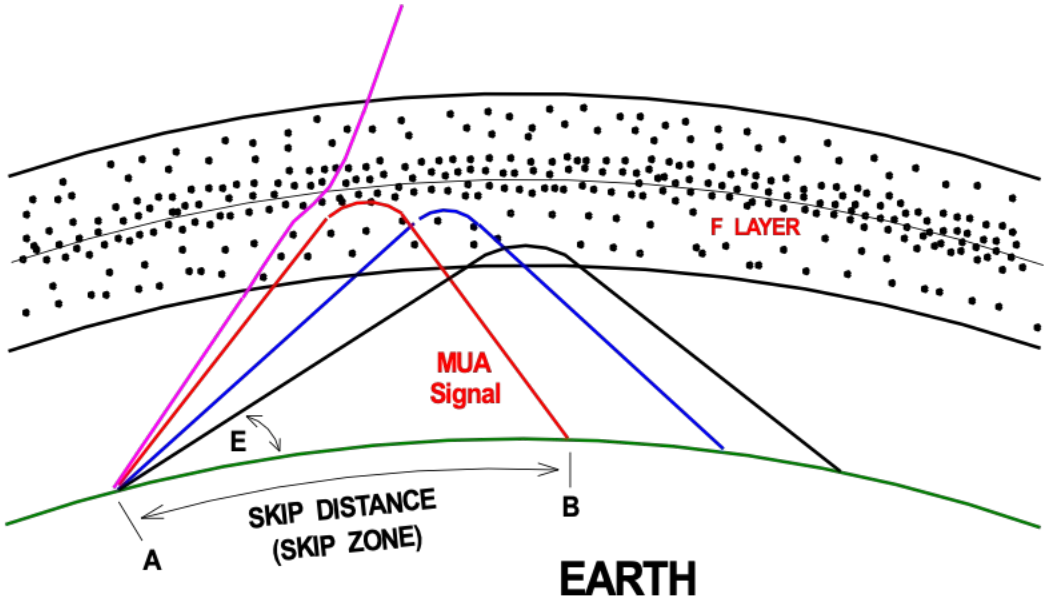
# Skip Distance 80 Meter Test

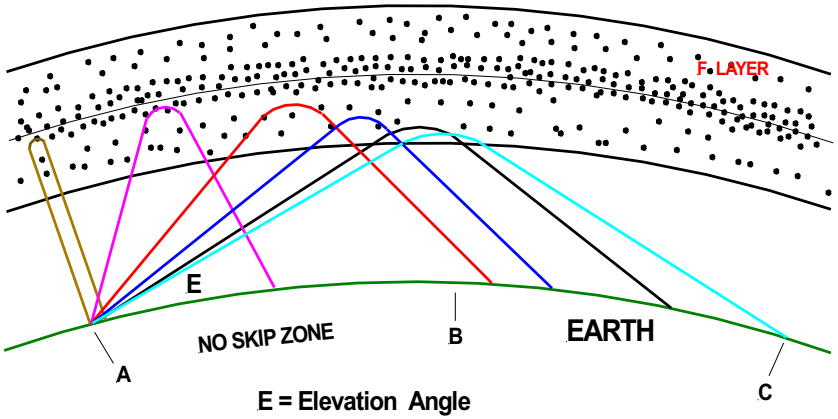



Ken Larson KJ6RZ

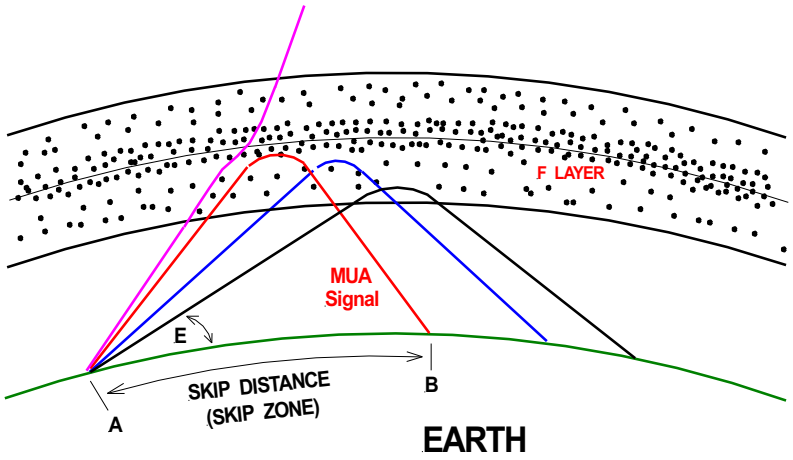
February 2024

www.skywave-radio.org

# 80 Meter Skip Distance Test



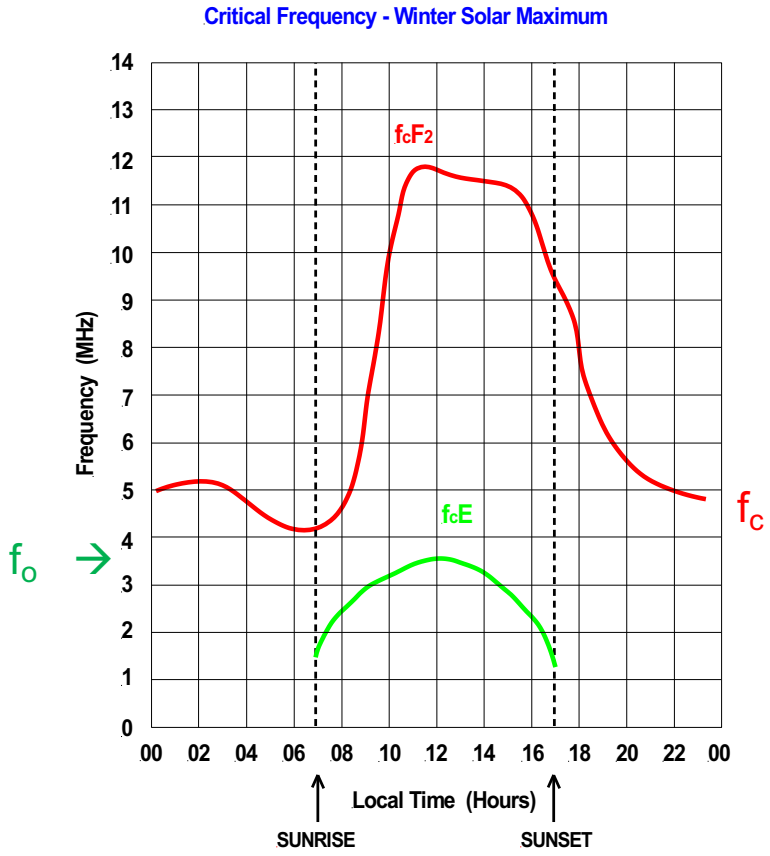

**No Skip Zone if $f_c > f_o$**

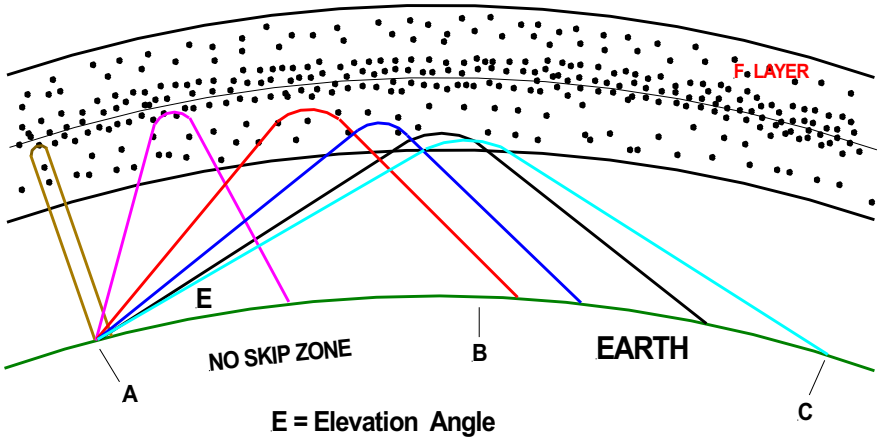



**Skip Zone Present if $f_c < f_o$**

- The presence of an 80 meter skip zone depends on:
  - The solar cycle,
  - The critical frequency, and
  - The time of day

# 80 Meter Skip Distance Test - Solar Maximum

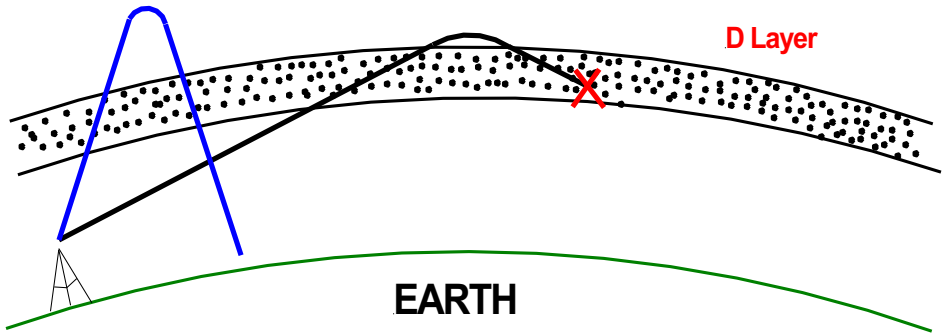



Generally, no 80 meter skip zones during solar maximum

- During **solar maximum** critical frequency $f_c$ is nearly always above the 80 meter operating frequency $f_o$ of 3.5 to 4.0 MHz, even at night
- Consequently, during solar maximum skip zones are generally not present on 80 meters
- Meaning most stations from close in ( < 10 miles away) out several hundred miles should be reachable all the time day and night – 80 meters should be a wonderful solar maximum band

# D Layer Absorption

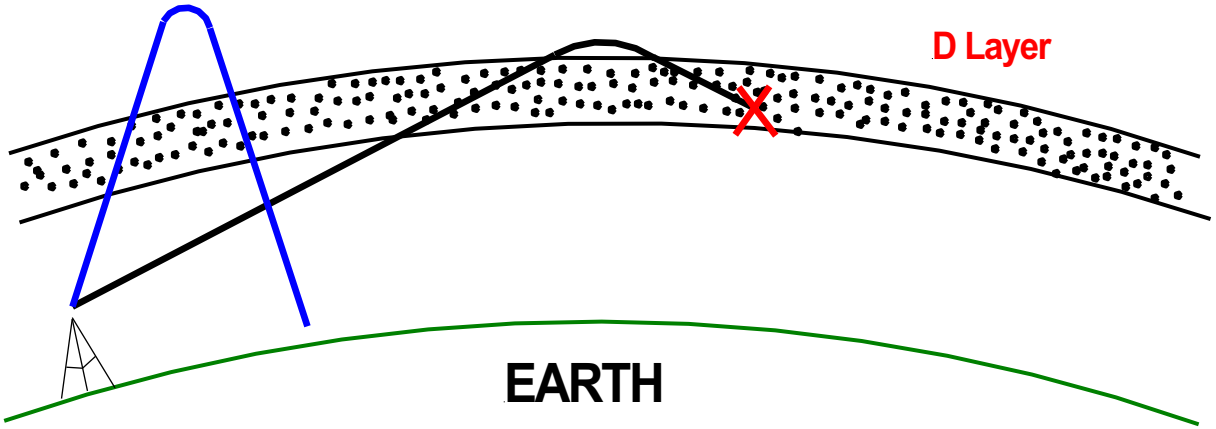



- While 80 meters does not have skip zones during solar maximum,
- 80 meter signals are heavily absorbed during the day by the ionosphere's D Layer preventing 80 meter day time operation
- D Layer absorption is inversely proportional to frequency squared

$$\text{Absorption} \propto \frac{1}{f^2}$$

- 160 and 80 meters are the two most heavily absorbed frequency bands
- Absorption on 80 meters is 4 times greater than on 40 meters and 16 times greater than on 20 meters

# Long Hop Signals Are Absorbed The Most

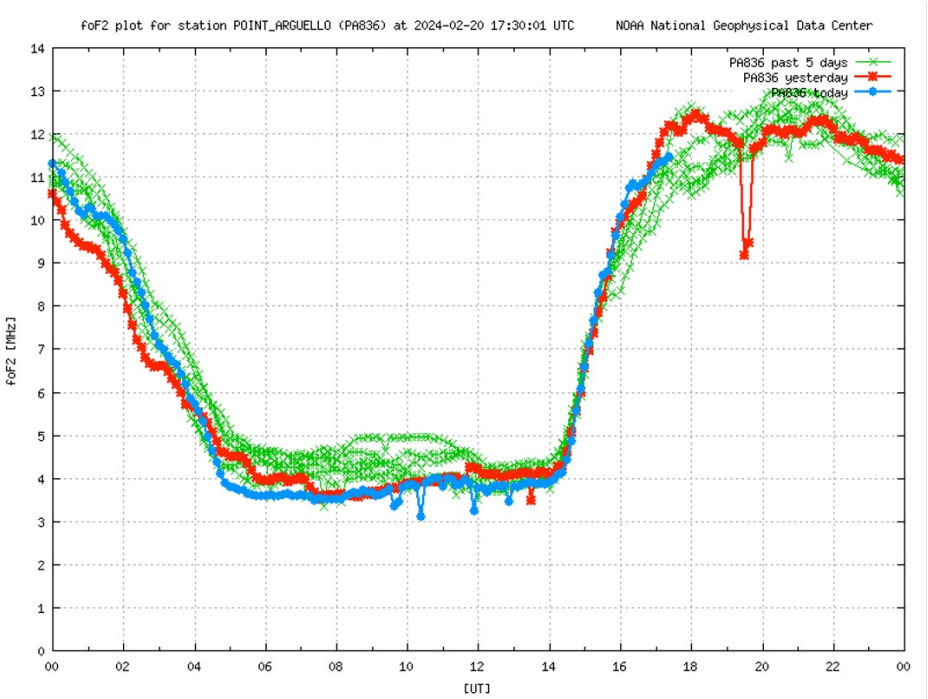



- A low elevation angle long hop signal spends more time traversing the D Layer than a high angle short hop signal
- Consequently, a low angle long hop signal is more likely to be absorbed by the D Layer than a high angle short hop signal
- This phenomena is observed in the day time 80 meter test data

# 80 Meter Test Parameters – 2/19/2024

- 80 meter test on 2/19/2024:
  - Sun Rise @ 6:34, Sun Set @ 17:40,
  - SFI = 152,
  - X-Ray Flux = C1.3,
  - A Index = 3, K Index = 0,
  - SSN = 64,
  - Inverted V antenna used with an apex of 32 ft
- VARA digital protocol used;
  - Contact duration of 0.18 considered a very good connections,
  - A duration of greater than 1 minute (>1:00) is a poor connection,
  - While nc = no connection
- A station with no entry means that the station could not be reached because the frequency was in use by others, a commonly encountered problem
- NA means the station was not available at the time of the test
- Transmit Frequency ranged from 5.578 to 5.596 MHz (WinLink RMS frequencies)

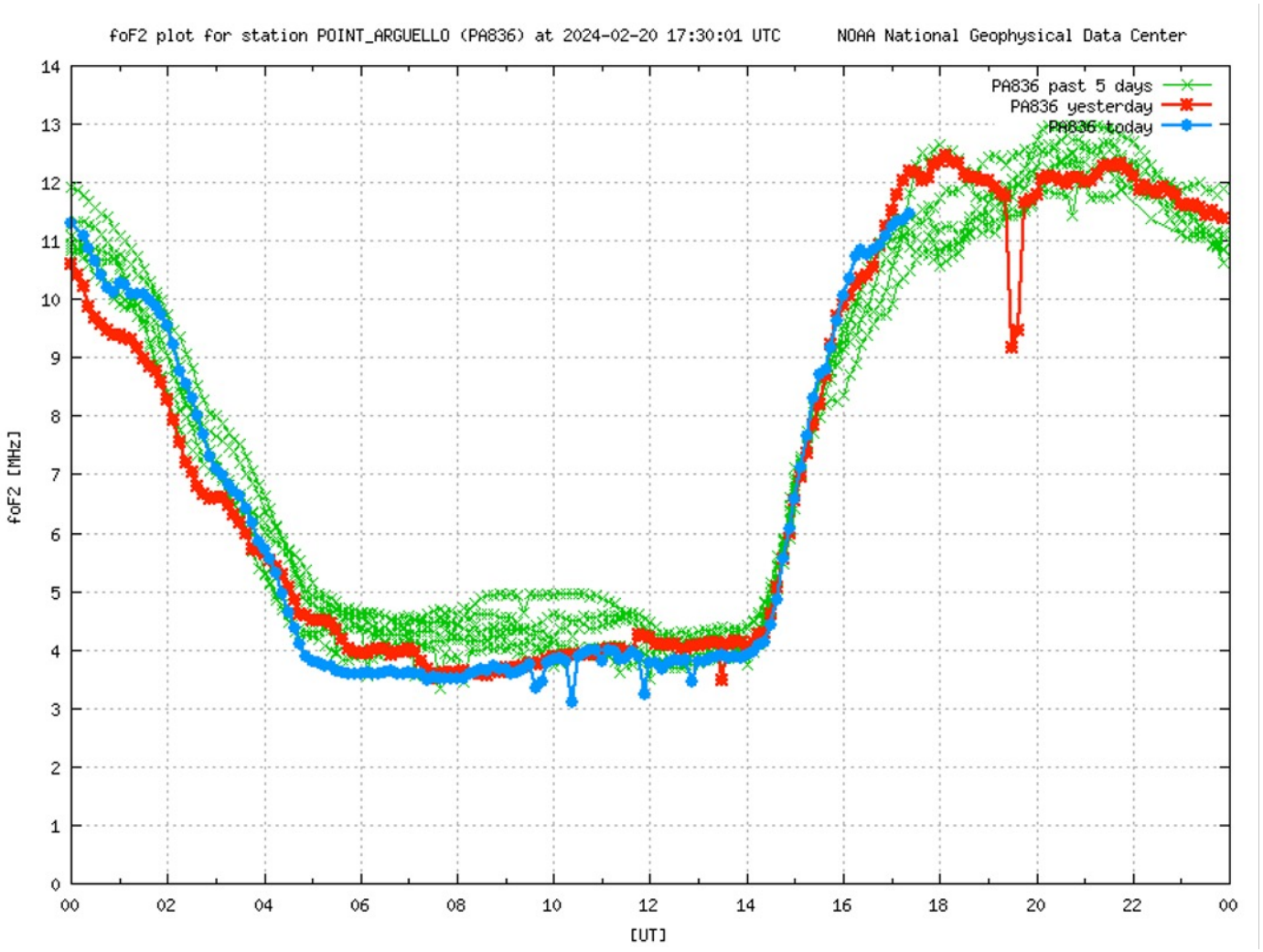
# Critical Frequency on 2/19/2024




During the test the critical frequency ranged from 12 down to 3.8 MHz

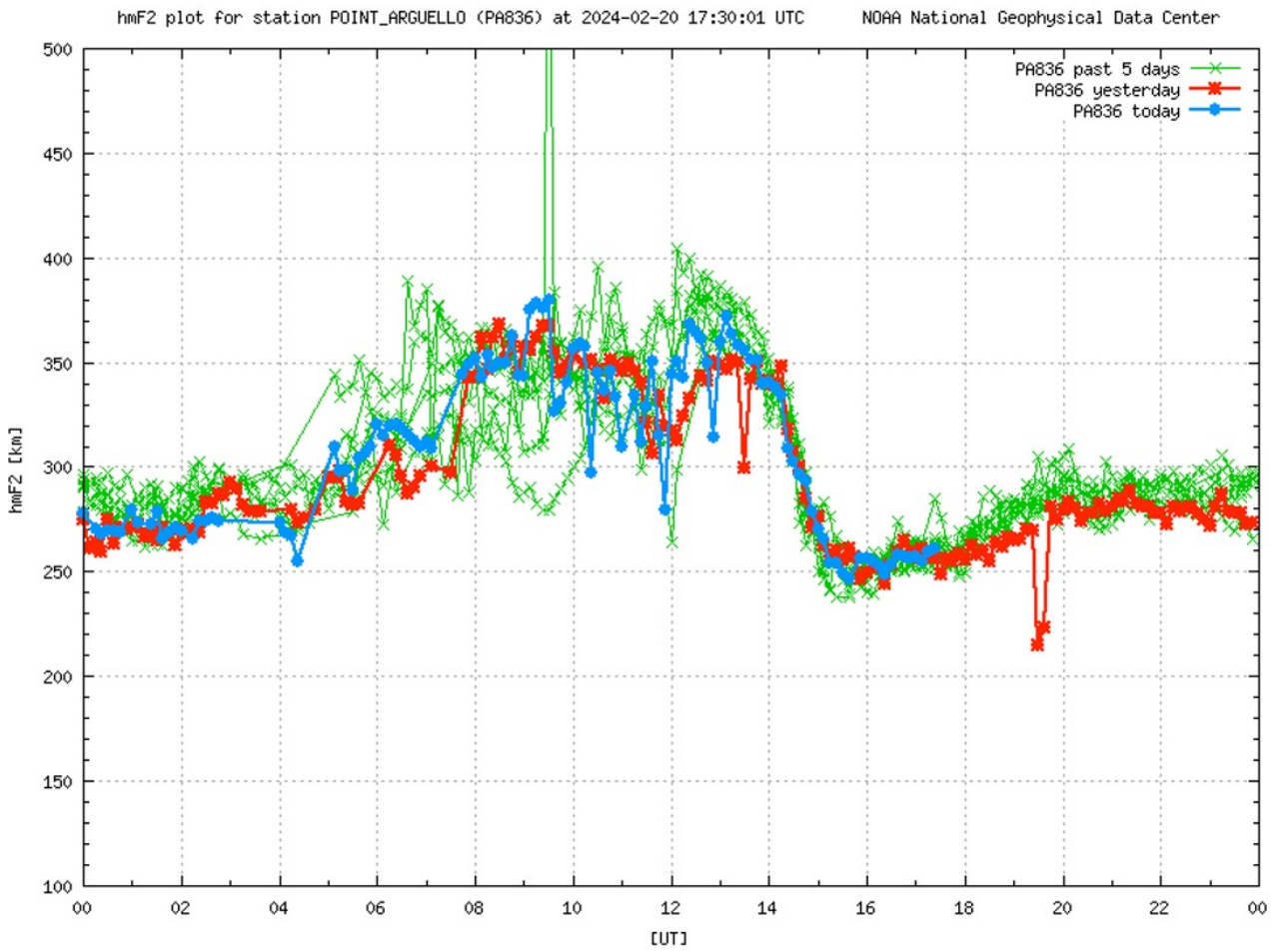
- Blue trace is the critical frequency for “today” 2/20/2024 in Universal Time (UT)
- Red trace is the critical frequency for “yesterday” 2/19/2024 in UT time
- The 80 meter test ran from 13:00 PST 2/19/2024 = 21:00 UT “yesterday” to
- 21:30 PST 2/19/2024 = 5:30 UT “today” 2/20/2024
- Critical frequency ranged from 12 MHz at 13:00 PST (21:00 UT yesterday) to
- 3.8 MHz at 21:30 PST (5:30 UT today)

# Critical Frequency on 2/19/2024




- Expanded view

# Height of Ionosphere's F2 Layer on 2/19/2024




- The height of the Ionosphere's F2 Layer during the 2/19/2024 test was around 275 km
- The color scheme and UT times are the same as for the critical frequency chart

# 80 Meter Day Time Propagation Data – 2/19/2024 @ 13:30 hours

| Time | Frequency MHZ | Call | Distance Miles | Contact Duration (min) | Power Watts | Antenna | Tries | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | Yellow | | Fc = 12 MHz |
| | 3595.500 | KE6NYT | 9 | NA | | | | Camarillo, CA |
| 13:33 | 3594.000 | W6BI | 11 | 3:07 | | | | Simi Valley, CA |
| 13:37 | 3595.500 | AJ7C | 31 | 0:23 | | | | Culver City,CA |
| 13:39 | 3591.000 | KN6BKT | 48 | 0:18 | | | 2 | San Gabrile, CA |
| 13:41 | 3582.500 | N7OP | 52 | 0:23 | | | | Lancaster, CA |
| | 3578.000 | K9NEY | 68 | NA | | | | Chino Hills, CA |
| 13:43 | 3590.200 | XE2BC | 160 | nc | | | 2 | Tijuana, Mexico |
| 13:45 | 3587.500 | KO0OOO | 252 | nc | | | 2 | North Las Vegas, NV |
| 13:47 | 3588.500 | K7OI | 301 | abort | | | | Meadview, AZ (E of Los Vegas in AZ |
| 13:52 | 3594.500 | KD7NHC | 320 | 1:00 | | | | Wellington, NV. [SE of Carson City] |
| 13:56 | 3596.500 | W7DEM | 345 | nc | | | 2 | Minden, NV [S of Carson City] |
| 13:58 | 3588.500 | N0DAJ | 348 | nc | | | 2 | Wickenburg, AZ. [NW of Phoenix] |
| 14:00 | 3585.000 | KL7RI | 368 | nc | | | 2 | Reno, NV |
| 14:01 | 3591.500 | KJ7GSK | 386 | nc | | | 2 | Chandler, AZ. [SE of Phoenix] |
| 14:03 | 3585.500 | K7RRR | 411 | nc | | | 2 | Gilbert, AZ. [SE of Phoenix] |
| 14:05 | 3592.500 | KD6OAT | 585 | nc | | | 2 | Sandy, UT |
| 14:06 | 3586.500 | AG7MM | 638 | nc | | | 2 | Burley, ID. [E of Twin Falls] |
| 14:08 | 3585.000 | KG7AV | 693 | nc | | | 2 | Bend, OR |

- During the middle of the day close in stations from 11 out to 52 miles were the only stations that could be reached, the high elevation angles of their signals penetrated the D Layer
- Stations further away than 52 miles in general could not be reached
- Their signals were absorbed in the ionosphere's D Layer

# 80 Meter Data Approaching Sunset – 2/19/2024 @ 16:30 hours

| Time | Frequency MHZ | Call | Distance Miles | Contact Duration (min) | Power Watts | Antenna | Tries | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | Yellow | | Fc = 11 MHz |
| | 3595.500 | KE6NYT | 9 | NA | | | | Camarillo, CA |
| 16:11 | 3595.500 | AJ7C | 31 | 0:23 | | | | Culver City,CA |
| 16:13 | 3591.000 | KN6BKT | 48 | 0:16 | | | | San Gabrile, CA |
| 16:14 | 3582.500 | N7OP | 52 | 0:23 | | | | Lancaster, CA |
| | 3578.000 | K9NEY | 68 | NA | | | | Chino Hills, CA |
| 16:16 | 3590.200 | XE2BC | 160 | 0:37 | | | | Tijuana, Mexico |
| 16:18 | 3587.500 | KO0OOO | 252 | 0:51 | | | | North Las Vegas, NV |
| 16:20 | 3588.500 | K7OI | 301 | abort | | | 2 | Meadview, AZ (E of Los Vegas in AZ |
| 16:23 | 3594.500 | KD7NHC | 320 | 0:27 | | | | Wellington, NV. [SE of Carson City] |
| 16:26 | 3596.500 | W7DEM | 345 | 0:20 | | | | Minden, NV [S of Carson City] |
| 16:28 | 3588.500 | N0DAJ | 348 | nc | | | 2 | Wickenburg, AZ. [NW of Phoenix] |
| 16:29 | 3585.000 | KL7RI | 368 | nc | | | 2 | Reno, NV |
| 16:31 | 3591.500 | KJ7GSK | 386 | 1:03 | | | 2 | Chandler, AZ. [SE of Phoenix] |
| 16:34 | 3585.500 | K7RRR | 411 | 0:25 | | | | Gilbert, AZ. [SE of Phoenix] |
| 16:36 | 3592.500 | KD6OAT | 585 | nc | | | 2 | Sandy, UT |
| 16:38 | 3586.500 | AG7MM | 638 | nc | | | 2 | Burley, ID. [E of Twin Falls] |
| | 3585.000 | KG7AV | 693 | | | | | Bend, OR |
| 16:41 | 3594.000 | W7INL | 741 | 1:01 | | | | Rigby, ID |
| 16:43 | 3595.500 | KF7RFI | 764 | nc | | | 2 | Mosier, OR (E of Hood River) |
| 16:45 | 3593.500 | K7UNI | 769 | nc | | | 2 | La Grande, OR (SE of Pendleton) |
| 16:46 | 3586.000 | KD7ZDO | 795 | nc | | | 2 | Oregon City, OR. [S of Portland] |
| 16:48 | 3583.200 | W7OWO | 798 | nc | | | 2 | Dundee, OR. [SE of Portland] |
| 16:51 | 3587.000 | KD0SFY | 845 | 1:55 | | | | Colorado Springs, CO |
| 16:56 | 3591.000 | KB2PCN-8 | 894 | 0:40 | | | | Evergreen, CO (N of Aspen) |
| 16:58 | 3585.000 | K7RHT | 899 | nc | | | 2 | Kerrville, TX (NW of San Antonio) |
| 17:00 | 3587.500 | K7HTZ | 917 | nc | | | 2 | Olympia, WA. [SW of Tacoma] |
| 17:01 | 3589.500 | N7LOB | 920 | nc | | | 2 | Aberdeen, WA. [On coast W of Olympia] |
| 17:03 | 3591.500 | VA7PF | 1054 | nc | | | 2 | BC, Canada |
| 17:05 | 3586.500 | VE7GN | 1063 | nc | | | 2 | Gabriola, BC, Vancouver Island |
| 17:07 | 3585.000 | KA0ZIS | 1219 | nc | | | 2 | Pierre, SD |

- In the late afternoon, an hour prior to the 17:40 sunset, station out to 411 miles were reached as the D Layer diminished
- However, stations from 585 out to 1,219 miles still could not be reliably reached since they were still being absorbed in the D Layer

# 80 Meter Data Following Sunset – 2/19/2024 @ 18:30 hours

| Time | Frequency MHZ | Call | Distance Miles | Contact Duration (min) | Power Watts | Antenna | Tries | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | Yellow | | Fc = 8 MHz |
| 18:21 | 3595.500 | KE6NYT | 9 | 0:27 | | | | Camarillo, CA |
| 18:26 | 3595.500 | AJ7C | 31 | 0:23 | | | | Culver City,CA |
| 18:29 | 3591.000 | KN6BKT | 48 | 0:18 | | | | San Gabrile, CA |
| 18:30 | 3582.500 | N7OP | 52 | 0:18 | | | | Lancaster, CA |
| 18:32 | 3578.000 | K9NEY | 68 | 0:27 | | | | Chino Hills, CA |
| 18:33 | 3590.200 | XE2BC | 160 | 0:18 | | | 2 | Tijuana, Mexico |
| 19:26 | 3587.500 | KO0OOO | 252 | 0:21 | | | | North Las Vegas, NV |
| 19:28 | 3588.500 | K7OI | 301 | 1:32 | | | 2 | Meadview, AZ (E of Los Vegas in AZ |
| 18:36 | 3594.500 | KD7NHC | 320 | 0:27 | | | | Wellington, NV. [SE of Carson City] |
| 18:40 | 3596.500 | W7DEM | 345 | 0:18 | | | | Minden, NV [S of Carson City] |
| 19:35 | 3588.500 | N0DAJ | 348 | 0:18 | | | | Wickenburg, AZ. [NW of Phoenix] |
| 18:48 | 3585.000 | KL7RI | 368 | 0:24 | | | | Reno, NV |
| 18:50 | 3591.500 | KJ7GSK | 386 | 0:18 | | | | Chandler, AZ. [SE of Phoenix] |
| 18:51 | 3585.500 | K7RRR | 411 | 0:18 | | | | Gilbert, AZ. [SE of Phoenix] |
| 18:52 | 3592.500 | KD6OAT | 585 | 0:17 | | | | Sandy, UT |
| 18:53 | 3586.500 | AG7MM | 638 | 0:40 | | | | Burley, ID. [E of Twin Falls] |
| 18:55 | 3585.000 | KG7AV | 693 | 2:01 | | | | Bend, OR |
| 18:58 | 3594.000 | W7INL | 741 | 0:18 | | | | Rigby, ID |
| 19:01 | 3593.500 | K7UNI | 769 | 0:37 | | | | La Grande, OR (SE of Pendleton) |
| 19:02 | 3586.000 | KD7ZDO | 795 | nc | | | 2 | Oregon City, OR. [S of Portland] |
| 19:04 | 3583.200 | W7OWO | 798 | nc | | | 2 | Dundee, OR. [SE of Portland] |
| 19:07 | 3587.000 | KD0SFY | 845 | 0:38 | | | | Colorado Springs, CO |
| 19:37 | 3591.000 | KB2PCN-8 | 894 | 0:18 | | | | Evergreen, CO (N of Aspen) |
| 19:14 | 3587.500 | K7HTZ | 917 | 0:54 | | | | Olympia, WA. [SW of Tacoma] |
| 19:16 | 3589.500 | N7LOB | 920 | 1:08 | QRM | | | Aberdeen, WA. [On coast W of Olympia] |
| 19:18 | 3591.500 | VA7PF | 1054 | 0:49 | | | | BC, Canada |
| 19:20 | 3586.500 | VE7GN | 1063 | 0:17 | | | | Gabriola, BC, Vancouver Island |
| 19:22 | 3585.000 | KA0ZIS | 1219 | nc | | | 2 | Pierre, SD |

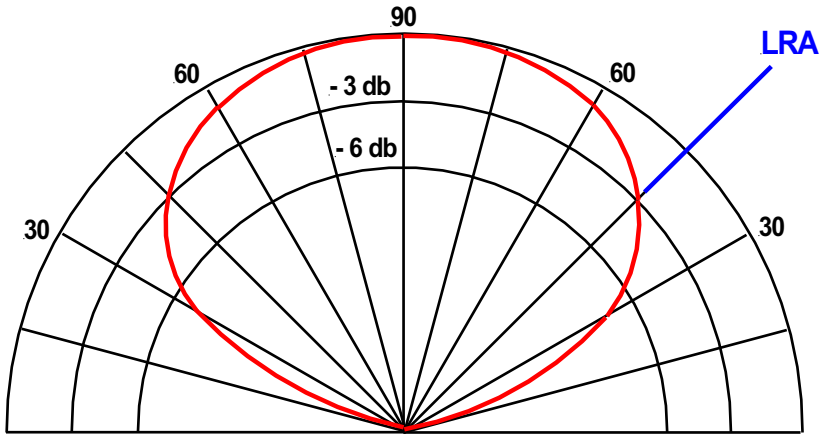
- Sunset occurred at 17:40 (5:40 PM)
- 45 minutes to an hour later the absorbing D Layer had mostly disappeared
- Allowing stations from close in (9 miles) out to 1,063 miles to be reached

# 80 Meter Evening Data – 2/19/2024 @ 21:00 hours

| Time | Frequency MHZ | Call | Distance Miles | Contact Duration (min) | Power Watts | Antenna | Tries | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | Yellow | | Fc = 3.8 MHz |
| 20:39 | 3595.500 | KE6NYT | 9 | 0:27 | | | | Camarillo, CA |
| 20:42 | 3595.500 | AJ7C | 31 | 0:17 | | | | Culver City,CA |
| 20:43 | 3591.000 | KN6BKT | 48 | 0:25 | | | | San Gabrile, CA |
| 20:45 | 3582.500 | N7OP | 52 | 0:18 | | | | Lancaster, CA |
| 20:46 | 3578.000 | K9NEY | 68 | 0:19 | | | | Chino Hills, CA |
| 20:49 | 3590.200 | XE2BC | 160 | 0:25 | | | | Tijuana, Mexico |
| 20:51 | 3587.500 | KO0OOO | 252 | 0:20 | | | | North Las Vegas, NV |
| 20:52 | 3588.500 | K7OI | 301 | 0:27 | | | | Meadview, AZ (E of Los Vegas in AZ |
| 20:54 | 3594.500 | KD7NHC | 320 | 0:27 | | | | Wellington, NV. [SE of Carson City] |
| 20:56 | 3596.500 | W7DEM | 345 | 0:18 | | | | Minden, NV [S of Carson City] |
| 20:57 | 3588.500 | N0DAJ | 348 | 0:18 | | | | Wickenburg, AZ. [NW of Phoenix] |
| 20:58 | 3585.000 | KL7RI | 368 | 0:16 | | | | Reno, NV |
| 21:00 | 3591.500 | KJ7GSK | 386 | 0:16 | | | | Chandler, AZ. [SE of Phoenix] |
| 21:01 | 3585.500 | K7RRR | 411 | 0:18 | | | | Gilbert, AZ. [SE of Phoenix] |
| 21:02 | 3592.500 | KD6OAT | 585 | 0:18 | | | | Sandy, UT |
| 21:04 | 3586.500 | AG7MM | 638 | 0:26 | | | | Burley, ID. [E of Twin Falls] |
| 21:05 | 3585.000 | KG7AV | 693 | 1:06 | | | | Bend, OR |
| 21:08 | 3594.000 | W7INL | 741 | 0:18 | | | | Rigby, ID |
| 21:11 | 3582.500 | K7UNI | 769 | 0:28 | | | | La Grande, OR (SE of Pendleton) |
| 21:42 | 3586.000 | KD7ZDO | 795 | 1:48 | | | 2 | Oregon City, OR. [S of Portland] |
| 21:17 | 3583.200 | W7OWO | 798 | 0:49 | | | | Dundee, OR. [SE of Portland] |
| 21:24 | 3587.000 | KD0SFY | 845 | 0:17 | | | 3 | Colorado Springs, CO |
| 21:25 | 3591.000 | KB2PCN-8 | 894 | 0:17 | | | | Evergreen, CO (N of Aspen) |
| 21:28 | 3587.500 | K7HTZ | 917 | 0:25 | | | | Olympia, WA. [SW of Tacoma] |
| 21:30 | 3589.500 | N7LOB | 920 | 0:42 | | | | Aberdeen, WA. [On coast W of Olympia] |
| 21:31 | 3591.500 | VA7PF | 1054 | 0:25 | | | | BC, Canada |
| 21:33 | 3586.500 | VE7GN | 1063 | 0:41 | | | | Gabriola, BC, Vancouver Island |
| 21:35 | 3585.000 | KA0ZIS | 1219 | 0:44 | | | | Pierre, SD |

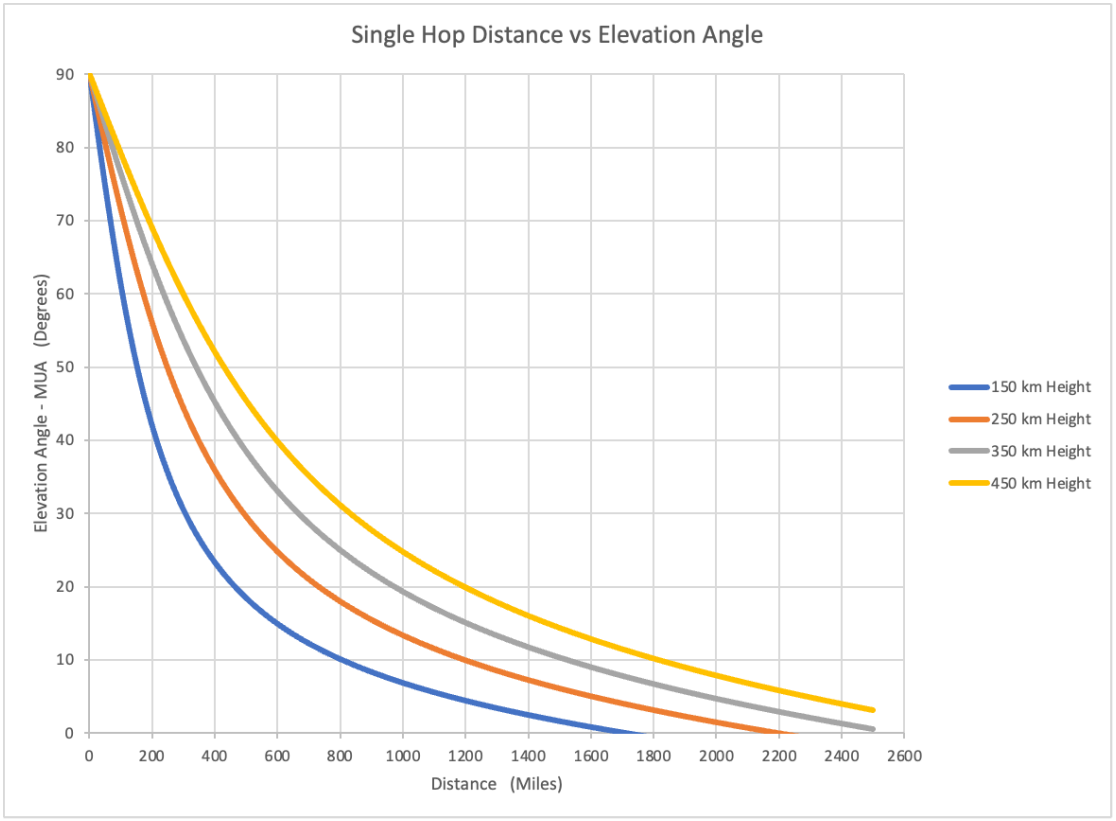
- In the evening (21:00 hours) stations from 9 out to 1,219 miles were easily reached indicating:
- The lack of an 80 meter skip zone, and
- The absence of the ionosphere's D Layer

# 80 Meter NVIS Antenna Pattern



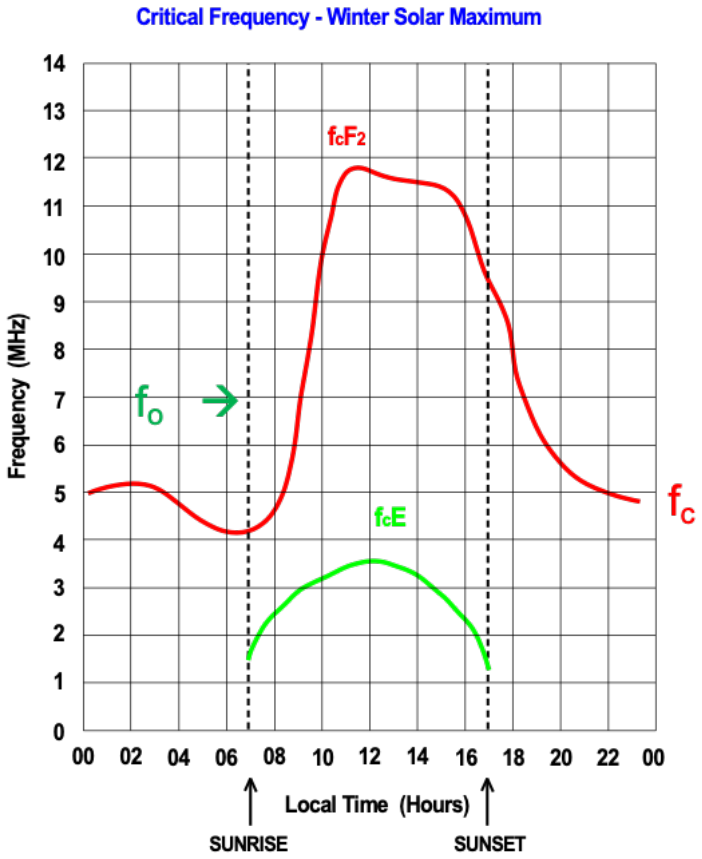

- 80 meter NVIS antennas radiate well at elevation angles from approximately 40 to 90 degrees

# 80 Meter NVIS Hop Distance



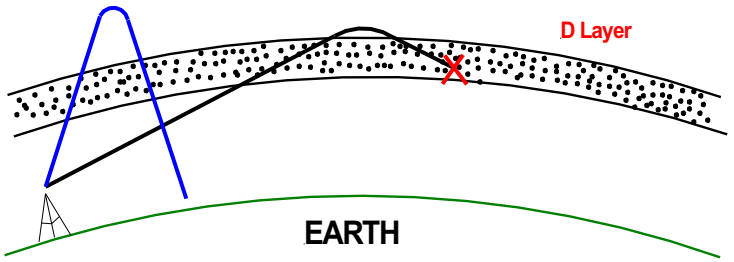

- The maximum single hop distance for an 80 meter NVIS antenna occurs at an elevation angle of approximately 40 degrees
- This is the antenna's Lowest Radiated Angle (LRA)
- At this angle, the single hop distance is approximately 350 miles when the height of the F2 layer is 250 km
- Distances longer than this require multiple hops and
- Multiple passes through the ionosphere's energy absorbing D Layer
- In the test data, stations more than roughly 400 miles away were probably reached by multiple hops

# NVIS Gap




- The NVIS gap is the period of time between the critical frequency ($f_c$ ) dropping below the 40 meter band (below $f_o$ = 7 MHz) and roughly sunset when the ionosphere's absorbing D Layer disappears
- During the gap, NVIS propagation is not possible on either 40 or 80 meters
- A skip zone preventing NVIS operation develops on 40 meters when the critical frequency drops below 7 MHz
- During the day a strong D Layer absorbs 80 meter signals preventing 80m NVIS operation
- Consequently, an NVIS gap occurs between the time the critical frequency drops below 7 MHz and disappearance of the D Layer at sunset
- Once the D Layer disappears, excellent 80 meter NVIS operation persists throughout the night until sunrise the next morning, provided the critical frequency remains above 4 MHz
- An 80 meter skip zone quickly develops, cutting off NVIS operation, if the critical frequency drops below 4 MHz (below 3.7 MHz for WinLink op)

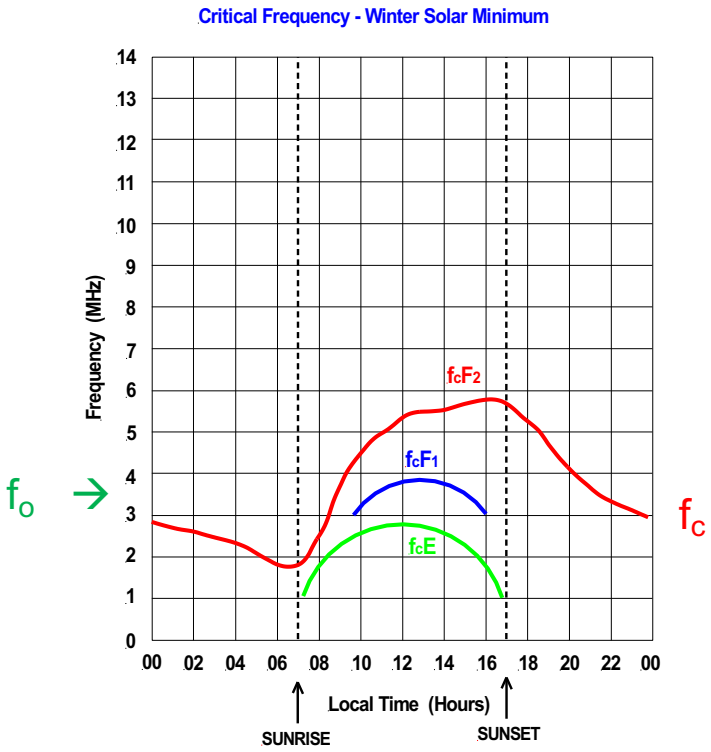
# NVIS Gap – Close In Stations

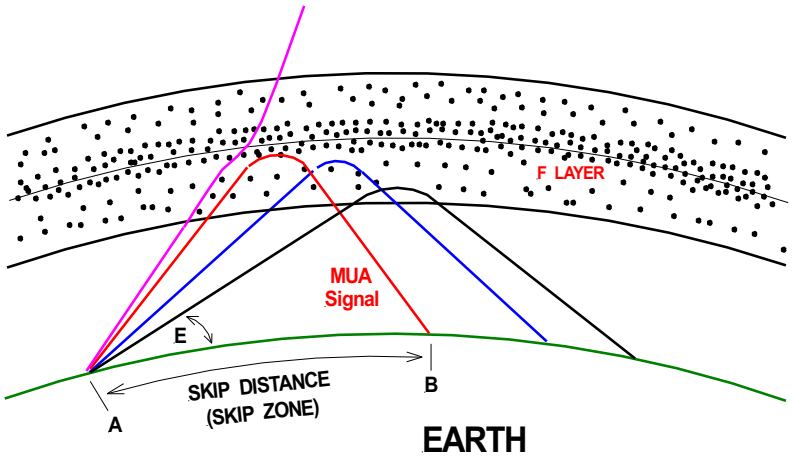



| Time | Frequency MHZ | Call | Distance Miles | Contact Duration (min) | Power Watts | Antenna | Tries | Comments |
|---|---|---|---|---|---|---|---|---|
| | | | | | 50 | Yellow | | Fc = 12 MHz |
| | 3595.500 | KE6NYT | 9 | NA | | | | Camarillo, CA |
| 13:33 | 3594.000 | W6BI | 11 | 3:07 | | | | Simi Valley, CA |
| 13:37 | 3595.500 | AJ7C | 31 | 0:23 | | | | Culver City,CA |
| 13:39 | 3591.000 | KN6BKT | 48 | 0:18 | | | 2 | San Gabrile, CA |
| 13:41 | 3582.500 | N7OP | 52 | 0:23 | | | | Lancaster, CA |
| | 3578.000 | K9NEY | 68 | NA | | | | Chino Hills, CA |
| 13:43 | 3590.200 | XE2BC | 160 | nc | | | 2 | Tijuana, Mexico |
| 13:45 | 3587.500 | KO0OOO | 252 | nc | | | 2 | North Las Vegas, NV |
| 13:47 | 3588.500 | K7OI | 301 | abort | | | | Meadview, AZ (E of Los Vegas in AZ |
| 13:52 | 3594.500 | KD7NHC | 320 | 1:00 | | | | Wellington, NV. [SE of Carson City] |
| 13:56 | 3596.500 | W7DEM | 345 | nc | | | 2 | Minden, NV [S of Carson City] |
| 13:58 | 3588.500 | N0DAJ | 348 | nc | | | 2 | Wickenburg, AZ. [NW of Phoenix] |
| 14:00 | 3585.000 | KL7RI | 368 | nc | | | 2 | Reno, NV |
| 14:01 | 3591.500 | KJ7GSK | 386 | nc | | | 2 | Chandler, AZ. [SE of Phoenix] |
| 14:03 | 3585.500 | K7RRR | 411 | nc | | | 2 | Gilbert, AZ. [SE of Phoenix] |
| 14:05 | 3592.500 | KD6OAT | 585 | nc | | | 2 | Sandy, UT |
| 14:06 | 3586.500 | AG7MM | 638 | nc | | | 2 | Burley, ID. [E of Twin Falls] |
| 14:08 | 3585.000 | KG7AV | 693 | nc | | | 2 | Bend, OR |

- The test data shows that stations within roughly 50 miles can be reached on 80 meters even during the middle of the day when the D Layer is fully developed
- The high elevation angle of these signals (the blue trace) causes them to quickly travers the D Layer with little signal loss
- Lower elevation angle longer hop signals to stations over 50 miles away spend longer traversing the D Layer and are absorbed preventing them from reaching their destinations

# 80 Meter Skip Distance Test - Solar Minimum

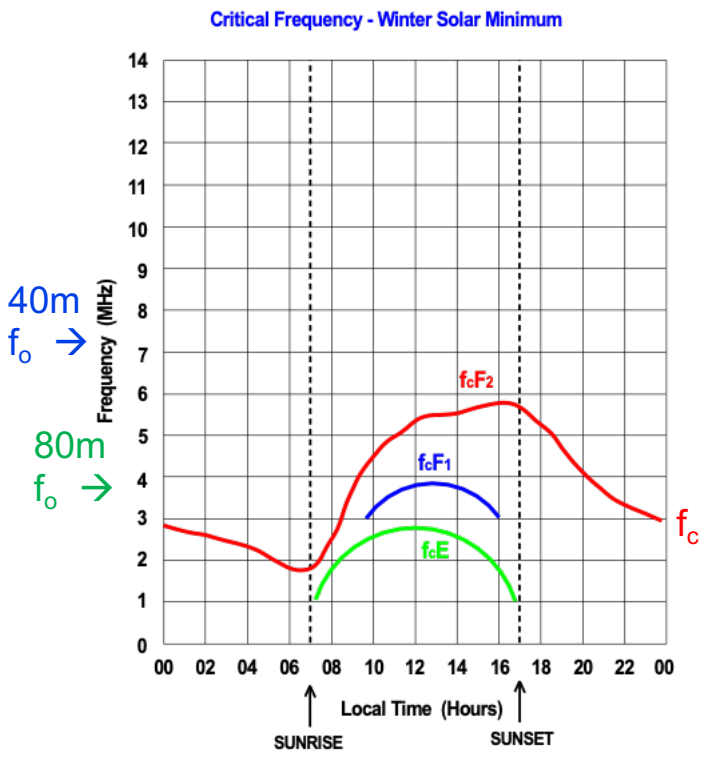



**An 80 meter Skip Zone is present at night when $f_c < f_o$**

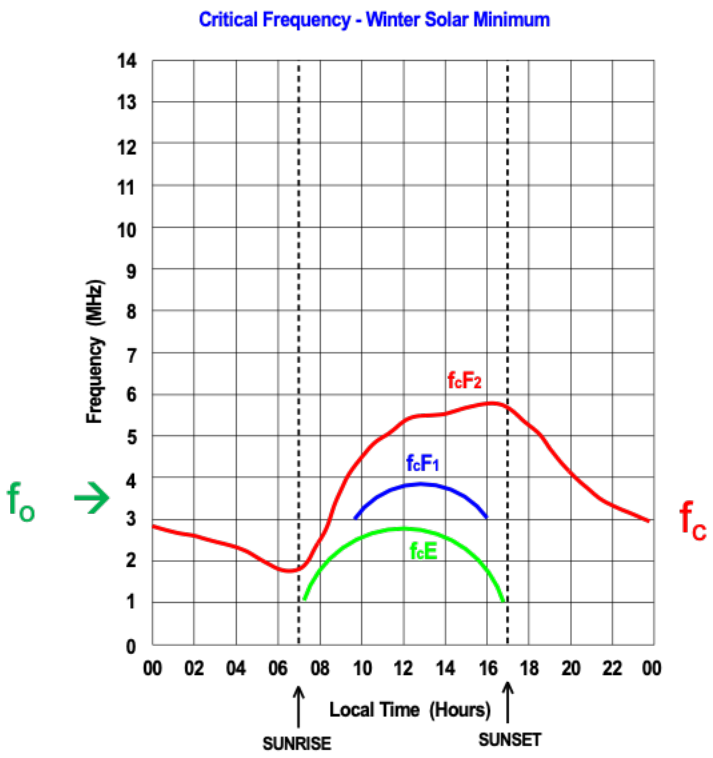
- During **solar minimum** critical frequency $f_c$ is less than the 80 meter operating frequency $f_o$ of 3.5 – 4.0 MHz during the night, typically from 10 PM (22:00) until 9 AM the next morning
- Consequently, during **solar minimum** an 80 meter night time skip zone is present

# Solar Minimum NVIS Gap



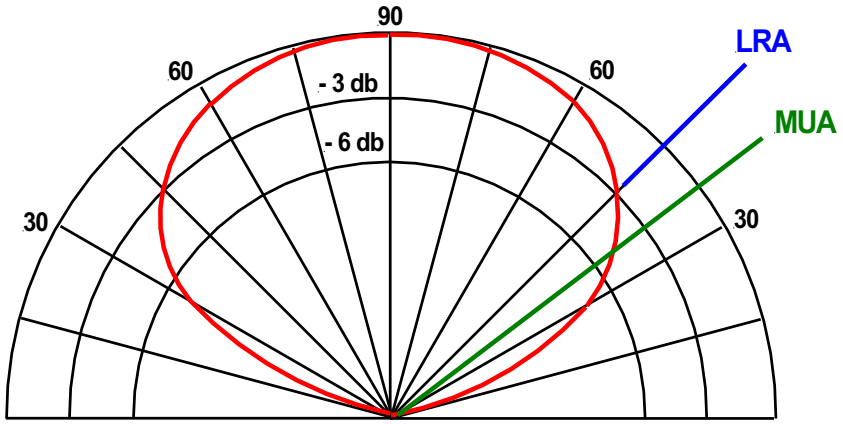

- During solar minimum the critical frequency $f_c$ is generally lower than the 40 meter operating frequency $f_o$ of 7.0 to 7.3 MHz
- The low critical frequency results in a 40 meter skip zone that is present most of the time preventing the use of 40 meter NVIS
- However, longer hop propagation to stations beyond the skip zone is still possible and extensively used
- It is the close in 40 meter NVIS communications (within 300 to 400 miles) that is lost due to the low critical frequency
- During the day the D Layer absorbs most 80 meter signals with the possible exception of those transmitted to stations within 50 miles
- The result is a day long NVIS gap that lasts until sunset

# Solar Minimum NVIS Gap - continued



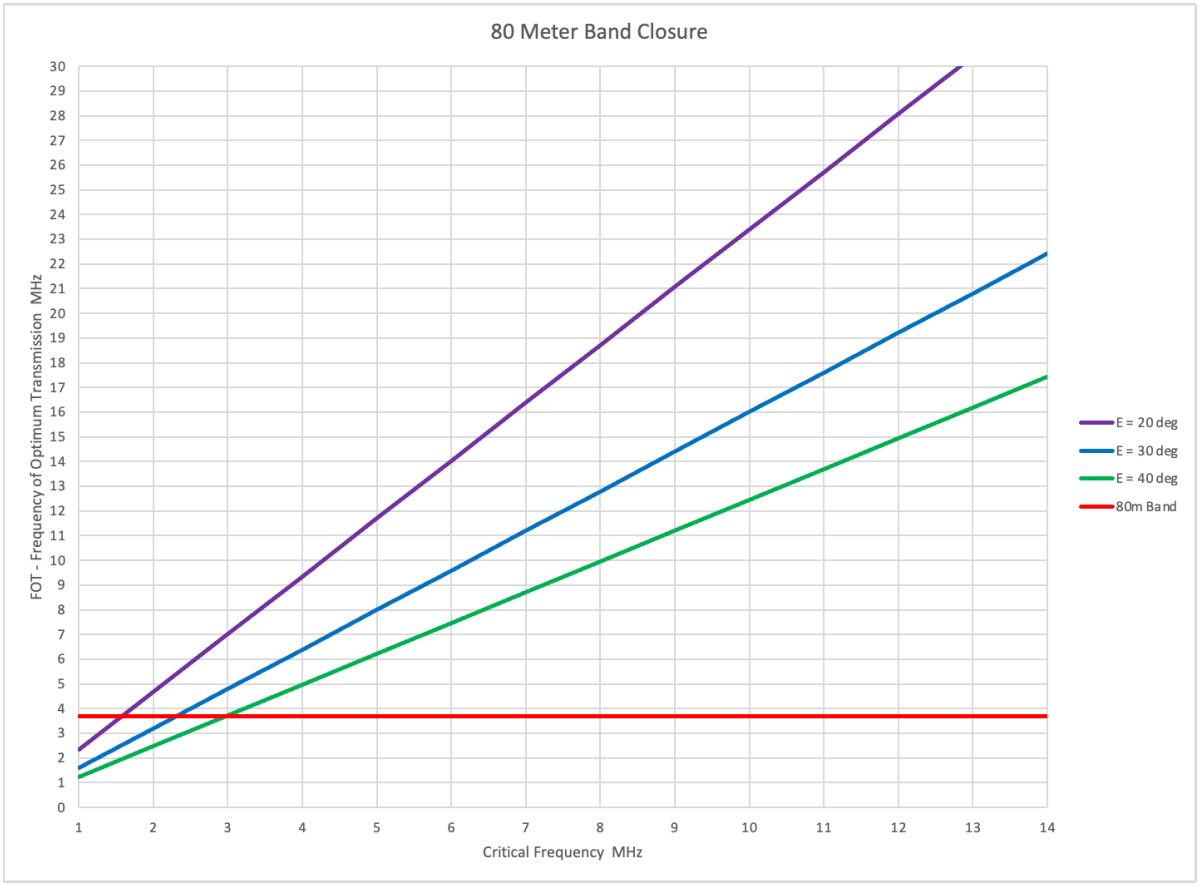

- Following sunset the D Layer disappears allowing a nearly ideal 80 meter NVIS band to immerge
- NVIS conditions typically last for about 3 hours from sunset around 17:00 until 20:00 when the critical frequency drops below 4.0 MHz
- An 80 meter skip zone quickly develops as the critical frequency drops under 4.0 MHz, terminating NVIS operation
- Long hop communications with stations beyond the skip zone typically continue another couple of hours until the critical frequency drops below 3 MHz
- This usually occurs around 22:00 hours
- At a critical frequency below 3 MHz, nearly all of the energy radiated by an 80 meter NVIS antenna is lost to outer space concluding use of the 80 meter band

# Lowest Radiated Angle (LRA)




- Lowest Radiated Angle (LRA) is the lowest angle at which an antenna can radiate a signal
- This is generally defined as the angle at which the antenna's radiated power drops 3 db below its peak level
- Beyond this point the antenna's radiated power falls off very quickly
- The LRA for an 80 meter NVIS antenna is typically around 40 to 45 degrees
- The ionosphere's Maximum Usable Angle (MUA) is the highest angle signal that can be transmitted without penetrating the ionosphere
- The only part of an antenna's radiated energy that can be used for communications is that part below the MUA
- Consequently, nearly all of an antenna's radiated energy will be lost to outer space if the ionosphere's Maximum Usable Angle is less than an antenna's Lowest Radiated Angle

# Band Closure For 80 Meter NVIS Antenna

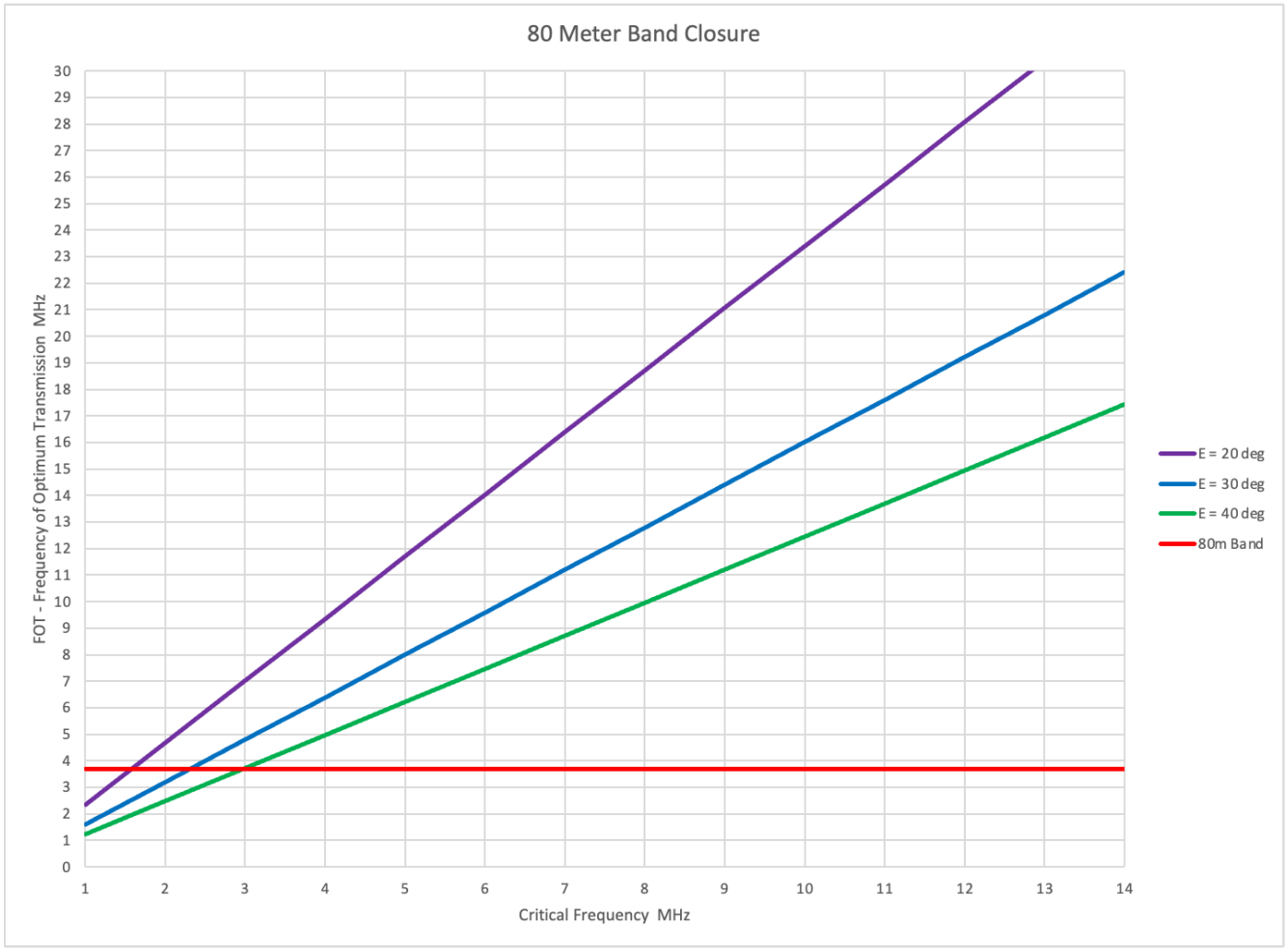



- At an elevation angle of $E_m$ = LRA, the Frequency of Optimum Transmission (FOT) given by

$$FOT = \frac{0.8\ f_c}{\sin E_m}$$

- steadily decreases as the ionosphere's critical frequency $f_c$ drops

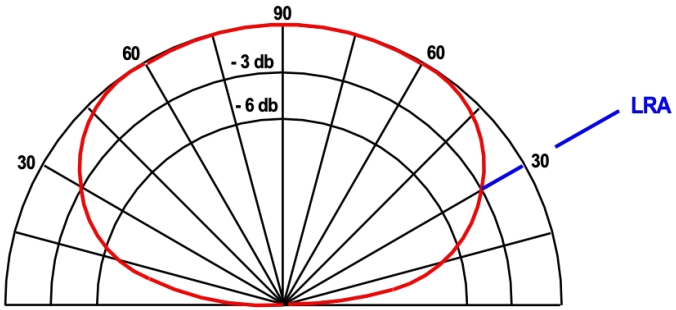
# Band Closure For 80 Meter NVIS Antenna - continued

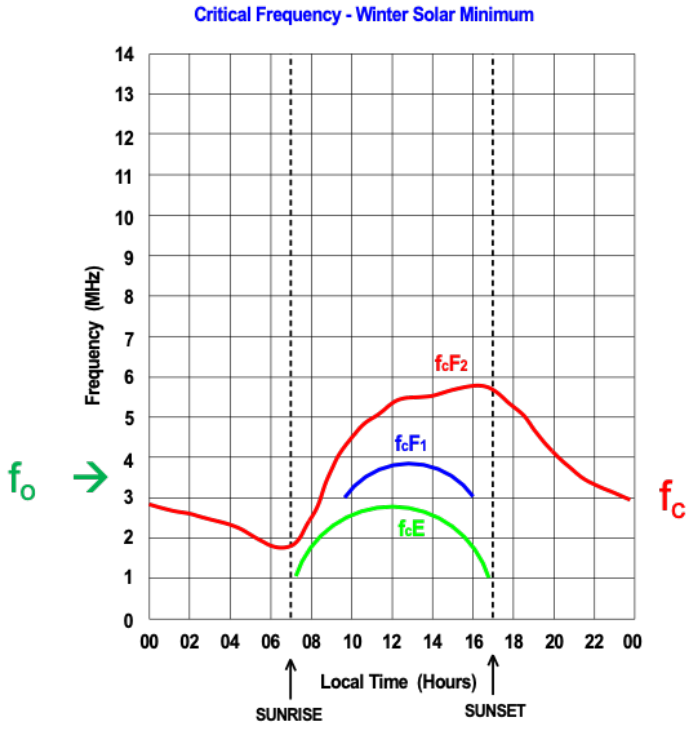



- The maximum usable frequency for communications (~ FOT) falls below the 80 meter band (~ 3.7 MHz) at a $f_c$ = 3 MHz when using an NVIS antenna with an $E_m$ = LRA = 40 degrees
- That is, an 80 m NVIS antenna can no longer be used for transmitting when $f_c$ is below 3 MHz

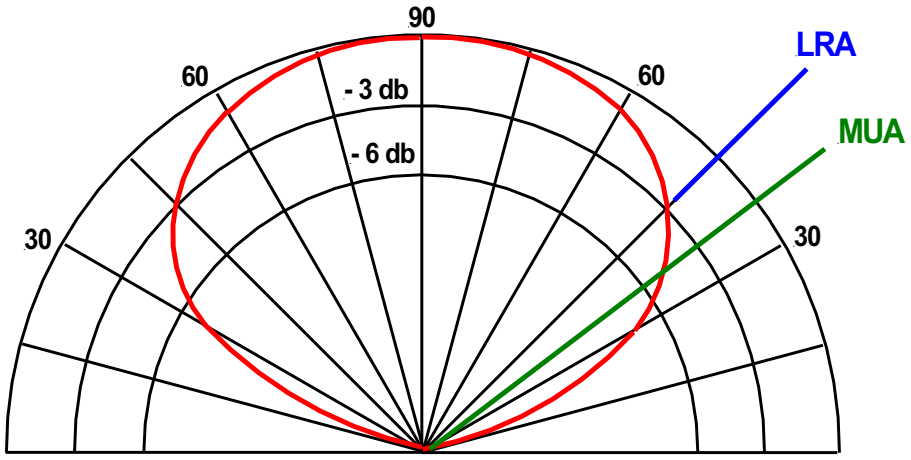
# Increasing The 80 Meter Operating Time

- The operating time of an 80 meter NVIS antenna during solar minimum can be extended beyond roughly 22:00 by
  - Using a higher antenna, and
  - Increasing transmitting power
- Increasing the height of the antenna from 1/8 to 1/4 wavelength above ground drops the antenna's LRA from roughly 40 to 30 degrees
- This allows the antenna to operate at a critical frequency down to approximately 2.4 MHz as illustrated in the previous slide
- Increasing the antenna's height allows operation to perhaps 2 AM in the morning



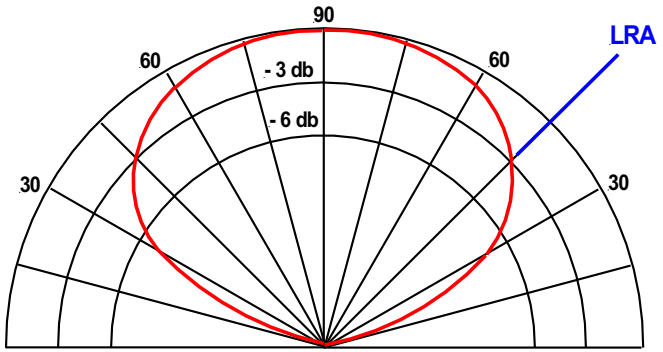



# Increasing 80 Meter Transmit Power

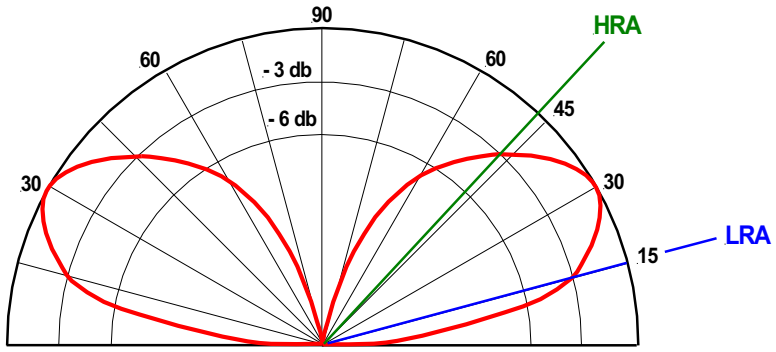



- While only a “sliver” of the antenna’s radiated power is useful when the antenna’s LRA > MUA
- Increasing transmitting power increases the amount of power radiated by that sliver
- A small amount of power ~ 10 watts can sustain successful communications out to a 1,000 miles or so
- Transmitting at 500 watts to get 10 watts of useful radiated power is not very efficient, but it can get the job done

# 80 Meter Vertical Antenna



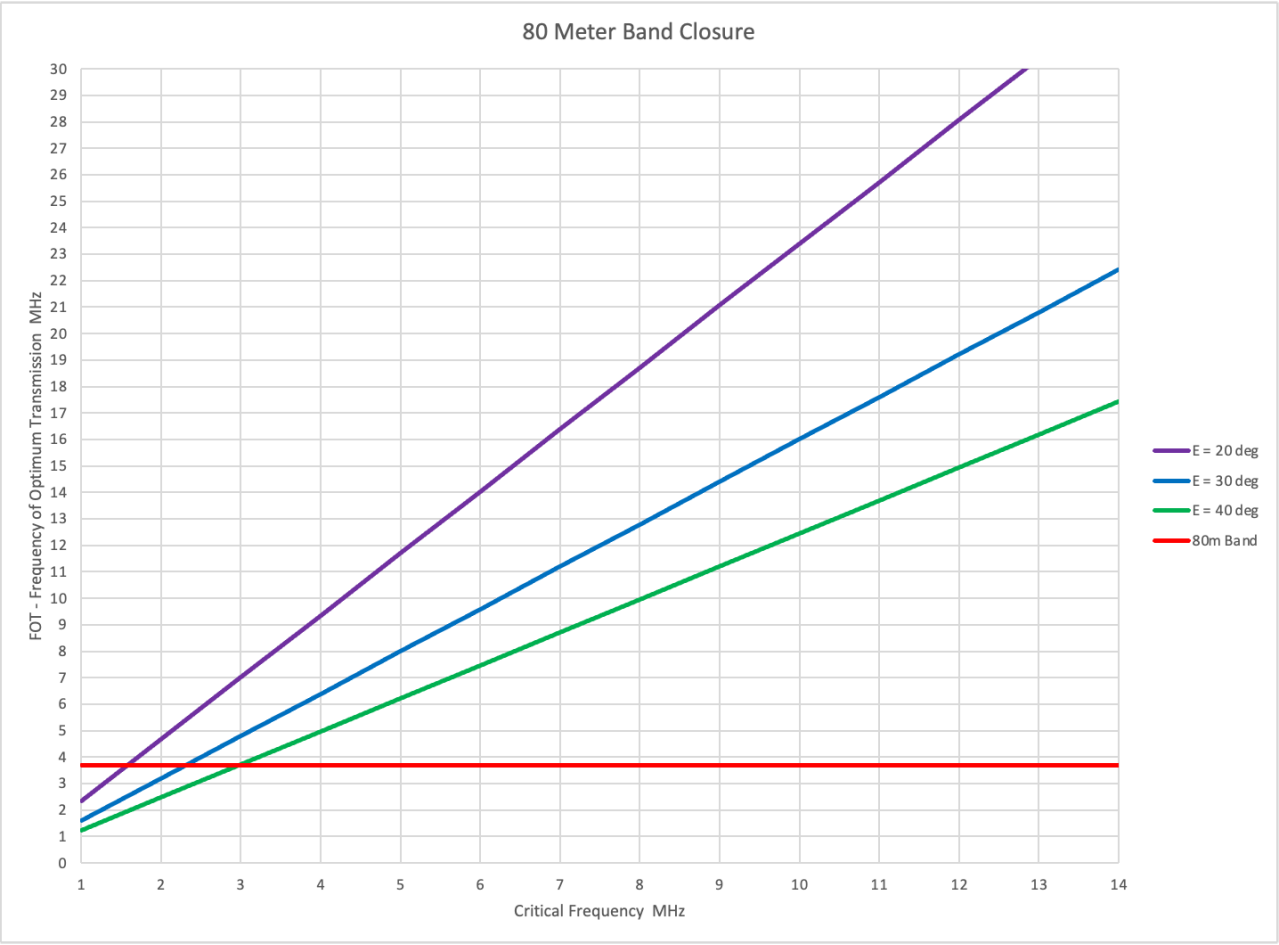

80 Meter NVIS Antenna.




80 Meter Vertical Antenna

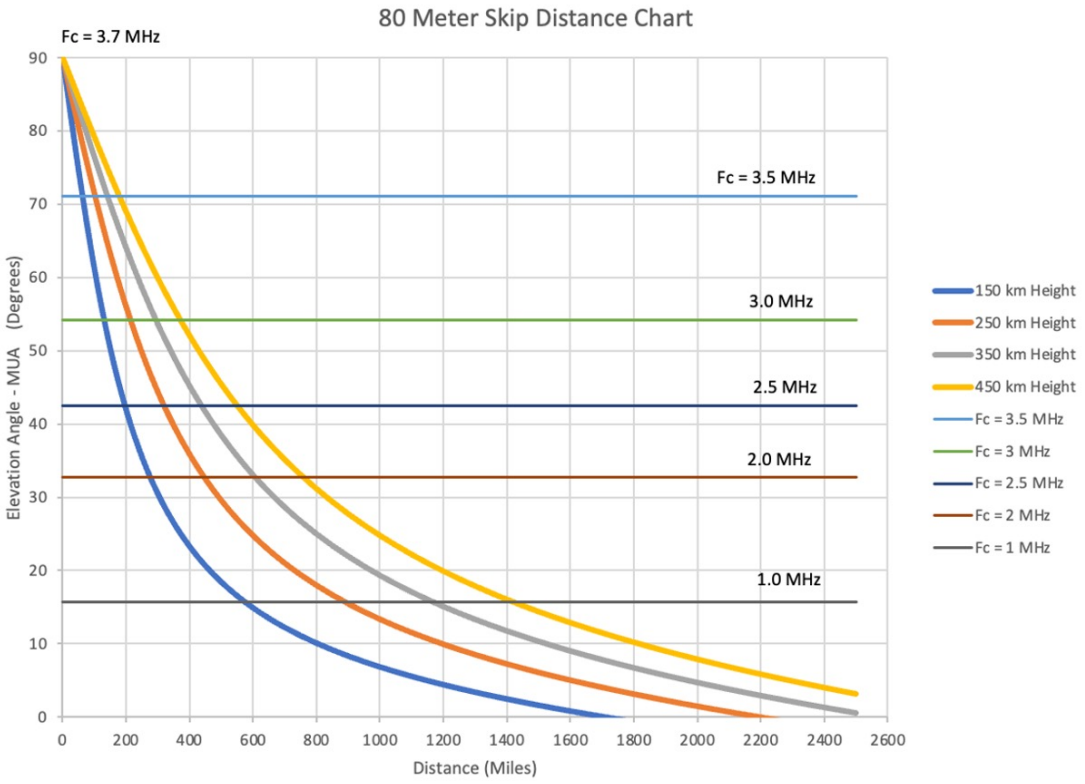
- An 80 meter vertical antenna may be a better antenna choice during solar minimum
- An 80 meter vertical antenna has a LRA of 15 to 20 digress allowing it to operate at a critical frequency down to nearly 1MHz
- A vertical antenna is the only option for operating throughout the night during solar minimum
- However, the vertical antenna's Highest Radiated Angle (HRA) of only 50 degrees prevents its use as an NVIS antenna for reaching close in stations
- The HRA for an NVIS antenna is 90 degrees
- During solar minimum, a combination of both an 80 meter NVIS and 80 meter vertical is ideal

# Band Closure For An 80 Meter Vertical Antenna



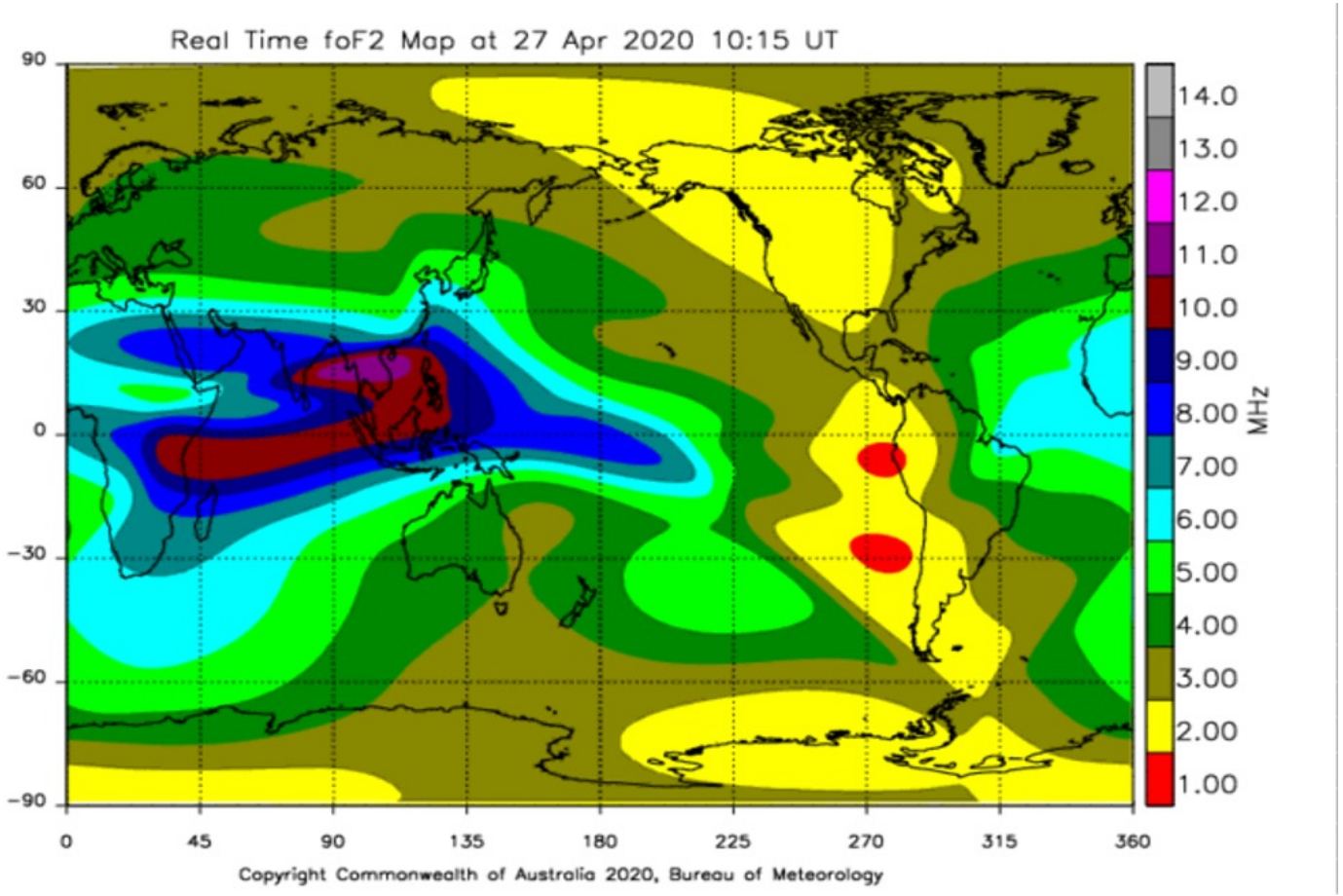

- The maximum usable frequency for communications (~ FOT) falls below the 80 meter band (~ 3.7 MHz) at a $f_c$ = 1.5 MHz when using a vertical antenna with an $E_m$ = LRA = 20 degrees
- An 80 meter vertical antenna can operate later into the night than an NVIS antenna

# When An 80 Meter Skip Zone Is Present




- Skip distance can be estimated using the 80m Skip Distance Chart by first determining the current critical frequency using the Global Critical Frequency Map (see next slide)
- At a critical frequency of 2 MHz and a typical ionosphere F2 Layer height of 250 km
- The skip distance is determined by reading down to the Distance axis from the intersection of the 250 km curve and Fc = 2 MHz
- This skip distance is approximately 450 miles
- The MUA of 32 degrees for Fc = 2 MHz is too low for an NVIS antenna
- A vertical antenna will be required

# Global Critical Frequency Map




- The above critical frequency map is for 10:15 UT (2 AM in the morning) on April 27, 2020 during solar minimum
- At this particular time the critical frequency above the United States was 2 MHz