



# **SKY WAVE RADIO COMMUNICATION PREDICTION FOR BSC,MSC AND PHD STUDENTS AND RESEARCHERS**

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# HF PROPAGATION MODELS

- **ICEPAC** - Ionospheric Communications Enhanced Profile Analysis & Circuit prediction program
- **VOACAP** - Voice Of America Coverage Analysis Program
- **REC533** - Recommendation ITU-R P.533-6

# ICEPAC

- **IONCAP** – **ION**ospheric **C**ommunications **A**nalysis and **P**rediction program (1983)
- **ICED** - Ionospheric **C**onductivity and **E**lectron **D**ensity profile model -Tascione (1987)
  - sub-auroral trough
  - auroral zone
  - polar cap
- Use  $K_p$  to model solar storms

# VOACAP

- 1985 - VOA adopts IONCAP as model to be used for broadcast station design
- NRL - modifies IONCAP into VOACAP
- 1993 - VOACAP released
- 1993 - NTIA/ITS add DOS GUI interface
- 1996 - Windows 3.x 16-bit version
- 1997 - Windows-NT 32-bit version
- Present - 04.0324W - Windows-XP/2000/NT/95/98

# REC533

- Recommendation ITU-R P.533-6
- First released - July 1993
- International HF Coordination

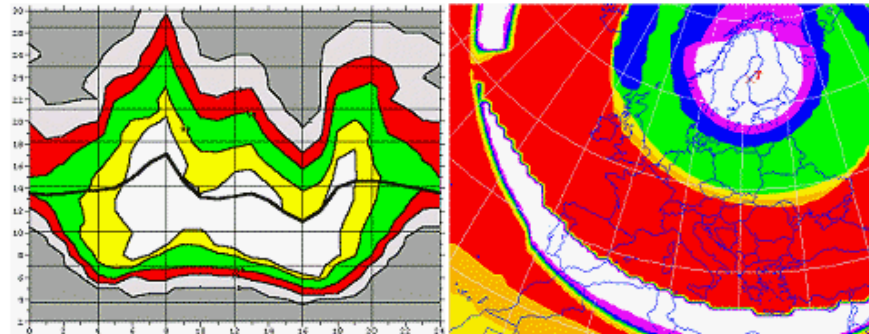
# USERS OF THE SOFTWARE

- HF Broadcasters (VOA, BBC, ITU, HFCC)
- Military
- Defense contractors
- Airline communications
- HAMs

# VOACAP Quick Guide

by Jari Perkiömäki, OH6BG

High-Frequency Ionospheric Communications Analysis and Prediction



Updated: 1 January 2004

This is a brief, a work in progress, guide to using VOACAP - a free professional HF prediction program from NTIA/ITS, originally developed for Voice of America (VOA). This guide should get you well started with VOACAP. A more comprehensive discussion about the finer details of using the software can be found in George Lane's recently-published book [Signal-to-Noise Predictions Using VOACAP. A User's Guide](#) (Rockwell Collins).



## What SunSpot Number indices should be used.

NOAA has changed how they put out the Ionospheric indices that are used in the NTIA/ITS HF Propagation Models. This will try to explain what indices to use.

- The SunSpot Number (SSN) used by these HF prediction programs should be what is called [R12 - the Smoothed SunSpot Number](#).
- NGDC used to have it linked [in this table](#).
- That was last updated May 15, 1999.
- George Lane says to use:  
[ftp://ftp.ngdc.noaa.gov/STP/SOLAR\\_DATA/SUNSPOT\\_NUMBERS/sunspot.predict](ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SUNSPOT_NUMBERS/sunspot.predict) for compatibility with VOACAP.
- SEC also maintains SunSpot data with slightly different numbers under [Solar Cycle Progression](#).
  - For past values, you must use the [Recent Solar Indices](#) table.
    - The proper column in this table is Smoothed RI
  - For predicted values, you must use the [Predicted Indices](#) table.
    - The proper column in this table is SunSpot Number Predicted
  - You will notice that the Predicted table is about 6 months behind the current date. That is because it takes that long for the smoothed SunSpot Number to become permanent.
- I questioned someone at SEC as to what was the difference between SEC's and NGDC's sunspot predictions, and [here](#) is his response.
- Note:** We cannot control the content nor accessibility of the NOAA web pages.



# POINT-TO-POINT DATA INPUT

ICEPAC Point-to-Point data input

File Run View Save to: Help

Method	20 = Complete system performance (C.S.P.)					
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	44.23N 76.50W KINGSTON					
Receiver	36.83S 174.78E AUKLAND					
Path	Short Distances: 14123km 7626nmi 8776mi Azimuth: 251.7deg					
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
	145(-dBw)	0.10deg	90%	73dB	3.00dB	0.10msec
Eprob	1.00*foE	1.00*foF1	1.00*foF2	0.70*foEs		
Ix 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:

# IONOSPHERIC COEFFICIENTS

- CCIR/Oslo
- URSI88/Australian
- Daily foF2 – interpolated URSI88

# ICEPAC - EFFECTIVE SSN

Specify foF2 values to calculate Effective SSN

URSI coefficients  
Month= 6 Day= 0

Point	Latitude	Longitude	Time UT	foF2 MHz	Effective SSN
1	35.8	-5.9	18	9.5	133.08
2	-99	-400	0	0	Ignore
3	-99	-400	0	0	Ignore
4	-99	-400	0	0	Ignore
5	-99	-400	0	0	Ignore

Average= 133.08

Input Help:

# POINT-TO-POINT OUTPUT

```

Scrollw:C:\ITSHFBC\RUN\ICEPACx.out 2311 bytes
File Edit
URSI Coefficients          METHOD 20  ICEPAC  Version 040324W  PAGE 1

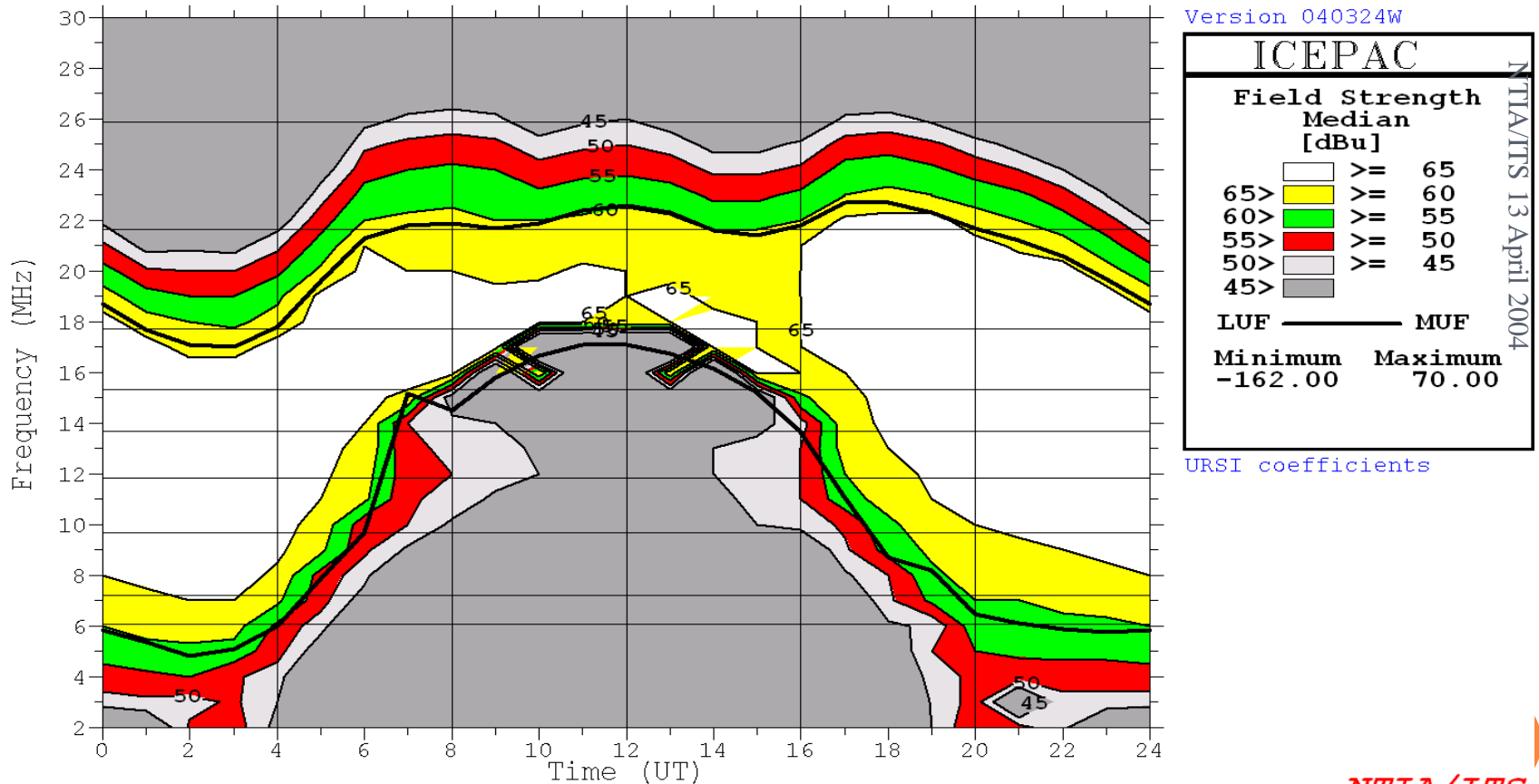
JUN 1995          SSN = 100.          Qeff= 0.0          Minimum Angle 0.10 deg
TANGIER, Morocco  BELGRADE          AZIMUTHS          N. MI.          KM
35.80 N 5.90 W - 44.90 N 20.50 E  57.41 254.73 1317.9 2440.5
XMTR 2-30 2-D Table [DEFAULT\CONST17.VOA ]  Az= 0.0 OFFaz= 57.4 500.000kW
RCVR 2-30 2-D Table [DEFAULT\SWWHIP.VOA ]  Az= 0.0 OFFaz=254.7
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

1.0 17.7 6.1 7.2 9.7 11.9 13.7 15.4 17.7 21.6 25.9 0.0 0.0 FREQ
1F2 1F2 1F2 1F2 1F2 1F2 1F2 1F2 1F2 1F2 1F2 - - MODE
14.1 7.6 7.9 8.5 9.1 9.7 10.5 14.1 14.1 14.1 - - ANGLE
8.9 8.5 8.5 8.6 8.6 8.6 8.7 8.9 8.9 8.9 - - DELAY
450 292 297 312 326 341 360 450 450 450 - - U HITE
0.50 1.00 1.00 1.00 0.97 0.91 0.78 0.49 0.05 0.00 - - MUFday
127 122 120 118 118 119 120 127 155 209 - - LOSS
63 62 65 68 69 69 69 63 37 -16 - - DBU
-70 -62 -61 -60 -61 -62 -63 -70 -98 -152 - - S DBW
-166 -149 -152 -158 -161 -163 -164 -166 -169 -171 - - N DBW
96 87 91 97 99 101 101 96 71 18 - - SNR
3 -5 -9 -13 -14 -14 -11 3 29 81 - - RPWRG
0.87 0.98 0.99 1.00 1.00 0.99 0.98 0.87 0.46 0.00 - - REL
0.00 0.92 0.95 0.00 0.00 0.00 0.00 0.00 0.00 0.00 - - MPROB
0.46 0.57 0.67 0.75 0.76 0.74 0.67 0.46 0.20 0.01 - - S PRB
25.0 2.6 4.2 6.5 7.6 10.3 14.0 25.0 25.0 25.0 - - SIG LW
11.0 8.9 7.6 6.6 6.1 5.9 6.5 11.1 25.0 25.0 - - SIG UP
26.8 8.5 9.4 11.2 12.1 14.0 17.0 26.8 26.8 26.8 - - SNR LW
12.5 10.3 9.0 8.1 8.1 8.2 8.7 12.6 25.7 25.7 - - SNR UP
17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 - - TGAIn
-0.5 -2.1 -1.9 -1.7 -1.6 -1.4 -1.2 -0.5 -0.5 -0.5 - - RGAIN
70 78 82 86 87 87 84 70 44 -8 - - SNRxx
-40 -32 -31 -30 -31 -32 -33 -40 -68 -122 - - DBM

```

# POINT-TO-POINT GRAPH

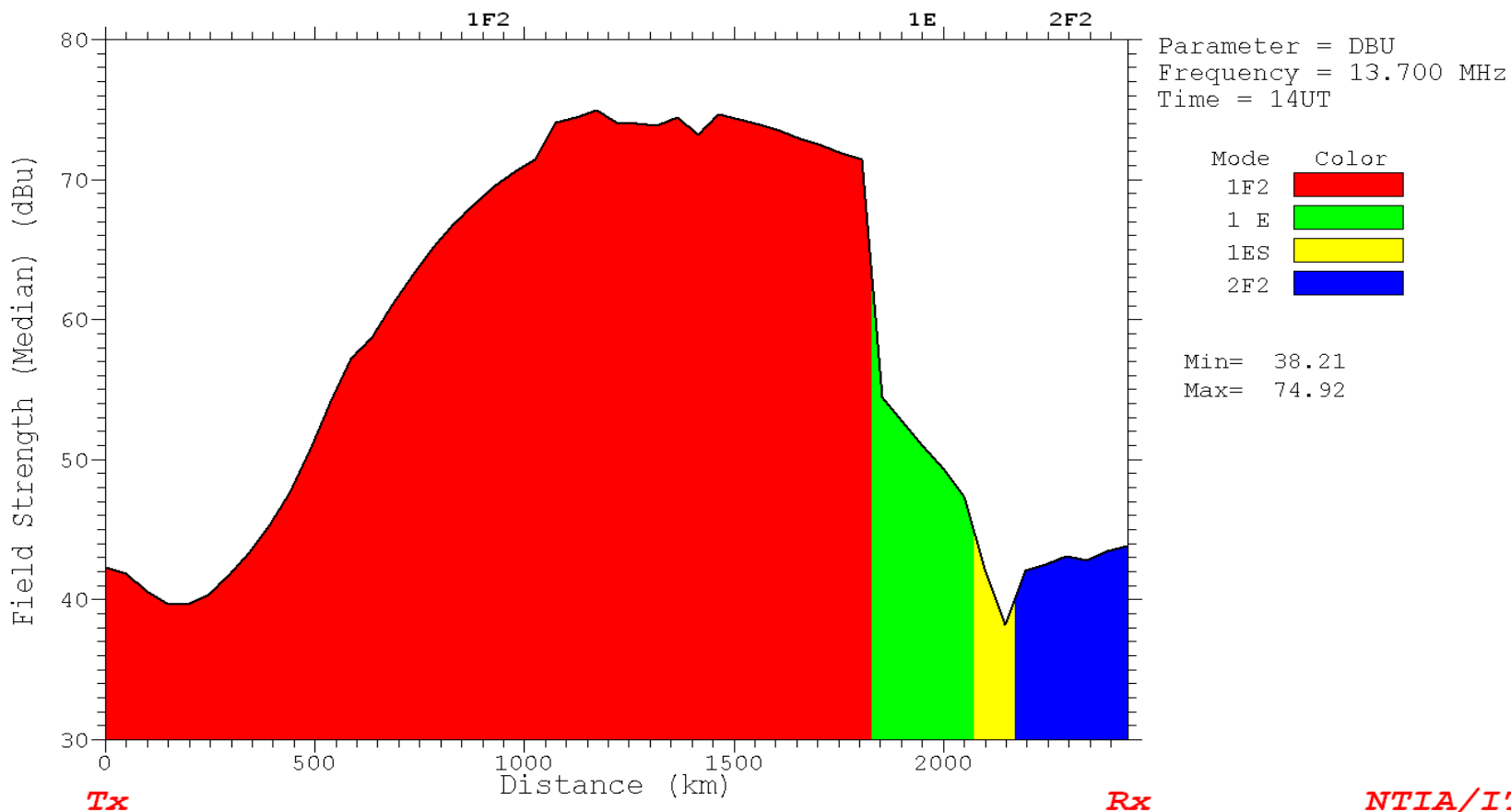
JUN 1995 SSN = 100. Q<sub>eff</sub> = 0.0 Minimum Angle 0.10 deg  
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 3 MHz NOISE = -145.0 DBW REQ. REL = .90 REQ. SNR = 73.0 DB  
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# POINT-TO-POINT BY DISTANCE

URSI Coefficients      METHOD 20      ICEPAC Version 040324W PAGE 1

JUN 1995      SSN = 100.      Qeff= 0.0      Minimum Angle 0.10 deg  
TANGIER, Morocco      BELGRADE      AZIMUTHS      N. MI.      KM  
35.80 N      5.90 W - 44.90 N      20.50 E      57.41      254.73      1317.9      2440.5  
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RCVR 2-30 2-D Table [DEFAULT\SWWHIP.VOA ] Az= 0.0 OFFaz=254.7  
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

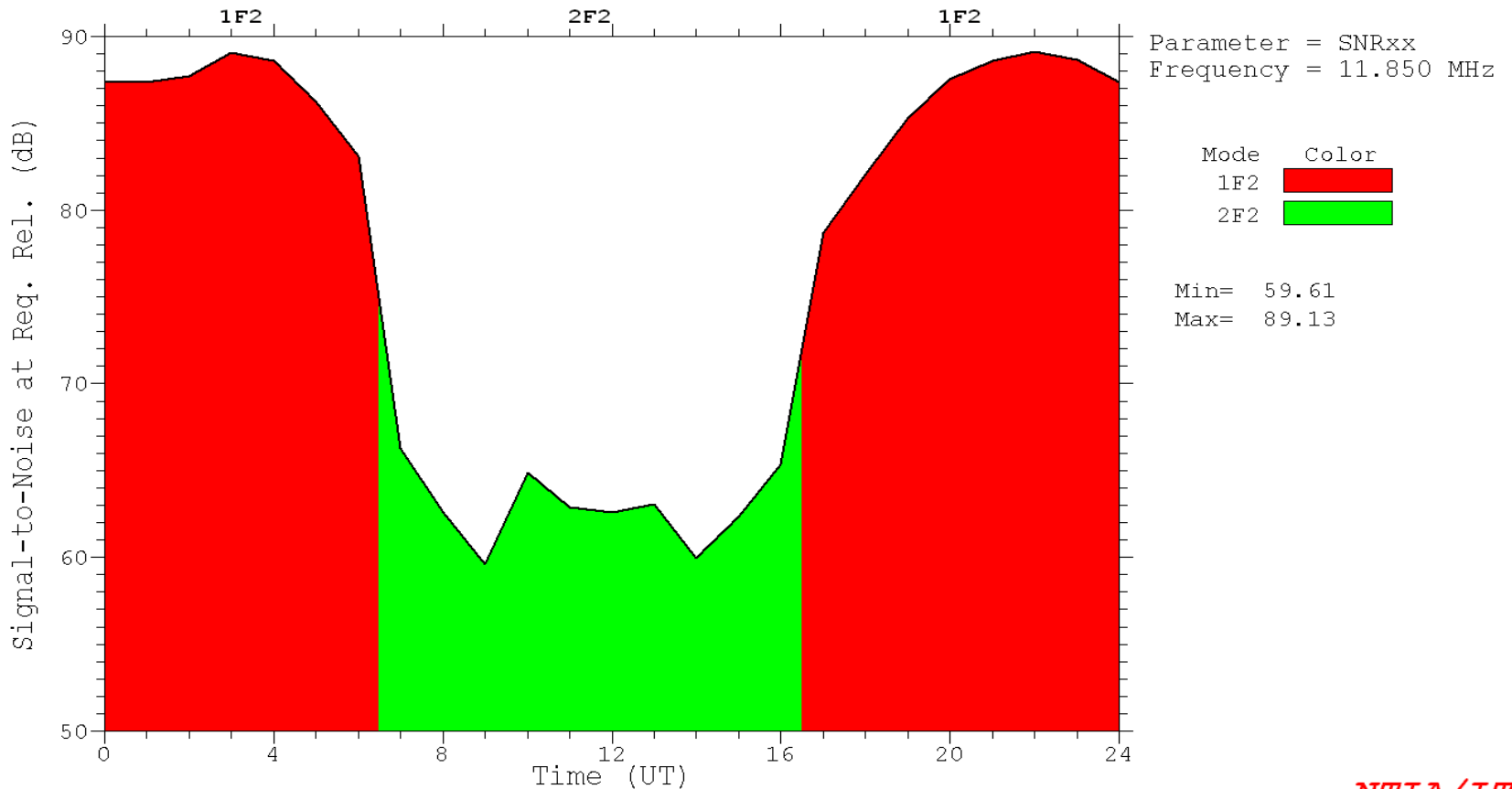


NTIA/ITS

# POINT-TO-POINT BY TIME

URSI Coefficients                      METHOD 20    ICEPAC    Version 040324W    PAGE    1

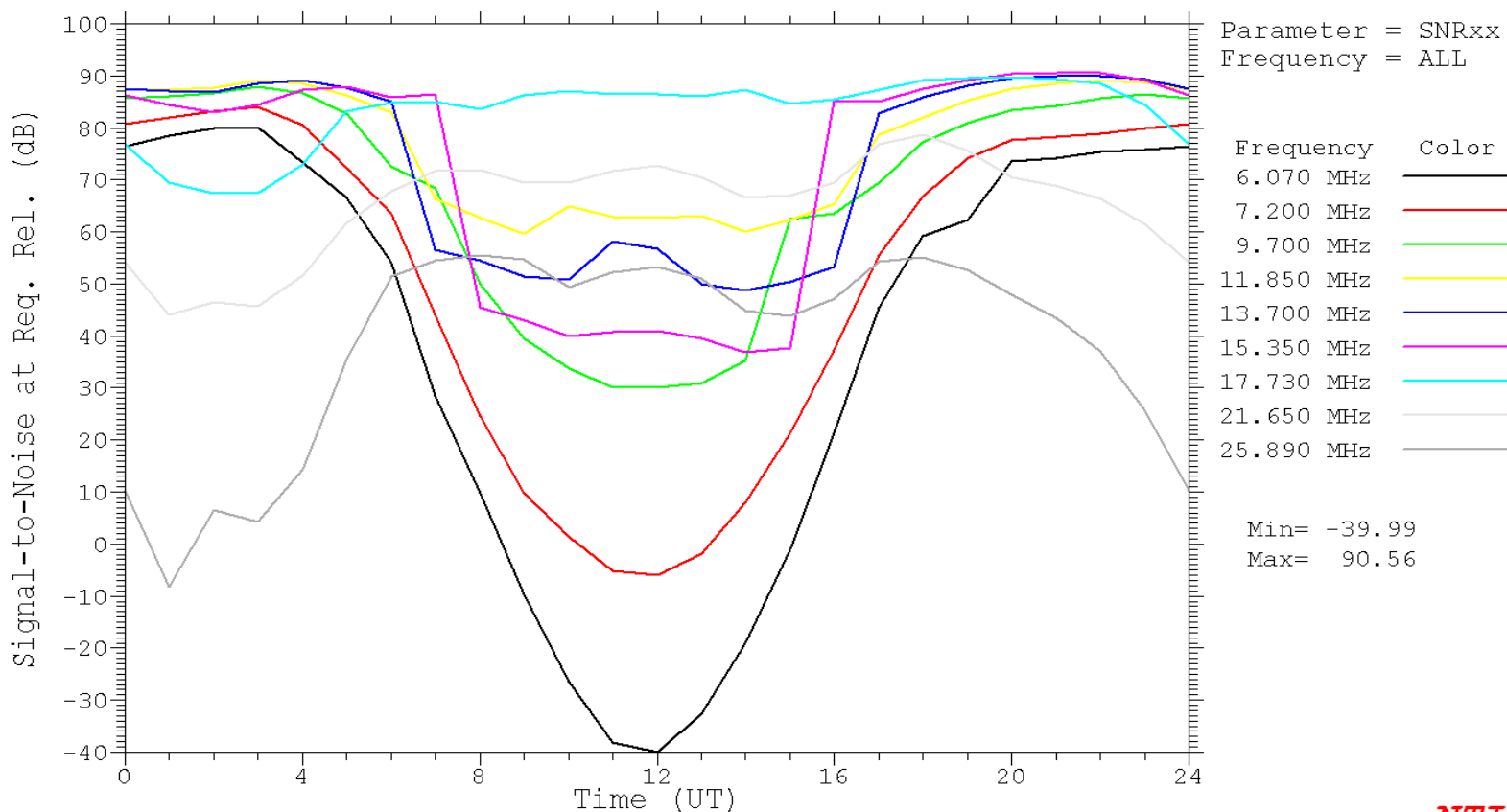
JUN        1995                      SSN = 100.            Qeff= 0.0            Minimum Angle 0.10 deg  
TANGIER, Morocco            BELGRADE            AZIMUTHS            N. MI.            KM  
35.80 N    5.90 W - 44.90 N    20.50 E            57.41    254.73            1317.9    2440.5  
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# POINT-TO-POINT BY TIME

URSI Coefficients                      METHOD 20    ICEPAC    Version 040324W    PAGE    1

JUN        1995                      SSN = 100.                      Qeff= 0.0                      Minimum Angle 0.10 deg  
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MULTIPATH POWER TOLERANCE = 3.0 DB                      MULTIPATH DELAY TOLERANCE = 0.100 MS





# AREA COVERAGE DATA INPUT

VOACAP Area Coverage data input

File Run Abort Save to: Comments Help

Layers Grid Countries Zones Cities MainBeam Contours  
 Black Blue Magent Ignore Red Black with shading

Parameters MUF DBU SNRxx REL Contours

Grid 0=Great Circle Size= 31 x 31

Path Short

Coefficients CCIR (Oslo) Method 20 = Auto Select

Transmitter 35.80N 5.90W TANGIER, Morocco

Plot Center 35.80N 5.90W TANGIER, Morocco  
 X-range=-1000.0km to 6000.0km Y-range=-1000.0km to 4000.0km

Groups Month.Day= 6.00  
 SSN = 100  
 Time UT = 18  
 Freq MHz = 11.850

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

Eprob 1.00\*foE 1.00\*foF1 1.00\*foF2 0.00\*foEs

Tx Antenna default\CCIR.003 REC705 #01 0.000MHz 57.0deg 500.0000kW

Rx Antenna DEFAULT\SWWHIP.VOA 0.0deg 0.00dB

Input Help:

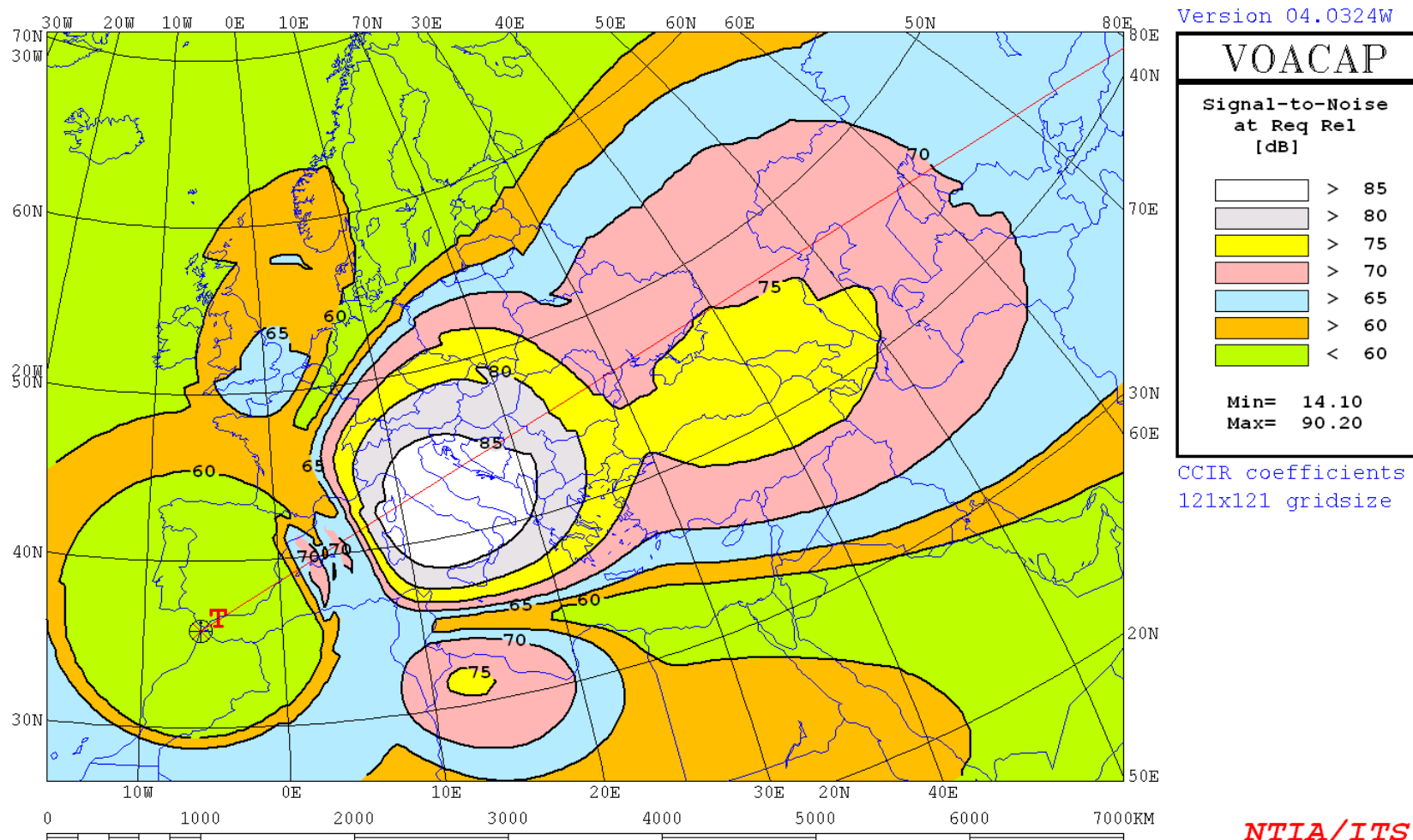
# AREA COVERAGE MAP

TANGIER, Morocco [HR 4/4/.5 ] 500kW 57deg 18ut 11.850MHz Jun 100ssn

Tx location to grid of Rx

SNR<sub>xx</sub>

AREADATA\DEFAULT\DEF\_121.V31



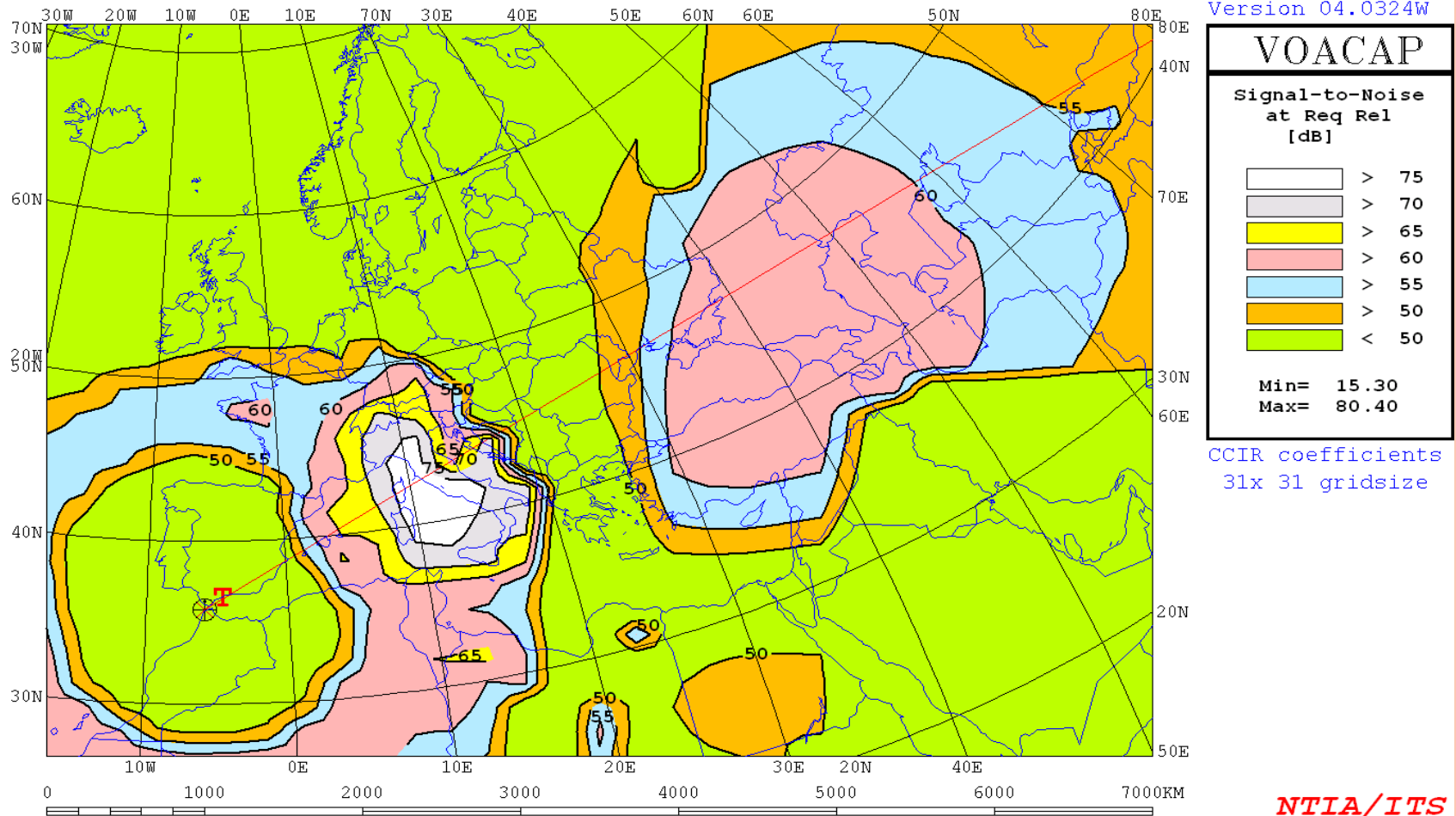
# COMBINE MULTIPLE COVERAGES

Combine 6 hours Min SNRxx

Tx location to grid of Rx

SNRxx  
AREADATA\DEFAULT\SSW\_MIN.V11

Version 04.0324W



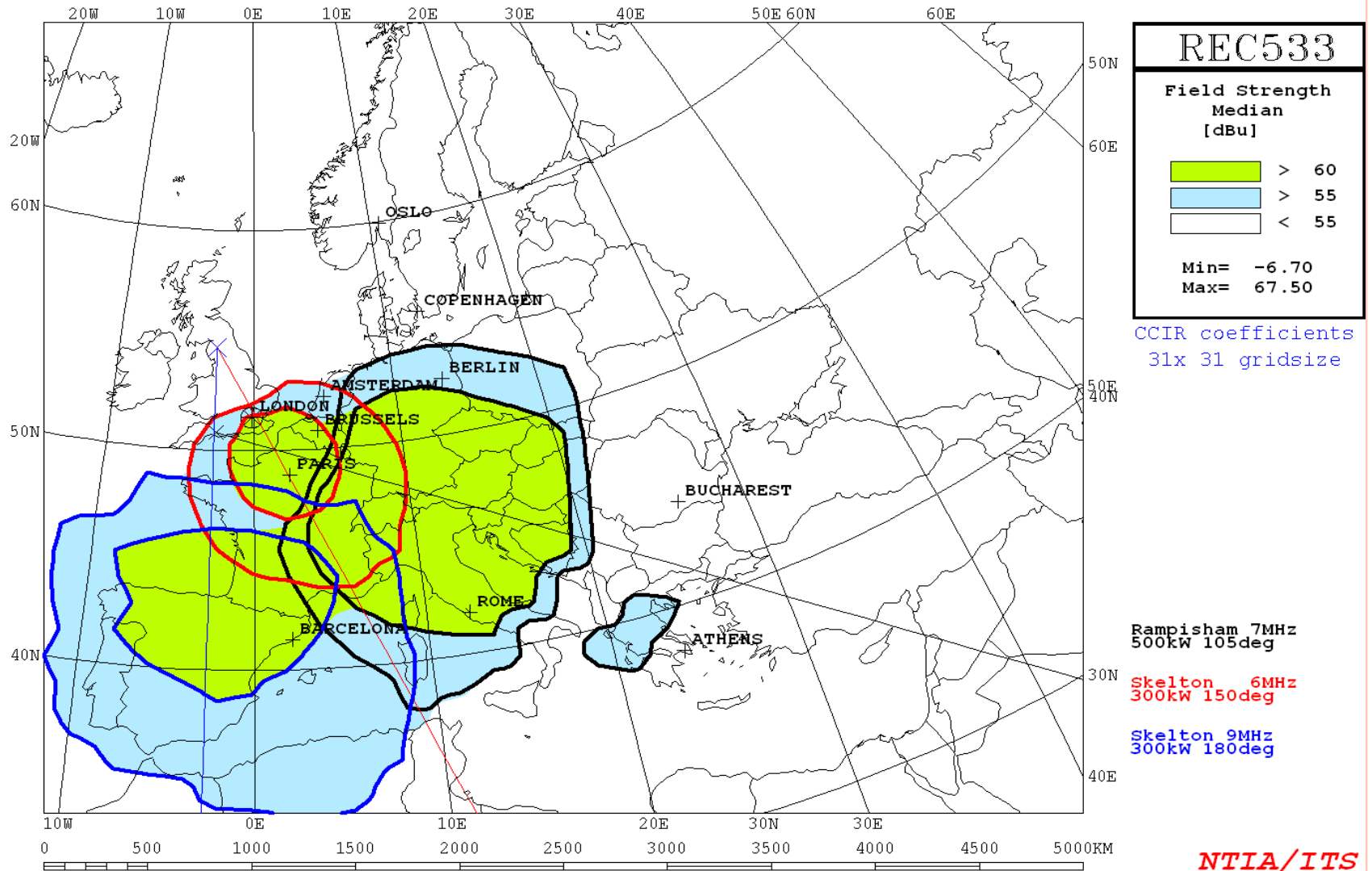
# OVERLAY MULTIPLE COVERAGES

Multiple Coverage 1800UTC June 50SSN

DBU

Overlay of multiple grid files

areadata\ian\overlay3.ovl



NTIA/ITS

ANY QUESTIONS?