VOACAP Online

User’s Manual

VOACAP: Your edge in the HF spectrum.

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Last revision: March 25, 2025

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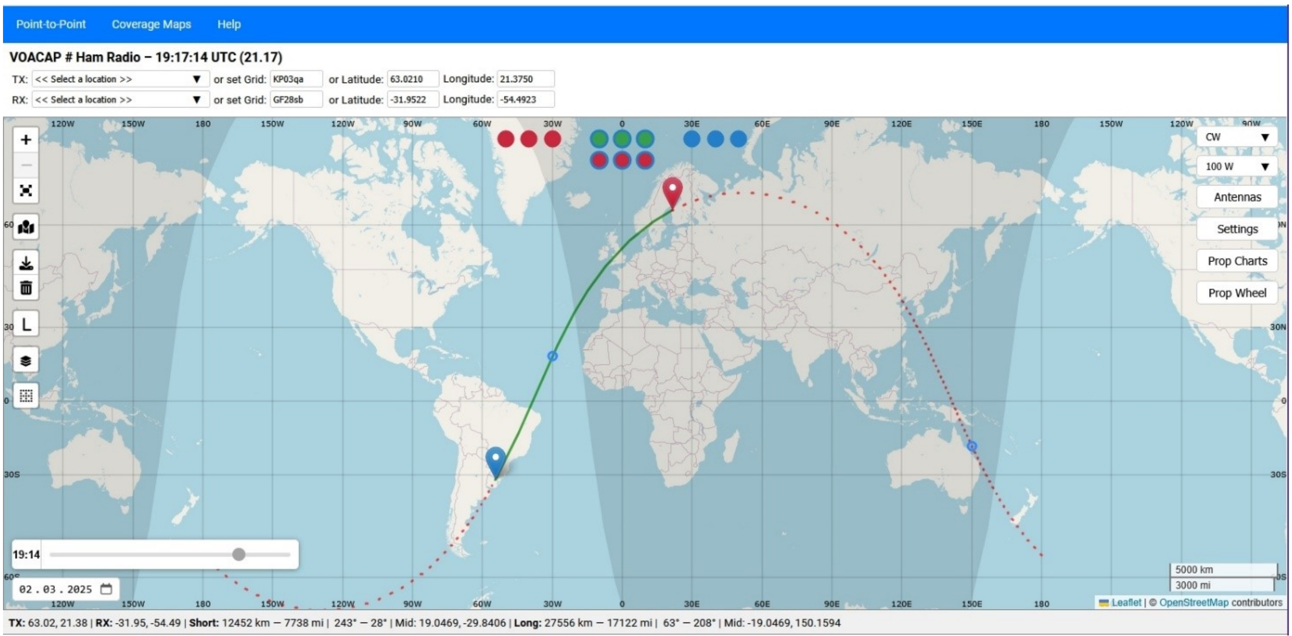
Say hello to intuitive prediction tools! VOACAP Online brings the power of the renowned Voice of America Coverage Analysis Program (VOACAP) to your fingertips, offering a streamlined experience for both novice and seasoned HF enthusiasts.

This improved service consolidates the best features of our previous platforms, providing a one-stop shop for all your HF propagation needs. Whether you're planning a DXpedition, strategizing for a contest, or simply curious about current conditions, VOACAP Online empowers you to explore the fascinating world of HF propagation with ease and precision.



Pinpointing Your Location: The Interactive Map

One of the most powerful features of VOACAP Online is its user-friendly interactive map. Gone are the days of manually inputting latitude and longitude! Simply drag and drop the red (transmitter) and blue (receiver) markers to your desired locations, and watch as the map updates in real-time, displaying:

- **Distance and Bearing:** Instantly see the distance (in kilometers and miles) and bearing (from True North) for both short-path and long-path great-circle circuits.
- **Geographical Midpoint:** Visualize the midpoint of your chosen path, providing valuable insights for propagation analysis.
- **Dynamic Updates:** Move the markers freely to explore different propagation paths and instantly see how distance, bearing, and midpoint change.

VOACAP Online offers unparalleled flexibility for defining your transmitter and receiver locations. In addition to the interactive map, you can also input coordinates using:

- **DXCC Country Selection:** Choose from a comprehensive list of DXCC entities, with meticulously researched coordinates for pinpoint accuracy.
- **Maidenhead Grid Locator:** Enter grid squares directly, and the tool will automatically calculate and populate the corresponding latitude and longitude.

- **Manual Latitude/Longitude Entry:** For ultimate precision, manually input your desired coordinates.

Easily swap the transmit (TX) and receive (RX) locations by double-clicking the blue (RX) marker. This action triggers a recalculation of the propagation prediction and other relevant details. Notice that circuit predictions are not always perfectly reciprocal after swapping TX and RX locations. This discrepancy in VOACAP calculations primarily stems from variations in noise power levels at the receive site(s).

Short-Path and Long-Path Visualization

VOACAP Online doesn't just connect two points on a map; it reveals the invisible highways of radio waves that link them. As you position your transmitter (red) and receiver (blue) markers, notice the two distinct paths that appear:

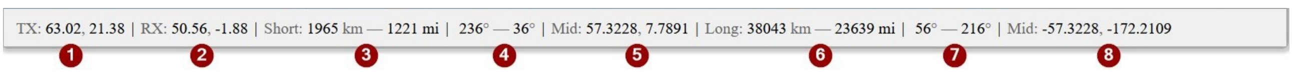
- **The Short Path (Green Line):** This solid green arc represents the most direct, shortest distance between your transmitter and receiver.
- **The Long Path (Red Dotted Line):** This dotted red path takes the scenic route, circling the globe to connect the locations.

A small blue circle marks the geographical midpoint along each path, providing a visual reference for understanding the distances between the transmitter and receiver.

The Data Bar

Beneath the map lies your personalized propagation command center, a dynamic data bar that updates in real-time as you adjust your transmitter and receiver locations. This information-rich display provides:

- **Precise Coordinates:** Latitude and longitude for both your transmitter and receiver, ensuring pinpoint accuracy.
- **Distance at a Glance:** See the total distance between your locations for both the short path and long path, displayed in both kilometers and miles.
- **Bearing for Optimal Aiming:** Determine the precise bearing (from True North) via both the short path and long path, enabling you to optimize your antenna orientation for maximum signal strength.
- **Midpoint Coordinates:** The latitude and longitude of the geographical midpoint for both paths are provided.



1. The latitude and longitude of Transmitter (in degrees)
2. The latitude and longitude of Receiver (in degrees)
3. The Short Path distance from Transmitter to Receiver in kilometers and miles
4. Short Path bearings. The first value: the bearing (in degrees) from True North from Transmitter to Receiver. The second value: the bearing (in degrees) from True North from Receiver to Transmitter.

5. The latitude and longitude of the geographical midpoint of the circuit from Transmitter to Receiver via Short Path
6. The Long Path distance from Transmitter to Receiver in kilometers and miles
7. Long Path bearings. The first value: the bearing (in degrees) from True North from Transmitter to Receiver. The second value: the bearing (in degrees) from True North from Receiver to Transmitter.
8. The latitude and longitude of the geographical midpoint of the circuit from Transmitter to Receiver via Long Path

Setting the Date and Grayline Terminator

Understanding HF propagation requires more than just knowing your location; it demands a grasp of time itself. VOACAP Online gives you the power to manipulate time, allowing you to visualize the movement of the grayline terminator for any date and time.

Your Time Machine: The Pop-Up Calendar

A user-friendly calendar, nestled in the bottom-left corner of the map, serves as your time machine. To embark on your temporal journey:

1. **Click to Open:** Click on the calendar date field (or the black downward arrow beside it, depending on your browser) to reveal the calendar interface.
2. **Navigate Through Time:** Use the left and right arrow icons to effortlessly browse through months and years, selecting your desired month.
3. **Choose Your Date:** Click on any day within your chosen month. This sets the date used for the grayline terminator, and the month set will be used for calculating propagation predictions. The day of the month is not used for calculations in any way, as VOACAP does not provide real-time or daily predictions.

The Time Slider

But your control over time doesn't end there! A dynamic time slider, positioned above the calendar, allows you to manipulate the very flow of day and night:

- **Slide Through the Hours:** Drag the slider left or right to adjust the time of day, watching as the grayline terminator (the boundary between day and night) gracefully dances across the map. **TIP:** If you want to quickly reset the grayline terminator to the current date and time, just click on top of the time area to the left of the time slider.
- **UTC Time Display:** The current UTC time, linked to the slider position, is conveniently displayed to the left of the time slider.

This interactive time control empowers you to visualize how day and night shift throughout the day, assisting you in finding the optimal communication windows, especially on low bands, for your chosen date/month and location.

Sunrise and Sunset Insights

At the top of the interactive map, three sets of colorful circles (red, blue-bordered green and red, and blue) provide a crucial layer of information for optimizing your HF communication strategy: sunrise, sunset, and midnight times.

- **Red Circles (Transmitter):** These circles reveal the precise UTC sunrise, sunset, and midnight times for your chosen transmitter location.
- **Blue-bordered Circles (Short-Path/Long-Path Midpoints):** Discover the sunrise, sunset, and midnight times at the geographical midpoint of the short-path/long-path propagation path.
- **Blue Circles (Receiver):** Uncover the sunrise, sunset, and midnight times for your chosen receiver location.

Click on any of the sunrise, sunset, or midnight circles to witness the magic unfold on the map below. The grayline terminator will dynamically adjust to display its position at the selected time, providing a visual representation of day/night boundaries across the globe. Also use the **Sun of the Day** visualization tool that can be found at the end of the Point-to-Point menu.

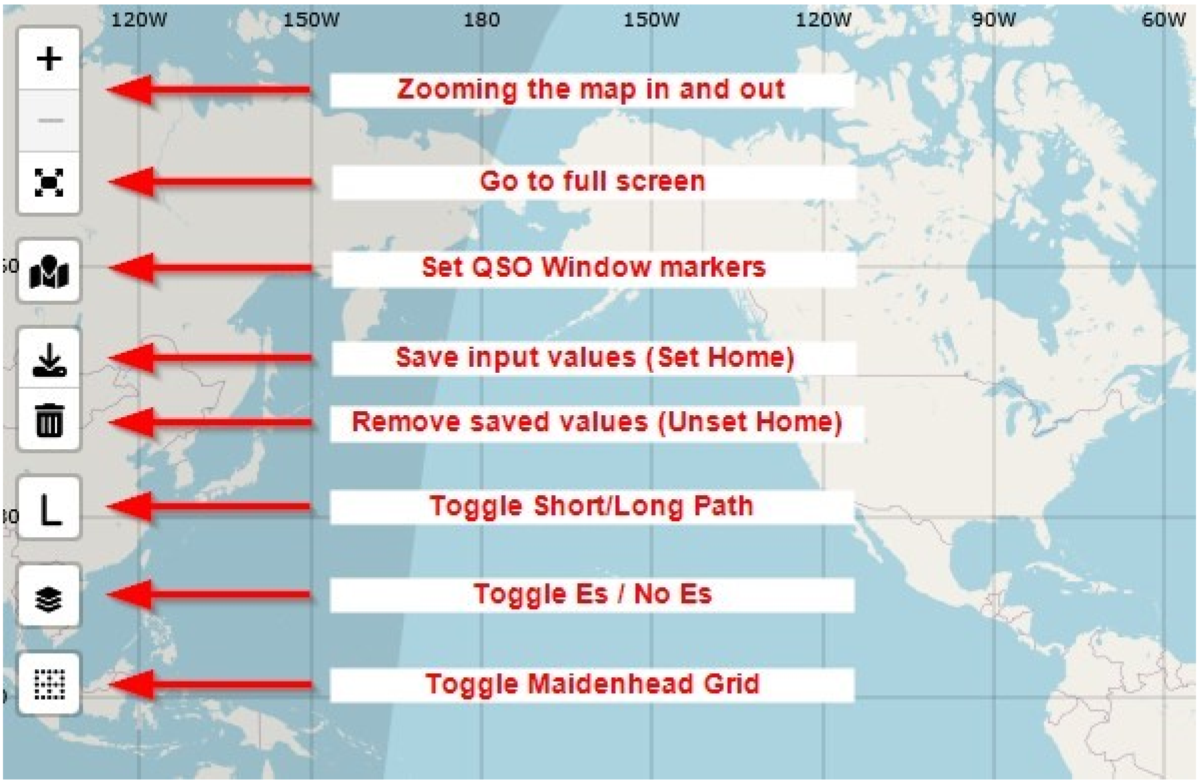
This interactive feature, inspired by the pioneering work of Steve G0KYA, empowers you to pinpoint the optimal times for exploiting grayline propagation and unlocking enhanced low-band signals. For even deeper insights into grayline propagation, be sure to explore the green **DXCC Grayline** button.

Navigating the Input Parameters

VOACAP Online puts you in the driver's seat, allowing you to fine-tune your propagation predictions with a range of customizable parameters. These controls, conveniently located on the left and right sides of the interactive map, empower you to tailor the analysis to your specific needs.

Left-Side Controls

The left side of the map presents a suite of essential controls for customizing your predictions:



- **QSO Window Markers**: Toggle the icon to show or hide five red markers (labeled A to E). Hover over a marker to view its label. Position the markers as needed for **QSO Window** and **Planner DIY** analyses.
- **Set Home:** Establish your home base by saving your preferred transmitter and receiver locations, along with your chosen antenna configurations, as a convenient cookie. This eliminates the need to re-enter this information every time you visit. Click **Unset Home** to clear these saved settings.
- **Short/Long Path (Default: SP):** Toggle between analyzing propagation along the great-circle Short Path (SP) or Long Path (LP) with a single click. This setting also influences many of the calculations performed by the green buttons beneath the map.
- **Sporadic-E Layer (Es) (Default: NoEs):** Account for the potential impact of sporadic-E propagation, particularly during summer months when this phenomenon can be prevalent. While the default setting is OFF (NoEs) due to the sporadic-E model not being fully tested during VOACAP's development, you can enable it if desired. Keep in mind that sporadic-E effects are not entirely excluded from VOACAP calculations, even when this setting is OFF.
- **Maidenhead Grid Overlay (Default: NoM):** Enhance your map visualization by toggling the Maidenhead grid overlay ON or OFF. This grid provides a convenient reference for quickly identifying locations based on their grid squares.

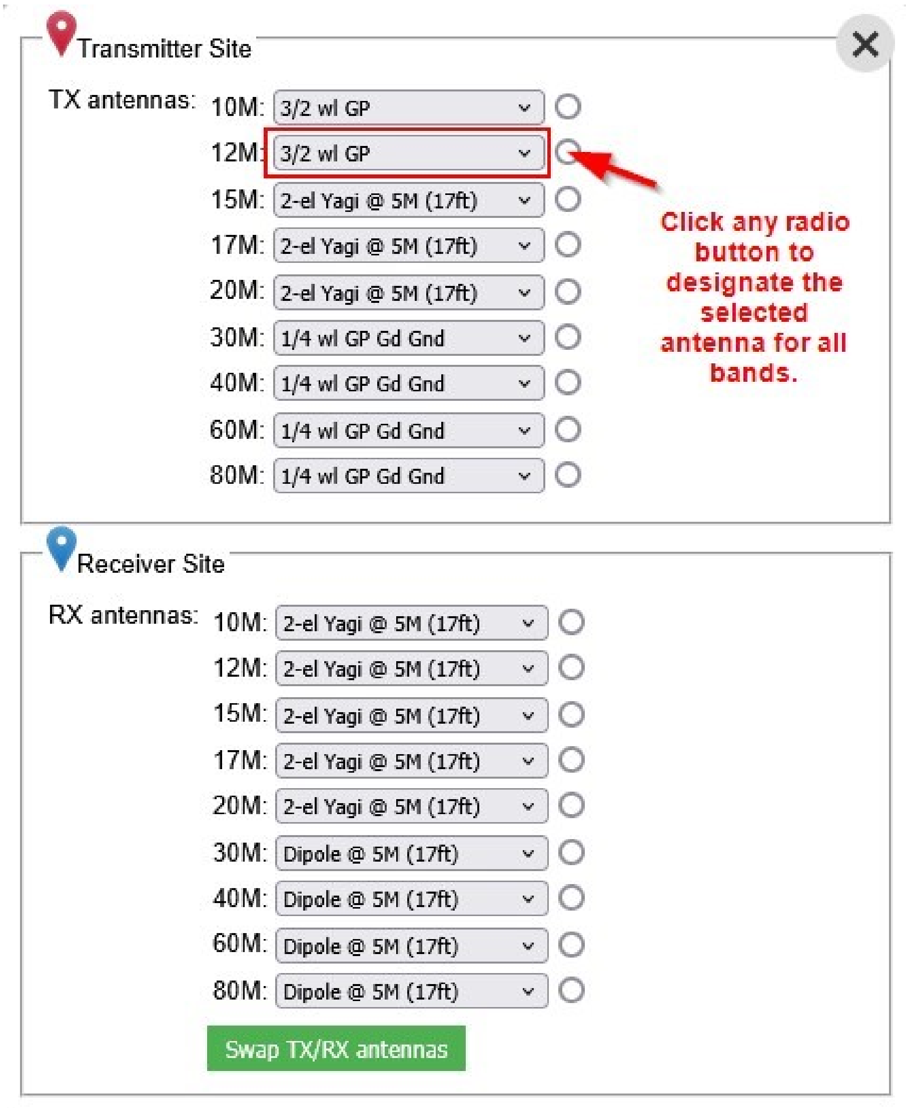
Right-Side Controls

On the right side of the map, you'll find controls that allow you to fine-tune the characteristics of your transmitted signal.

- **Transmitting Mode:** Select your desired operating mode from a dropdown menu featuring popular options such as WSPR, FT8, CW, SSB, and AM. CW is set as the default mode.
- **Transmitting Power:** Choose your desired power level from a range of options, spanning from a modest 0.1 watts to a robust 1500 watts (the default setting), and up to 20 kW. To account for real-world line losses, the tool automatically factors in an 80% efficiency, meaning your selected power is adjusted accordingly for the calculations.
- **Antennas:** This button unveils a world of antenna possibilities. Select a different antenna for each amateur radio band, tailoring your setup for optimal performance across the spectrum.
- **Settings:** Customize the fundamental parameters used for all propagation predictions. Clicking it reveals an overlay window, conveniently sliding in from the left side of the map, containing five distinct setting groups. This allows you to tailor your predictions to your specific needs, ensuring accurate and relevant results.

Important Considerations for Antenna Selection

While the tool provides a wide array of antenna choices, it's important to remember that these are idealized, omnidirectional representations. This deliberate simplification allows you to visualize potential openings to all corners of the globe without the constraints of real-world antenna patterns.



When choosing your antennas, prioritize:

- **Elevation Angle:** Consider the typical elevation angles and select antennas that perform well at those angles.
- **Gain:** Higher-gain antennas can provide a significant advantage in signal strength, particularly for challenging long-distance communication.

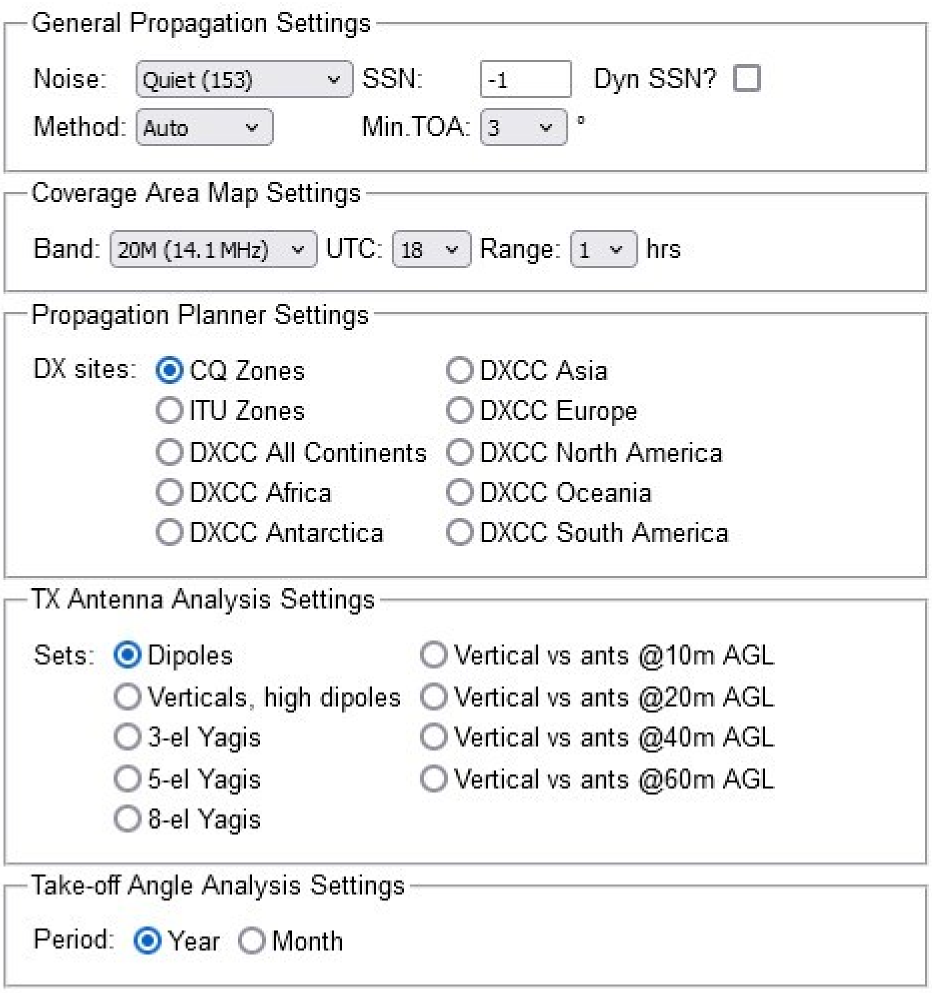
Designate One Antenna for All Bands: For a quick TX and RX antenna setup, click the radio button next to the selected antenna on any band. This will apply that antenna to all bands in both the TX and RX sections.

Swap TX/RX Antennas: For quick comparisons and experimentation, conveniently swap your chosen transmitter and receiver antennas with a single click using the **Swap TX/RX antennas** button.

Settings for Precision Control

VOACAP Online goes beyond basic predictions, offering a sophisticated suite of settings that allow you to fine-tune every aspect of your analysis. Clicking the **Settings** button on the right side of the map unveils an overlay menu, your portal to five distinct parameter sections:

- **General Propagation Settings:** Fine-tune the fundamental parameters that influence all propagation calculations.
- **Coverage Area Map Settings:** Customize the generation of coverage area maps for visualizing signal reach.
- **Propagation Planner Settings:** Tailor the analysis performed by the Propagation Planner for strategic planning.
- **TX Antenna Analysis Settings:** Compare the performance of different transmitting antennas for your chosen path.
- **Take-off Angle Analysis Settings:** Evaluate how well your selected antennas align with predicted take-off angles.



Let's delve into the intricacies of each section:

1. General Propagation Settings

- **Noise:** Simulate real-world conditions by defining the noise level at the receiver end of the circuit. Choose from presets ranging from "Noisy" (extensive noise) and "Remote" (minimal noise). “Quiet” is the default setting. This setting influences QSO probabilities, with lower noise generally leading to higher probabilities of successful communication.
- **Smoothed Sunspot Number (SSN):** For advanced users, this setting allows manual control over the SSN used in calculations. Set by default to -1, VOACAP Online automatically utilizes predicted smoothed SSN values for up to 9 months into the future. However, you can override this and input specific SSN values for specialized analysis or historical simulations. Remember that VOACAP relies on smoothed monthly SSN figures rather than daily values, as it is not designed for real-time predictions. For the most accurate results, adhere to the Lincoln-McNish smoothed SSN figures provided by WDC-SILSO.
- **Dynamic SSN:** For situations where recent solar activity significantly deviates from predicted monthly averages, enable this experimental option to utilize a running three-day average of daily sunspot numbers.
- **Propagation Model (Method):** Select your desired VOACAP propagation model:
    - **Auto (Default):** This intelligent mode, referred to as Method 30 in VOACAP terminology, acts as your autopilot. It automatically selects either the ray-hop or ducted model based on the distance between your transmitter and receiver, ensuring optimal prediction accuracy. For paths exceeding 7,000 km, a smoothing function is applied to enhance prediction reliability.
    - **Ducted:** Force the use of the ducted (forward-scatter) model, typically suitable for paths exceeding 10,000 km. This mechanism, prevalent in paths with three or more ionospheric hops, involves signals being trapped within layers of the ionosphere and guided over long distances. For shorter paths where ray-hop propagation dominates, this model may produce less accurate results.
    - **Ray-hop:** Employ the classic ray-hop propagation mechanism, best suited for shorter paths generally under 10,000 km. It accounts for multiple reflections between the ionosphere and Earth's surface, factoring in signal losses incurred during each hop. While highly accurate for shorter to medium distances, this model may produce overly pessimistic predictions for paths beyond the third ionospheric hop, where ducting mechanisms can significantly enhance signal propagation.
- **Minimum Take-off Angle (Min. TOA):** Define the lowest takeoff or arrival angle considered for antenna analysis. The default setting of 3.0 degrees can be a good choice in typical cases. However, if you employ highly efficient antennas with very low takeoff angles, consider lowering this value to 0.1 degrees to capture potential low-angle propagation modes. Experimenting with this setting can reveal optimal values for your specific antenna setup.

Deep Dive into the Importance of the Minimum Take-off Angle Setting
VOACAP's calculations involve analyzing various propagation modes, each associated with a specific range of take-off angles. By setting the Minimum TOA, you're essentially instructing VOACAP to focus its analysis on modes that fall within a certain angular range.

Here's why this matters:

- **Missing Optimal Modes:** Setting an overly low Minimum TOA (e.g., 0.1 degrees) with antennas designed for higher take-off angles can lead to VOACAP overlooking the most efficient propagation modes. Since VOACAP typically analyzes only three modes per ionospheric layer, starting at a very low angle might cause it to miss higher-angle modes that align better with your antenna's capabilities.
- **Real-World Terrain Considerations:** A Minimum TOA of 3.0 degrees is often recommended as a balanced starting point. This value accounts for the fact that skywave signals rarely arrive at extremely low angles due to terrain irregularities and obstructions.
- **Antenna Characteristics:** The ideal Minimum TOA setting depends heavily on your antenna setup. For highly efficient antennas designed for low-angle radiation, a lower Minimum TOA (e.g., 0.1 degrees) might be appropriate. However, for antennas with higher take-off angles, a Minimum TOA of 3.0 degrees or higher often yields more accurate results.

Finding Your Optimal Minimum TOA
Don't be afraid to experiment! VOACAP Online encourages exploration. Try running predictions with different Minimum TOA values between 0.1 and 3.0 degrees, observing how the results change based on your chosen antennas and propagation paths. This hands-on approach will help you determine the optimal setting for your specific HF setup, ensuring the most accurate and insightful predictions.

2. Coverage Area Map Settings

VOACAP Online recognizes that generating accurate and insightful coverage area maps requires flexibility. Therefore, you have dedicated control over key parameters, allowing you to tailor the analysis to your specific needs.

Key Parameters

- **Year and Month:** The desired year and month for your coverage area analysis will be read from the calendar.
- **UTC Time:** Define the starting hour (in UTC) for your maps. By default, this is set to the current UTC hour.
- **Range (Plotting Time Range):** Determine the time span you want to visualize on your maps, up to a maximum of 9 hours. Opting for a number of shorter runs ensures smoother processing and optimal performance. Keep in mind that even exceeding 6 hours might lead to timeouts, depending on server load.

3. Propagation Planner Settings

Maximize your success in HF contesting and DXing by strategically planning your sessions to take advantage of every propagation opportunity.

- **DX Sites:** Choose your target regions for analysis, selecting from CQ Zones, ITU Zones, or specific DXCC countries and entities grouped by continent. The Propagation Planner utilizes your chosen settings for antennas, short/long path selection, sporadic-E, transmission mode, and power to generate comprehensive predictions for your desired locations.

4. TX Antenna Analysis and Take-off Angle Analysis Settings

VOACAP Online empowers you to go beyond simply selecting antennas; it provides the tools to analyze and optimize their use for your specific propagation needs.

TX (Transmit) Antenna Analysis: Finding the Right Antenna for the Job
Within the "TX Antenna Analysis Settings" section, you can unleash the power of comparative analysis. Compare the performance of various transmitting antennas for your defined circuit and chosen month. Select from a diverse range of antenna types, including isotropic, dipoles, and Yagis, at various heights. Note that this analysis temporarily overrides your user-defined TX antennas, but your selected RX (receive) antennas for each band remain unchanged.

In many comparisons, various vertical antennas are compared to a number of dipoles and Yagi antennas to give insights into their performance.

How it works:

1. **Antenna Selection:** Choose from a comprehensive list of antenna types, including:
    - **ISOTROPE:** The theoretical benchmark, an isotropic antenna radiates equally in all directions with 0 dBi gain.
    - **HVD025:** A half-wave vertical dipole fed at 0.25 wavelengths above ground level.
    - **Vertical Antennas (V14, V14GD, V14VYGD, V58, 2-EL VDA):** Various vertical antennas with different lengths and ground conditions: Average, Good (GD) and Very Good (VYGD) grounds.
    - **Horizontal Dipoles (DxxM):** Horizontal half-wave dipoles at user-defined heights (xx meters above ground level).
    - **Yagi Antennas (3ELxxM, 5ELxxM, 7ELxxM):** Horizontal Yagi antennas with varying element counts (3, 5, or 7) and heights (xx meters above ground level).
2. **Initiate Analysis:** Click the "Antenna" button below the world map to run the analysis. VOACAP Online will simulate propagation using each selected antenna, providing insights into their relative performance.

Take-off Angle Analysis: Aligning Your Antennas with Propagation
The "Take-off Angle Analysis Settings" section helps you understand how well your chosen antennas align with the predicted take-off angles for your circuit.

Fine-tuning Your Analysis:

- **Time Period:** Choose to analyze take-off angles for the entire year or focus on the selected month for a more targeted assessment.

Running the Analysis:

- Click the **TO Angle** button below the world map to initiate the analysis. This process will calculate the optimal take-off angles for your circuit and provide insights into how well your selected antennas match those angles.

By leveraging these powerful analysis tools, you can make informed decisions about your antenna selection, ensuring your HF station is optimized for maximum performance and signal propagation.

Your HF Toolkit: The Deep Dive

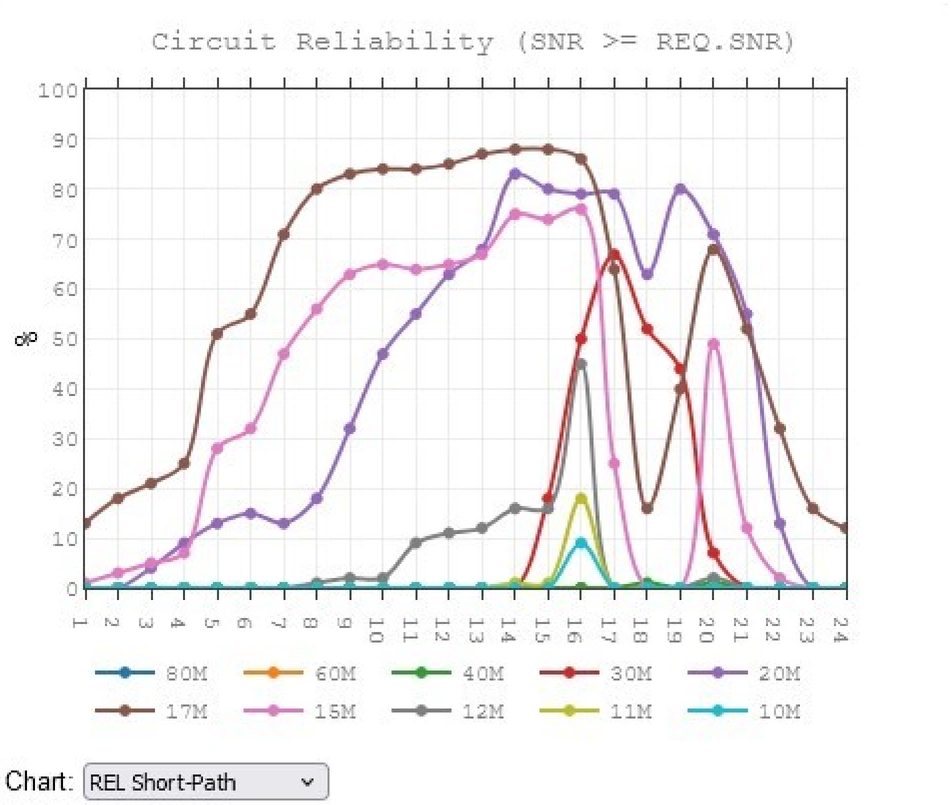
VOACAP Online doesn't just crunch numbers; it transforms them into insightful visualizations that deepen your understanding of HF propagation. It offers an impressive arsenal of 16+ distinct services, each accessible via three menus on top of the page (**Point-to-Point**, **Coverage Maps** and **Help**), or on the right side of the map. These services encompass both point-to-point predictions, focusing on specific TX/RX pairs, and coverage area maps, which visualize signal propagation over broader geographical regions.

Each prediction menu item opens a new window dedicated to its specific analysis, providing detailed results and visualizations to empower your HF explorations. Whether you're seeking optimal communication windows, exploring long-path propagation, or analyzing antenna performance, VOACAP Online equips you with the tools to navigate the fascinating world of HF radio with confidence and precision.

1. Prop Charts & Prop Wheel

1.1. Prop Charts

Clicking the Propagation Charts (**Prop Charts**) button on the right side of the map reveals 15 interactive charts covering amateur radio bands from 3.5 MHz to 28 MHz. These charts provide valuable insights into predicted propagation conditions between your chosen transmitter (TX) and receiver (RX) locations.



Visualizing multiple output parameters on interactive charts enhances our understanding of HF propagation, offering a much richer picture than a single parameter alone. For a truly comprehensive assessment, three key parameters – REL (Circuit reliability), SDBW (Signal power), and MUFday – are essential:

REL (Circuit reliability): Expressed as a percentage, REL indicates the likelihood of successful communication (QSO) on a given frequency and time. A higher REL means a greater chance of clear, reliable communication.

- REL is directly linked to SNR (Signal-to-Noise Ratio) and REQ.SNR (Required Signal-to-Noise Ratio), acting as a circuit reliability factor.
- It represents the percentage of days within a month when the SNR value (not shown separately in the charts) reaches or exceeds the REQ.SNR.
- REQ.SNR, an internally defined value, is tied to the chosen transmitting mode. For example, for CW, it is set to 19 dB-Hz, while for SSB it is 38 dB-Hz. All transmitting modes have internal threshold values of their own.

SDBW (Signal power): SDBW represents the predicted median signal strength at the receiver.

- The green line on the chart represents the predicted dBW (decibels relative to one watt) value that can be maintained on 50% of the days (15 days out of the month).
- The SDBW distribution, shown as a light-gray area above and below the green SDBW line, reveals the expected signal power levels at the receiver throughout the month, for a specific frequency and hour.
- SDBW90 (90% of days, 27 days) and SDBW10 (10% of days, 3 days) mark the upper and lower boundaries of the light-gray area, indicating the range of potential signal strength.

It's important to note that these values don't specify which days will be good or bad, but rather, the overall range of possibilities.

- Use the SDBW to S-Meter conversion table to convert the SDBW values to S-meter readings: https://www.voacap.com/2023/understanding/s-meter.html

MUFday: This parameter reveals the percentage of days in a month, at the given hour, when the operating frequency will be below the predicted median Maximum Usable Frequency (MUF) for the Most Reliable Mode (MRM).

- The MRM is the mode of propagation with the highest reliability of achieving the required SNR (REQ.SNR).

Data Presentation

- REL and MUFday data are expressed as percentages from 0 to 100.
- SDBW data is presented in dBW values, ranging from -164 (extremely low noise level) to -103 (corresponding to an S-meter reading of S9).
- Each step in the SDBW scale corresponds to 6 dB or one S-meter reading step.

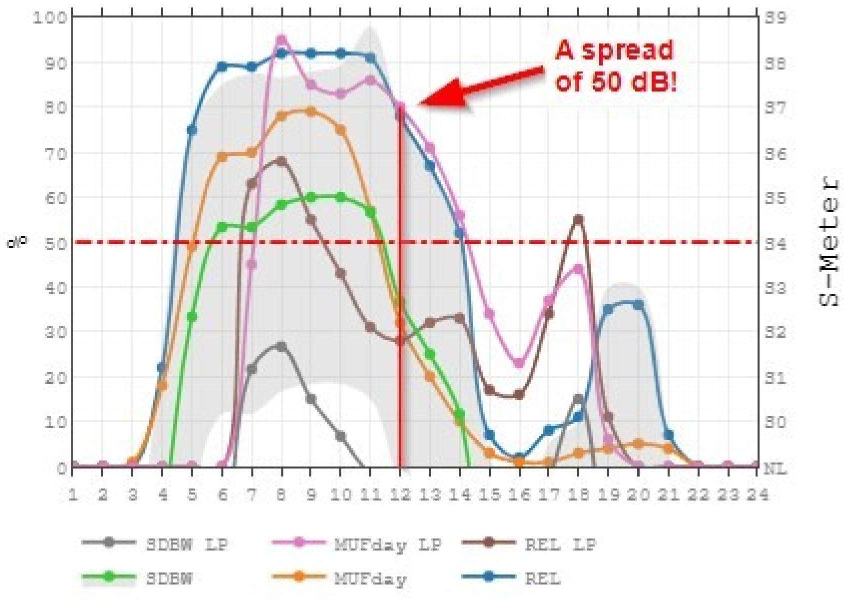
Short-Path and Long-Path Considerations
It is important to remember that all three parameters are calculated using both Short-Path and Long-Path propagation paths. This provides a comprehensive view of the potential propagation conditions for a given communication scenario.

Interactive Charts for Enhanced Analysis
The charts present multi-colored lines representing each parameter, and you can toggle the visibility of individual parameters and frequencies directly from the legend, allowing them to focus on the most relevant information. Additionally, a robust toolbox provides a suite of features for further exploration, including:

- **Saving as PNG**: Capture and share your insights with ease.
- **Zooming**: Dive into specific areas of interest for detailed analysis.
- **Data Comparison**: Hover over any point to compare results across all frequencies.
- **Panning**: Explore the chart freely for a comprehensive view.

1.2. Predicting Prime Time for Radio Communication

Propagation Graphs are your essential guide to understanding the nuances of radio communication, helping you choose the optimal time and frequency for your transmissions.



Let's decode the visual clues in a band-specific propagation chart:

- **The Blue Line (REL, Reliability):** Like a quick weather forecast, the blue line reveals the probability of successful communication via the short path, hour by hour. It offers a quick glance at propagation possibilities.
- **The Orange Line (MUFday):** This line acts like a frequency guide, showing the probability of your chosen frequency staying below the calculated MUF (Maximum Usable Frequency) for the short path.
- **The Green Line (SDBW, Signal Power):** This green line unveils the median signal strength for 15 days of the month via the short path. The corresponding S-meter scale is shown on the right of the chart.

The Gray Zone: Dive into the gray zone above and below the green line for a glimpse into the variation of the predicted signal strength via the short path. The upper edge hints at the strongest signal you might encounter on those lucky 3 days (10% of the time), while the lower edge reveals the minimum signal strength you can expect on those more frequent 27 days (90% of the time).

When the gray zone widens, uncertainty creeps in. A gap or spread of 40-50 dB means VOACAP is unsure of the future. Such a vast range can signify a high degree of uncertainty in the propagation prediction. But when the gap narrows, you're looking at better prediction accuracy and a brighter chance of communication.

In our example chart, VOACAP's prediction for such a wide distribution implies that 80% of the days within a month (as defined by SDBW90 and SDBW10) could experience Signal Power levels anywhere between below noise and S7 – a staggering 50 dB difference! If VOACAP could speak, it would likely express its own uncertainty about the expected conditions on that frequency at that hour.

Prime Time for Communication: The best times to connect are those with:

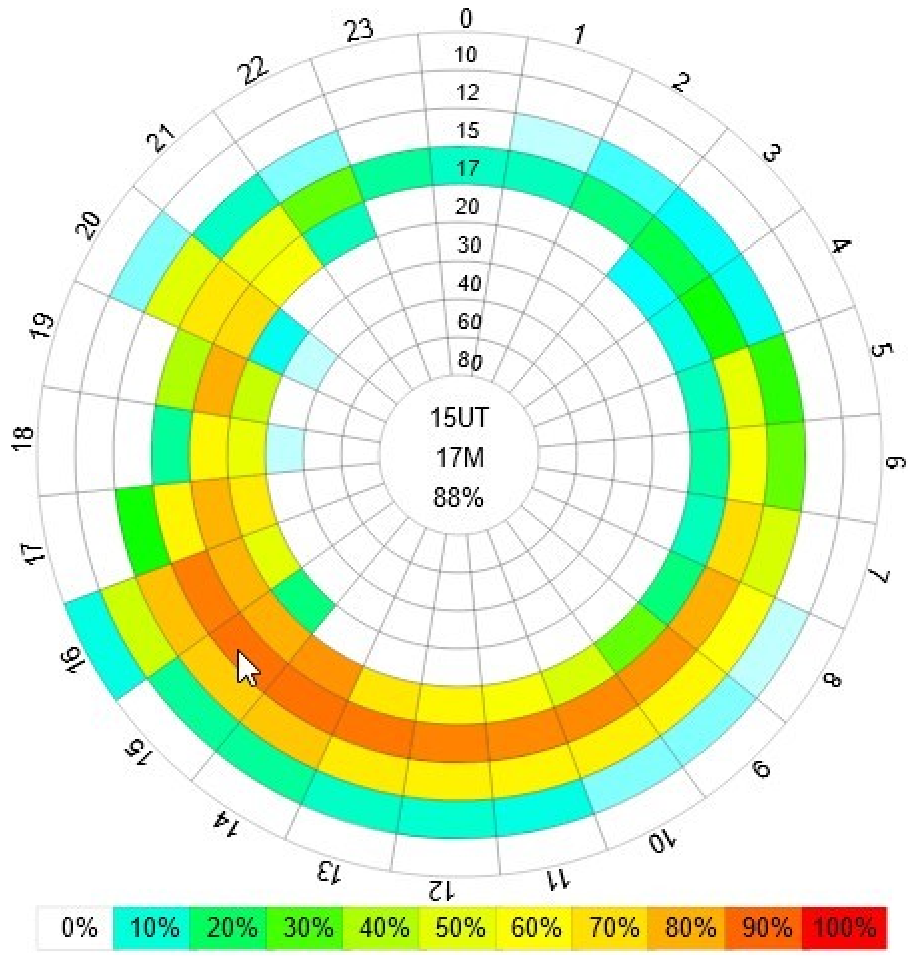
- a high lower edge of the grey zone (a strong signal on most days)
- a soaring orange line (high probability of staying below the MUF), ideally over 50%
- a robust green line (good signal strength for 15 days in a month)

Don't forget: LP in the graphs stands for propagation via the long path.

Now, equipped with this visual language, you can decipher the clues of VOACAP and find those perfect communication windows.

1.3. Prop Wheel

The Propagation Wheel (**Prop Wheel**) on the right side of the map will provide a quick and intuitive overview of propagation potential with its iconic 24-hour clock. This dynamic wheel displays the REL (Circuit Reliability) parameter for all amateur bands, using a color-coded system to represent the probability of successful communication throughout the day. Keep this window open as you experiment with different TX/RX locations and settings, and watch as the predictions update on-the-fly, providing instant feedback and insights.



Note about times: The Propagation Wheel is designed to provide an intuitive representation of hourly predictions. Here's how to interpret it: the hour mark on the outer ring signifies the top of the hour. Each hour segment is divided equally, representing a 30-minute interval before and after the hour mark. For instance, when you look at the prediction labeled as 07 UTC, it encompasses the time period from 06:30 to 07:30 UTC!

1.4. Getting Started with Propagation Prediction Analysis

1. **Start with REL:** Use the Propagation Wheel to quickly identify bands with the highest REL values for your desired path.
2. **Analyze SDBW:** Navigate to the Propagation Charts and examine the SDBW values for the bands shortlisted in the previous step. Look for bands with higher SDBW values and narrower distributions, indicating stronger and more consistent signals.
3. **In-depth Analysis with Band-Specific Charts:** For further analysis, focus on the charts for your chosen bands. Pay close attention to MUFday values and the SDBW distribution. Be wary of extremely wide SDBW distributions, as these suggest less reliable predictions.
4. **Don't Forget Long-Path:** Explore both Short-Path and Long-Path predictions, especially for long-distance communication, as Long-Path propagation can sometimes offer unexpected opportunities.

2. Point-to-Point Menu

2.1. VOA Band-by-Band: VOACAP Predictions

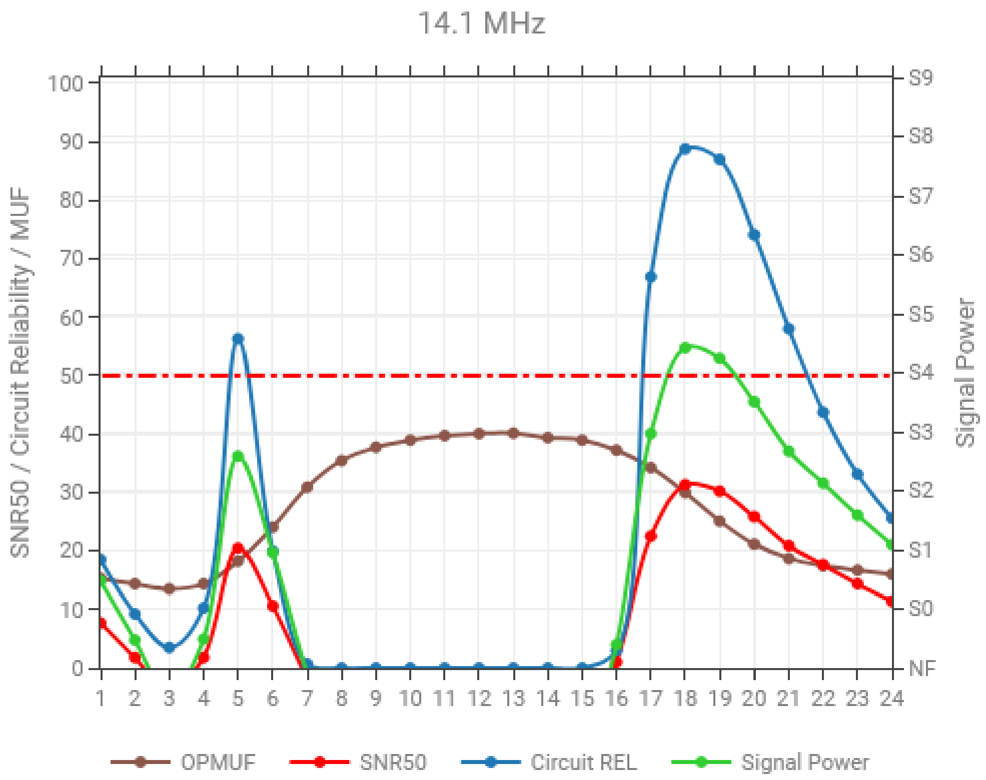
Ever wished you could see the full HF picture at once? Based on the **Propagation Charts** analysis above, the **Band-by-band** option in the Point-to-Point menu grants you that wish, presenting all 15 prediction charts and both short-path and long-path propagation tables in one, easy-to-absorb layout. These predictions are made with VOACAP. Get ready for an "Aha!" moment as you uncover hidden propagation opportunities across the entire spectrum.

2.2. ITU Band-by-Band: ITURHFProp Predictions

This option will perform HF propagation predictions band-by-band using the ITURHFProp application – a software method for the prediction of the performance of HF circuits in accordance with Recommendation ITU-R P.533-14 – provided by the ITU. This prediction method applies a ray-path analysis for path lengths up to 7000 km, composite mode empirical formulations from the fit to measured data beyond 9 000 km, and a smooth transition between these two approaches over the 7000–9000 km distance range.

At VOACAP Online, ITURHFProp prediction graphs include:

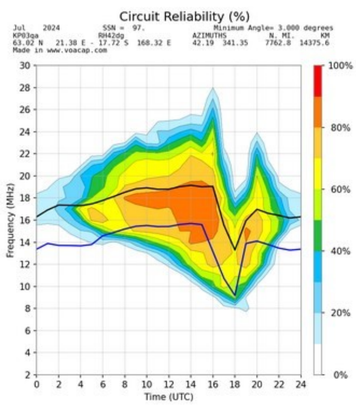
- Median Signal-to-Noise Ratio (SNR50)
- Basic Circuit Reliability (BCR)
- Operational MUF
- Signal Strength (Signal Power)

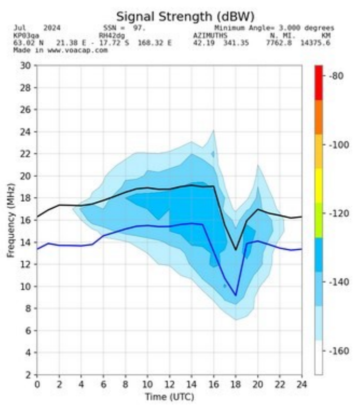


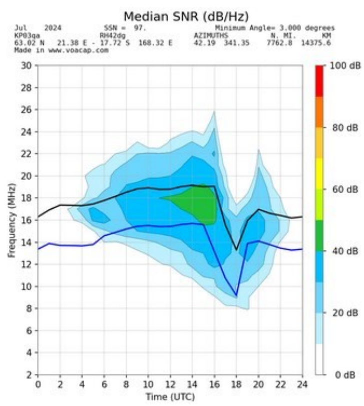
With VOACAP and ITURHFProp using different prediction methodologies, you can now compare their results side by side and gain deeper insights into HF propagation. While services like Proppy (https://soundbytes.asia/proppy/) by James Watson have offered ITURHFProp predictions for years, it is now also integrated into VOACAP Online.

2.3. REL | SDBW | SNR: Three-in-One Predictions

The REL | SDBW | SNR graphs under the Point-to-Point menu provide a comprehensive overview of predicted propagation conditions for your chosen frequency and path. This section guides you through interpreting the data.







Generating the Graphs

Clicking the **REL | SDBW | SNR** menu item initiates a detailed calculation for the entire frequency range of 2 MHz to 30 MHz. This generates three key graphs:

- **REL (Circuit Reliability):** This graph, further detailed below, illustrates the probability of successful communication.
- **S DBW (Signal Power):** This graph displays the predicted signal strength at the receiver.
- **SNR (Signal-to-Noise Ratio):** This graph depicts the signal strength relative to background noise.

Key Features

- **Median MUF (Maximum Usable Frequency):** Represented by the black curve, this indicates the highest frequency likely to provide stable communication.
- **FOT (Frequency of Optimum Traffic):** The blue curve highlights the frequency predicted to offer the most reliable communication.

2.4. Best FREQ: Guide to Optimal Frequency Selection

The **Best FREQ** analysis (under Point-to-Point) is your secret weapon for identifying the prime operating frequencies for each hour of the day, throughout the entire month! It analyzes all ham radio bands, taking the guesswork out of finding the optimal frequencies for your chosen circuit.

```
  Feb    2025          SSN = 107.               Minimum Angle= 3.000 degrees
  KP10dk              GF05te               AZIMUTHS          N. MI.      KM
  60.44 N   22.29 E - 34.81 S   58.36 W    243.86   32.64    6935.0  12842.7
  REQ.SNR = 19 dB, TX POWER = 0.08 kW, SHORT-PATH

The best operating frequencies by hour
```

UTC	FREQ	REL	MUFday	SIG10	SIG50	SIG90	ΔSIG	SNR10	SNR50	SNR90	ΔSNR	FOT	MUF	HPF
01	7.1	2%	100%	-141 (S3)	-146 (S2)	-156 (S0)	15.3	14	7	-5	19.4	9.7	11.7	14.0
01	5.4	0%	100%	-145 (S2)	-150 (S2)	-158 (S0)	13.6	6	-1	-11	17.8			
01	10.1	33%	85%	-133 (S4)	-144 (S3)	-169 (--)	35.4	26	15	-11	37.4			
02	7.1	1%	99%	-141 (S3)	-147 (S2)	-160 (S0)	18.1	12	6	-8	20.8	9.5	11.9	14.2
02	10.1	33%	83%	-133 (S4)	-145 (S2)	-170 (--)	36.2	26	15	-11	37.8			
02	5.4	0%	100%	-146 (S2)	-151 (S1)	-160 (S0)	14.7	4	-2	-13	17.9			
03	7.1	0%	99%	-143 (S3)	-149 (S2)	-162 (S0)	18.3	12	5	-10	22.0	9.4	11.8	14.0
03	10.1	31%	82%	-134 (S4)	-147 (S2)	-172 (--)	37.7	27	14	-12	39.3			
03	5.4	0%	100%	-147 (S2)	-153 (S1)	-162 (S0)	14.3	3	-4	-15	18.2			
04	10.1	35%	59%	-129 (S5)	-149 (S2)	-174 (--)	44.6	33	13	-13	46.0*	8.4	10.5	12.4
04	5.4	0%	100%	-150 (S2)	-156 (S0)	-166 (--)	15.3	0	-7	-18	18.5			
04	7.1	0%	98%	-147 (S2)	-153 (S1)	-172 (--)	25.1	8	1	-19	27.7			
05	5.4	0%	100%	-155 (S0)	-161 (S0)	-173 (--)	17.9	-3	-11	-25	21.8	7.3	9.2	10.9
05	10.1?	19%	25%	-136 (S4)	-161 (S0)	-186 (--)	50.0*	26	1	-25	51.3*			
05	7.1	1%	93%	-146 (S2)	-155 (S0)	-180 (--)	33.5	9	0	-26	35.8			

Here's how it works:

After careful analysis, the three most promising frequency bands (**FREQ**) are displayed per hour. The first frequency of the hour is the best, the second is the second best, and the third is the third best. The evaluation is based on the Signal-to-Noise ratio at 90% of the days in a month (see the **SNR90** column). However, looking at the SNR90 alone is not enough to find the "best" operating bands. You will also need to consider the Signal Power at 50% (**SIG50**, 15 days) and 90% (**SIG90**, 27 days) of the days in a month. Furthermore, you must also consider the **MUFday**. See the descriptions below.

Decoding the Results: The output page displays the top three frequencies alongside crucial performance indicators for each UTC hour:

- **REL (Circuit reliability):** Expressed as a percentage, REL indicates the likelihood of successful QSO on the given frequency. It's directly linked to SNR50 (Median Signal-to-Noise Ratio) and REQ.SNR (Internal Required Signal-to-Noise value for the chosen transmitting mode, e.g. CW = 19 dB-Hz, SSB = 38 dB-Hz). You can also say that the REL represents the percentage of days within a month when the SNR50 reaches or exceeds the REQ.SNR.
- **MUFday:** This indicates the percentage of days in a month, showing the probability of the given frequency staying below the calculated MUF (Maximum Usable Frequency). Be cautious of the frequencies with MUFday values falling below 50% or so. Note that there can multiple ionospheric paths from the transmitter to the receiver, and each of them has a median MUF of their own. The MUFday is calculated for the ionospheric path that VOACAP evaluates to be "the most reliable" of them all.
- **SIG10 (Signal Strength on 3 days):** The predicted signal strength (in dBW) achievable on 10% of the days, or 3 days in a month. The corresponding S-Meter Signal Strength is displayed in parentheses.
- **SIG50 (Signal Strength on 15 days):** The predicted median signal strength (in dBW) achievable on 50% of the days, or 15 days in a month. The corresponding S-Meter Signal Strength is displayed in parentheses.
- **SIG90 (Signal Strength on 27 days):** The predicted signal strength (in dBW) achievable on 90% of the days, or 27 days in a month. The corresponding S-Meter Signal Strength is displayed in parentheses.
- **ΔSIG (Signal Strength Spread):** This value indicates the difference in decibels between the maximum signal strength you might encounter on 3 days (SIG10) in a month and the minimum signal strength you can expect on 27 days (SIG90) in a month. As explained earlier, a spread of 40-50 dB means VOACAP is feeling unsure. Such a vast range can signify a high degree of uncertainty in the propagation prediction, and an asterisk (*) is used to indicate it. But when the spread narrows, you're looking at better prediction accuracy and a brighter chance of communication.
- **SNR10 (Signal-to-Noise Ratio on 3 days):** The SNR achievable on 10% of the days, or 3 days, in a month.
- **SNR50 (Signal-to-Noise Ratio on 15 days):** The median SNR achievable on 50% of the days, or 15 days, in a month.
- **SNR90 (Signal-to-Noise Ratio on 27 days):** The SNR achievable on 90% of the days, or 27 days, in a month.
- **ΔSNR (Signal-to-Noise Spread):** This value indicates the difference in decibels between the maximum SNR you may achieve on 3 days (SNR10) in a month and the minimum SNR you can expect on 27 days (SNR90) in a month. As said, a spread of 40-50 dB means VOACAP is feeling unsure. Such a vast range can signify a high degree of uncertainty in the propagation prediction, and an asterisk (*) is used to indicate it.
- **FOT (Frequency of Optimum Traffic):** This is the frequency where communication is achievable on 90% of the days (or 27 days), representing another highly reliable choice.
- **MUF (Median Maximum Usable Frequency):** This represents the frequency supported by the ionosphere on 50% of the days (or 15 days).
- **HPF (Highest Possible Frequency):** This is the frequency where communication is possible on 10% of the days (or 3 days), representing a less reliable option.

Prioritizing Performance: While FOT, MUF, and HPF offer valuable insights, the most accurate predictions come from considering the **Signal Power, Signal-to-Noise Ratio, and MUFday** together. This analysis leverages all these factors to pinpoint the optimal frequency for each hour.

Note: If the SIG50 and MUFday values are deemed too low for successful communication, the frequency in question will be marked with a question mark (?).

2.5. Full Analysis: Detailed Propagation Statistics

After meticulously setting your transmitter and receiver locations and fine-tuning other parameters, you're ready to unlock a wealth of propagation insights. The **Full Analysis** option under Point-to-Point nestled below the world map – this is your gateway to a comprehensive analysis of your communication circuit.

```
Feb    2025          SSN = 107.              Minimum Angle= 3.000 degrees
KP10dk               GF05te               AZIMUTHS          N. MI.      KM
60.44 N   22.29 E - 34.81 S   58.36 W    243.86   32.64    6935.0  12842.7
REQ.SNR = 19 dB, TX POWER = 0.08 kW, SHORT-PATH
```

MUFday

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
3.60	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.60
5.40	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	5.40
7.10	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7.10
10.10	0.8	0.8	0.8	0.6	0.2	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	10.10
14.10	0.1	0.1	0.1	.	.	.	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.5	0.2	0.2	0.1	14.10
18.10	.	.	.	.	.	.	0.1	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.3	0.0	.	.	.	18.10
21.10	.	.	.	.	.	.	.	0.3	0.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.4	0.1	.	.	.	.	21.10
24.90	.	.	.	.	.	.	.	0.1	0.1	0.6	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.5	0.1	.	.	.	.	.	24.90
28.20	.	.	.	.	.	.	.	.	.	0.3	0.9	0.9	0.9	0.9	0.8	0.8	0.5	0.2	.	.	.	.	.	.	28.20

REL

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
3.60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.60
5.40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5.40
7.10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.10
10.10	0.3	0.3	0.3	0.3	0.2	0.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.1	0.2	0.3	10.10
14.10	0.1	0.1	0.1	.	.	.	0.6	0.3	.	.	.	.	.	.	.	.	.	.	.	0.1	0.3	0.2	0.2	0.2	14.10
18.10	.	.	.	.	.	.	0.3	0.7	0.6	0.2	.	0.5	.	.	.	.	.	0.0	0.5	0.3	.	.	.	.	18.10
21.10	.	.	.	.	.	.	.	0.5	0.6	0.6	0.3	.	0.2	.	.	.	0.1	0.6	0.5	0.0	.	.	.	.	21.10
24.90	.	.	.	.	.	.	.	0.2	0.4	0.8	0.8	0.7	0.5	0.4	0.3	0.5	0.6	0.6	0.2	.	.	.	.	.	24.90
28.20	.	.	.	.	.	.	.	.	0.1	0.6	0.8	0.8	0.9	0.8	0.7	0.7	0.7	0.4	.	.	.	.	.	.	28.20

SNR10

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
3.60	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.60
5.40	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5.40
7.10	14.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13.4	7.10
10.10	26.4	26.8	27.3	33.0	26.3	29.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16.4	21.3	24.6	10.10
14.10	16.3	19.3	17.4	.	.	.	36.2	25.0	14.3	.	.	.	.	.	.	.	.	.	.	19.3	32.5	29.6	29.4	28.3	14.10
18.10	.	.	.	.	.	.	34.6	46.7	38.7	21.5	.	26.2	.	.	.	.	.	15.1	31.6	36.4	.	.	.	.	18.10
21.10	.	.	.	.	.	.	.	45.6	50.8	35.3	24.4	15.3	21.3	.	.	.	19.0	32.4	45.5	.	.	.	.	.	21.10
24.90	.	.	.	.	.	.	.	28.6	40.6	53.8	37.8	32.5	27.5	25.0	24.4	29.0	37.8	51.6	30.6	.	.	.	.	.	24.90
28.20	.	.	.	.	.	.	.	.	13.6	47.6	49.6	46.5	49.0	47.7	41.2	43.5	48.2	41.6	.	.	.	.	.	.	28.20

Unpacking the Treasures: Understanding Your Report

The report presents data meticulously calculated for each hour of the day, from 01:00 to 24:00 UTC. This data empowers you to make informed decisions about your radio communication setup.

Key Propagation Metrics

- **MUFday: A Frequency Gauge**

  Imagine this: you're aiming to transmit on a specific frequency. MUFday tells you, for each hour, what percentage of the month this frequency will be below the predicted median Maximum Usable Frequency (MUF) for the Most Reliable Mode (MRM). In simpler terms, a higher MUFday percentage increases the likelihood of your chosen frequency being usable for successful communication. Keep in mind that a favorable MUFday alone doesn't guarantee a good connection. You'll also need to consider other crucial factors like a high level of reliability (REL) and sufficient signal strength (SDBW) to ensure clear and consistent communication.

- **REL (Circuit Reliability): The Confidence Builder**

  This figure cuts to the chase – it represents the likelihood of establishing successful communication on your chosen frequency and time. A higher REL translates to a more reliable connection.

- **SNR (Signal-to-Noise Ratio): The Clarity Indicator**

  Think of SNR as the clarity of your transmission. The report provides SNR predictions at three distinct confidence levels, painting a comprehensive picture:

  - **SNR10 (Optimistic):** This reflects the best-case scenario – the best predicted SNR achievable on a mere 10% of the days (i.e., 3 days) in the month.
  - **SNR50 (Typical):** This represents the median expectation – the SNR you can anticipate on 15 days in the month.
  - **SNR90 (Conservative):** This provides a realistic lower limit – the SNR achievable on 90% of the days (i.e., 27 days) in the month.

- **SDBW (Signal Power at Receiver): The Strength Barometer**

  Similar to SNR, SDBW measures the strength of your signal as it reaches the receiver. It's also presented at three confidence levels:

  - **SDBW10 (Optimistic):** The most optimistic prediction - the signal strength achievable on 10% of the days, i.e. 3 days in the month.
  - **SDBW50 (Typical):** The median signal strength you can expect on 15 days month.
  - **SDBW90 (Conservative):** The minimum signal strength you can reasonably anticipate on 27 days in the month.

Data Presentation: Navigating Your Report with Ease

To make this wealth of data easily digestible, the report is structured in two user-friendly ways:

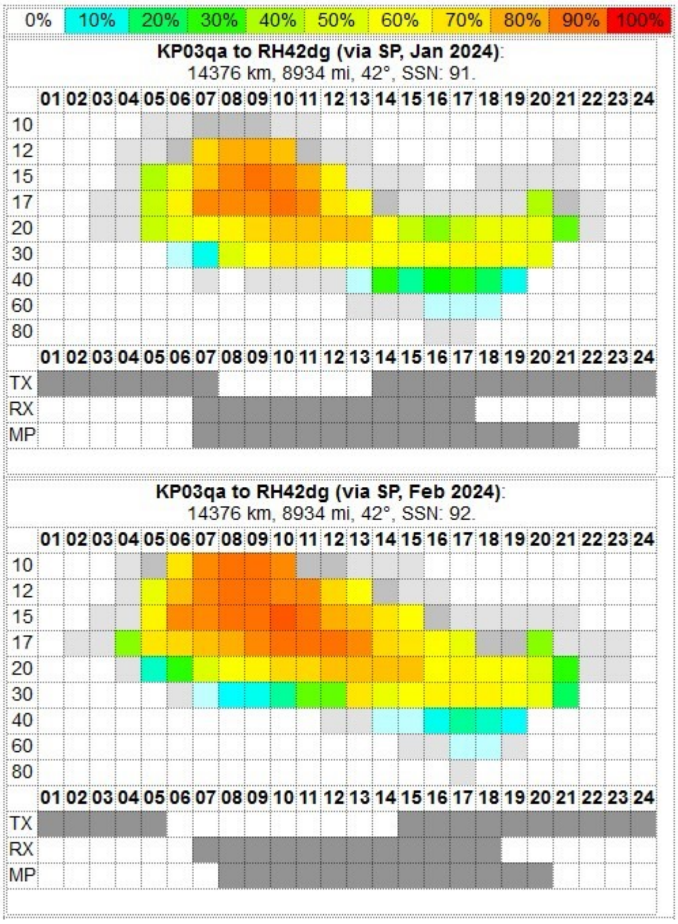
1. **Tabulated by Parameter**
   The data is initially organized into clear tables, with each table dedicated to the specific parameters: MUFday, REL, SNR and SDBW. This allows you to quickly hone in on the metrics most relevant to your needs.
2. **Organized by Amateur Band**
   For amateur radio enthusiasts, the report then presents the data grouped by HF amateur bands. This provides a convenient overview of propagation conditions on your preferred frequencies. Two additional parameters further enhance this view:

   - **dSNR (SNR Spread):** This value represents the difference between SNR10 and SNR90, essentially showing the expected fluctuation in signal clarity throughout the month.
   - **dSDBW (Signal Strength Spread):** This figure illustrates the difference between SDBW10 and SDBW90, providing an understanding of the potential variation in signal strength.

Raw VOACAP Output: Delving Deeper
For seasoned users who crave the nitty-gritty details, the report concludes with a link to the raw data output from the VOACAP engine. This allows for in-depth analysis and customization for experienced users.

2.6. All Year: All-Year Propagation Predictions

The **All-Year** Prediction (under Point-to-Point) tool provides a powerful way to visualize HF propagation conditions for an entire year. Let's break down how to interpret this valuable data.



This prediction calculates point-to-point propagation between your chosen transmitter (TX) and receiver (RX) location, spanning a full year. The tool leverages the latest Sunspot Number predictions for each month of the year from SIDC in Belgium to provide the most accurate forecast.

Each hourly prediction covers a 60-minute window centered on the displayed hour. For example, 01 UTC represents the period from 00:30 to 01:30 UTC. At the top of each table, you'll find:

- TX and RX location labels
- Short-path (SP) or Long-path (LP) indication
- Circuit distance in kilometers and miles
- Bearing from TX to RX in degrees from True North
- Sunspot Number (SSN) used for calculations

Color-Coded Probability
The prediction tables utilize a color gradient to represent the probability of establishing a successful contact. You will see the color code with percentages at the top and the bottom of the prediction window.

- **White:** 0% probability
- **Blueish:** 10% probability
- **Greenish:** 30-40% probability
- **Yellowish:** 50-60% probability
- **Yellow-Orangeish:** 70-80% probability
- **Orange-Reddish:** 90% probability
- **Red:** 100% probability

Gray Areas
The color gray requires special attention. On lower frequencies, gray indicates that while VOACAP doesn't predict a high probability of contact (REL), there's still predicted signal power (SDBW). This suggests a "gray area" where successful communication might be possible.

On higher frequencies, gray typically signifies poor probabilities above the Maximum Usable Frequency (MUF). While VOACAP might show some potential, the actual conditions are likely unfavorable.

Key Parameters
Three crucial parameters are displayed within each hourly cell, visible at a mouse hover:

- **R (Reliability):** VOACAP's calculated probability of a successful QSO (contact) expressed as a percentage.

- **S (Signal Power):** Estimated signal strength in dBW. Use the SDBW to S-Meter conversion table to convert the SDBW values to S-meter readings: https://www.voacap.com/2023/understanding/s-meter.html

- **M (MUFday):** This percentage represents the likelihood of the operating frequency being below the MUF for that specific hour. A higher MUFday value generally indicates better communication if the two other parameters are also favorable.

Sunrise/Sunset Visualization
For added convenience, the tables visually represent sunrise and sunset times for both TX, RX and circuit geographical midpoint (MP) locations. The sunrise and sunset times are calculated for Day 15 of each month. Dark gray signifies nighttime, while white represents daytime. Hover your mouse over the TX/RX/MP labels to view precise sunrise and sunset times in UTC.

2.7. QSO Window: Your Secret Weapon for DX Success

Chasing that rare DX contact? It's a race against propagation and a battle against competing stations. But what if you had a secret weapon, a way to predict the optimal time to make your move? Enter the QSO Window, a game-changing feature inspired by DX veterans Risto OH3UU and Cesar PY2YP. Set your QSO Window markers to the map and select on the **QSO Window** option under Point-to-Point to start!

Imagine this: you've pinpointed your target DX station on an interactive map. Now, activate the QSO Window and watch as five additional markers appear, representing potential competitors also vying for that coveted contact. The magic? The QSO Window runs live propagation predictions from all six stations (yours and the five competitors) to the DX station, displaying the results as dynamic, easy-to-compare charts.
Ready to dive deeper into the QSO Window and unlock its full potential? Let's break down its features and benefits, empowering you to strategize your DX contacts like never before.

1. Unveiling the Competitive Landscape
The QSO Window's magic lies in its ability to simulate a real-world DX pileup. Input your location as the Transmitter (TX) and the DX station as the Receiver (RX). Strategically position the five competitor markers (A to E) to reflect common rivals (think US coasts, Europe, Japan) or customize them based on your target, all vying for the same DX station. Now, this allows you to:

- **Identify Prime Time:** Determine the optimal UTC hours when your signal stands out from the crowd, maximizing your chances of a successful QSO.
- **Anticipate Challenges:** Be prepared for periods of increased competition and adjust your strategy accordingly.
- **Exploit Propagation Advantages:** Capitalize on fleeting openings where your location enjoys a temporary advantage over others.

2. Harnessing the Power of VOACAP Data
The QSO Window presents the VOACAP data in an intuitive and actionable format. Each graph provides unique insights:

- **Median Power (SDBW):** Visualize your signal strength at the DX station relative to other stations. Higher values on the S-meter scale indicate a stronger signal and a better chance of being heard.
- **Reliability (REL):** Gauge the consistency of your signal path. Higher percentages indicate a more reliable QSO.
- **Median Signal-to-Noise Ratio (SNR):** This is the critical factor for successful communication. In case of CW, the higher your SNR above the 19 dB/Hz threshold (the red dotted line in the charts), the more powerful your signal will be amidst the noise.

3. Mastering the Interactive Interface
The QSO Window empowers you with:

- **Short/Long Path Analysis:** The header displays whether the short or long path is selected, along with distance and bearing to the DX station.
- **Competitor Coordinates:** Easily view the coordinates of all five competitor stations (A to E) in the results header.

The QSO Window's intuitive design empowers you to manipulate data and customize your view:

- **Dynamic Graphs:** Hover over any point on the graphs to reveal precise values for each station at a specific UTC hour.
- **Customizable Visibility:** Toggle station visibility by clicking on their corresponding colors in the legend, decluttering the graphs and focusing on your key competitors.
- **Strategic Marker Placement:** Fine-tune the simulation by strategically positioning the five competitor markers on the map (via the QSO marker icon on the left-side controls) to reflect realistic scenarios or target specific regions.

Remember, the QSO Window is a powerful tool that complements your existing knowledge and experience. Consider these additional factors when interpreting the data:

- **Antenna Performance:** The simulation assumes identical antennas for all stations. Your actual antenna setup can significantly impact your results.
- **Propagation Variability:** While VOACAP provides accurate predictions, real-world propagation can fluctuate. Remain adaptable and use the QSO Window as a guide.
- **Operating Skills:** Strong operating skills, including efficient calling practices and clear audio, remain crucial for securing DX contacts, even with favorable propagation.

2.8. Antenna: Comparative Antenna Performance Analysis

The **Antenna** option under Point-to-Point acts as your gateway to a comprehensive exploration of your antenna setup. Selecting it sets in motion a comparative study, meticulously analyzing your chosen transmit antennas and revealing their potential across the entire HF spectrum, based on the circuit and input parameters of your choice.

Unveiling the Best Reliability
First, we embark on a quest for the highest reliability across the amateur bands, from 3 to 28 MHz. Every transmit antenna you've selected will be evaluated for every hour of the day, utilizing your chosen receive antennas. This analysis, however, doesn't reveal the specific band where this peak reliability occurs; instead, it presents the absolute maximum reliability achievable with your chosen antennas across the entire HF spectrum. A clear color-coding system within the table cells will highlight the best reliability values, making the results instantly digestible.

BEST RELIABILITY BY HOUR, 3-28 MHz

TX= (63.02N, 021.38E), RX= (17.72S, 168.32E). Power= 1.2000 kW, Mode= 19 dB/Hz, SSN= 97 • JULY
Es= 0, Min.TOA= 3.0°, Noise= -153 dBW, Method= 30, 14378 km, 8934 mi, 42°, SHORT-PATH

UTC	D05M	D10M	D15M	D20M	D25M	D30M	D40M	D60M	UTC
01									01
02									02
03									03
04									04
05		50	60	60	60	60	50	60	05
06	50	60	60	60	60	60	60	60	06
07	60	70	70	70	80	70	70	70	07
08	70	80	80	80	80	80	80	80	08
09	80	80	80	80	80	80	80	80	09
10	80	80	80	80	80	80	80	80	10
11	80	80	80	80	80	80	80	80	11
12	80	80	80	90	90	80	80	80	12
13	80	80	90	90	90	90	80	90	13
14	80	80	90	90	90	90	80	90	14
15	80	90	90	90	90	90	90	90	15
16	80	80	90	90	90	90	90	90	16
17	70	80	80	80	80	80	80	80	17
18	50	60	70	70	70	60	60	70	18
19	70	80	80	80	80	80	80	80	19
20	60	70	70	80	80	80	80	80	20
21	50	50	60	60	60	70	70	60	21
22						50	50		22
23									23
24									24

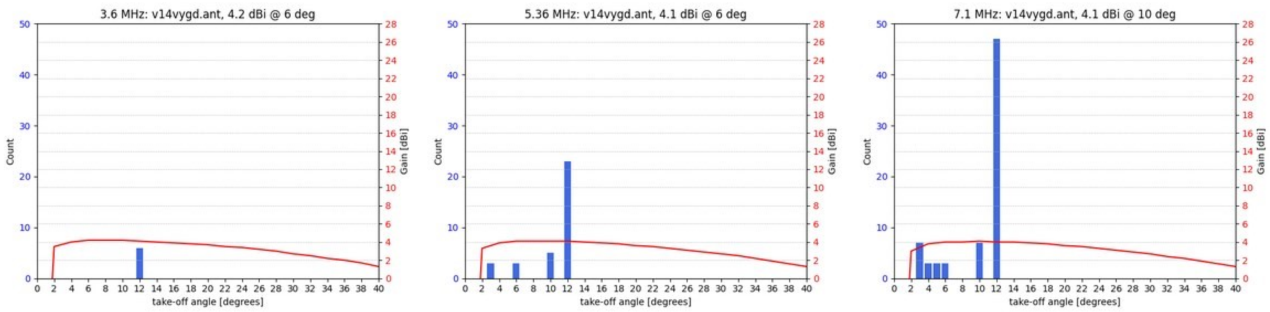
Optimizing Frequency Selection: A Quest for the Best SNR
Next, we turn our attention to maximizing the signal strength to noise. The Best Frequency by Hour analysis scrutinizes the Signal-to-Noise Ratio (SNR) for each of your antennas, across all amateur bands and UTC hours. The results are elegantly presented in a table, revealing the antenna with the highest SNR and the corresponding frequency where this peak performance occurs for each hour. Like the reliability analysis, a color-coded system within the table cells highlights the best SNR values for effortless comprehension.

Delving Deeper: Unveiling the Power of Signal Power and SNR
Beyond these initial comparative studies, a treasure trove of in-depth analysis awaits. A meticulous examination of Signal Power and SNR for each selected antenna is presented, broken down by both hour and amateur band. This granular view empowers you to truly understand the nuances of your antenna performance, identifying optimal operating frequencies and hours for each antenna within your setup.

For the Data-Driven Explorer: CSV Export
For those who crave even deeper insight, the results are readily available in CSV format. This allows you to seamlessly transfer the data to Excel, where you can perform advanced analysis, create custom visualizations, and uncover hidden trends within your antenna performance. The possibilities are endless!

2.9. TOA Analysis: A Journey into Take-Off Angles

The **TOA Analysis** option under Point-to-Point unlocks a powerful tool for understanding the performance of your antennas in the context of real-world propagation. Select it, and you'll embark on a journey to uncover the "take-off angles" – the angles at which radio waves leave your antenna – and how they align with the optimal angles for successful communication.



A Deep Dive into Angles
First, VOACAP calculates the predicted take-off angles for each of your chosen transmit antennas across the entire amateur band spectrum (3 to 28 MHz). Using VOACAP Method 30, it then determines the optimal take-off angles needed for the most reliable propagation mode – the mode that promises the best communication for your chosen circuit. This simplified approach focuses on the most effective angles only, so not all take-off angles available from other propagation modes are reported. You can choose to analyze the optimal take-off angles for a single month or the entire year, giving you a comprehensive understanding of your antenna's performance across different seasons.

Visualizing the Perfect Match
Next, VOACAP creates a series of visual graphs, one for each amateur band. These graphs beautifully illustrate the interplay between your antenna's theoretical take-off angle and the predicted optimal angles for reliable communication. A red line represents your antenna's take-off angle, with the corresponding gain at that angle displayed in red on the right-side scale. Across the graph, blue bars depict the distribution of all predicted take-off angles needed for optimal communication, with the number of occurrences for each angle displayed in blue on the left side.

Unveiling Antenna Suitability
By visually aligning your antenna's take-off angle pattern with the predicted optimal angles, you can instantly grasp whether your antennas are well-suited for the chosen circuit. You can also see how much gain your antenna provides at those optimal angles, a crucial factor for successful communication.

The Ultimate Antenna Comparison Tool
This tool is a powerful resource for comparing various transmit antennas. By analyzing each antenna's take-off angle pattern and gain against the predicted optimal angles, you can make informed decisions about which antenna will deliver the best performance for your specific communication goals.

Unlocking Deeper Insights with HFTA
For those seeking even deeper analysis, the VOACAP Take-Off Angle Analyzer allows you to download a PRN formatted file of the elevation statistics. This file can be imported into the HFTA (High-Frequency Terrain Assessment) software, enabling you to conduct advanced analysis, taking into account the effects of terrain and other factors on your signal's path.

2.10. Planner: Your Key to Planning Contests and DXpeditions

By mastering the Propagation Planner (the menu item **Planner** under Point-to-Point), you gain a significant advantage in the world of HF contesting and DXing. Plan your next operating session with confidence, knowing you're strategically positioned to make the most of every propagation opportunity.

Why Planning Matters
Imagine preparing for a big game without scouting your opponent or strategizing your plays. That's what it's like diving into a contest or DXpedition without understanding propagation. The Propagation Planner acts as your personal scout, revealing:

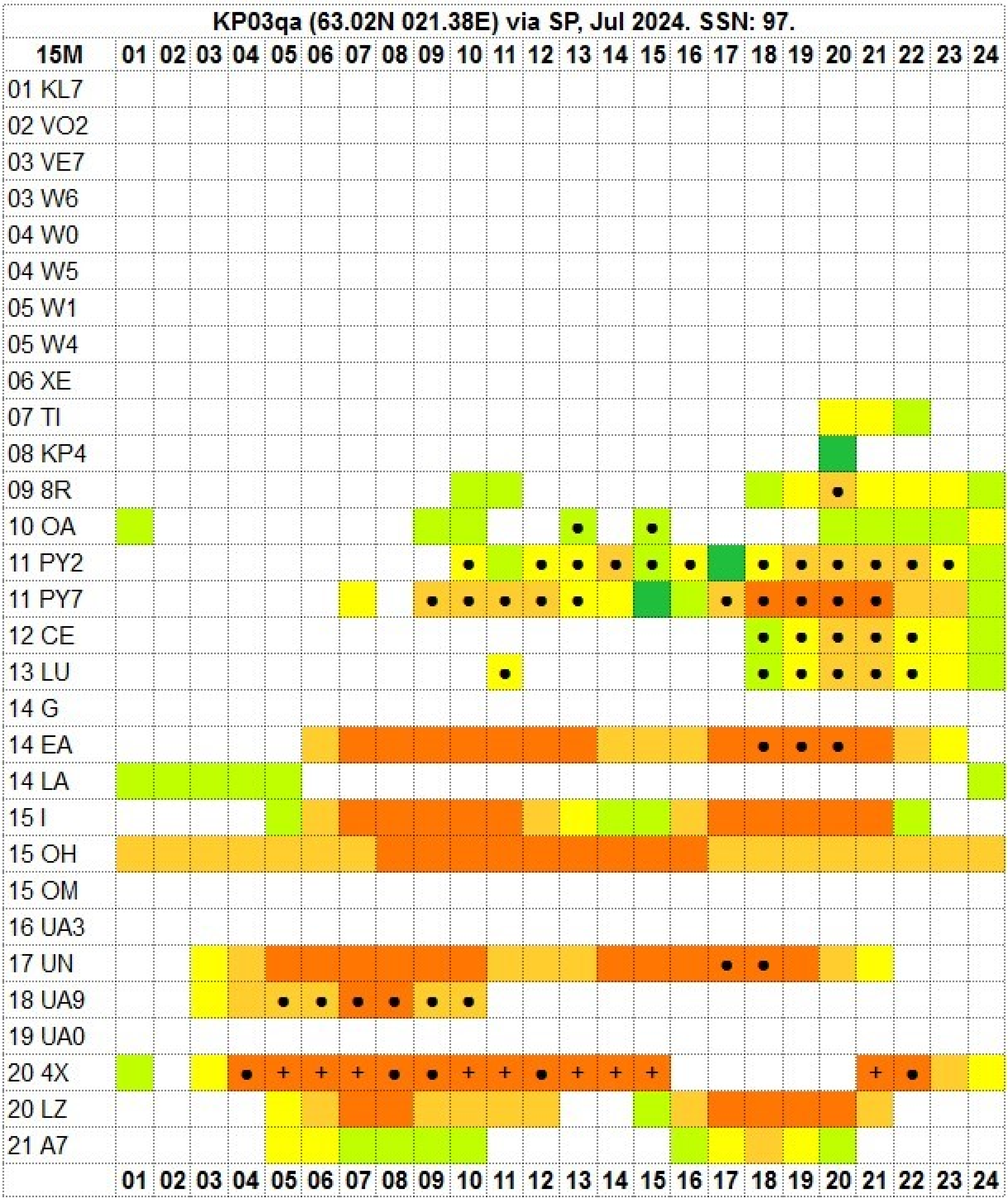
- **Optimal Bands and Times:** Discover when and where to find the strongest openings for your target zones.
- **Long-Path Opportunities:** Uncover hidden propagation paths that can give you an edge in contests and DXing.
- **Strategic Operating Windows:** Plan your operating schedule around peak propagation times for maximum efficiency.

How the Planner Works
This online tool presents the results in two intuitive ways:

1. **Zone-Based Charts:** Visualize propagation predictions for both CQ and ITU zones, with options for short-path and long-path analysis.
2. **Band-Specific Zone Charts:** Focus on specific bands and zones to fine-tune your operating strategy.

Interpreting the Charts

- **Color-Coded Reliability:** Cell colors represent the probability of making a QSO (red = highest, white = lowest).
- **Signal Power Indicators:** Cell characters (+, ++, ●) indicate predicted signal strength and MUFday probability. See below for their explanations.
- **Sunrise/Sunset Visualization:** Horizontal bars below each zone-specific chart depict day/night cycles for the TX, RX and circuit midpoint (MP) locations.
- **Interactive Data:** Hover your mouse over any cell to reveal detailed REL (R), SDBW (S) and MUFday (M) values.



Tips for Optimal Use

- **Utilize Google Chrome:** For the best experience, access the Propagation Planner using the Google Chrome browser.
- **Combine with Grayline Maps:** Supplement low-band predictions with grayline map software for greater accuracy.
- **Remember, predictions are not guarantees:** While powerful, propagation predictions are still estimations, and real-world conditions can vary.

Explaining the Table Colors and Characters

The cell colors reflect the predicted Reliability: red is best, white is worst. The following characters reflect the level of Signal Power: ++, + and ●.

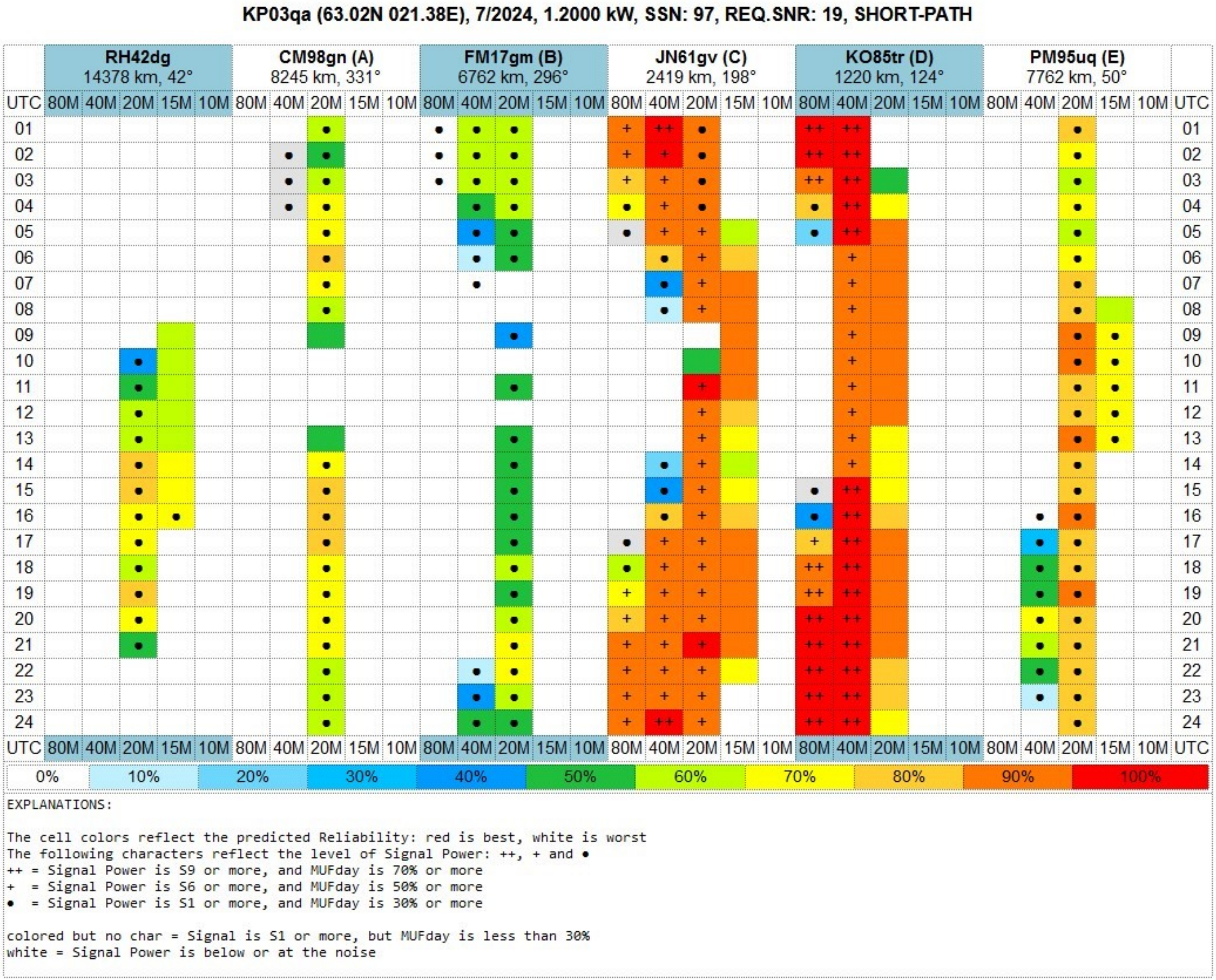
```
++ = Signal Power is S9 or more, and MUFday is 70% or more
+  = Signal Power is S6 or more, and MUFday is 50% or more
●  = Signal Power is S1 or more, and MUFday is 30% or more

colored but no char = Signal is S1 or more, but MUFday is less than 30%
white = Signal Power is below or at the noise
```

2.11. Mini Planner: Your Personalized Propagation Snapshot

Want a quick and easy way to assess propagation conditions to your favorite spots around the globe? This streamlined version of the Propagation Planner provides a personalized snapshot of HF propagation to five locations of your choosing. Select the **Mini Planner** from the Point-to-Point menu.

Simple Setup, Powerful Insights

Using the familiar red markers from the QSO Window, pinpoint up to five destinations on the world map. This Planner instantly generates an easy-to-read overview, revealing propagation potential at a glance.



KP03qa (63.02N 021.38E), 7/2024, 1.2000 kW, SSN: 97, REQ.SNR: 19, SHORT-PATH

	RH42dg 14378 km, 42°					CM98gn (A) 8245 km, 331°					FM17gm (B) 6762 km, 296°					JN61gv (C) 2419 km, 198°					KO85tr (D) 1220 km, 124°					PM95uq (E) 7762 km, 50°					
UTC	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	UTC
01								●			●	●	●			+	++	●			++	++						●			01
02							●	●			●	●	●			+	+	●			++	++						●			02
03							●	●			●	●	●			+	+	●			++	++						●			03
04							●	●				●	●			●	+	●			●	++						●			04
05								●				●	●			●	+	+			●	++						●			05
06								●				●	●				●	+				+						●			06
07								●				●					●	+				+						●			07
08								●									●	+				+						●			08
09													●									+						●	●		09
10			●																			+						●	●		10
11			●										●					+				+						●	●		11
12			●															+				+						●	●		12
13			●										●					+				+						●	●		13
14			●					●					●				●	+				+						●			14
15			●					●					●				●	+			●	++						●			15
16			●	●				●					●				●	+			●	++					●	●			16
17			●					●					●			●	+	+			+	++					●	●			17
18			●					●					●			●	+	+			++	++					●	●			18
19			●					●					●			+	+	+			++	++					●	●			19
20			●					●					●			+	+	+			++	++					●	●			20
21			●					●					●			+	+	+			++	++					●	●			21
22								●				●	●			+	+	+			++	++					●	●			22
23								●				●	●			+	+	+			++	++					●	●			23
24								●				●	●			+	++	+			++	++						●			24
UTC	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	80M	40M	20M	15M	10M	UTC

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

```
EXPLANATIONS:

The cell colors reflect the predicted Reliability: red is best, white is worst
The following characters reflect the level of Signal Power: ++, + and ●
++ = Signal Power is S9 or more, and MUFday is 70% or more
+  = Signal Power is S6 or more, and MUFday is 50% or more
●  = Signal Power is S1 or more, and MUFday is 30% or more

colored but no char = Signal is S1 or more, but MUFday is less than 30%
white = Signal Power is below or at the noise
```

Visualize Your Propagation Landscape
The output provides a clear and concise summary, allowing you to quickly compare conditions across your chosen locations. This at-a-glance view helps you:

- **Identify Favorable Openings:** Spot potential propagation paths and time windows for optimal communication.
- **Compare Signal Strengths:** Assess signal quality and potential challenges for each destination.
- **Make Informed Operating Decisions:** Choose the best times and frequencies to connect with your desired locations.

Whether you're chasing DX, planning a contest strategy, or simply curious about current conditions, this five-location, quick Planner provides a user-friendly way to stay ahead of the propagation curve.

The colors and characters used in the prediction tables are the same as in the Propagation Planner (see “Explaining the Table Colors and Characters”).

2.12. Grayline: Exploring Low-Band Propagation

Grayline (under Point-to-Point) is a powerful point-to-point (P2P) tool designed to help you understand how the sun's position affects radio propagation, especially on lower bands. It calculates sunrise, sunset, and solar midnight times for three specific locations: your transmitter, receiver, and the geographical midpoint along your communication path. This data is provided for both the selected month and the next month, allowing you to plan ahead and anticipate changing conditions.

```
VOACAP POINT-TO-POINT GRAYLINE ANALYSIS
All times UTC

TX    Lat:   63.021, Lon:    21.375 (KP03qa) SP: 14378 km,  8934 mi,  42°
RX    Lat:   -17.72, Lon:    168.32 (RH42dg) LP: 25629 km, 15925 mi, 222°
MIDPT Lat:  43.2625, Lon:  144.9382 (QN23lg) Short-path
MIDPT Lat: -43.2625, Lon:  -35.0618 (HE26lr) Long-path

July 2024

             TX (KP03qa) -----------------------------------------|  RX (RH42dg) -----------------------------------------|
DATE         DAWN   RISE   POST   |  PRE    SET    DUSK   |  MNITE  |  DAWN   RISE   POST   |  PRE    SET    DUSK   |  MNITE  |
2024-07-01     +    00:36  01:33     19:43  20:40    +       22:39     18:54  19:18  19:35     06:07  06:23  06:47     12:51
2024-07-02     +    00:37  01:34     19:42  20:39    +       22:39     18:55  19:18  19:35     06:07  06:23  06:47     12:51
2024-07-03     +    00:39  01:36     19:41  20:37    +       22:39     18:55  19:18  19:35     06:07  06:24  06:47     12:51
2024-07-04     +    00:41  01:37     19:40  20:36    +       22:39     18:55  19:18  19:35     06:08  06:24  06:48     12:51
2024-07-05     +    00:43  01:38     19:39  20:34    +       22:39     18:55  19:18  19:35     06:08  06:24  06:48     12:51
2024-07-06     +    00:45  01:40     19:38  20:33    +       22:39     18:55  19:18  19:35     06:08  06:25  06:48     12:52
2024-07-07     +    00:47  01:41     19:37  20:31    +       22:40     18:55  19:18  19:35     06:09  06:25  06:49     12:52
```

Here's how Grayline works:

1. Key Times Calculated
Grayline calculates seven distinct times for each of the three locations:

- **Sunrise-related:**
  - **DAWN:** The moment the sun is **6 degrees below the horizon** before sunrise.
  - **RISE:** The actual sunrise time when the sun is at the horizon.
  - **POST:** The moment the sun is **6 degrees above the horizon** after sunrise.

- **Sunset-related:**
  - **PRE:** The moment the sun is **6 degrees above the horizon** before sunset.
  - **SET:** The actual sunset time when the sun is at the horizon.
  - **DUSK:** The moment the sun is **6 degrees below the horizon** after sunset.
- **Solar Midnight:**
  - **MNITE:** The time opposite to solar noon when the sun is closest to the nadir, representing the middle of the night. It is dependent on longitude and time of year, not time zones.

2. The Importance of POST and PRE Times
These times are based on empirical observations, rather than a specific scientific theory. We know that low-band propagation tends to weaken after sunrise and improve before sunset. The "6 degrees above the horizon" cutoff was chosen as a practical way to define these transition periods.

3. Analyzing the Results
P2P Grayline presents these times in a clear table format, allowing you to:

- **Identify Optimal Communication Windows:** Determine when the sun's position favors better propagation for your circuit.
- **Strategize Your Operations:** Plan your communication sessions around the times most likely to yield strong signals.
- **Explore Grayline Propagation:** Understand how the grayline terminator, the boundary between day and night, impacts propagation conditions.

Additional Notes

- **The Dawn and Dusk Periods:** The 6-degree threshold used for DAWN and DUSK is based on the traditional definition of these periods.
- **Solar Noon:** This refers to the moment the sun reaches its highest point in the sky for a given location. Solar midnight is the exact opposite of this.
- **Real-World Variability:** While P2P Grayline provides valuable insights, real-world propagation is always influenced by a variety of factors. Use it as a guide to inform your decisions.

2.13. Grayline for DXCC aka VOACAP Greyline

Want to leverage the magic of grayline propagation for your next DX contact? VOACAP Greyline (the item **Grayline for DXCC** under Point-to-Point) is your key to understanding the sun's dance across the globe and how it impacts your communication.

This tool provides a wealth of sun-related data for any location, specifically designed to help DXers and contesters like you.

Here's what you can do:

1. **Get Precise Sunrise and Sunset Data**
   - Instantly access daily sunrise, sunset, dawn, dusk, and solar midnight times for a vast selection of DXCC locations.

- Understand the precise times the sun is at specific points below and above the horizon, crucial for predicting low-band openings.

2. **Plan Your Year with Custom Sun Calendars**
   - Generate a full-year calendar displaying sunrise and sunset times for your specific location.
   - Easily find optimal propagation windows throughout the year.
3. **Dive Deep with Grayline Analysis**
   - Analyze DXCC countries located along the grayline terminator or shrouded in darkness at sunrise and sunset from your location.
   - Identify prime DX targets by pinpointing locations experiencing sunrise or sunset propagation opportunities.
   - Obtain distance and bearing information for both short-path and long-path propagation.

How to Use VOACAP Greyline:

1. Select the **Grayline for DXCC menu item** or visit http://www.voacap.com/greyline/index.html
2. Explore the three calculation types
   - **Default**: Daily sunrise/sunset data for DXCC locations.
   - **Calendar**: Full-year sunrise/sunset data for your location.
   - **Deep Analysis**: Identify DXCC locations along the grayline terminator or in darkness.
3. Input your Maidenhead grid locator for personalized results

Uncover Hidden Propagation Paths
VOACAP Greyline empowers you to:

- Predict low-band openings with greater accuracy.
- Identify optimal times for reaching specific DXCC entities.
- Plan your radio operations strategically.

Read more in the VOACAP Greyline manual: https://voacap.blogspot.com/2016/11/voacap-greyline-user-manual.html

2.14. Discover Earth-Moon-Earth (EME) Times

Planning your next EME QSO just got easier! We provide a powerful tool to determine common moon window times for any two locations on Earth for the following seven-day period.

How to Find Your EME Window:

1. **Set Your Locations:** Place the TX and RX markers on the map at your desired transmitter and receiver coordinates.
2. **Choose Your Date:** Select the starting date for your EME window calculations using the calendar in the bottom-left corner.
3. **Activate EME Analysis:** Select the **EME** menu item from the Point-to-Point menu.

VOACAP Online does the rest:

- **Calculates Moon Visibility:** The system determines moon rise, solar noon, and set times for both locations over a seven-day period.
- **Identifies Common Windows:** It pinpoints the overlapping time periods when the moon is visible at both locations simultaneously.
- **Provides Detailed Data:** Within each common window, you'll find calculations for moon elevation, azimuth, and distance at 5-minute intervals. Results are displayed side-by-side for easy comparison.

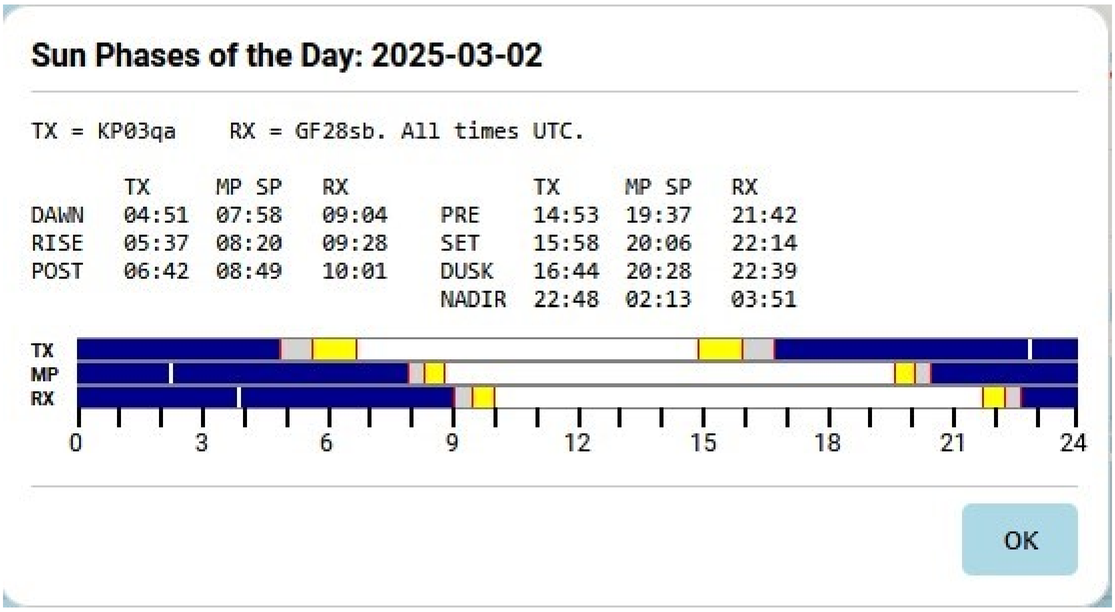
```
VOACAP MOON WINDOW CALCULATOR. All dates and times UTC.

TX = KP03qa [63.0210,  21.3750]
RX = RH42dg [-17.7200, 168.3200]

TX to RX: 14378 km,  8934 mi, SP  42.2°, LP 222.2°
RX to TX: 14378 km,  8934 mi, SP 341.3°, LP 161.3°

QTH       MOON RISE         AZIM  AT MERIDIAN       ELEV  MOON SET          AZIM  ILL  EME
KP03qa    2024-07-15 14:22  135°  2024-07-15 17:39    8°  2024-07-15 20:41  221°   68  False
RH42dg    2024-07-15 01:06  106°  2024-07-15 07:33   89°  2024-07-15 14:04  252°   65

KP03qa    2024-07-16 16:17  151°  2024-07-16 18:27    3°  2024-07-16 20:24  206°   76  False
RH42dg    2024-07-16 01:44  111°  2024-07-16 08:19   86°  2024-07-16 14:58  247°   75

KP03qa    2024-07-17 00:00  Moon below the horizon.                                    False

KP03qa    2024-07-18 00:00  Moon below the horizon.                                    False

KP03qa    2024-07-19 00:00  Moon below the horizon.                                    False

KP03qa    2024-07-20 00:00  Moon below the horizon.                                    False

KP03qa    2024-07-21 21:19  154°  2024-07-21 23:16    3°  2024-07-22 01:27  209°   99  False
RH42dg    2024-07-21 06:17  117°  2024-07-21 13:04   83°  2024-07-21 19:47  246°   99

KP03qa    2024-07-22 21:01  137°  2024-07-23 00:12    8°  2024-07-23 03:42  228°   95  False
RH42dg    2024-07-22 07:22  112°  2024-07-22 14:02   88°  2024-07-22 20:37  251°   97

KP03qa    2024-07-23 20:49  121°  2024-07-24 01:05   15°  2024-07-24 05:43  245°   89  True
RH42dg    2024-07-23 08:26  106°  2024-07-23 14:56   86°  2024-07-23 21:21  257°   91

DETAILED ANALYSIS OF SHARED MOON VISIBILITY

D (KM) is the distance to the closest point on Moon.
LOSS   is the two-way EME path loss on 6M with isotropic antennas, the average = -242.9 (dB).

2024-07-23 20:49 - 2024-07-23 21:21. Duration: 0:32

                                       KP03qa                            RH42dg
                           ELEV   AZIM   D (KM)    LOSS     ELEV   AZIM   D (KM)    LOSS
    2024-07-23 20:49  :   -0.0° 121.0°   363202  -242.0     7.2° 259.0°   362411  -242.0
    2024-07-23 20:54  :    0.5° 122.0°   363146  -242.0     6.1° 259.0°   362535  -242.0
    2024-07-23 20:59  :    0.9° 123.0°   363091  -242.0     4.9° 259.0°   362659  -242.0
    2024-07-23 21:04  :    1.4° 124.0°   363036  -242.0     3.8° 258.0°   362783  -242.0
    2024-07-23 21:09  :    1.9° 125.0°   362982  -242.0     2.7° 258.0°   362907  -242.0
    2024-07-23 21:14  :    2.4° 126.0°   362928  -242.0     1.5° 258.0°   363032  -242.0
    2024-07-23 21:19  :    2.8° 127.0°   362876  -242.0     0.4° 257.0°   363156  -242.0

END.
```

2.15. Sun of the Day, or the sun phases of the day visualized

The **Sun of the Day** function (found under the Point-to-Point menu) calculates and displays the sun phase times for three key locations in a radio propagation path:

- **Transmitter (TX) location**
- **Receiver (RX) location**
- **Geographical midpoint (MP)** of the short-path great-circle route between TX and RX

The calculations are performed for the specific day selected in the VOACAP calendar, and all times are given in **UTC**.



Calculated Sun Phases
The following sun phase times are determined:

- **DAWN** – The sun is **6 degrees below the horizon** before sunrise
- **RISE** – The moment of **sunrise**
- **POST** – When the sun is **6 degrees above the horizon** after sunrise
- **PRE** – When the sun is **6 degrees above the horizon** before sunset
- **SET** – The moment of **sunset**
- **DUSK** – The sun is **6 degrees below the horizon** after sunset
- **NADIR** – The **celestial midnight**, when the sun is at its lowest point in the sky

Visualization
The sun phase times are displayed on a **graphical timeline** consisting of three stacked horizontal slides:

1. **TX location** (top slide)
2. **MP location** (middle slide)
3. **RX location** (bottom slide)

Below the third slide, **hour markers** are shown at **three-hour intervals** for reference.

Each sun phase is represented by a specific color:

- **Night** (sun below DAWN and after DUSK) → **Dark Blue**
- **DAWN to SUNRISE → Light Gray**
- **SUNRISE to POST → Yellow**
- **PRE to SUNSET → Yellow**
- **SUNSET to DUSK → Light Gray**
- **NADIR** is marked by a **white vertical bar** on each timeline

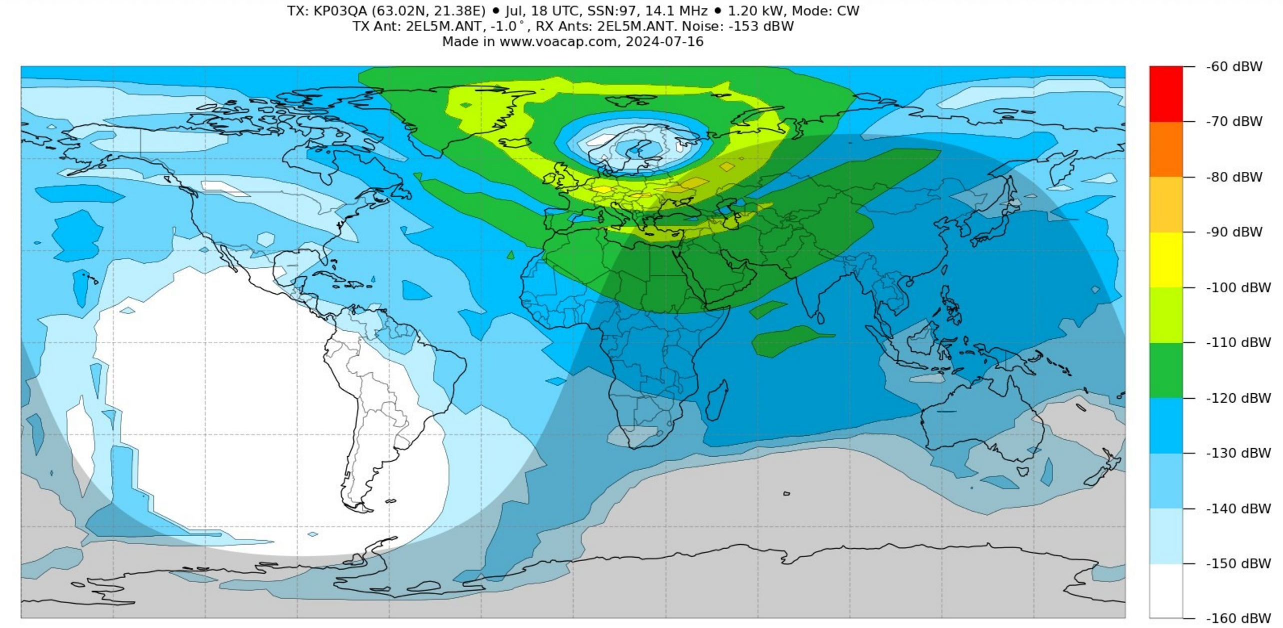
Display of Sun Phase Times
In addition to the graphical representation, the **exact calculated times** for each sun phase are displayed as text, providing precise values for TX, MP, and RX locations.

This functionality is essential for understanding daylight conditions along the signal path, aiding, for example, in low-band propagation analysis and prediction for radio communication.

3. Coverage Maps Menu

3.1. Exploring the Power of Coverage Area Maps

Go beyond simple point-to-point predictions and visualize your signal's potential reach with our powerful coverage area maps. This service allows you to generate customized maps highlighting **Signal Strength** (SDBW) or **Circuit Reliability** (REL) across the world. These two mapping options are available under the Coverage Maps menu.



Mapping Your Propagation Landscape

- **Multiple Parameters, One View:** Explore different aspects of propagation by plotting maps for Circuit Reliability, REL (the item **Reliability Map**) or Signal Strength, SDBW (the item **Signal Strength Map**). This comprehensive perspective helps you understand the interplay between these key factors.
- **Customize Your Coverage:** Fine-tune your analysis by adjusting input parameters under the **Settings** button. This allows you to tailor the maps to your specific needs and operating scenarios.
- **Easy Printing and Sharing:** Conveniently download all generated maps from the result page in PDF format for offline analysis or sharing with fellow enthusiasts.

Unlocking Strategic Insights
These coverage area maps empower you to:

- **Identify Optimal Operating Zones:** Discover regions with favorable propagation conditions for your desired frequency and time.
- **Plan DXpeditions and Contests:** Strategically target areas with the highest probability of successful communication.
- **Visualize Signal Coverage:** Understand the potential reach of your signal and identify potential coverage gaps.

Important notes on the maps
Please note that generated coverage maps are periodically cleared from the server. Avoid directly linking to these maps, as they may not be permanently accessible.

4. Help Menu

4.1. Space Weather: Understanding Ionospheric Disturbances

The VOACAP Space Weather page (**Space Weather** under Help) provides a comprehensive overview of current and predicted space weather conditions that can impact the ionosphere and, consequently, HF radio propagation. This page offers a user-friendly interface to understand and interpret key space weather indices, empowering you to anticipate potential disturbances and adjust your communication strategies accordingly.

Key Space Weather Indices

The Space Weather page displays a selection of critical indices, updated in real-time, that provide insights into ionospheric activity:

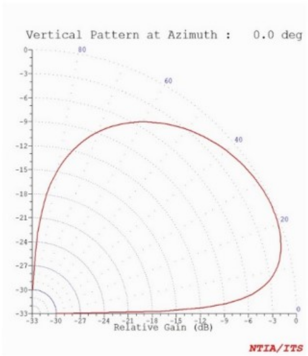
- **Kyoto Dst (Disturbance Storm Time) Index:** This index measures the strength of the ring current around Earth, caused by solar protons and electrons. A negative Dst value indicates a weakening of Earth's magnetic field, which can occur during solar storms and significantly affect HF propagation.
- **Proton Flux:** Incoming energetic protons can enhance ionization in the lower ionosphere, leading to increased absorption levels, particularly in polar regions. This can completely block ionospheric radio communications, resulting in polar cap absorption events.
- **Tromso (Norway) A-Index:** Calculated from K-indices measured in Tromso, this index provides an indicator of geomagnetic activity at high latitudes. It is hoped to be a more sensitive measure of solar disturbances than the planetary A index (Ap).

The Space Weather page presents these indices in a visually engaging way:

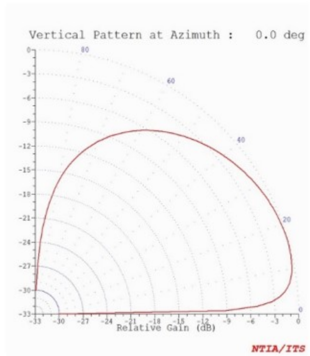
- **Main Graph:** A continuously updated graph displays the Kyoto Dst, proton flux, and Tromso A-index values for the running year. Users can filter these data for specific time periods, ranging from 1 day to 9 months. The graph is fully interactive, allowing users to zoom in, pan, and save the display.
- **Long-Term Forecast:** This graph presents 27-day forecasts for solar flux, planetary A index, and the highest planetary K index, provided by NOAA.
- **Short-Term Forecast:** A 3-day forecast for the planetary K index, also provided by NOAA, is presented for closer observation of short-term geomagnetic activity.

By monitoring these indices, you can gain a better understanding of how solar disturbances in space weather can affect HF communication. This knowledge is crucial as VOACAP propagation predictions are based on the assumption of quiet geomagnetic activity.

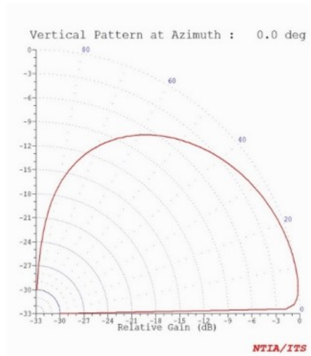
Take-Off Angles: VOACAP Online Vertical Antennas



1-4 wl GP (AVG GND)



1-4 wl GP (GD GND)



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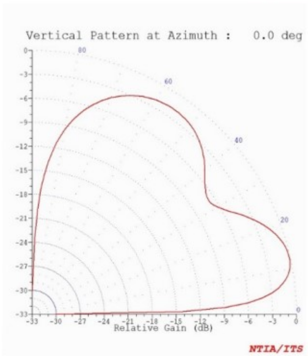
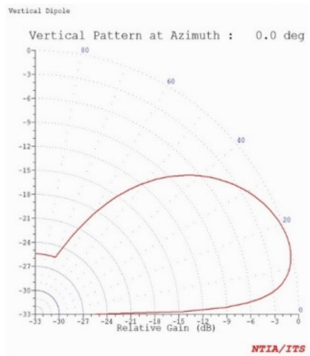
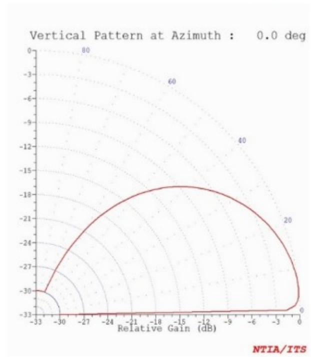


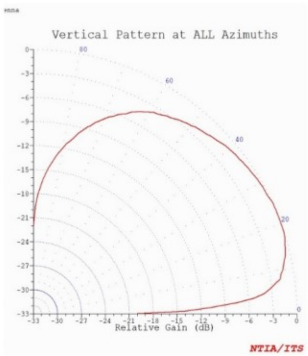
5-8 wl GP



Vertical Dipole, 0.25 wl



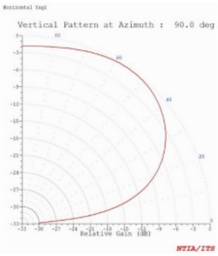
2-el VDA at Sea Water



SW Whip for Receive

Page: 1 / 1

Take-Off Angles: Yagis at 5 m (17 ft) Above the Ground



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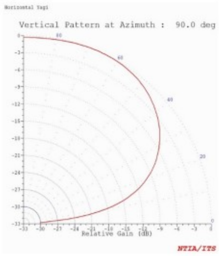
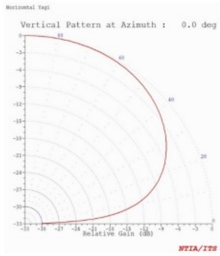


2el5m-5.36_MHz



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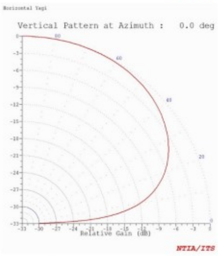

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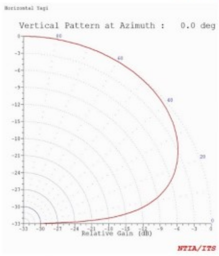

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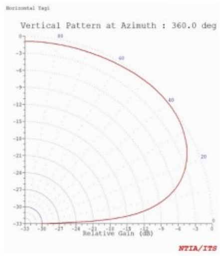
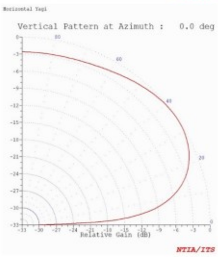
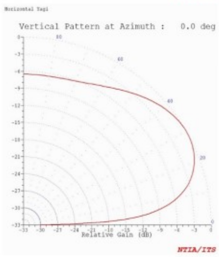


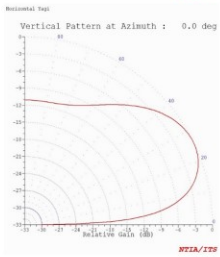
2el5m-18.1_MHz



2el5m-21.1_MHz

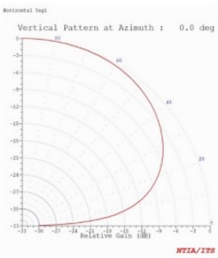


2el5m-24.9_MHz



2el5m-28.2_MHz

Take-Off Angles: Yagis at 10 m (33 ft) Above the Ground



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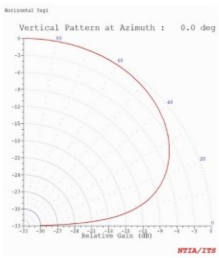
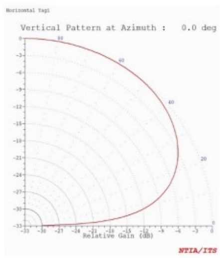
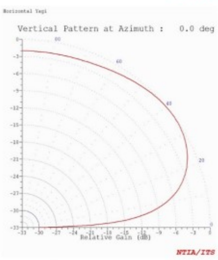


2el10m-5.36_MHz



2el10m-7.1_MHz



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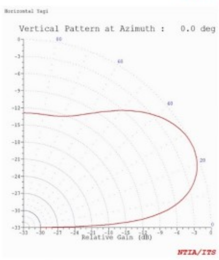

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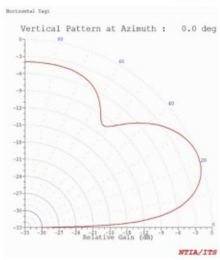

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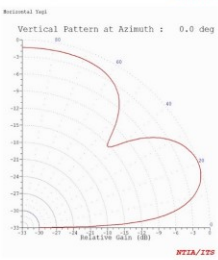
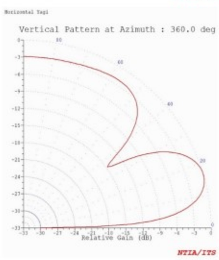
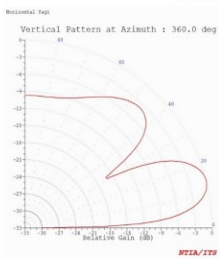


2el10m-21.1_MHz

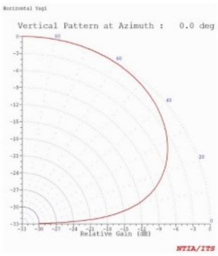


2el10m-24.9_MHz



2el10m-28.2_MHz

Take-Off Angles: Yagis at 15 m (50 ft) Above the Ground



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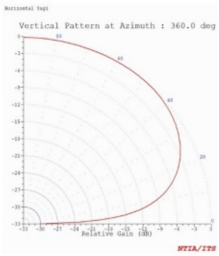
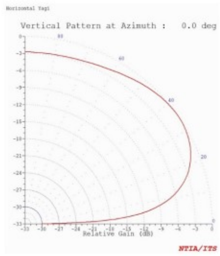
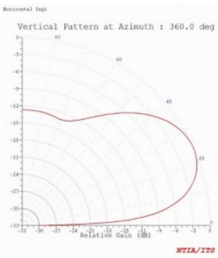


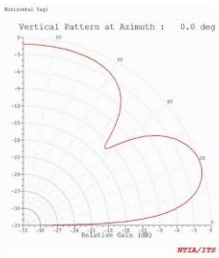
2el15m-5.36_MHz



2el15m-7.1_MHz



2el15m-10.1_MHz



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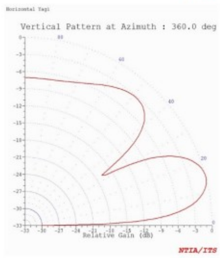
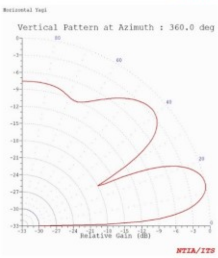


2el15m-18.1_MHz



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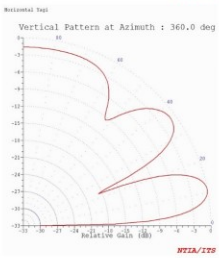
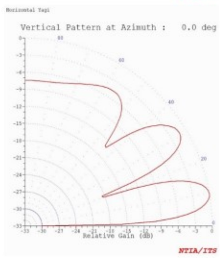
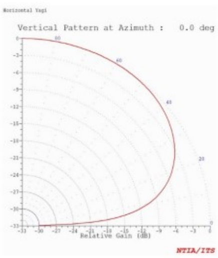


2el15m-24.9_MHz

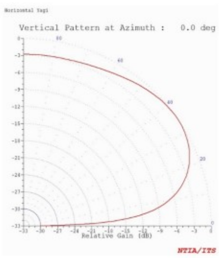


2el15m-28.2_MHz

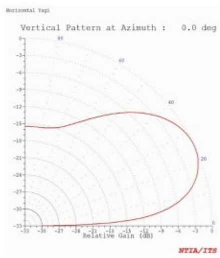
Take-Off Angles: Yagis at 20 m (66 ft) Above the Ground



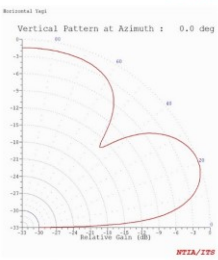
2el20m-3.6_MHz



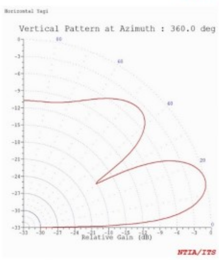
2el20m-5.36_MHz



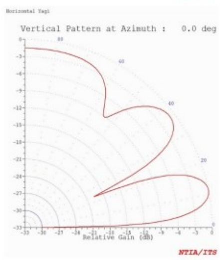
2el20m-7.1_MHz



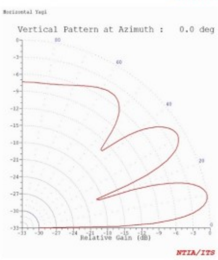
2el20m-10.1_MHz



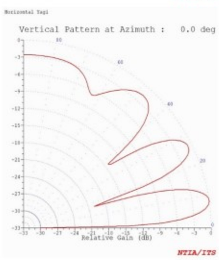
2el20m-14.1_MHz



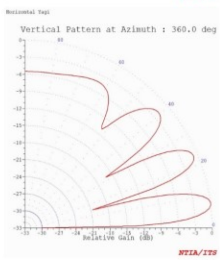
2el20m-18.1_MHz



2el20m-21.1_MHz

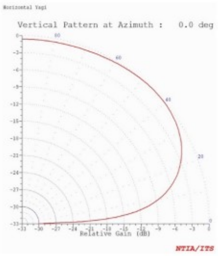


2el20m-24.9_MHz

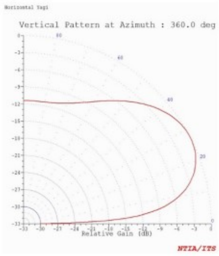


2el20m-28.2_MHz

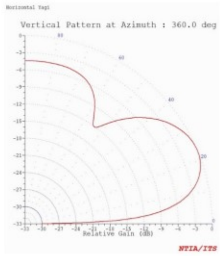
Take-Off Angles: Yagis at 25 m (82 ft) Above the Ground



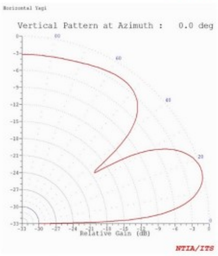
2el25m-3.6_MHz



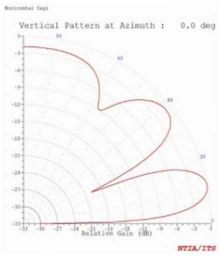
2el25m-5.36_MHz



2el25m-7.1_MHz



2el25m-10.1_MHz



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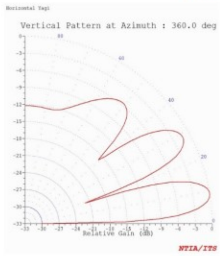
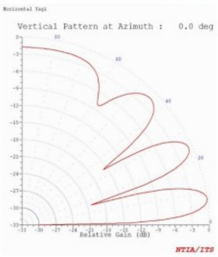
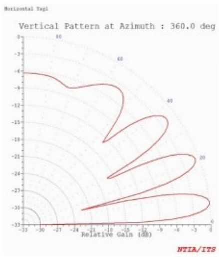


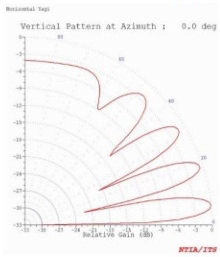
2el25m-18.1_MHz



2el25m-21.1_MHz

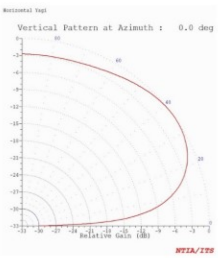


2el25m-24.9_MHz

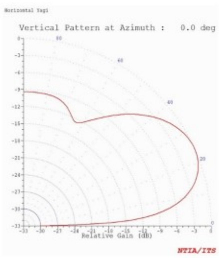


2el25m-28.2_MHz

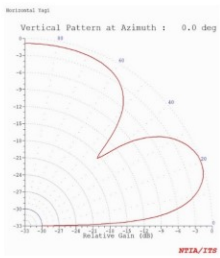
Take-Off Angles: Yagis at 30 m (99 ft) Above the Ground



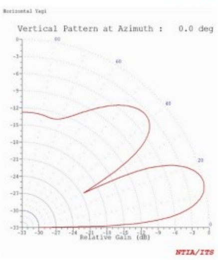
2el30m-3.6_MHz



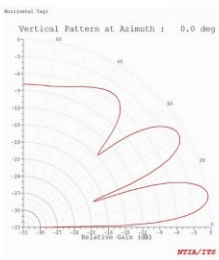
2el30m-5.36_MHz



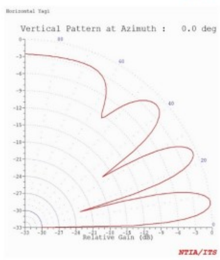
2el30m-7.1_MHz



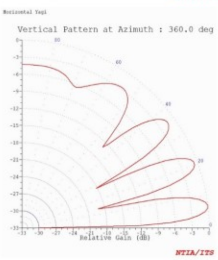
2el30m-10.1_MHz



2el30m-14.1_MHz



2el30m-18.1_MHz



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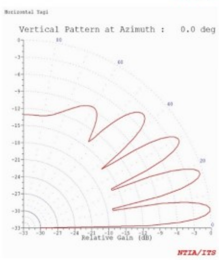

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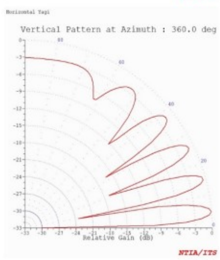
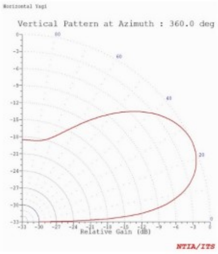
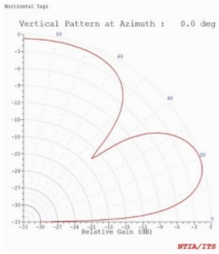


2el30m-28.2_MHz

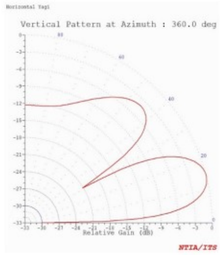
Take-Off Angles: Yagis at 40 m (132 ft) Above the Ground



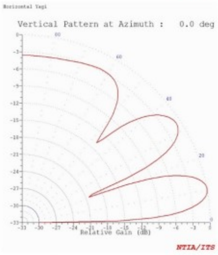
2el40m-3.6_MHz



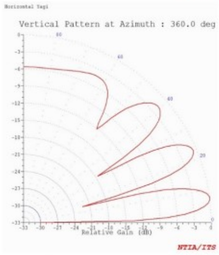
2el40m-5.36_MHz



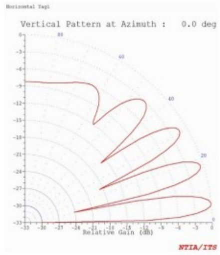
2el40m-7.1_MHz



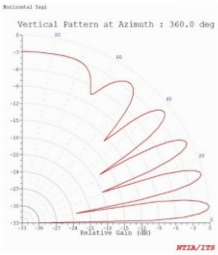
2el40m-10.1_MHz



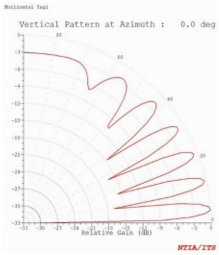
2el40m-14.1_MHz



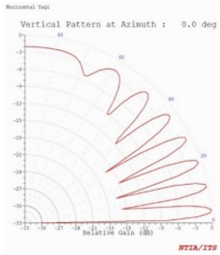
2el40m-18.1_MHz



2el40m-21.1_MHz

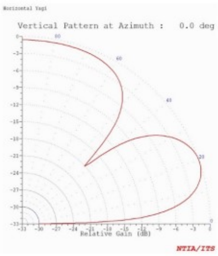


2el40m-24.9_MHz

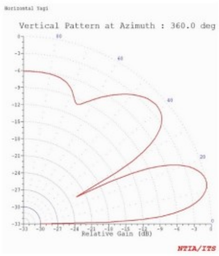


2el40m-28.2_MHz

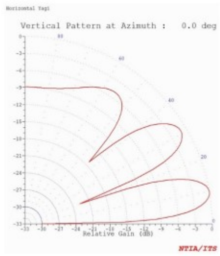
Take-Off Angles: Yagis at 60 m (198 ft) Above the Ground



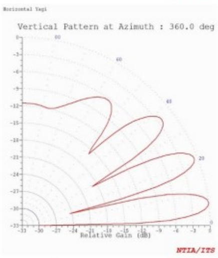
2el60m-3.6_MHz



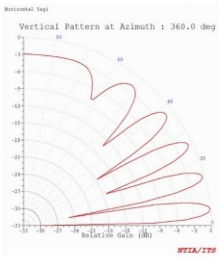
2el60m-5.36_MHz



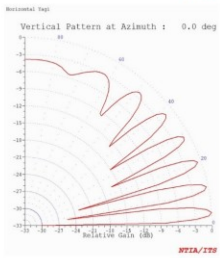
2el60m-7.1_MHz



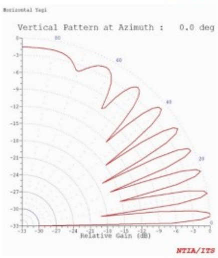
2el60m-10.1_MHz



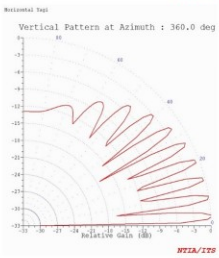
2el60m-14.1_MHz



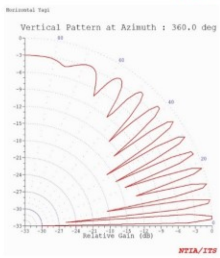
2el60m-18.1_MHz



2el60m-21.1_MHz



2el60m-24.9_MHz



2el60m-28.2_MHz