Propagation Prediction Programs Explained - Part 20

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This is the last issue of this series "Propagation Prediction Programs Explained." Grateful thanks go to the many readers who contacted me with encouragement, suggestions and questions. They guided me throughout in terms of what was needed, what was unknown, or what they struggled with. When I started this series I did not have the slightest idea if it would be a topic in which the reader would have much interested. I truly appreciate the worldwide praise-worthy comments I received.

At this issue I give some more answers to reader FAQ's and a summary of common mistakes with do's and don'ts.

VOACAP – ICEPAC Comparison

Occasionally I hear the comment about ICEPAC giving better predictions at long distance on high latitude paths than VOACAP. I have only limited experience to confirm or to deny this statement. I plan to make a reliable study about this with comparison of both predictions using my daily beacon monitoring. Some primarily comparisons up until now have displayed negligible differences.

The main reason, I think, that VOACAP was assigned more "correct" than ICEPAC is that Method 30 in VOACAP uses the smoothing function between the short path (normal hop modes) and the long path (ducting mode) models. This is no longer valid: ICEPAC recently added support also for the Method 30 option. So, only long time comparisons might give us an answer.

ICEPAC has two extra input parameter within the Group option: the **Qindex** and the **Effective SSN** (Eff SSN) calculation with given and known foF2 values at specified locations (up to five inputs).

- **The Qindex**: This represents the effective geomagnetic activity index if the planetary magnetic index Kp is known range [0-8], see **Table 50.1.**
 Qe = effective geomagnetic activity index, **Kp** = planetary magnetic index.
 I did several predictions with different Qindex inputs and I notice no spectacular output differences where I knew that with major storms there should be. This is an item I have to compare with real time monitoring when there are at least major storms.

- **The Calculate Effective SSN with given foF2 values:** An approximation to use instantaneous data to calculate the SSN. Mind, use this facility with care and try it out with comparisons of real time propagation monitoring. I have not tested this option in depth yet, but it is anyway a tool to experiment with.

Qe	Kp	Ap	Geomagnetic Activity
0.0	0.0 for values of Qe < 3; Kp = Qe/3.	0	Quit
1.0	0.33		Quit
2.0	0.67		Quit
3.0	1.0 for values of Qe > 3; Kp = Qe - 2.	3	Quit
4.0	2.0	7	Unsettled
5.0	3.0	15	Active
6.0	4.0	27	Minor storms
7.0	5.0	48	Major storms
8.0	6.0	60	Major storms

Table 50.1. *The currently used relationship between* ***Qe*** *and* ***Kp*** *if Kp is known.Use in general Q-index = 0, this depicts an undisturbed period.*

Calculate Effective SSN given foF2 values

Although ICEPAC is a model based on monthly median data, this represents a first step approximation by using instantaneous data. It assumes you have access to vertical ionosonde information for one or more locations. That data is put into the foF2 ionospheric coefficients to produce the effective **Sun Spot Number.** Be precise, define the measured foF2 value of the specified location(s) and time exactly. This effective SSN can then be used to predict the propagation for the next few hours. If more than one foF2 measurement is known, the average effective SSN will be used.

To remove a point from the calculations, simply put in an illegal value for any of the input parameters (Latitude, Longitude, Time UT, or foF2).

The ideal sounder location is the midpoint of the path of interest. The further you are from that location, the less confidence you should place on the result. Select the **Calculate** button to perform the effective SSN calculation. Then, selecting the **Accept** button will replace the SSN with the effective SSN calculated.

Note: This option is not available within ICEAREA.

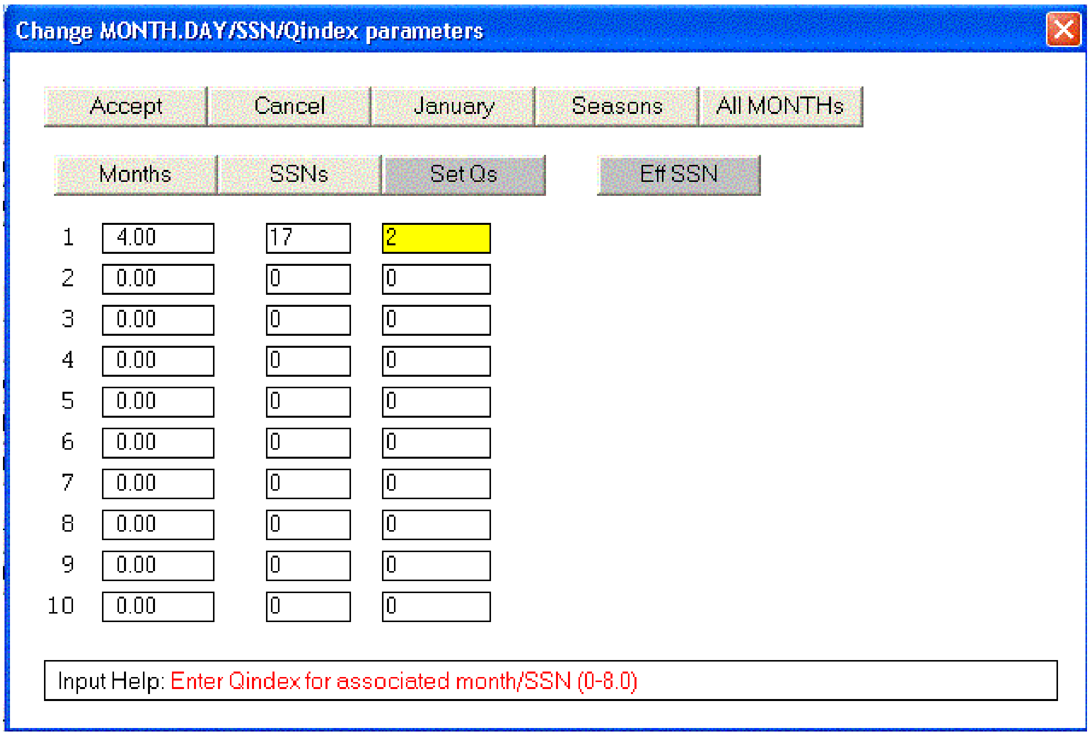

Fig. 50.1. *The ICEPAC Group* ***Change MONTH.DAY/SSN/Qindex*** *parameters input screen.*

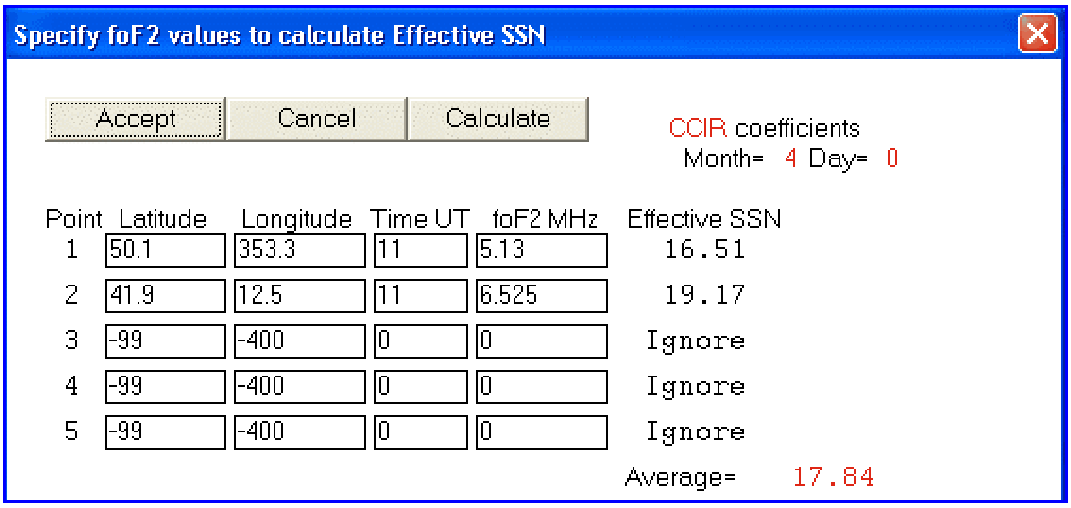

Fig. 50.1. *The* ***Specify foF2 values to calculate Effective SSN*** *input screen.*

Method 25, the All Modes Table

The All Modes Table of Method 25 functions only with the Short-Path Model. VOACAP computes up to 18 different possible modes such as 2F2, 3F2, 2F1, 3F1, 3E, 4E, etc, respectively for the high ray and the low ray modes plus 3 sporadic-E modes when activated by Fprop as 2Es, 3Es, etc. For each of the possible modes, the program computes the monthly median parameters and the upper and lower decile values, which should be exceeded on 27 days and on 3 days of the month. These are hourly median predictions at a given hour over the day of the month.

By computing all those possible modes multipathing is possible and detected. This might increase the circuit signal strength over the days of the month compared to what any individual mode might contribute by itself. The calculation process is done as such. The signal power in dBW is first converted to watts and the values are added to obtain the combined signal power. The sum is then computed as dBW. This process is done for the median, upper, and lower deciles. Usually this contribution of secondary modes is not much but may be 4 to 6 dB, especially when the antenna-radiating pattern supports a secondary mode better than the primary mode. So, once again the antenna in use is important and it is quite possible that a 2F2 mode predicts sometimes stronger than a 1F2 mode due to the antenna's multiple radiating lobes. Method 25 tells you the MRM (most reliable mode) but on some days another mode might be the better one. This phenomenon is not daily at a specific hour, since it strongly depends on the height of the F2 refracting region.

The output file of Method 25 is rather huge if you define several frequencies in the Freq(s) option and define several months and/or SSNs in the Groups option. Keep them as small as strictly necessary. See **Table 50.1, 50.2** for a partial picture of the output file. I color highlighted the important outputs.

Mostly we use Method 25 to troubleshoot a circuit that doesn't perform as predicted. It is possible to construct a monthly median oblique ionogram for a given hour. By running very fine frequency increments, we can use the time delay and frequency predictions and plot them manually. The program itself does not support directly creations of oblique ionograms as Proplab-Pro does. See **Chapter 19 of Volume 2** for information's about oblique ionograms. Perhaps it contains a tip to make a program that creates oblique ionograms in a user-friendly way?

Real-time propagation do not equal the predictions

One of the most disappointing things when predictions are made is when they do not reflect what actually happens on the circuit. Do not decide too soon that the prediction program is useless; there are a number of things to check. Remember that the predictions are mostly quite accurate and if the difference between your prediction and the real-time is large, then **you probably did something wrong**.

Common mistakes in using VOACAP

- The choice of a wrong **Smoothed Sunspot Number** (SSN) for the month. More then often you experimented with various SSN values, just to find-out, and forgot to correct them to the actual to use for the month. There is nothing wrong with experimenting and comparing, on the contrary, but just remember it and correct them after your experimental phase. The recommend values to use can be obtained at:
  ftp://ftp.ngdc.noaa.gov/STP/SOLAR_DATA/SUNSPOT_NUMBERS/sunspot.predict
  or
  http://sidc.oma.be/current/ri.html
  In previous chapters I explained and compared SSN (Smoothed Sunspot Number) and MSN (Monthly median Sunspot Number) use.

- The use of the **Required SNR** (REQ. SNR.) value for the transmission mode. This is sometimes difficult for a number of people. This varies case-by-case depending on the service grade you wish to achieve: CW, SSB, etc. Good practice is using 20 to 27 dB/Hz for CW, 40 to 45 dB/Hz for SSB and higher for digital transmitting modes.

- The use of the wrong **Transmitting Power**. The value to use is the power at the antenna feedpoint, not at your transmitter antenna output connector plug. A rule of thumb is defining 75% of the transmitter power as the power at the antenna feedpoint. **Pay Attention:** the value to enter is in KW, so 100 watt = 0.1 KW, 10 watt = 0.01 KW, etc.

- The defined **Month** or even defining a **Day of the Month**. Always check that the correct month is defined with its related SSN; this is easily overlooked. Defining a day of the month automatically forces VOACAP to use the URSI coefficients for calculations without warning you. Most literature and the VOACAP manual do not recommend the URSI use. I explained why in a previous chapter (foF2 values not consistent with the epoch of the other parameters), but my experience tells me that the differences are often but not always negligible.

- Setting the **Required Reliability** (Req. REL.). This has only impact to the SNRxx predictions and needed power, but is ***best set to 90%.*** This allows you to determine very quickly the best operating frequency.

- Setting to little/much **Man Made Noise**. This is rather difficult and depends entirely on your location. The value ***145 is a good starting point*** but when you live in the countryside you may take 164 (remote) and in the cities or industrial environments 140.

- Setting an optimistic **Minimum Angle**. The default value 0.1 degree is unrealistic and too good to be true with our radio amateur antennas. ***Best use 3.0 degrees***; this cancels out any unrealistic antenna radiations. Do not set it too high because this influences the MUF properties.

- Selecting a wrong **Antenna**. This is the most frequent mistake to have wrong predictions. Reread the chapters about these matters. To remind you with clear and easy-to-understand example: selecting a Yagi is OK for the 20 through 10 meters ham bands but unrealistic for the low bands 160 through 40 meters. To convince yourself you are using the correct antenna for the specific frequency bands investigate the defined antenna with the **HFANT** program or **Run Method 15**. Both give you an insight of the antenna azimuth and elevation patterns and properties. Take also care that the antenna is beaming to the right azimuth with fixed non-rotary types, and with rotary antennas use preferably the faking omni directional radiating types. Do not forget to take into account the actual antenna height when modeling an antenna type; this is also an often-made mistake.

- The use of the correct **Method**. Using method 30 is best and least cumbersome: it switches automatically between the short and the long path model and for patch distances between 7 000 and 10 000 km it takes into account the smoothing process. A frequent returning mistake is to forget to change the Method when used Method 21 (Forced long path model) or Method 22 (Forced short path model).

- The occasionally use off **Fprob multipliers**. The best setting are: foE = 1, foF1 = 1, foF2 = 1 and foEs = 0. At the three previous chapters I explained and studied the Fprob multiplier use in depth. The recommendation is to use them only carefully when you fully understand what you are doing. In truth, it is the only option to simulate Sporadic-E conditions, but do not forget to redefine the settings to predict non Sporadic-E conditions.

Causes of much better or much worse propagation

The problem can be break down into two conditions: one is where the actual propagation is **much better** than predicted and the other is when the actual propagation is **much worse** than predicted.

Even when all previsions and preconditions are made, is it not an exception that the predictions does not coincide the real-time propagation. Remember the predictions are computed upon median input data, resulting to median output parameter values. The ionospheric properties are constantly changing and perhaps deviating from these median conditions. The deviations are mostly not high enough to have remarkable differences, but in extreme the real-time observations can differ much better or much worse than predicted. First of all the median results will occur 50% of the days in the month, that is, 15 days. You have no clue at all which days these will be. Under normal deviating ionosphere properties it might be about 10% better or worse; that's what I found with my daily monitoring. So, a margin of 12 days or 18 days of the month is still reasonable and credible, which is not so bad. In the extreme it can be exceptionally much better or worse by a few reason that do not occur daily.

- For 1 and occasionally 2 hop mode paths, Sporadic-E can be the cause. You will for certain experience this more than often during the late Spring and Summer. Sporadic-E effects may be very consistent during a few days, weeks or even a month, but then go away. Rarely but possibly, Es might appear suddenly at a period where it is not a matter of course.
  - The sporadic-E becomes the only propagation mode and lends to a much higher MUF. Higher frequency bands are open that should be not available without Es, or the skip distance decreases.
  - The sporadic-E cloud might create a N-type hop and bring that station into your range.
  - Or the sporadic-E cloud might screen-off the downward propagating waves and follow a M-type hop mode.

- Another factor that causes better or worse real-time conditions is the refraction height (h'F1 or h'F2). The critical frequencies (foF1 and foF2) vary slightly compared day-to-day leading to slightly varying MUF. This varying MUF lies still within that 10% margin deviating from the median 50%. But as explained in previous chapters the height of these layers plays a most significant role to the MUF (secant law). Lower situated = higher MUF and higher = lower MUF. I found several times when comparing the ionograms day-to-day that the h'F2 in particular, can be 100 to 150 kilometers higher than median. This will for certain lead to much worse conditions that are impossible to predict. In contrast, the layer can be 50 km lower than median which should display much better but also unpredictable conditions.

- Sudden geomagnetic storms can bring down temporarily the propagation conditions.

- A solar flare can knock out the entire HF band(s) for many hours in the daylight area. The effects, if near sunset on the path, can last for most of the night.

- CME (Coronal Mass Ejection). The leading edges of fast-moving CMEs drive giant shock waves before them through the solar wind at speeds up to 1 200 km per second. These will disturb the entire ionosphere characteristics.

Note: geomagnetic indices, solar phenomena, CME, etc, will be a later subject to be explained in more depth.

Prediction programs using the VOACAP engine

Several on the market available propagation prediction programs use VOACAP as the engine, such as: **WinCAP Wizard**, **HF-ACE**, **Hamcap/DXatlas**, **Multiprop**. Often they are more users friendly, and display better and orderly outputs, but not one offers more options than VOACAP itself. When using these programs, the same rules of do's and don'ts apply. In particular their antenna-type choice is not always convenient or not well documented. It is recommended to insert your own antenna types displaying your station antenna "farm." Create an extra folder with your antenna definitions at the program antenna folder. Most programs do not support the windows explorer to browse to the C:/itshfbc/ where your antenna creations might be saved.

Coming next: "Ionosphere properties and behaviors" series. Stay tuned. **–30-**

```
  CCIR Coefficients         METHOD 25   VOACAP 06.0304W  PAGE  35

Apr    2006          SSN =  15.                Minimum Angle= 3.000 degrees
ON5AU                W2-CQDX-5             AZIMUTHS          N. MI.       KM
51.00 N    3.83 E - 40.43 N   74.00 W    290.85    50.59    3168.2    5867.1
XMTR  2-30 2-D Table [antennas\OmniYg05w.hfa] Az=290.9 OFFaz=360.0   0.100kW
RCVR  2-30 2-D Table [antennas\OmniYg05w.hfa] Az= 50.6 OFFaz=360.0
3 MHz NOISE = -150.0 dBW     REQ. REL = 90%    REQ. SNR = 20.0 dB

                              YE =  20.0     HE = 110.0     HS = 110.0
```

LAT	LONG	LMT	UT	E	F1	Y1	H1	FH/2	F2Z	Y2	H2	ES	MED	HI	M3000	HPF2	RAT	ZEN	ZMAX	MAGL
53.4N	10.3W	17.3	18.0	1.85	0.0	0.0	0.0	0.6	5.6	78.9	288.6	0.0	0.0	0.0	3.21	288.3	4.0	80.4	68.9	58.0N
53.9N	25.5W	16.3	18.0	2.55	3.8	51.5	205.9	0.6	5.5	80.5	271.4	0.0	0.0	0.0	3.18	292.1	3.7	71.8	69.6	61.3N
52.7N	39.5W	15.4	18.0	3.10	4.2	48.8	195.4	0.6	5.6	86.1	273.8	0.0	0.0	0.0	3.14	298.6	3.4	63.7	69.8	62.2N
50.0N	52.2W	14.5	18.0	2.84	4.0	50.2	200.8	0.7	5.6	86.1	273.8	0.0	0.0	0.0	3.09	306.4	3.2	55.7	69.4	60.9N
45.7N	64.0W	13.7	18.0	3.10	4.2	48.8	195.4	0.7	5.7	92.0	279.3	0.0	0.0	0.0	3.04	314.9	3.0	47.2	68.6	57.2N

SUMMARY   5 MODES   FREQ = 14.2 MHZ   UT = 18.0

	2.F1	2.F2	3. E	3.F1	3.F2	Most REL 2.F2
TIME DEL.	21.11	21.10	20.27	20.78	21.71	21.10
ANGLE	10.02	10.00	7.14	11.49	17.31	10.00
VIR. HITE	455.52	454.66	203.18	285.06	402.30	454.66
TRAN.LOSS	185.57	141.55	271.38	212.18	175.32	141.55
T. GAIN	9.91	9.90	7.34	10.79	12.96	9.90
R. GAIN	9.91	9.90	7.34	10.79	12.96	9.90
ABSORB	5.06	5.07	5.81	4.72	3.64	
FS. LOSS	131.52	131.52	131.17	131.39	131.76	
FIELD ST.	-45.24	-1.20	-128.48	-72.72	-38.03	-1.20
SIG. POW.	-165.57	-121.55	-251.38	-192.18	-155.32	-121.55
SNR	0.41	44.43	-85.40	-26.19	10.67	44.44
MODE PROB	0.89	0.86	0.87	0.18	0.20	0.86
R. PWRG	1000.00	1000.00	1000.00	1000.00	1000.00	2.05
RELIABIL	0.16	0.88	0.00	0.01	0.32	0.88
SERV PROB	0.09	0.48	0.00	0.02	0.14	0.48
SIG LOW	25.00	25.00	25.00	25.00	25.00	25.00
SIG UP	25.00	10.87	25.00	25.00	25.00	10.92

```
NOISE =    -166      S. POWER = -121.6
SIGNAL =   16.0   12.3    7.0  /     2.8      5.6      1.8
NOISE =     8.7 -166.0    4.8  /     1.5      3.2      1.6
RELIAB =   11.9   44.4   26.5
SPROB =    33.8   17.9   33.8
```

Table 50.1. *Method 25 partial output. Antenna height at 0.5 wavelength.*

```
    CCIR Coefficients         METHOD 25   VOACAP 06.0304W  PAGE  35

  Apr    2006          SSN =  15.              Minimum Angle= 3.000 degrees
  ON5AU               W2-CQDX-5            AZIMUTHS          N. MI.       KM
  51.00 N    3.83 E - 40.43 N   74.00 W    290.85   50.59    3168.2    5867.1
  XMTR  2-30 2-D Table [antennas\Omniyg1w.hfa] Az=290.9 OFFaz=360.0   0.100kW
  RCVR  2-30 2-D Table [antennas\Omniyg1w.hfa] Az= 50.6 OFFaz=360.0
  3 MHz NOISE = -150.0 dBW     REQ. REL = 90%    REQ. SNR = 20.0 dB


SUMMARY    5 MODES   FREQ =  14.2 MHZ  UT =  18.0
```

	2.F1	2.F2	3. E	3.F1	3.F2	Most REL 2.F2
TIME DEL.	21.11	21.10	20.27	20.78	21.71	21.10
ANGLE	10.02	10.00	7.14	11.49	17.31	10.00
VIR. HITE	455.52	454.66	203.18	285.06	402.30	454.66
TRAN.LOSS	177.18	133.15	261.44	204.57	173.28	133.15
T. GAIN	14.11	14.10	12.31	14.60	13.98	14.10
R. GAIN	14.11	14.10	12.31	14.60	13.98	14.10
ABSORB	5.06	5.07	5.81	4.72	3.64	
FS. LOSS	131.52	131.52	131.17	131.39	131.76	
FIELD ST.	-41.05	3.00	-123.51	-68.92	-37.02	3.00
SIG. POW.	-157.18	-113.15	-241.44	-184.57	-153.28	-113.15
SNR	8.81	52.84	-75.45	-18.58	12.70	52.84
MODE PROB	0.89	0.86	0.87	0.18	0.20	0.86
R. PWRG	1000.00	1000.00	1000.00	1000.00	1000.00	-6.35
RELIABIL	0.29	0.94	0.00	0.03	0.36	0.94
SERV PROB	0.13	0.57	0.00	0.03	0.16	0.57
SIG LOW	25.00	25.00	25.00	25.00	25.00	25.00
SIG UP	25.00	10.87	25.00	25.00	25.00	10.88

```
  NOISE =   -166      S. POWER = -113.1
  SIGNAL =   16.0   12.3    7.0  /     2.8      5.6      1.8
  NOISE =     8.7 -166.0    4.8  /     1.5      3.2      1.6
  RELIAB =   11.9   52.8   26.5
  SPROB =    33.8   26.3   33.8
```

Table 50.2. *Method 25 output. Antenna height at 0.5 wavelength.*