Using Propagation Analysis Software and Antenna Modeling to Choose an Antenna

Ed Hare, ARRL

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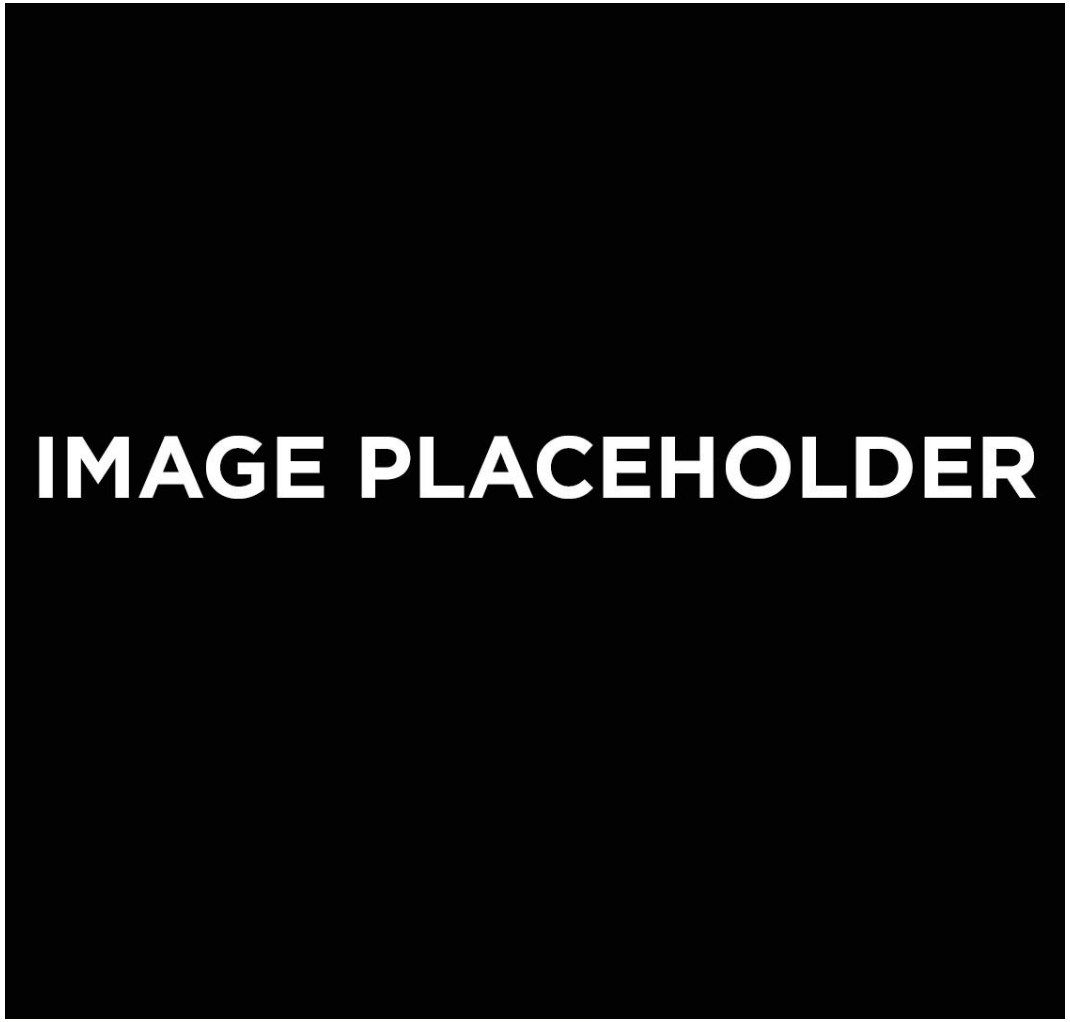
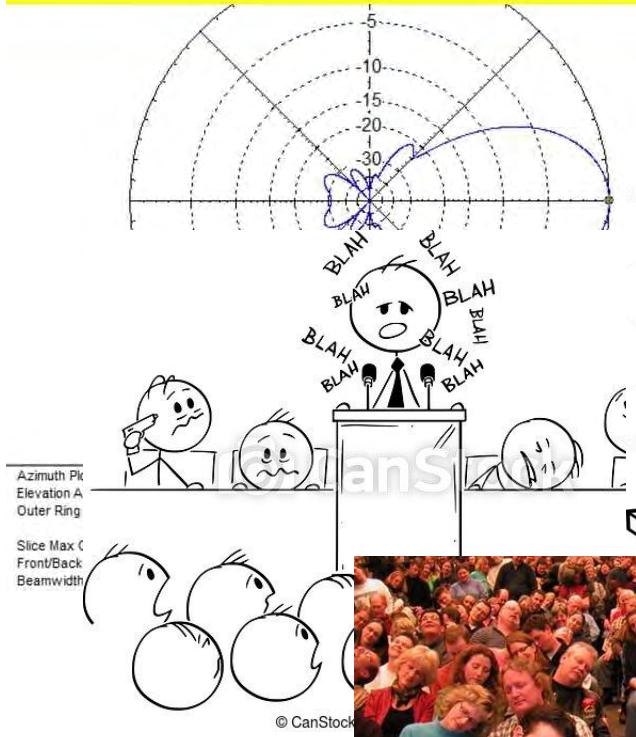
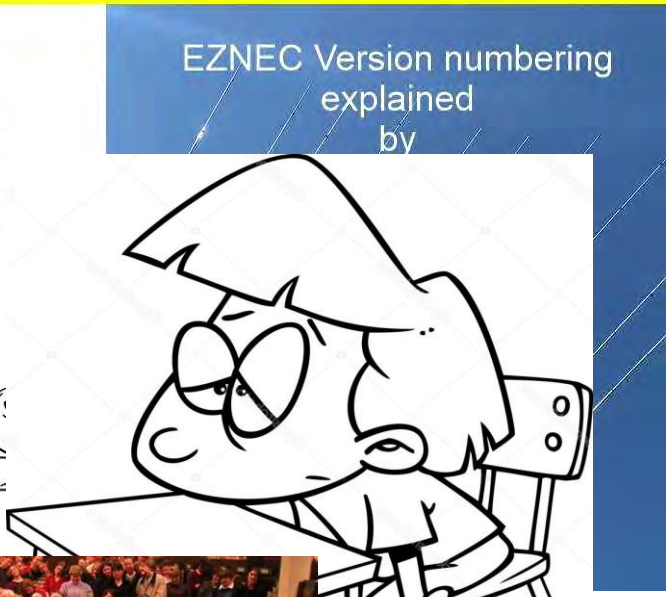
Ed Hare, W1RFI, has worked for ARRL, the US national association of amateur radio since 1986. He currently holds the honor of managing the ARRL Laboratory, overseeing ARRL's RFI program, Product Review testing and various ARRL service programs. He serves as the IEEE EMC Society Vice President for Standards, having been involved in the creation of industry standards for most of his career.



Boring!

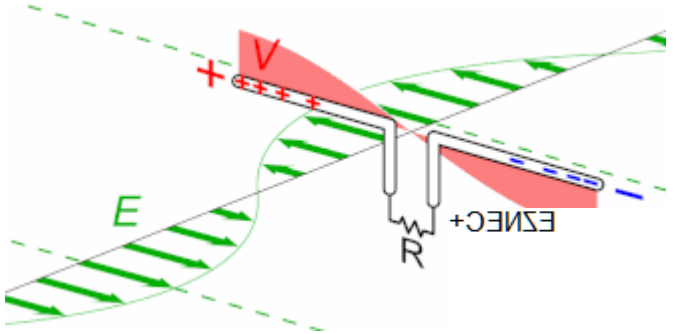
Watching someone teach a course on antenna modeling and propagation prediction would be boring! To make sure I don't put you to sleep, this presentation will show how propagation and antenna-modeling software can be used to make decisions about which antennas to use under what circumstances?

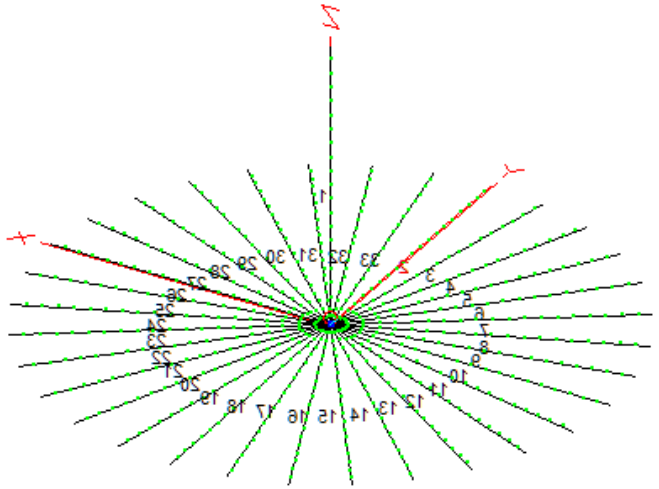


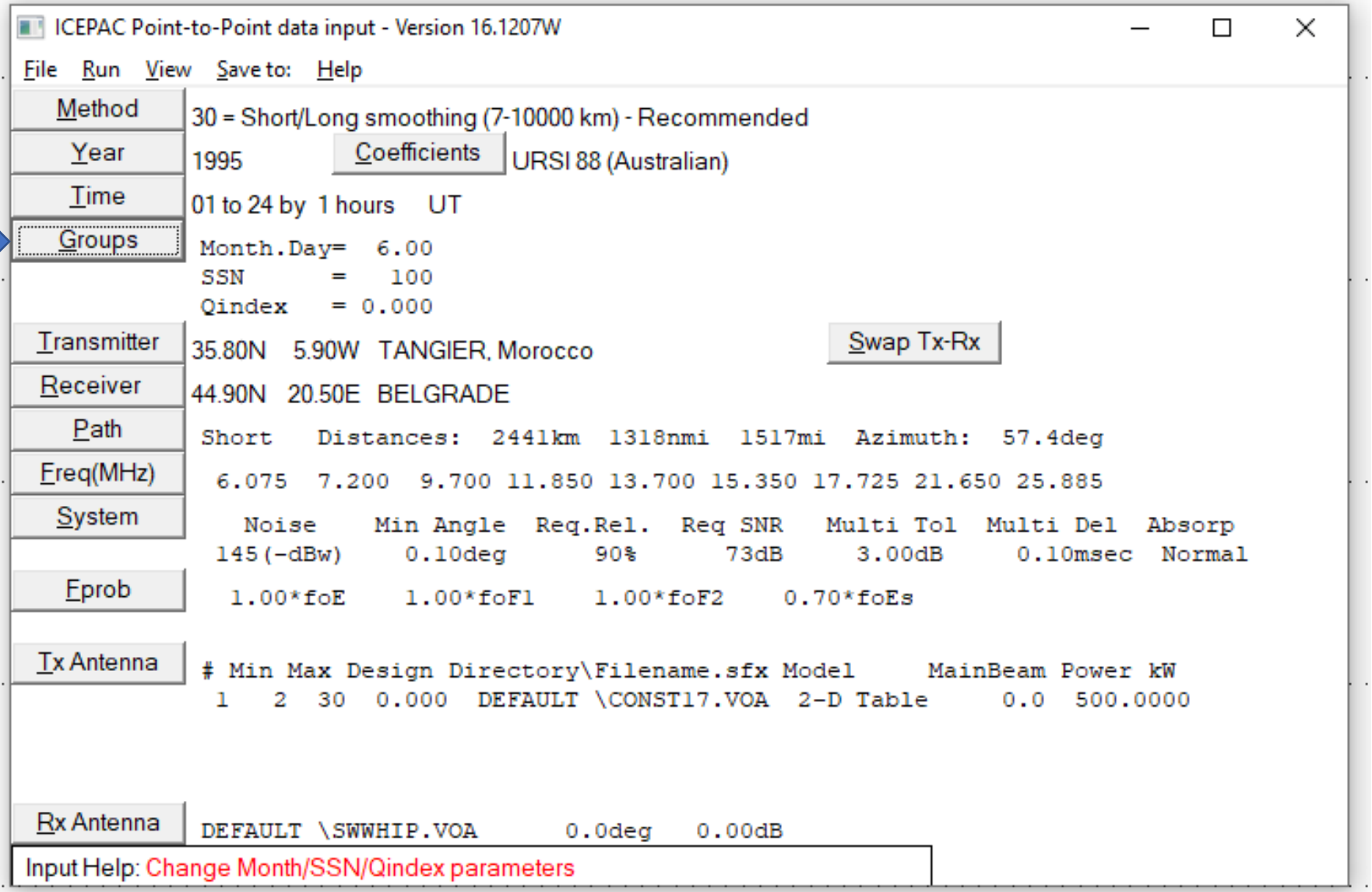


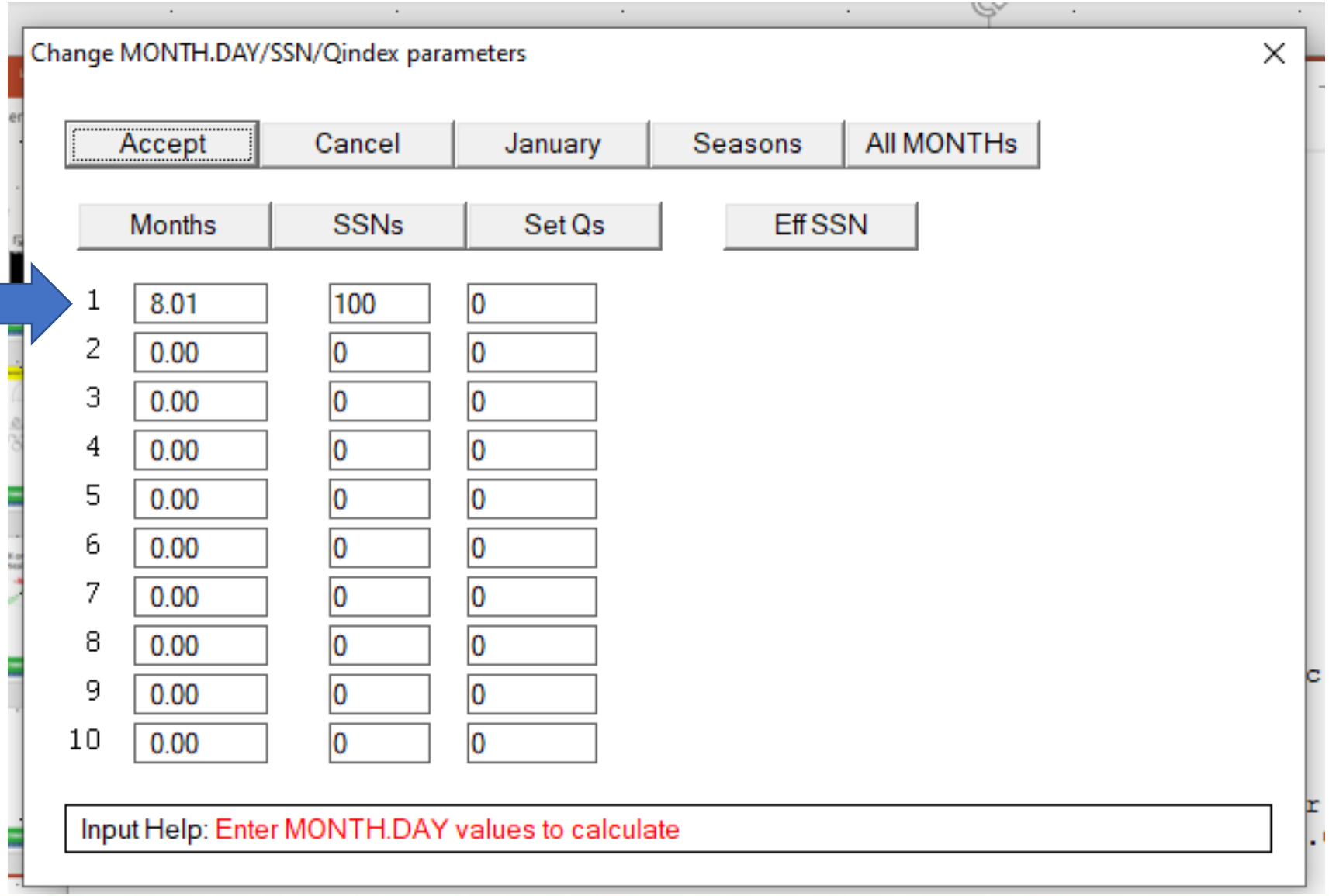
Q: Which antenna is best for DX on 40 meters? A half-wave dipole up 40 feet or a vertical with 4 radials?

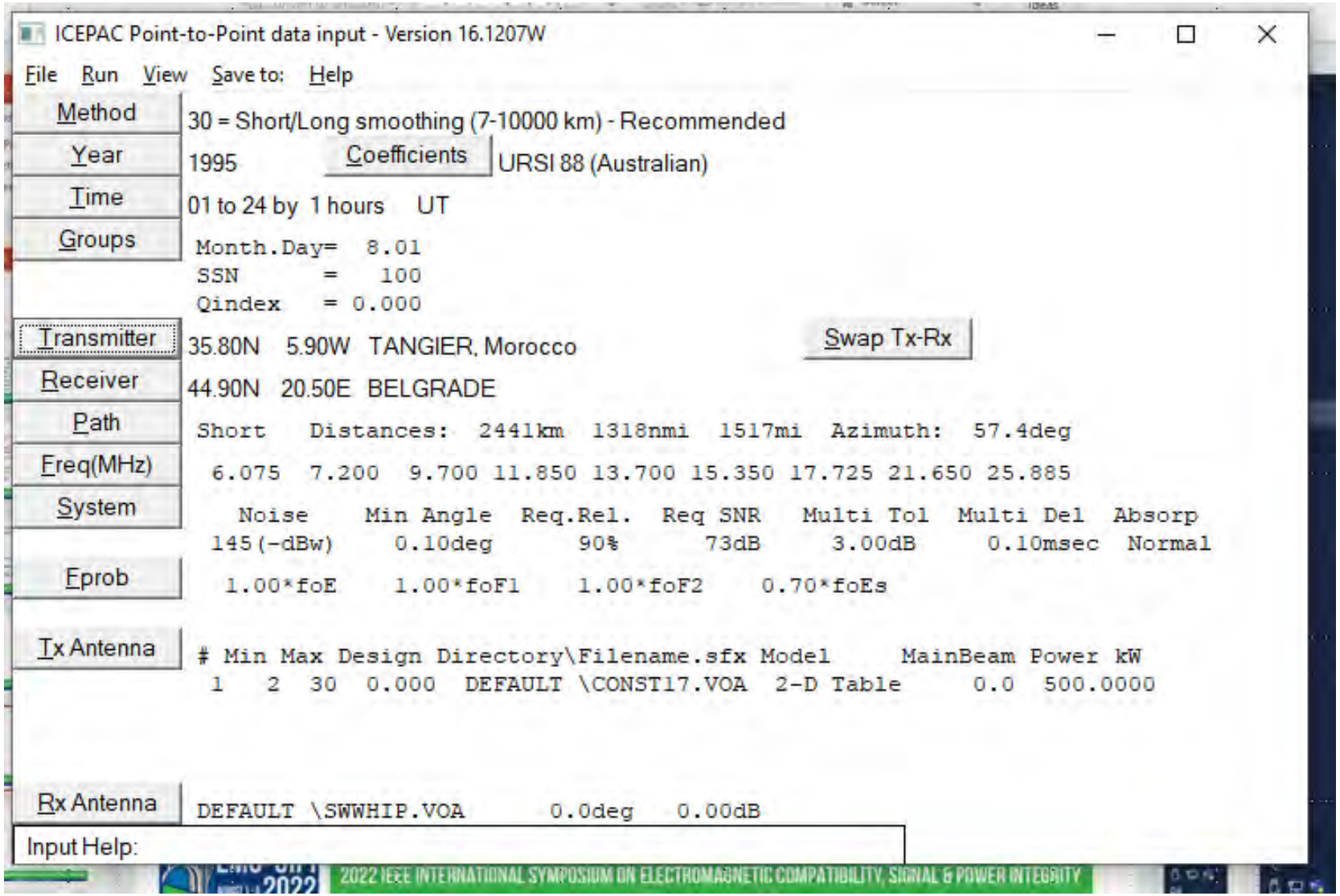
- **Show of hands!**
- **Lore vs science**
- **ITS HF BC software to predict propagation**
- **EZNEC antenna modeling software to show antenna performance**
- **Will use ITSHF to predict propagation angles**
- **Will use EZNEC to see what each antenna does at the predicted angles**

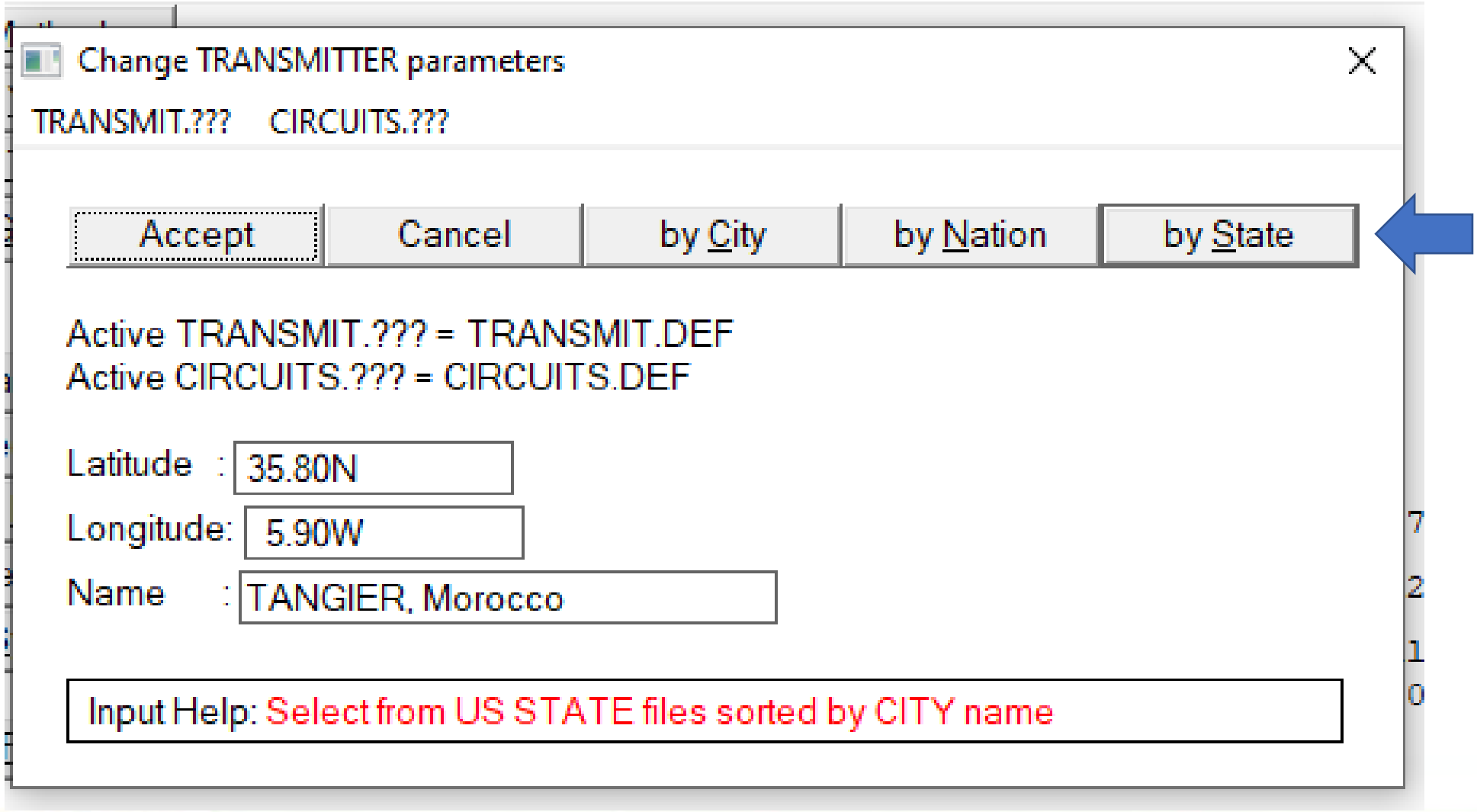


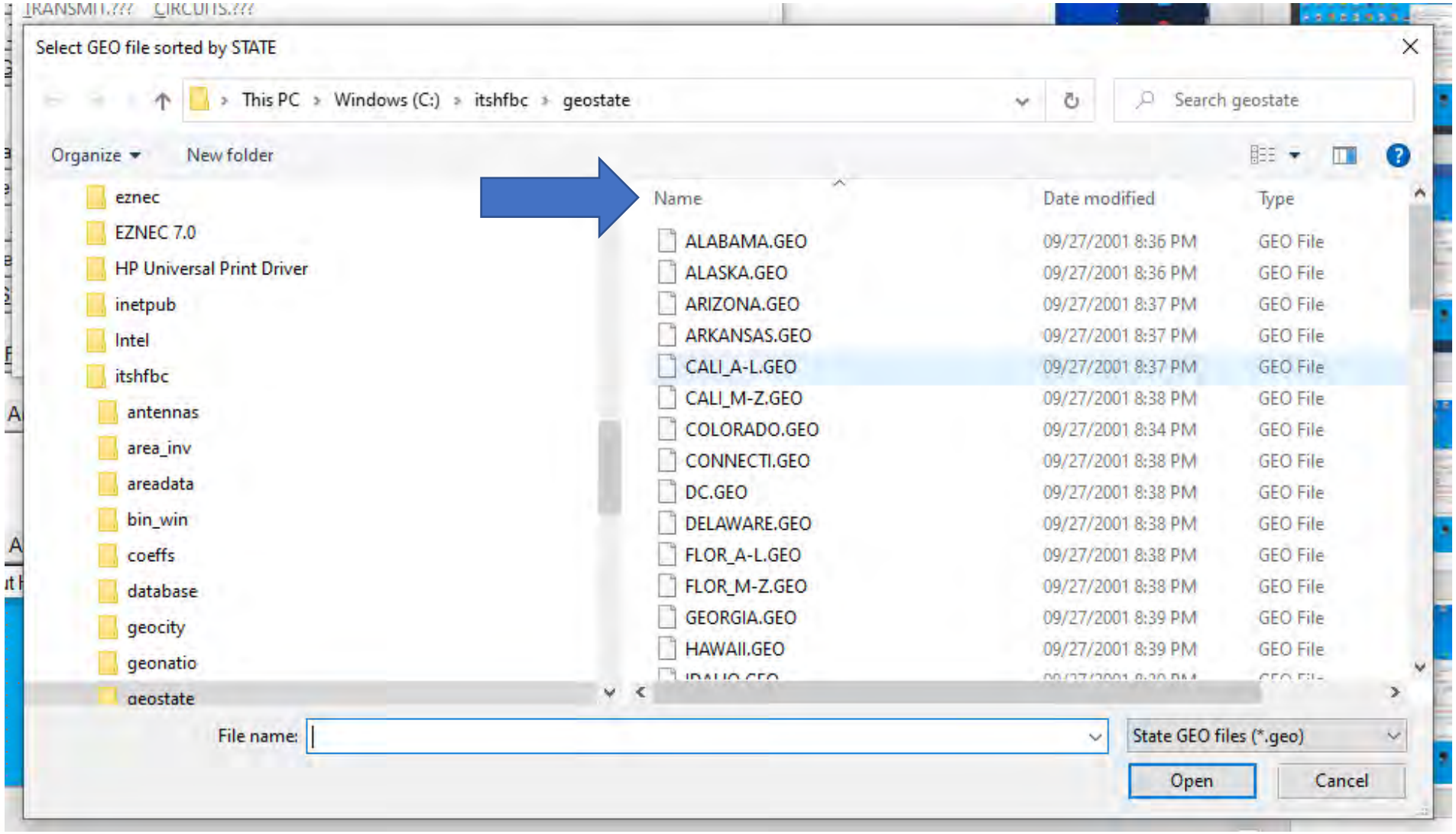


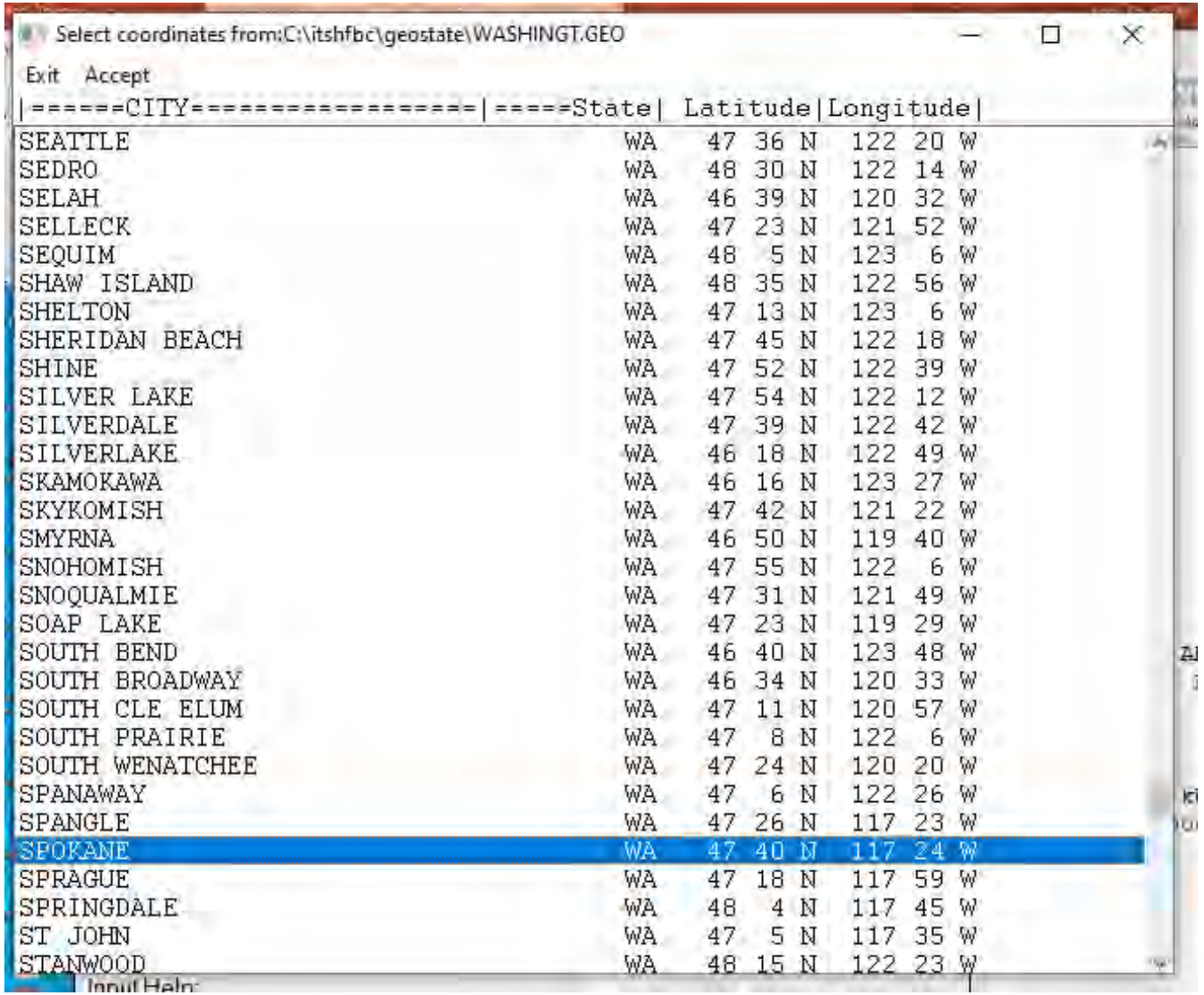

ICEPAC Point-to-Point data input - Version 16.1207W
File Run View Save to: Help
Method
30 = Short/Long smoothing (7-10000 km) - Recommended
Year
1995
Coefficients
URSI 88 (Australian)
Time
01 to 24 by 1 hours UT
Groups
Month.Day= 6.00
SSN = 100
Qindex = 0.000
Transmitter
35.80N 5.90W TANGIER, Morocco
Swap Tx-Rx
Receiver
44.90N 20.50E BELGRADE
Path
Short Distances: 2441km 1318nmi 1517mi Azimuth: 57.4deg
Freq(MHz)
6.075 7.200 9.700 11.850 13.700 15.350 17.725 21.650 25.885
System
Noise Min Angle Req.Rel. Req SNR Multi Tol Multi Del Absorp
145 (-dBw) 0.10deg 90% 73dB 3.00dB 0.10msec Normal
Fprob
1.00*foE 1.00*foF1 1.00*foF2 0.70*foEs
Tx Antenna
Min Max Design Directory\Filename.sfx Model MainBeam Power kW
1 2 30 0.000 DEFAULT \CONST17.VOA 2-D Table 0.0 500.0000
Rx Antenna
DEFAULT \SWWHIP.VOA 0.0deg 0.00dB
Input Help: Change Month/SSN/Qindex parameters


Change MONTH.DAY/SSN/Qindex parameters
Accept
Cancel
January
Seasons
All MONTHs
Months
SSNs
Set Qs
Eff SSN
1 8.01 100 0
2 0.00 0 0
3 0.00 0 0
4 0.00 0 0
5 0.00 0 0
6 0.00 0 0
7 0.00 0 0
8 0.00 0 0
9 0.00 0 0
10 0.00 0 0
Input Help: Enter MONTH.DAY values to calculate

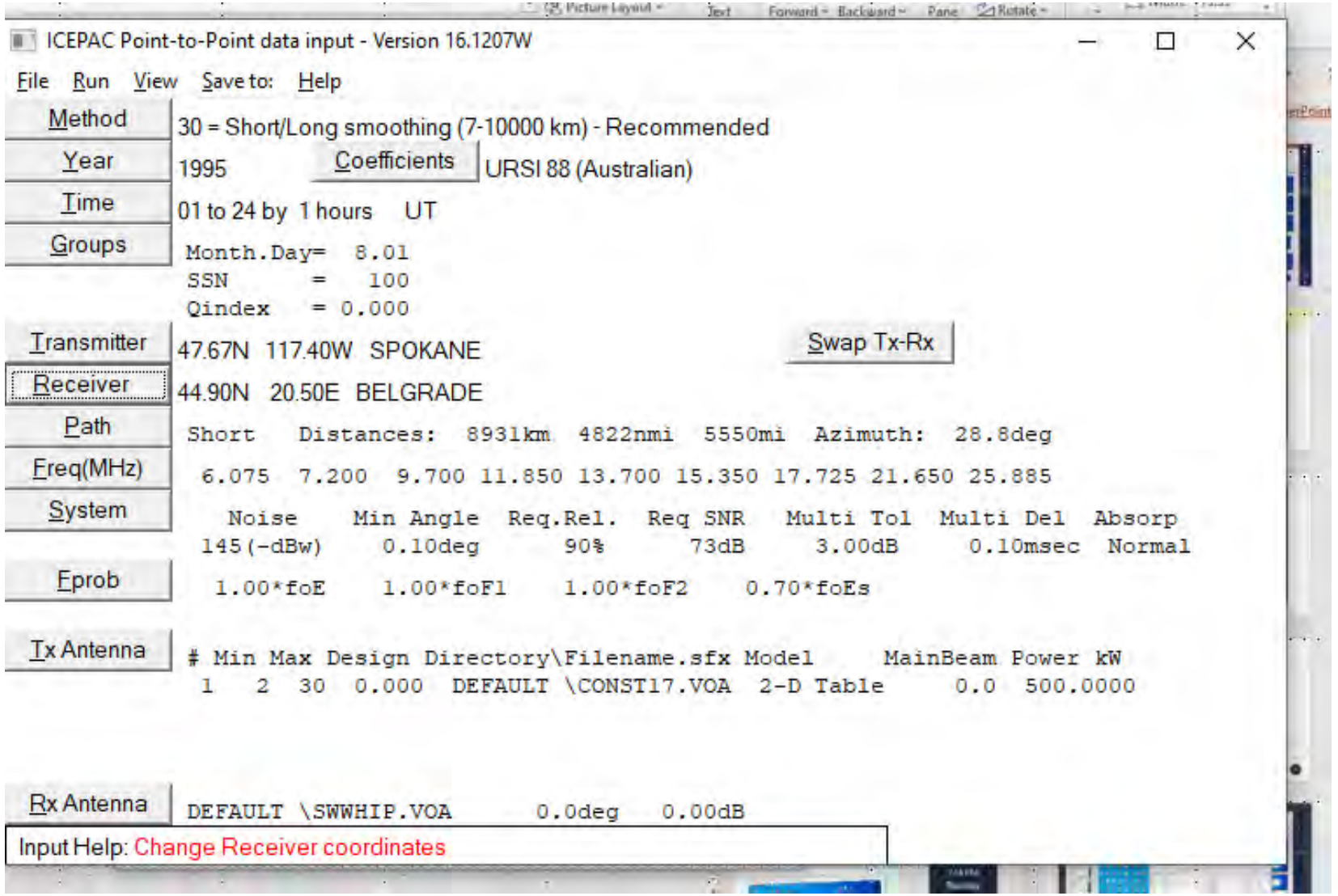

ICEPAC Point-to-Point data input - Version 16.1207W
File Run View Save to: Help
Method
30 = Short/Long smoothing (7-10000 km) - Recommended
Year
1995
Coefficients
URSI 88 (Australian)
Time
01 to 24 by 1 hours UT
Groups
Month.Day= 8.01
SSN = 100
Qindex = 0.000
Transmitter
35.80N 5.90W TANGIER, Morocco
Swap Tx-Rx
Receiver
44.90N 20.50E BELGRADE
Path
Short Distances: 2441km 1318nmi 1517mi Azimuth: 57.4deg
Freq(MHz)
6.075 7.200 9.700 11.850 13.700 15.350 17.725 21.650 25.885
System
Noise Min Angle Req.Rel. Req SNR Multi Tol Multi Del Absorp
145(-dBw) 0.10deg 90% 73dB 3.00dB 0.10msec Normal
Eprob
1.00*foE 1.00*foF1 1.00*foF2 0.70*foEs
Tx Antenna
Min Max Design Directory\Filename.sfx Model MainBeam Power kW
1 2 30 0.000 DEFAULT \CONST17.VOA 2-D Table 0.0 500.0000
Rx Antenna
DEFAULT \SWWHIP.VOA 0.0deg 0.00dB
Input Help:

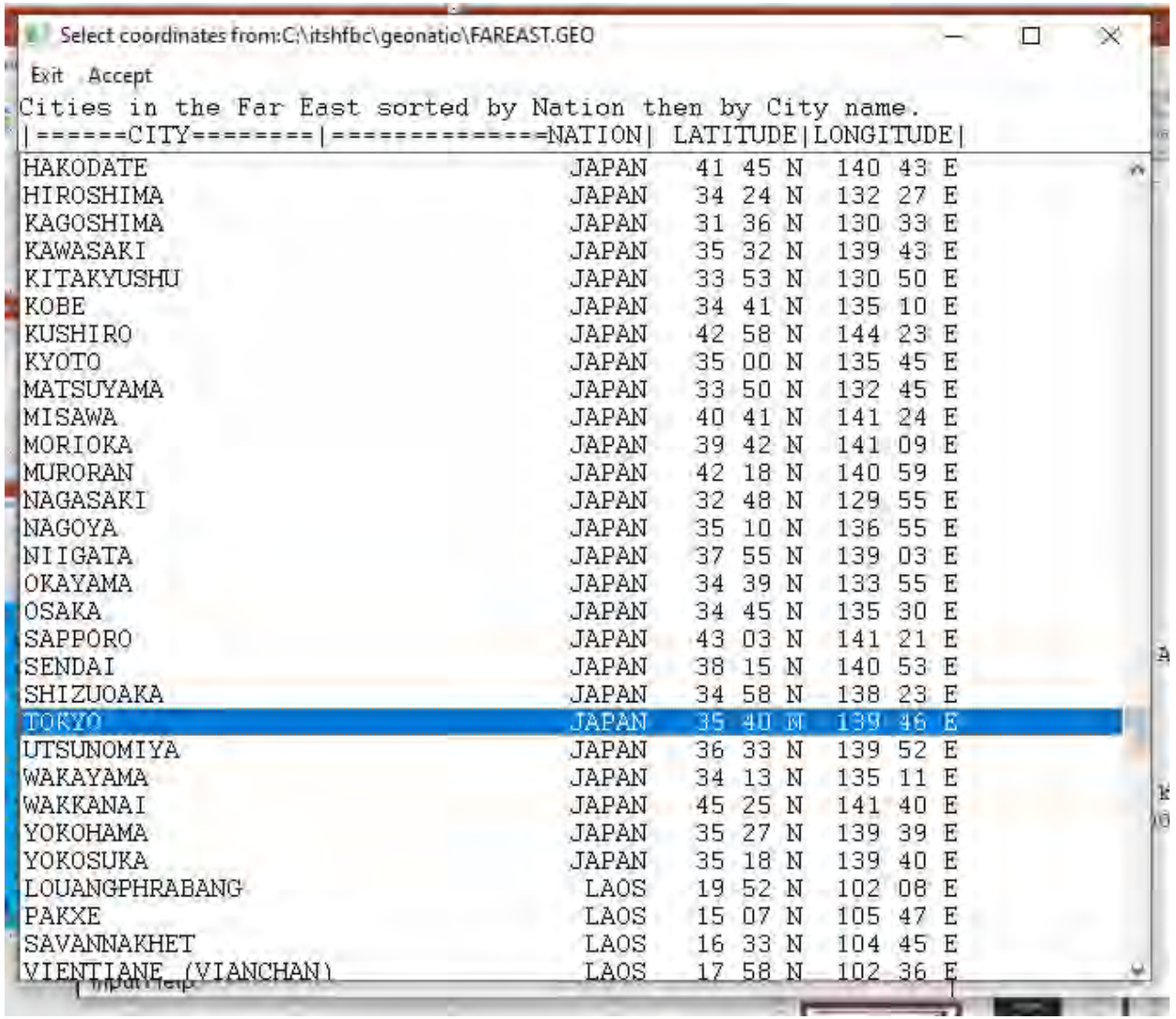

Change TRANSMITTER parameters
TRANSMIT.???
CIRCUITS.???
Accept
Cancel
by City
by Nation
by State
Active TRANSMIT.??? = TRANSMIT.DEF
Active CIRCUITS.??? = CIRCUITS.DEF
Latitude : 35.80N
Longitude: 5.90W
Name : TANGIER, Morocco
Input Help: Select from US STATE files sorted by CITY name

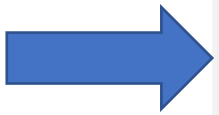

Select GEO file sorted by STATE
This PC › Windows (C:) › itshfbc › geostate
Search geostate
Organize
New folder
eznec
EZNEC 7.0
HP Universal Print Driver
inetpub
Intel
itshfbc
antennas
area_inv
areadata
bin_win
coeffs
database
geocity
geonatio
geostate
Name
Date modified
Type
ALABAMA.GEO 09/27/2001 8:36 PM GEO File
ALASKA.GEO 09/27/2001 8:36 PM GEO File
ARIZONA.GEO 09/27/2001 8:37 PM GEO File
ARKANSAS.GEO 09/27/2001 8:37 PM GEO File
CALI_A-L.GEO 09/27/2001 8:37 PM GEO File
CALI_M-Z.GEO 09/27/2001 8:38 PM GEO File
COLORADO.GEO 09/27/2001 8:34 PM GEO File
CONNECTI.GEO 09/27/2001 8:38 PM GEO File
DC.GEO 09/27/2001 8:38 PM GEO File
DELAWARE.GEO 09/27/2001 8:38 PM GEO File
FLOR_A-L.GEO 09/27/2001 8:38 PM GEO File
FLOR_M-Z.GEO 09/27/2001 8:38 PM GEO File
GEORGIA.GEO 09/27/2001 8:39 PM GEO File
HAWAII.GEO 09/27/2001 8:39 PM GEO File
File name:
State GEO files (*.geo)
Open
Cancel



======CITY=================	=====State	Latitude	Longitude
SEATTLE	WA	47 36 N	122 20 W
SEDRO	WA	48 30 N	122 14 W
SELAH	WA	46 39 N	120 32 W
SELLECK	WA	47 23 N	121 52 W
SEQUIM	WA	48 5 N	123 6 W
SHAW ISLAND	WA	48 35 N	122 56 W
SHELTON	WA	47 13 N	123 6 W
SHERIDAN BEACH	WA	47 45 N	122 18 W
SHINE	WA	47 52 N	122 39 W
SILVER LAKE	WA	47 54 N	122 12 W
SILVERDALE	WA	47 39 N	122 42 W
SILVERLAKE	WA	46 18 N	122 49 W
SKAMOKAWA	WA	46 16 N	123 27 W
SKYKOMISH	WA	47 42 N	121 22 W
SMYRNA	WA	46 50 N	119 40 W
SNOHOMISH	WA	47 55 N	122 6 W
SNOQUALMIE	WA	47 31 N	121 49 W
SOAP LAKE	WA	47 23 N	119 29 W
SOUTH BEND	WA	46 40 N	123 48 W
SOUTH BROADWAY	WA	46 34 N	120 33 W
SOUTH CLE ELUM	WA	47 11 N	120 57 W
SOUTH PRAIRIE	WA	47 8 N	122 6 W
SOUTH WENATCHEE	WA	47 24 N	120 20 W
SPANAWAY	WA	47 6 N	122 26 W
SPANGLE	WA	47 26 N	117 23 W
SPOKANE	WA	47 40 N	117 24 W
SPRAGUE	WA	47 18 N	117 59 W
SPRINGDALE	WA	48 4 N	117 45 W
ST JOHN	WA	47 5 N	117 35 W
STANWOOD	WA	48 15 N	122 23 W


ICEPAC Point-to-Point data input - Version 16.1207W
File Run View Save to: Help
Method
30 = Short/Long smoothing (7-10000 km) - Recommended
Year
1995
Coefficients
URSI 88 (Australian)
Time
01 to 24 by 1 hours UT
Groups
Month.Day= 8.01
SSN = 100
Qindex = 0.000
Transmitter
47.67N 117.40W SPOKANE
Swap Tx-Rx
Receiver
44.90N 20.50E BELGRADE
Path
Short Distances: 8931km 4822nmi 5550mi Azimuth: 28.8deg
Freq(MHz)
6.075 7.200 9.700 11.850 13.700 15.350 17.725 21.650 25.885
System
Noise Min Angle Req.Rel. Req SNR Multi Tol Multi Del Absorp
145 (-dBw) 0.10deg 90% 73dB 3.00dB 0.10msec Normal
Eprob
1.00*foE 1.00*foF1 1.00*foF2 0.70*foEs
Tx Antenna
Min Max Design Directory\Filename.sfx Model MainBeam Power kW
1 2 30 0.000 DEFAULT \CONST17.VOA 2-D Table 0.0 500.0000
Rx Antenna
DEFAULT \SWWHIP.VOA 0.0deg 0.00dB
Input Help: Change Receiver coordinates


Select coordinates from:C:\itshfbc\geonatio\FAREAST.GEO
Exit Accept
Cities in the Far East sorted by Nation then by City name.
|======CITY========|==============NATION| LATITUDE|LONGITUDE|
HAKODATE JAPAN 41 45 N 140 43 E
HIROSHIMA JAPAN 34 24 N 132 27 E
KAGOSHIMA JAPAN 31 36 N 130 33 E
KAWASAKI JAPAN 35 32 N 139 43 E
KITAKYUSHU JAPAN 33 53 N 130 50 E
KOBE JAPAN 34 41 N 135 10 E
KUSHIRO JAPAN 42 58 N 144 23 E
KYOTO JAPAN 35 00 N 135 45 E
MATSUYAMA JAPAN 33 50 N 132 45 E
MISAWA JAPAN 40 41 N 141 24 E
MORIOKA JAPAN 39 42 N 141 09 E
MURORAN JAPAN 42 18 N 140 59 E
NAGASAKI JAPAN 32 48 N 129 55 E
NAGOYA JAPAN 35 10 N 136 55 E
NIIGATA JAPAN 37 55 N 139 03 E
OKAYAMA JAPAN 34 39 N 133 55 E
OSAKA JAPAN 34 45 N 135 30 E
SAPPORO JAPAN 43 03 N 141 21 E
SENDAI JAPAN 38 15 N 140 53 E
SHIZUOAKA JAPAN 34 58 N 138 23 E
TOKYO JAPAN 35 40 N 139 46 E
UTSUNOMIYA JAPAN 36 33 N 139 52 E
WAKAYAMA JAPAN 34 13 N 135 11 E
WAKKANAI JAPAN 45 25 N 141 40 E
YOKOHAMA JAPAN 35 27 N 139 39 E
YOKOSUKA JAPAN 35 18 N 139 40 E
LOUANGPHRABANG LAOS 19 52 N 102 08 E
PAKXE LAOS 15 07 N 105 47 E
SAVANNAKHET LAOS 16 33 N 104 45 E
VIENTIANE (VIANCHAN) LAOS 17 58 N 102 36 E



ICEPAC Point-to-Point data input - Version 16.1207W

File Run View Save to: Help

Method — 30 = Short/Long smoothing (7-10000 km) - Recommended

Year — 1995 — Coefficients — URSI 88 (Australian)

Time — 01 to 24 by 1 hours UT

Groups

```
Month.Day=   6.00
SSN      =    100
Qindex   = 0.000
```

Transmitter — 35.80N 5.90W TANGIER, Morocco — Swap Tx-Rx

Receiver — 44.90N 20.50E BELGRADE

Path

```
Short   Distances:  2441km  1318nmi  1517mi  Azimuth:  57.4deg
```

Freq(MHz)

```
 6.075  7.200  9.700 11.850 13.700 15.350 17.725 21.650 25.885
```

System

```
   Noise     Min Angle  Req.Rel.  Req SNR   Multi Tol  Multi Del  Absorp
145 (-dBw)    0.10deg      90%      73dB      3.00dB     0.10msec  Normal
```

Fprob

```
 1.00*foE    1.00*foF1    1.00*foF2    0.70*foEs
```

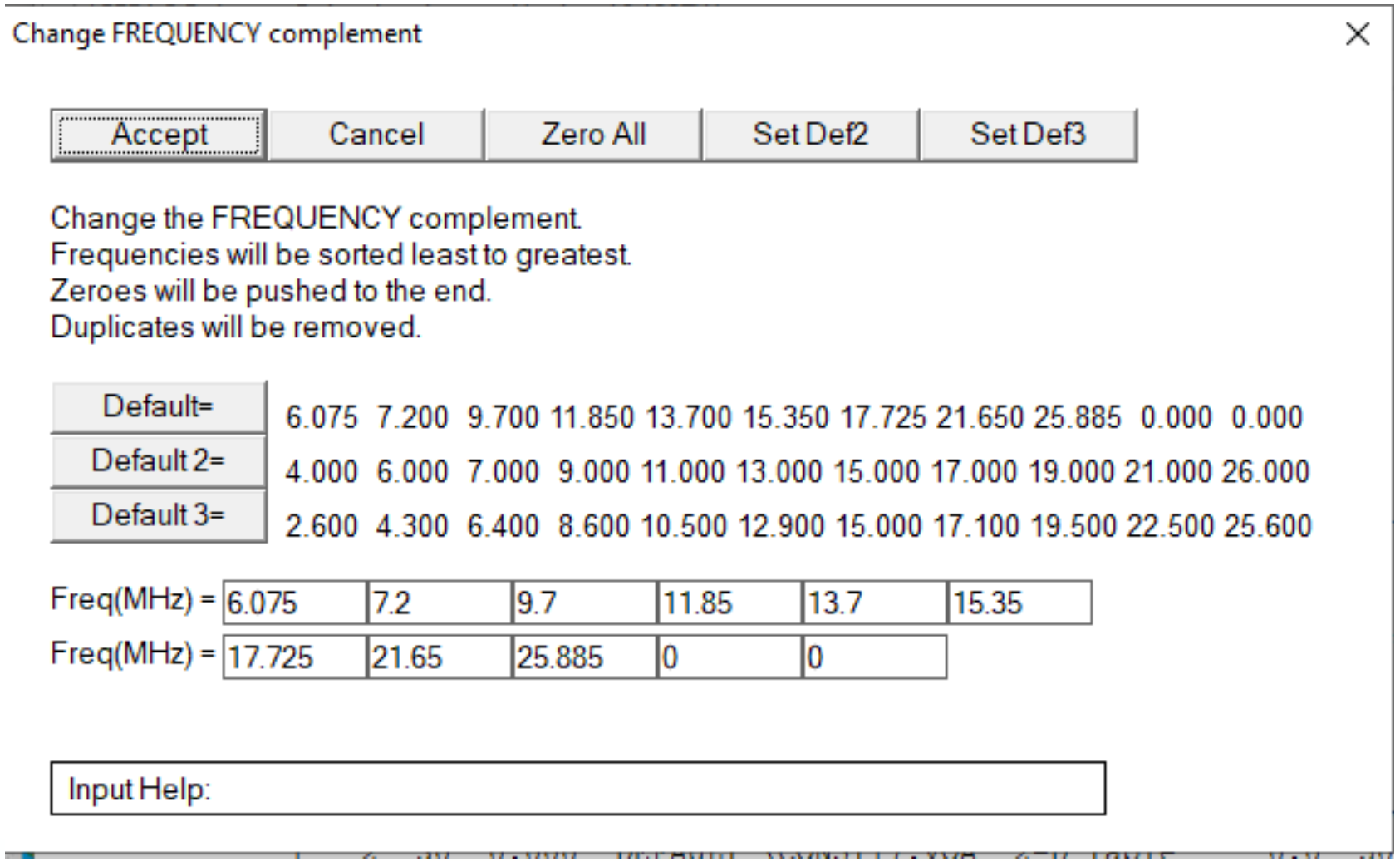
Tx Antenna

```
# Min Max Design Directory\Filename.sfx Model     MainBeam Power kW
 1   2   30  0.000  DEFAULT \CONST17.VOA  2-D Table     0.0  500.0000
```

Rx Antenna

```
DEFAULT \SWWHIP.VOA      0.0deg    0.00dB
```

Input Help: Change Month/SSN/Qindex parameters


Change FREQUENCY complement
Accept
Cancel
Zero All
Set Def2
Set Def3
Change the FREQUENCY complement.
Frequencies will be sorted least to greatest.
Zeroes will be pushed to the end.
Duplicates will be removed.
Default=
6.075 7.200 9.700 11.850 13.700 15.350 17.725 21.650 25.885 0.000 0.000
Default 2=
4.000 6.000 7.000 9.000 11.000 13.000 15.000 17.000 19.000 21.000 26.000
Default 3=
2.600 4.300 6.400 8.600 10.500 12.900 15.000 17.100 19.500 22.500 25.600
Freq(MHz) = 6.075 7.2 9.7 11.85 13.7 15.35
Freq(MHz) = 17.725 21.65 25.885 0 0
Input Help:

ICEPAC Point-to-Point data input - Version 16.1207W

File Run View Save to: Help

Method — 30 = Short/Long smoothing (7-10000 km) - Recommended

Year — 1995 — Coefficients — URSI 88 (Australian)

Time — 01 to 24 by 1 hours UT

Groups

```
Month.Day=   6.00
SSN      =    100
Qindex   = 0.000
```

Transmitter — 35.80N 5.90W TANGIER, Morocco — Swap Tx-Rx

Receiver — 44.90N 20.50E BELGRADE

Path

```
Short   Distances:  2441km  1318nmi  1517mi  Azimuth:  57.4deg
```

Freq(MHz)

```
 6.075  7.200  9.700 11.850 13.700 15.350 17.725 21.650 25.885
```

System

```
   Noise     Min Angle  Req.Rel.  Req SNR   Multi Tol  Multi Del  Absorp
145 (-dBw)    0.10deg      90%      73dB      3.00dB     0.10msec  Normal
```

Fprob

```
 1.00*foE    1.00*foF1    1.00*foF2    0.70*foEs
```

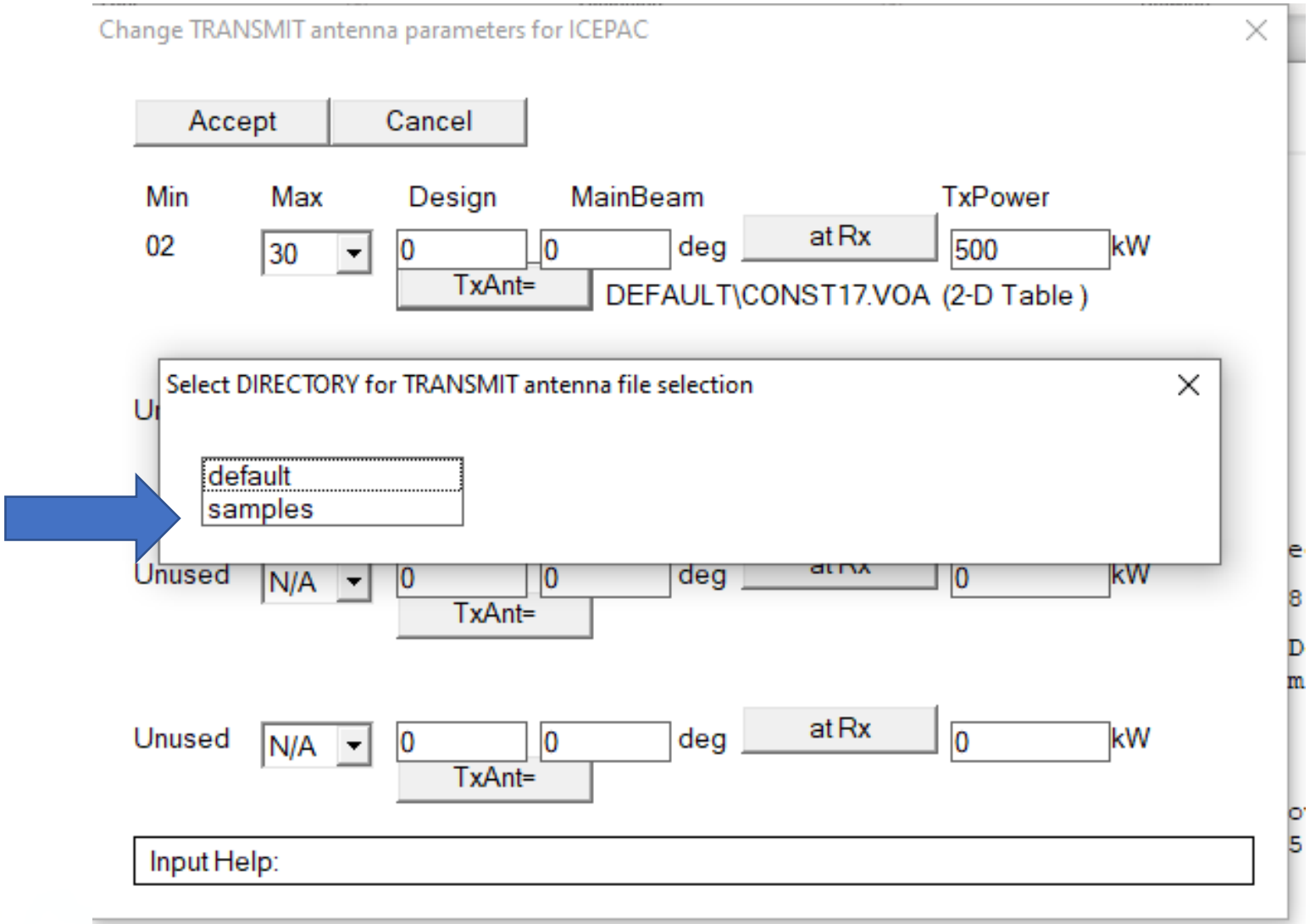
Tx Antenna

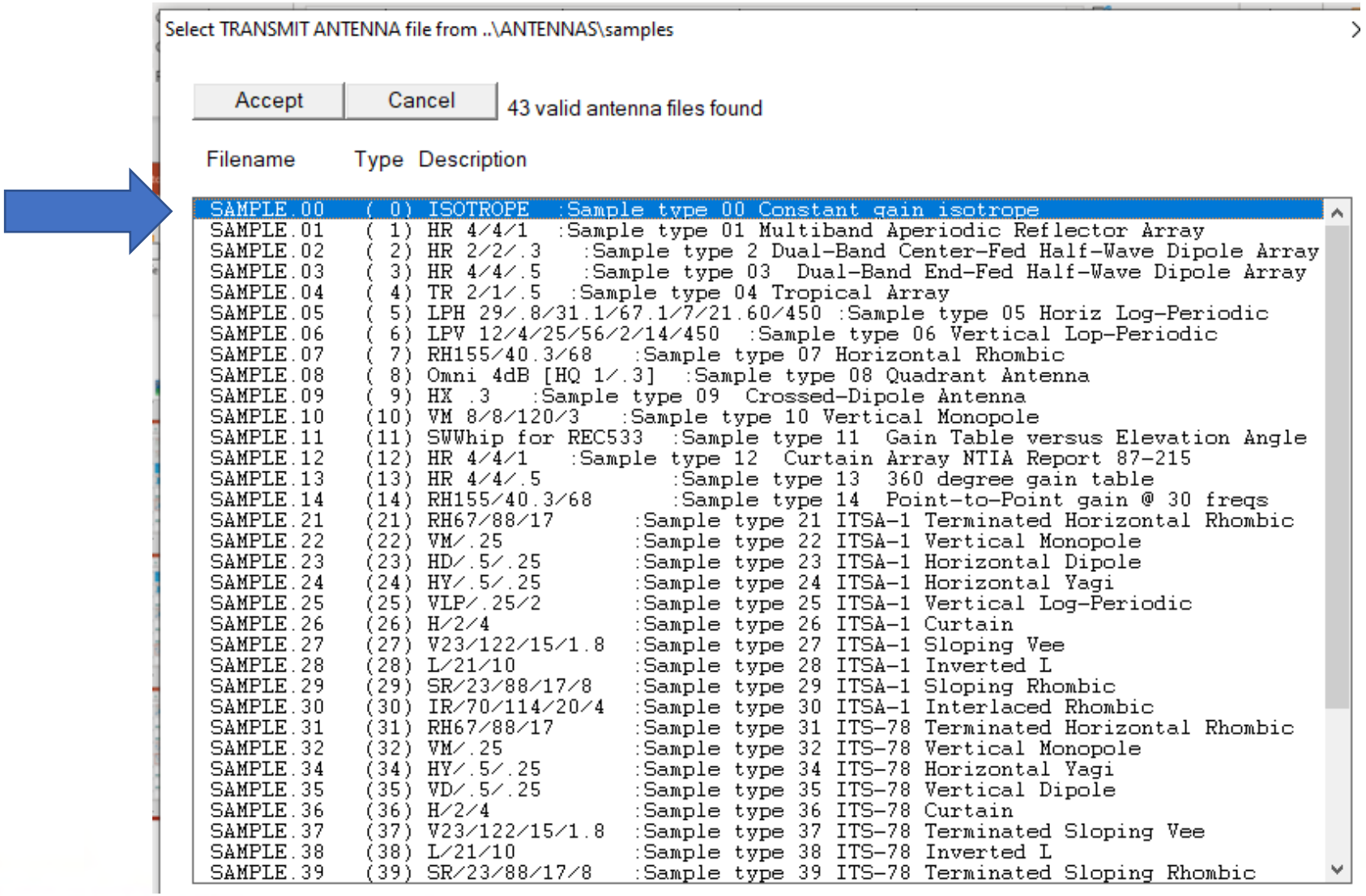
```
# Min Max Design Directory\Filename.sfx Model     MainBeam Power kW
 1   2   30  0.000  DEFAULT \CONST17.VOA  2-D Table     0.0  500.0000
```

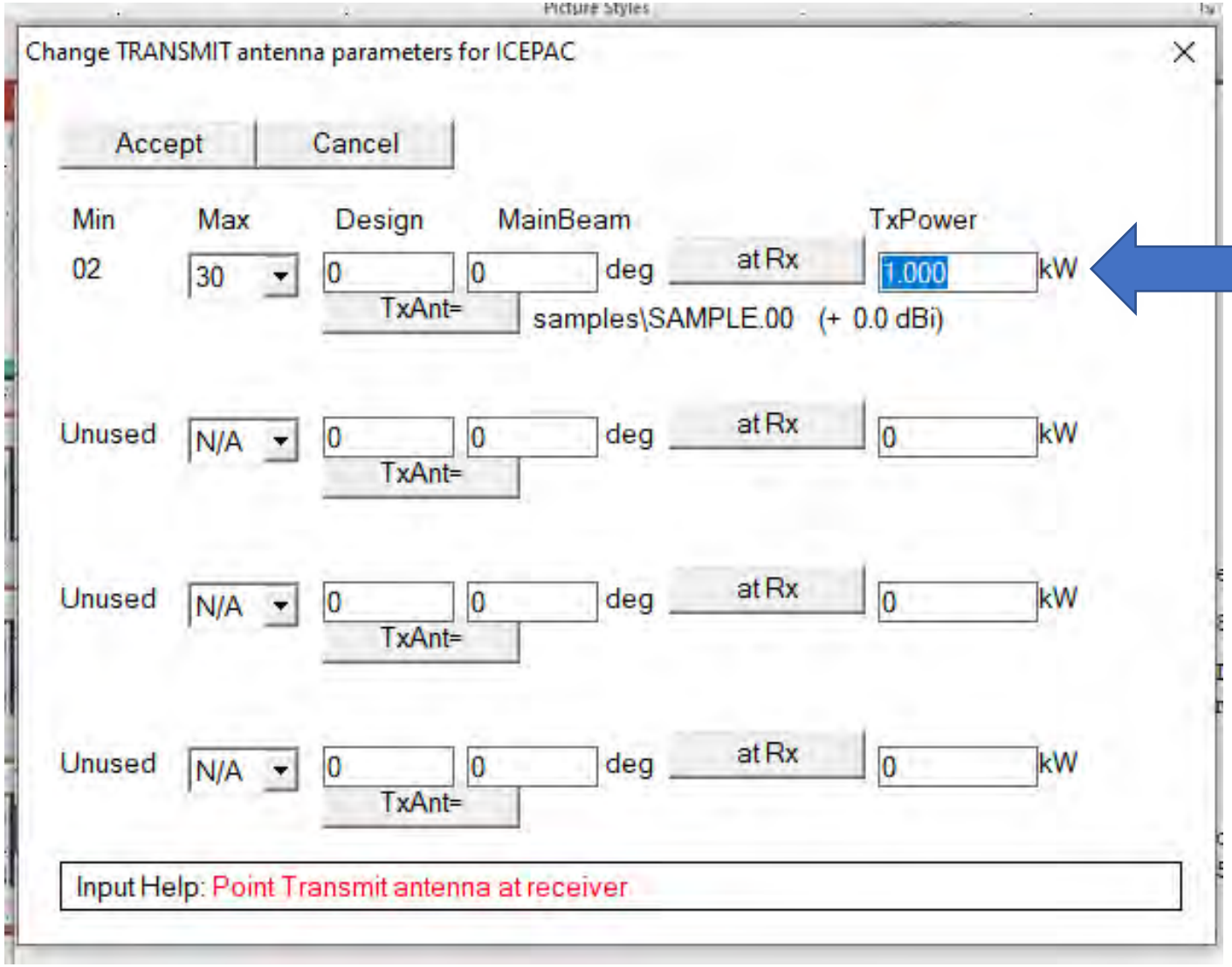
Rx Antenna

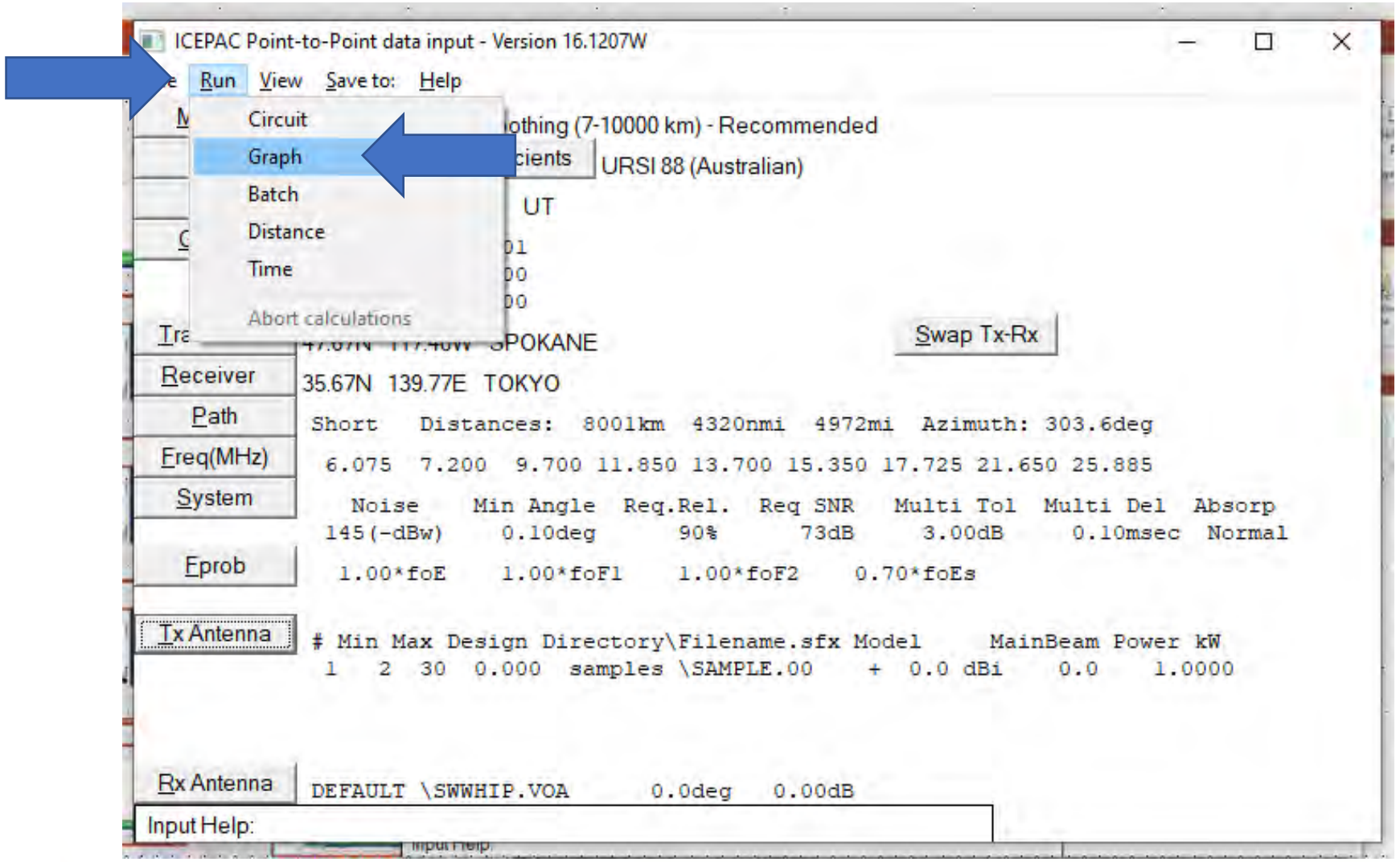
```
DEFAULT \SWWHIP.VOA      0.0deg    0.00dB
```

Input Help: Change Month/SSN/Qindex parameters


Change TRANSMIT antenna parameters for ICEPAC
Accept
Cancel
Min
Max
Design
MainBeam
TxPower
02
30
0
0
deg
at Rx
500
kW
TxAnt=
DEFAULT\CONST17.VOA (2-D Table)
Select DIRECTORY for TRANSMIT antenna file selection
default
samples
Unused
N/A
0
0
deg
at Rx
0
kW
TxAnt=
Unused
N/A
0
0
deg
at Rx
0
kW
TxAnt=
Input Help:


Select TRANSMIT ANTENNA file from ..\ANTENNAS\samples
Accept
Cancel
43 valid antenna files found
Filename Type Description
SAMPLE.00 (0) ISOTROPE :Sample type 00 Constant gain isotrope
SAMPLE.01 (1) HR 4/4/1 :Sample type 01 Multiband Aperiodic Reflector Array
SAMPLE.02 (2) HR 2/2/.3 :Sample type 2 Dual-Band Center-Fed Half-Wave Dipole Array
SAMPLE.03 (3) HR 4/4/.5 :Sample type 03 Dual-Band End-Fed Half-Wave Dipole Array
SAMPLE.04 (4) TR 2/1/.5 :Sample type 04 Tropical Array
SAMPLE.05 (5) LPH 29/.8/31.1/67.1/7/21.60/450 :Sample type 05 Horiz Log-Periodic
SAMPLE.06 (6) LPV 12/4/25/56/2/14/450 :Sample type 06 Vertical Lop-Periodic
SAMPLE.07 (7) RH155/40.3/68 :Sample type 07 Horizontal Rhombic
SAMPLE.08 (8) Omni 4dB [HQ 1/.3] :Sample type 08 Quadrant Antenna
SAMPLE.09 (9) HX .3 :Sample type 09 Crossed-Dipole Antenna
SAMPLE.10 (10) VM 8/8/120/3 :Sample type 10 Vertical Monopole
SAMPLE.11 (11) SWWhip for REC533 :Sample type 11 Gain Table versus Elevation Angle
SAMPLE.12 (12) HR 4/4/1 :Sample type 12 Curtain Array NTIA Report 87-215
SAMPLE.13 (13) HR 4/4/.5 :Sample type 13 360 degree gain table
SAMPLE.14 (14) RH155/40.3/68 :Sample type 14 Point-to-Point gain @ 30 freqs
SAMPLE.21 (21) RH67/88/17 :Sample type 21 ITSA-1 Terminated Horizontal Rhombic
SAMPLE.22 (22) VM/.25 :Sample type 22 ITSA-1 Vertical Monopole
SAMPLE.23 (23) HD/.5/.25 :Sample type 23 ITSA-1 Horizontal Dipole
SAMPLE.24 (24) HY/.5/.25 :Sample type 24 ITSA-1 Horizontal Yagi
SAMPLE.25 (25) VLP/.25/2 :Sample type 25 ITSA-1 Vertical Log-Periodic
SAMPLE.26 (26) H/2/4 :Sample type 26 ITSA-1 Curtain
SAMPLE.27 (27) V23/122/15/1.8 :Sample type 27 ITSA-1 Sloping Vee
SAMPLE.28 (28) L/21/10 :Sample type 28 ITSA-1 Inverted L
SAMPLE.29 (29) SR/23/88/17/8 :Sample type 29 ITSA-1 Sloping Rhombic
SAMPLE.30 (30) IR/70/114/20/4 :Sample type 30 ITSA-1 Interlaced Rhombic
SAMPLE.31 (31) RH67/88/17 :Sample type 31 ITS-78 Terminated Horizontal Rhombic
SAMPLE.32 (32) VM/.25 :Sample type 32 ITS-78 Vertical Monopole
SAMPLE.34 (34) HY/.5/.25 :Sample type 34 ITS-78 Horizontal Yagi
SAMPLE.35 (35) VD/.5/.25 :Sample type 35 ITS-78 Vertical Dipole
SAMPLE.36 (36) H/2/4 :Sample type 36 ITS-78 Curtain
SAMPLE.37 (37) V23/122/15/1.8 :Sample type 37 ITS-78 Terminated Sloping Vee
SAMPLE.38 (38) L/21/10 :Sample type 38 ITS-78 Inverted L
SAMPLE.39 (39) SR/23/88/17/8 :Sample type 39 ITS-78 Terminated Sloping Rhombic


Change TRANSMIT antenna parameters for ICEPAC
Accept
Cancel
Min
Max
Design
MainBeam
TxPower
02
30
0
0
deg
at Rx
1.000
kW
TxAnt=
samples\SAMPLE.00 (+ 0.0 dBi)
Unused
N/A
0
0
deg
at Rx
0
kW
TxAnt=
Unused
N/A
0
0
deg
at Rx
0
kW
TxAnt=
Unused
N/A
0
0
deg
at Rx
0
kW
TxAnt=
Input Help: Point Transmit antenna at receiver

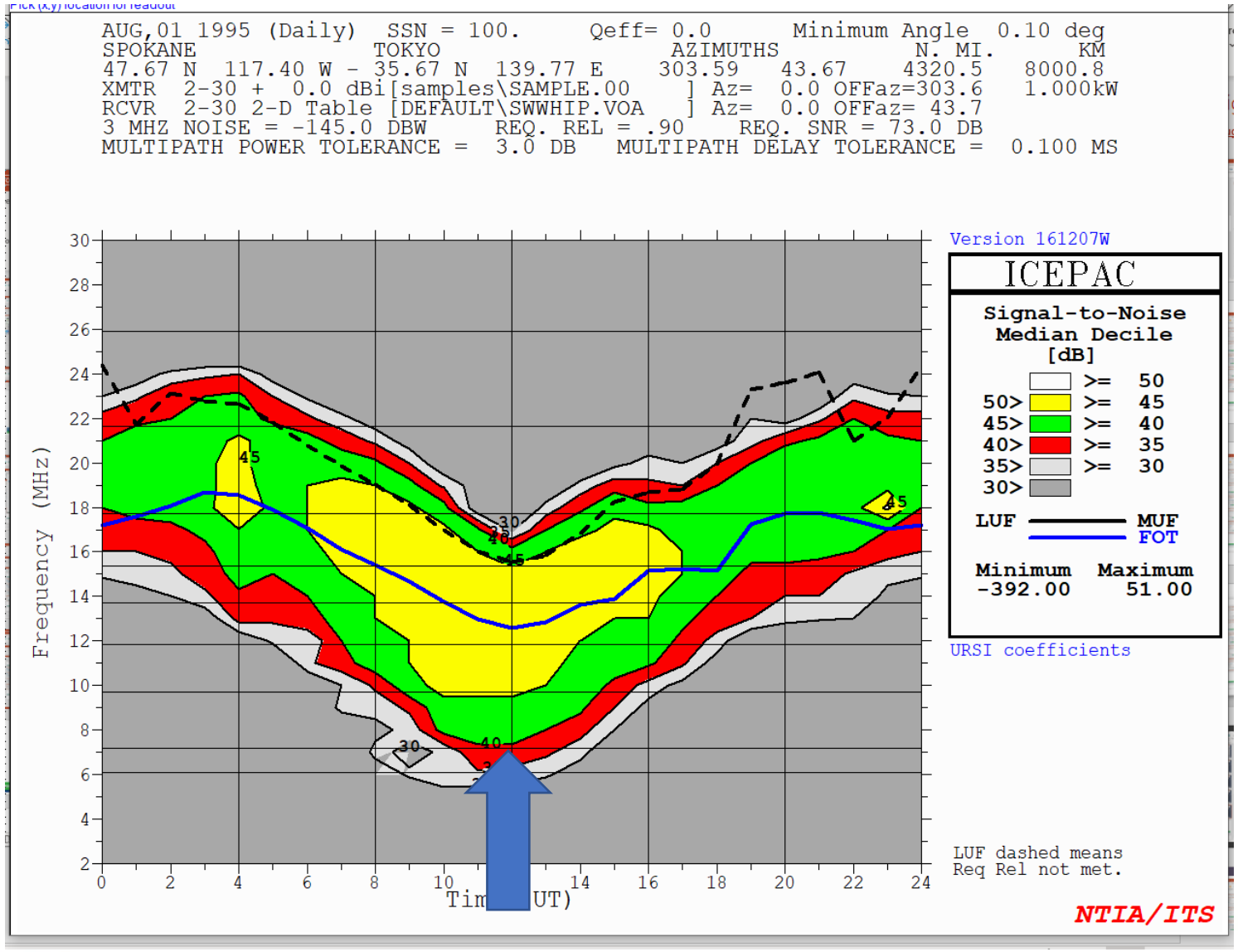

ICEPAC Point-to-Point data input - Version 16.1207W
Run
View
Save to:
Help
Circuit
Graph
Batch
Distance
Time
Abort calculations
Swap Tx-Rx
Receiver
Path
Freq(MHz)
System
Eprob
Tx Antenna
Rx Antenna
URSI 88 (Australian)
SPOKANE
35.67N 139.77E TOKYO
Short Distances: 8001km 4320nmi 4972mi Azimuth: 303.6deg
6.075 7.200 9.700 11.850 13.700 15.350 17.725 21.650 25.885
Noise Min Angle Req.Rel. Req SNR Multi Tol Multi Del Absorp
145(-dBw) 0.10deg 90% 73dB 3.00dB 0.10msec Normal
1.00*foE 1.00*foF1 1.00*foF2 0.70*foEs
Min Max Design Directory\Filename.sfx Model MainBeam Power kW
1 2 30 0.000 samples \SAMPLE.00 + 0.0 dBi 0.0 1.0000
DEFAULT \SWWHIP.VOA 0.0deg 0.00dB
Input Help:

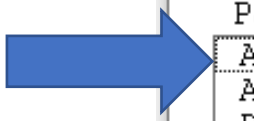
Select PARAMETER to plot from: Group # 1 8.01 100ssn 0.00Q

Exit

Group # 1 8.01 100ssn 0.00Q

Parameter	[Minimum/Maximum]
ANGLE = Radiation angle (degrees)	[0.50/ 28.00]
ANGLER= Receiver Radiation angle (degrees)	[0.50/ 28.00]
DELAY = Time delay (milliseconds)	[26.90/ 32.60]
VHITE = Virtual height (km)	[70.00/ 598.00]
MUFday= % of days/month sky-wave propagation expected at MUF	[0.00/ 100.00]
LOSS = Median system loss (dB)	[150.00/ 566.00]
DBU = Median field strength at receive location (dBu)	[-411.00/ 8.00]
SDBW = Median signal power at receiver (dBW)	[-536.00/-120.00]
NDBW = Median noise power at receiver (dBW)	[-177.00/-136.00]
SNR = Median signal-to-noise ratio (dB)	[-392.00/ 51.00]
RPWRG = Required power & antenna gain to achieve reliab (dB)	[39.00/ 478.00]
REL = Time availability, % time SNR exceeds required SNR	[0.00/ 3.00]
MPROB = Probability additional mode in multipath tolerances	[0.00/ 0.00]
SPRB = Service probability, required reliabilty will be met	[0.00/ 8.00]
SIGLW = Lower decile signal pwr (field strength & loss) (dB)	[0.70/ 25.00]
SIGUP = Upper decile signal pwr (field strength & loss) (dB)	[0.50/ 25.00]
SNRLW = Lower decile SNR increment (dB)	[7.00/ 26.80]
SNRUP = Upper decile SNR increment (dB)	[5.40/ 25.70]
TGAIN = Transmitter Antenna Gain (dB)	[0.00/ 0.00]
RGAIN = Receiver Antenna Gain (dB)	[-17.00/ 0.00]
SNRxx = Signal-to-Noise ratio (dB) at Req. Rel.	[-405.00/ 34.00]
DBM = Median signal power at receiver (dBm)	[-506.00/ -90.00]


AUG,01 1995 (Daily) SSN = 100. Qeff= 0.0 Minimum Angle 0.10 deg
SPOKANE TOKYO AZIMUTHS N. MI. KM
47.67 N 117.40 W - 35.67 N 139.77 E 303.59 43.67 4320.5 8000.8
XMTR 2-30 + 0.0 dBi[samples\SAMPLE.00] Az= 0.0 OFFaz=303.6 1.000kW
RCVR 2-30 2-D Table [DEFAULT\SWWHIP.VOA] Az= 0.0 OFFaz= 43.7
3 MHZ NOISE = -145.0 DBW REQ. REL = .90 REQ. SNR = 73.0 DB
MULTIPATH POWER TOLERANCE = 3.0 DB MULTIPATH DELAY TOLERANCE = 0.100 MS
Frequency (MHz)
Tim UT)
Version 161207W
ICEPAC
Signal-to-Noise
Median Decile
[dB]
>= 50
50> >= 45
45> >= 40
40> >= 35
35> >= 30
30>
LUF MUF
FOT
Minimum Maximum
-392.00 51.00
URSI coefficients
LUF dashed means
Req Rel not met.
NTIA/ITS



Select PARAMETER to plot from: Group # 1 8.01 100ssn 0.00Q

Exit

Group # 1 8.01 100ssn 0.00Q

Parameter	[Minimum/Maximum]
ANGLE = Radiation angle (degrees)	[0.50/ 28.00]
ANGLER= Receiver Radiation angle (degrees)	[0.50/ 28.00]
DELAY = Time delay (milliseconds)	[26.90/ 32.60]
VHITE = Virtual height (km)	[70.00/ 598.00]
MUFday= % of days/month sky-wave propagation expected at MUF	[0.00/ 100.00]
LOSS = Median system loss (dB)	[150.00/ 566.00]
DBU = Median field strength at receive location (dBu)	[-411.00/ 8.00]
SDBW = Median signal power at receiver (dBW)	[-536.00/-120.00]
NDBW = Median noise power at receiver (dBW)	[-177.00/-136.00]
SNR = Median signal-to-noise ratio (dB)	[-392.00/ 51.00]
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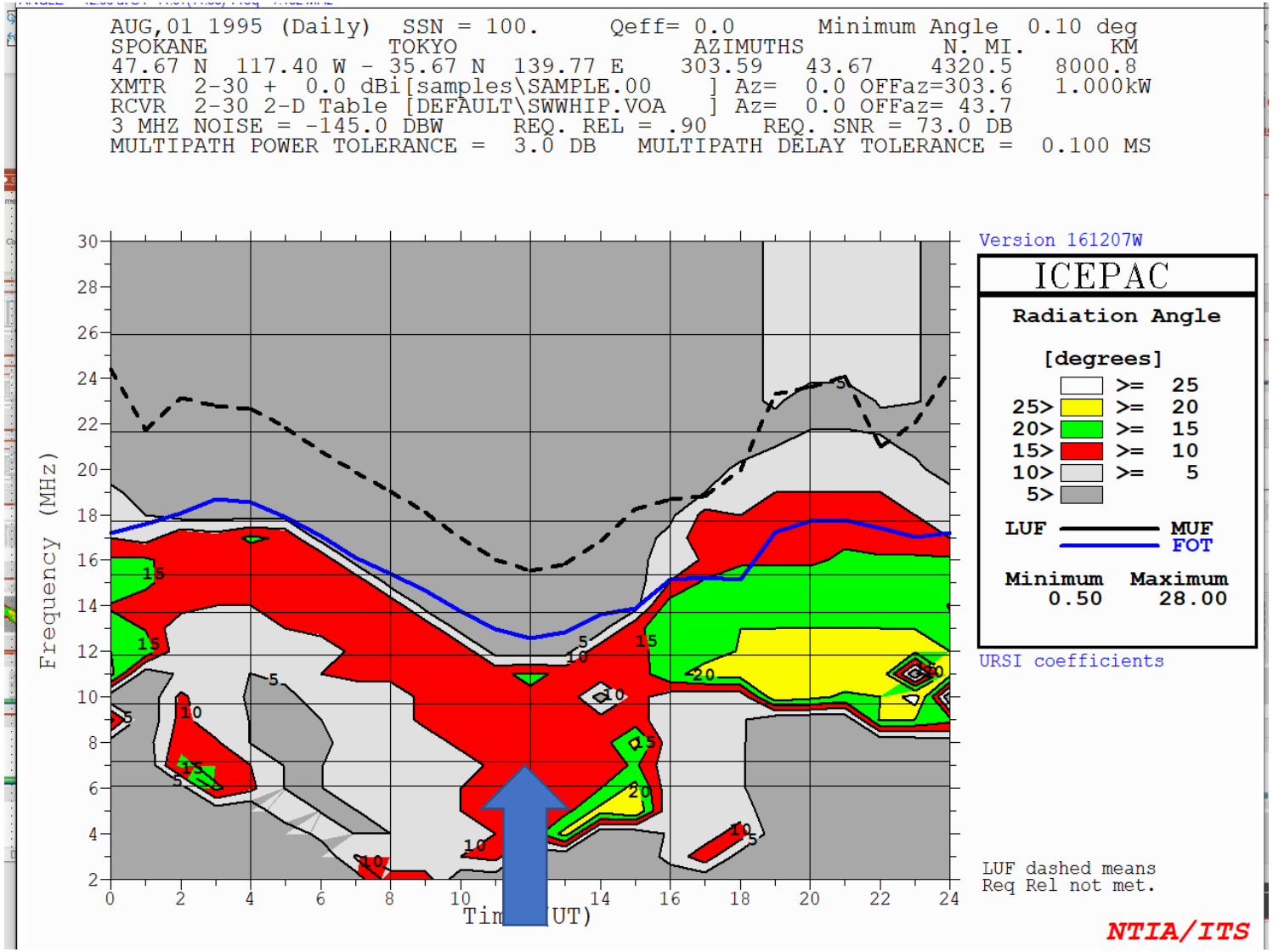
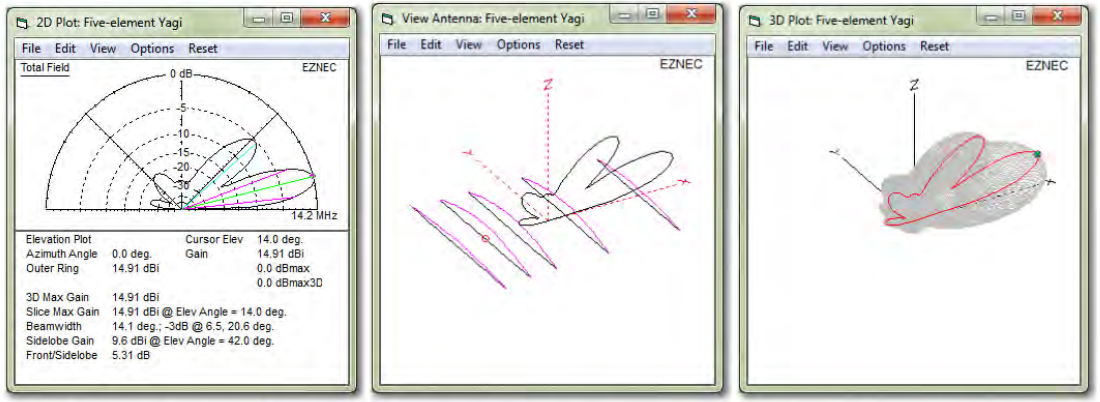
MPROB = Probability additional mode in multipath tolerances	[0.00/ 0.00]
SPRB = Service probability, required reliabilty will be met	[0.00/ 8.00]
SIGLW = Lower decile signal pwr (field strength & loss) (dB)	[0.70/ 25.00]
SIGUP = Upper decile signal pwr (field strength & loss) (dB)	[0.50/ 25.00]
SNRLW = Lower decile SNR increment (dB)	[7.00/ 26.80]
SNRUP = Upper decile SNR increment (dB)	[5.40/ 25.70]
TGAIN = Transmitter Antenna Gain (dB)	[0.00/ 0.00]
RGAIN = Receiver Antenna Gain (dB)	[-17.00/ 0.00]
SNRxx = Signal-to-Noise ratio (dB) at Req. Rel.	[-405.00/ 34.00]
DBM = Median signal power at receiver (dBm)	[-506.00/ -90.00]


AUG,01 1995 (Daily) SSN = 100. Qeff= 0.0 Minimum Angle 0.10 deg
SPOKANE TOKYO AZIMUTHS N. MI. KM
47.67 N 117.40 W - 35.67 N 139.77 E 303.59 43.67 4320.5 8000.8
XMTR 2-30 + 0.0 dBi[samples\SAMPLE.00] Az= 0.0 OFFaz=303.6 1.000kW
RCVR 2-30 2-D Table [DEFAULT\SWWHIP.VOA] Az= 0.0 OFFaz= 43.7
3 MHZ NOISE = -145.0 DBW REQ. REL = .90 REQ. SNR = 73.0 DB
MULTIPATH POWER TOLERANCE = 3.0 DB MULTIPATH DELAY TOLERANCE = 0.100 MS
Frequency (MHz)
Time (UT)
Version 161207W
ICEPAC
Radiation Angle
[degrees]
>= 25
25> >= 20
20> >= 15
15> >= 10
10> >= 5
5>
LUF
MUF
FOT
Minimum 0.50
Maximum 28.00
URSI coefficients
LUF dashed means
Req Rel not met.
NTIA/ITS

EZNEC Antenna Software by W7EL

FREE - EZNEC Pro+ v. 7.0 is now available! - FREE

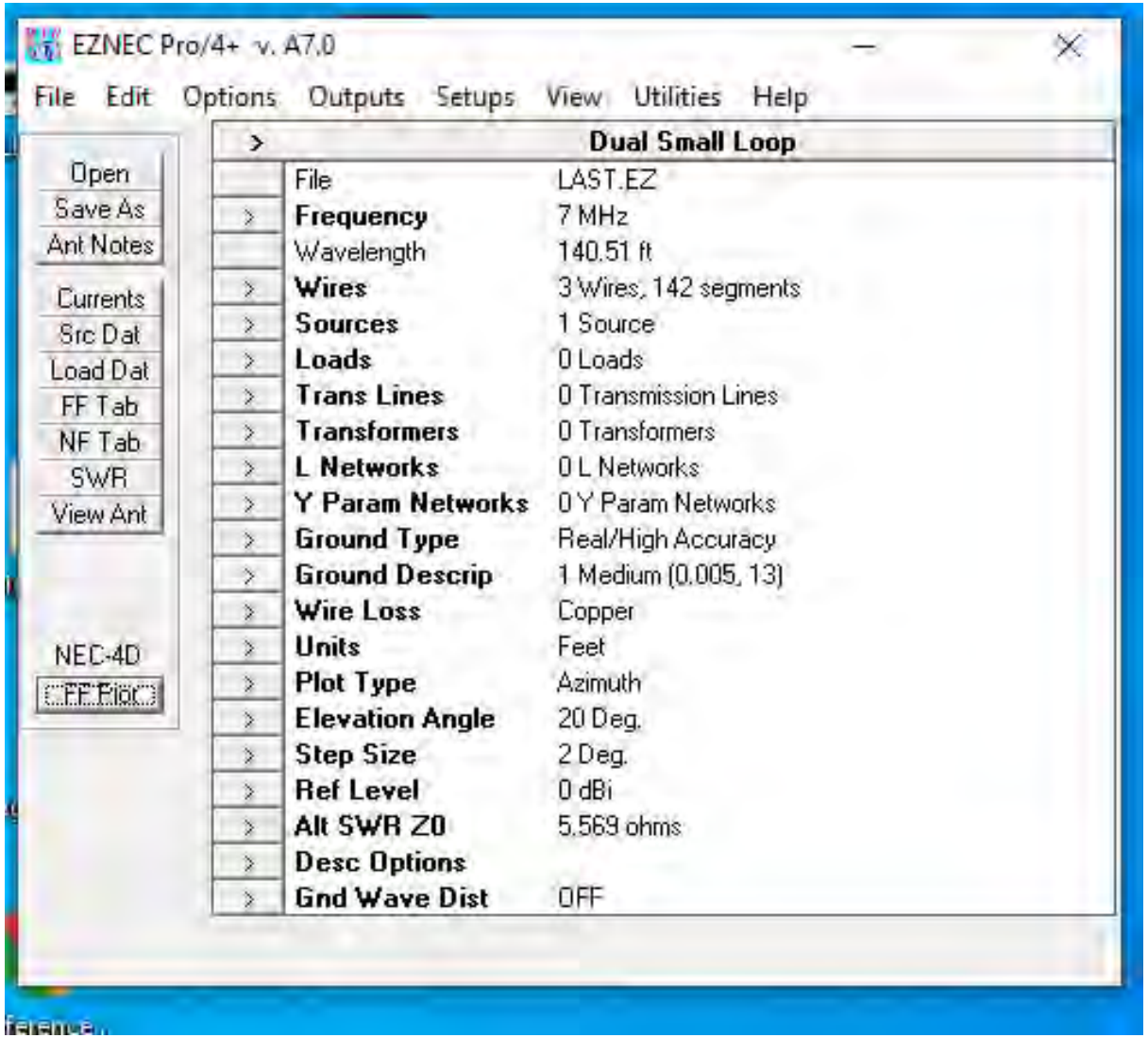


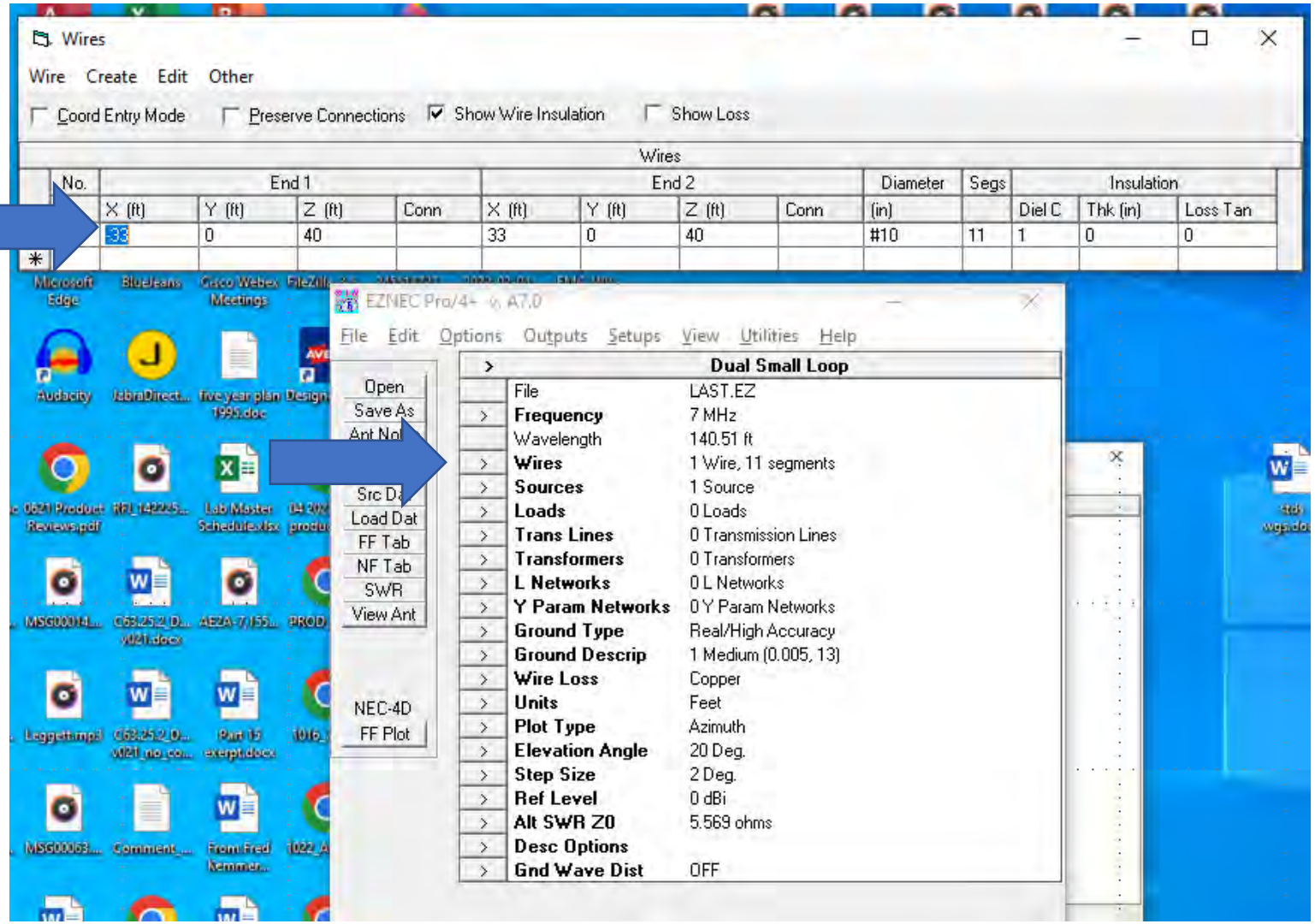
Above: Screen shots from several ***EZNEC*** displays. **Right:** 3D far field pattern, with 2D elevation "slice" highlighted. Any azimuth or elevation slice can be highlighted. **Center:** View Antenna display, showing the "wires" making up the model of the five-element beam, with currents and 2D slice superimposed to show orientation. Several other items, such as currents and wire numbers, can be added to this display. **Left:** 2D display showing detailed information about the selected slice.

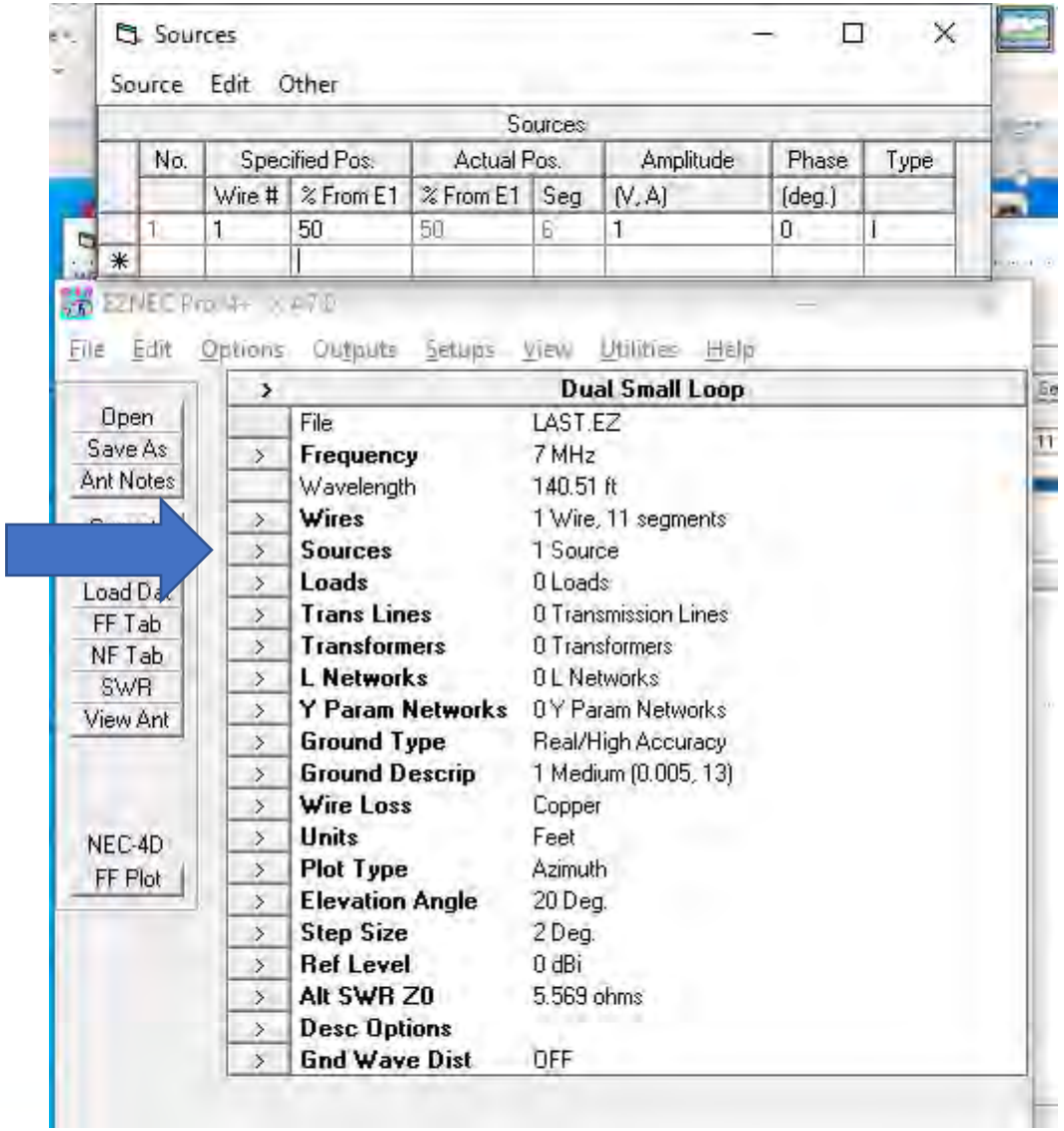
What's New in v. 7.0

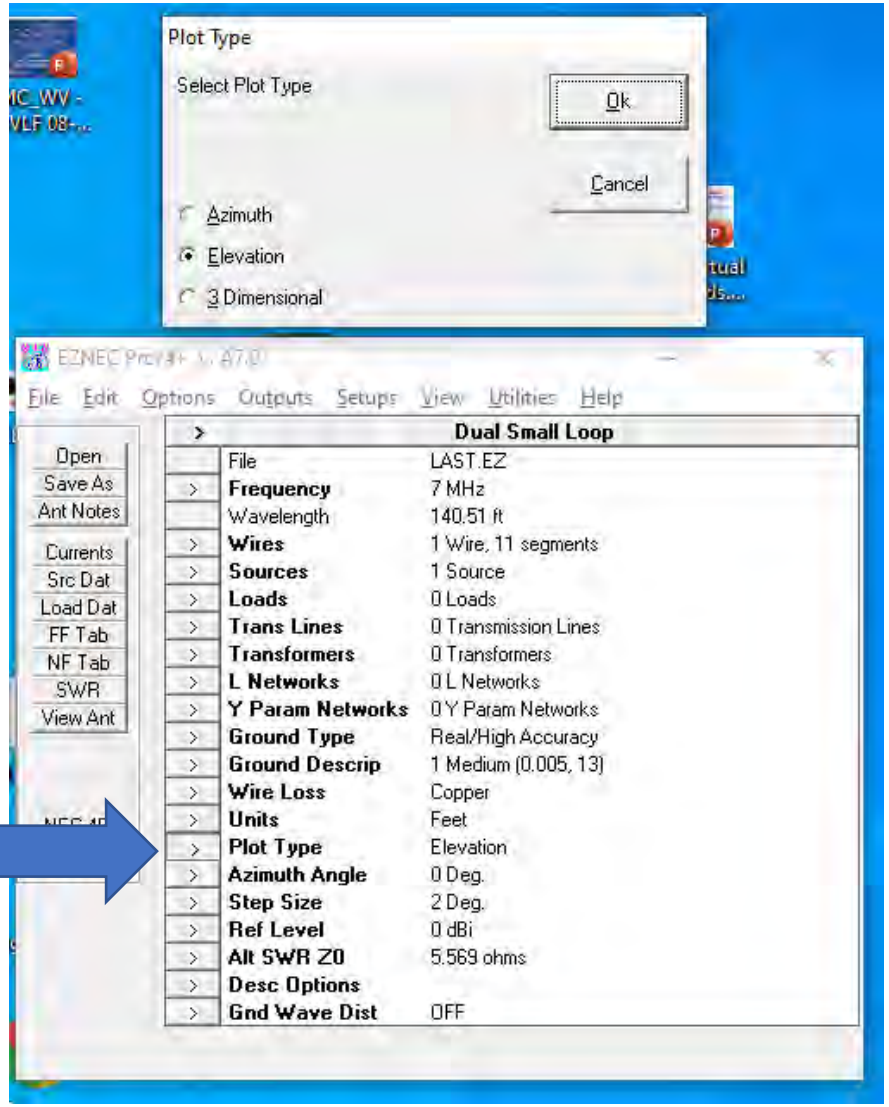
All features which were available in ***EZNEC Pro/2*** v. 6.0 are incorporated into ***EZNEC Pro/2+*** v. 7.0 with a few exceptions described below. **EZNEC Pro/4** v. 6.0 was identical to ***EZNEC Pro/2*** except for the inclusion of an internal NEC-4.2 calculating engine. That also holds true for ***EZNEC Pro/4+ and /2+***.

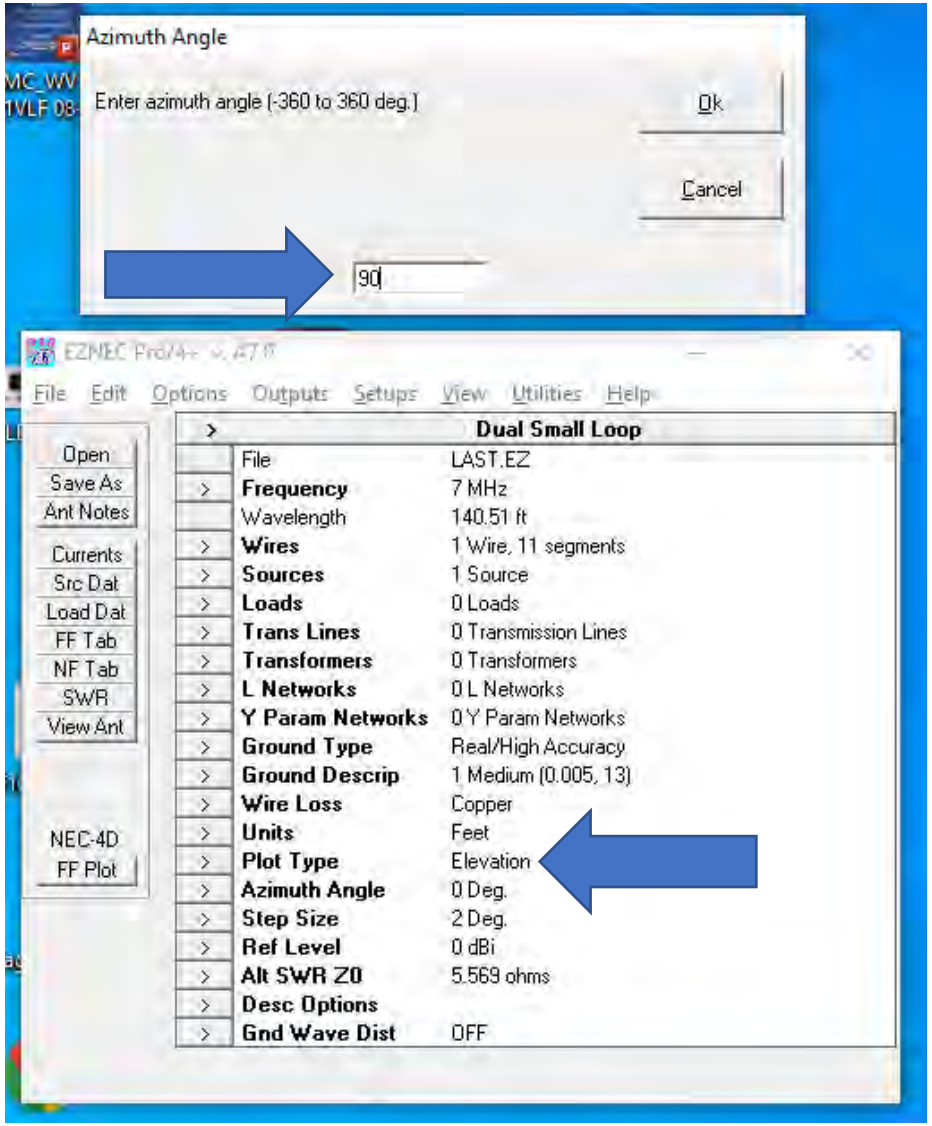
- **External calculating engines** - Both ***EZNEC Pro/2+*** and ***EZNEC Pro/4+*** can use external NEC-4.2 and NEC-5 programs for calculations. After installing ***EZNEC Pro/2+*** or ***EZNEC Pro/4+***, open the manual (Help/Contents) then open the Reference/Additional Information/Calculating Engines topic for detailed information about these and how to get them.
- **Individual wire loss** - Each wire can have different loss if desired.
- **Improved NEC format file reading** - A number of deficiencies were addressed and corrected.
- **Plot display enhancements** - Line widths and object sizes can be changed in the 2D, 3D, SWR, and View Antenna displays.
- **Charge density table** - New Options menu selection to optionally add charge density data to the Currents table.

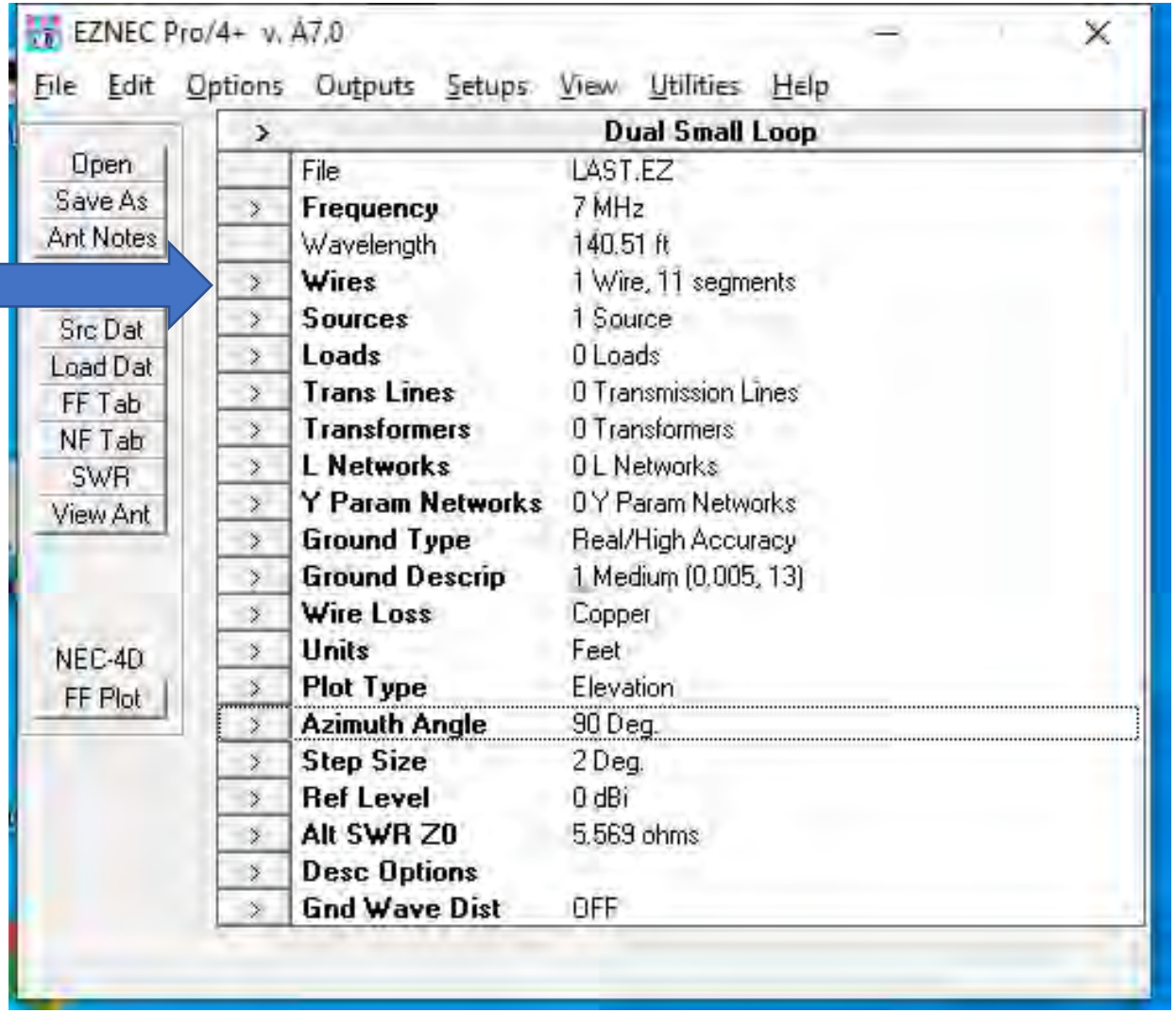

EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 3 Wires, 142 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Azimuth
Elevation Angle 20 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

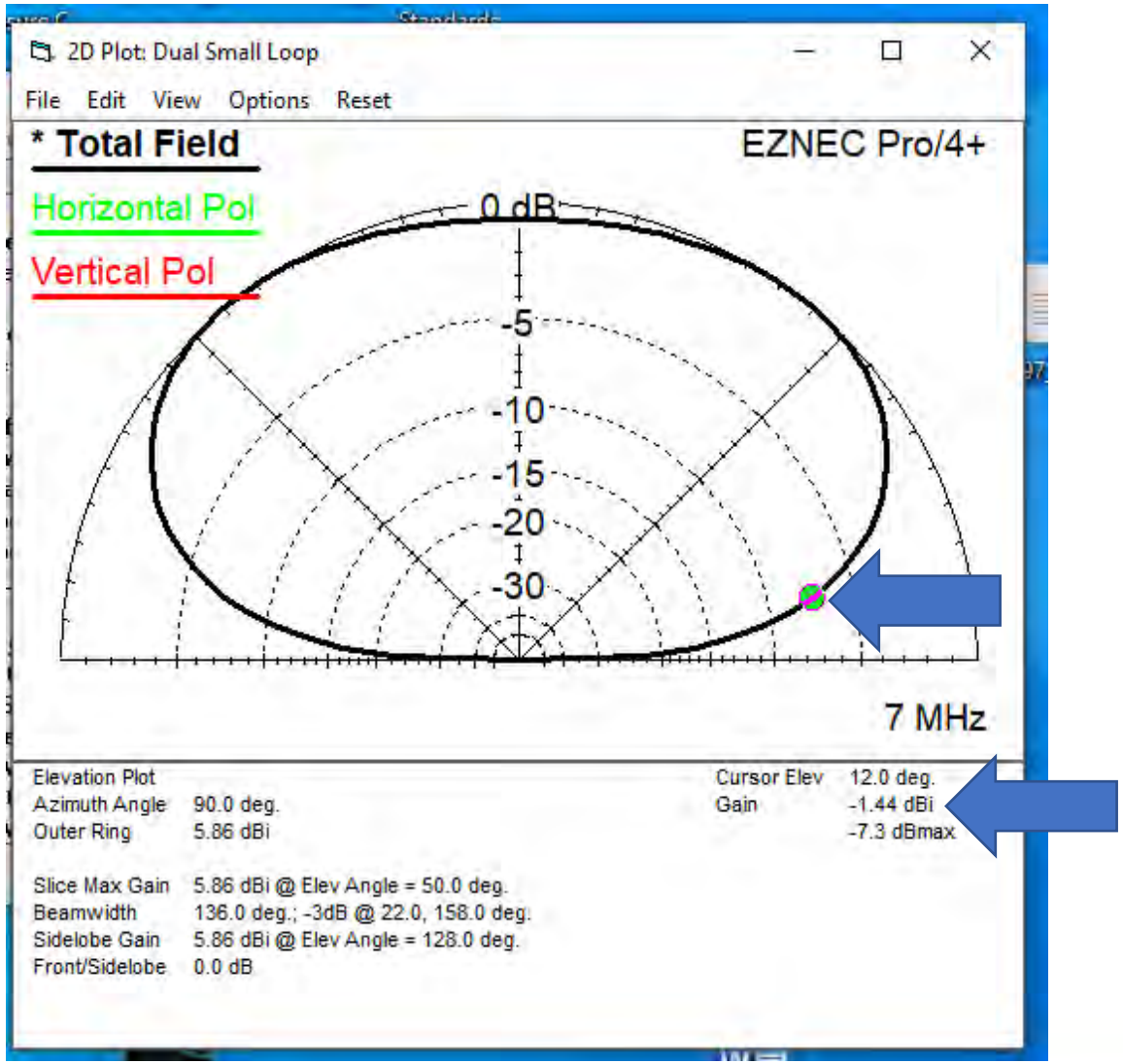

Wires
Wire Create Edit Other
Coord Entry Mode
Preserve Connections
Show Wire Insulation
Show Loss
Wires
No. | End 1 | End 2 | Diameter | Segs | Insulation
X (ft) | Y (ft) | Z (ft) | Conn | X (ft) | Y (ft) | Z (ft) | Conn | (in) | | Diel C | Thk (in) | Loss Tan
-33 | 0 | 40 | | 33 | 0 | 40 | | #10 | 11 | 1 | 0 | 0
EZNEC Pro/4+ v. 7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Azimuth
Elevation Angle 20 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

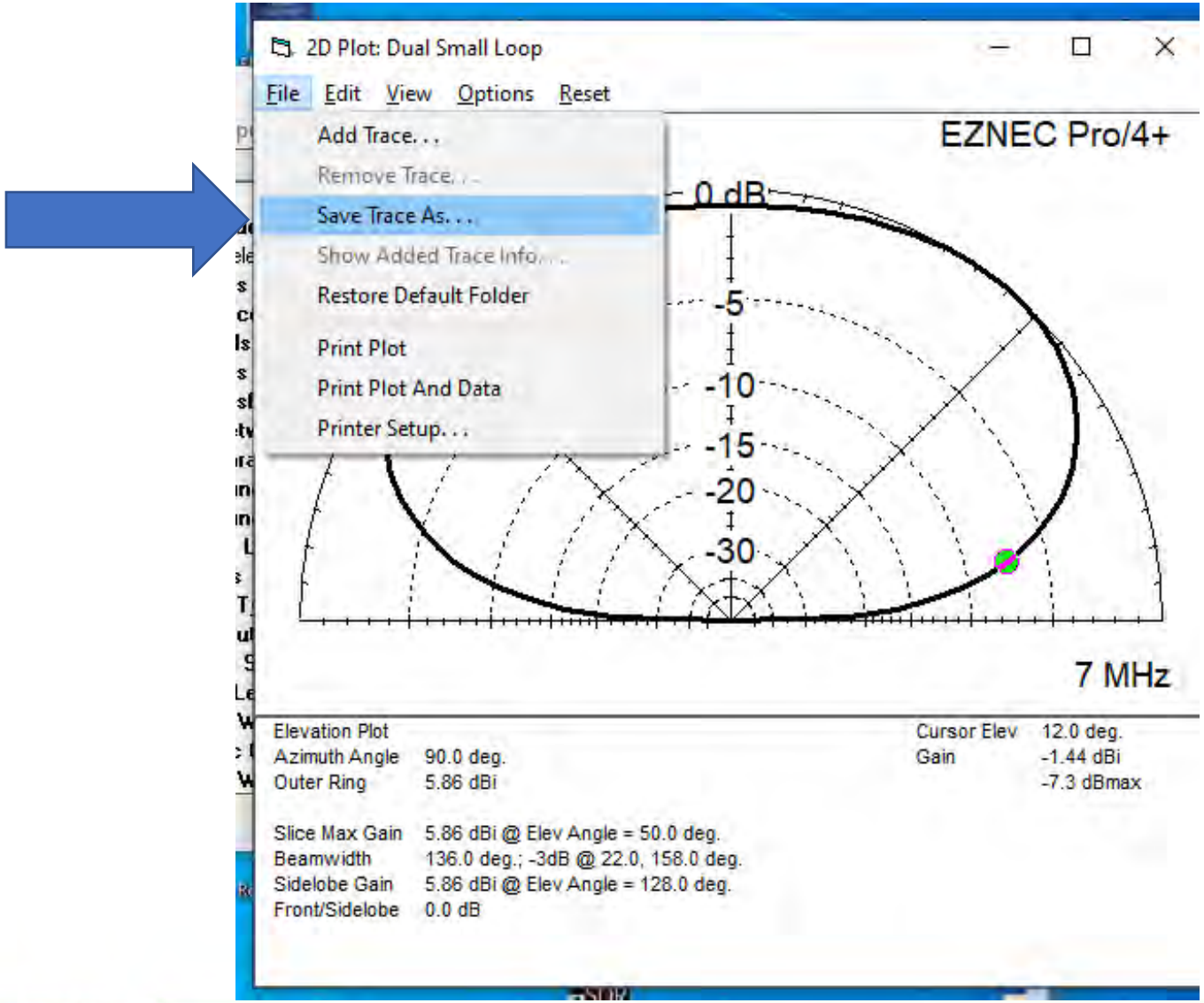

Sources
Source Edit Other
Sources
No. Specified Pos. Actual Pos. Amplitude Phase Type
Wire # % From E1 % From E1 Seg (V, A) (deg.)
1 1 50 50 6 1 0
EZNEC Pro/4+ v.6.70
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Azimuth
Elevation Angle 20 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

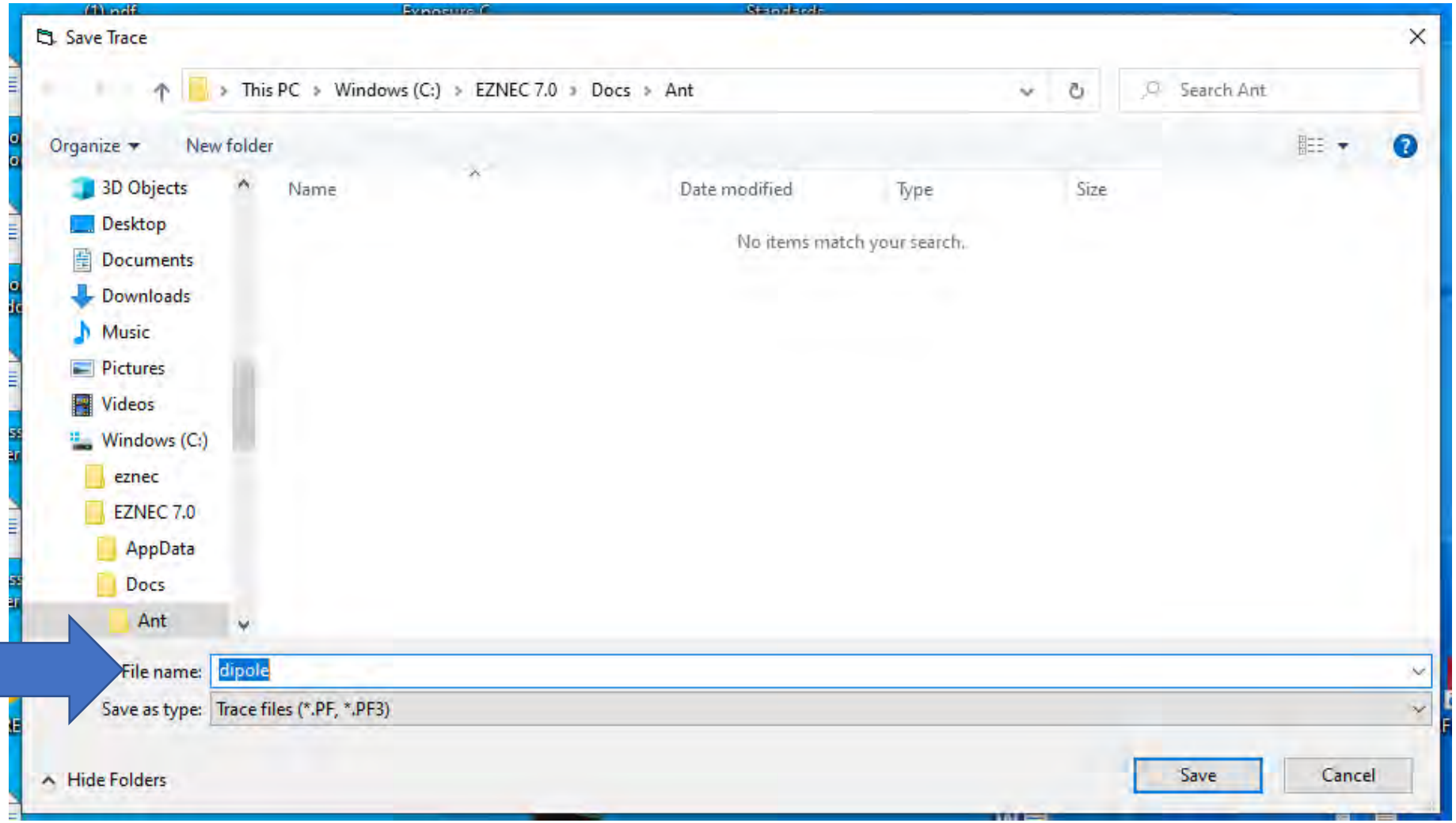

Plot Type
Select Plot Type
Ok
Cancel
Azimuth
Elevation
3 Dimensional
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 0 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

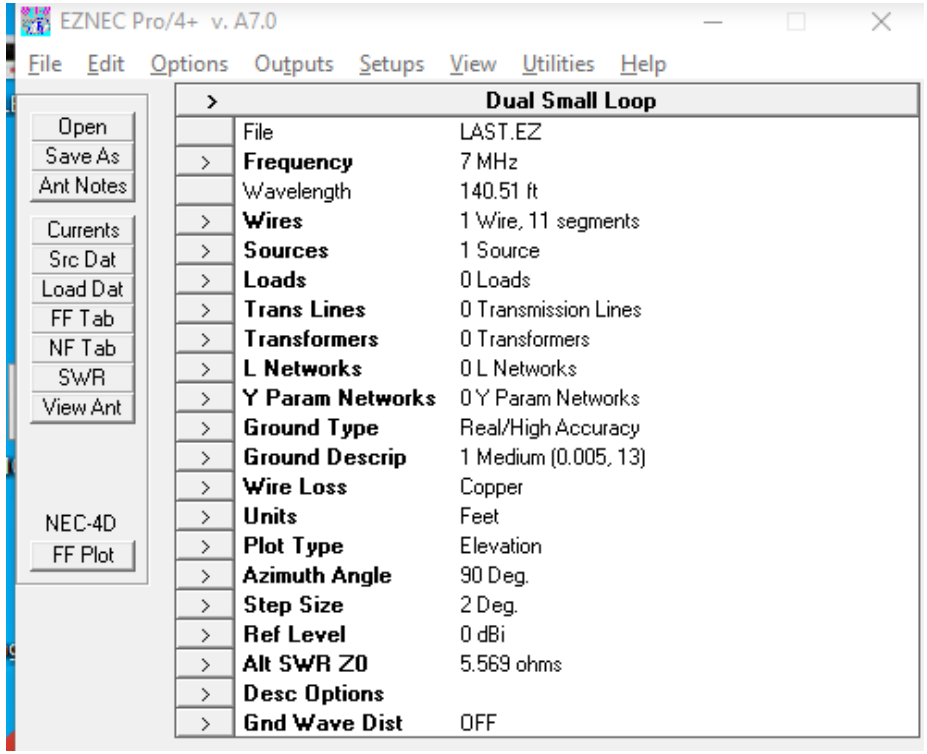

Azimuth Angle
Enter azimuth angle (-360 to 360 deg.)
Ok
Cancel
90
EZNEC Pro/4+ v. 4.7.6
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 0 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

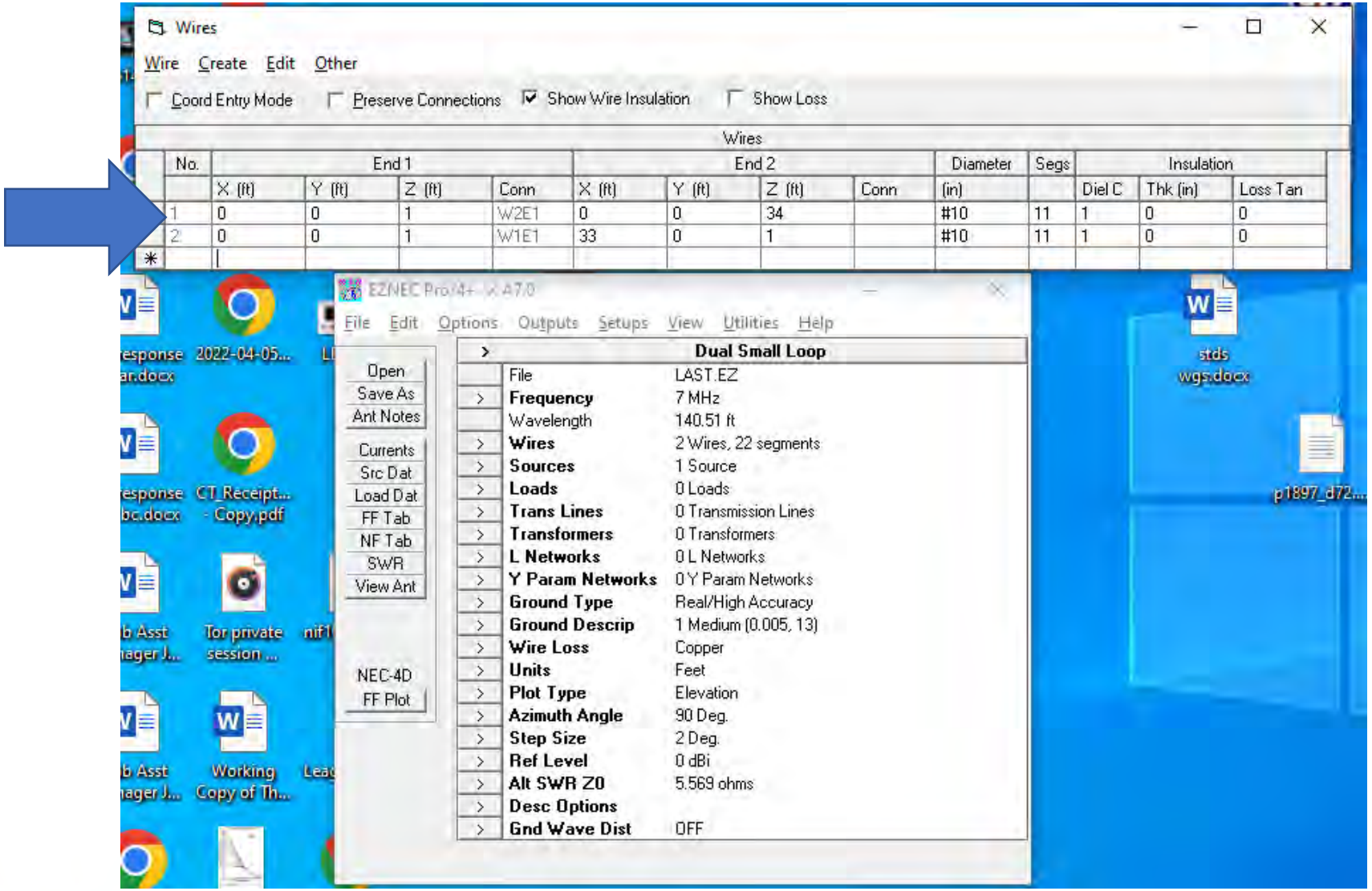

EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 90 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF

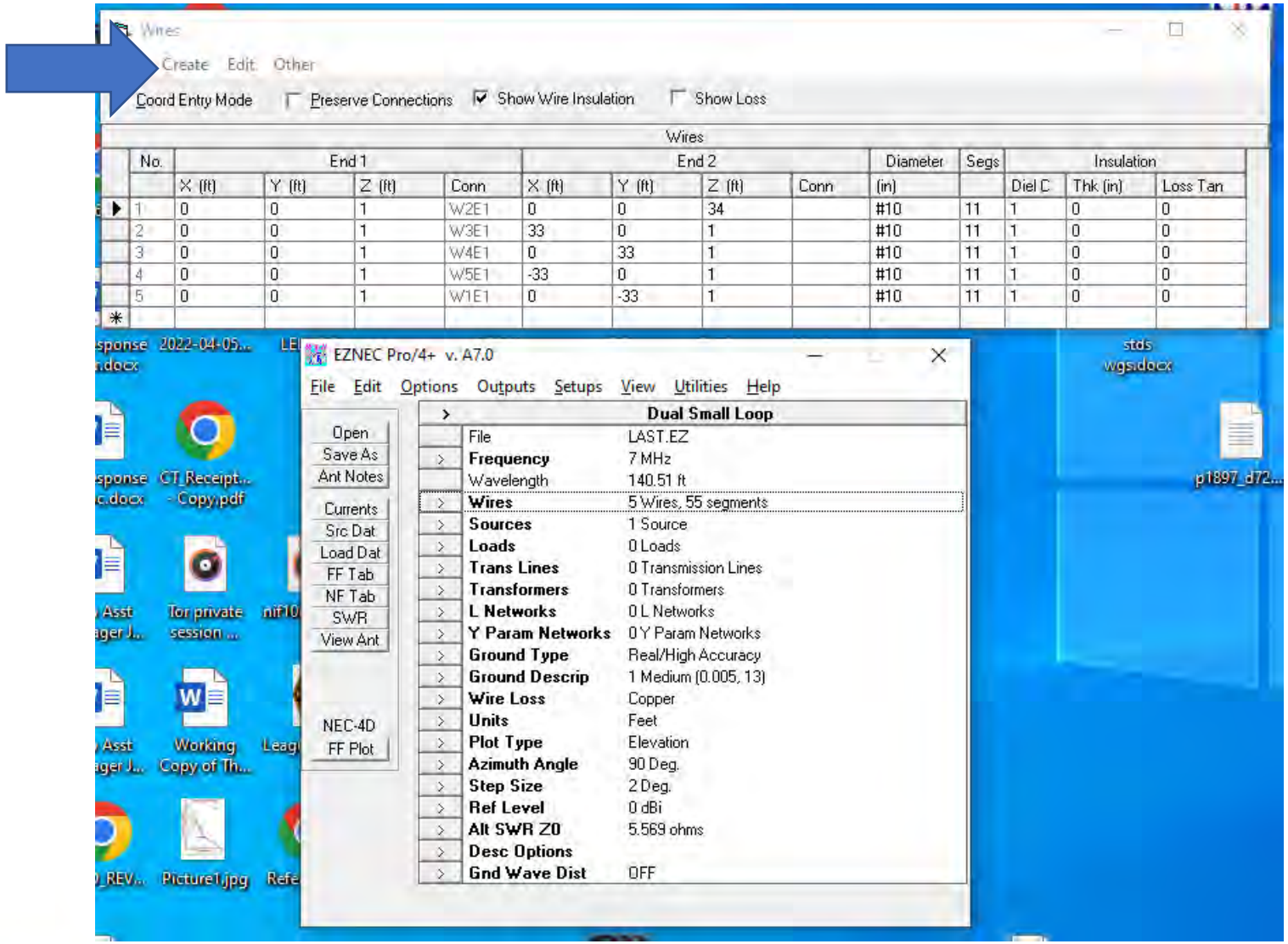

2D Plot: Dual Small Loop
File Edit View Options Reset
* Total Field
EZNEC Pro/4+
Horizontal Pol
Vertical Pol
0 dB
-5
-10
-15
-20
-30
7 MHz
Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring 5.86 dBi
Cursor Elev 12.0 deg.
Gain -1.44 dBi
-7.3 dBmax
Slice Max Gain 5.86 dBi @ Elev Angle = 50.0 deg.
Beamwidth 136.0 deg.; -3dB @ 22.0, 158.0 deg.
Sidelobe Gain 5.86 dBi @ Elev Angle = 128.0 deg.
Front/Sidelobe 0.0 dB

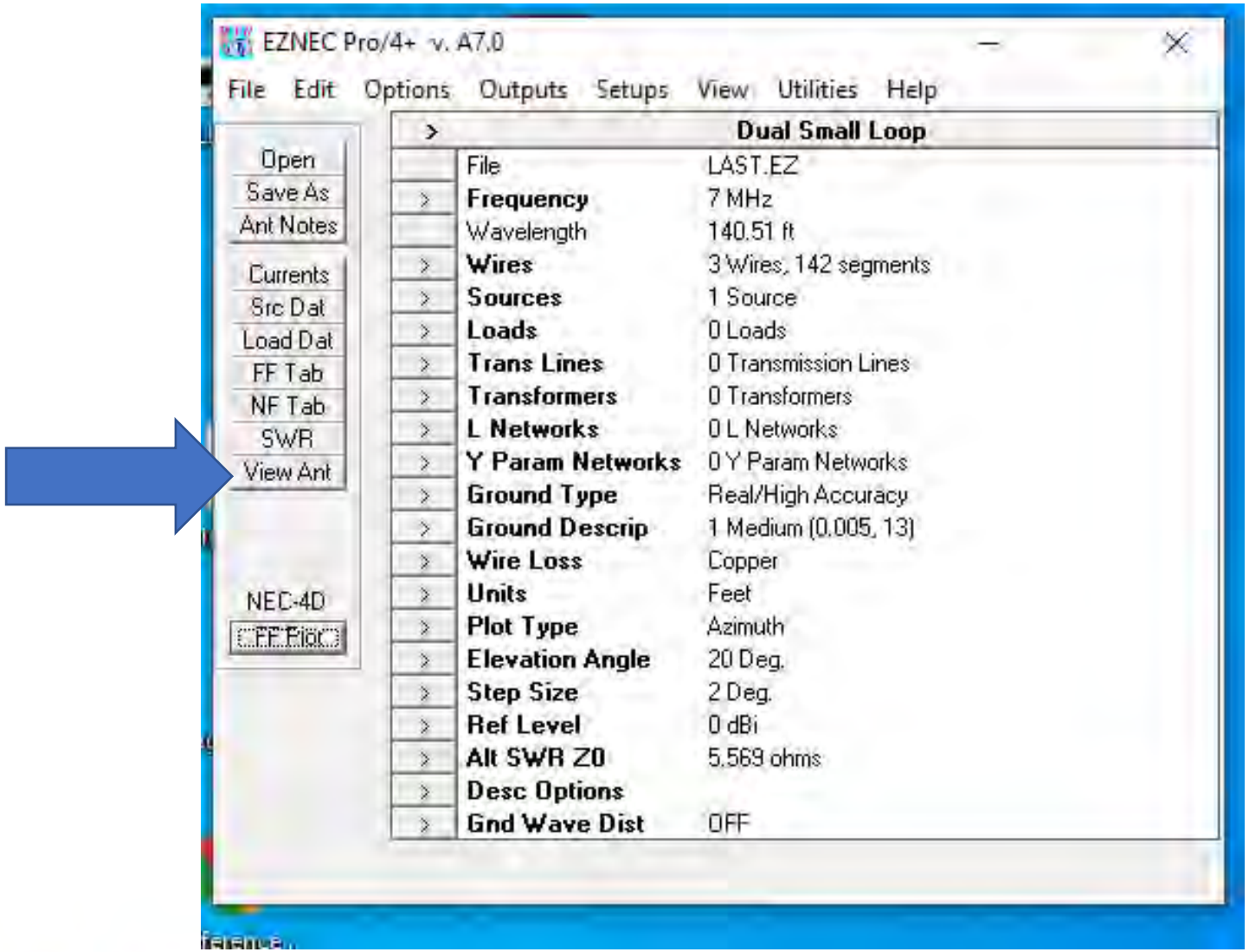

2D Plot: Dual Small Loop
File
Edit
View
Options
Reset
Add Trace. . .
Remove Trace. . .
Save Trace As. . .
Show Added Trace Info. . .
Restore Default Folder
Print Plot
Print Plot And Data
Printer Setup. . .
EZNEC Pro/4+
0 dB
-5
-10
-15
-20
-30
7 MHz
Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring 5.86 dBi
Cursor Elev 12.0 deg.
Gain -1.44 dBi
-7.3 dBmax
Slice Max Gain 5.86 dBi @ Elev Angle = 50.0 deg.
Beamwidth 136.0 deg.; -3dB @ 22.0, 158.0 deg.
Sidelobe Gain 5.86 dBi @ Elev Angle = 128.0 deg.
Front/Sidelobe 0.0 dB

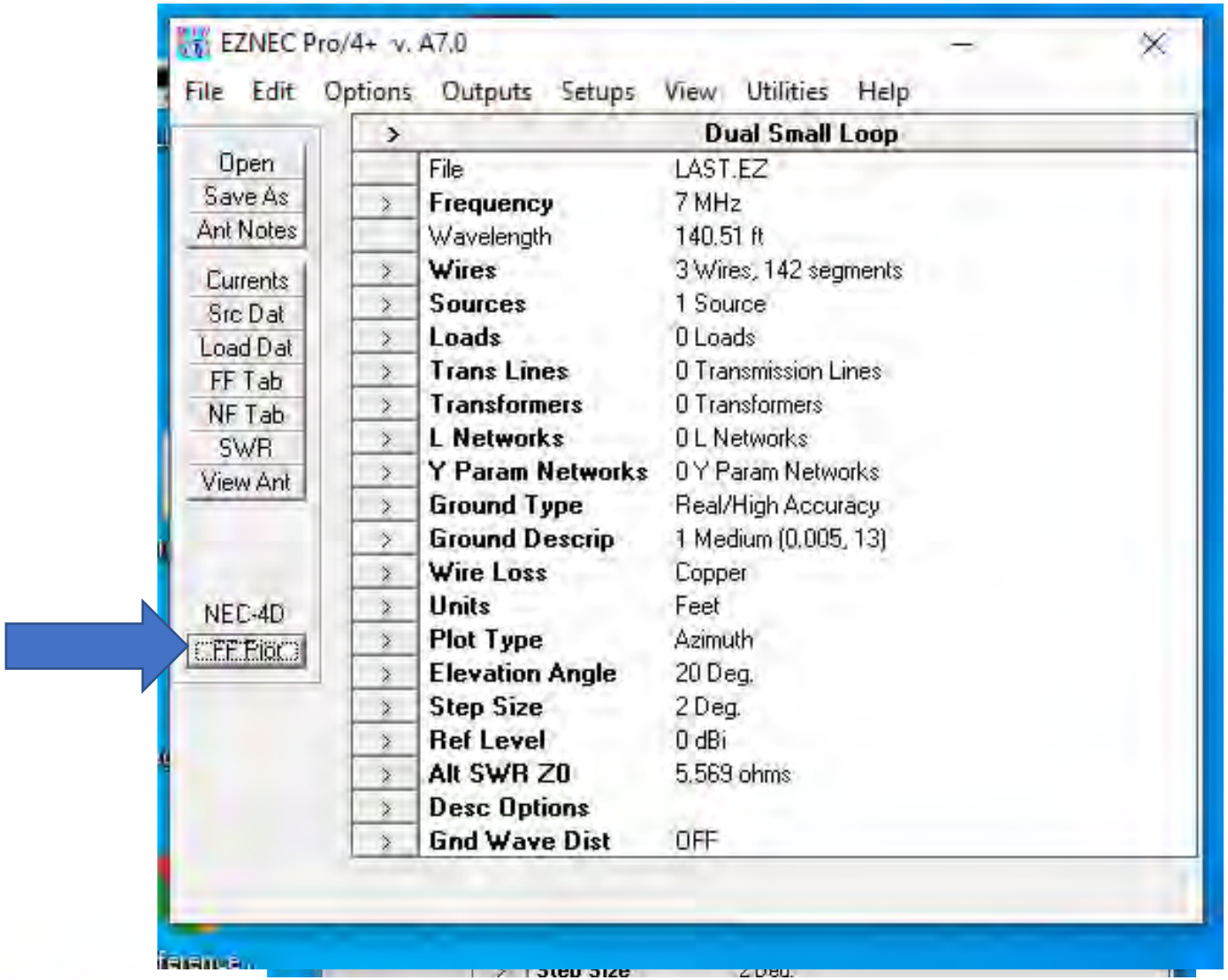

Save Trace
This PC › Windows (C:) › EZNEC 7.0 › Docs › Ant
Search Ant
Organize
New folder
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
Windows (C:)
eznec
EZNEC 7.0
AppData
Docs
Ant
Name
Date modified
Type
Size
No items match your search.
File name: dipole
Save as type: Trace files (*.PF, *.PF3)
Hide Folders
Save
Cancel


EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 1 Wire, 11 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 90 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF


Wires
Wire Create Edit Other
Coord Entry Mode
Preserve Connections
Show Wire Insulation
Show Loss
Wires
No. | End 1 | End 2 | Diameter | Segs | Insulation
X (ft) | Y (ft) | Z (ft) | Conn | X (ft) | Y (ft) | Z (ft) | Conn | (in) | Diel C | Thk (in) | Loss Tan
1 | 0 | 0 | 1 | W2E1 | 0 | 0 | 34 | | #10 | 11 | 1 | 0 | 0
2 | 0 | 0 | 1 | W1E1 | 33 | 0 | 1 | | #10 | 11 | 1 | 0 | 0
EZNEC Pro/4+ - V 7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 2 Wires, 22 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 90 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF
2022-04-05...
CT_Receipt... - Copy.pdf
Tor private session ...
Working Copy of Th...
stds wgs.docx
p1897_d72...


Wires
Create Edit Other
Coord Entry Mode
Preserve Connections
Show Wire Insulation
Show Loss
Wires
No. | End 1 | End 2 | Diameter | Segs | Insulation
X (ft) | Y (ft) | Z (ft) | Conn | X (ft) | Y (ft) | Z (ft) | Conn | (in) | Diel C | Thk (in) | Loss Tan
1 | 0 | 0 | 1 | W2E1 | 0 | 0 | 34 | | #10 | 11 | 1 | 0 | 0
2 | 0 | 0 | 1 | W3E1 | 33 | 0 | 1 | | #10 | 11 | 1 | 0 | 0
3 | 0 | 0 | 1 | W4E1 | 0 | 33 | 1 | | #10 | 11 | 1 | 0 | 0
4 | 0 | 0 | 1 | W5E1 | -33 | 0 | 1 | | #10 | 11 | 1 | 0 | 0
5 | 0 | 0 | 1 | W1E1 | 0 | -33 | 1 | | #10 | 11 | 1 | 0 | 0
EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 5 Wires, 55 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Elevation
Azimuth Angle 90 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF
stds wgs.docx
p1897_d72...
CT Receipt... - Copy.pdf
Tor private session ...
Working Copy of Th...
Picture1.jpg


EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
Save As
Ant Notes
Currents
Src Dat
Load Dat
FF Tab
NF Tab
SWR
View Ant
NEC-4D
FF Plot
Dual Small Loop
File LAST.EZ
Frequency 7 MHz
Wavelength 140.51 ft
Wires 3 Wires, 142 segments
Sources 1 Source
Loads 0 Loads
Trans Lines 0 Transmission Lines
Transformers 0 Transformers
L Networks 0 L Networks
Y Param Networks 0 Y Param Networks
Ground Type Real/High Accuracy
Ground Descrip 1 Medium (0.005, 13)
Wire Loss Copper
Units Feet
Plot Type Azimuth
Elevation Angle 20 Deg.
Step Size 2 Deg.
Ref Level 0 dBi
Alt SWR Z0 5.569 ohms
Desc Options
Gnd Wave Dist OFF


EZNEC Pro/4+ v. A7.0
File Edit Options Outputs Setups View Utilities Help
Open
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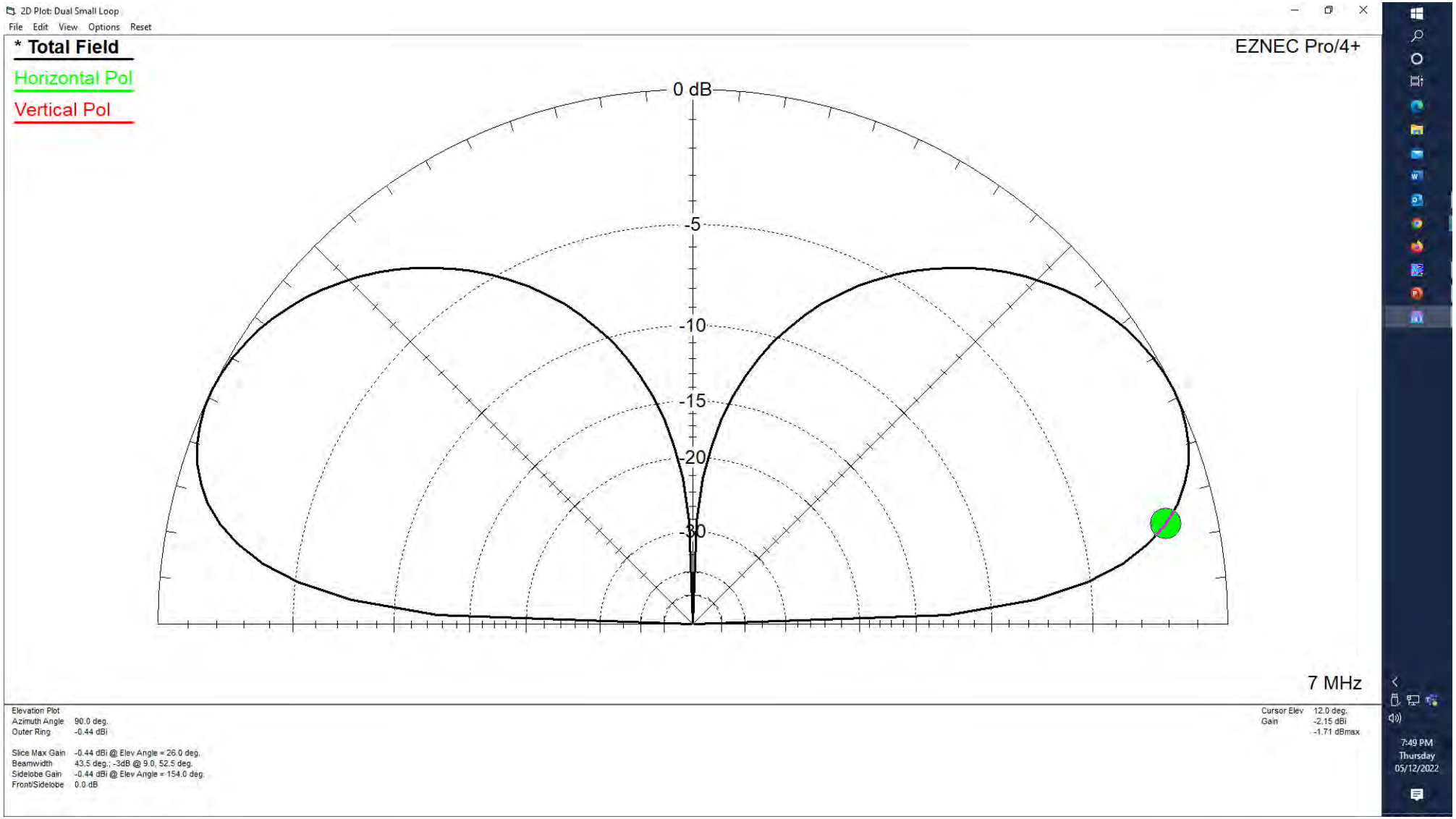
Gnd Wave Dist OFF


2D Plot: Dual Small Loop
File Edit View Options Reset
* Total Field
Horizontal Pol
Vertical Pol
EZNEC Pro/4+
0 dB
-5
-10
-15
-20
-30
7 MHz
Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring -0.44 dBi
Slice Max Gain -0.44 dBi @ Elev Angle = 26.0 deg.
Beamwidth 43.5 deg.; -3dB @ 9.0, 52.5 deg.
Sidelobe Gain -0.44 dBi @ Elev Angle = 154.0 deg.
Front/Sidelobe 0.0 dB
Cursor Elev 12.0 deg.
Gain -2.15 dBi
-1.71 dBmax
7:49 PM
Thursday
05/12/2022

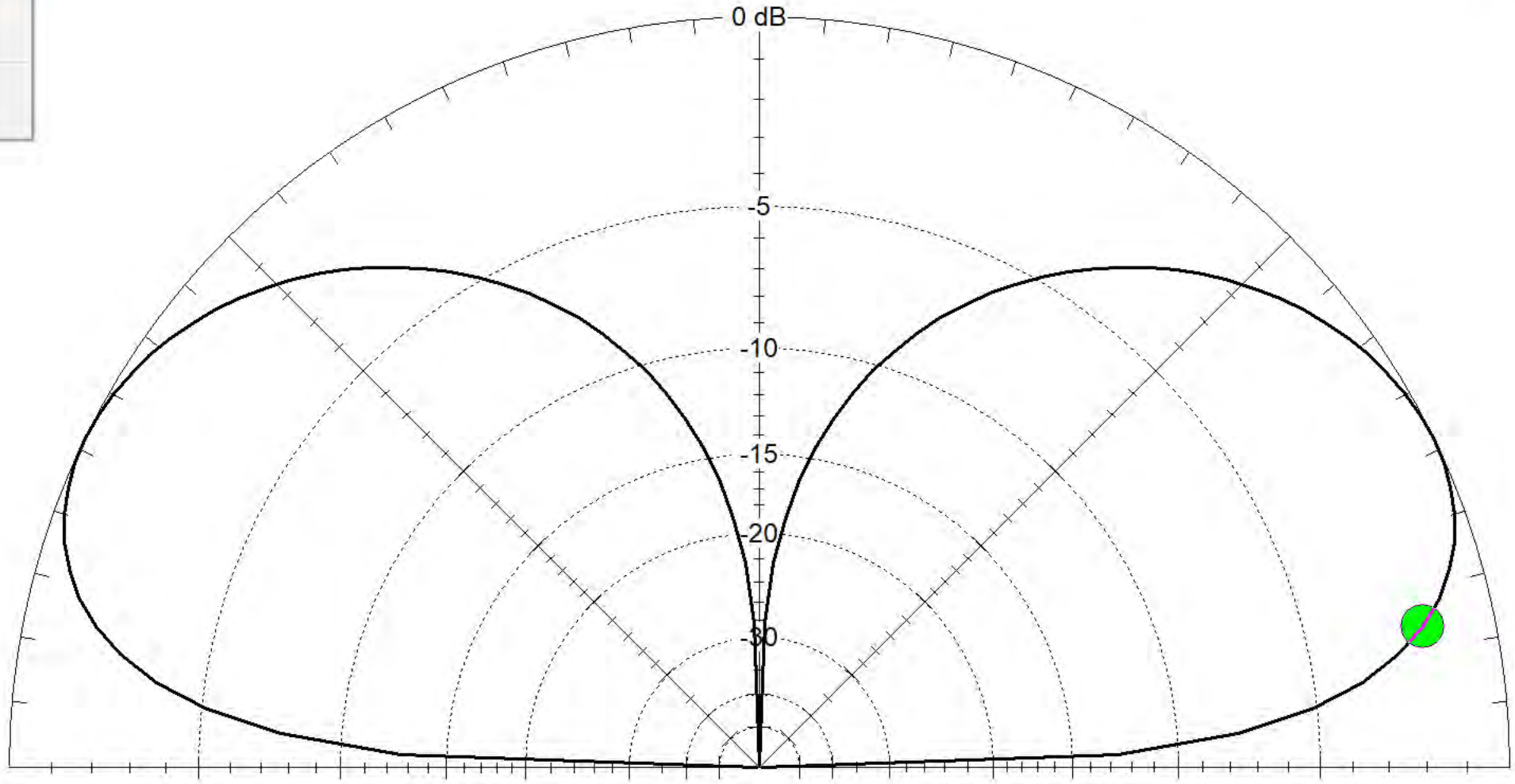
2D Plot: Dual Small Loop

File Edit View Options Reset

Add Trace. . .
Remove Trace. . .
Save Trace As. . .
Show Added Trace Info. . .
Restore Default Folder

Print Plot
Print Plot And Data
Printer Setup. . .

EZNEC Pro/4+

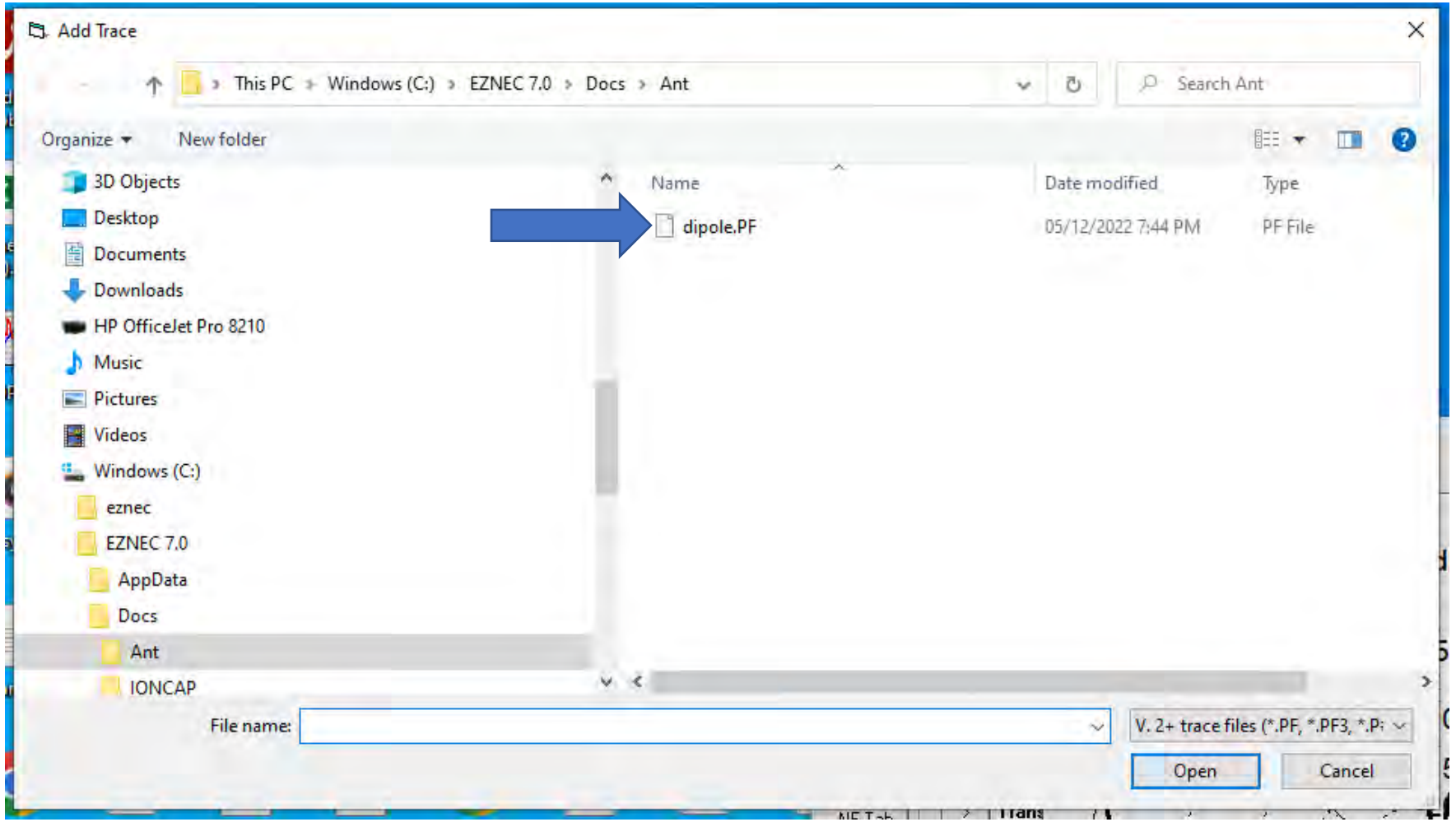


7 MHz

Elevation Plot	
Azimuth Angle	90.0 deg.
Outer Ring	-0.44 dBi
Slice Max Gain	-0.44 dBi @ Elev Angle = 26.0 deg.
Beamwidth	43.5 deg.; -3dB @ 9.0, 52.5 deg.
Sidelobe Gain	-0.44 dBi @ Elev Angle = 154.0 deg.
Front/Sidelobe	0.0 dB

Cursor Elev	12.0 deg.
Gain	-2.15 dBi
	-1.71 dBmax

7:49 PM
Thursday
05/12/2022


Add Trace
This PC › Windows (C:) › EZNEC 7.0 › Docs › Ant
Search Ant
Organize
New folder
3D Objects
Desktop
Documents
Downloads
HP OfficeJet Pro 8210
Music
Pictures
Videos
Windows (C:)
eznec
EZNEC 7.0
AppData
Docs
Ant
IONCAP
Name
Date modified
Type
dipole.PF
05/12/2022 7:44 PM
PF File
File name:
V. 2+ trace files (*.PF, *.PF3, *.P:
Open
Cancel

2D Plot: Dual Small Loop

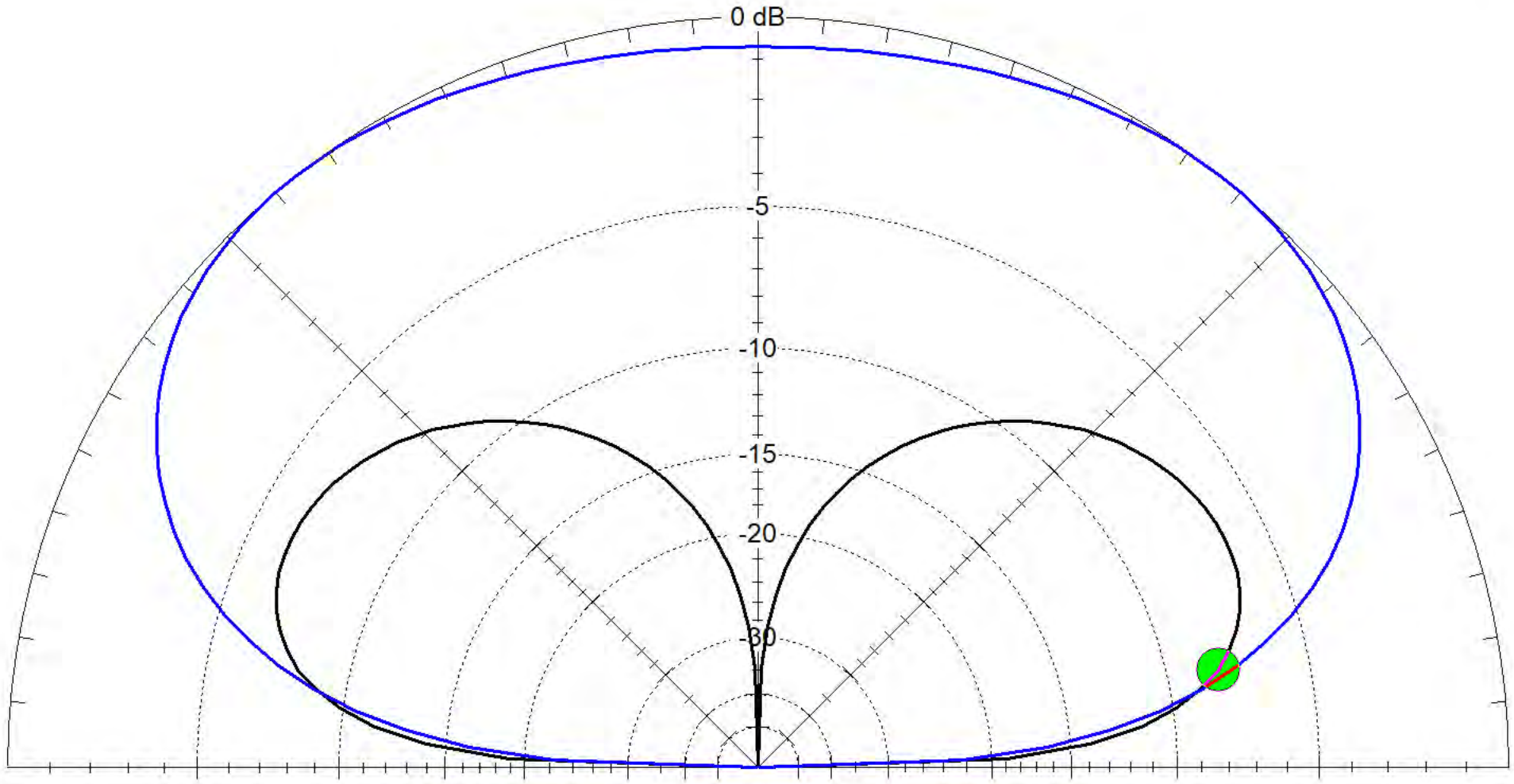
File Edit View Options Reset

Total Field

EZNEC Pro/4+

*** Primary**

dipole



7 MHz

Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring 5.86 dBi

Slice Max Gain -0.44 dBi @ Elev Angle = 26.0 deg.
Beamwidth 43.5 deg.; -3dB @ 9.0, 52.5 deg.
Sidelobe Gain -0.44 dBi @ Elev Angle = 154.0 deg.
Front/Sidelobe 0.0 dB

Cursor Elev 12.0 deg.
Gain -2.15 dBi
-1.71 dBmax

7:52 PM
Thursday
05/12/2022

We have time, so let's look at a few other configurations

- **120 radials**
- **Better ground**
- **Elevated radials**
- **What about other propagation angles**

Questions: Also known as “Stump the Speaker”

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