CRITICAL FREQUENCY DETERMINATION
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Optimum NVIS propagation is achieved by operating at or slightly below the local Critical Frequency (CF). The CF is defined as the highest frequency signal that will reflect directly back to its transmission location as shown in Figure 1. The signal will be reflected from the higher F-layer if the operating frequency is below the foF2 (frequency of the Ordinary wave reflected from the F2 layer) critical frequency. The CF is dependent on the intensity of the ultra-violet (UV) radiation from the sun and so varies with the time of day and day of the sunspot cycle. Increased UV radiation will increase the CF of the F-layer. The CF is measured by ionosondes located all over the world. An ionosonde measures the structure of the ionosphere directly overhead by transmitting a sequence of varying frequency pulses and then analyzing the strength and delay time of the echoes.

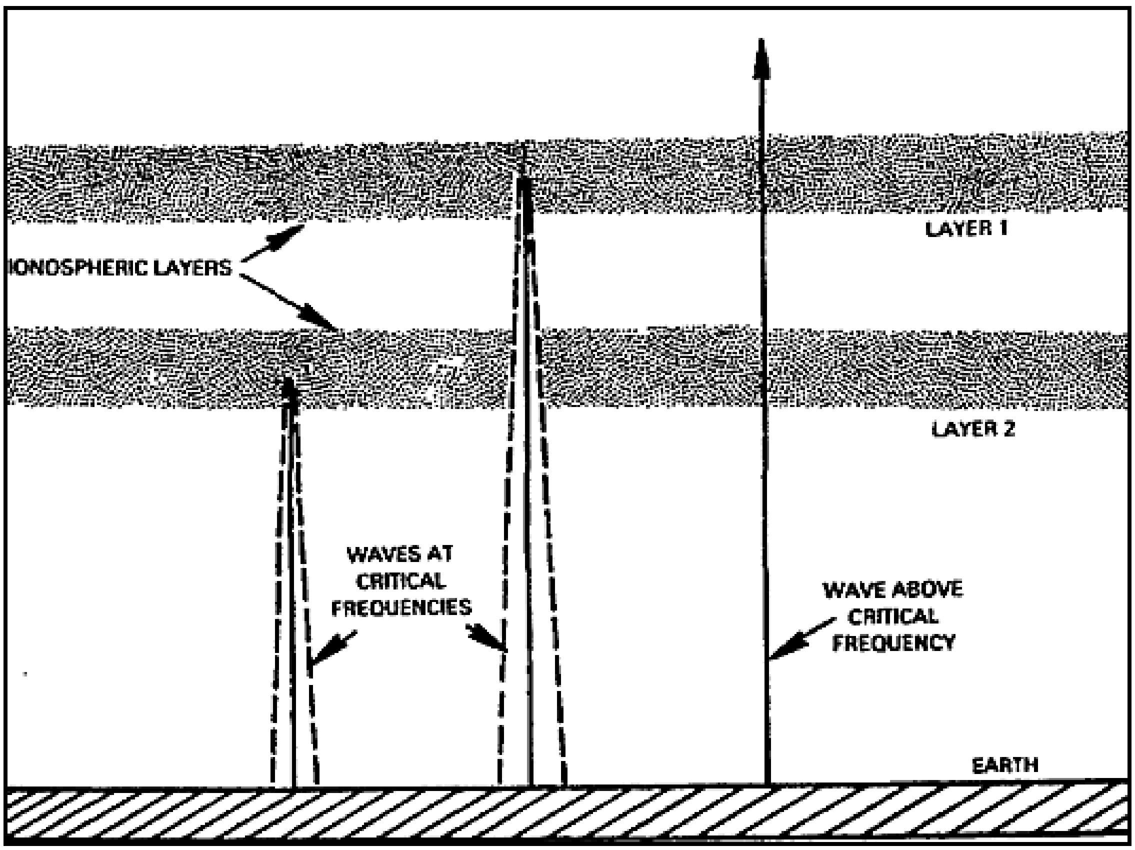

Figure 1: Critical Frequency Definition

Data from this world-wide series of Ionosondes can be found at:
http://ulcar.uml.edu/DIDBase/ and on the Texas Army MARS website:
https://txarmymars.org/resources/solarweather.php
At the DIDBASE site, click on *Station List* and then select *#13 EG931-Eglin AFB.* This will bring up a series of screens that allow you to select the Year, Month, Day, and Time.

All dates and times are in UTC (Zulu) time. Eglin AFB is 52 minutes in sun time ahead of central Texas (difference in Latitude) so what will happen to the ionosphere over Texas is occurring over Eglin about one hour earlier.   For example, to determine the Critical Frequency for our 1401Z net (0800 CST) look at the 1300Z data for Eglin AFB. You can also look ahead in time to see what is going to happen to the CF during the net. This is very valuable for the 0101Z net since typically the CF with drop rapidly after dark, requiring a frequency change during the net. The Texas Army MARS Website capture of this same data has the actual net time posted with the data.

Ionosonde Interpretation For Selection of Critical Frequency

An idealized ionosonde plot is shown in Figure 2.

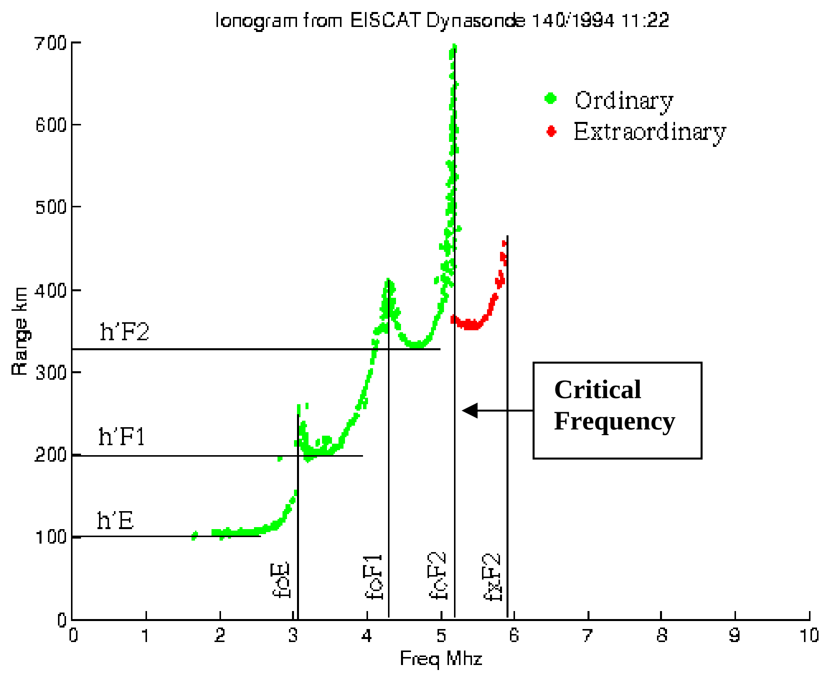

Figure 2: Ionosonde Plot Definitions

The Critical Frequency, foF2, is the frequency at which the Ordinary Wave reflection rises rapidly in height (Range). The Virtual height of the reflection is h'F2. An actual Ionogram from Eglin AFB is shown in Figure 3.

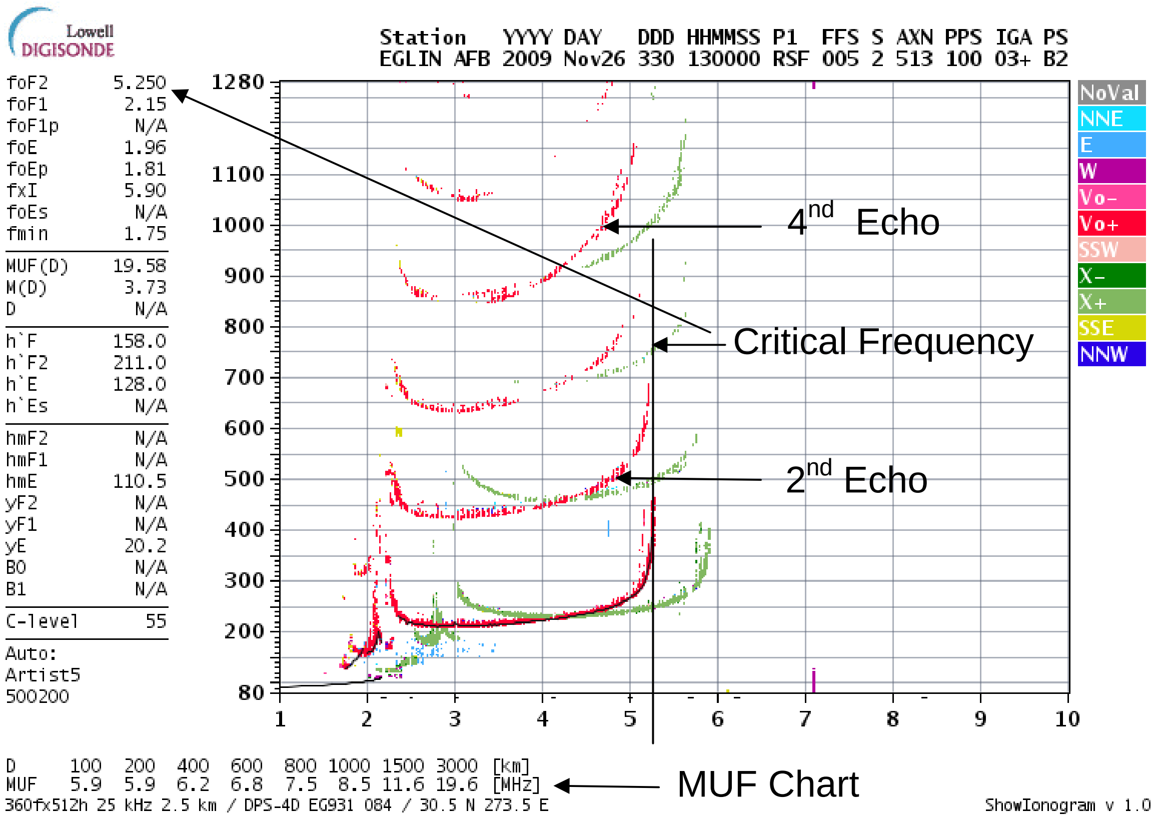

Figure 3: Eglin AFB Ionogram

Observe that the colors of the Ordinary and Extraordinary Wave plots are reversed from Figure 2. Typical multiple echoes, ionosphere/ground/ionosphere reflections can be seen above the first echo. If the controlling computer can scale the data, the ionospheric parameters will be listed in upper left table.

A very useful second table, the MUF Chart, can be seen in the lower left part of Figure 3. The parameter "D" is the skip (exclusion) distance in Km. For example, net operation on KCO (FoF2) would be excellent but KFF would have a skip zone of almost 800 miles. Note that the MUF Chart is quite useful for the regional relay station concept being developed by AAM6RO. The frequency KCO would be best for in-state nets but KFF or KEG would be better to get to other region 6 states with minimum D-absorption.

Many times the computer is unable to scale the data, but the plot is still available for your interpretation. Figure 4 shows an un-scaled Ionogram with a critical frequency of 3.9 MHz.

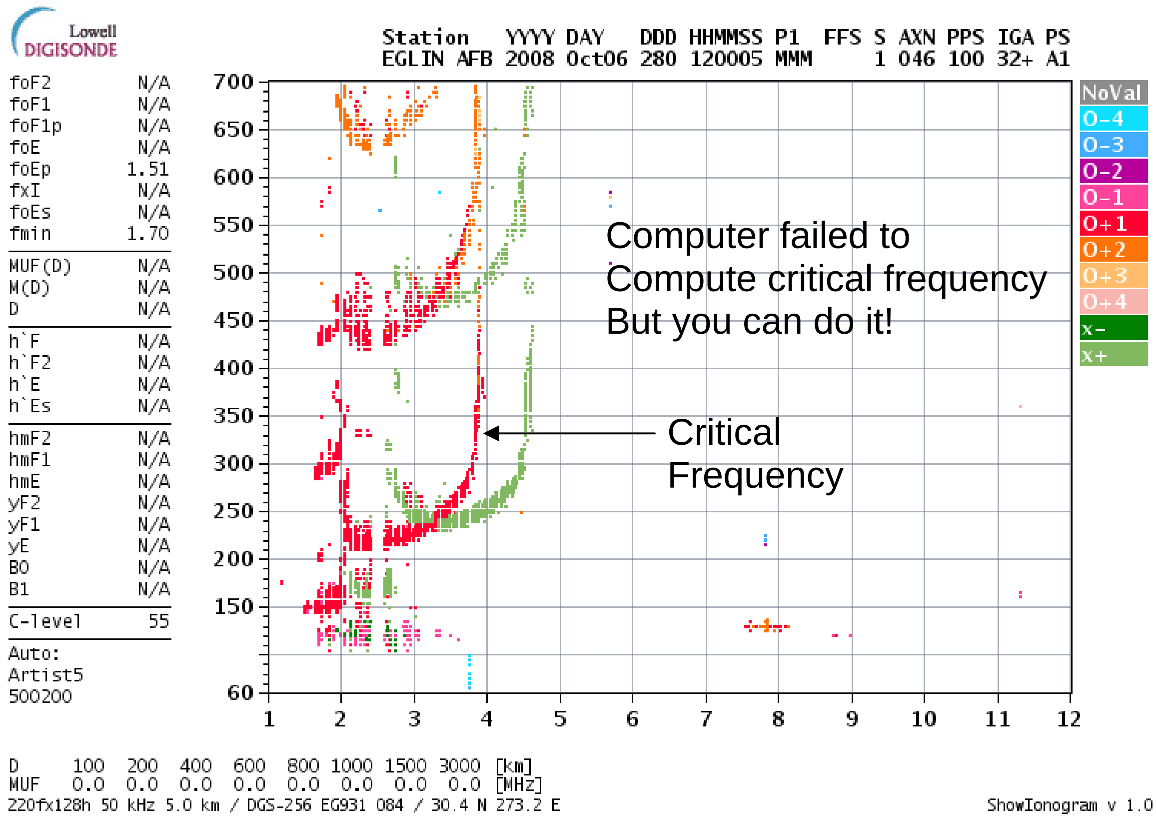

Figure 4: Ionogram Without Computer Scaling

Finally, the computer can make a scaling error resulting in reporting an incorrect CF as shown in Figure 5. This error is due to a U.S. Government requirement for U.S. Ionosondes to not transmit on certain government frequencies. The computer then sometimes interprets this frequency drop out as the rapid foF2 rise.

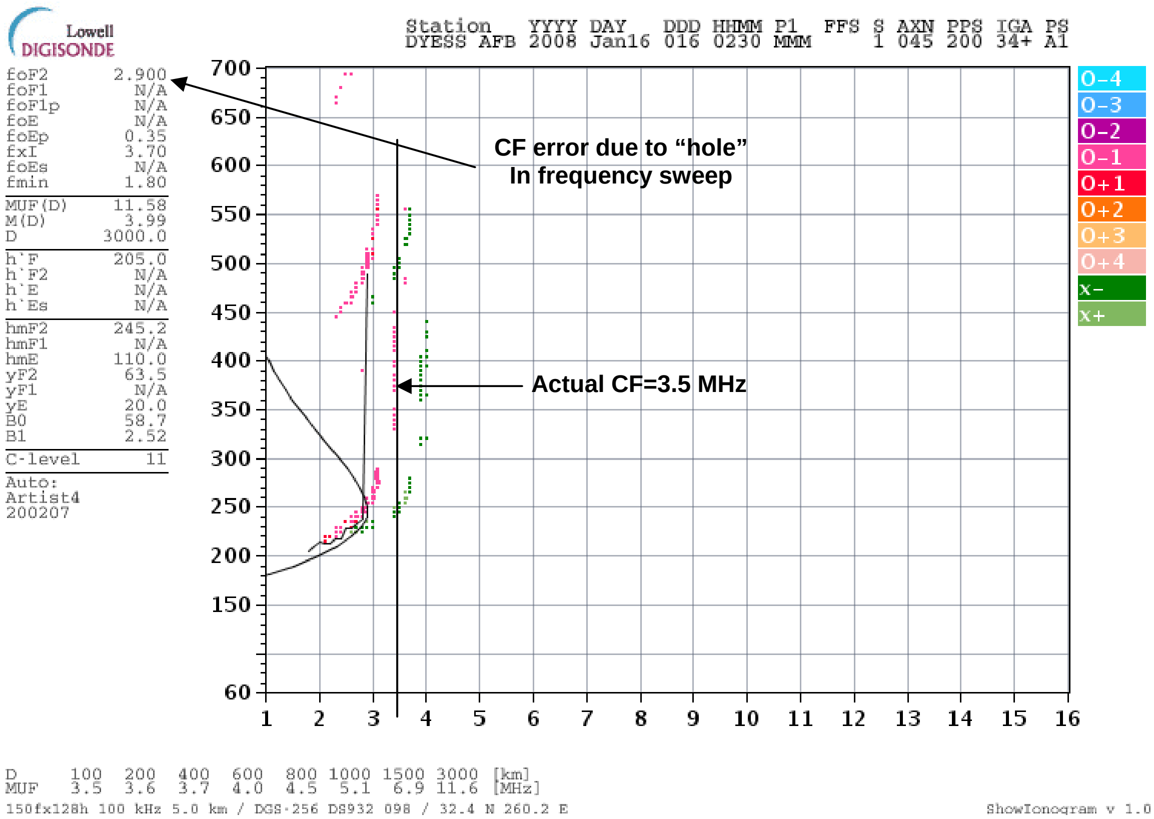

Figure 5: Ionosonde Computer Scaling Error

Net Frequency Selection

The optimum day time net frequency should be slightly below the CF but as high as possible to minimize D-layer absorption. Recall that D-layer absorption is inversely proportional to the frequency mathematically squared. Other factors such as solar x-ray flares and coronal mass ejections can also have adverse effects on ionospheric propagation. Night time net frequency selection should also follow the CF only because antenna efficiency and atmospheric noise reduce communications ranges, i.e., KBN is better than KAH!

Please see: https://txarmymars.org/downloads/NVIS-Theory-and-Practice.pdf for a more complete discussion of solar and other effects on NVIS propagation.