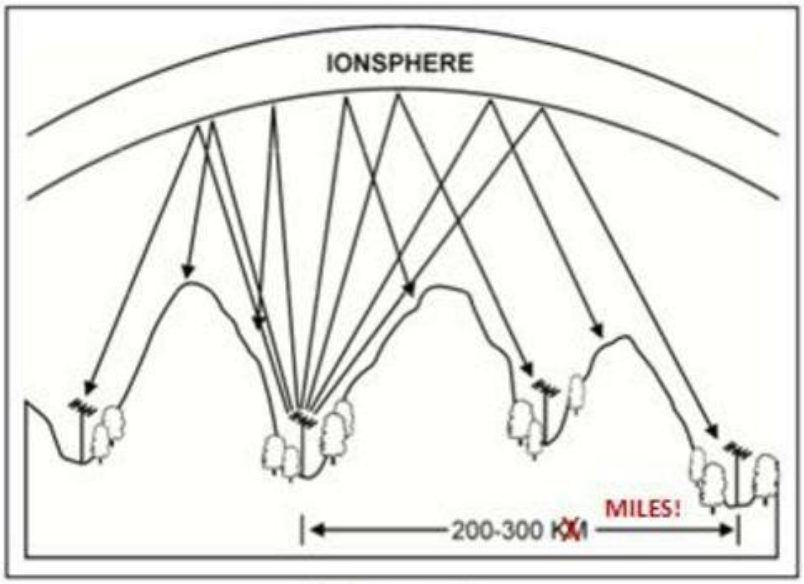
Near Vertical Incidence Skywave (NVIS)

A Tool for Amateur Regional Emergency Communications

Dave Moore N7RF



NVIS propagation

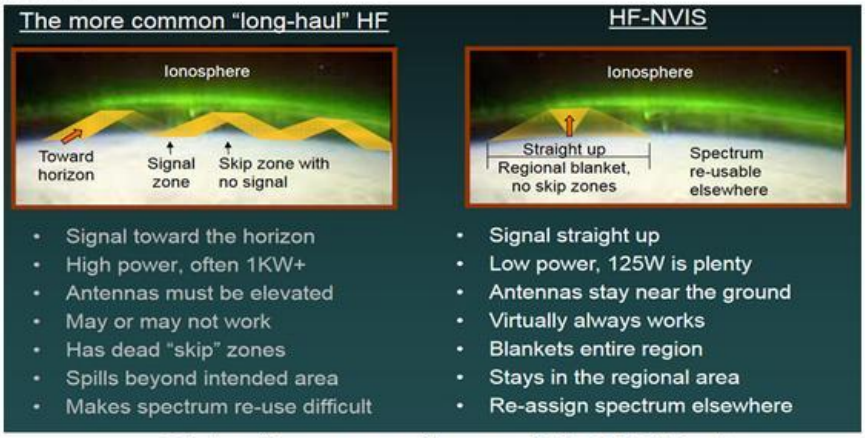
Courtesy: https://nsl.bcin.army.mil/catalog/view/100.ATSC/80CF2060-7548-4193-8F02-64068531F069-1500782565613/6-02.55/chap2.htm

Making Use of the Ionosphere- DX vs NVIS

The very same ionospheric layer is used to reflect signals when operating DX or NVIS. The difference is the angle at which you launch your signal..

DX operating always emphasizes getting your antenna beam as low to the horizon as possible. This allows your signal to skip as far as possible.

NVIS operating is precisely the opposite. NVIS stations aim for putting most of the signal straight up overhead (70° - 90°). The signal reflects just as well but covers the local area geographically centered on your station.



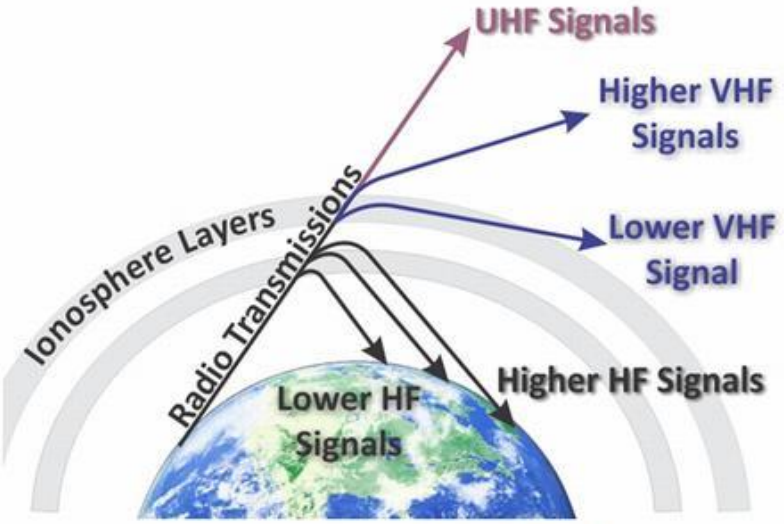
Ref: http://www.napco.org/documents/MCC_2014_NVIS.pdf

How the Ionosphere Works - DX vs NVIS

Principle: the higher you go in frequency, the lower the elevation angle whereby the ionosphere will support reflection.

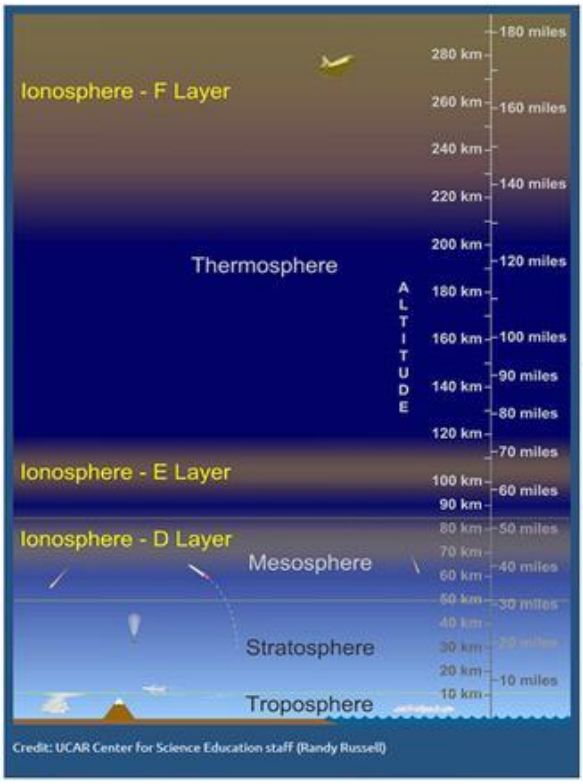
(1) This is why NVIS works best at the low end of the HF range (1-12 MHz). Higher frequencies do not reflect straight overhead.

(2) This is why signals skip farther as you go up in frequency.



Courtesy: http://www.hamradioschool.com/wp-content/uploads/2015/07/FreqEffectsBands.jpg

Layers of the Ionosphere – 60 km to 1,000 km



Topside – Above F layer (H+, He+)
(Insignificant radio reflection)

F Layer 150 – 500 km

F2 Layer – day and night (O+)
Primary skip region for HF
F1 Layer – day time only (NO+)
Skip at lower HF frequencies

E Layer 90 - 150 km (O+) – weaker at night

D Layer 60 – 90 km (NO+) – day time only

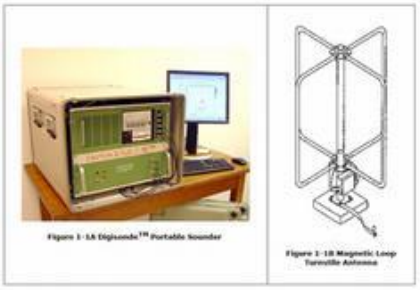
Measuring the Ionosphere – the Science of Predicting Propagation – the Vertical Incidence Sounder (VIS)

How does it work? The VIS consists of a variable frequency transmitter, a tracking receiver that follows the transmit frequency, and a NVIS antenna capable of launch the signal straight up. The VIS acts as a radar by receiving the signal reflected back off the ionosphere. The altitude of reflection is calculated directly by the propagation time up and back again. From the properties of the reflected signal, the density of the ionization layers can be estimated. Knowing this, radio propagation can be predicted at angles other than straight up.

Data Online. There is a network of world wide sounders of the type designed by the University of Massachusetts Lowell's Center for Atmospheric Research (UMLCAR) and referred to as Digisondes™. Anyone can access the current and past data collected by each station here: https://lgdc.uml.edu/common/DIDBFastStationList
Austin, Texas, is the network station closest to us.

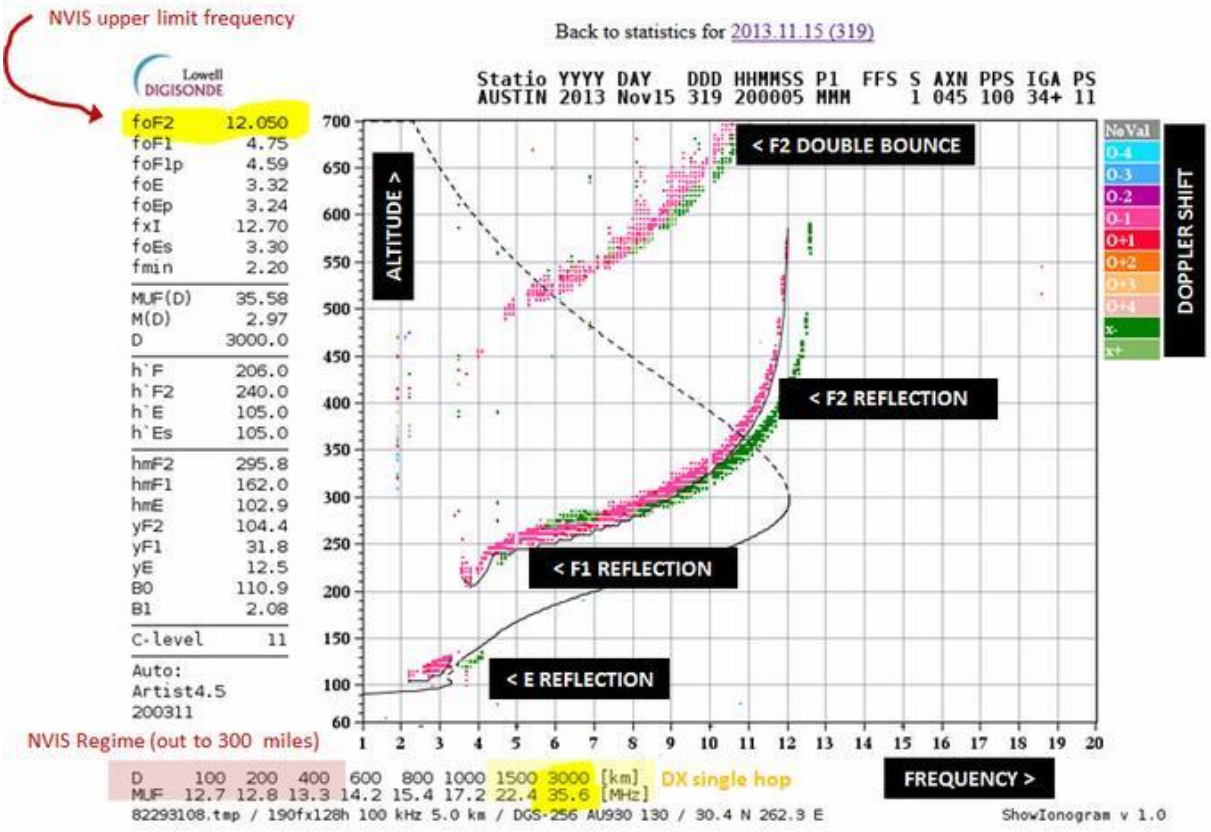
← National Bureau of Standards original multi-frequency ionosonde, 1939

Quasi-modern 300W UMLCAR Digisonde™ →



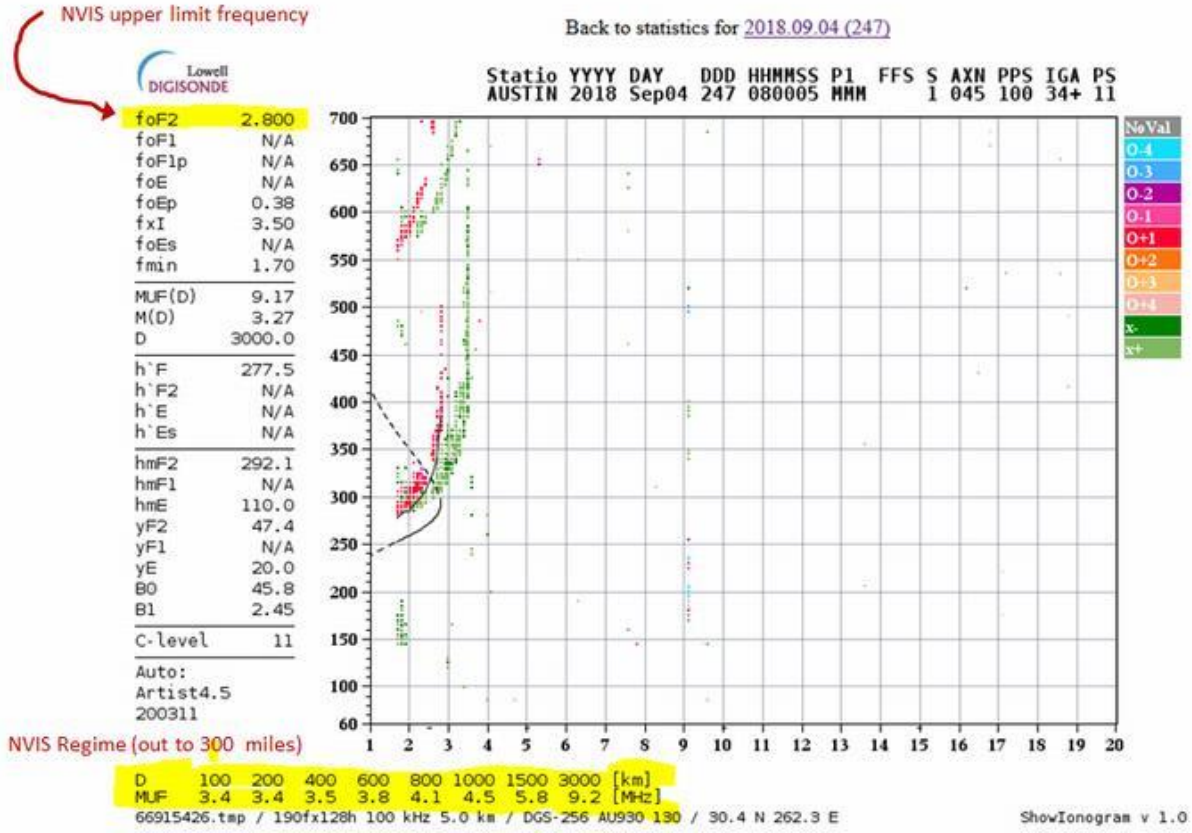
What Does a Good Ionogram Look Like? – Peak of the Cycle

Here is a typical day time ionogram from Austin taken near the peak of the 24th solar cycle on November 15, 2013, 3:00 PM Local



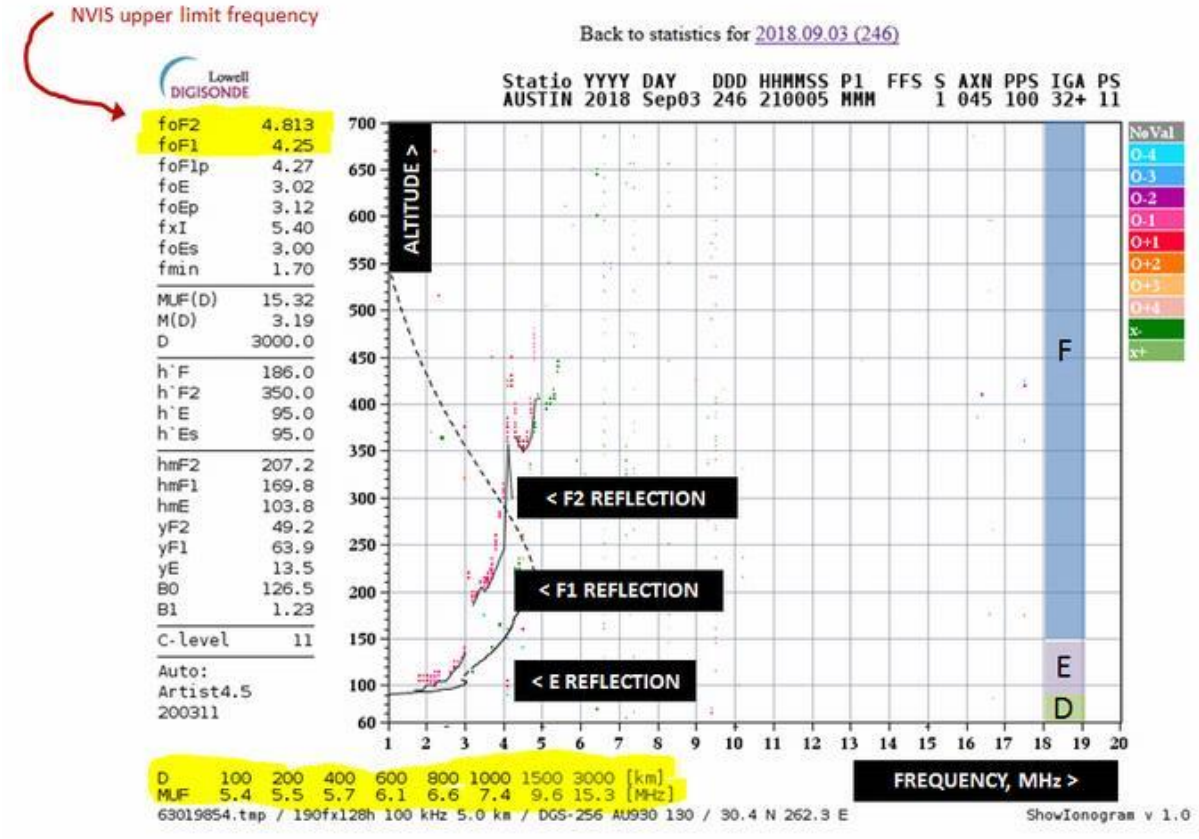
Living at the Bottom of Solar Cycle 24

Here is a typical night time ionogram from Austin taken Sept. 04 (3:00 AM Local)



Living at the Bottom of Solar Cycle 24

Here is a typical day time ionogram from Austin taken on Sept. 03 (5:00 PM Local)

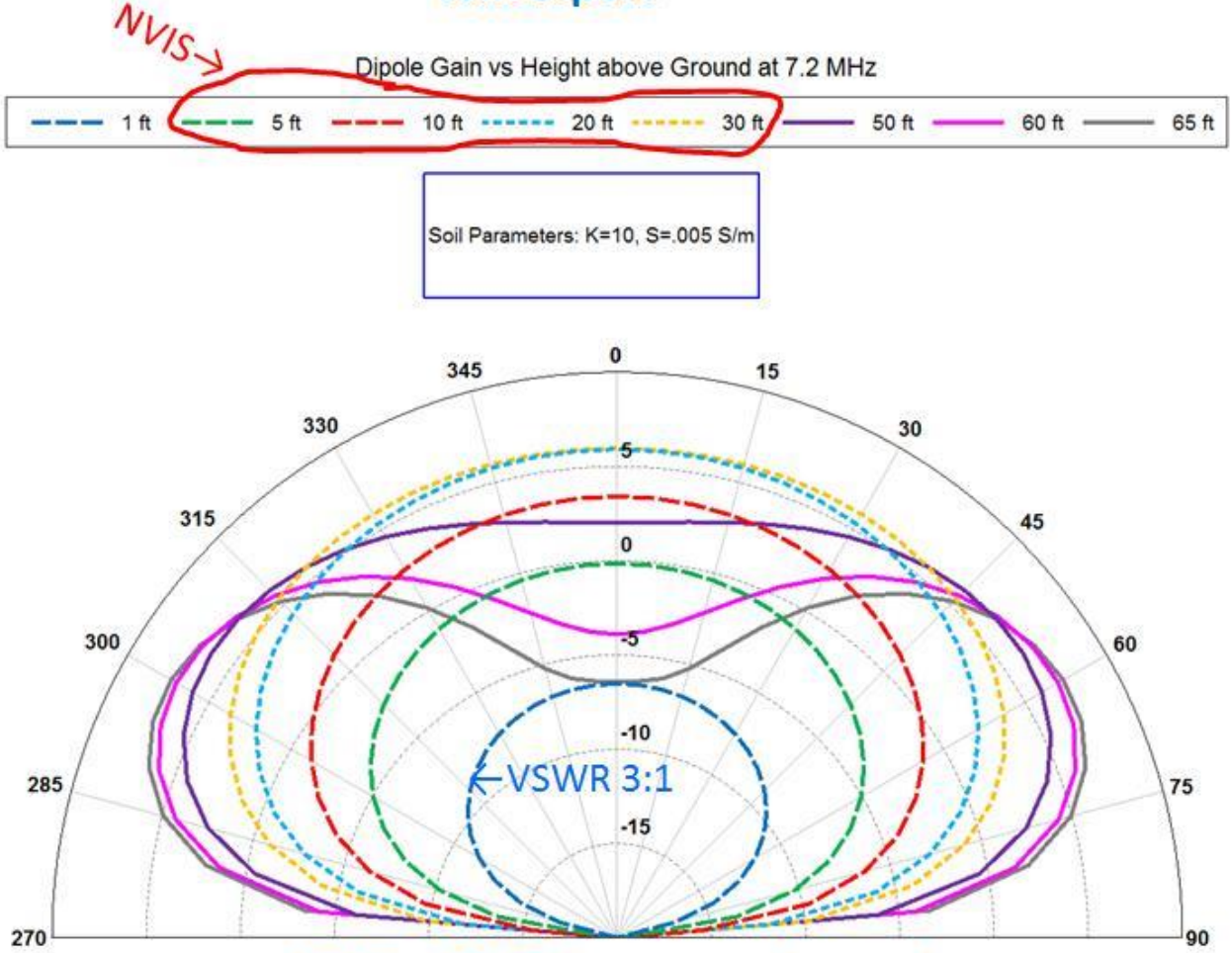


ANTENNAS FOR NVIS COMMUNICATIONS

- **Launch Angle** –
  - A good antenna for DX has a low angle of radiation (aimed at the horizon) to take advantage of F2 layer skip.
  - A good NVIS antenna has a high angle of radiation (aimed up at 70° - 90°).

- **Antenna Types** –
  - Vertical or whip – good DX antenna, terrible NVIS antenna. By nature, verticals project a null straight up.
    - Solution: fold the antenna over so it is mostly horizontal.
  - Dipole or wire (center fed, off-center fed, end fed, multiband, etc.)
    - Radiation pattern results from the currents in the antenna summed with image currents induced in the ground under it. A good dipole (or yagi) for DX low angle radiation is mounted approximately a half wavelength above ground. This results in near cancellation of the energy going straight up.
    - Solution: Mount an NVIS dipole closer to the ground than a half wavelength.
  - Electrically small loop antenna
    - Compact, easy to carry around, launches signal straight up when close to the ground.
    - Disadvantage: less antenna efficiency (lower gain).

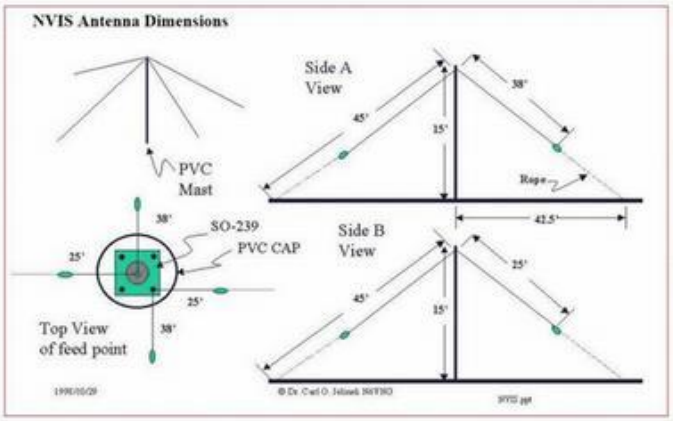
HOW HIGH OFF THE GROUND?
40m Dipole



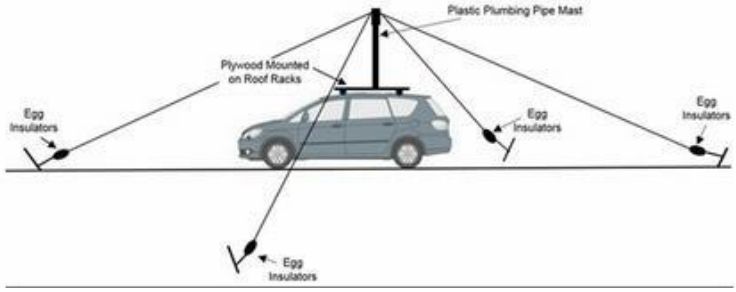
VSWR<1.5 if 5-ft or more off ground

ANTENNAS FOR NVIS COMMUNICATIONS – HORIZONTAL DIPOLES/WIRE

40/80 meter NVIS antenna
(DXEngineering.com)



40/80 meter NVIS antenna (courtesy N6VNG)



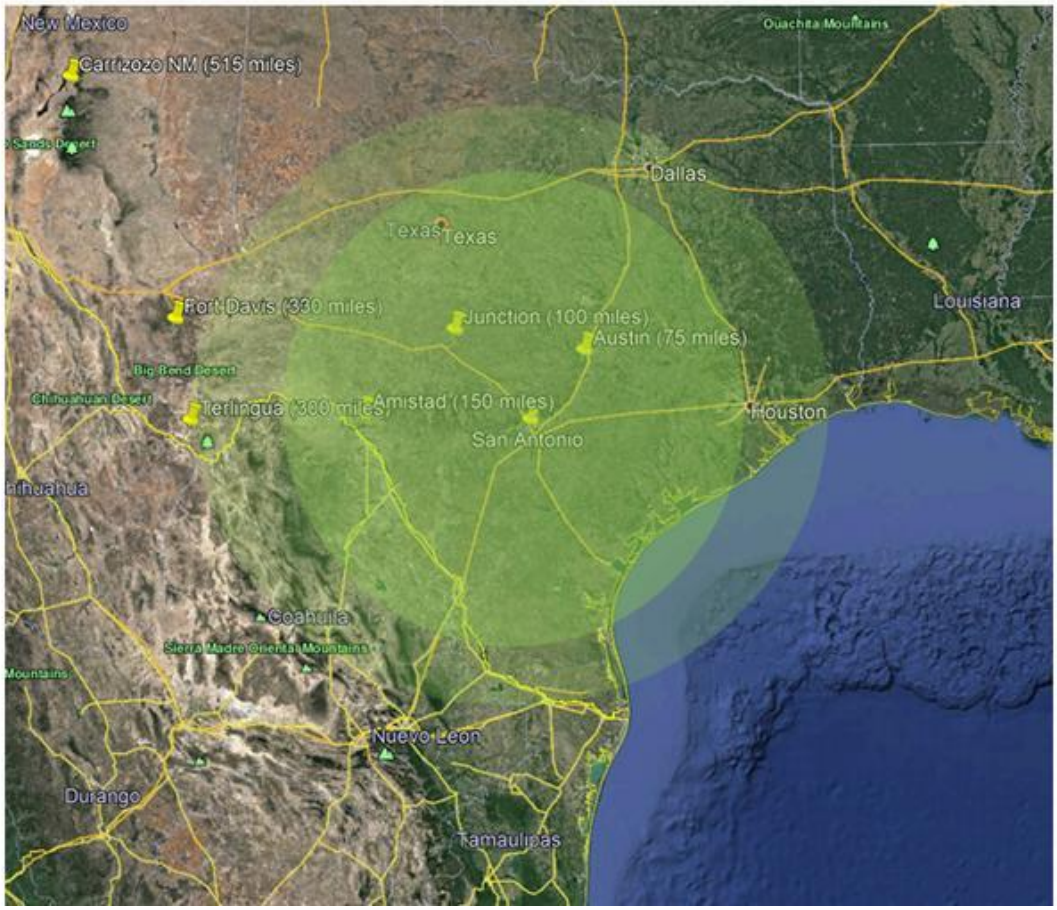
ANTENNAS FOR NVIS COMMUNICATIONS – HORIZONTAL DIPOLES/WIRE

Fold over mobile whip antenna

Center-fed pair of electrically short resonant whips (Hustler, etc.)

Hundreds of NVIS ideas found by Google search. Improvise almost anything.

Near Vertical Incidence Skywave (NVIS) – Practical Coverage 200-300 miles



Examples of HF NVIS Use

- **World War II**. By 1944, NVIS was well understood. American radio pioneer Dr. H. H. Beverage assisted the Army Signal Corps in planning D-Day communications. NVIS was used between England and all the forward communications centers on the landing beaches.
- **USMC**. In 1989, the Marines verified the effectiveness of NVIS mobile communications in an exercise extending from South Carolina to Virginia. Mobile and fixed stations reported near-100% reliability.
- **US Navy**. In 1995, CNO and SPAWAR incorporated HF NVIS as a battle force secure electronic mail system to augment SATCOM and VHF SINCGARS radio systems.
- **California State Military Reserve.** In a 1994 exercise, CSMR demonstrated reliable digital PACTOR HF communications by proper selection of NVIS antennas and frequency management plan based on ionospheric conditions.
- **US Army.** Chapter 3 of Army manual 24-18, entitled Tactical Single Channel Radio Communications Techniques, discusses NVIS communications. In Vietnam, radiomen discovered vehicle radios worked better when the whips were tied down horizontally. NVIS was also used to communicate with Special Forces operating on the other side of mountain ranges from command.
- **Who uses NVIS?** Federal, state (national guards), and local governmental agencies, and critical infrastructure operations such as power authorities, gas/oil pipelines, airports, and hospital networks.
- NVIS is also part of planning by USAFA Civil Air Patrol, RACES, MARS, and ARRL ARES organizations.