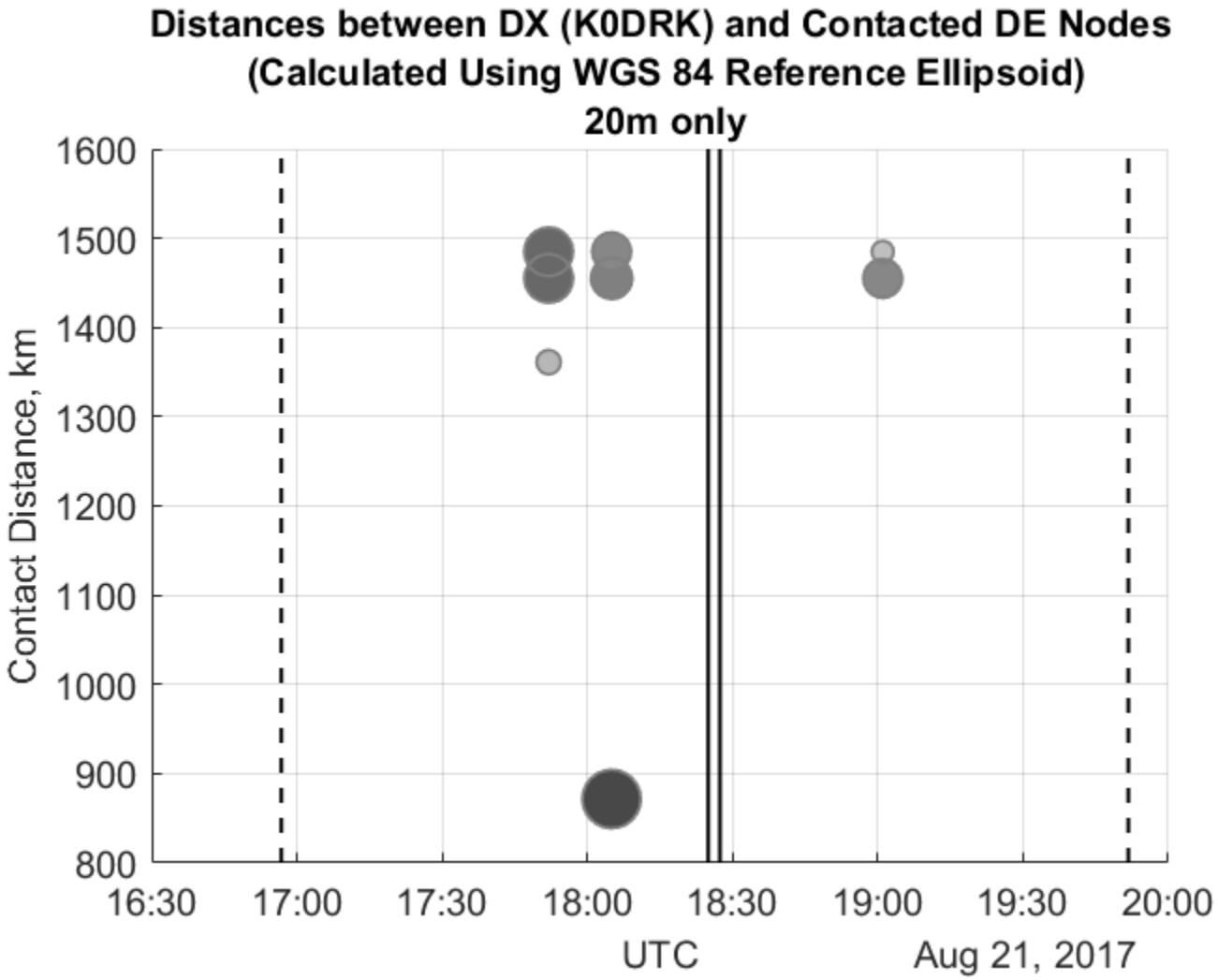
Data analysis (all contacts)



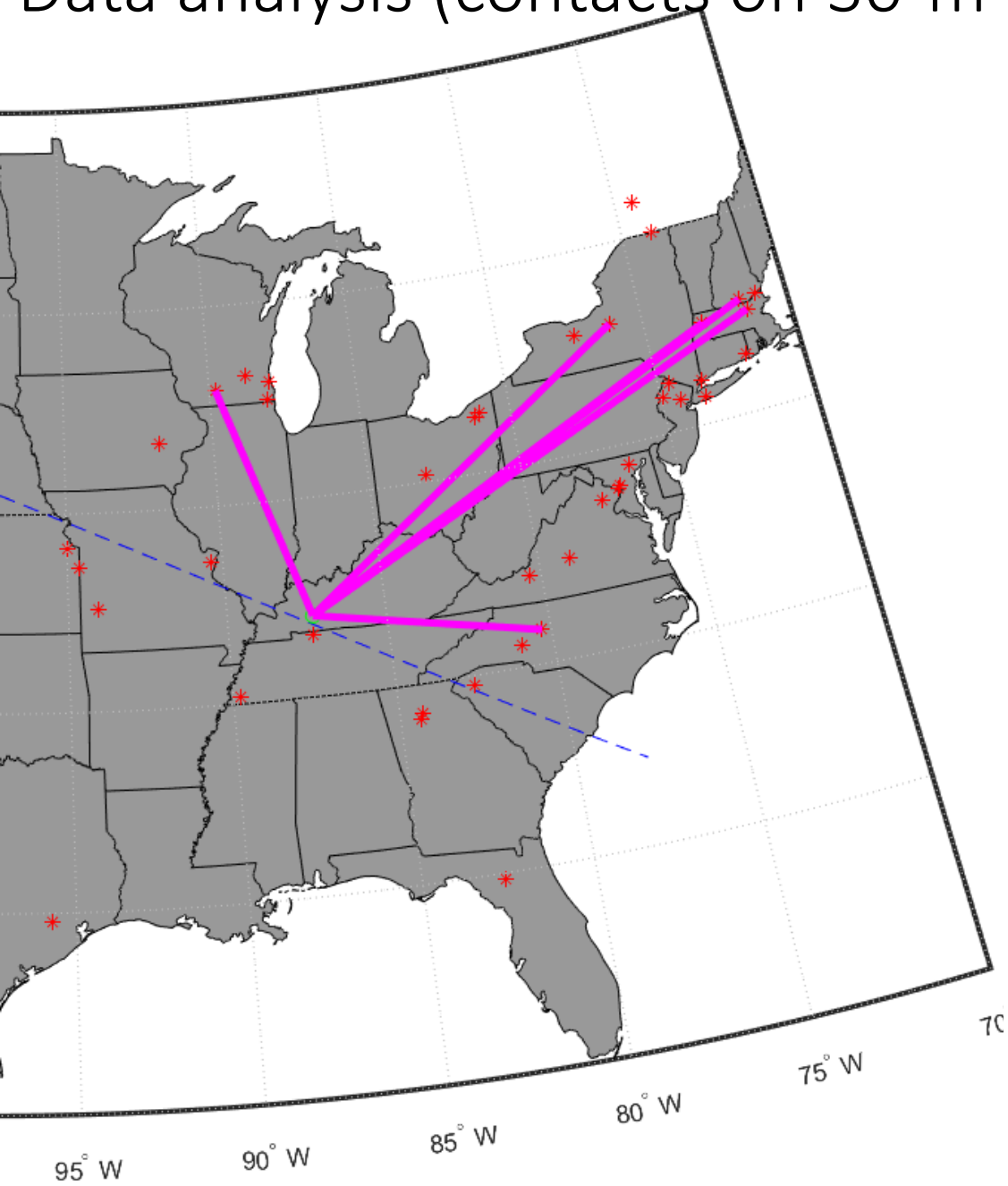


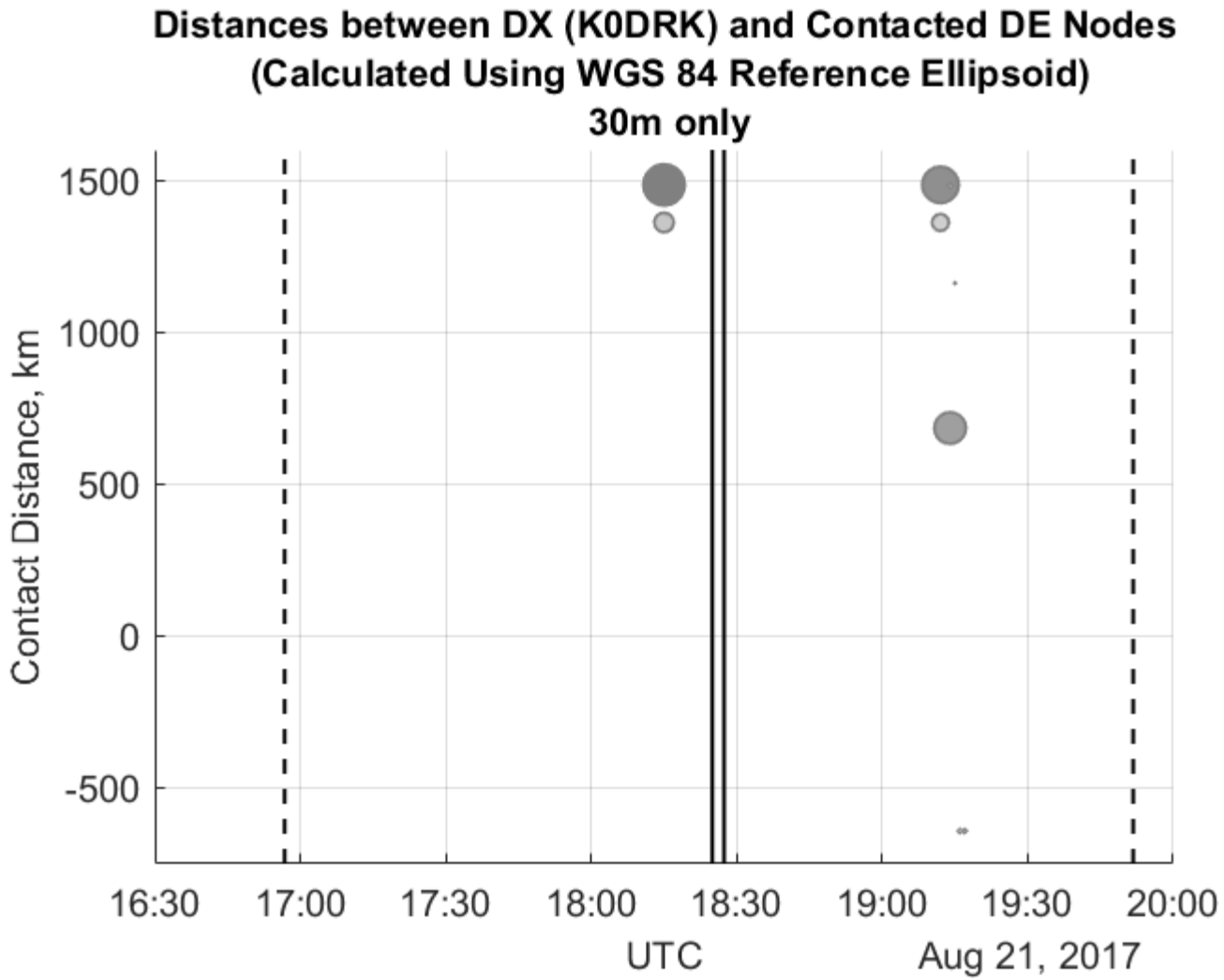
Data analysis (contacts on 20-m only)



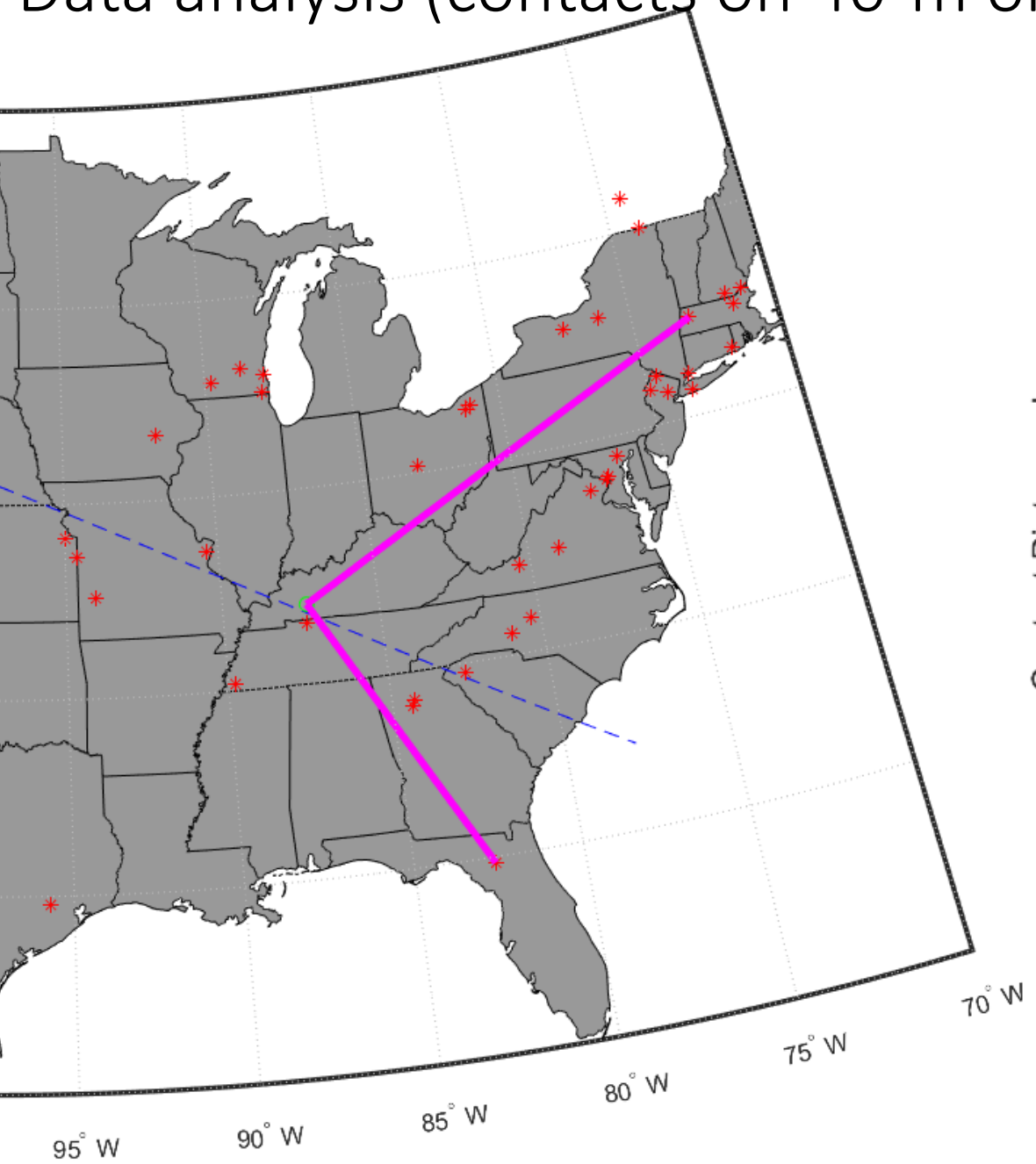


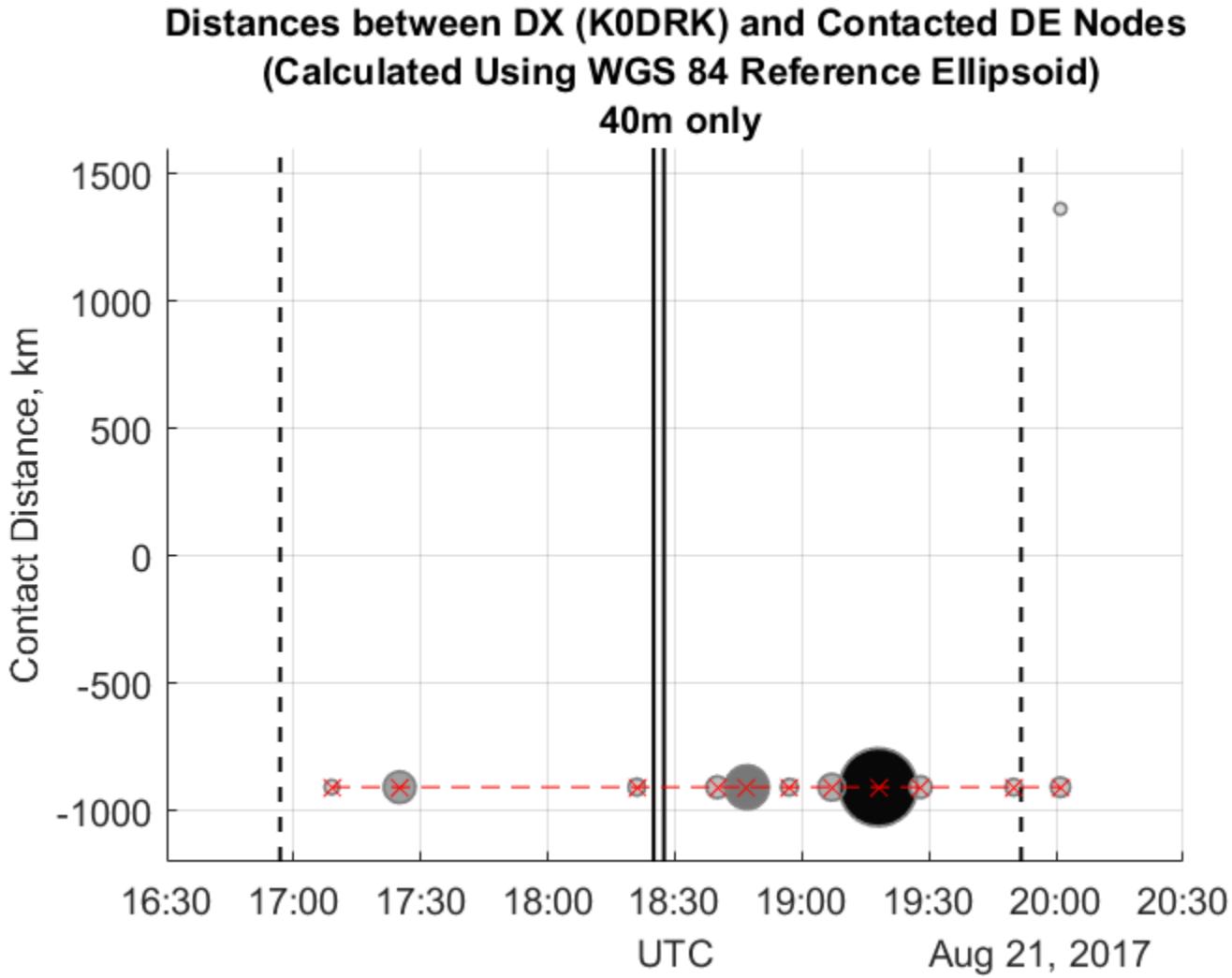
Data analysis (contacts on 30-m only)





Data analysis (contacts on 40-m only)





2 unique DE stations

Discussion

Stats:

- 30 total contacts day of eclipse
- 12 contacts (40 meter)
- 10 contacts (30 meter)
- 8 contacts (20 meter)
- 10 unique DE stations
- 11 (most contacts with same DE)
- Wanted to use 80m (see lesson learned)

Observations

Lesson Learned!

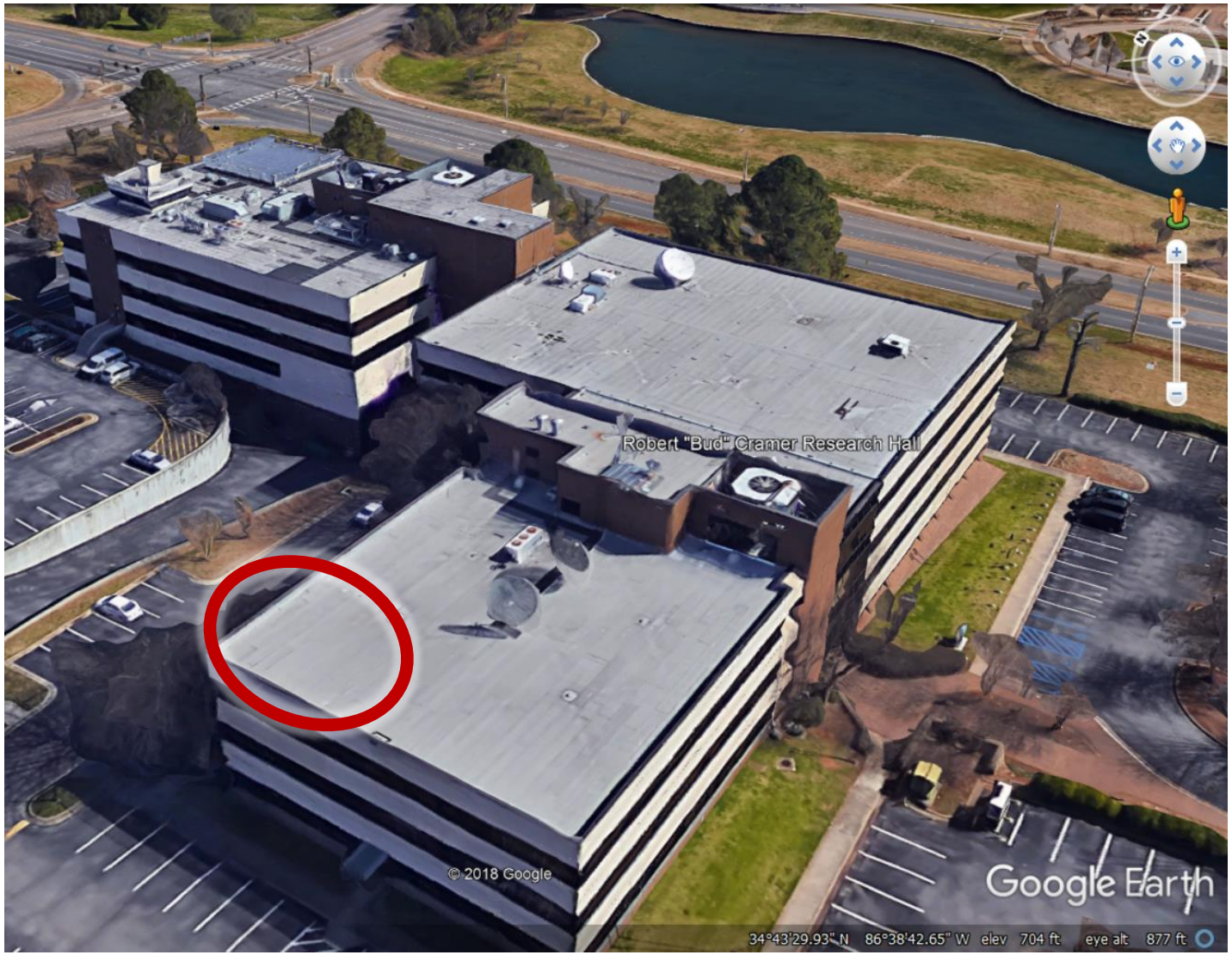
- Very limited internet!
  - Made dynamic experimentation nearly impossible
- Apparent directionality of contacts (as expected with NVIS)
- Low number of data points
- Lack of confirmed DE/DX locations
- Did not contact MSFC's receiving node (WL7C)
  - Lat: 36.50N, Lon: 87.34W, Distance: 60.61 km
- Work remains to extract science from this dataset

Band (meters)	Frequency Range (MHz)	Range (kHz)
20	14.00 – 14.35	350
30	10.10 – 10.15	50
40	7.00 – 7.30	300

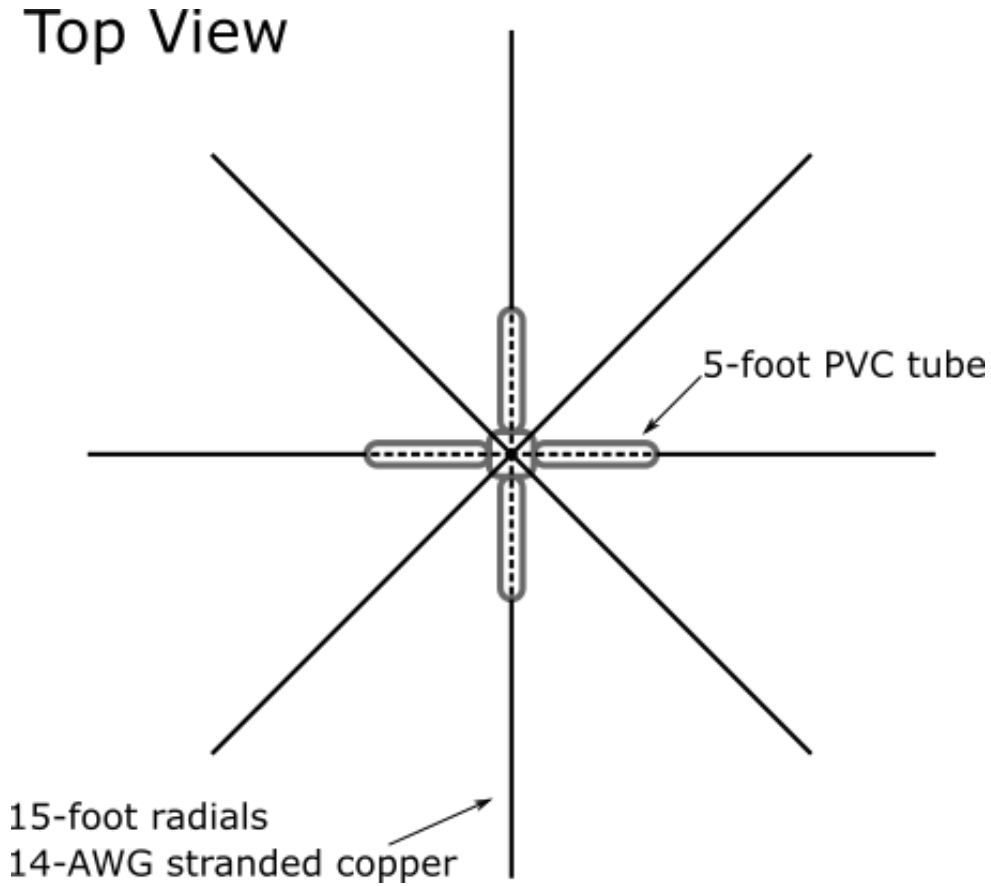
Select ham-radio band plan, for reference

Future plans

Future Plans include a long-term receiving node at NSSTC



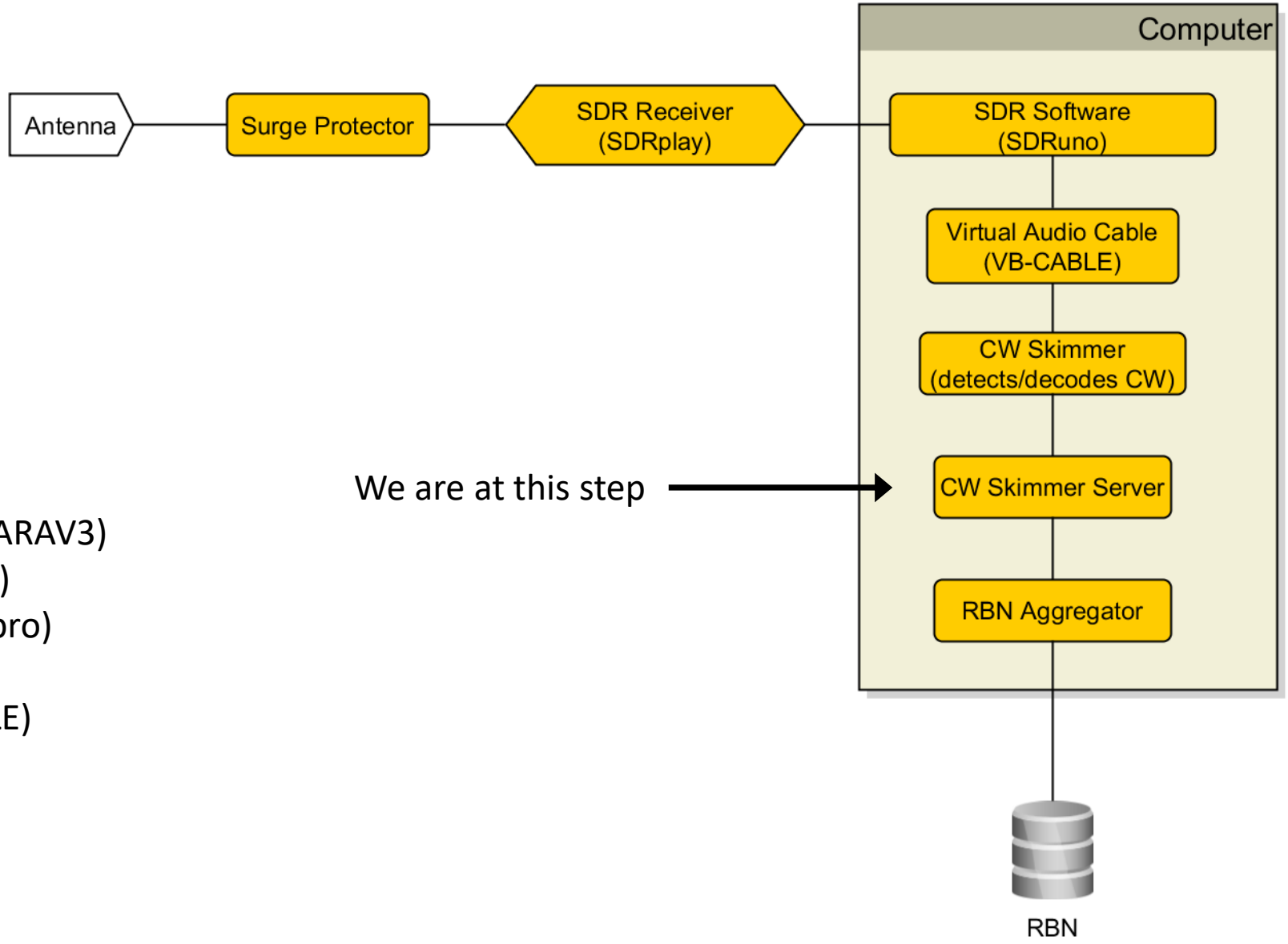
Concrete roof (don't think there is a metal layer)



Active Receive Antenna

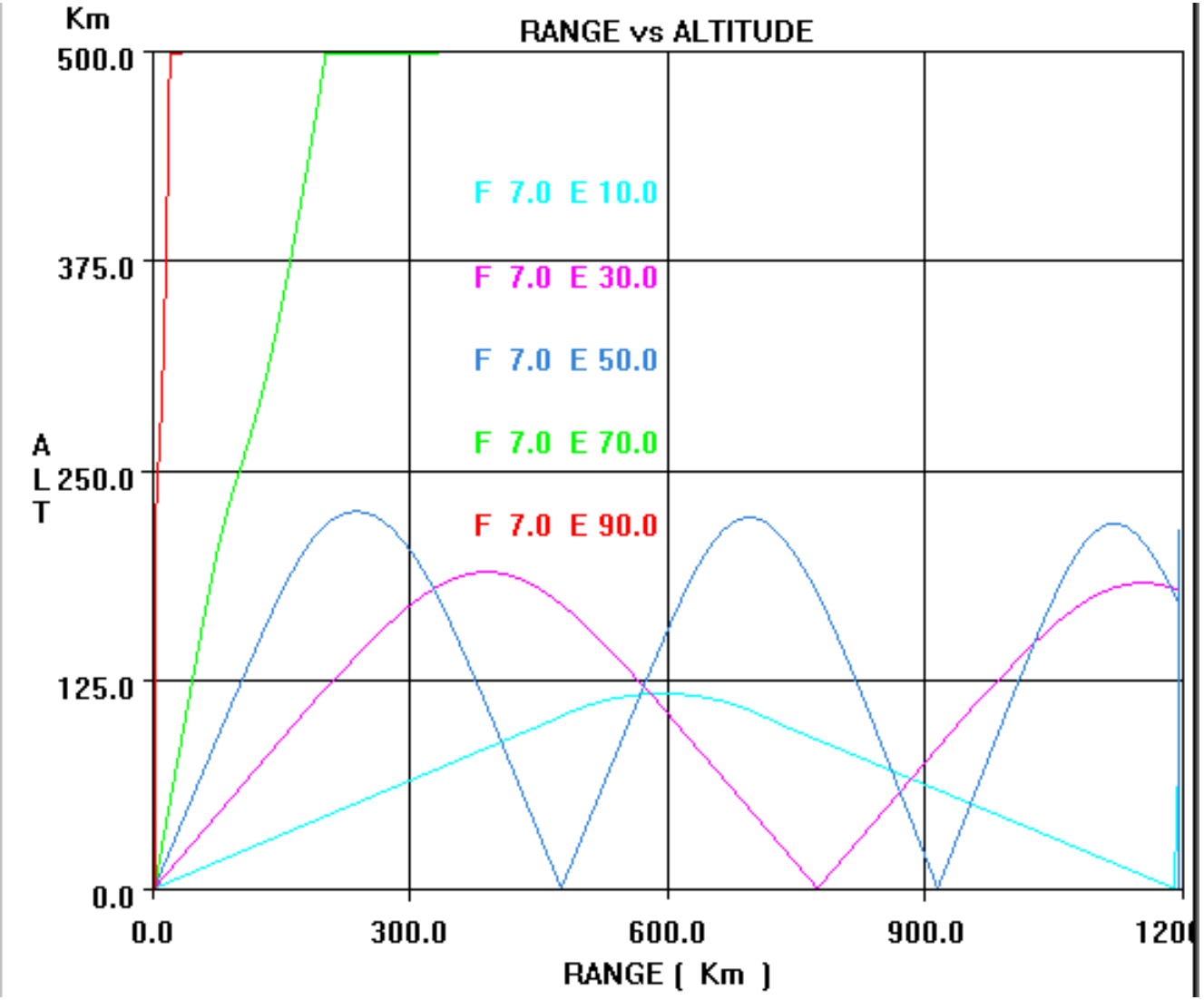
design review

The receiving node (RBN, WSPRnet, PSKReporter, etc.) is almost running in "phase 1"



Equipment List:
Active Receive Antenna (DXE-ARAV3)
Surge Protector (DXE-RLP75FF)
SDR Hardware (SDRplay RSP2pro)
SDR Software (SDRuno)
Virtual Audio Cables (VB-CABLE)
CW Decoder (CW Skimmer)

Future plans: ray tracing with AF-Geospace and PIM



AF-Geospace simulation using
Parameterized Ionospheric Model (PIM)

Preliminary Analysis

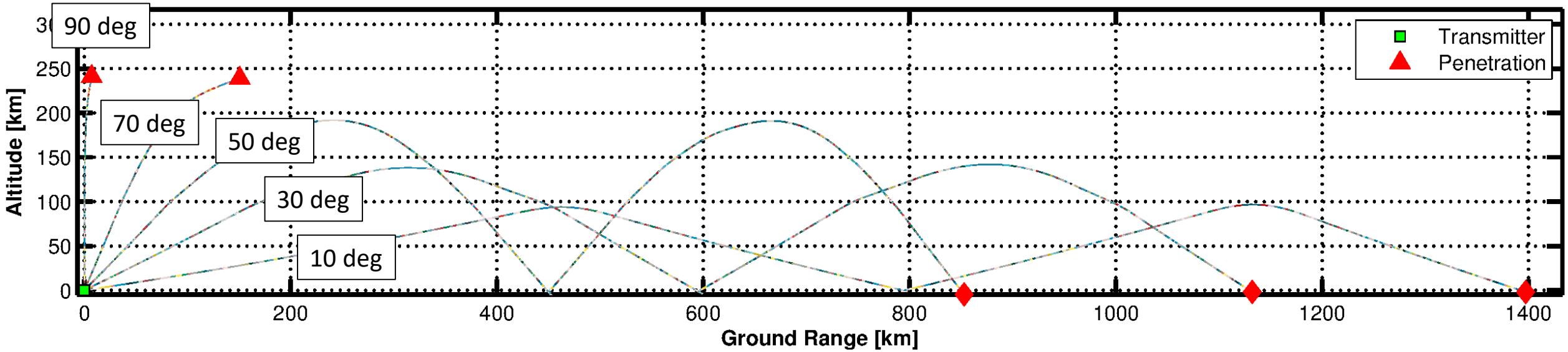
Frequency = 7 MHz (40m)
Elevation span = 10 – 90 degrees
Relevant ionospheric parameters

Notice how NVIS signals penetrate the F layer.
(70 and 90 degrees)

Caveat: no collisions

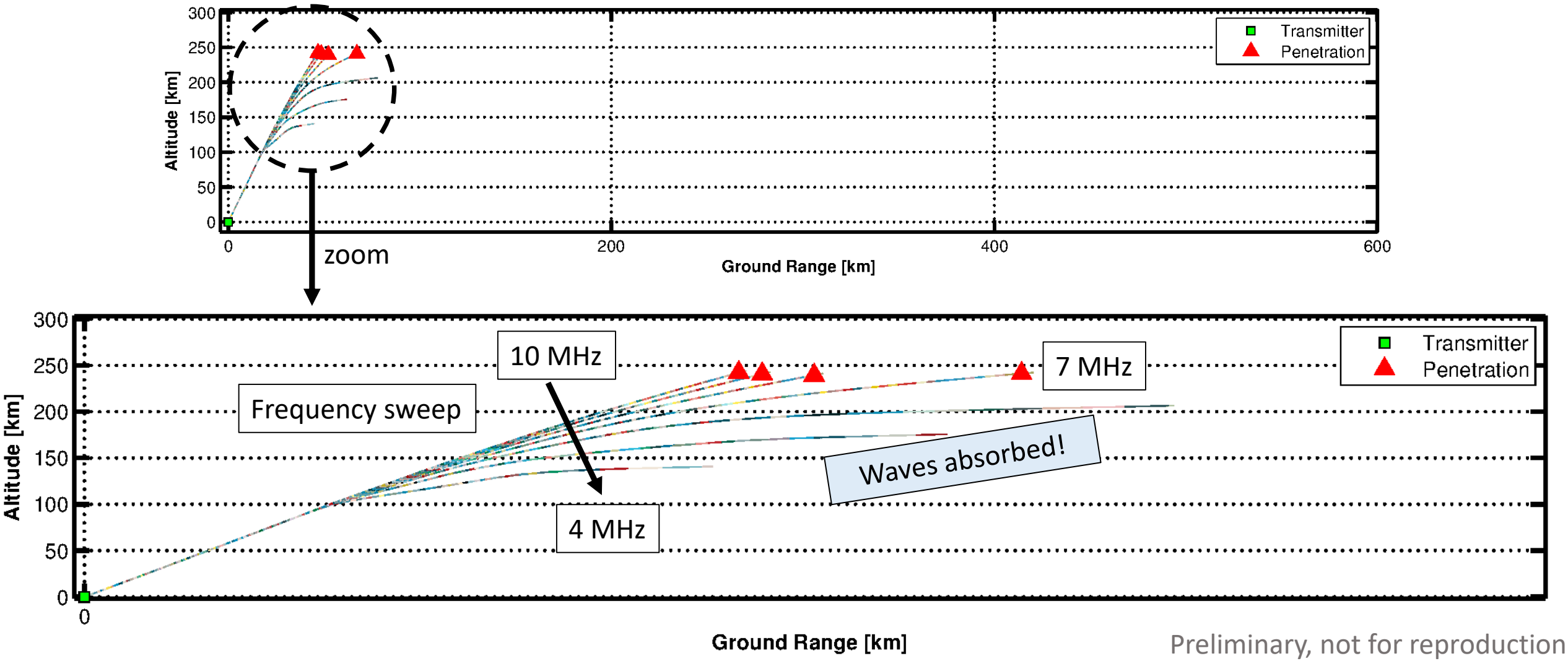
Future plans: ray tracing with IONOspheric Ray Tracing (IONORT)

Simulated 7-MHz ray pointed toward WL7C 60.6 km (37.7 miles) away at various elevations
(electron density profiles created using IRI-2016)



Future plans: ray tracing with IONOspheric Ray Tracing (IONORT)

Simulated ray pointed toward WL7C 60.6 km (37.7 miles) away at 80-degree elevation
(electron density profiles created using IRI-2016)



Conclusion

- Transmitted on 20m, 30m, and 40m from within totality using 80 watts and NVIS antenna
- We are establishing a receiving node at NSSTC (MSFC)
  - RBN, WSPRnet, PSKReporter, other?
- We will use ray tracing to investigate why our DX and DE stations did not make contact
- We are hoping to apply our lessons learned during future eclipses!

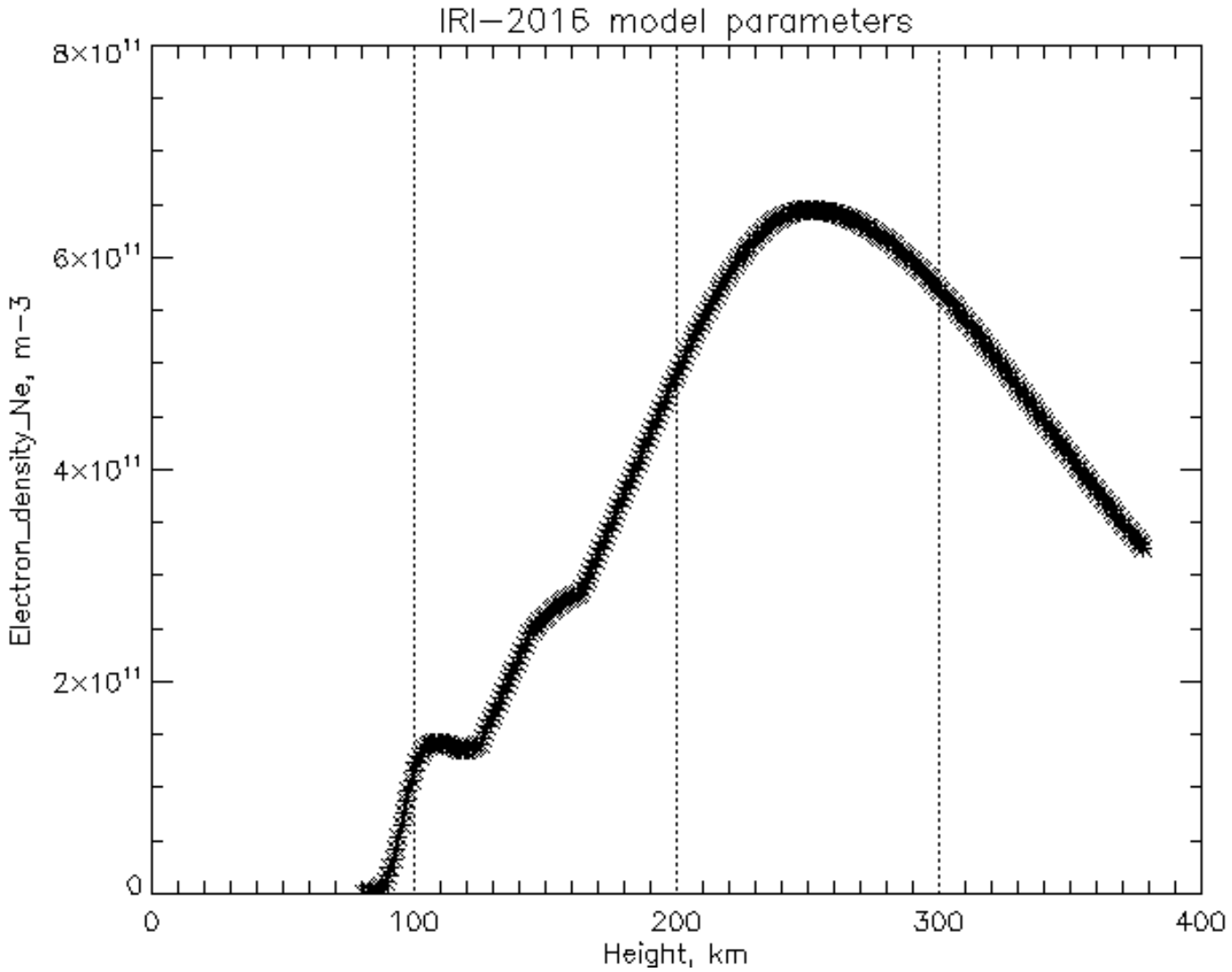
Please connect with us:

- Experience setting up receiving nodes?
- Plans for future solar eclipses (2019, 2020, 2024)?
- Ray tracing?

Thank you for your attention!

Extra slides

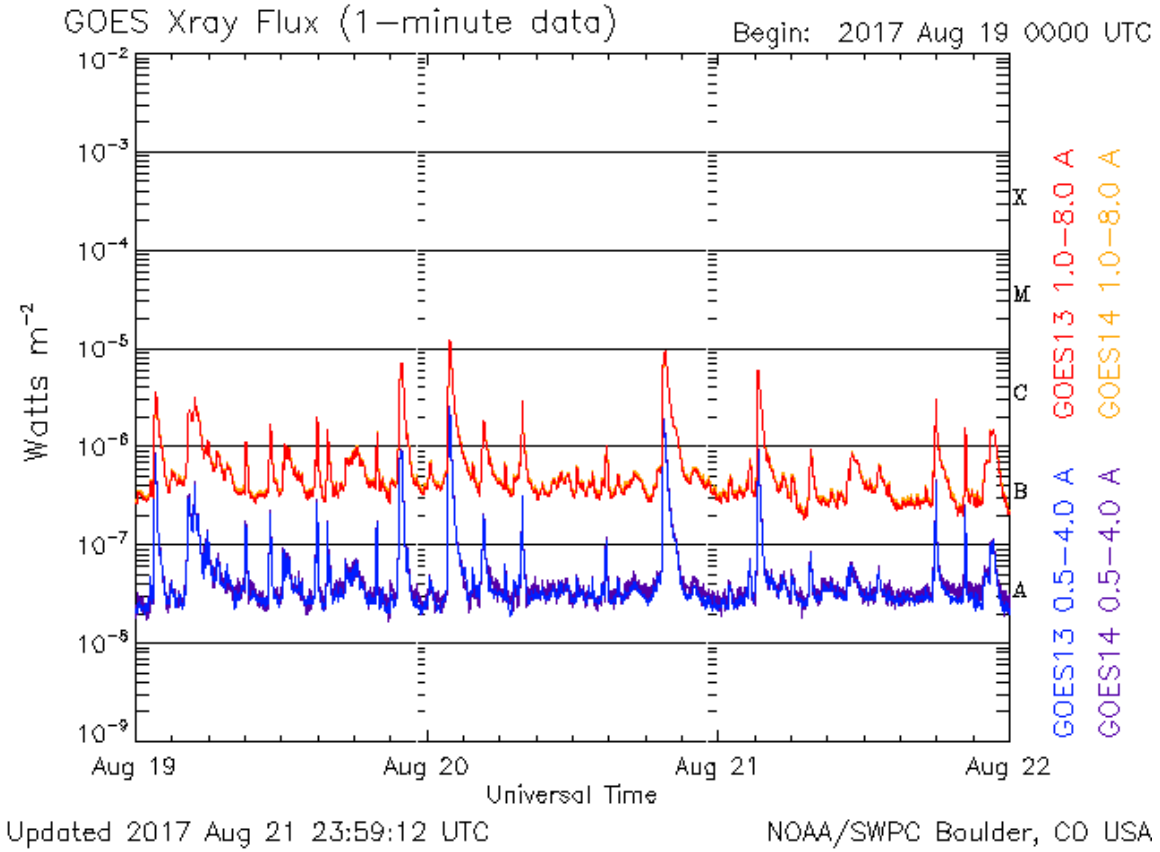
IRI-2016



IONORT

- D-region (collisions)
- Discrete electron density grids
  - Lat, lon, height

Sample output from IRI-2016 online
August 21, 2017
Hour = 16.42
Latitude = 30N
Longitude = -75W


GOES Xray Flux (1-minute data)
Begin: 2017 Aug 19 0000 UTC
Watts m-2
X
M
C
B
A
GOES13 1.0-8.0 A
GOES14 1.0-8.0 A
GOES13 0.5-4.0 A
GOES14 0.5-4.0 A
Aug 19
Aug 20
Aug 21
Aug 22
Universal Time
Updated 2017 Aug 21 23:59:12 UTC
NOAA/SWPC Boulder, CO USA