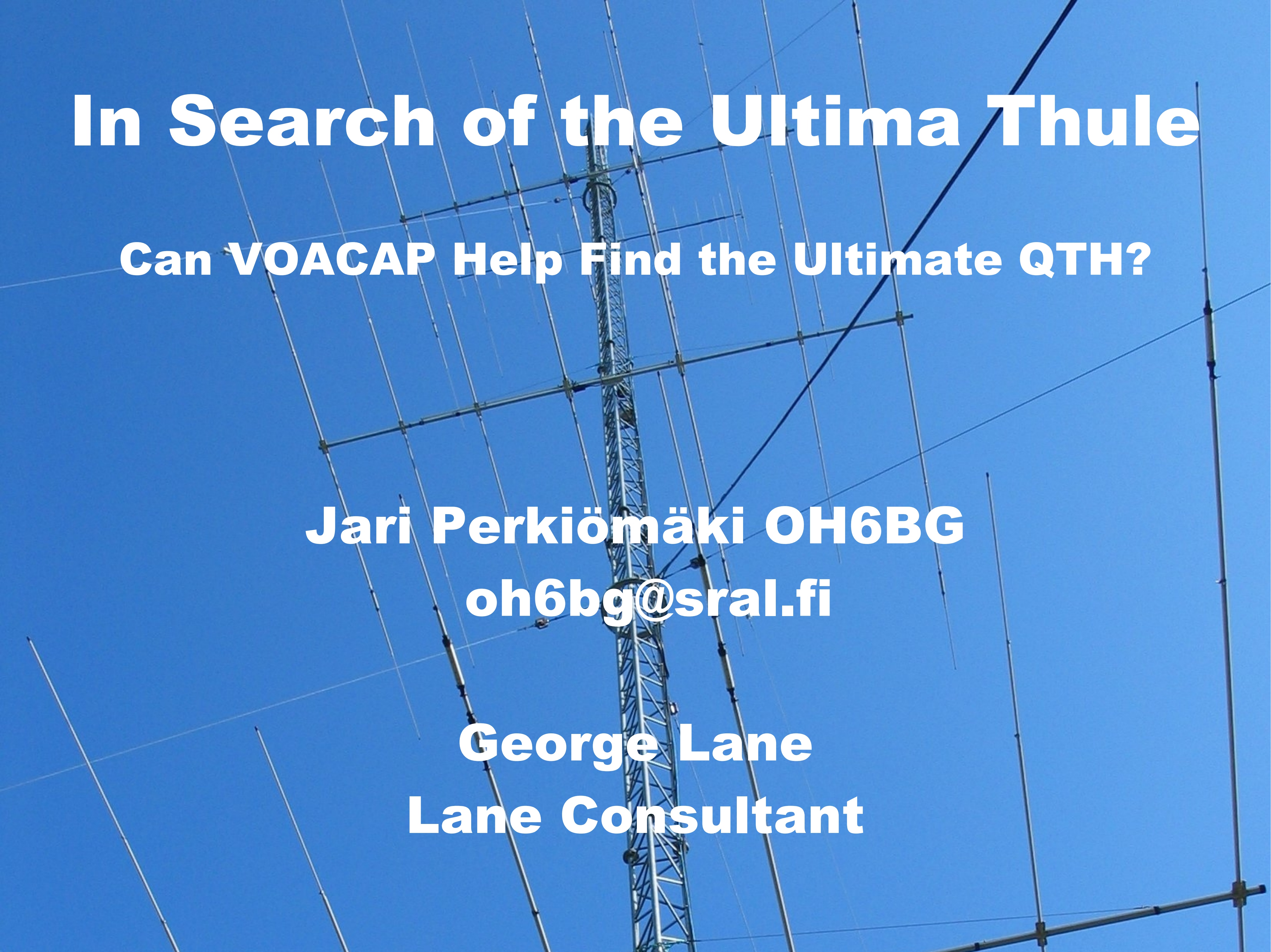

In Search of the Ultima Thule

Can VOACAP Help Find the Ultimate QTH?

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George Lane
Lane Consultant

The Problem

- Where on earth is the ultimate QTH to run the CQ WW DX Contest from 160M to 10M during the sunspot minimum (November 2006)?
  - 10M may be an extremely important band!
- We will use VOACAP – the HF propagation prediction program – to tackle the problem from 40M up. Free download from www.voacap.com.
- We will use DX Atlas/GeoClock on low-bands.

The Solution

- Contest Strategy Planning, no pre-defined antennas
  - 24-hour calculations of the MUF, Required Power and Take-Off Angles of antennas for most important zones
    - Antennas designed to meet predictions
- Contest Strategy Planning, existing antennas
  - Straightforward calculations of Reliability (REL)
  - Simulation of the existing setup
- Accurate simulation model is very important.

VOACAP SWOT Analysis

STRENGTHS

- Solid, professional-grade propagation prediction engine
- Versatile graphical output
- Freely available, online community support

WEAKNESSES

- Low-band DX propagation
- Steep learning curve
- Statistical, not real-time

OPPORTUNITIES

- Good understanding of HF propagation
- Strategic HF planning
- Rich simulation possibilities (QTH, Ants, Pwr, Sunspots, Month,...)

THREATS

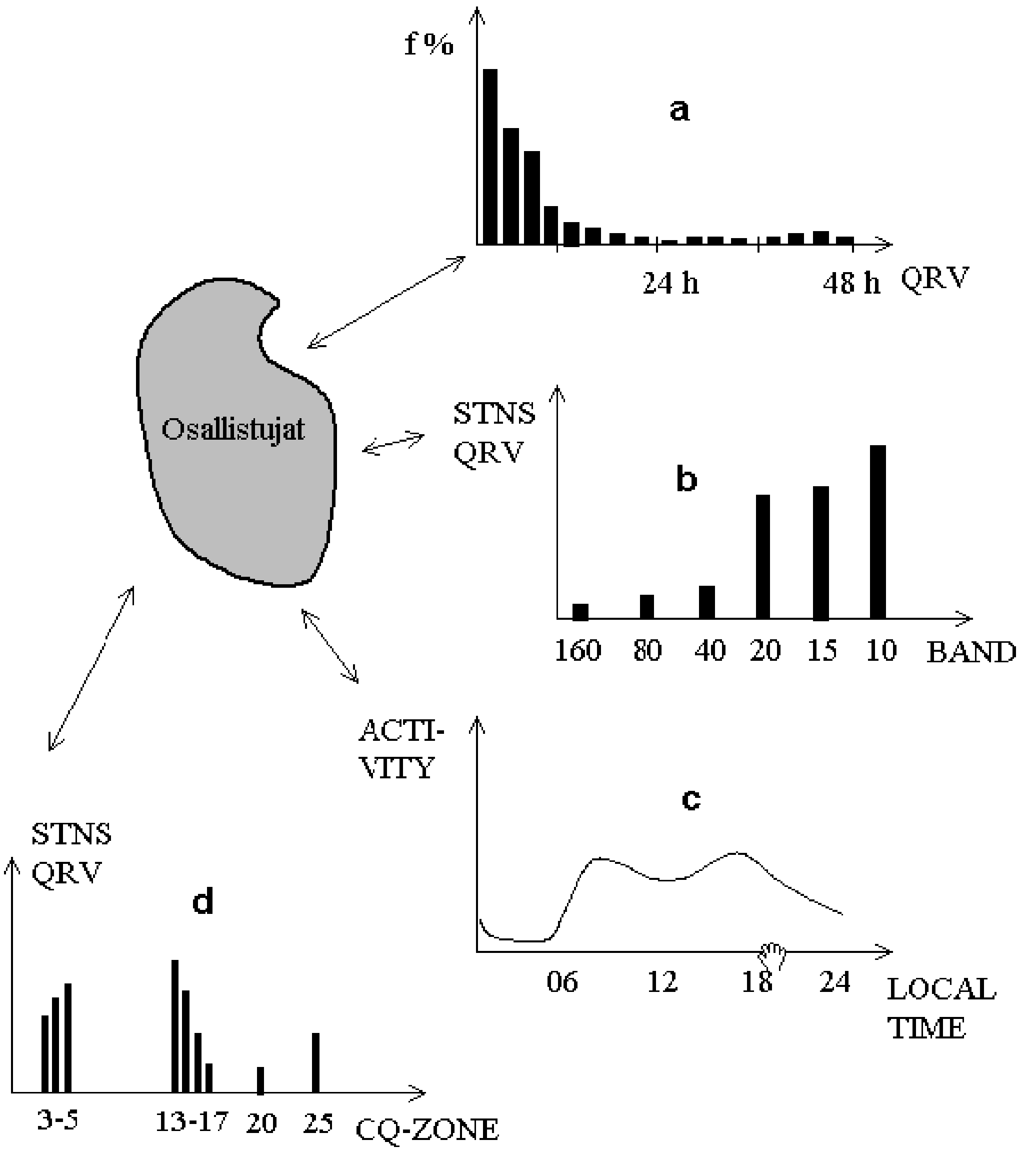
- Incorrect input parameters from user
- Misinterpretation of results by user
- Seeing the trees and the wood

A Reminder from Our Sponsors

- Contacts from one continent to another are 3 points, within the continent 1 point (except within North American countries: 2 points)
- CQ Zones and DXCC countries are multipliers

Not every country is as desirable as another because – besides the multiplier – you would like those countries to have a large contesting ham population, too.

Breakdown of contesters



a) by operating time

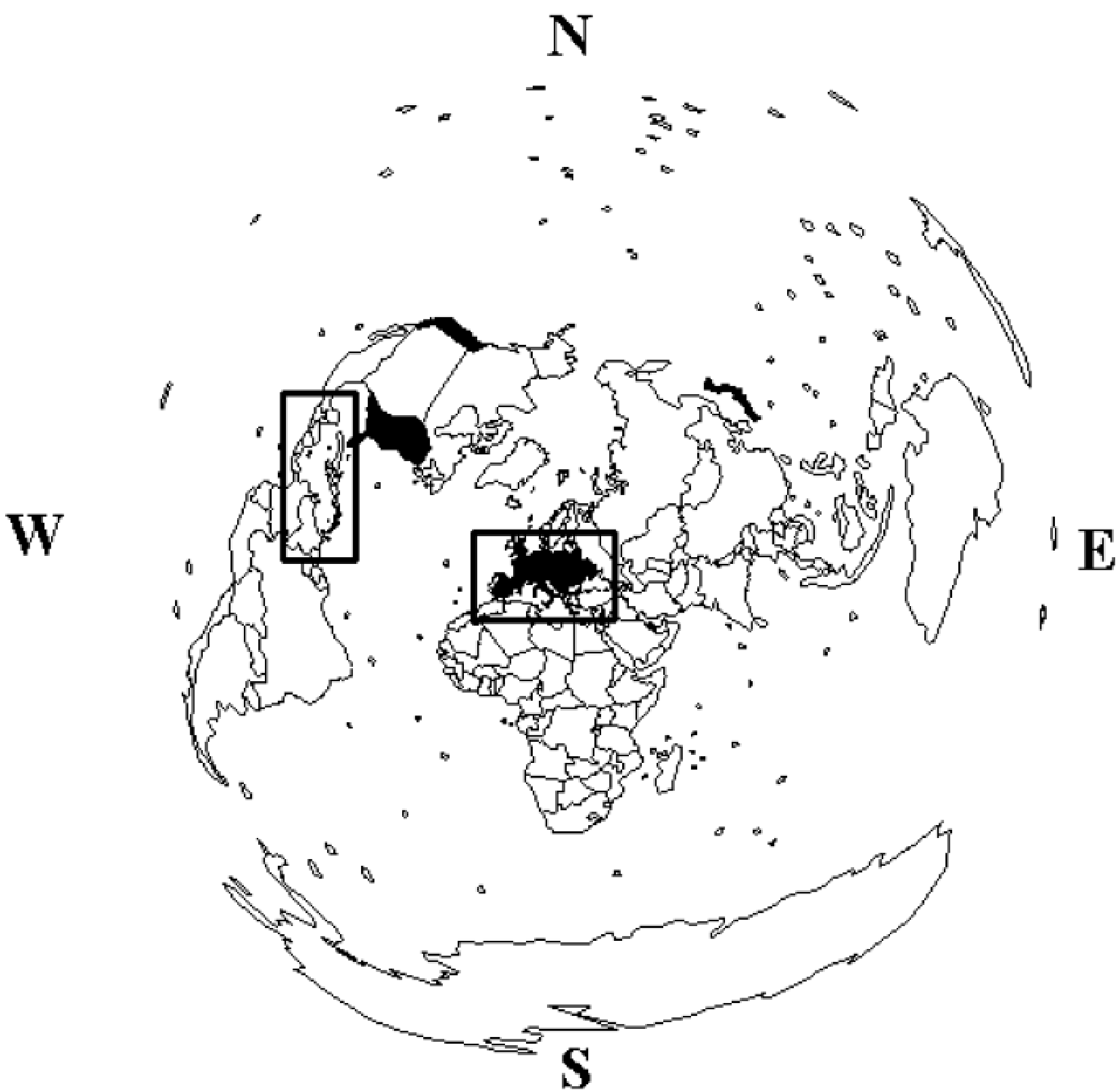
b) by band

c) by local time

d) by zone

Analysis courtesy of Ilkka OH1WZ

Concentration of QSOs and mults



- Zones & countries as mults => mults have a ”rarity factor”

Analysis courtesy of Ilkka OH1WZ

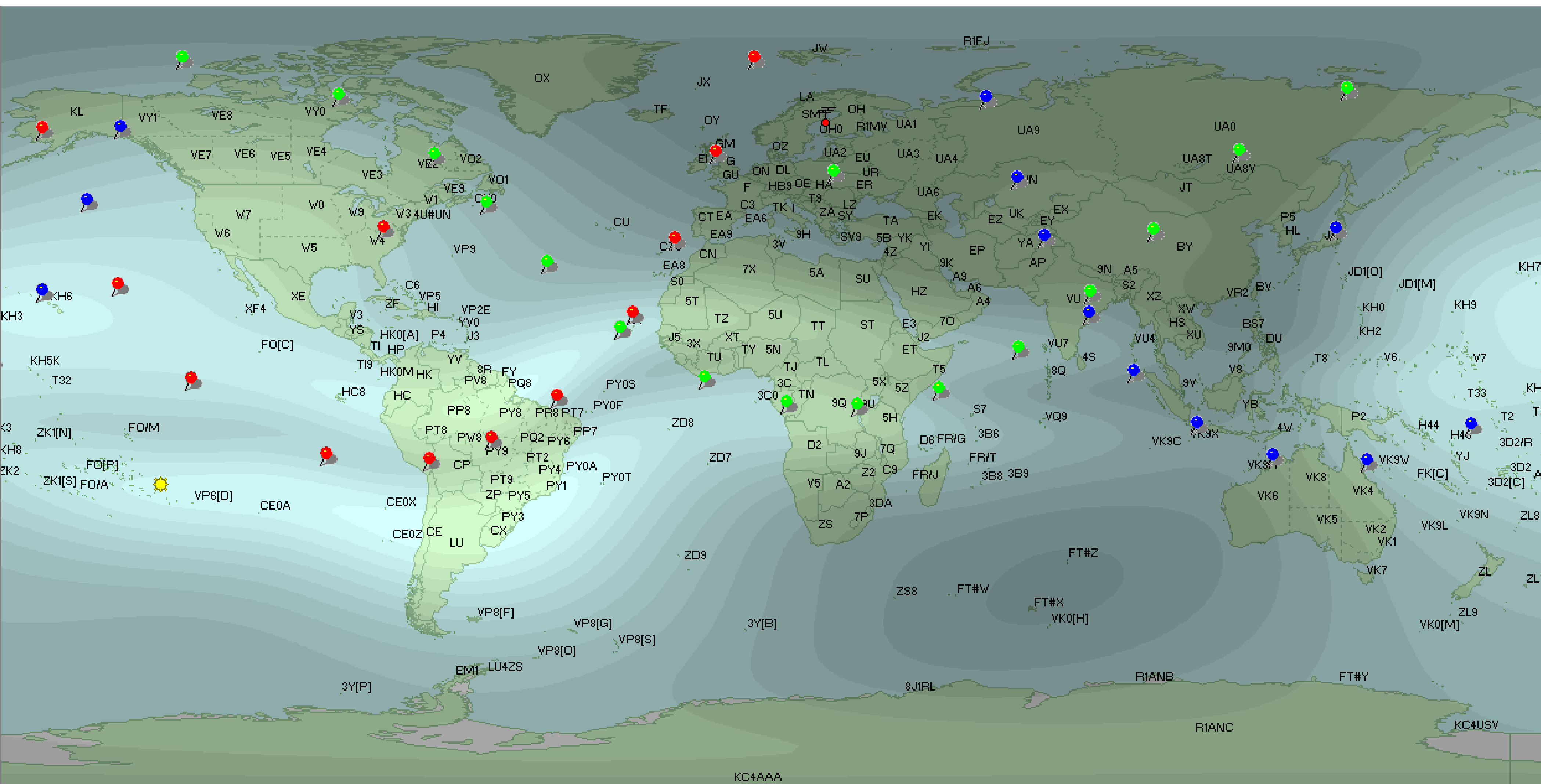
The 6000-km Rule

- Use the 1F2 or 2F2 modes which means a maximum path distance of about 6000 km.
- See if there is a location on the earth that gets to the most hams within the 6000 km limit. That location gives you the highest probability of getting contacts fast on the lower bands.
- However, on 1.8 and 3.5 MHz there may be 4F2 or even 5F2 modes at 6000 km.
- On the upper bands one would also expect very long paths to work... i.e. trans-equatorial E-W, N-S paths of over 6000 km.

The 6000-km Rule

Centers: Red = W4; Green = HA; Blue = JA

drawn on an foF2 map (the lighter the area, the stronger the ionosphere)



Head for Lower Latitudes

- Use a lower latitude site to get away from geomagnetic storms, and other solar disturbances.
- The MUFs will be higher for more of the day as the sun will help.
- Stay away from areas of high atmospheric noise for that season. In general, November would indicate a Northern Hemisphere location rather than a Southern location.
- Wherever you locate, pick a place with low man-made noise.

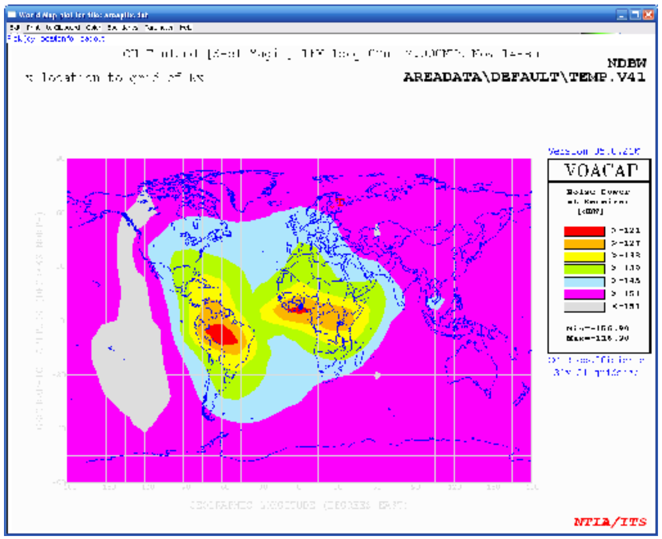
Again, Watch for Noise!

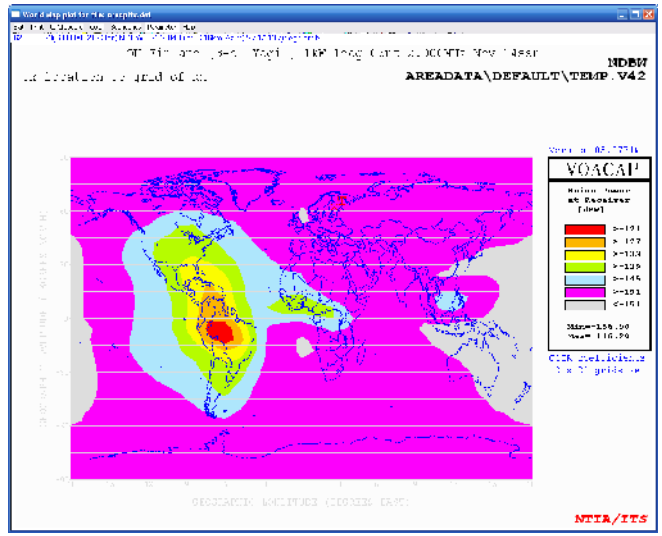
- The NDBW maps of VOAAREA are good for planning purposes since they include man-made noise contribution which the CCIR Atmospheric Noise maps do not.
- Atmospheric noise will be the highest at the lowest band. So you want a location where the atmospheric noise is low at 2 MHz. The noise decreases as the frequency increases.
- Look at the Noise Maps of 02, 06, 10, 14, 18, 22 UTC. The original maps were set up for 4-hour time blocks.

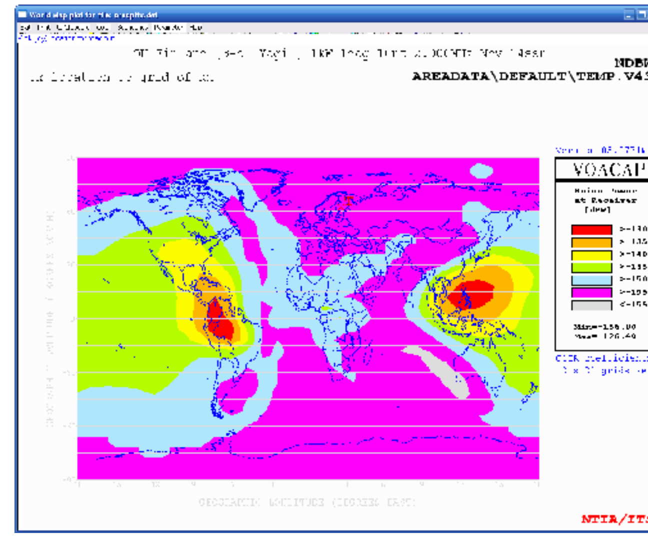
More on Noise.

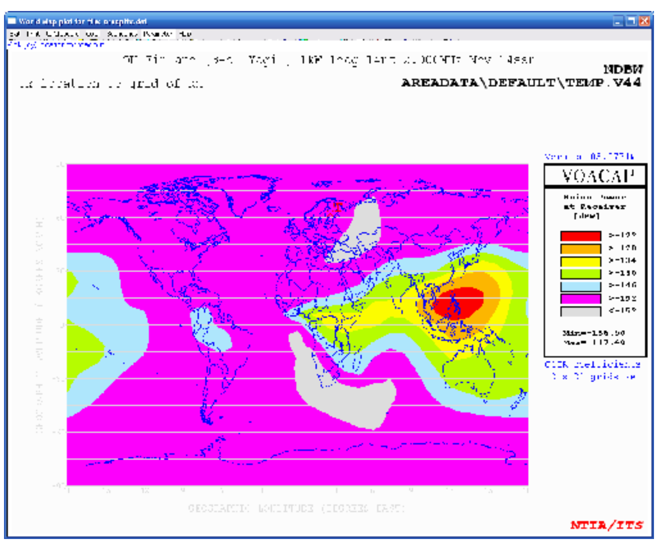
- If you want to study Noise closer, run NDBW maps for each band (2, 3.5, 7, 14, 21 and 28) for every 4 hours; might not be necessary.
- Set the man-made noise to remote rural (-164) or rural (-150) so that you do not get too low values of noise.
- The VOAAREA noise maps are for UTC whereas the CCIR Noise maps are for Local Time!
- In the daytime the atmospheric noise is absorbed in the D-layer and local man-made noise prevails.

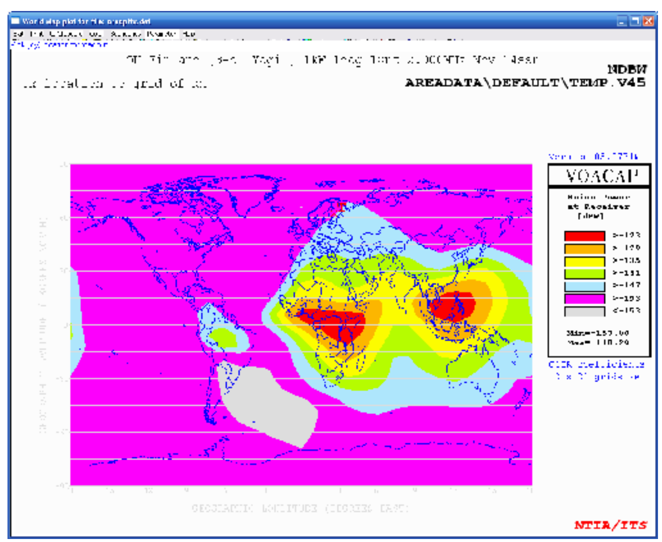
Atmospheric Noise, November

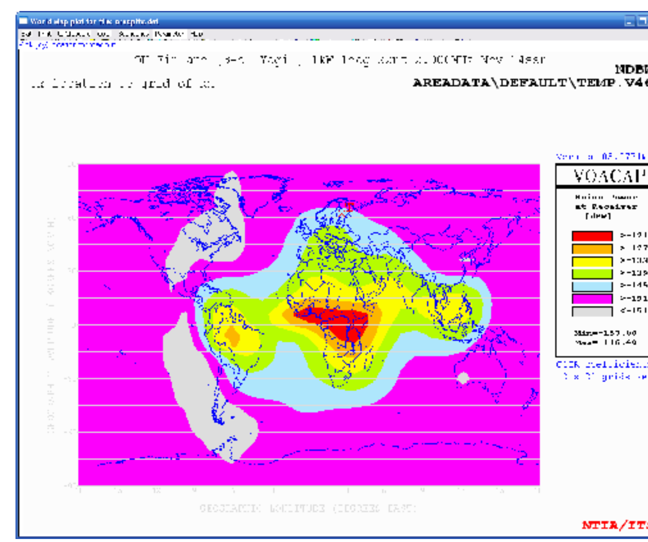






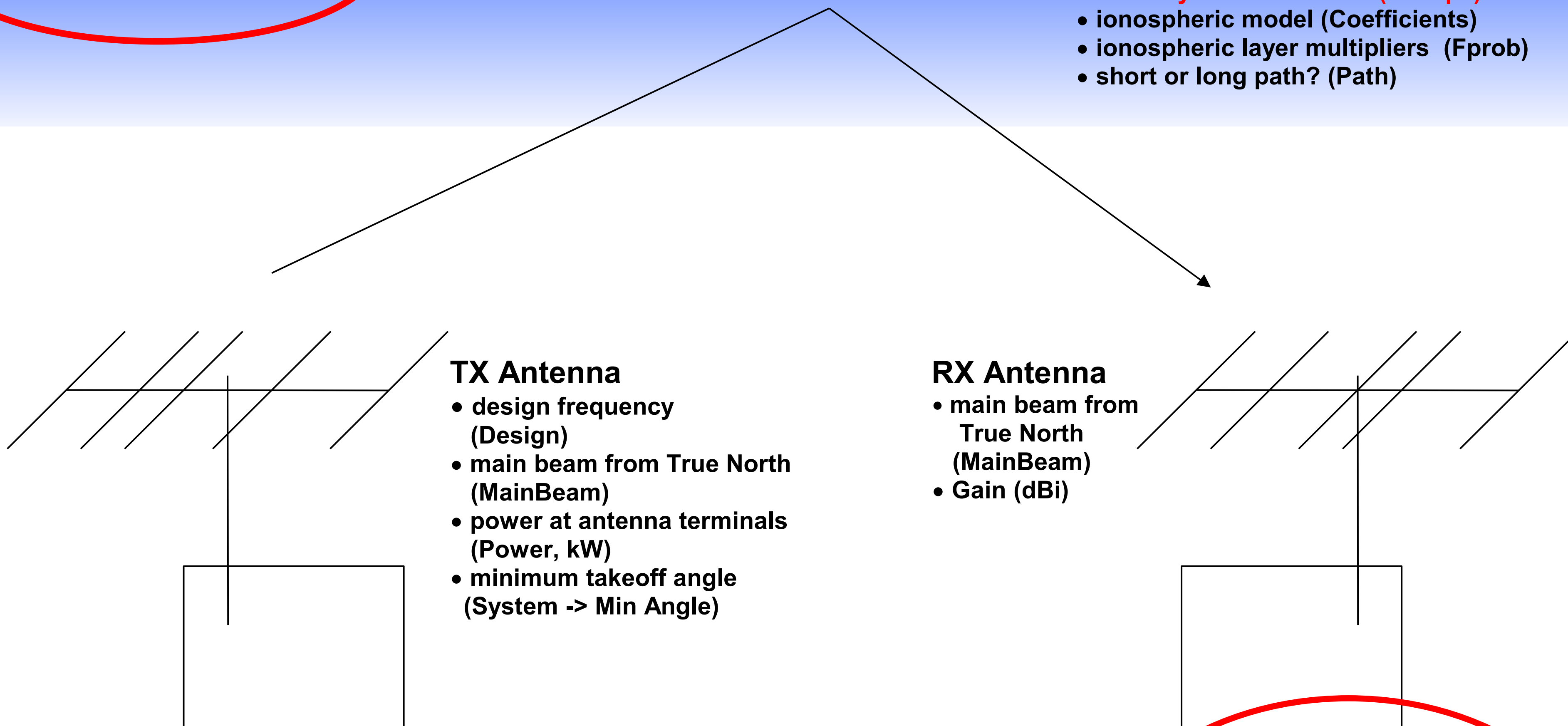






Ionosphere

- propagation calculation method (Method)
- monthly smoothed SSN (Groups)
- ionospheric model (Coefficients)
- ionospheric layer multipliers (Fprob)
- short or long path? (Path)



TX Antenna

- design frequency (Design)
- main beam from True North (MainBeam)
- power at antenna terminals (Power, kW)
- minimum takeoff angle (System -> Min Angle)

RX Antenna

- main beam from True North (MainBeam)
- Gain (dBi)

Station A

(Transmitter)

- **coordinates**

Station B

(Receiver)

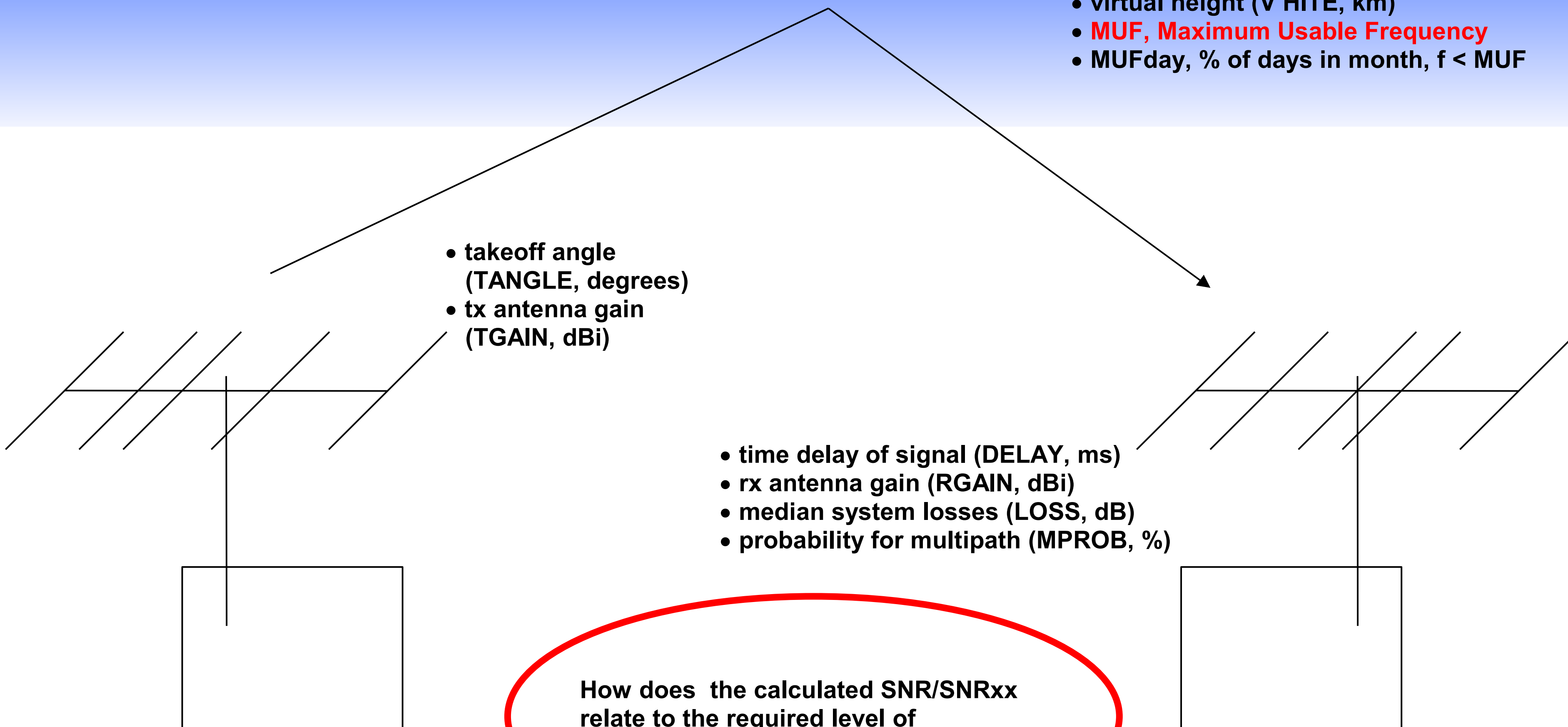
- **coordinates**
- **man-made noise (System -> Noise)**

Key points for the communication system

- output parameters on the given frequencies (Freq(MHz))
- required level of reliability (System -> Req.Rel, use always 90%)
- required level of intelligibility (System -> Req SNR), varies by mode

Ionosphere

- ionospheric path (MODE)
- virtual height (V HITE, km)
- MUF, Maximum Usable Frequency
- MUFday, % of days in month, f < MUF



How does the calculated SNR/SNRxx relate to the required level of intelligibility, REQ SNR?

Station A

Key points for the communication system

- signal/noise median SNR; lower decile: SNR LW, upper: SNR UP
- SNR90, signal/noise at Req.rel. (90% = 27 days)
- required power gain RPWRG (dB)
- REL, % of time SNR >= REQ SNR (availability of REQ SNR)
- S PRB, probability of reaching Req.rel.

Station B

- field strength DBU
- signal power S DBW
- noise power N DBW
- lower decile of signal power SIG LW
- upper decile of signal power SIG UP

VOACAP and low-bands

- Use VOACAP with caution on longer paths – will not predict DX. Looks good down to 40M.
- As ON4UN puts it, ”In my 40+ years of DXing on 80, and in my 15+ years on 160, I have never successfully used a propagation-prediction program.”
- Use sunrise/sunset times and a good mapping software such as DX Atlas!
- **For sunrise and sunset times**, see http://www.uwasa.fi/~jpe/sun.shtml or better yet: http://aa.usno.navy.mil/data/docs/RS_OneYear.html

Low-band rules (ON4UN)

- For E-W paths (±45°)
  - peak at around sunset at West end of the path
  - peak at around sunrise at the East end of the path
  - often a peak at local half-way midnight
- For N-S paths (±30°), a distinct peak at local midnight at the half-way spot.
- **Half-way point calculator**: http://www.movable-type.co.uk/scripts/LatLong.html

Midnight time calculation

WEST OF GREENWICH:

When SR > SS:

MIDNIGHT = SS + (SR - SS)/2

When SR < SS:

MIDNIGHT = SS + (SR - SS – 2400)/2

EAST OF GREENWICH:

When SR > SS:

MIDNIGHT = SS + (SR - SS)/2

When SR < SS:

MIDNIGHT = SS + (2400 + SR - SS)/2

Example:

OH to VK3 (Melbourne),

midpoint 22 55N 110 03E

SR 2322, SS 1020 UTC

(January 21, 2006)

MIDNIGHT =

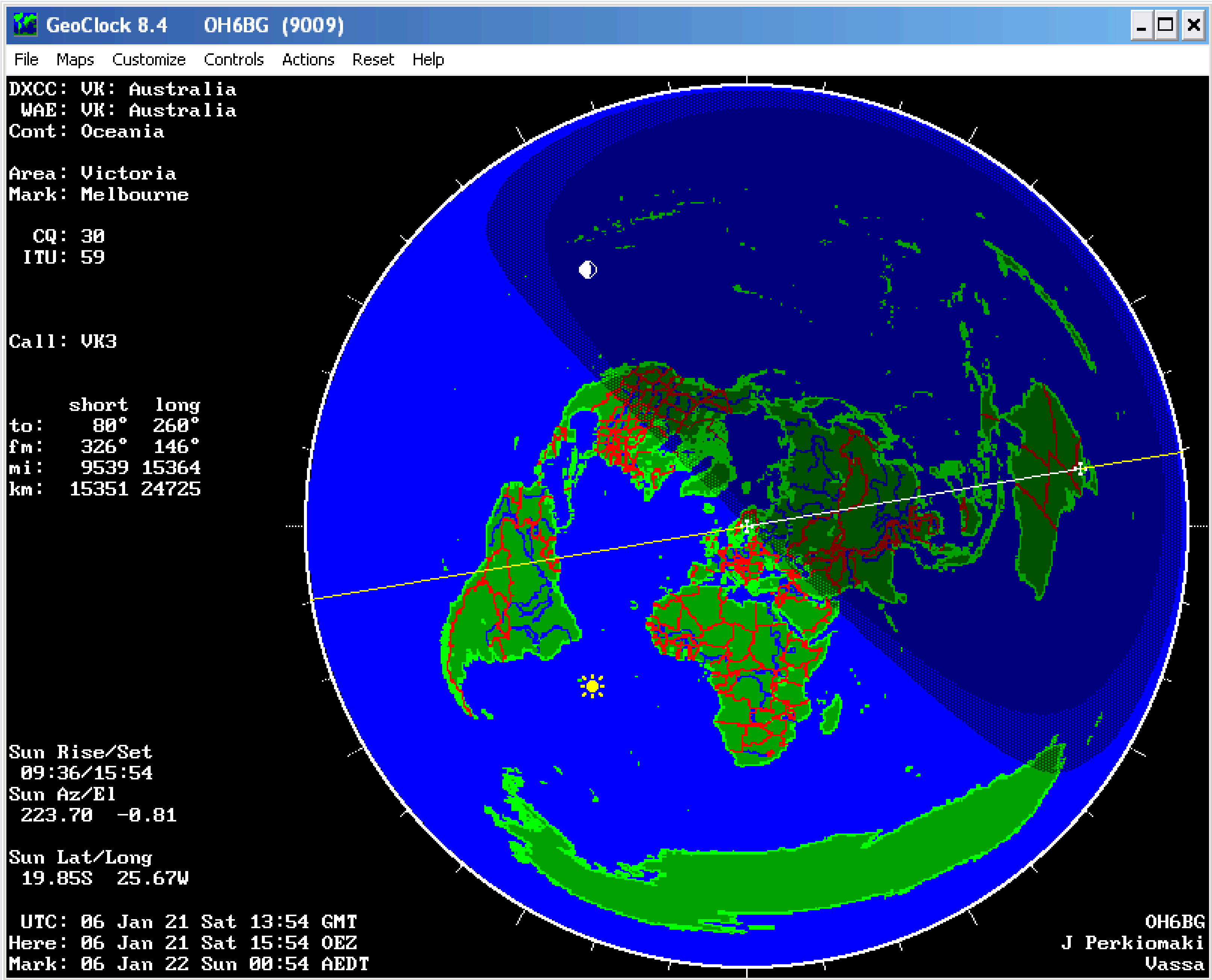
1020 + (2322 – 1020) /2 =

1651 UTC

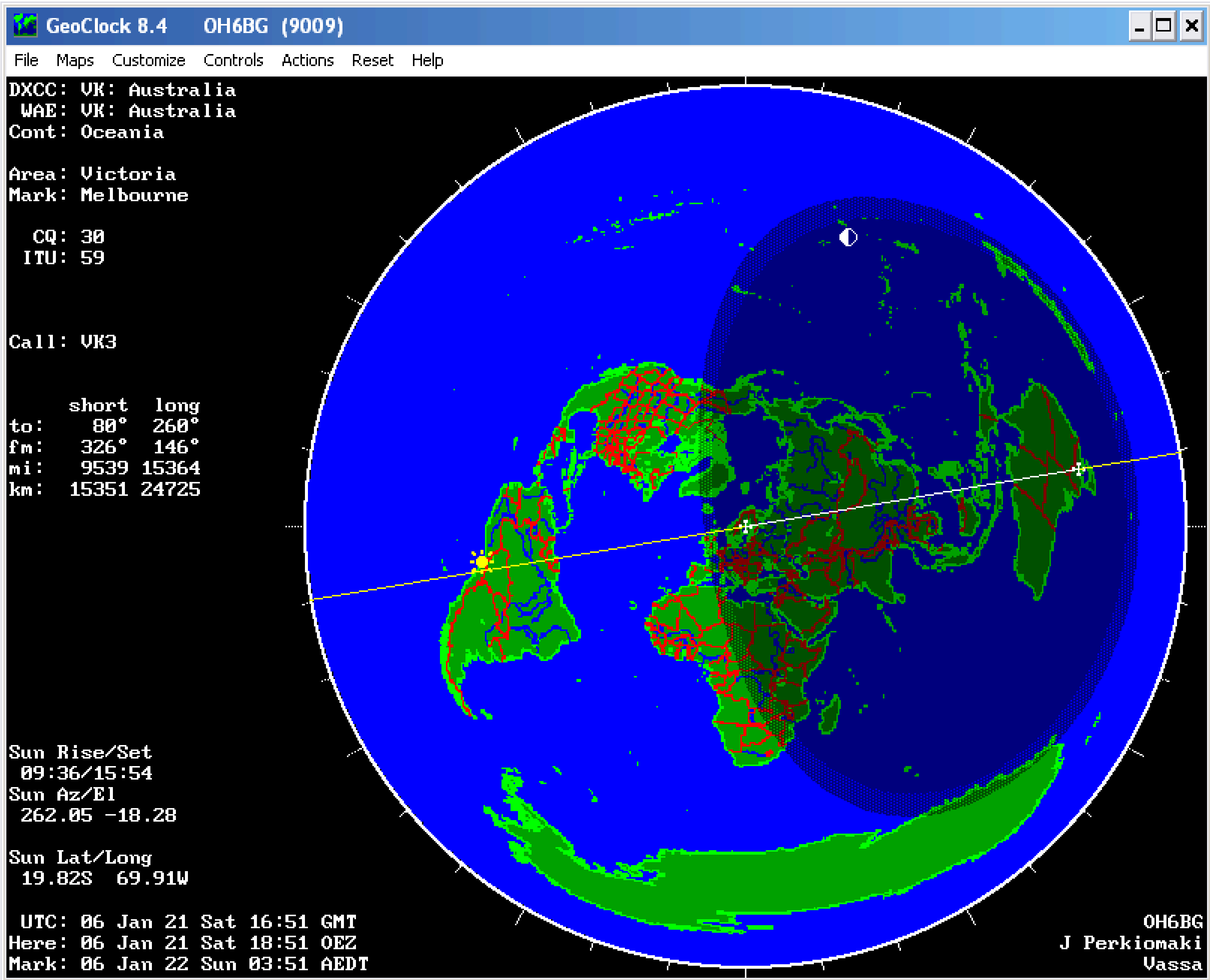
EVEN MUCH EASIER:

http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html

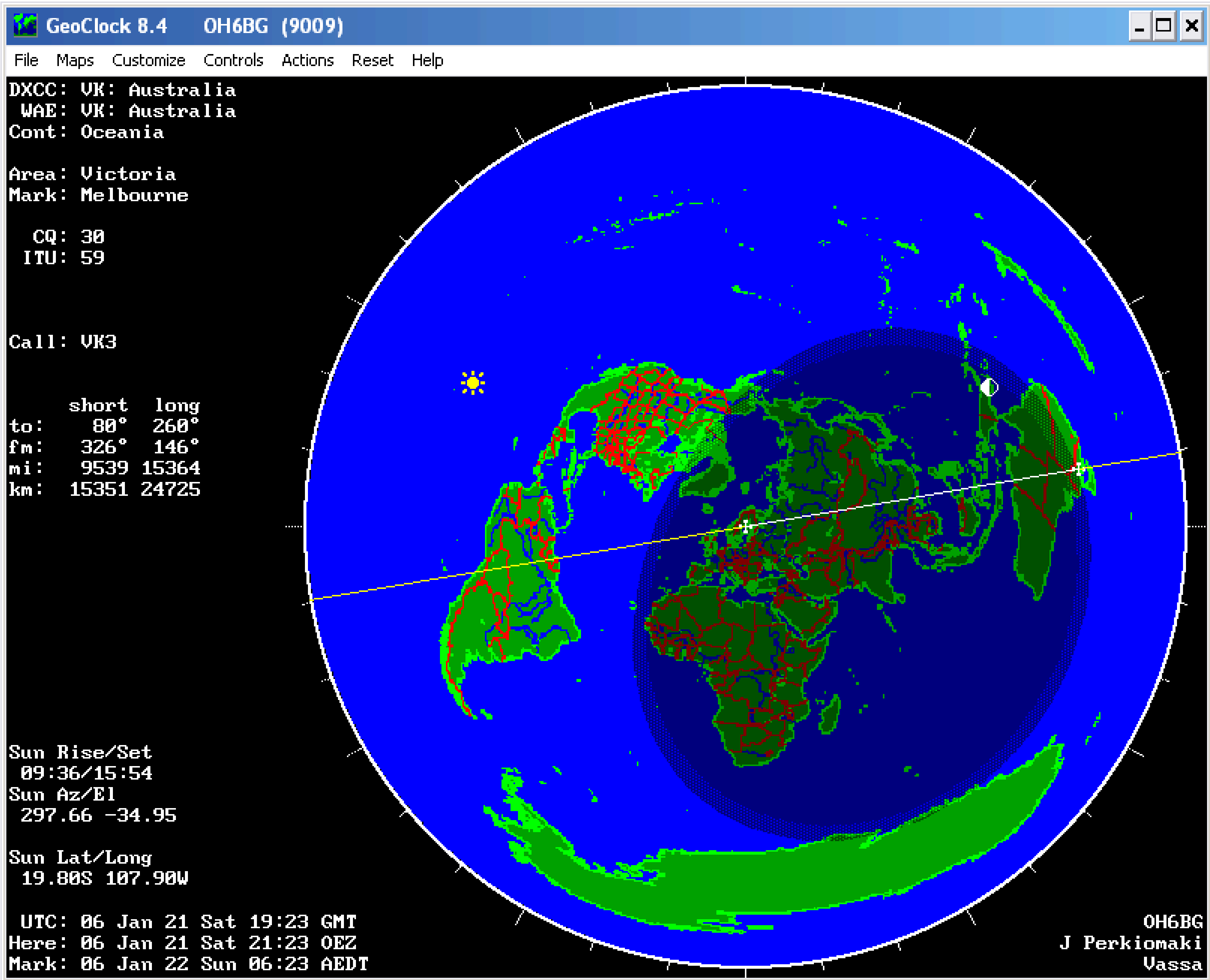
Peak at sunset at West end (1354Z)



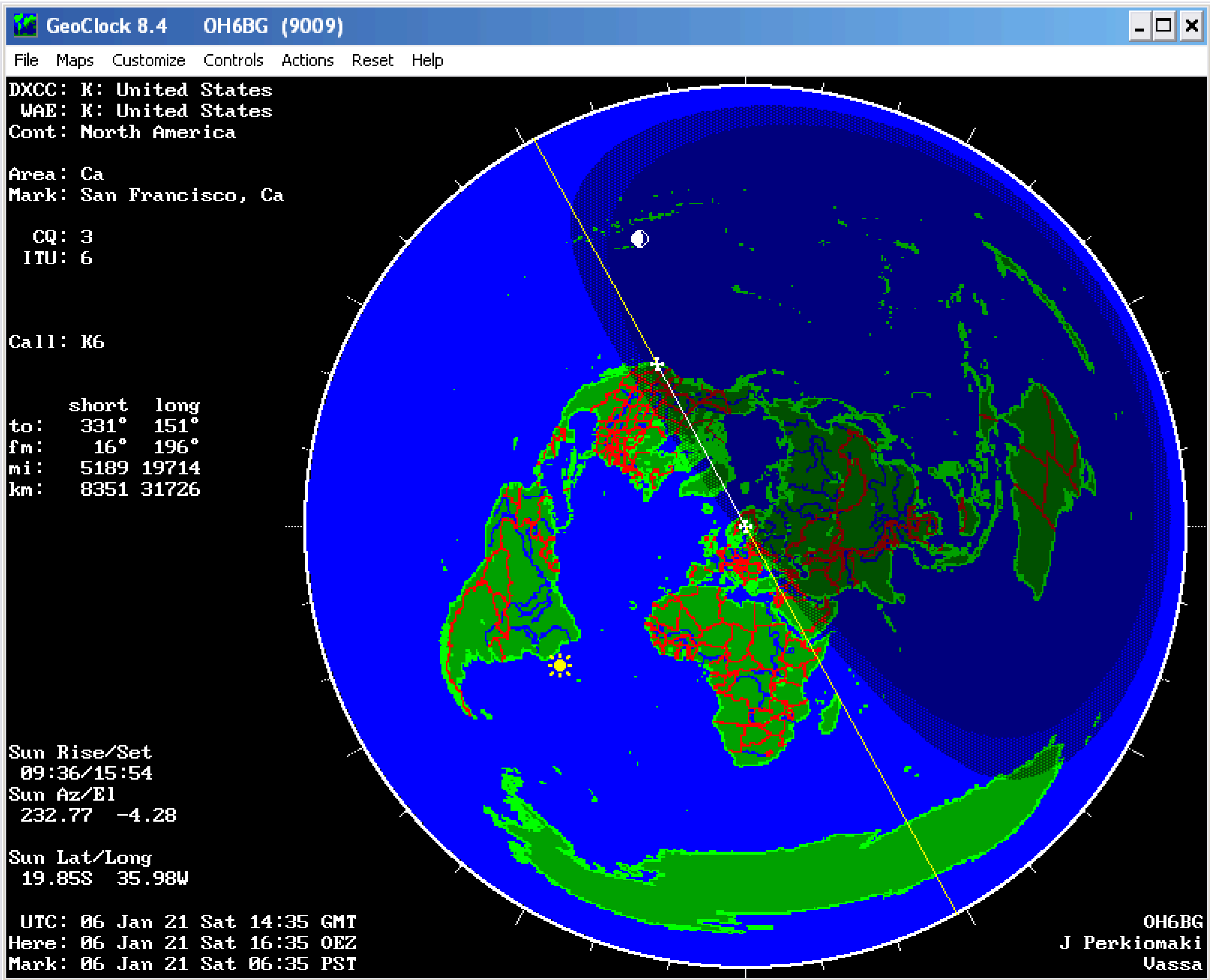
Peak at half-way midnight (1651Z)



Peak at sunrise at East end (1923Z)



Pseudo-long-path OH-K6 (1435Z)



CQWW 80M @ OH2BH in 2002-05

ZONE 3: W/VE sunrise @ OH sunset, pseudo-LP (**1400 to 1500 UTC**)

ZONE 2, 4, 5: W/VE sunset to OH sunrise (**2200/2230 UTC to 0700 UTC**)

ZONE 8, 9: **2130 UTC (sunset) / 2330 UTC** to OH sunrise (**0700 UTC**) ; no clear halfway midnight effect. **Zone 10**: near OH sunrise

ZONE 11, 13: PY7 peak 2300-0100 UTC. **2100 UTC** PY local sunset to OH sunrise (**0700 UTC**). no clear halfway midnight effect.

ZONE 12: CE sunset (**0000-0100 UTC**)

ZONE 25: OH sunset to JA sunrise (**1300 UTC to 2200 UTC**)

ZONE 29, 30, 32: OH sunrise/ZL sunset (**0700 UTC**), OH sunset (**1300-1400 UTC**) ZL halfway midnight 1420 UTC; VK sunrise (**1830-2130 UTC**); OH-VK halfway midnight (1550-1630 UTC East; 1800 UTC West)

ZONE 31: OH sunset ; KH6 sunrise (**1600 to 1630 UTC**)

ZONE 36, 37, 38, 39: local sunset (**1320** [VQ9], V5, ZS, ZD8 [**1900 UTC**]), local sunrise (**0025** [VQ9] to **0600** [ZD8] UTC) ; halfway midnight (5H: 2140[2118]; 5X: 2148[2218])

CQ 160M @ EA8BH in 2004

- Most of QSOs within the range of around 6000-7000 km
- Max distance of around 9000 km (CA, WA)
- Assumptions for propagation peaks:
  - Near Eastern-end-of-path sunrise
  - Halfway midnight peak? Hard to tell from available data.

OK, let's do high bands now!

MUF, TANGLE & RPWRG at glance

- The MUF map leads you to the best frequency for the geographical region under consideration.
- The TANGLE map shows you the take-off angles at which the TX antenna gain is needed to cover the desired region on the best frequency.
- The RPWRG map gives you a qualitative idea of contacts on the best frequency within the desired region.

Start with MUF maps /1

Once you have selected a candidate site:

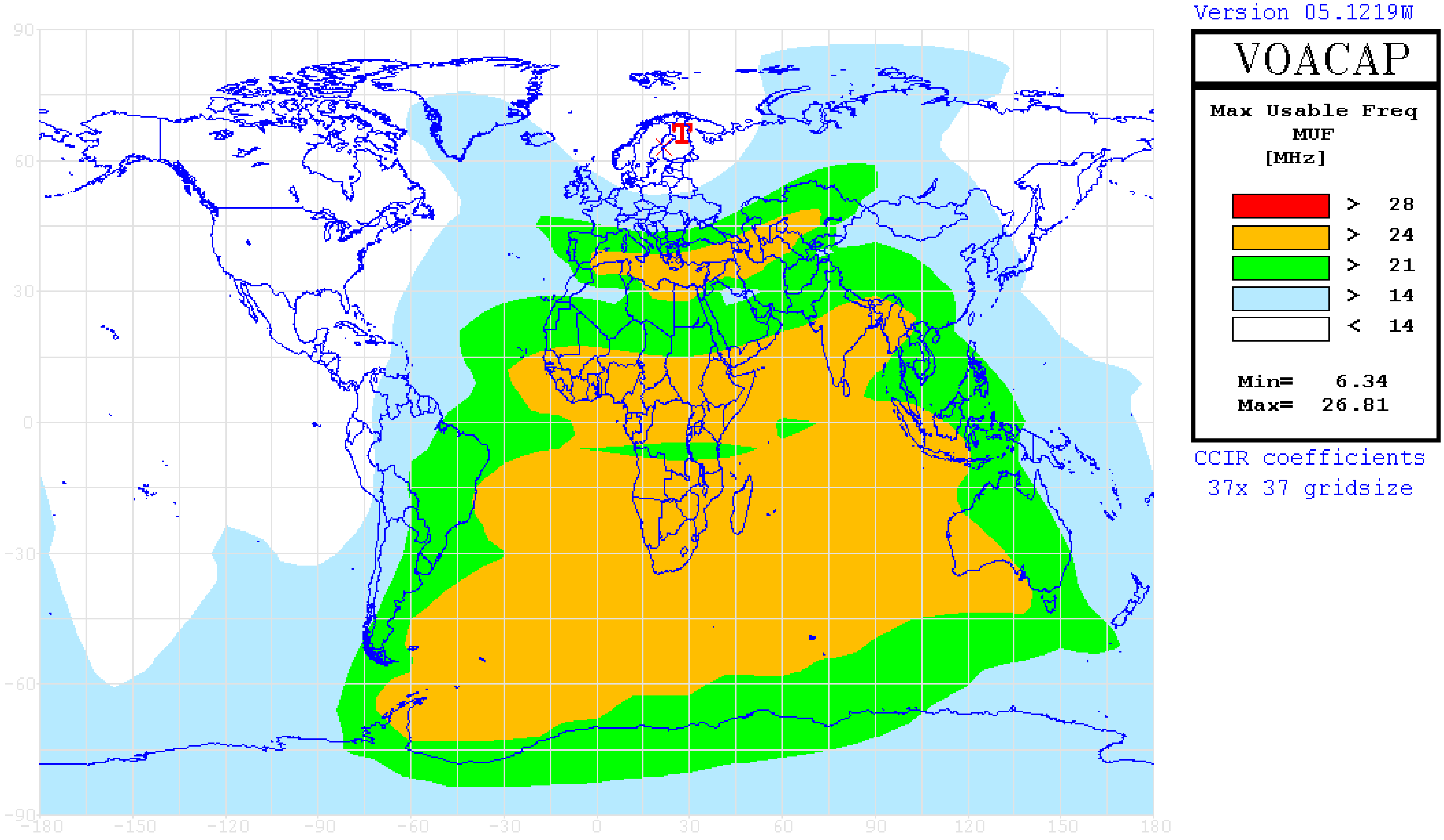
- Run VOAAREA maps for MUF from that site at each hour of the day.
- This will show you where you have a 50-50 chance of contact at that indicated frequency contour.
- Bands slightly lower than MUF will be even more likely.
- These maps will tell you exactly what bands to use for the most contacts per country by hour.

Start with MUF maps /2

- Good signal powers are still available, say, 2-3 MHz above the MUF (however, less reliable)
- Your antenna systems, or power, are not considered in MUF predictions!

When the number of contacts is important, one should concentrate on the bands with the higher reliability. During non-peak hours one can scan the less likely bands based on what might be expected on those hours - gray line, anti-podal focusing and sporadic E layer etc.

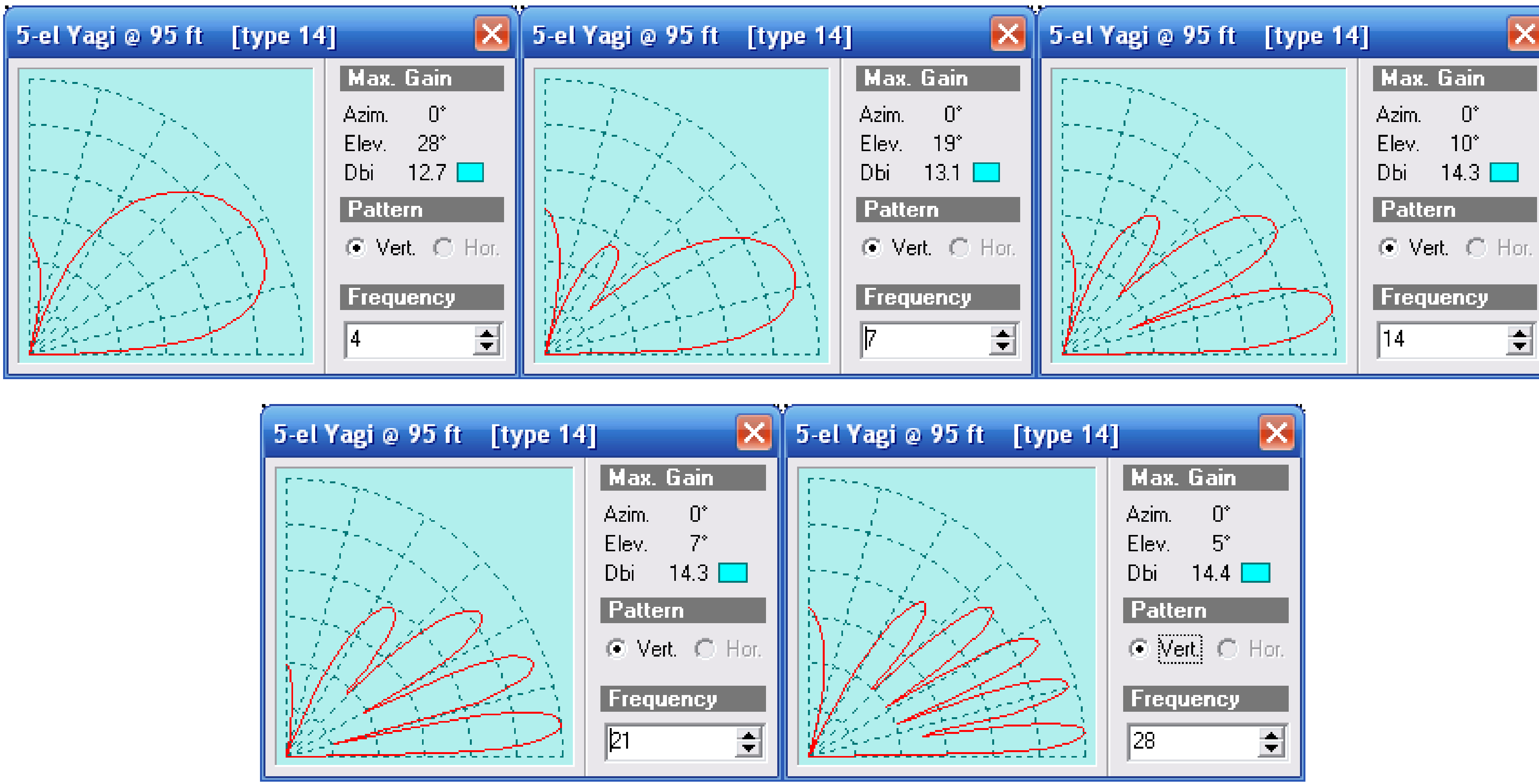
OH6BG MUF 10UT Nov 2005



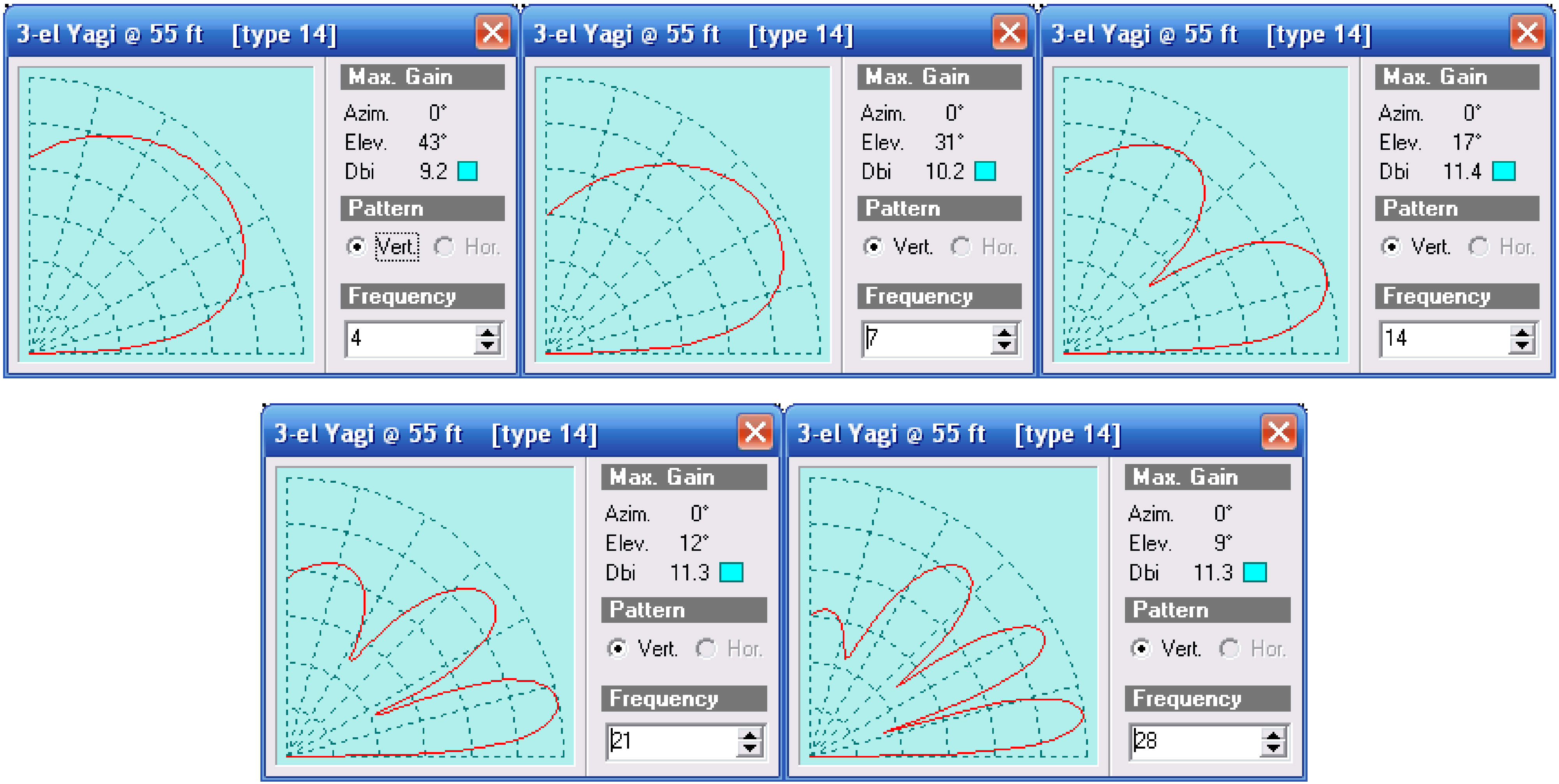
Look at Takeoff Angles /1

- The TANGLE map will tell you the (median) angle at which the antenna gain is needed.
- The TANGLE output parameter is the angle for the most reliable propagation mode (MRM).
- Use reasonable omni-directional Yagi patterns at TX and RX, e.g. TX: 5-ele Yagi @ 95 ft (28.5M); RX: 3-ele Yagi @ 55 ft (16.5M).
- Take-off angles of 3 to 13 degrees are good for DX.

5-ele Yagi @ 95 ft (28.5M)



3-ele Yagi @ 55 ft (16.5M)

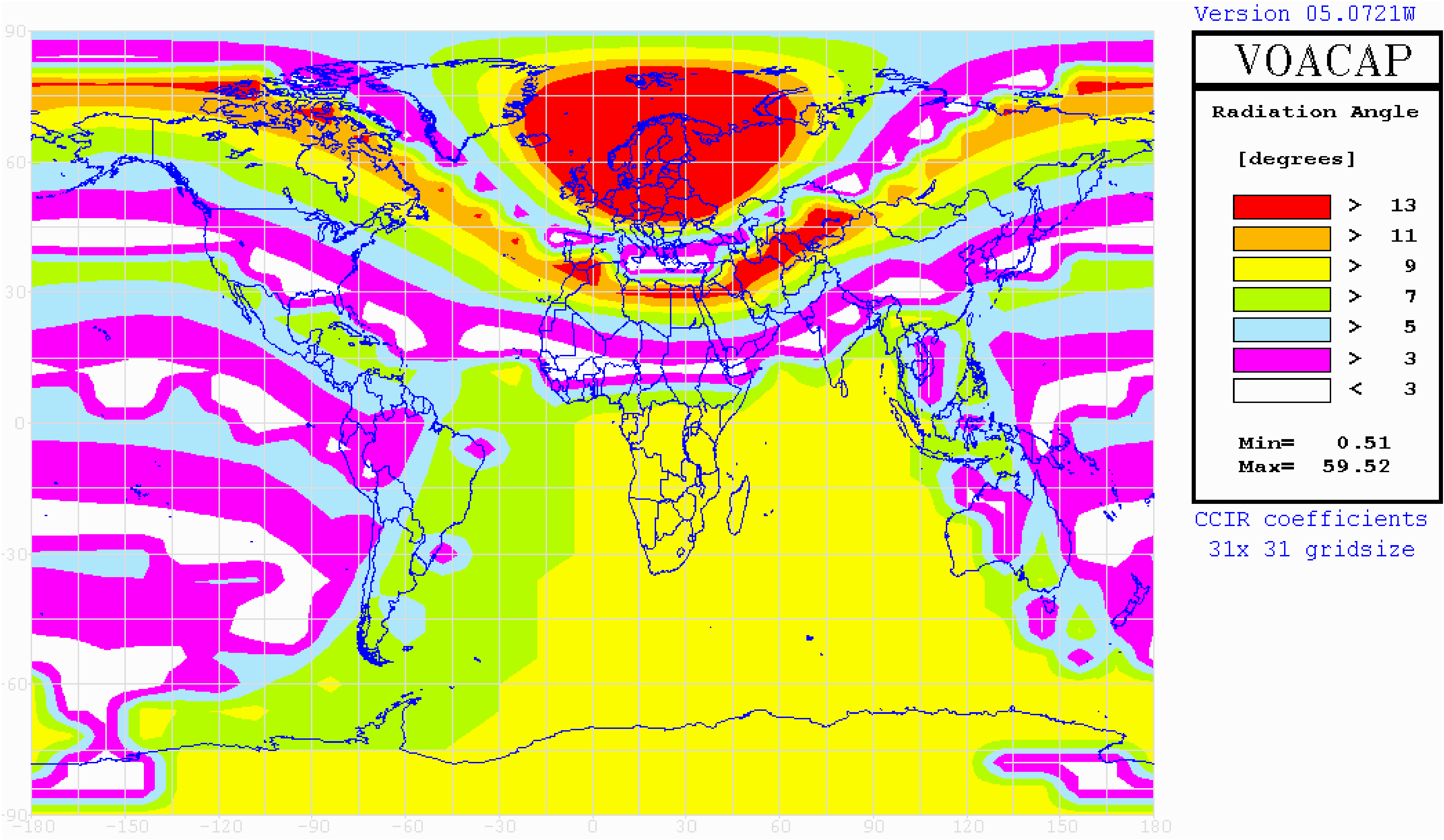


Look at Takeoff Angles /2

Are both the TX and RX antennas considered while predicting the Takeoff Angle of the TX antenna?

George Lane: For path lengths less than 7000 km, the angle prediction takes into account the gain of both the TX and RX antennas. Remember that VOACAP develops a reflectrix table of possible takeoff and arrival angles which will be supported on that path hour and operating frequency. The program finds the most reliable mode and its associated angle based on combining the path loss for the possible angles and the combined gain of the TX and RX antenna at each possible angle. For longer paths (>7000 km), the best takeoff angle and best arrival angle are computed and printed out based on the ionospheric conditions between 1000 and 2000 km of each end of the circuit.

OH6BG 21 MHz TANGLE 10UT



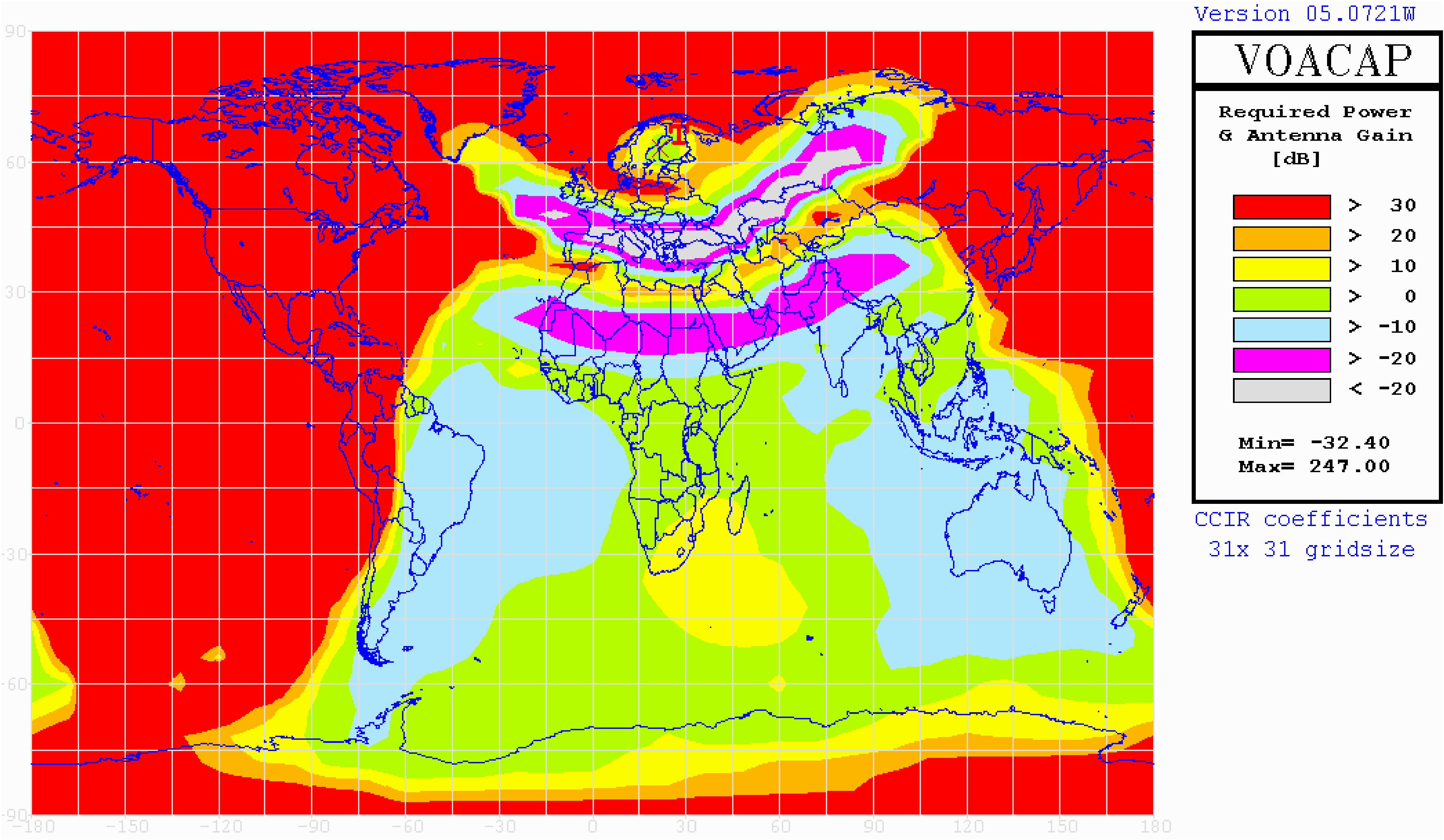
Study RPWRG maps /1

- The required power gain RPWRG map provides the gain needed by the transmit antenna to meet our Req.SNR (required signal-to-noise ratio)
- The Required SNR for CW = 24 dB-Hz (250 Hz BW), SSB = 38 dB-Hz (2100 Hz BW)
- Valid for 27 days out of 30 days (when Required Circuit Reliability (Req.Rel.) = 90%).
- dB-Hz = ratio as measured in a 1-Hz bandwidth REQ.SNR = SNR + 10 Log BW(Hz)

Study RPWRG maps /2

- Negative RPWRG over the desired coverage region, reduce TX power by that amount of dB.
- Positive RPWRG over the desired coverage region, increase TX power by that amount of dB.
- The Zero Value is the optimum (in terms of power consumption).
- A tool for estimating Low-Power or QRP success.

OH6BG 21 MHz RPWRG 10UT



Contest Planning Made Simple /1

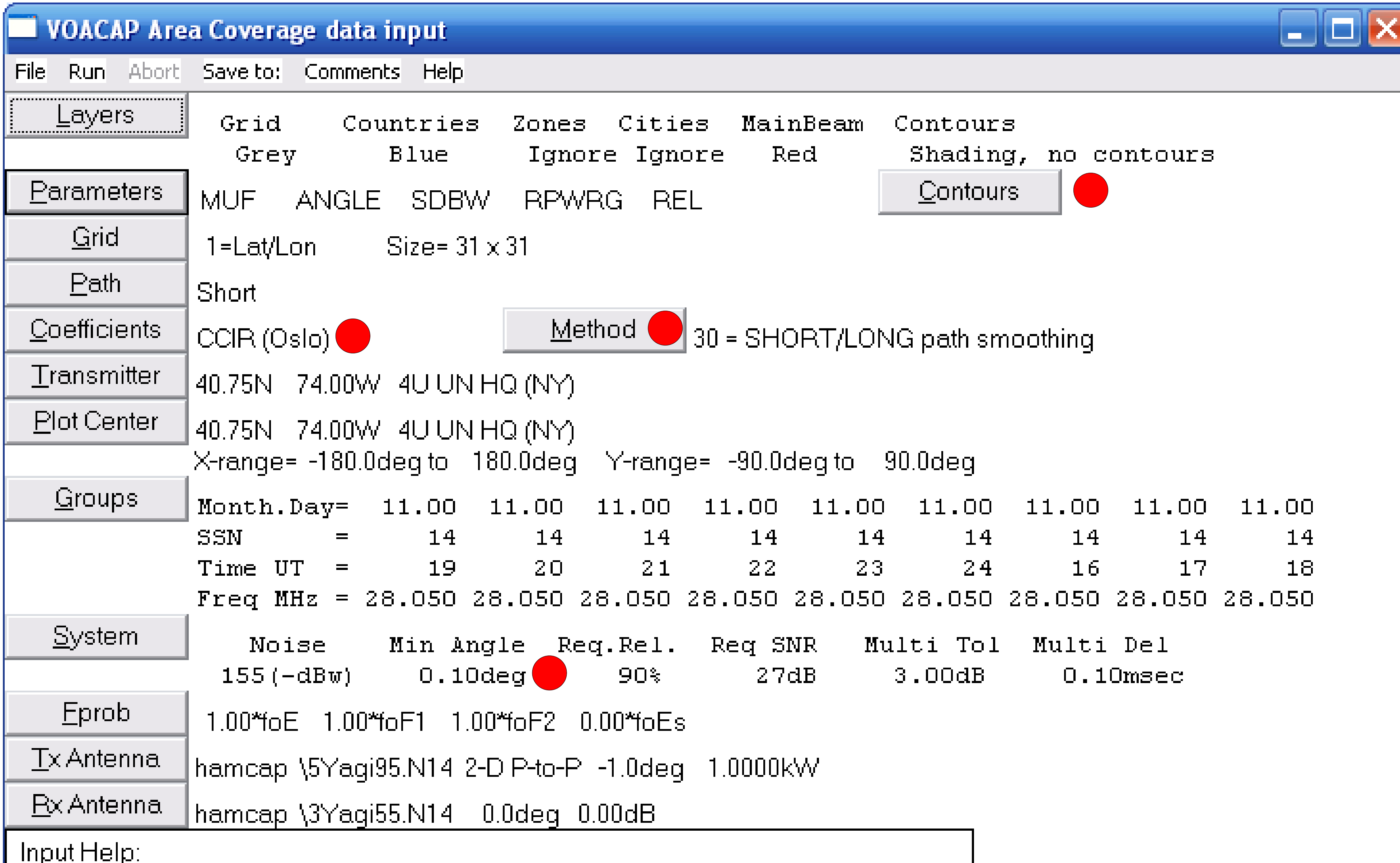
- If you know the antenna you will be using, it is not really necessary to do all of the MUF, TANGLE, and RPWRG maps. Just use the following approach to find the 'operational MUF' for contacts.

Contest Planning Made Simple /2

Set up VOAAREA for your antenna with omni-directional coverage (assuming the Yagis we spoke about earlier):

- Req. SNR = 27 (dB-Hz, 500 Hz BW)
- Man-made Noise at -155 DBW
- Xmtr PWR at something less than 1.5 KW (line loss, etc.)
- Minimum angle at 0.1 degrees

Contest Planning Made Simple /3



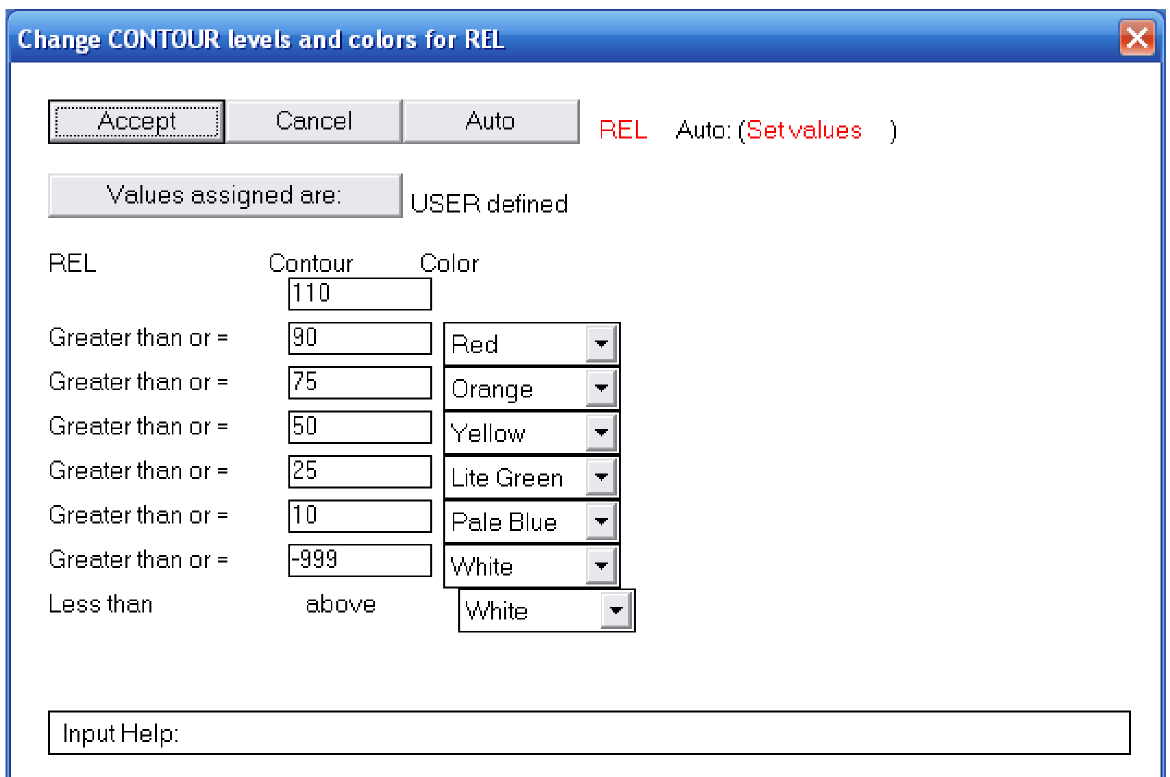
Contest Planning Made Simple /4

Can we set the minimum angle to 0.1 degrees; in most cases, we should be using 3 degrees, right?

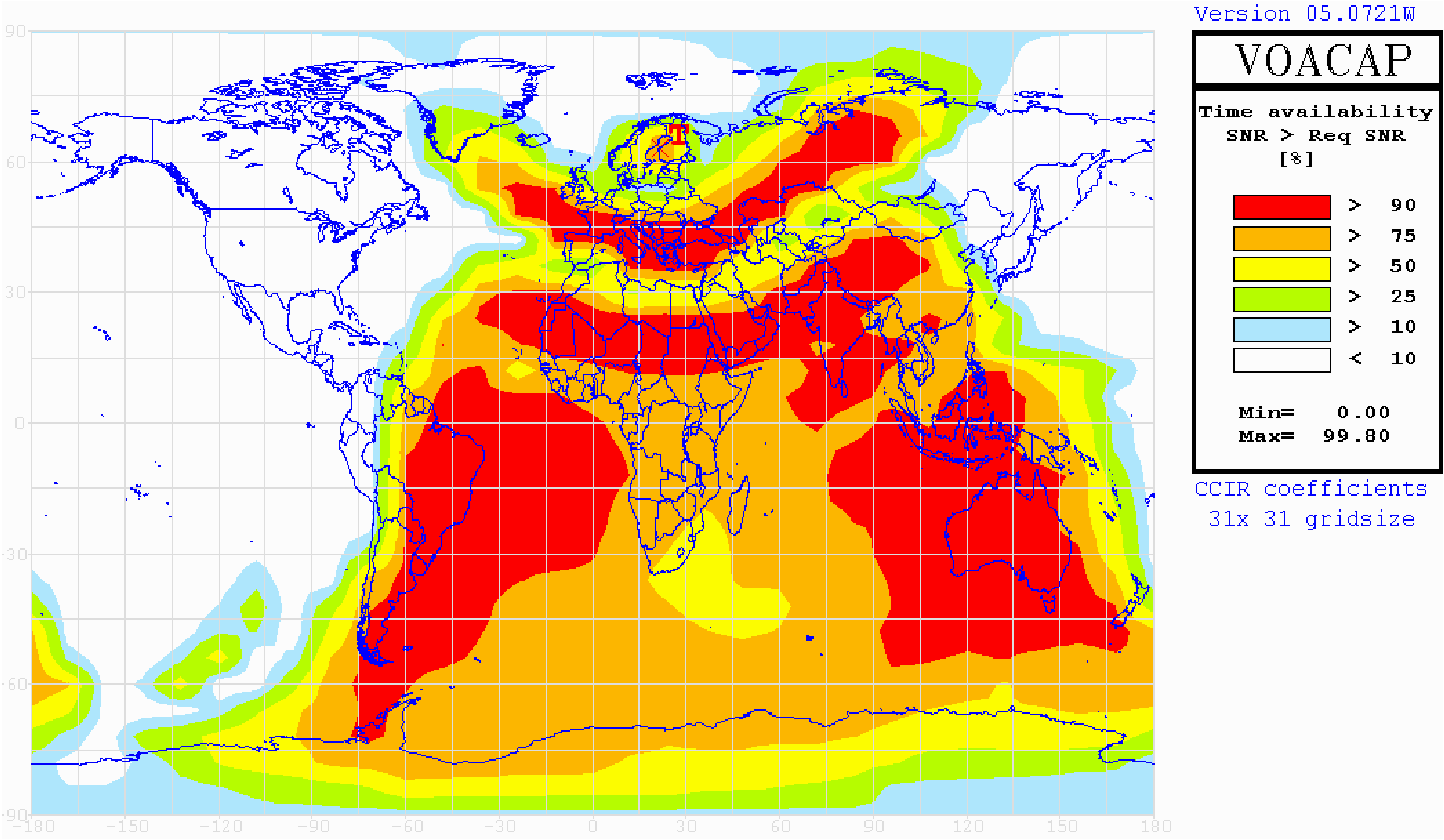
George Lane: According to Donald Lucas, you get a better calculation of the frequency dependence of the ionosphere (i.e. the MUF for the lowest order mode for the circuit). John Lloyd told me the value of 3 degrees was better from a practical standpoint. It depends on the actual horizon clearance at both the transmit and receive site. So Lucas is right (use 0.1 minimum angle) when the radiation patterns for the antenna have very low gains at near-horizon angles. But if you don't know the low-angle gain and/or are using isotropes, then Lloyd is right (use 3.0 degrees for minimum angle).

Contest Planning Made Simple /5

Make maps for REL with contours for 90%, 75% 50%, 25% and 10%. Set these values at the input screen rather than after calculating and saving.



OH6BG 21 MHz REL 10UT



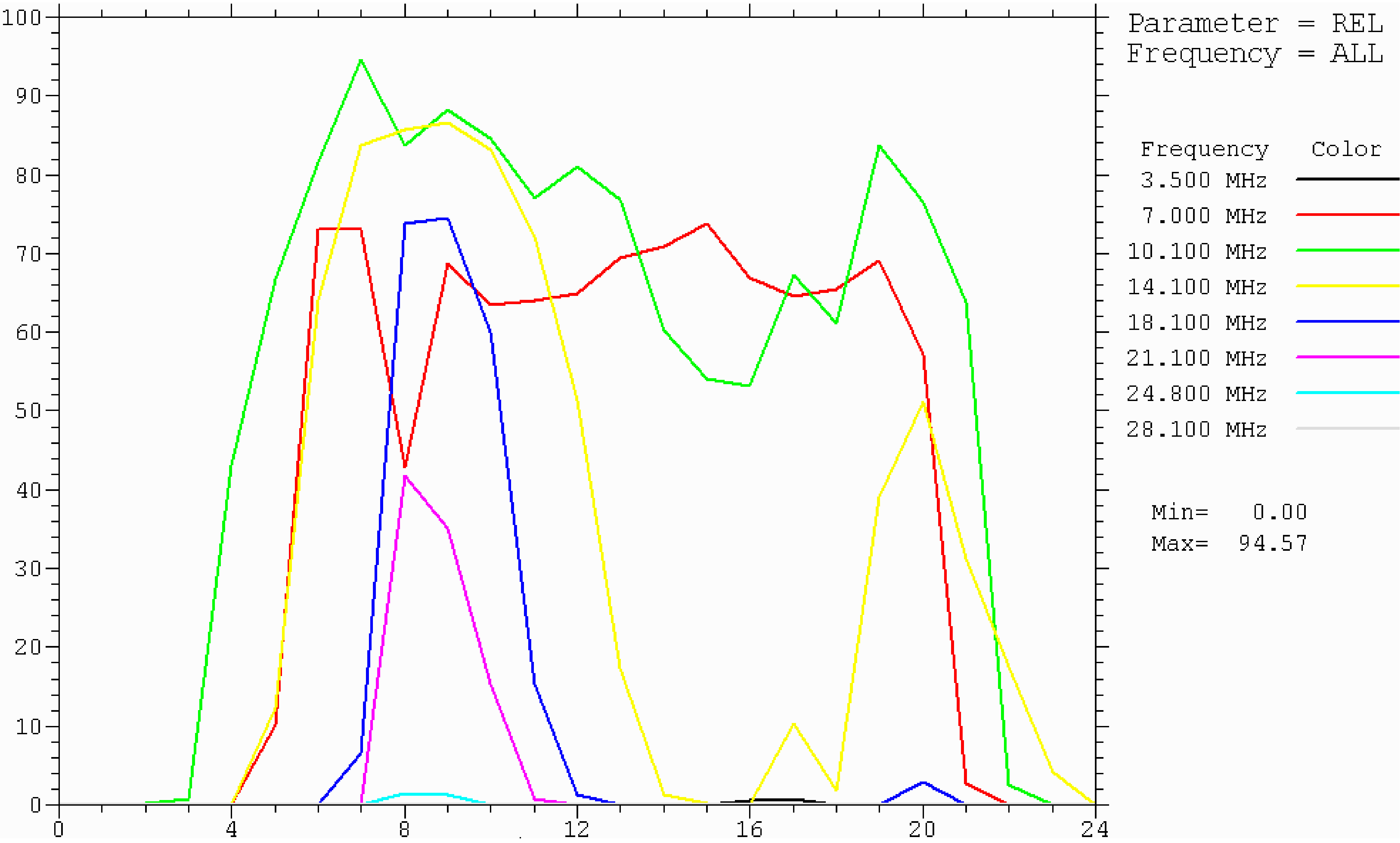
Contest Planning Made Simple /5

George Lane on ”operational MUF” approach:

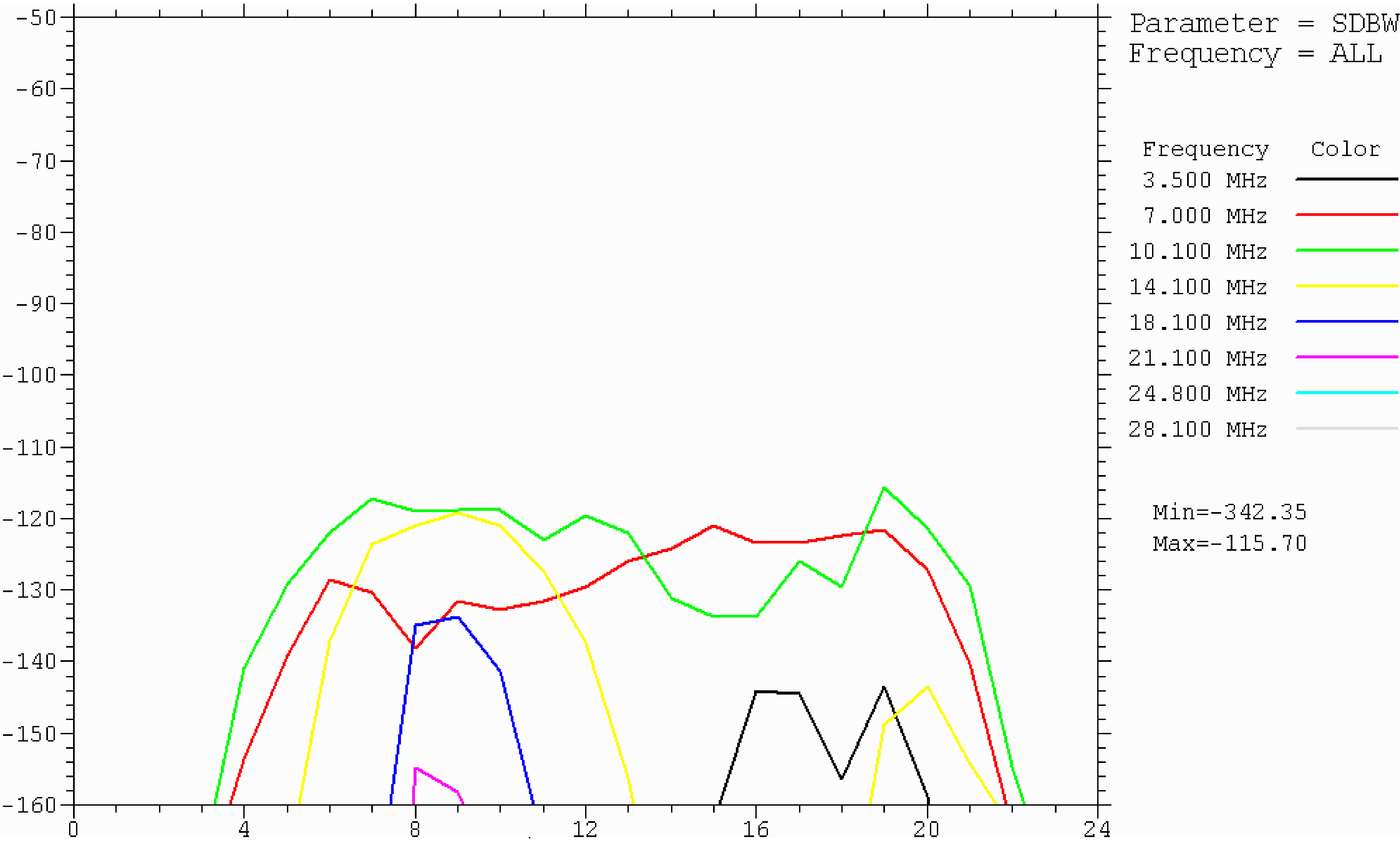
– My reasoning is this: Reliability at 50% (the REL map) is the operational maximum likelihood for narrow band CW taking into account the ionosphere, noise, antenna gains, etc. The hot spots for contacts will be in the >75% REGIONS, areas in the >50% are good contact locations.

When looking for antipodal focusing regions, be sure to look at both the long path and short path conditions. I have found that the 50% REL. VOACAP predictions are really more like 75% to 90% contacts in reality.

Case: T30 Kiribati to OH, Jan 06



Case: T30 Kiribati to OH, Jan 06



General Rules of Thumb

These general rules shall guide our choice of site for optimum performance:

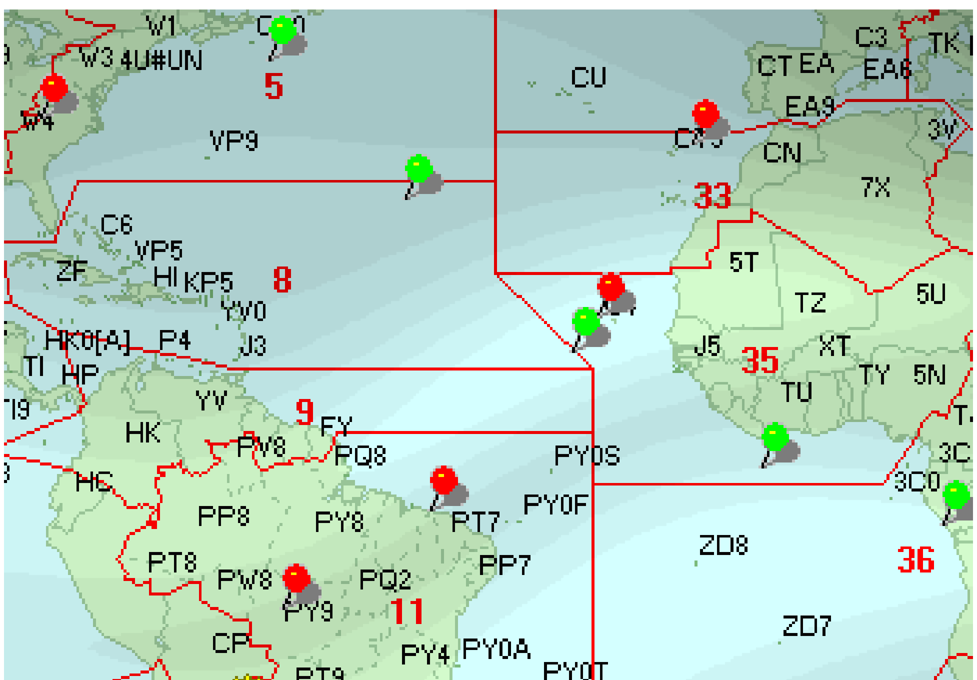
- For all bands, use the 6000-km rule
- For lower bands, find a location where the Atmospheric Noise is at minimum @ 2 MHz
- For upper bands, find a location where foF2 values are the highest (DX Atlas foF2 maps)
- Mostly 3p QSOs, rare Zone, rare Country

However...

- The best QSO activity is in Europe/W.Russia and North America
- For most points, be outside EU and N.A., make 3p(2p) QSOs : South America, Africa, Asia or Oceania (& Caribbean)
- Is 10M the strategic band at sunspot minimum?
  - Use 1F2 (or 2F2) modes in N-S paths

The Ultimate Thule

- Northern South America for N.America
- Africa for Europe
- a low-latitude QTH works in E-W direction, too.



- **P4, PJ2, HK, YV...**
- **D4, EA8, CT3**

How about:

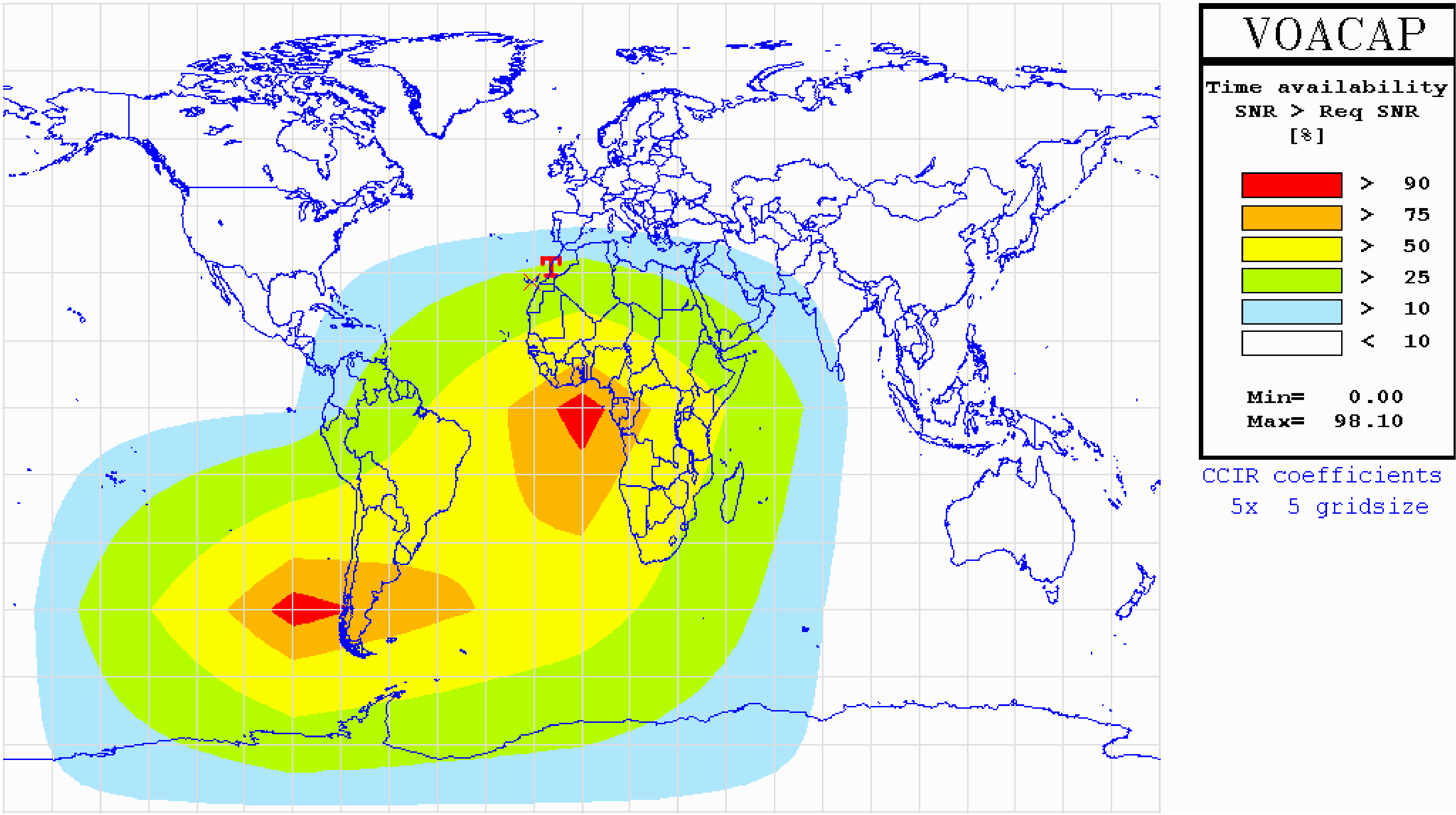
- **PY0S, ZD8**
- **5T, TZ, 6W, S0, C5**
- **J5, 3X, 9L**

Let's do some coverage maps

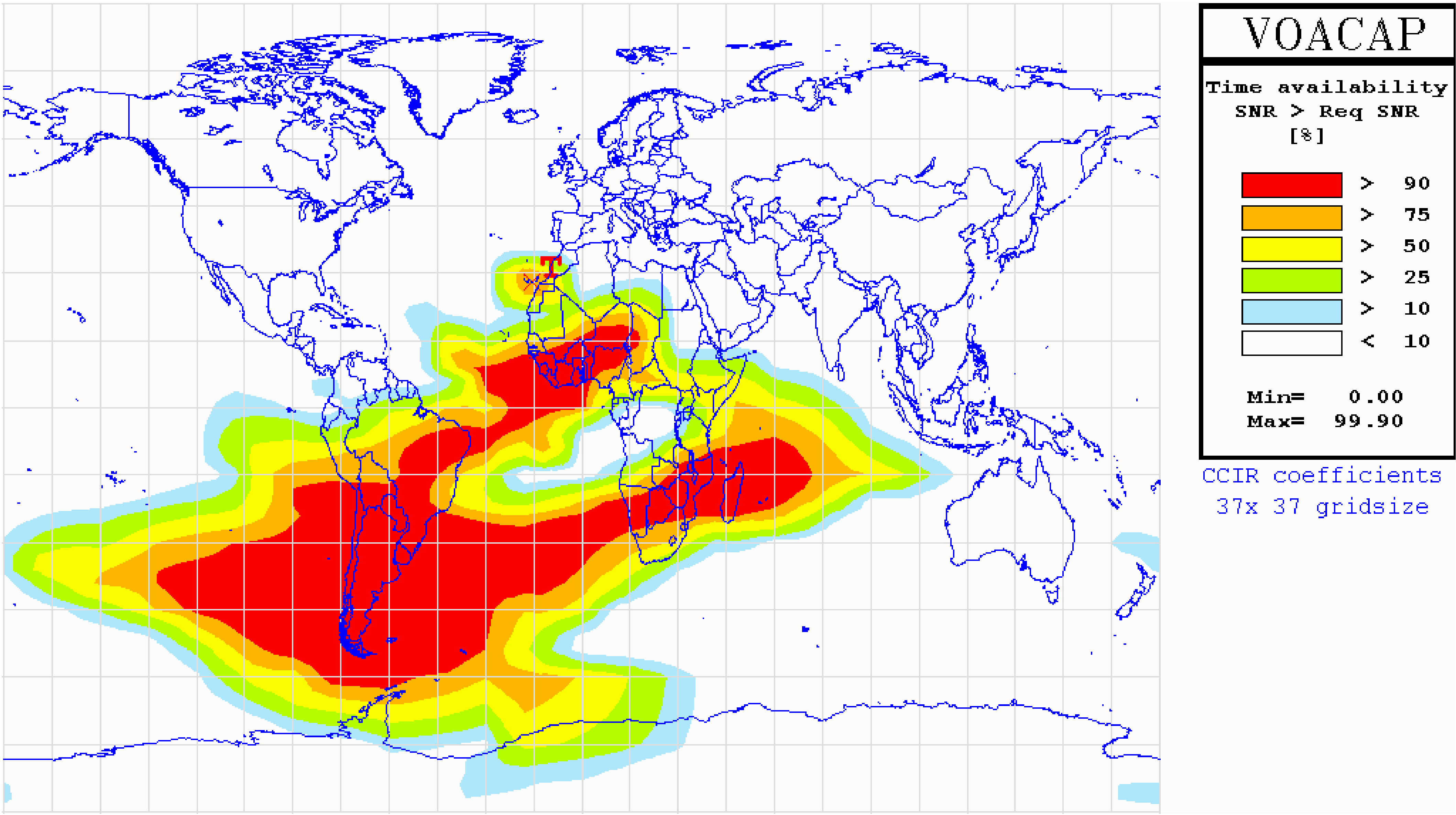
Assumptions:

- The man-made noise is allwhere the same
- Choose right grid size for calculations
- Run REL maps; run maps of signal power (SDBW)
    - Noise greater on lower bands, signal power may still be available
    - Signal power can be very low on upper bands while REL is good (very low noise)

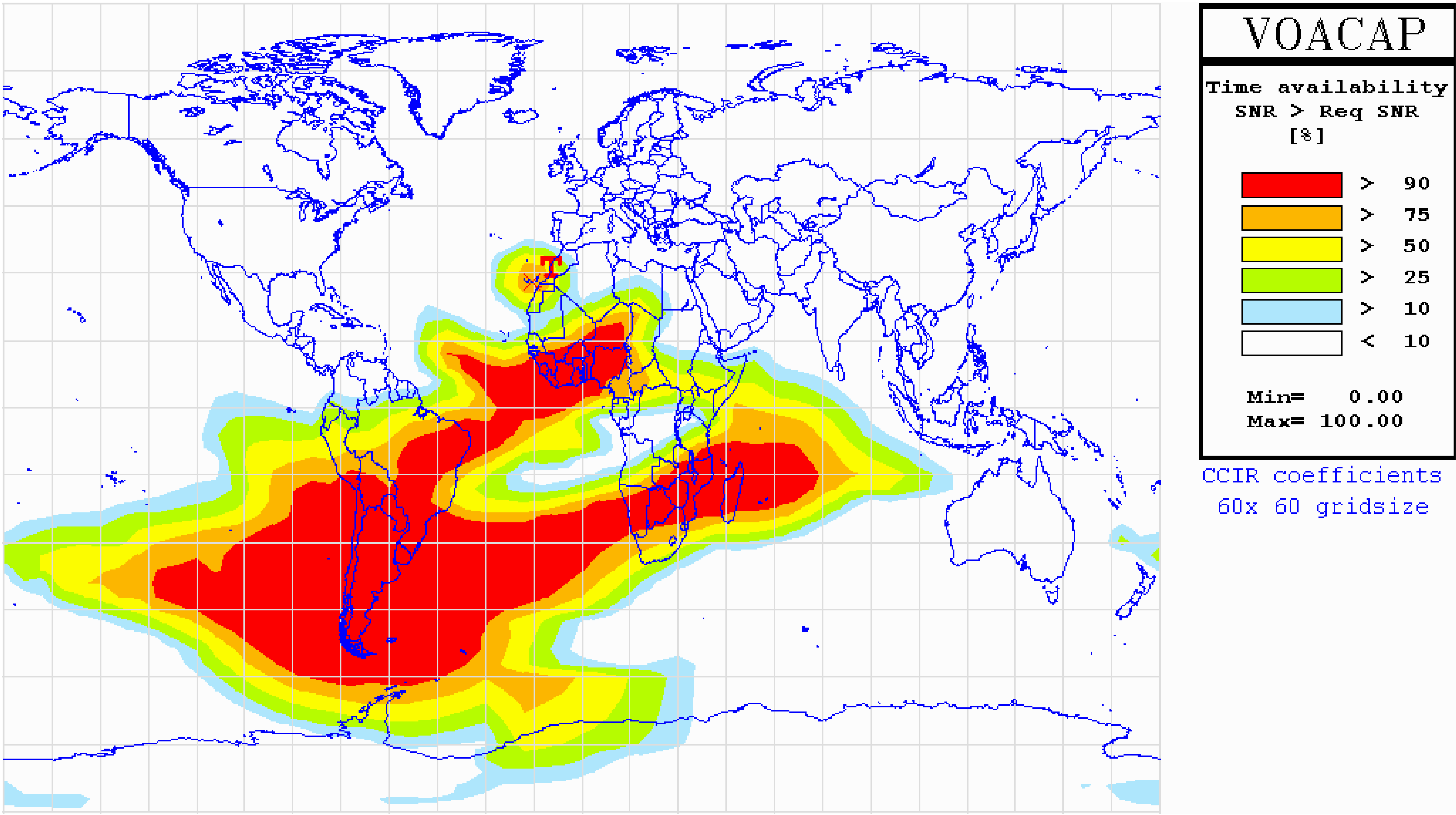
Map resolutions: 5x5



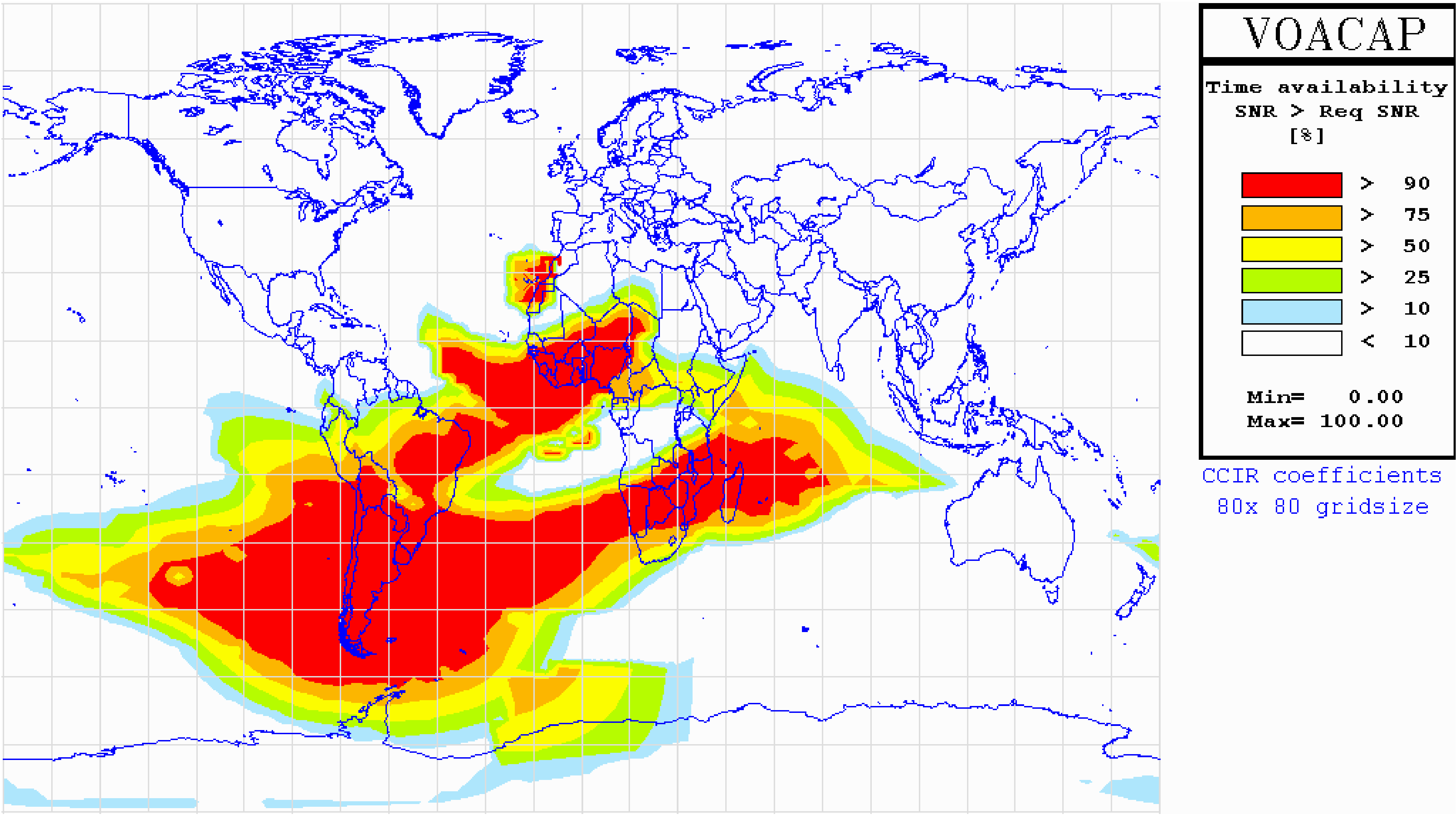
Map resolutions: 37x37



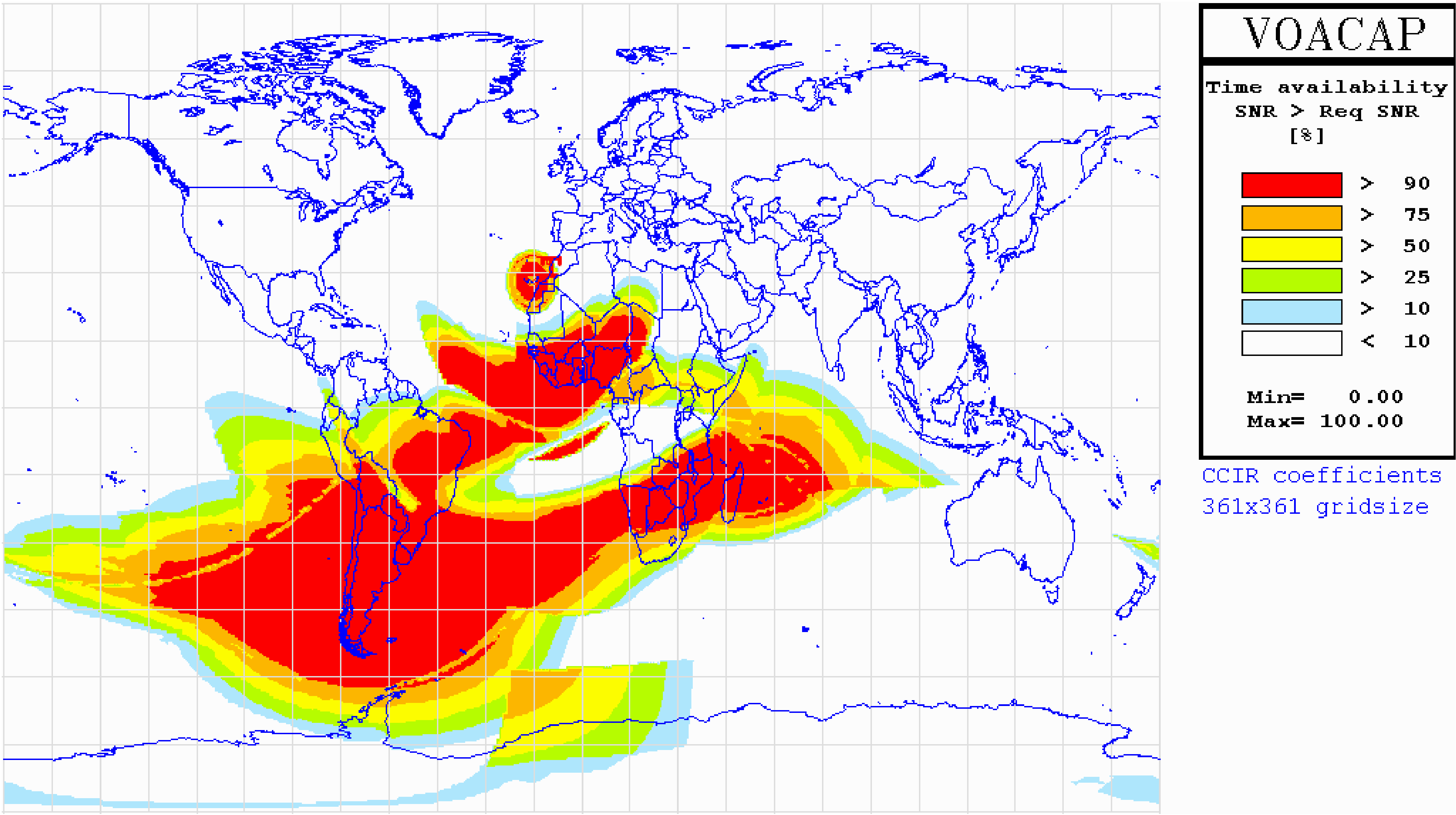
Map resolutions: 60x60



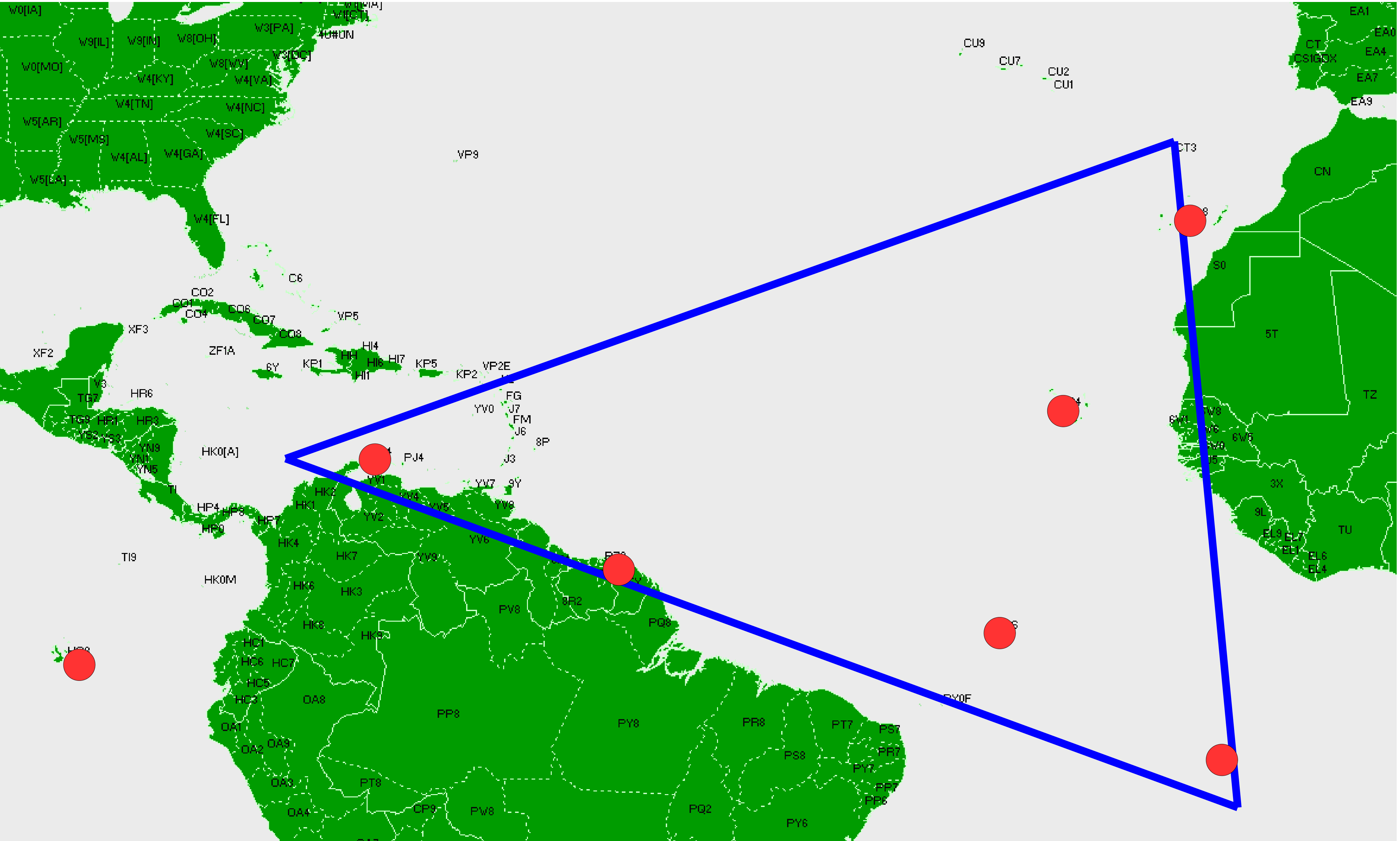
Map resolutions: 80x80



Map resolutions: 361x361



The Atlantic Triangle



Coverage Map Examples

- P4 – Aruba
- EA8 – Canary Islands
- D4 – Cape Verde
- ZD8 – Ascension
- PZ – Suriname
- PY0S – St Peter & St Paul's Rock
- HC8 Galapagos & TT Chad (for comparison)

• 14 & 28 MHz :
  - TX 5-ele Yagi @ 95 ft / RX 3-ele Yagi @ 55 ft

• 7 MHz : 0.5 wl vertical on vy good gnd

Executive Summary

- Head for lower latitudes
- Stay away from areas of high atmospheric noise
- Use the 6000-km rule (1F2, 2F2)
- Maximize QSOs, points and multipliers
- Run the REL maps for candidate sites, 40M to 10M
- 160M to 80M, use sunrise/sunset times and mapping software