# Why Is 160m So Tough?

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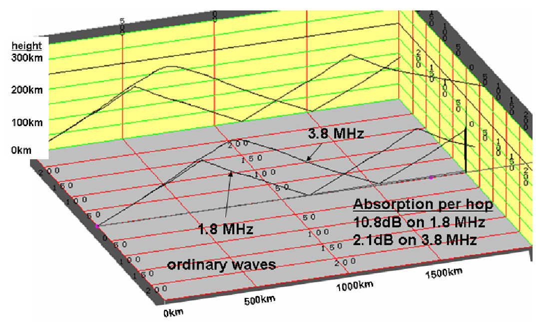
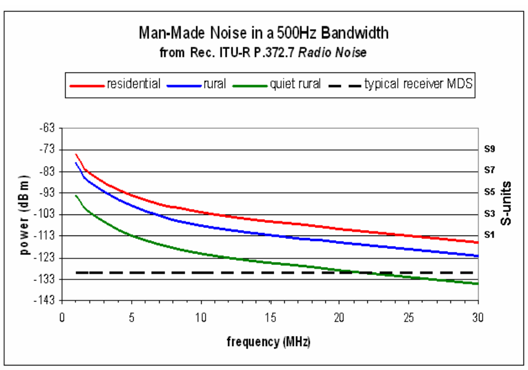
160m is a tough band for DXing. In addition to a wavelength on 160m being longer than on the 3-30 MHz HF bands (which means larger antennas), there are issues related to propagation that make 160m unique.

There are two fundamental issues when an electromagnetic wave propagates through the ionosphere. The first is the amount of ionospheric absorption is inversely proportional to the square of the frequency (the lower the frequency, the greater the absorption). This says signals on 160m will in general be weaker than on the HF bands. The second is the amount of refraction (bending) for a given electron density gradient is also inversely proportional to the square of the frequency (the lower the frequency, the greater the amount of refraction). This says an electromagnetic wave on 160m bends more and therefore does not get as high into the ionosphere as a wave on the HF bands. Thus propagation on 160m generally consists of shorter hops with more loss. Also tied to the refraction issue is the fact that maximum usable frequencies are generally not an issue on 160m – there's always enough ionization, even at night at solar minimum, to refract oblique 160m waves back to earth. A ray trace nicely highlights the absorption and refraction issues.

The ray trace to the right is from Proplab Pro (from Solar Terrestrial Dispatch in Canada), and is for a nighttime path in January at solar minimum. Both rays start at a 15$^o$ elevation angle. The 1.8 MHz ray refracts at 164 km, returns to earth at 1149 km after the first hop, and incurs 10.8 dB of absorption per hop. The 3.8 MHz ray refracts at 215 km, returns to earth at 1531 km after its first hop, and incurs only 2.1 dB of absorption per hop. Quite a difference!




Another extremely critical issue on 160m is noise – specifically man-made noise from machinery, power lines, appliances, etc. The plot to the left shows that man-made noise (in terms of noise power on the left-hand vertical axis and in terms of S-units on the right-hand vertical axis) increases as frequency decreases. Even if you live in a quiet rural environment, you will likely be limited by external noise on 160m. In other words, you won't be able to hear signals down to the minimum discernible signal (MDS) of your receiver.

If larger antennas, shorter more lossy hops, and more noise isn't enough of a problem, the Earth's magnetic field gets in the picture on 160m. Since the ionosphere is immersed in the Earth's magnetic field, two characteristic waves propagate through the ionosphere (an ordinary wave and an extraordinary wave) and ionospheric electrons spiral around magnetic field lines at a frequency called the electron gyro-frequency. The electron gyro-frequency depends on the strength of the magnetic field, and ranges from about 0.7 MHz to 1.7 MHz worldwide. Since 160m is at the upper end of this range, the amount of absorption, the index of refraction, and the polarization of both characteristic waves is affected by the presence of the Earth's magnetic field. One important consequence is both characteristic waves propagate on the HF bands, but on 160m only the ordinary wave propagates due to excessive absorption of the extraordinary wave. All of this, coupled with not having a good understanding of the day-to-day variability of the lower E region (where absorption occurs at night) makes it difficult to predict propagation on 160m.

Working DX on 160m takes a commitment to station improvement and working under difficult conditions. There are general guidelines for 160m propagation (like paying special attention to sunrise and sunset times), but topband operators know that the best way to work DX on 160m is to be there on a regular basis.