
INTRODUCING ACE-HF PRO VERSION 2.05

By Richard P. Buckner, P.E.

The well-known *ACE-HF System Simulation and Visualization* software for Ham Operators and Short Wave Listeners is now available from the *antenneX* Shopping Shack. Long-term readers of the *antenneX* on-line magazine know that *antenneX* stands for *antenna eXperimentation*, and experiments with radio antennas can often be aided by software simulation. Why build an antenna and measure its characteristics if we can first preview that antenna using software? ACE-HF software focuses on that need. For the first time, radio operators can simulate their entire HF system—including both transmit and receive terminal antennas, the propagation channel itself and the environment in which the system operates by using ACE-HF.

WHY USE ACE-HF? With ACE-HF, you can truly *try-before-buy*! Are you dissatisfied with your ham contacts and wonder how much better a new Yagi might work than your old Vertical? ACE-HF can tell you. Do you have a QSO schedule with a buddy on 40 meters and wonder how well your dipole antenna will support the circuit on 80 meters? ACE-HF can quickly model that antenna and show the effects on connectivity. And what about ham contests? Do your present antennas cover that missing country, or would it be worth the investment to put up a Yagi stack? Again, ACE-HF can compare the effectiveness of different antennas and automatically find the best band for each at every time-of-day. *And*, ACE-HF can do this for current conditions or for any month in the future! Talk about try-before-buy planning!

ACE-HF has been called *the Cadillac of HF Propagation Programs*. That name isn't surprising since the design derives from the professional ACE-HF NETWORK software for government and commercial HF network operators. But ACE-HF is much more than a propagation model, although it uses the worldwide gold standard VOACAP model as its computational engine. The key design focus is on system simulation—not merely signal propagation. With ACE-HF, signal-to-noise (SNR) calculations are always emphasized (although signal predictions may also be shown).

Two words best describe ACE-HF: *Visualization* and *Animation*. ACE stands for *Animated Communications Effectiveness*, the copyrighted technique for displaying both transmission and reception area coverage on maps of the world. All of the charts used to visualize HF system performance may be animated. These features alone make the product worth investigating for your station.

To review ACE-HF key features, we will first set up a simple ham circuit using the intuitive ACE-HF input screen. Then we will analyze the circuit and illustrate the various analysis charts for that circuit. Third, we will show some of ACE-HF's area coverage maps—those key maps that automatically animate to show how station coverage changes from hour-to-hour. Then, finally, we will return to our *antenneX* emphasis and discuss some of the ACE-HF features of special interest to antenna experimenters.

POINT-TO-POINT CIRCUIT ANALYSIS. To illustrate ACE-HF's circuit analysis features, we set up a circuit from the ARRL W1AW station in Newington, CT to London, England, using the ACE-HF Circuits Inputs Screen shown in **Figure 1**. (London was selected from the included database of more than 35,000 locations.) We assumed a 1000-watt transmit power using Single

Sideband and selected the month of January. ACE-HF imported the January Smoothed Sunspot Number (SSN) from the Internet and found an SSN of only 12 for this month, showing that we are near the bottom of the current solar cycle. So the predictions are likely to be relatively poor in the higher-frequency ham bands. (ACE-HF can quickly show the effect on circuit communications as one experimentally changes the predicted SSN value.)

For the W1AW transmit station, we selected a Yagi antenna model from the ACE-HF antenna library. In this default example, the antenna was modeled as a five-element Yagi, but we could have customized the model by specifying an exact length and spacing for any number of elements. Since we assumed no knowledge of the London station, we specified an Isotropic antenna with a gain of +6 dBi.

ACE-HF V2.05 Inputs Screen

Ham Transmitter

Name	Tx Pwr	Location	Lat	Lon	Select Antenna	
W1AW	1000 Watts	NEWINGTON, CT, USA	41.68 North is +	-72.73 East is +	\Userant\ YAGI34.34	Azimuth Dg from N 52 Point at Rx

Receiver

Name	Location	Lat	Lon	Noise Level	Select Antenna	
LONDON	N/A, UNITED KINGDOM	51.50 North is +	-0.17 East is +	Rural	\Userant\ Isot.000	Azimuth Dg from N 288 Point at Tx

System Parameters

Smoothed Sunspot No.	Month	Service Type	Required Reliability	Path
User: 12 Selected: 12 Default: <input type="checkbox"/>	Jan Current: <input checked="" type="checkbox"/>	SSB Default: <input checked="" type="checkbox"/>	50 % Default (ALE or 50%): <input checked="" type="checkbox"/>	Short Long: <input type="radio"/>

Equivalent Solar Flux: 73 SFU

Dist: 5417 km	Tx Az to Rx: 52.2 dg	Long: 232.2 dg	Rx Az to Tx: 288.5 dg	Short: 108.5 dg	Long: 108.5 dg	Mag Dec at Tx: -14.2 dg
Calc Mag Dec	Mag Az to Rx: 66.4 dg	246.4 dg	Mag Az to Tx: 290.7 dg	110.7 dg		Rx: -2.2 dg

Circuit Comment Line

W1AW 1000 YAGI34 52 -> LONDON Iso +6 288 SSN 12 Jan SSB Rul 50% Sh N.

Current Circuit: HamDefault.ckh Re-run Predictions after changing Inputs or Frequencies.

Save Circuit Recall Circuit Run Circuit Predictions Cancel

Figure 1. W1AW-to-London Inputs Screen.

After switching to the Circuit Analysis Screen we used a favorite ACE-HF tool—the SNR Summary Chart of **Figure 2**, which displays predicted SNR for all frequencies and times-of-day. The chart shows that 40 meters (7.1 MHz) would be a good bet for this contact, at least for our time-of-day at about 23 UTC. This was confirmed by the Best Frequency Chart of **Figure 3**. The 40m SNR vs. time-of-day chart of **Figure 4** confirmed that at the current time the band should be open, but also showed that the band would close at other times of day.

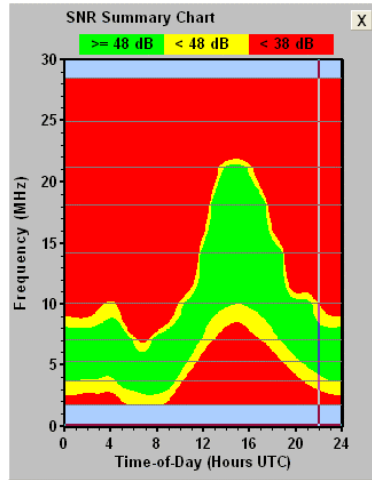


Figure 2. SNR Summary.

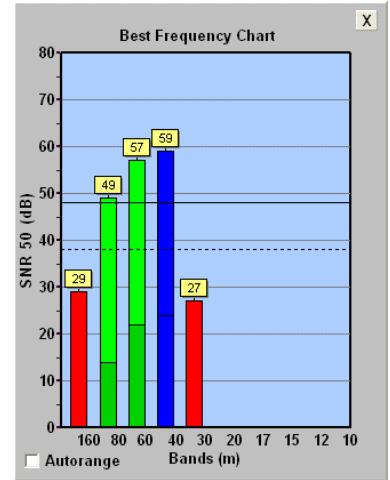


Figure 3. Best Freq. Chart.

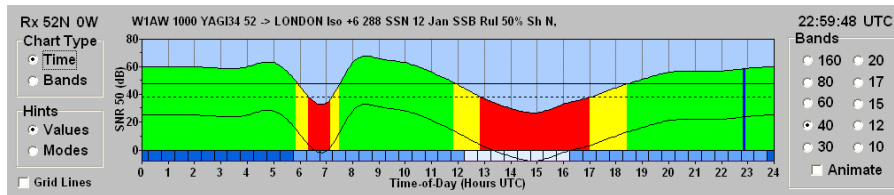


Figure 4. SNR vs. Time-of-Day Chart.

CONTESTING AIDS. With ACE-HF, you can now make simultaneous predictions for up to 18 separate circuits, and the results are displayed on a table like that in **Figure 5**. One can specify different antennas for each end of each circuit, and can even specify different antenna models for every contest band. The table shows color-coded SNR values for each frequency and can be animated through every time-of-day. You can easily see when different bands are “in the green,” and the best frequency is colored *blue*. The table appears for the current time and then advances automatically every hour. It’s a great tool for contesting as you can see at a glance the bands that are open, or can advance the time for planning your next contacts.

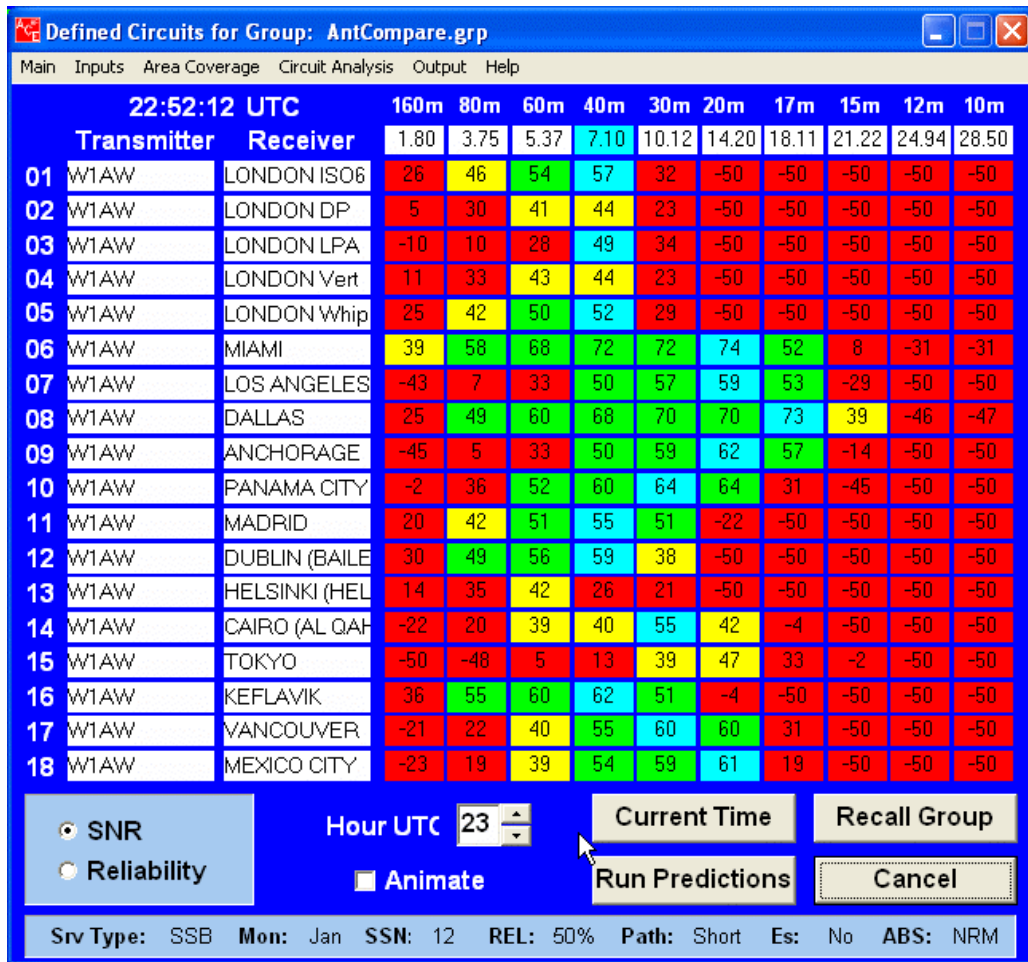


Figure 5. Example Circuit Group Predictions.

ANTENNA COMPARISONS. Circuit group predictions may also be used to compare antenna effectiveness. The first five entries in **Figure 5** show the W1AW-to-London circuit where only the receive antenna is changed. Because propagation loss is different at various frequencies, the first line specifies a fixed-gain Isotropic antenna at the receiver. In the example, this circuit yields an SNR level of 57 dB-Hz at 40 meters, but only 46 dB-Hz at 80 meters due to propagation changes. ACE-HF thus permits the antenna experimenter to isolate propagation effects when comparing antennas.

The next four lines of the chart are for (1) a 40-meter half-wave horizontal dipole, (2) a log periodic antenna, (3) a 40-meter quarter-wave vertical and (4) a short whip receive antenna having a -4.8 dBi gain. The dipole is shown to have a fairly broad frequency response, essentially following the signal attenuation of the propagation channel. The same can be said for the vertical and the short whip, but the gain of the log periodic declines sharply below 40 meters, confirming that this LPA model is not designed for the lower bands. Both gain and pattern must be considered when comparing antennas, and ACE-HF also shows antenna pattern displays, as will be seen later in this article.

AREA COVERAGE. Perhaps the most powerful tool in ACE-HF is the animated area coverage display. **Figure 6** shows a typical 40-meter area coverage chart from W1AW at 23 UTC. In this case, a two-stack Yagi array antenna having a 13.9 dBi gain at 40 meters was specified.

When one creates files for all 24-hours, the display first appears for the current hour and advances every hour automatically. This display confirmed that the London area would be open at this time-of-day. The good trans-Atlantic coverage is due to nighttime propagation to the East of the station, shown by the day-night terminator (grayline) just to the West of W1AW.

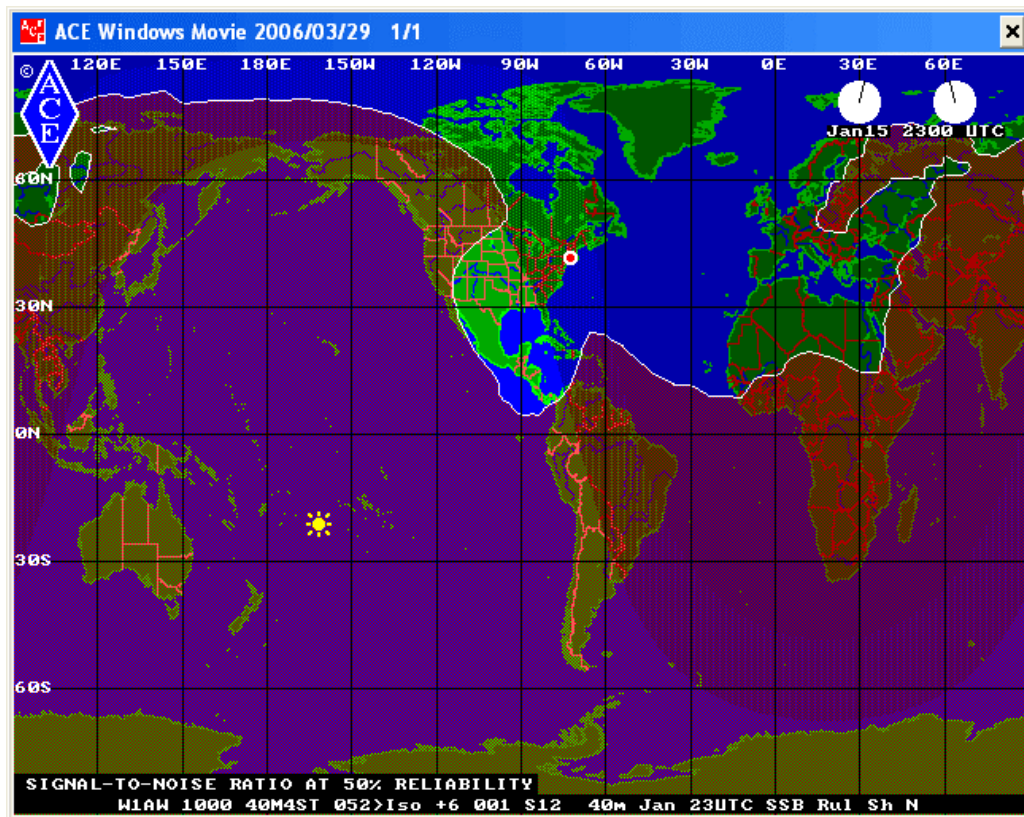


Figure 6. 40-meter Area Coverage from W1AW at 23 UTC.

One can gain amazing insight when the area coverage displays are animated through 24 hours! Coverage comes and goes, quickly explaining why certain frequencies are preferred in contest situations. (One can also animate the displays as a function of frequency at any time-of-day.) What a great teaching tool for new Ham operators!

In this case, the directional pattern of the Yagi array can be seen by the extended coverage over Europe. This pattern, having a high front-to-back ratio, is shown in **Figure 7** (from the ACE-HF included HFANT program). With such high-gain beam antennas the area covered is highly sensitive to the antenna's azimuth setting, and the effect is seen in the display.

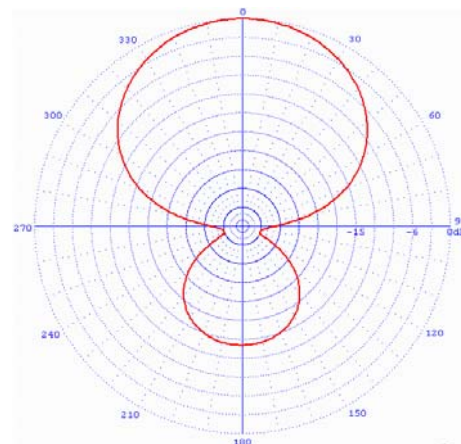


Figure 7. Yagi Array Horiz. Pattern.

A fun experiment is to create sequential area coverage displays at a fixed time-of-day, varying the antenna's azimuth setting in the ACE-HF model. If you create 36 displays, say at 10° intervals, ACE-HF will spin the antenna and show the resulting coverage changes as a movie!

ANTENNA ANALYSIS WITH ACE-HF. *antenneX* subscribers will be interested in the new ACE-HF capabilities for enhanced antenna analysis. In addition to the built-in HFANT program, with which the user can show antenna patterns for the many supplied antenna models or for models that he or she has created, there is a new animated chart for comparing antenna patterns with predicted elevation angles.

One of the most difficult problems in choosing antennas for your station is knowing the best vertical radiation pattern for a given circuit. This problem is particularly troublesome when short circuits that rely on NVIS (Near Vertical Incidence Skywave) propagation must be accommodated. For NVIS, a simple vertical monopole simply won't do.

The new ACE-HF Selected Antenna Analysis Chart automatically graphs the antenna's vertical acceptance (take-off) pattern along with elevation angles of the arriving propagation modes. The chart may be animated through the user's assigned frequencies and directivity gain is given for each. In **Figure 8**, the chart shows that a vertical antenna is a poor match for the 204-km NVIS circuit from W1AW, because the vertical antenna emits little energy toward the zenith. The dipole selected in **Figure 9** is a better choice. The computed elevation angle (the green line) is well within the antenna's radiation pattern, so this NVIS circuit should work well.

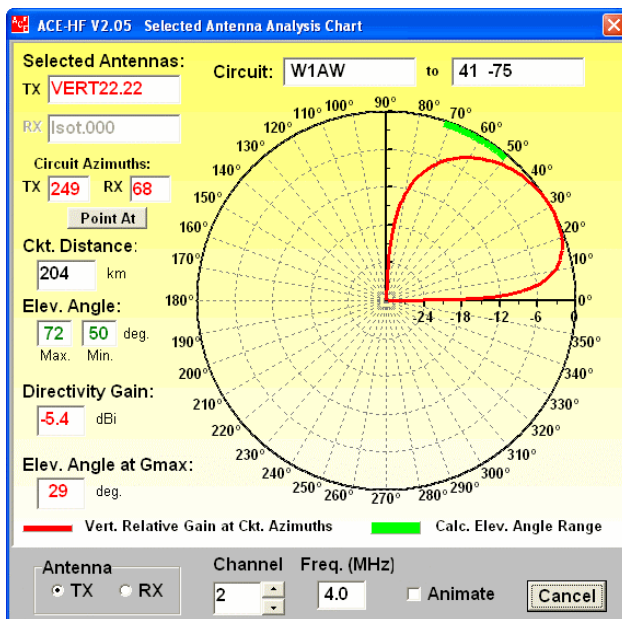


Figure 8. Vertical Antenna Pattern.

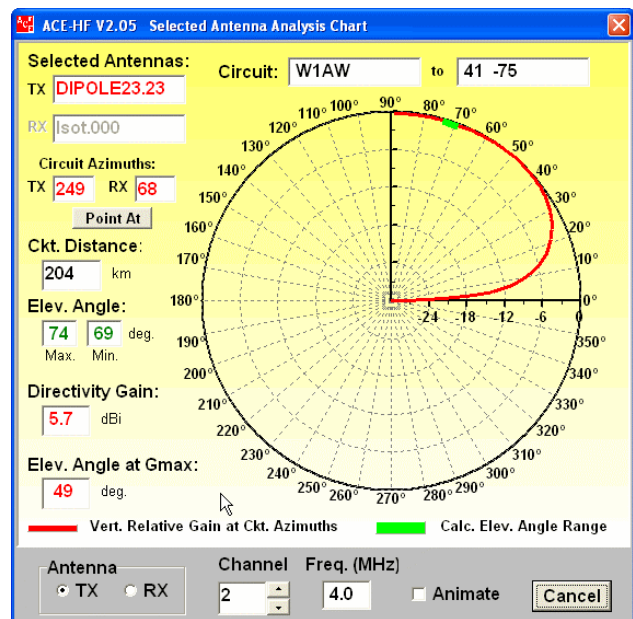


Figure 9. Dipole Antenna Pattern.

But what about other circuits? It's easy to just move the receive dot on the circuit analysis screen and see what happens. And using the pop-up menu, the user can select different antennas without leaving the chart, so comparisons can easily be made. This chart is great fun to play with, and will quickly become a favored tool in the experimenter's toolbox.

NEC Antenna Analysis with ACE-HF. Experimenters who have acquired the Nittany Scientific Inc. *NEC-Win Plus+* or *NEC-Win PRO* antenna modeling software ([available from antennex](#)) can save their antenna models in a VOACAP gain-table format called .ANT. Such files can then be used directly within ACE-HF to display antenna patterns or for use directly in circuit analyses or area coverage displays. (Such files use the standard VOACAP .13 extension when used within ACE-HF.) Or, customers who have acquired the L. B. Cebik antenna model CD from *antennex* can use the NEC programs to save each model in the VOACAP format for use with ACE-HF.

ACE-HF Version 2.05 includes new Type 13 analyses charts to illustrate the gains and radiation patterns of each .13 file. The pattern charts may be viewed individually, or in the case of multiple files—one file for each frequency—they may be animated through the sequence.

Figures 10 and 11 show charts from the example file-set that comes with ACE-HF. This set of Type 13 antenna models shows radiation patterns and maximum gains and was produced for ACE-HF by L. B. Cebik, W4RNL. The set of 29 files examine a typical Terminated Folded Dipole antenna with models for frequencies from 2 through 30 MHz. The chart may be animated through the frequency range to see the rather astounding pattern fragmentation that occurs with even a simple antenna when it is used outside its design range.

In **Figure 10**, the antenna exhibits a reasonable omni-directional gain at 4 MHz. But the azimuthal pattern begins to break up at 7 MHz and in **Figure 11** becomes seriously multi-lobed as 30 MHz is approached.

It is common practice to characterize antennas by their Directivity Gain—the maximum gain the antenna emits at some combined azimuthal and vertical angle. For example, at 30 MHz this antenna’s maximum gain (Gmax) occurs at a 55° azimuthal angle and at a 9° vertical angle. However, the nature of the total pattern is often neglected when comparing antennas and this chart helps to visualize how the total pattern exists at various frequencies.

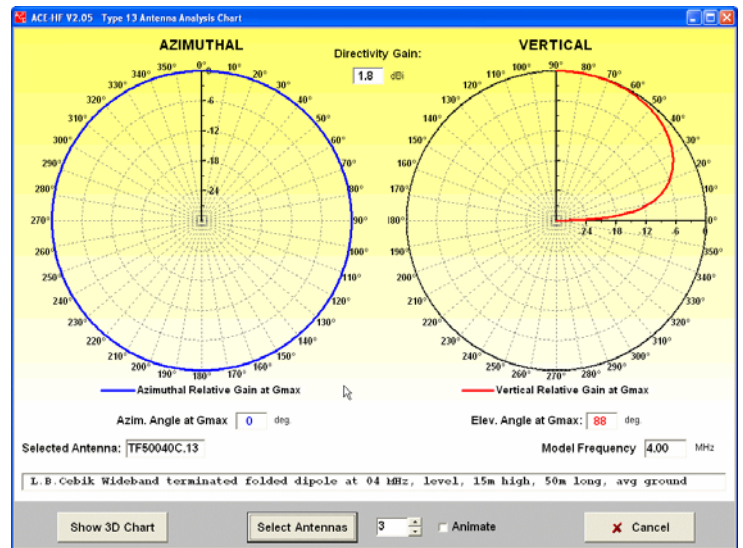


Figure 10. Type 13 Patterns at 4 MHz.

Using ACE-HF, one can readily see why a circuit might be weak if it is found to be at one of the nulls in a multi-lobed radiation pattern.

To aid antenna pattern visualization, ACE-HF can also display the total pattern in a 3D chart, such as seen in **Figure 12**. This chart may also be animated through the frequency range and adjusted for viewing angle.

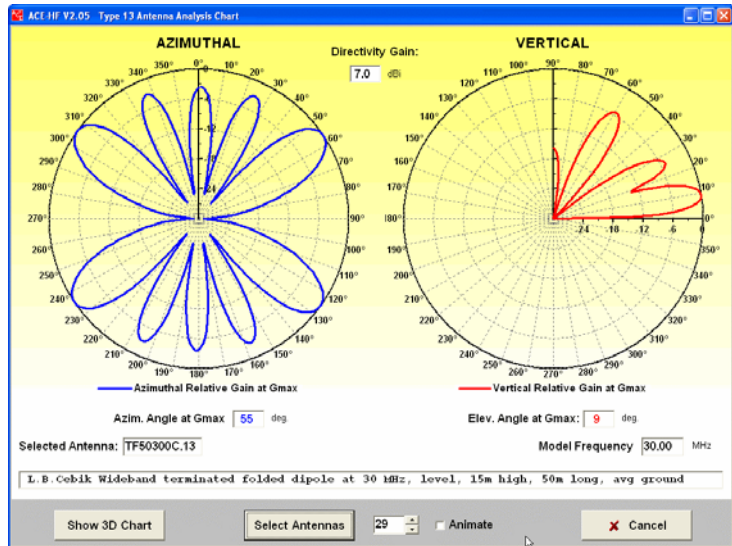


Figure 11. Type 13 Patterns at 30 MHz.

ACE-HF Accuracy. Radio experimenters sometimes ask which propagation program is the most *accurate*? Some years ago, the U.S. Navy funded the authors of ACE-HF to determine which HF propagation program was the most suitable for their HF networks. The resulting study selected VOACAP as the most highly validated model and it was then included in the ACE-HF software. VOACAP—widely regarded as the world’s gold standard—is based on the IONCAP operations research model, and was then improved by a rigorous development program funded by the Voice of America. During that development, every potential improvement was subjected to more than 500,000 circuit path-frequency hours comparisons with field data for paths at all latitudes and ranges. Nevertheless, when VOACAP changes that improve accuracy are found, updated files are posted as free downloads on the ACE-HF website.

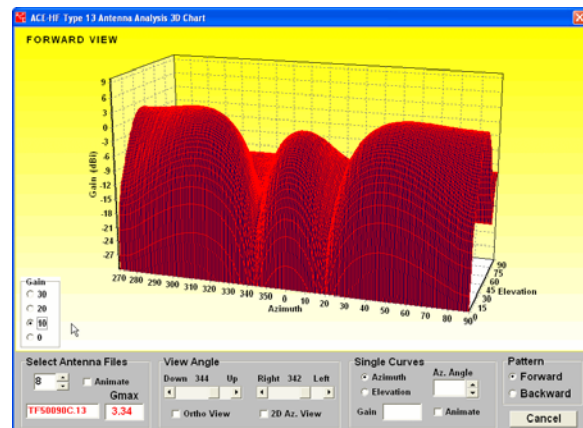


Figure 12. 3D Antenna Analysis Chart.

antenneX is most pleased to offer ACE-HF V2.05 as software that augments our emphasis on antenna experimentation. The software is available for purchase from <http://www.antennex.com/Sshack/software.htm> and is highly recommended. The price for new users is only \$99.00, and existing ACE-HF users will want to upgrade for a modest \$44.00 fee. If you have technical questions, you may contact Dick Buckner at RichardPBuckner@cs.com.

BRIEF BIOGRAPHY OF THE AUTHOR

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ACE-HF Designer and Consultant

PROFESSIONAL EXPERIENCE

Richard Buckner has specialized in VLF/LF/HF communications system design and analysis for more than 50 years, and has recently designed HF system simulation software for use in military, commercial and amateur radio applications. ACE-HF is based on the similar ACE-VLF software Buckner developed to support U.S. Navy strategic systems.



Buckner retired from Rockwell Collins in 1986 after 23 years with Collins Radio and Rockwell Collins. In 1994 he became an independent consultant with assignments on various Defense programs that led to the ACE (Animated Communications Effectiveness) concept—a method for depicting VLF submarine connectivity.

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