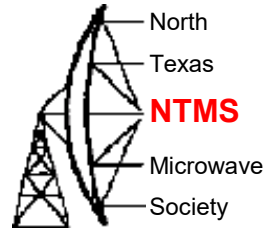


Propagation studies before activities

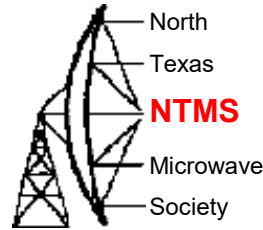
KM5PO – Jim McMasters
October 10, 2026

Purpose



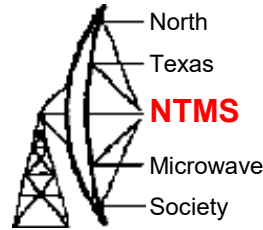
- Be prepared for conditions
 - Change strategy if warranted
- Maximize your DX, time on the band, points and grids!

How



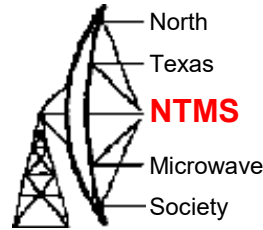
- For higher frequencies like above 900 MHz, become a student of propagation.
- NTMS has a powerful propagation prediction website.
- The NTMS propagation engine can analyze what atmospheric enabler provided the support for a contact. You just enter the contact details.
- Study propagation predictions over time
 - Keep a baseline

When propagation won't help



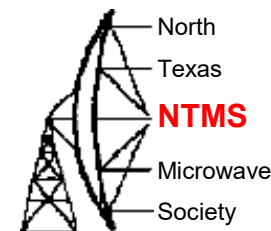
- Advice to the rovers and explanations to the fixed stations.
- “well, I just worked xxx and they were S9, I don’t understand why we couldn’t complete”
- If your location is poor, then propagation will not make up for it.
- Many other dynamics at play
 - Pointing (either station or both not aligned)
 - Frequency coordination
 - Power, receive noise figure, etc.

Homework



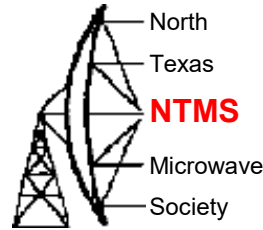
- Using beacons
 - Gain experience in verifying the path to beacon
 - Compare relative beacon strength to other rovers and fixed station signals
- Validate the paths if they are new
 - Record the SNR over time and learn how the bands are behaving before contest day (more on this later)
- Is your strategy aligned to the band propagation?
 - Is it better to start at max distances to catch the diurnal enhancement and work closer as the day goes on?

New to roving? Use vetted locations



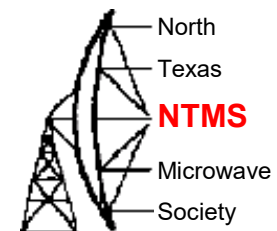
- Location! What makes a good one? You can learn from vetted locations why they are good...
- NTMS rover locations listing on the website
- Brad WQ5S, Pat W5VY, Jerry K5SOP, Ross K5ZSJ, Steve K5MNZ, W5OC & AB5SS and me. Also others that came before us

Location

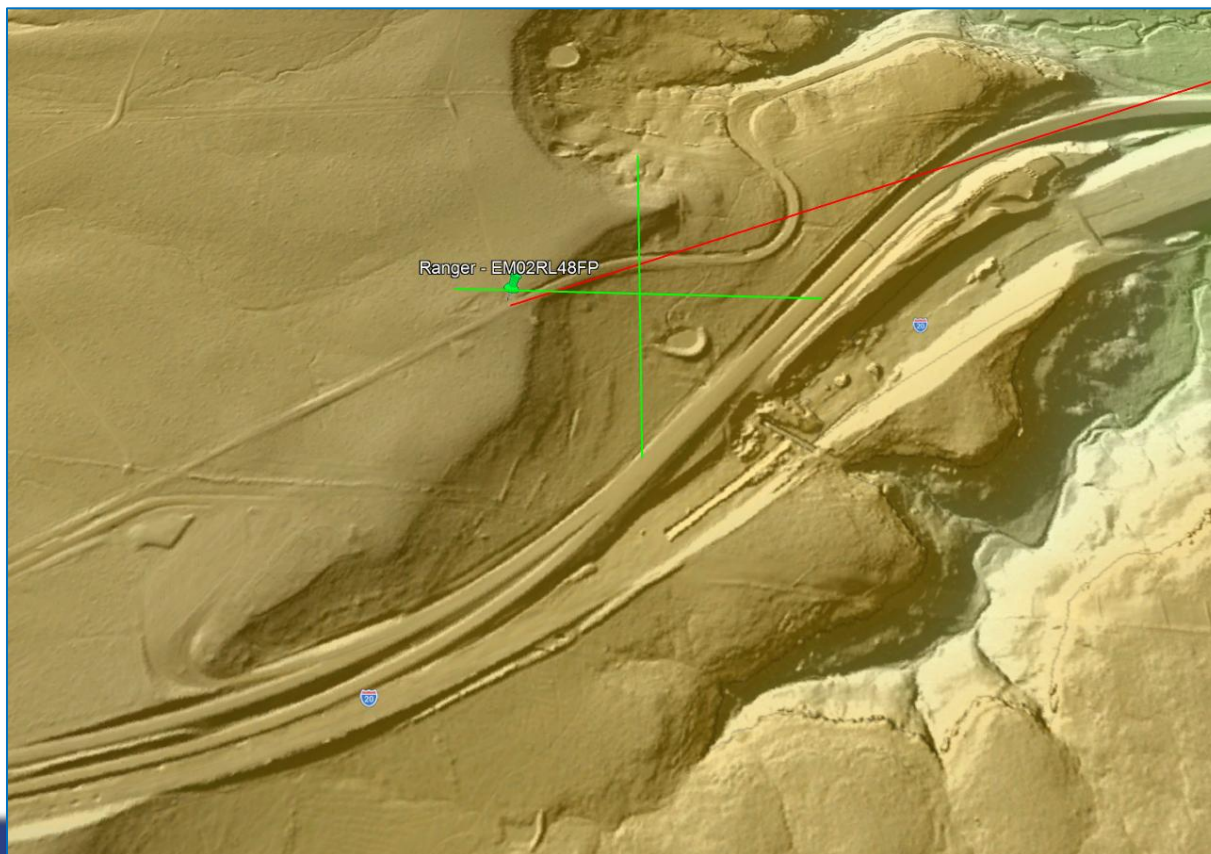


- Using LIDAR
 - National Map Viewer
 - [TNM Downloader - The National Map](#)
 - Download LIDAR maps
 - Elevation Products (3D Elevation Program Products and Services)
 - Select (Extent) the area you want with bounding box selector
 - “Find Products”
 - Pick 1 meter data if it’s available
 - Download the file
 - SAGA GIS
 - Open the downloaded file and select it on left side
 - Select Geoprocessing> Visualization>Grid>Terrain Map View
 - It runs algorithm over LIDAR maps
 - Map>Save>Export to Google Earth
 - It will auto open in Google Earth

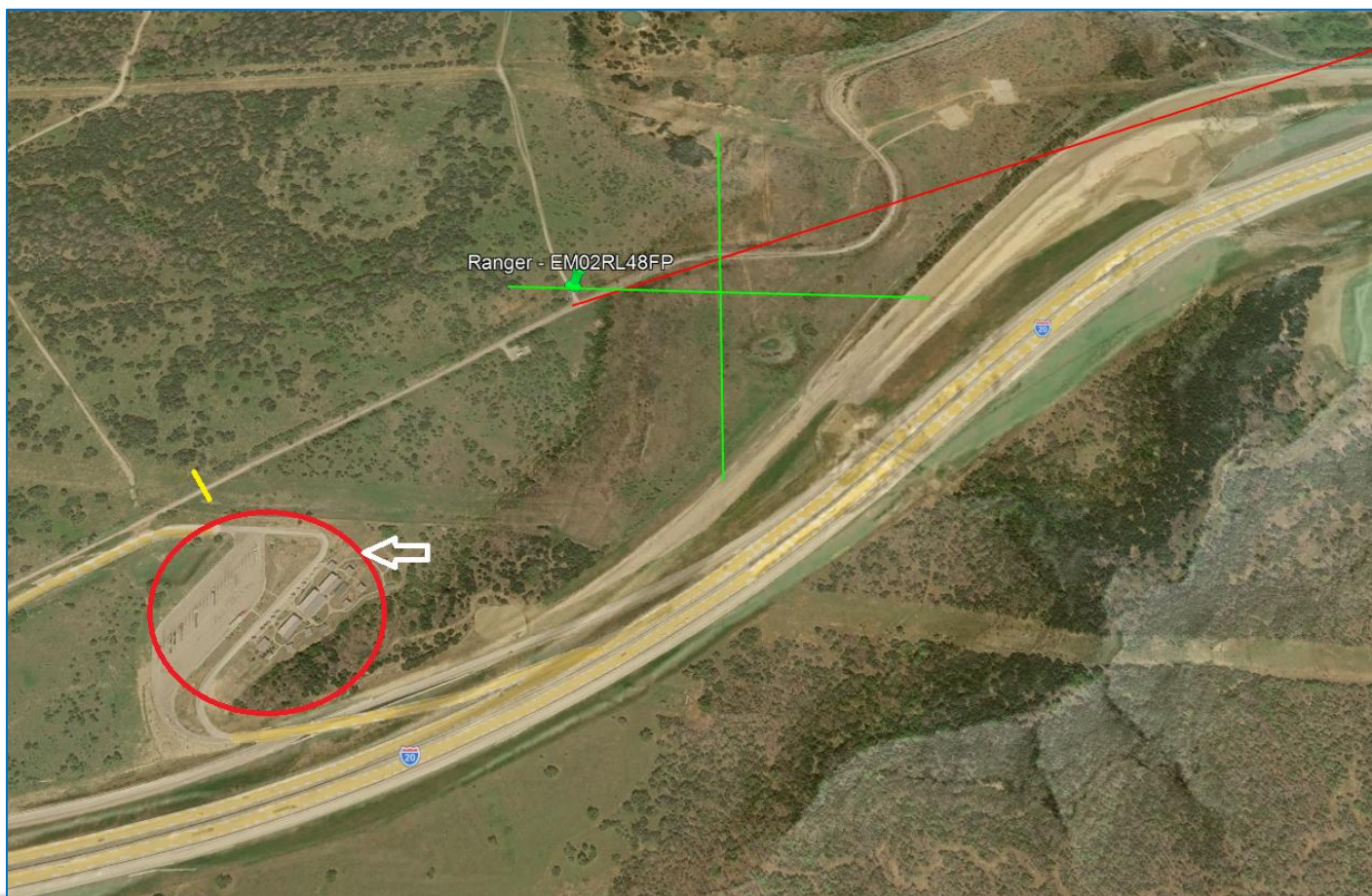
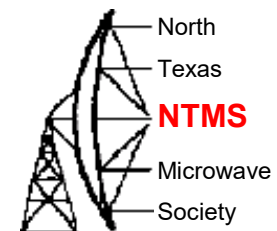
Best laid plans



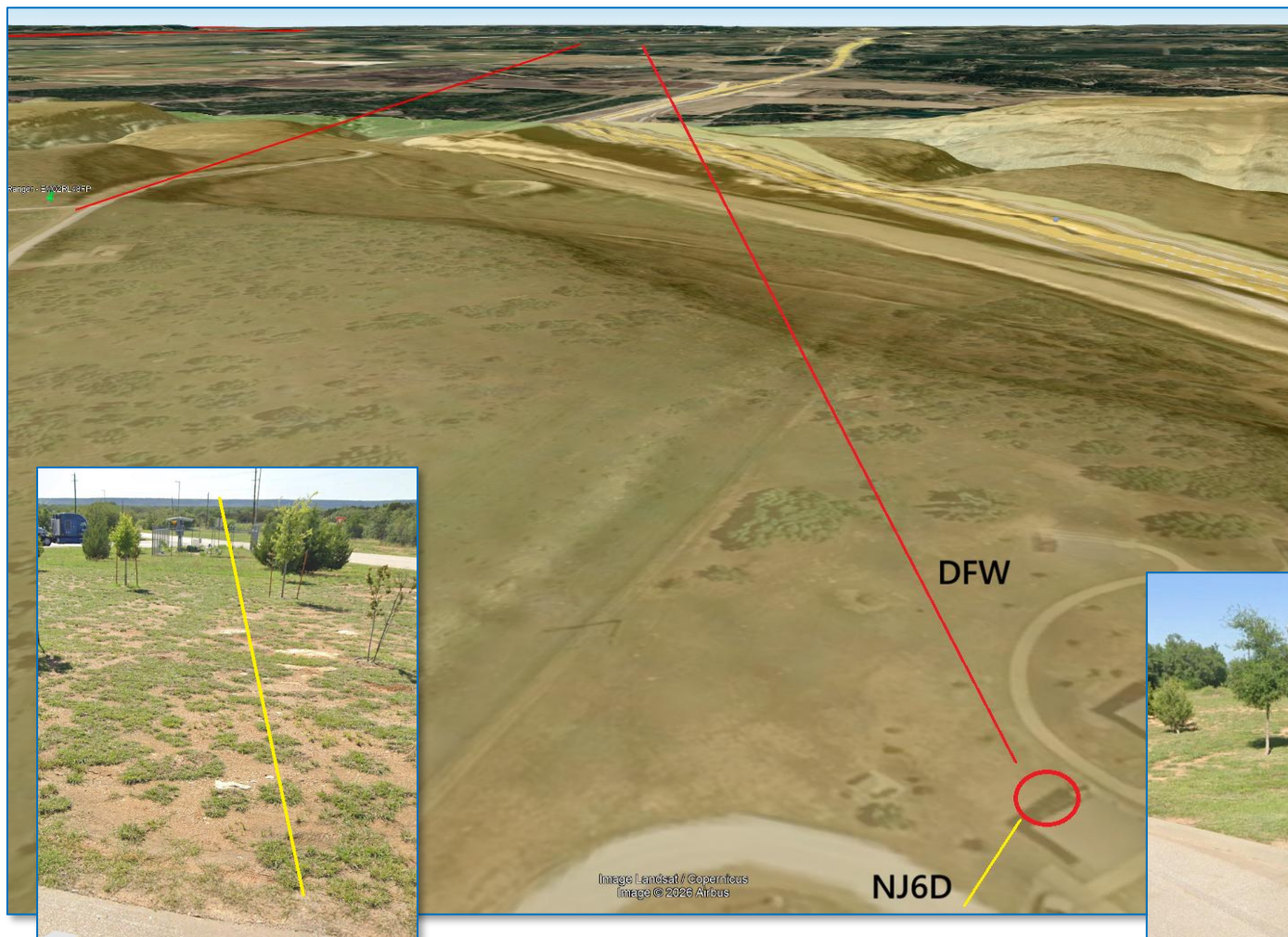
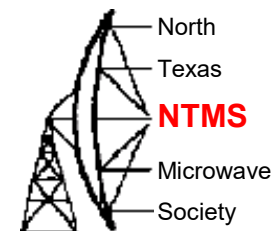
- This location had a surprise to it.
- Ranger hill.



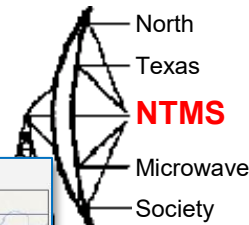
Time to pivot



The height overcame



Aircraft scatter



AircraftScatterSharp Version 1.0.9726.18712

Options Selected Aircraft Data (metric) 10/07/2026 12:34:43 UTC

Hex Code ABB507 Flight Number SWA1445 Altitude 11536.68 Message Time 10/07/2026 12:34:30 UTC 13

B738 Airframe 12 Home->DX Bearing 273.98 EL -3.38

Heading 263.720 Speed 216.324 Distance 1061.12

Set DB Reset Dn 200 Up 200 Show Planes New

Home Midpoint DX Station Aircraft

Call EM02RL48FP DM72VG6NV DM52BP86CA DM82CE29JL

Grid 32.4942708333 32.699508 32.65 32.206081

Lat -98.5482638889 -104.195456 -109.849305556 -103.813211

Long 497.2 66.4 570.5 230.3 17.44

km to Plane 267.72 Set Home and DX Positions 93.33 km time

AZ 6.26 Skew 5.45

EL 0.40 0.07 0.00 -1.07

All 447 1078 3053 Auto Center and Zoom

Primary Alert Second Alert Skew Lines Key Capture SQLite DB

PWR 40 Home DX Station 50

Gain 37 2.32 37 2.32

BW 500 500

NF 1 1

Take Off -0.1 0.00

km 42.6 0.3

Alt 447.0 3053.0

dBm -161.1 -162.0

Marg -15.1 -15.1 -16.0 -16.0

Dop -88.05 -88.05 -0.122 Dop Change

Total Path Loss dB -282.1 Aircraftscatter Angle

Maximum FE dB Troposcatter Angle 7.0

Reflector

Learn -2

DC9 - 8

707 - 16

Med - 20

Lg - 40

747 - 63

J Jet- 100

Auto 12

Prop Mode

Aircraft

Tropo

Free Space

Frequency

50

144

222

432

903

1296

2 GHz

3 GHz

5 GHz

10 GHz

24 GHz

470

START STOP

Key Capture Altitude Static Mouse Calculations

Save Plane Data CSV SQLite raw

Min H El -10 | Min DX El -10

Min Alt 11000 | Min RCS 0

Satellite Street

Internet Plane Sources RTL1090 D On

Local 0 Unique 0 Total 50 FAA Use Curr

Path Altitude Profile

Station

DX Sta

Hz -82.33

-77.33

216.3

216.1

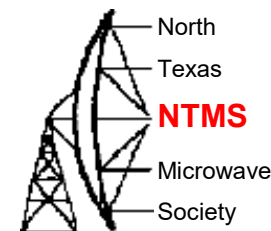
215.9

m/sec

Degrees

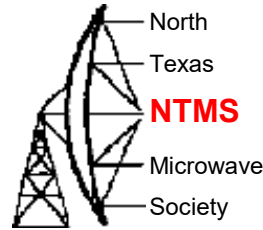
11

Google Earth Pro



- Google Earth Pro – It's free (used to cost \$)
 - General rover organization
 - Plot good existing locations and observe their success factors
 - They are free of obstructions
 - They are high ASL
 - They are accessible or we have property owner permission
 - Research new locations
 - High ASL
 - FAA/FCC data
 - LIDAR maps show ridges and peaks

Viewshed



- **Edit the viewshed.h configuration file to adjust the kMaxWorldSpaceLength parameter.**
- This value represents the maximum viewshed distance as a fraction of the Earth's radius (6,378,137 meters).
- to extend the viewshed to 100 km, calculate the fraction:
- $100000 / 6378137 \approx .015678559$
- C:\Program Files\Google\Google Earth Pro\client\shaders
 - Demo Dorchester path

```
viewshed.h
File Edit View

#if defined(GL_ES) && defined(GE_PIXEL_SHADER)

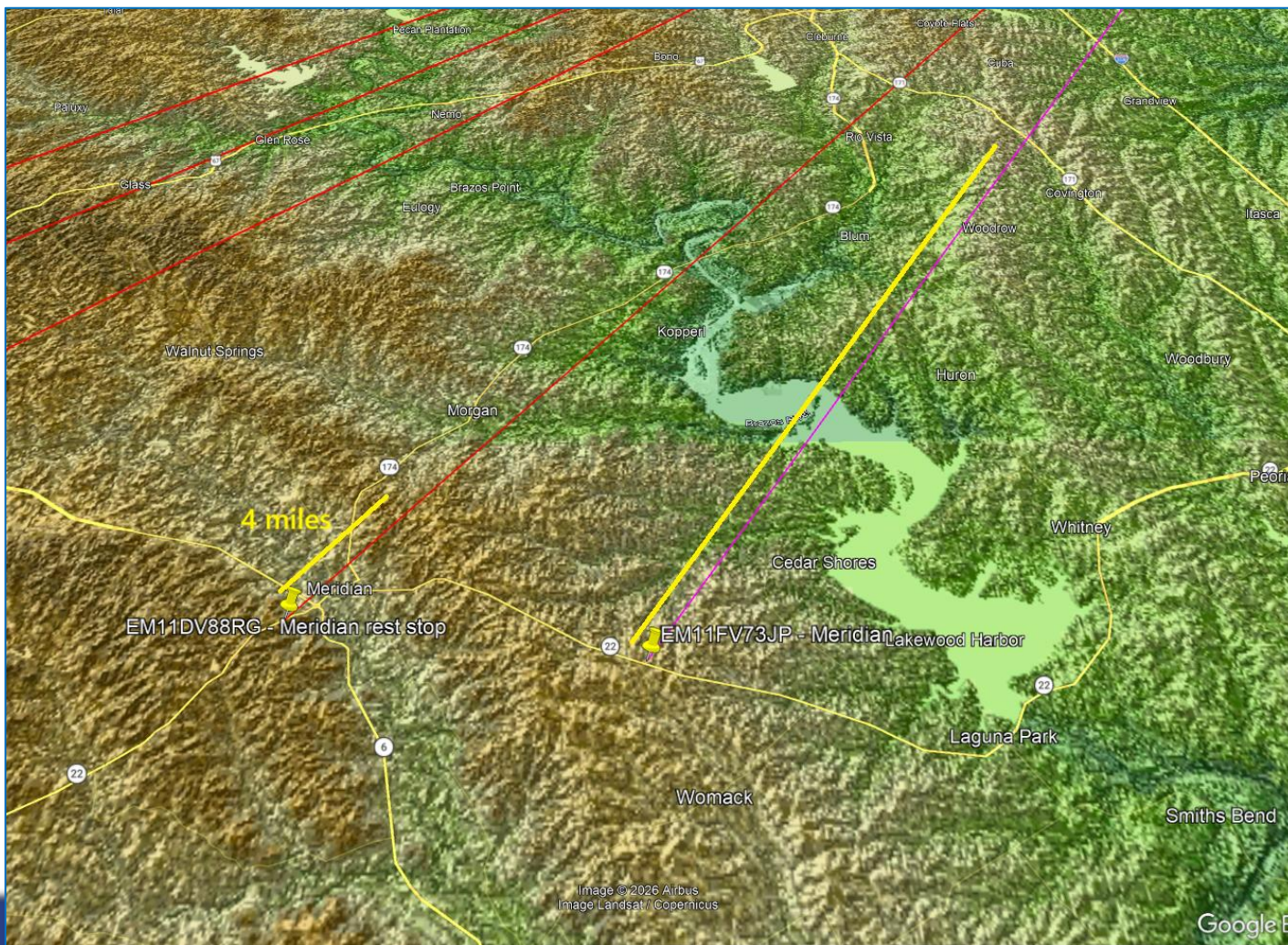
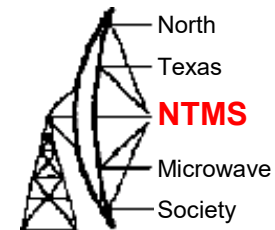
// This is needed to use fwidth().
#extension GL_OES_standard_derivatives : enable

#endif

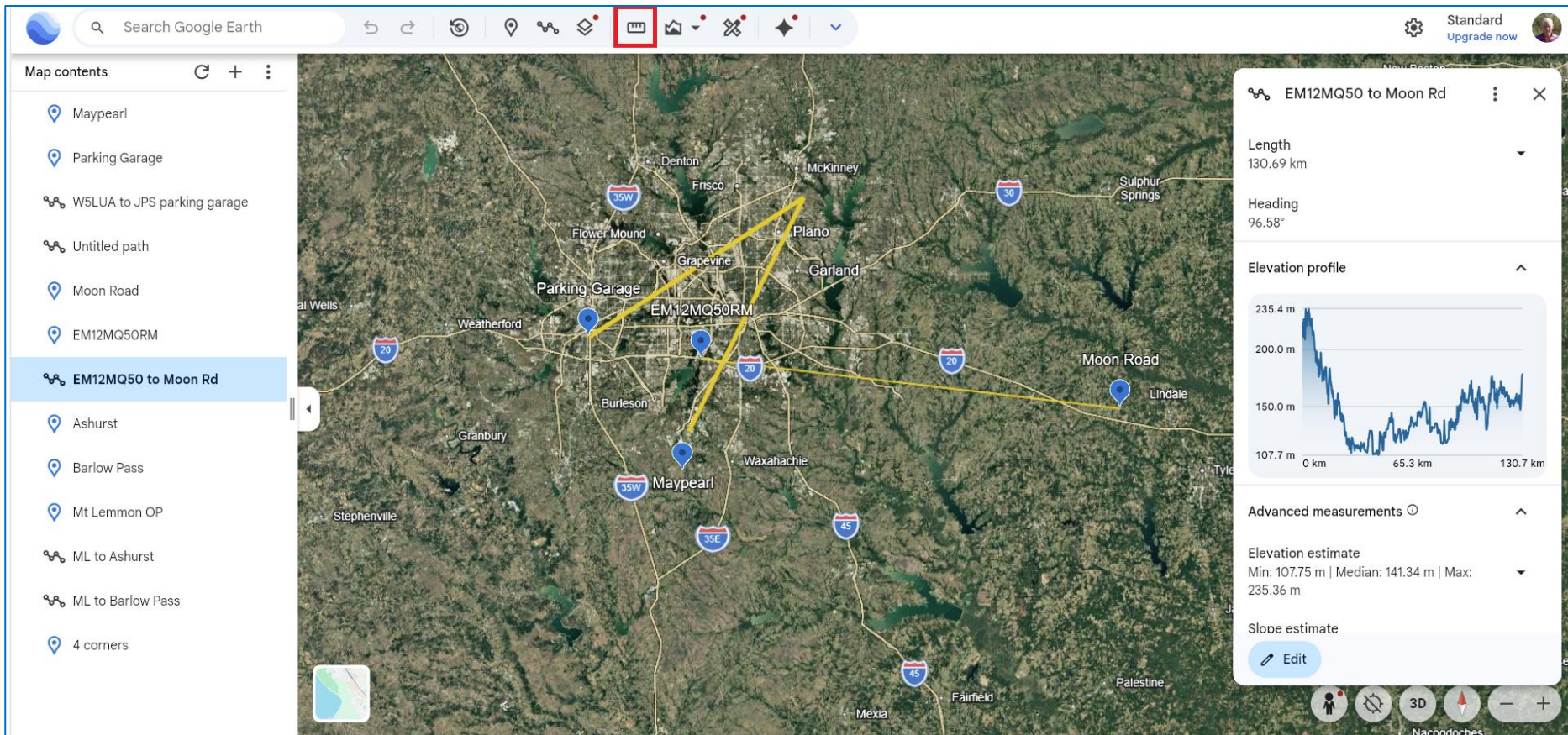
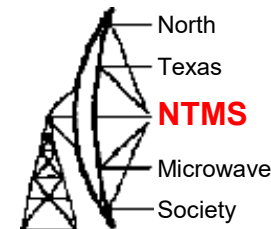
uniform highp mat4 viewshedMatrix;
varying highp vec3 viewshedDir;
varying highp float viewshedLen;

// Maximum world space radius of viewshed in fraction of Earth radius.
// Currently, kMaxWorldSpaceLength = 10000m / kWGS84Radius
// See earth/client/libs/math/units.cc
// #define kMaxWorldSpaceLength 0.007839278
#define kMaxWorldSpaceLength 0.015678559
// Offset in distance to reduce shadow acne.
#define kViewshedDepthOffset 0.0000031357119
// "Fringe" distance to fade nicely from good color to bad color.
#define kViewshedFringe 0.0000031357119
```

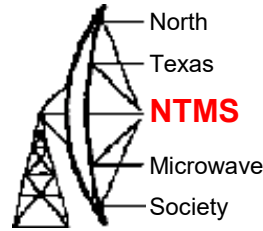
Be aware of ridges on boresight



Google Earth Web

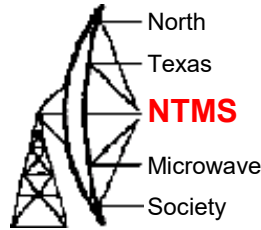


Using NTMS prop website



- **In your browser: <https://prop.w5isp.com/>**
- NTMS propagation engine/website upgrades (click “What’s new”)
- How to check beacons? Look at the monitors (demo)

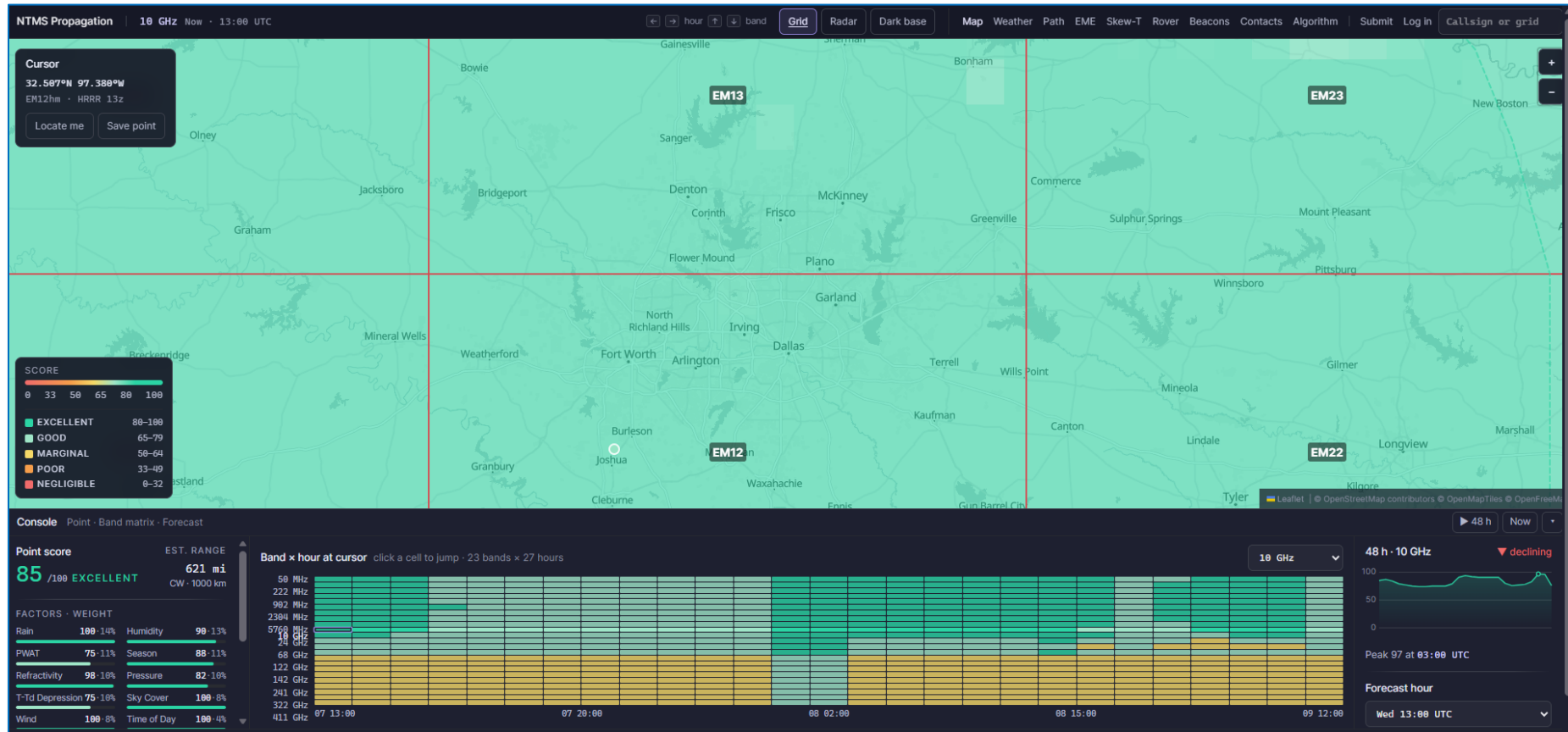
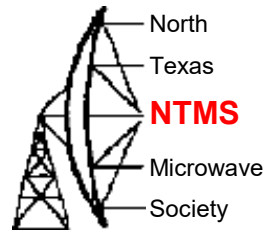
Map/Path Analysis



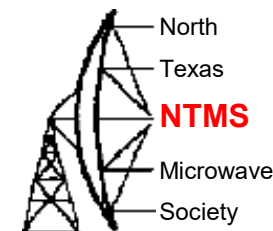
- **In your browser: <https://prop.w5isp.com/>**
- You will land on the “Map” (we will demo)
 - Locate me
 - Select frequency band
 - Observe “now” conditions and graphed forecast lower right
 - Click in the grid to advance the forecast and frequency
- On menu bar at top click on “Path” (we will demo)
 - Populate two grid locations
 - Select band
 - Update “Station” metric values
 - Click Calculate
 - Observe: Margin, Metrics, Future trend/predictions

Recent enhancement

- NTMS propagation “Map”

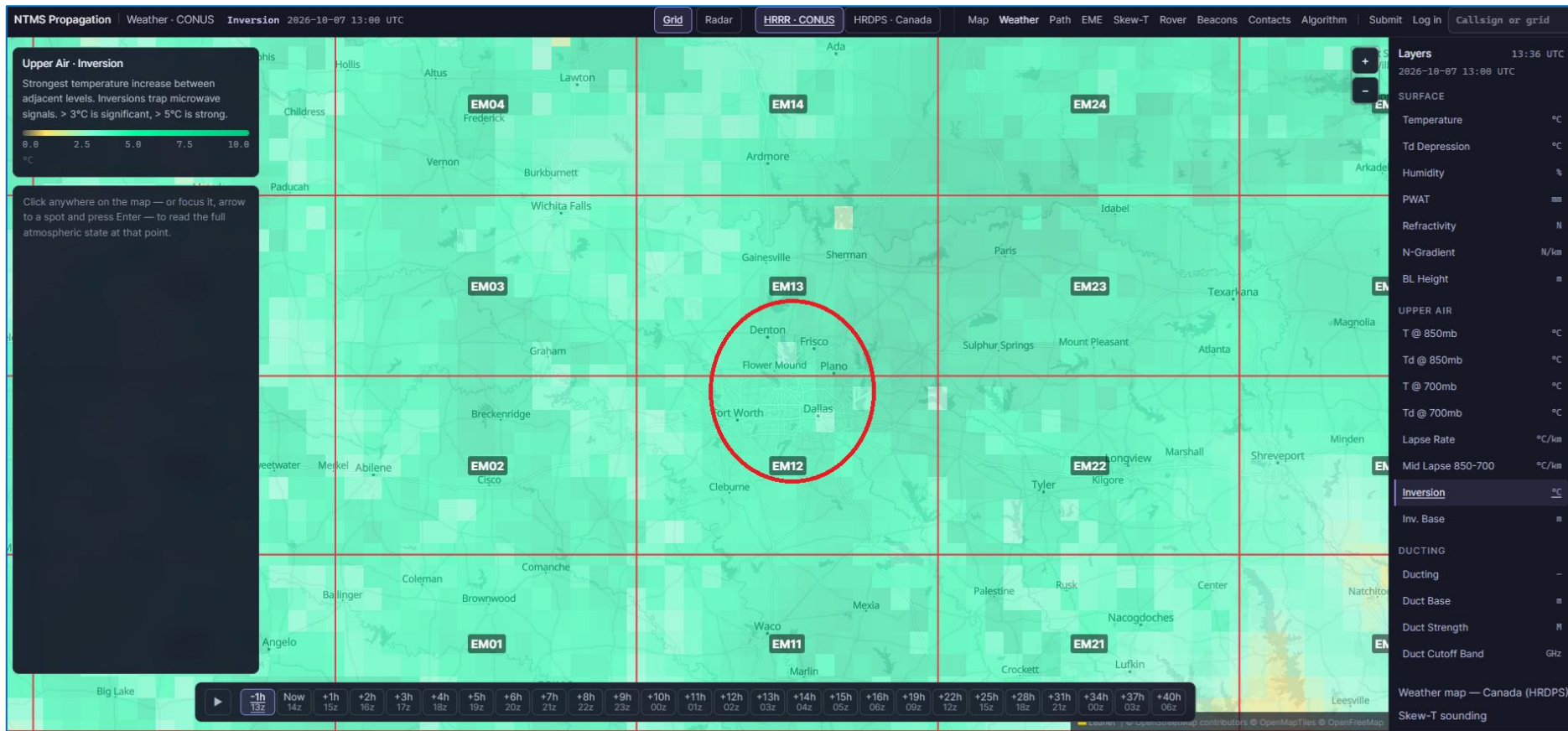
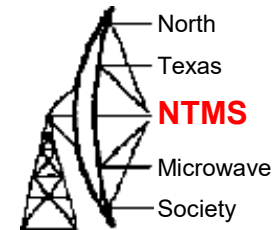


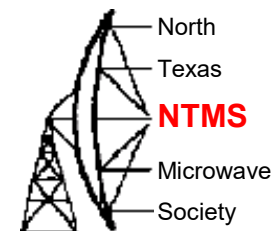
- **NTMS propagation “Refractivity”**



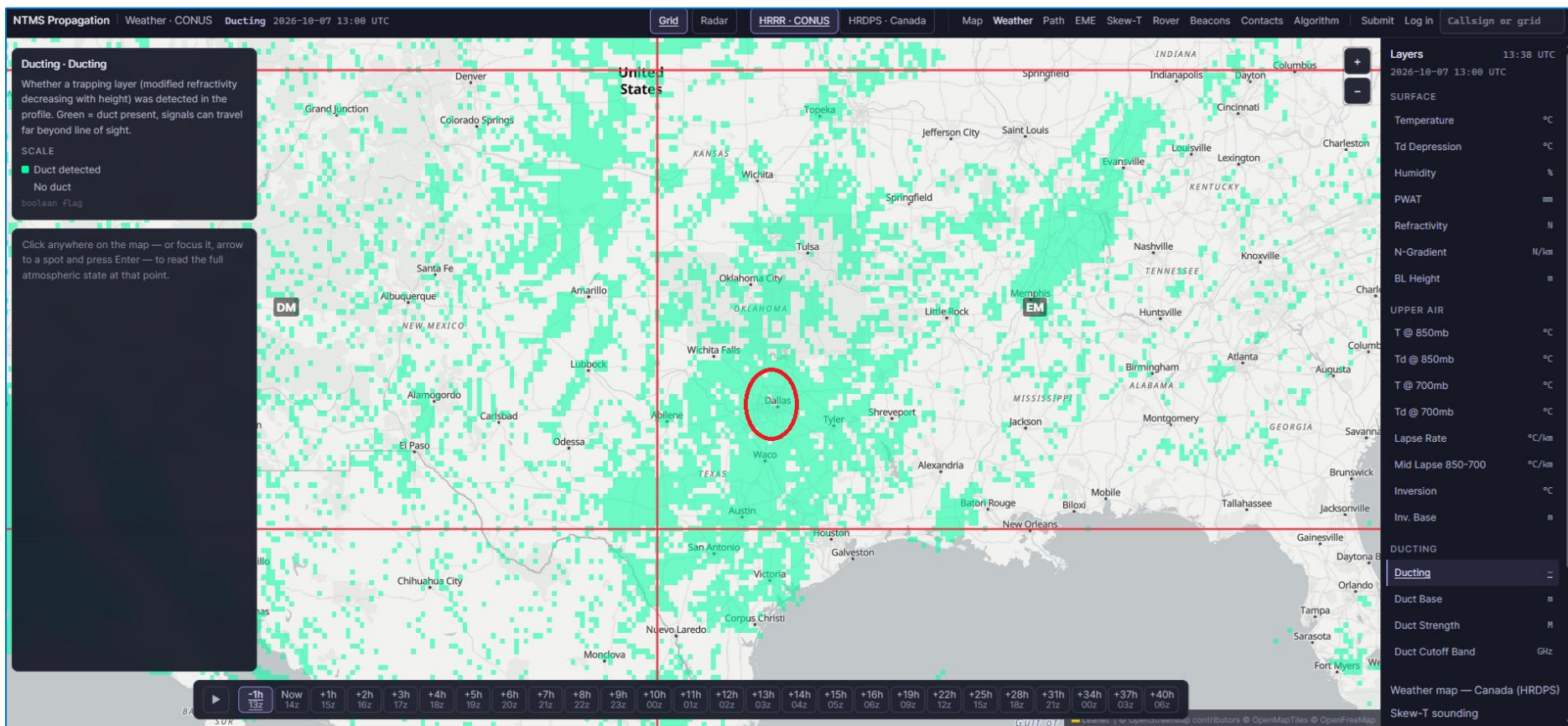
Recent enhancement

- NTMS propagation “Inversion”



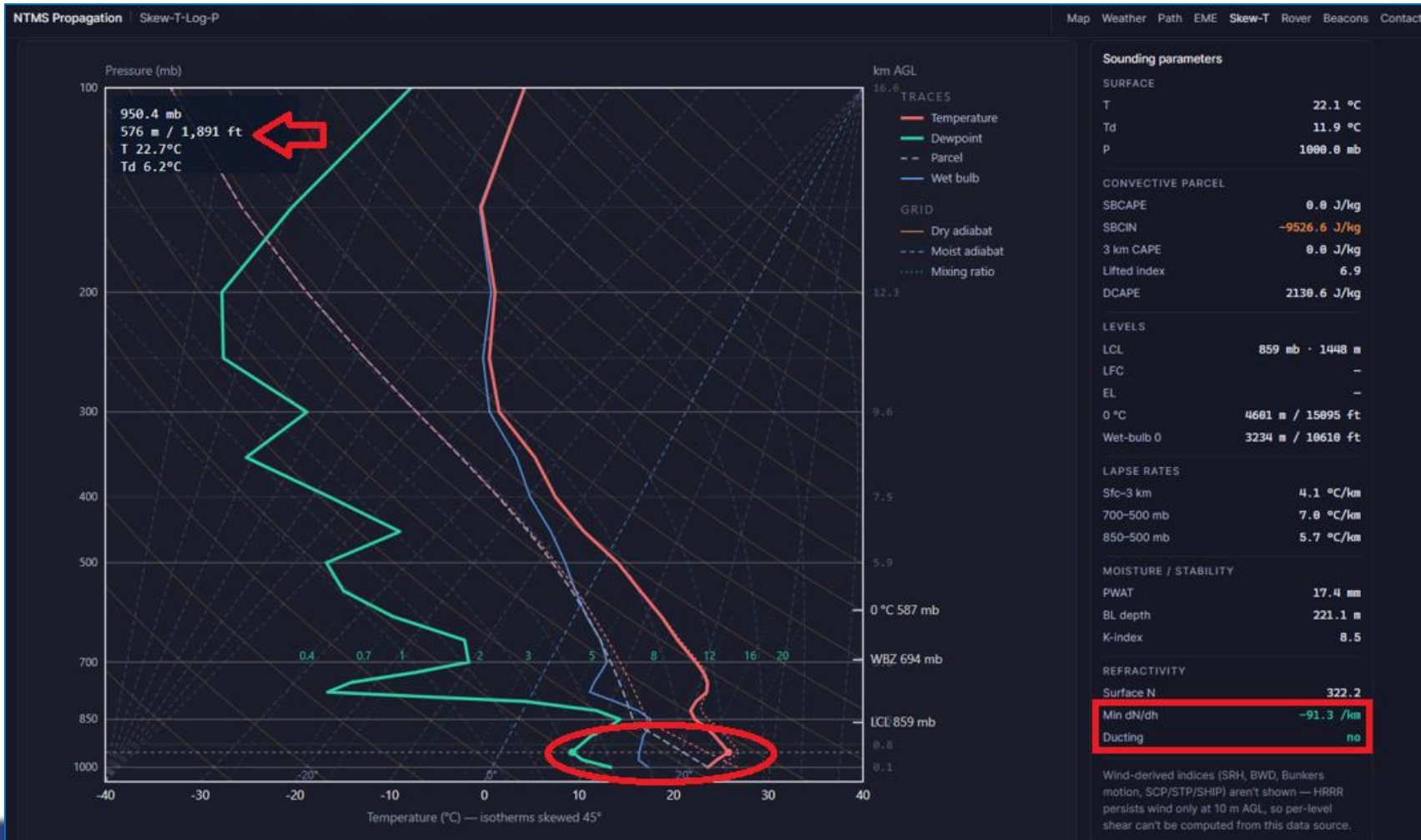
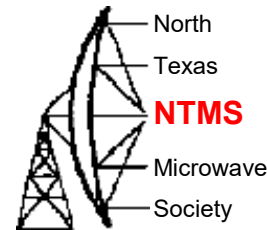


- **NTMS propagation “Ducting”**



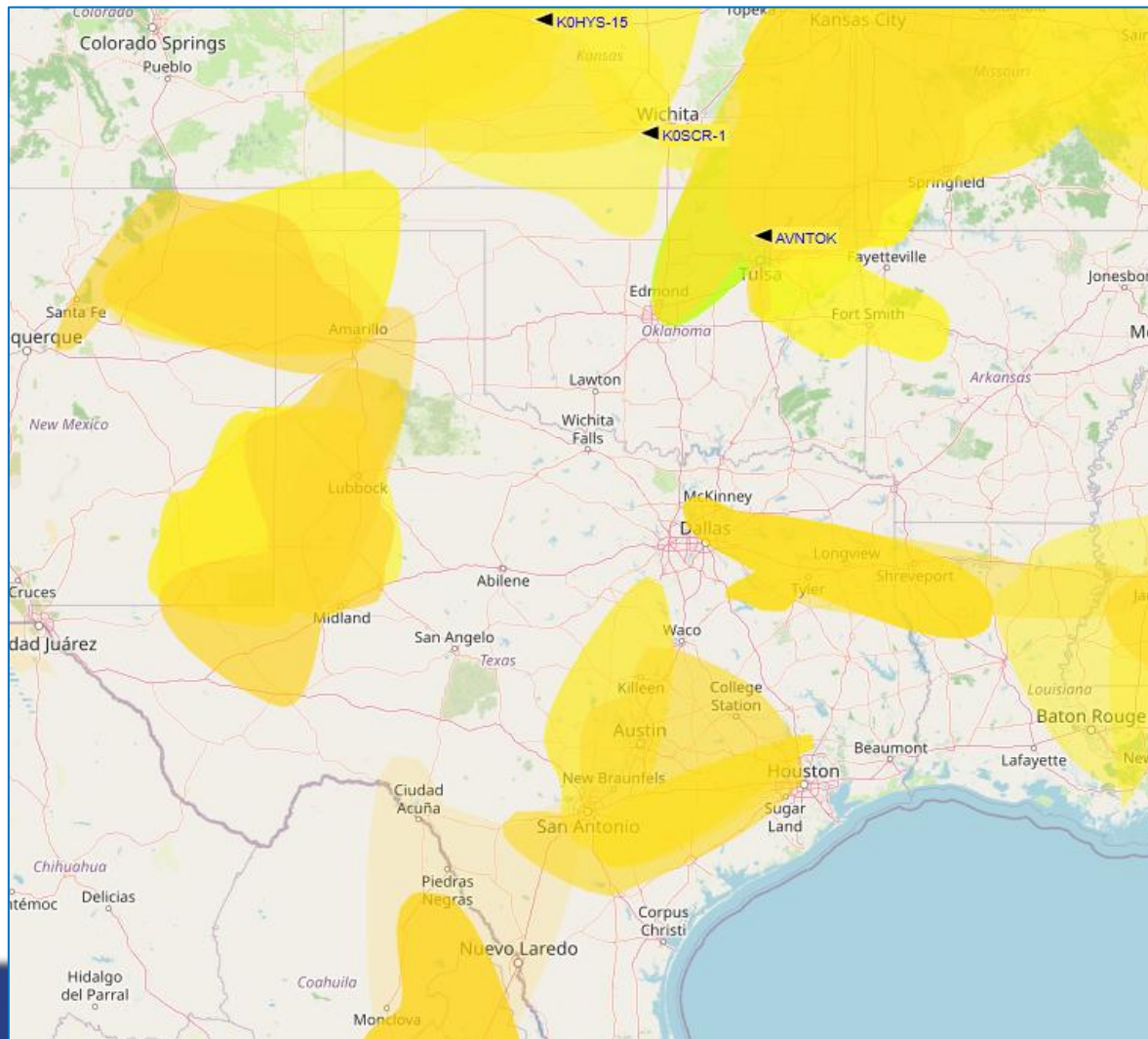
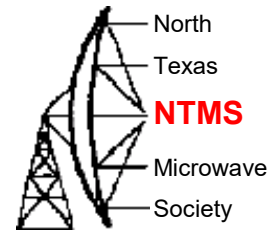
Recent enhancement

- NTMS propagation “Skew-T”



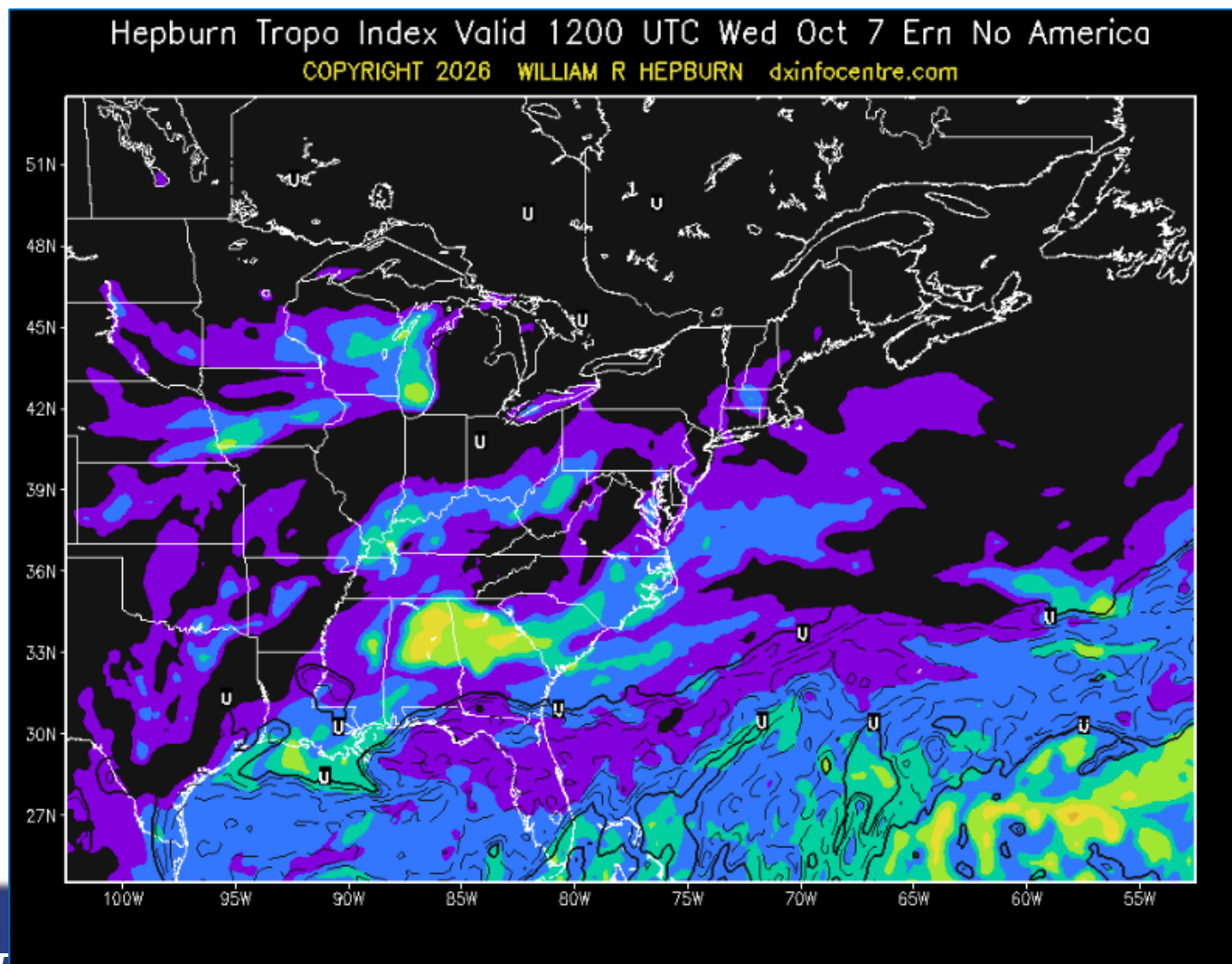
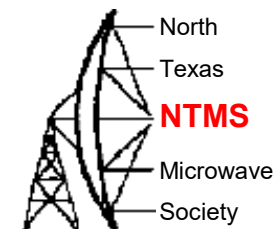
Recent enhancement

- **APRS, VHF level**



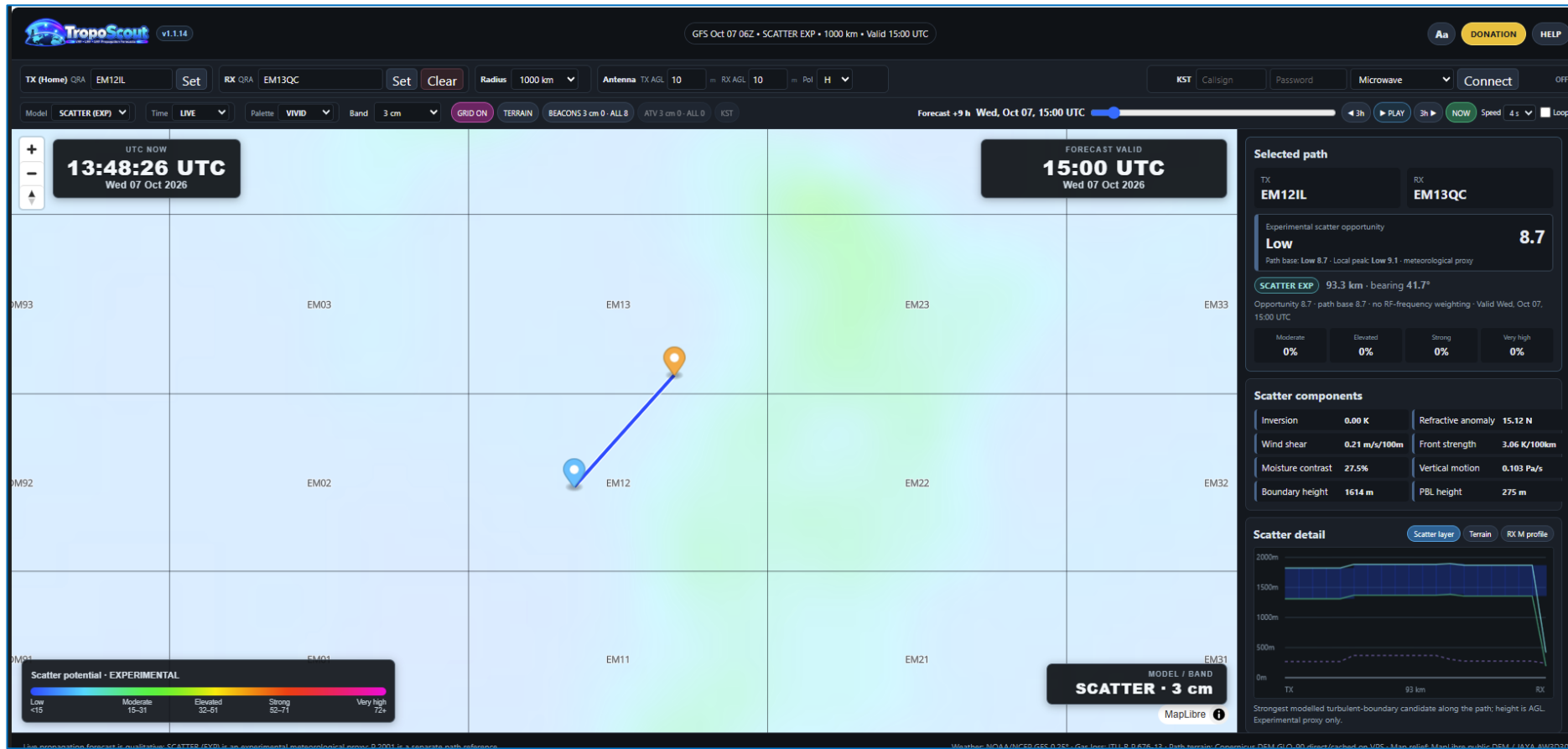
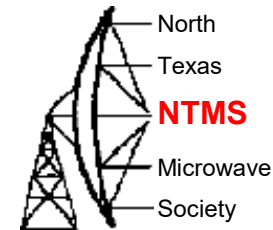
Recent enhancement

- Hepburn Tropo Index

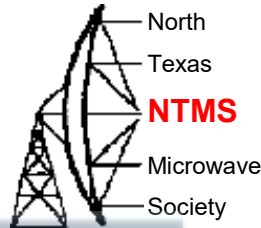


Recent enhancement

- Tropo Scout



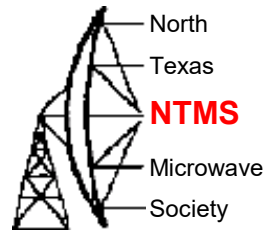
Multiple path analysis



- **Create csv file of location/station data**
- Use a wrapper script that calls each csv file on the hour
- Aggregate hourly files
- Evaluate data versus weather phenomena and other observable factors
- Have one table of known good locations that have been successful in the past. This is the sanity check that the propagation engine is giving reasonable results.

Known good locations analysis

– 6 to 9 am, averaging 19 historically successful locations

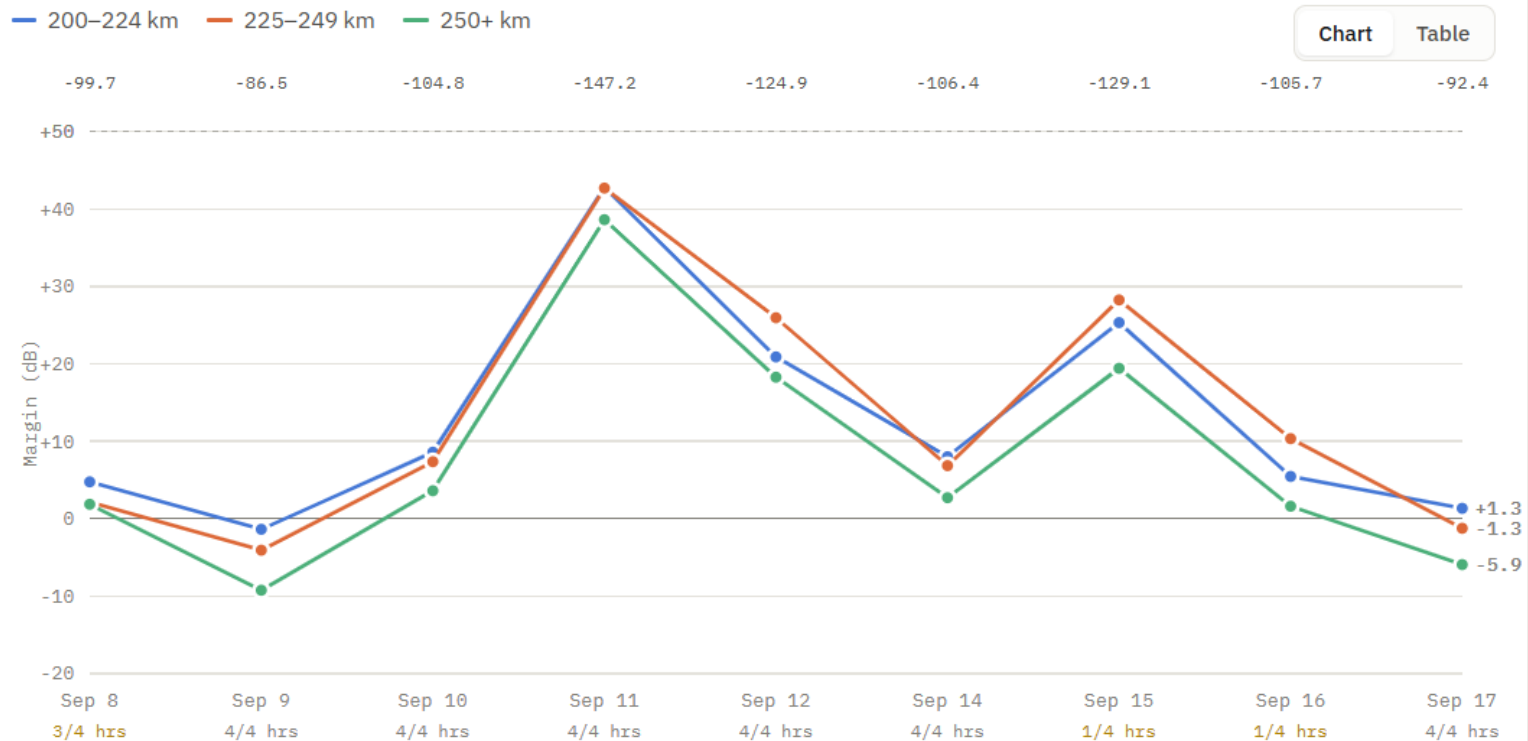


NTMS • ROVER LOCATION PROP ANALYSIS

Historical Locations — Margin by Day

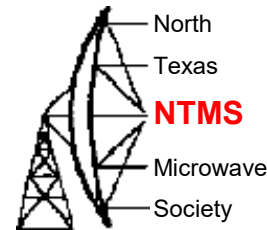
Average link margin for worked historical paths, by distance band, for the morning window (6–9 AM local) going into the contest. Paths under 200 km are excluded.

The row above the +50 line is the day's average refractivity gradient (N units/km), same filters.



Prospective locations analysis

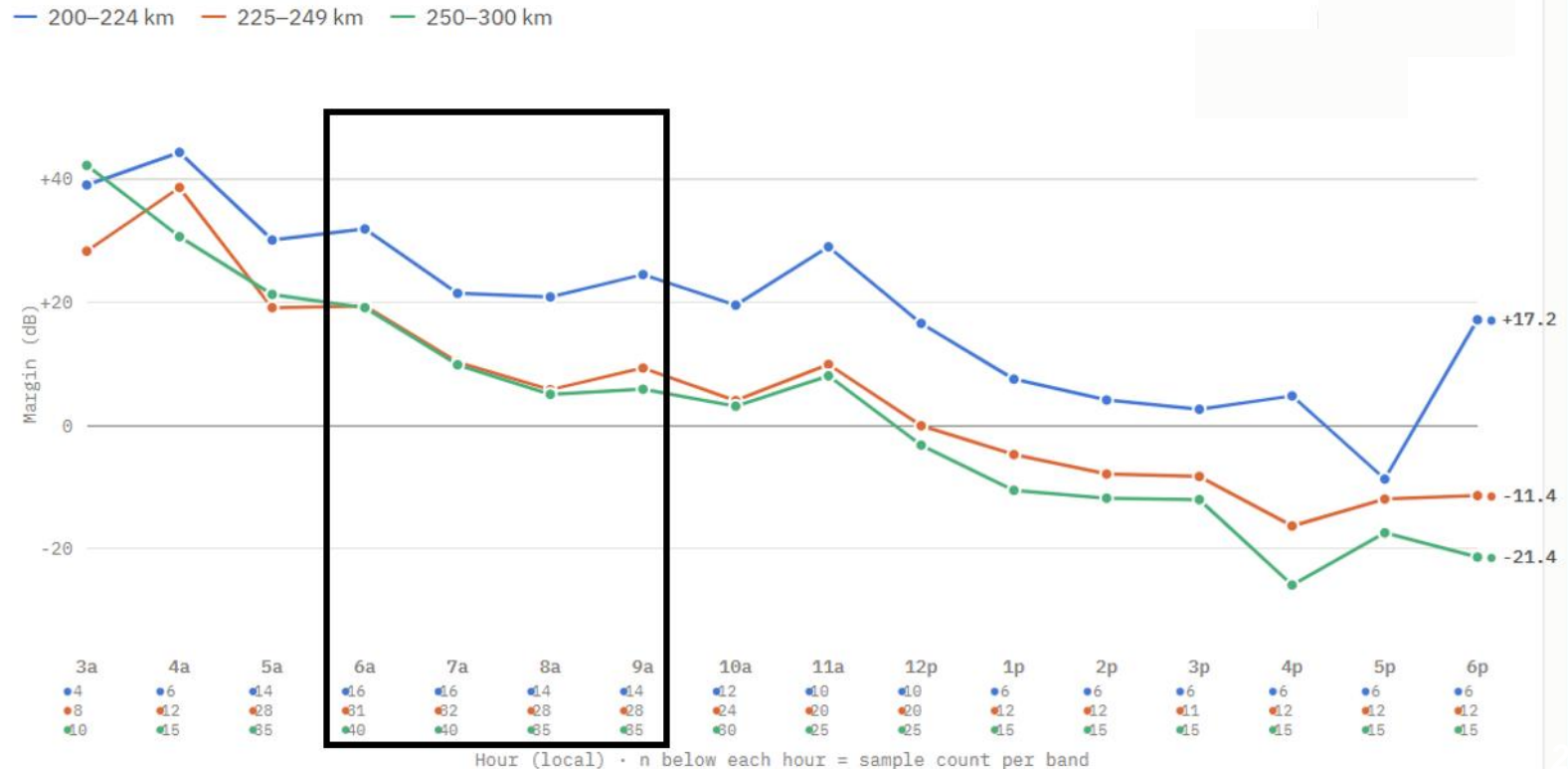
– 3 am to 6 pm, predictions covering Sept 8 - 17



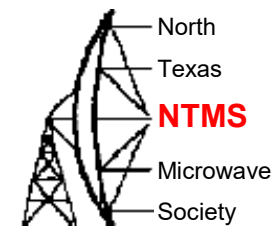
NTMS · ROVER LOCATION PROP ANALYSIS

Prospective Locations — Margin by Hour

Average link margin by local hour (3 AM–6 PM) for candidate 2nd-leg Saturday paths, 200–300 km, averaged across all dates and stations run at that hour. EM02NS97ML and EM01PT90NF are excluded (not visited).

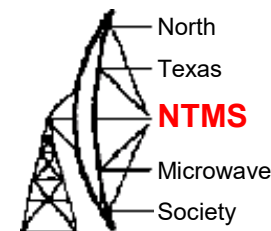


Alcatel propagation analysis



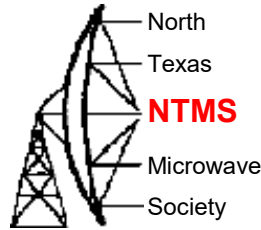
- We will play a 10 minute video created by Alcatel.
- The video has been enhanced to improve the sharpness of the video and clarity of the audio.
 - Tool: AlseeSoft
- The analysis is presented as information to assist the microwave engineer with references to Multipath fading and Meteorological effects and Counter measures.
- The model of information is the same model we are using now in our propagation studies – Empirical data correlated to calculated atmospheric enabling events.

Alcatel propagation analysis



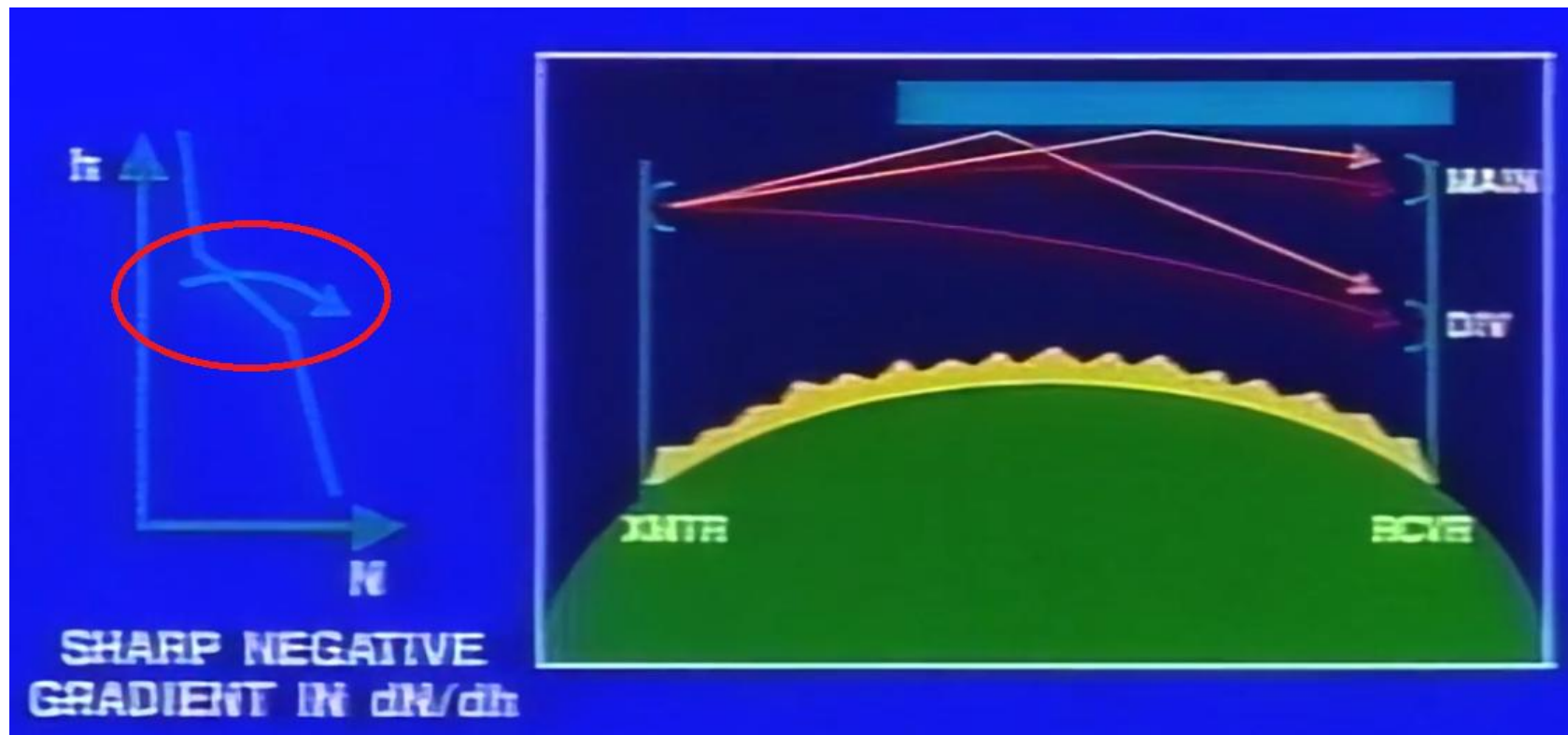
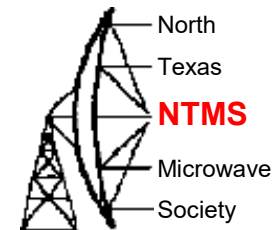
- **Empirical data used in the study**
 - Spectrum Analyzers receiving 40 MHz bandwidth for main and diversity antenna
 - Weather metrics:
 - Wind velocity and direction
 - Temperature in F at 10' and 250' on tower
 - Humidity sensors at 10' and 260' on tower
- **Calculated data**
 - Refractivity in N units 270 – 370 plotted as a function of height above ground 0 to 280 feet

Alcatel propagation analysis

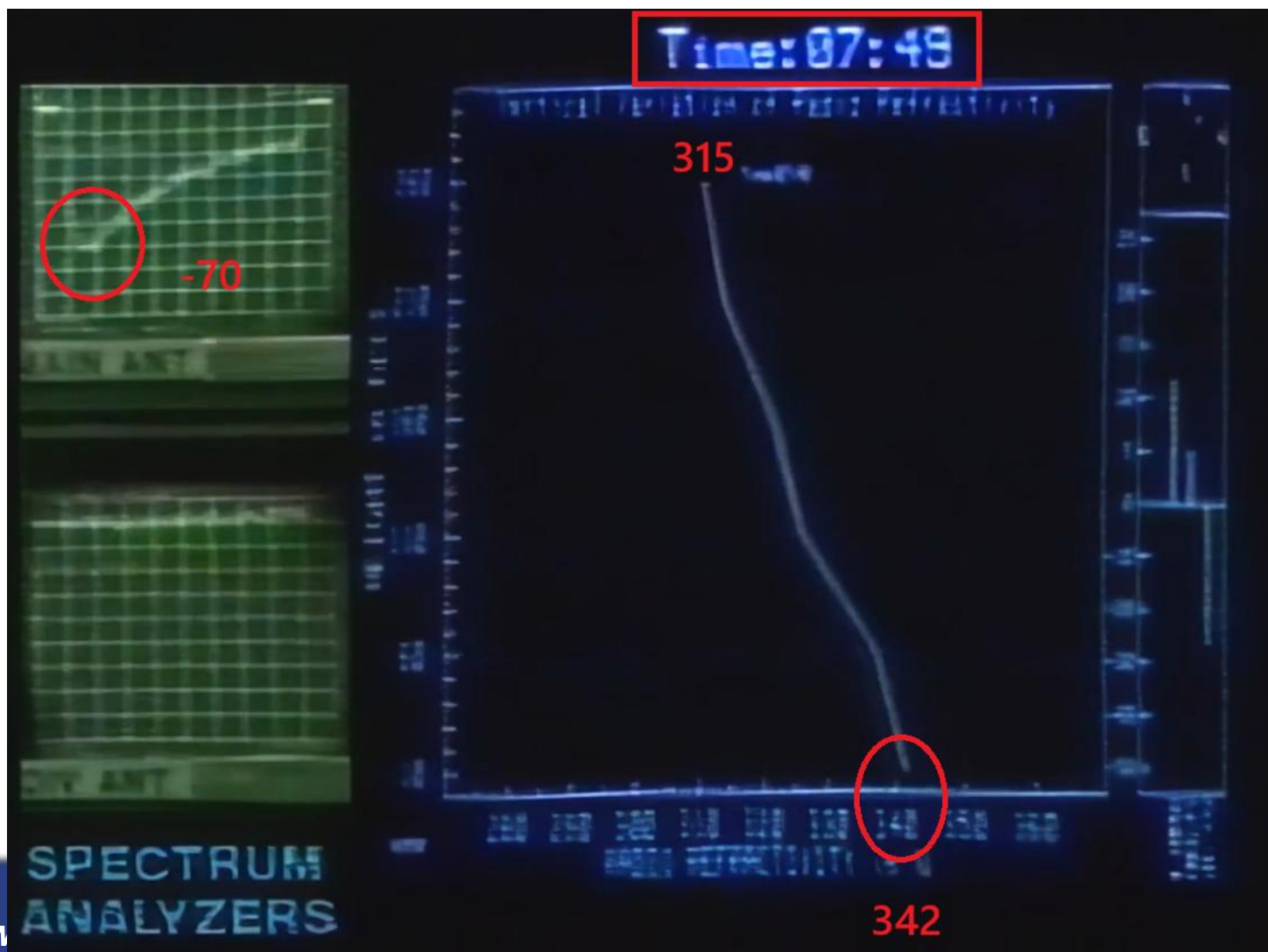
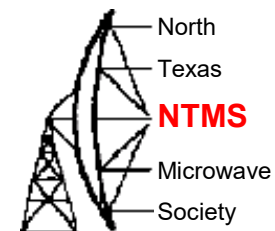


- **Important (for us) terms used in the video**
 - Sharp Negative Gradient
 - Super Refractivity
 - Vertical Mixing
 - Refractivity Dispersion

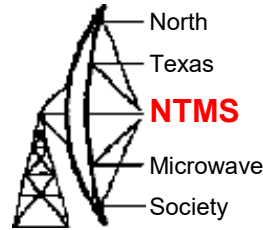
Sharp negative gradient in dN/dh



Sharp negative gradient in dN/dh

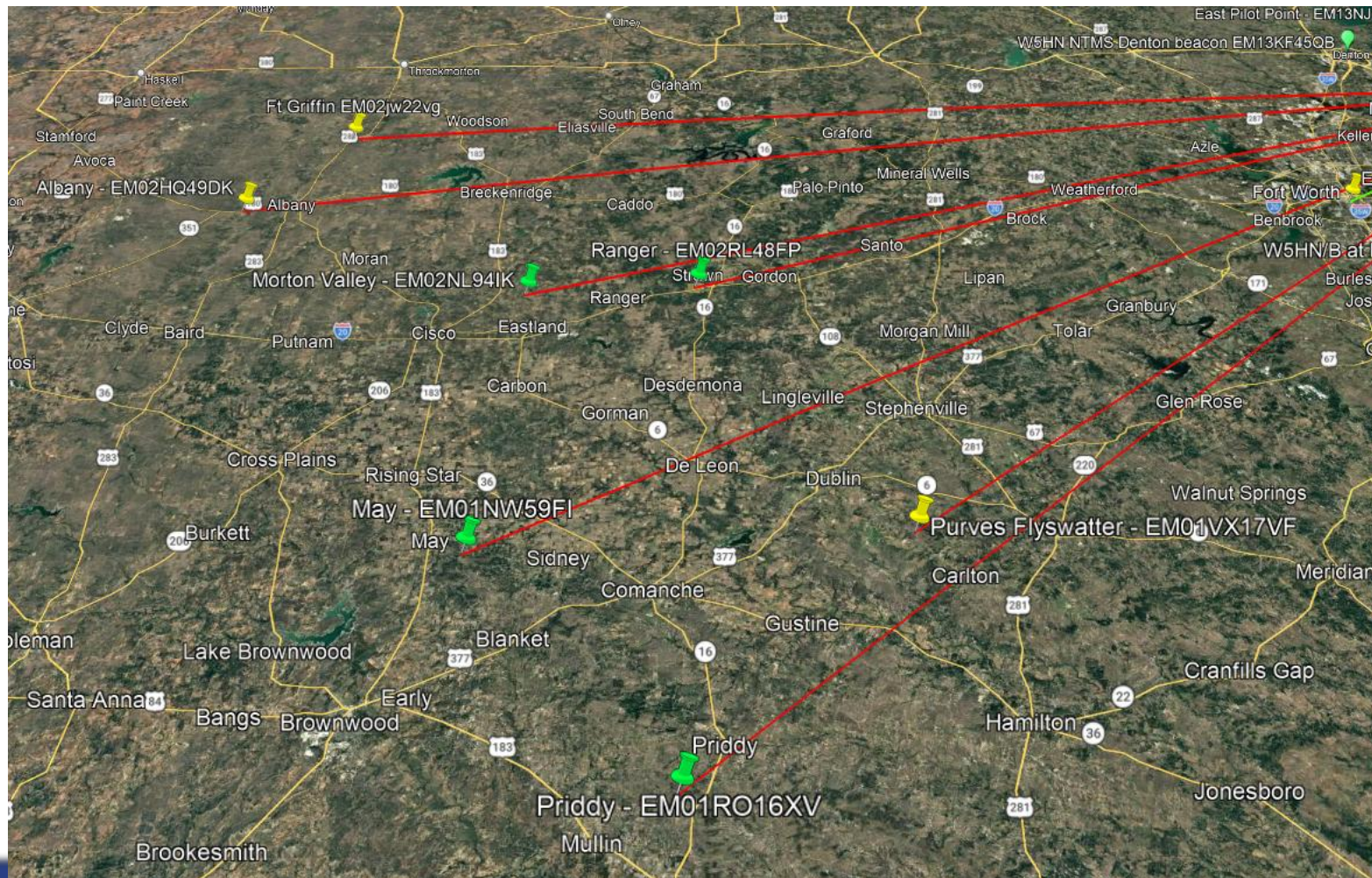
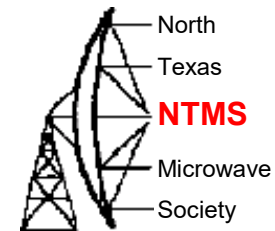


Future study



- We have beacons and beacon monitors that help to study the propagation < 100 km but while interesting, we have come to trust 10 GHz is reliable at this distance.
- We are still in the early stages of studying 24 and 47 GHz at distances < 100 km.
- We have reports of 10 GHz beacon reception at 250 km which correlate to RS and ducting.
- Deployment of additional 24 and 47 GHz beacons and beacon monitors is needed.
- Automated empirical measurements are best.

4 new locations found and verified (green pins)



Questions?

