In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

Tony Emanuele
K8ZR

NTMS Meeting
3 April 2021

Ex: WA8RJF

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

47 GHz North America DX Records

345km/214 miles	AD6FP/6 (DM07as) & W6QIW/6 (DM04ms)	2015
342km/213 miles	W6QI/6 (DM04ms) & AD6FP/6 (DM07bs)	2005
246km/153 miles	W0EOM/6 (CM97ei) & KF6KVG/6 (DM06ms)	2003
232km/144 miles	KB8VAO/6 (CM96qi) & AD6FP/6 (DM04ms)	2004

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207km/128 miles	W5LUA, VE4MA & K8ZR (DM42ok56ig)	- W7QQ & N0IO (DM33rn26sp)	2018
205km/127 miles	N1JEZ/1 (FN44ig)	WA1MBA/1 (FN42bl)	2014

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The Challenges:

Equipment:

Until recently no commercial gear.

Power:

1 watt is considered big power on 47 GHz.

Power limit on 76 GHz is now 55dBm EIRP.

>10 milliwatts & 12” Dish exceeds the legal limit 76 GHz.

Operating sites:

Since LOS (Line-of-Sight) access to Mountain tops.

Additional Path Loss:

Water vapor absorption – primarily.

Example: Assume Dew Point of 35F.

Additional path loss ~0.2 dB/km on 47 GHz.

Additional path loss ~0.3 dB/km on 76 GHz.

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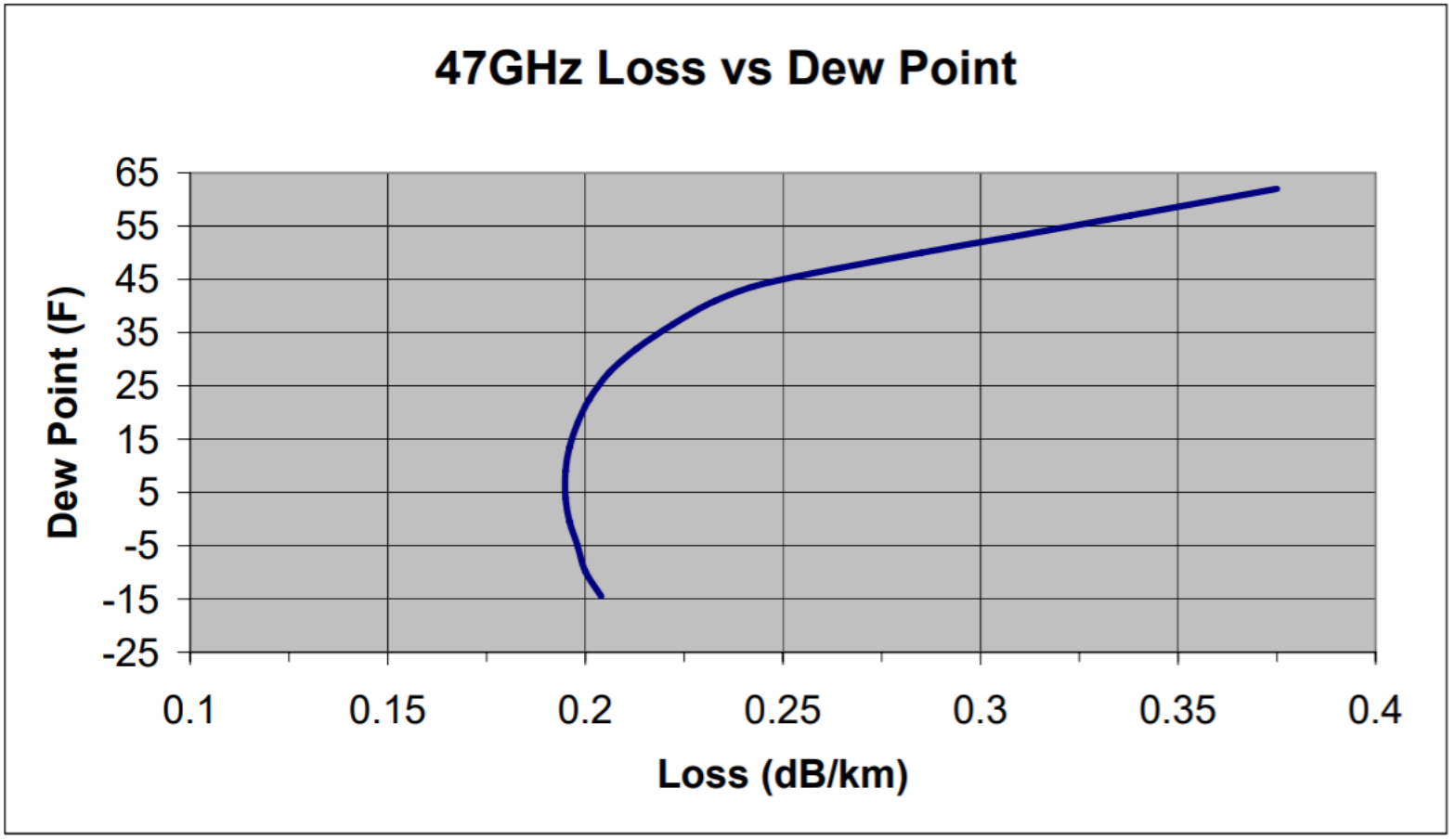

Prepared by Brian Justin WA1ZMS
WA1MBA Website

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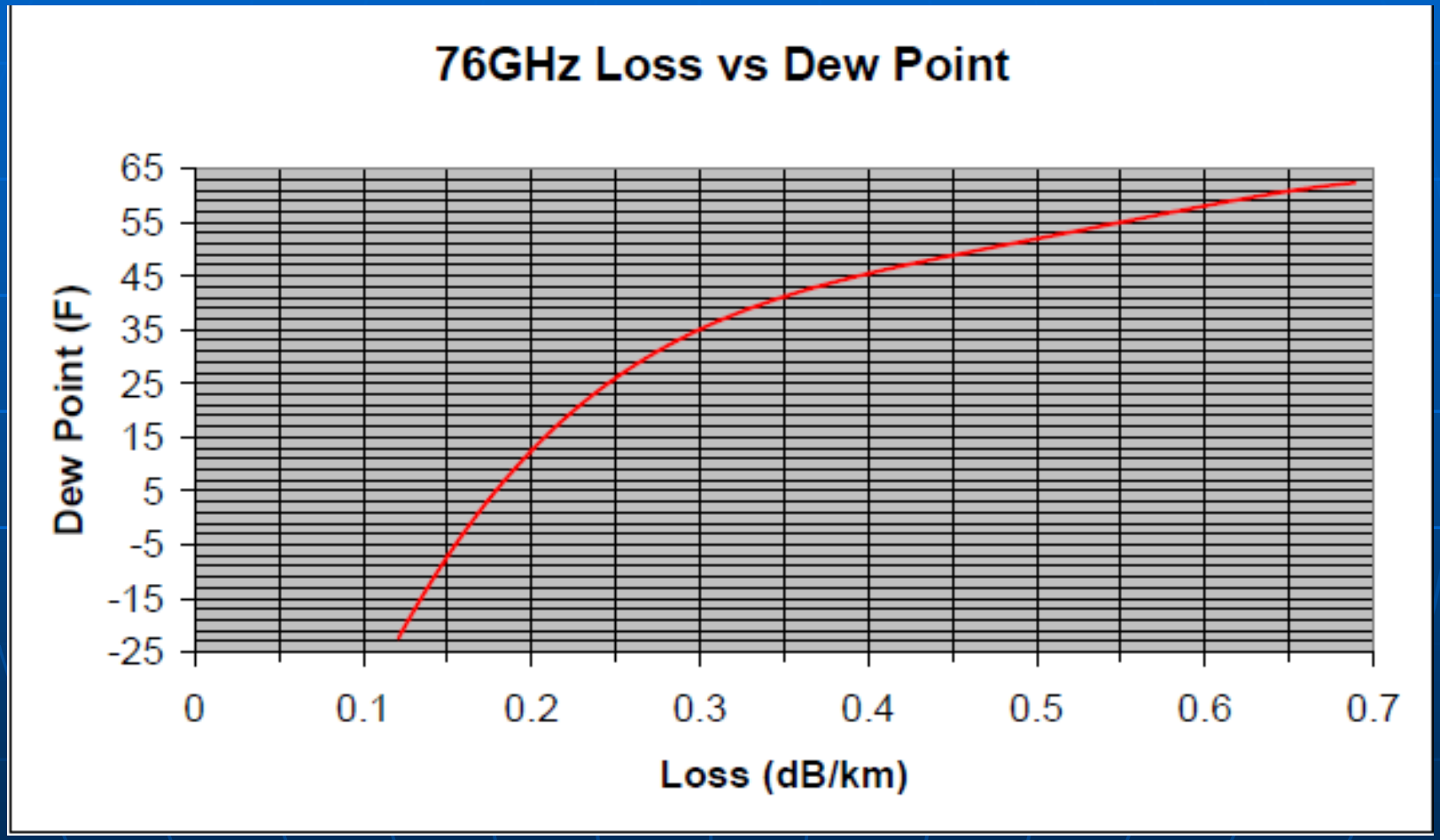

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Free Space Path Loss Calculation

$FSPL = (4 \bullet \Pi \bullet d \bullet f)/c$

d = distance in meters

f = frequency in Hz

c = speed of light meters/second

FSPL: 76 GHz @ 200km = 176 dB path loss

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76 GHz over 200km Path

Free Space Path Loss	-176dB
Transmit Power & Antenna Gain	+55dB
Receive Antenna Gain	+45dB
Receiver noise floor (1KHz BW)	+144dB
NF of XVTR	-8dB
Additional Path Loss due to Water vapor attenuation (*Dew Point 10F*)	-40dB
Total: S/N	20dB

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	Location	Distance KM	S/N DP 10F	S/N DP 25F	S/N DP 35F
47 GHz	EN81rj35vl	20	87dB	86dB	84dB
	EN81vl73ph	44	75dB	74dB	73dB
	EN91em28co	89	61dB	59dB	58dB
	EN91kt00ix	132	50dB	47dB	45dB
	EN91lu41jh	143	47dB	44dB	42dB
	EN91ov36cr	164	36dB	39dB	36dB
	EN91rx33qe	186	32dB	34dB	30dB
	EN92wd34ie	225	29dB	24dB	20dB
76 GHz	EN81rj35vl	20	76dB	75dB	74dB
	EN81vl73ph	44	64dB	62dB	60dB
	EN91em28co	89	50dB	45dB	40dB
	EN91kt00ix	132	37dB	31dB	24dB
	EN91lu41jh	143	34dB	27dB	20dB
	EN91ov36cr	164	29dB	21dB	12dB
	EN91rx33qe	186	23dB	14dB	5dB
	EN92wd34ie	225	14dB	3dB	-9dB

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	5,800 ft ASL	***8,017ft ASL***	
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	8,017ft ASL	***5,600ft ASL***	
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	4,000ft ASL	***7,200ft ASL***	
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from the Flatlands of the Midwest.

What to do ?
If only there was a wide flat expanse with no obstructions……

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Lake Erie

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

I have it on good authority that the Earth is not flat.

Curvature of the Earth and LOS (Line-of-Sight)

Optical Line-of-Sight: $d=(3.57*\sqrt{h})$ h in meters
or $d=(1.23*\sqrt{h})$ h in feet
Optical LOS if h = 100 feet is LOS is 12.3 miles

Radio Line-of-Sight: $d=(4.15*\sqrt{h})$ h in meters
or $d=(1.41*\sqrt{h})$ h in feet

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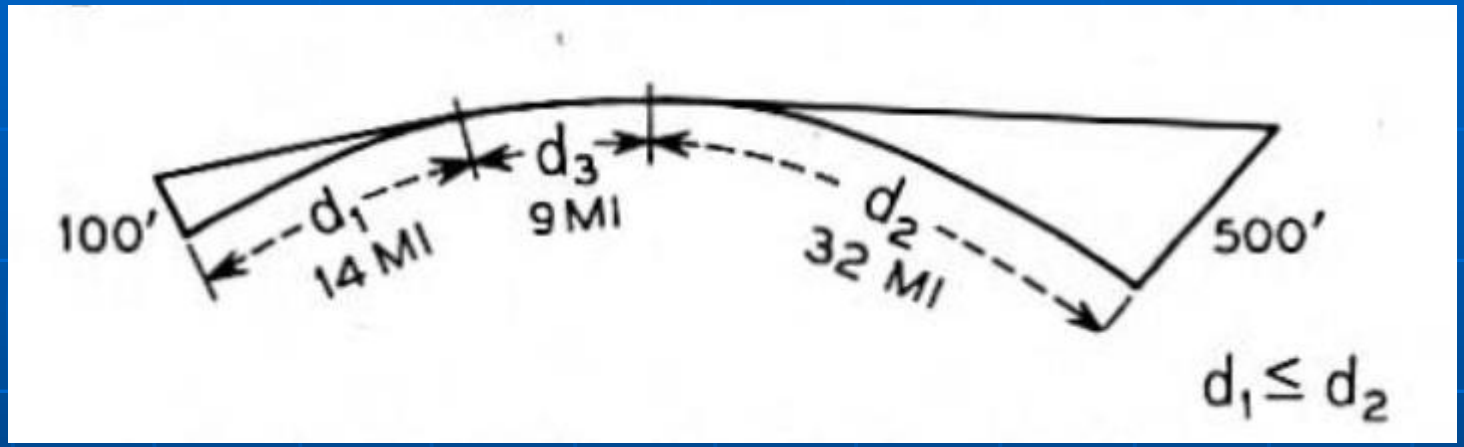

Bell System Technical Journal
Radio Propagation Fundamentals
May 1957 Volume XXXVI Number 3

Suggests under certain conditions the path is 20% further than the sum of the Radio Horizons.

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Radio LOS Calculation:

West end: h = 12 feet above lake level
Radio LOS: 8km/5miles

East end: h = 75 feet above lake level
Radio LOS: 20km/12miles

Total: 28km/17miles + 20% Bell Labs factor = 34km/20miles

Implies that any QSO > 34km/20miles *not* LOS.

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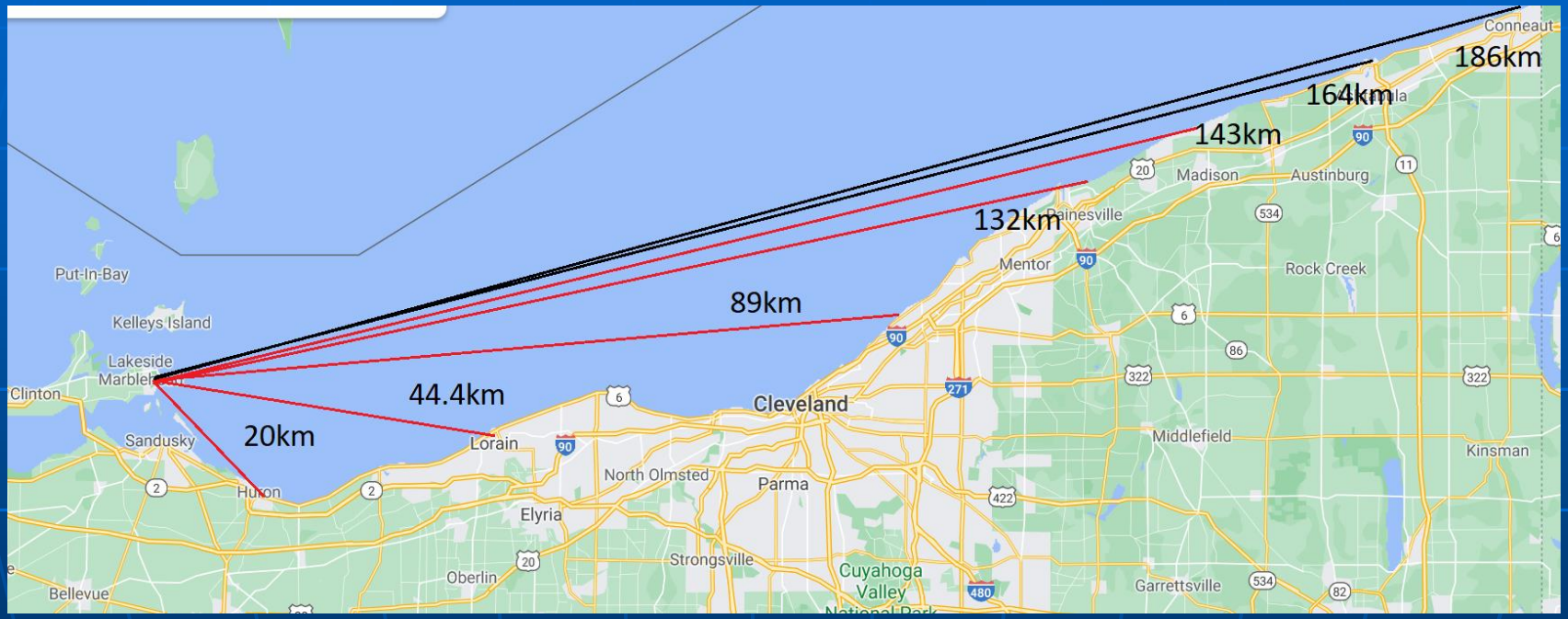

47 & 76 GHz Lake Erie Paths

47 GHz paths worked: 20km, 45km, 89km, 132km & 143km
76 GHz paths worked: 20km, 45km, 89km & 132km

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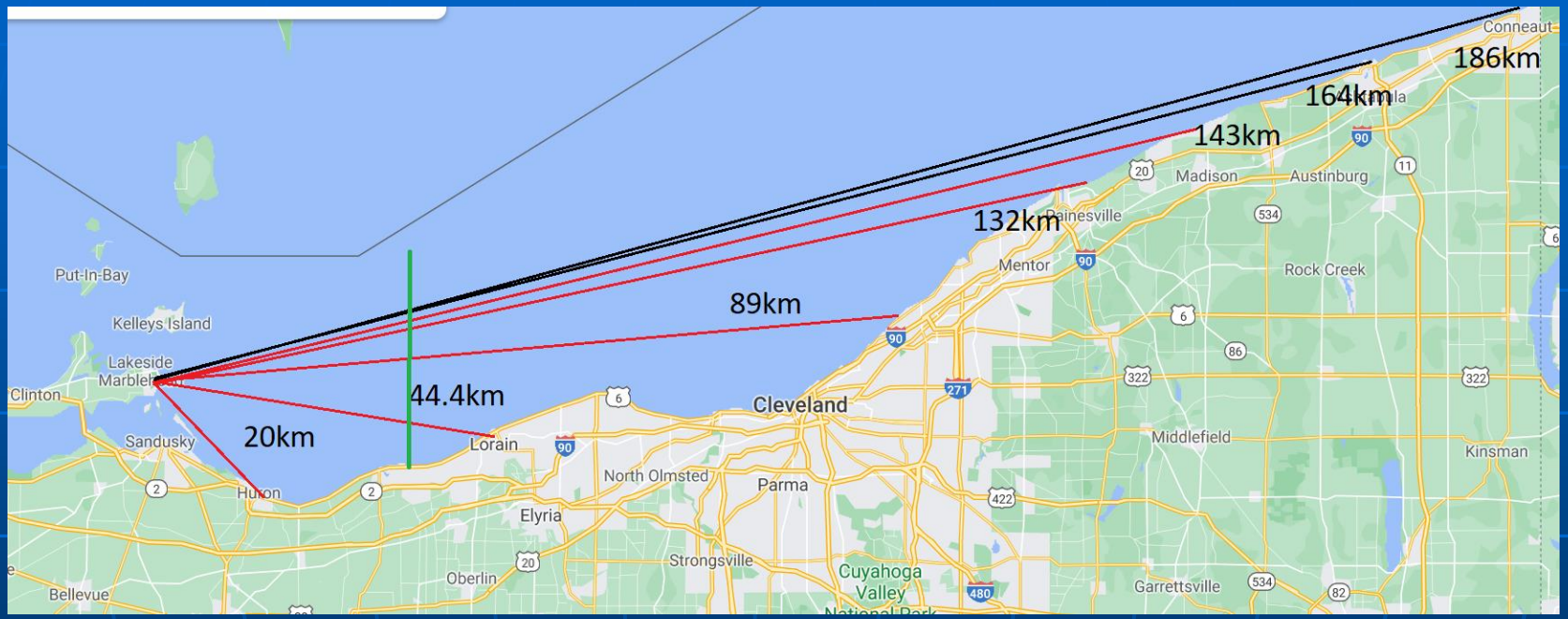

Beyond the green vertical line not LOS Path

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

If the 132km (76 GHz) & 143 km 47 GHz QSOs were beyond LOS

What was the propagation mode?

Non-ionospheric:

- Reflection
- Refraction
- Diffraction
- Evaporation ducting ? ? ? ?

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Evaporation ducting

The air in immediate contact with the surface of the water is saturated with water vapor due to evaporation.

At some distance above the water the air is not saturated.

The decrease in water vapor concentration with increasing height creates a duct.

The duct forms 20 to 50 feet above the surface of the water.

The literature suggests “profound” effect on microwave propagation to at least 40 GHz.

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Evaporation ducting

Antidotal evidence of evaporation ducting over Lake Erie and Lake Michigan.

Ops at Sleeping Bear Dunes in northern Michigan have observed evaporation ducting across Lake Michigan.

No QSOs at 1,000 feet but stations at Lake level reported S9++ signals over the same path.

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KB8VAO on 76 GHz @ 132km February 2020

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

https://www.youtube.com/watch?v=_lQbb-TTuhY

KB8VAO on 76 GHz @ 132km February 2020

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Notice broken straight key

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

47 GHz
KB8VAO EN81pm46lk & K8ZR EN91kt00ix
@ 132km March 2021

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See YouTube link:
https://www.youtube.com/watch?v=aLgIBV_YSJA

47 GHz
KB8VAO EN81pm46lk & K8ZR EN91kt00ix
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In the Pursuit of ADX on 47 & 76 GHz from the Flatlands of the Midwest.

KB8VAO & K8ZR 76 GHz @ 132km
21 March 2021

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KB8VAO & K8ZR 76 GHz @ 132km
21 March 2021

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Area Stations active on 47 and/or 76 GHz:

- Michigan:
  - WW8M: 47 & 76 GHz
  - WB8TGY: 47 & 76 GHz
  - WA8VPD: 47 GHz
- Southern Ontario:
  - VA3ELE: 47 GHz
  - VA3TO: 47 GHZ
- Ohio:
  - KB8VAO: 47 GHz & 76 GHz
  - K8ZR:47 GHz & 76 GHz

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Summary:

- Much more to learn. Are condx on 10 GHz an indicator?

- Collect additional data for QSOs that fail.

- Under favorable conditions Lake Erie paths may result in achieving DX distances at record breaking distances.

- Collect evaporation duct data.

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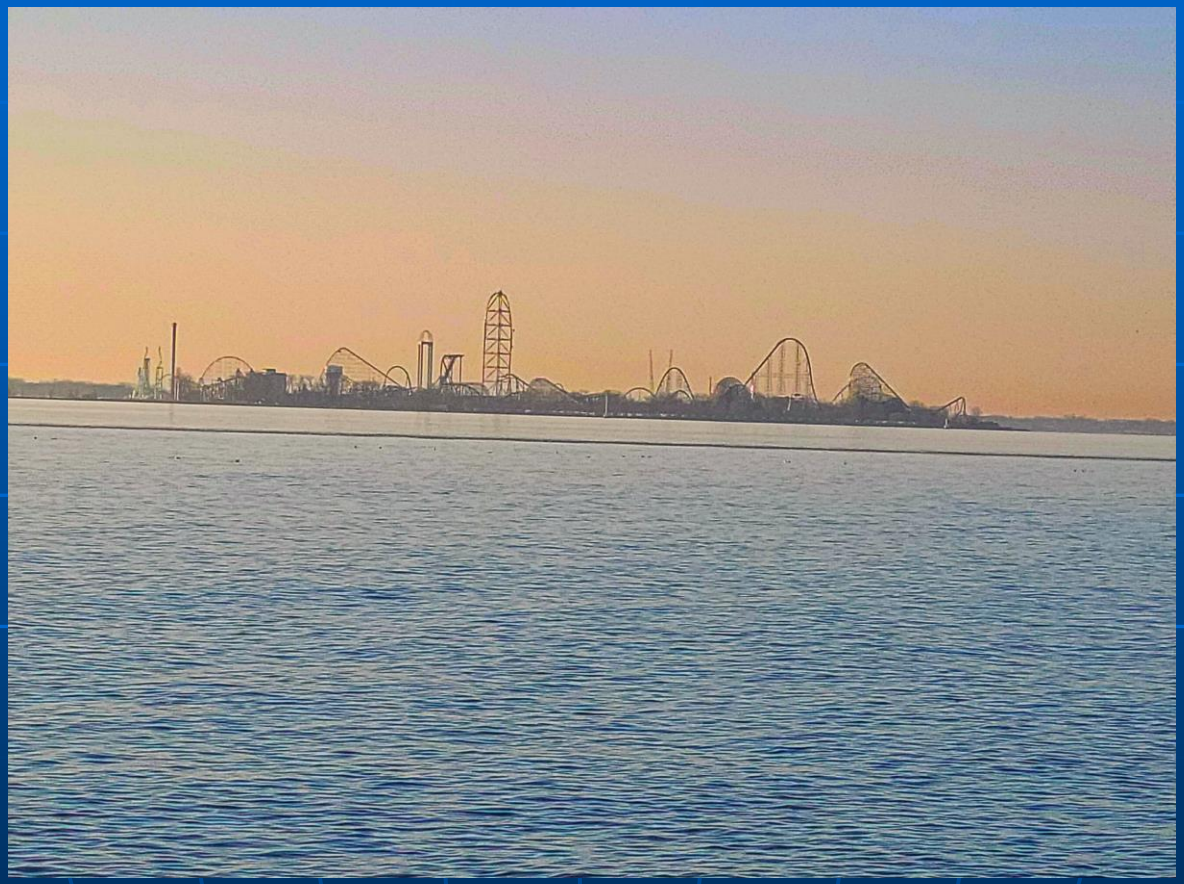

Cedar Point Amusement Park
Antenna alignment @ 3 miles from KB8VAO
@ EN81pm46lk

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KB8VAO’s view looking East from EN81pm46lk

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from the Flatlands of the Midwest.

Mark WB8TGY @ Marblehead

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

K8ZR
76 GHz QSO
@ 132km
February 2020

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

K8ZR 76 GHz @ 132km February 2020

In the Pursuit of DX on 47 & 76 GHz from the Flatlands of the Midwest.

Addendum:

On 47 GHz: KB8VAO 40 milliwatts to 12-inch dish
K8ZR 400 milliwatts to 12-inch dish

On 76 GHz: KB8VAO ~0dBM to 12-inch dish
K8ZR “Legal limit” 55dBm EIRP

Questions ? ? ? ? ?