Question: I'm interested in 40-meter (7.2 MHz) regional communications (local out to 500 miles). My current vertical antenna is not doing the job. Is there a fix for the vertical, or can you recommend another antenna that is a better compromise for performance, easy installation, and low observability?

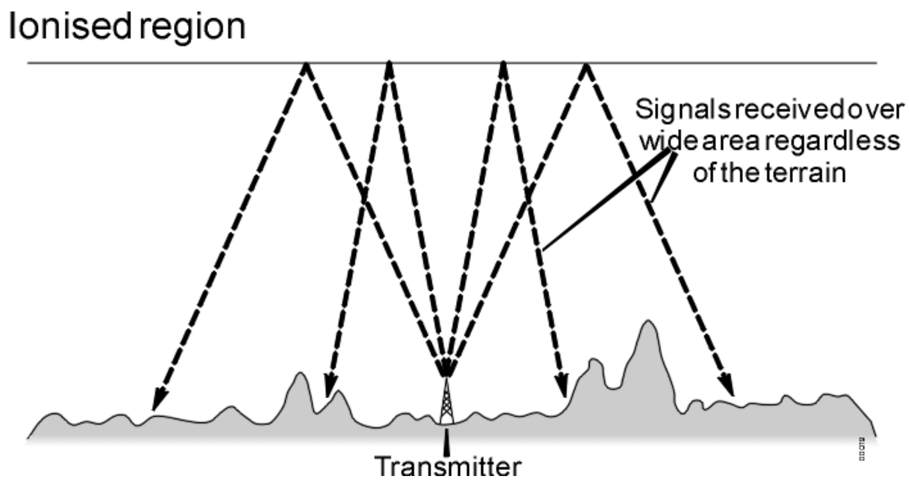
Answer: Before diving directly into antennas, let's determine our signal propagation requirements, and therefore our antenna requirements, for our desired range. Presuming a location like New York City, a range of 500 miles would yield satisfactory communications encompassing the entire northeast US, southern Ontario, westward out to Detroit, and as far south as Charlotte, NC.

Propagation

So, what would be our signal path? There are two possible paths - ground wave and skywave.

A **ground wave** signal travels in the electric field near the ground, direct from our transmit antenna to the receiving station. Ground wave is rarely useful beyond 30 miles or so. Hence, it's not useful to us.

A **skywave** signal arrives at its destination by way of refracting from the ionosphere's F-layer (the "ionised region" shown below). This refractive F-layer is approx 250 to 500 miles above the earth, dependent upon time-of-day, season, and solar conditions.



Our antenna then is tasked to launch a signal toward the F-layer at the angle necessary to refract down toward the desired receive station. For very nearby stations, the required "takeoff angle" can be quite vertical, nearly straight up and back down - for more distant stations, the takeoff angle must become shallower (closer to ground). We need not concern ourselves with targeting an exact angle - our antennas are not that directive - but we do need at assure we are radiating power over the range of takeoff angles necessary to illuminate the appropriate area of the F-layer.

Our antenna requirements: Presuming a worst-case 250-mile F-layer height, a 45-degree takeoff angle will assure proper F-layer illumination for our desired 500 mile range. Also, everything from 45 degrees up to the zenith must be illuminated for more local contacts. Hence, our antenna must fully radiate the entire area from the zenith downward to a 45-degree elevation.

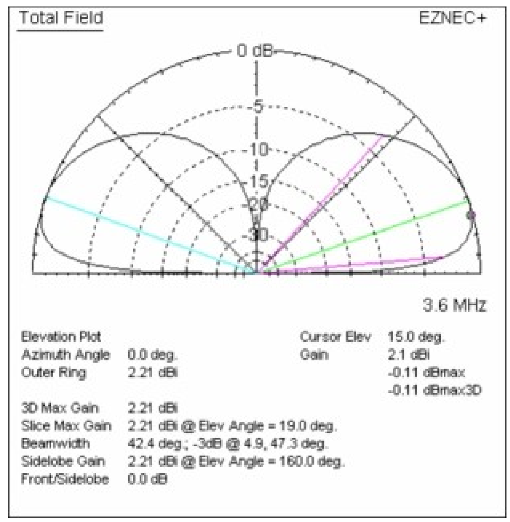
We are only discussing transmit antennas. For our purposes, an efficient transmit antenna will also serve well as a receive antenna. On the other hand, a lossy antenna may serve as a good receive antenna, but work poorly for transmit. A 15 dB loss in an HF antenna, may go unnoticed on receive, yet be totally inadequate for transmit.

Antennas

At this 40-meter frequency, we have two major antenna choices - a vertical, or some varient of a half-wave horizontal wire.

The Vertical Antenna

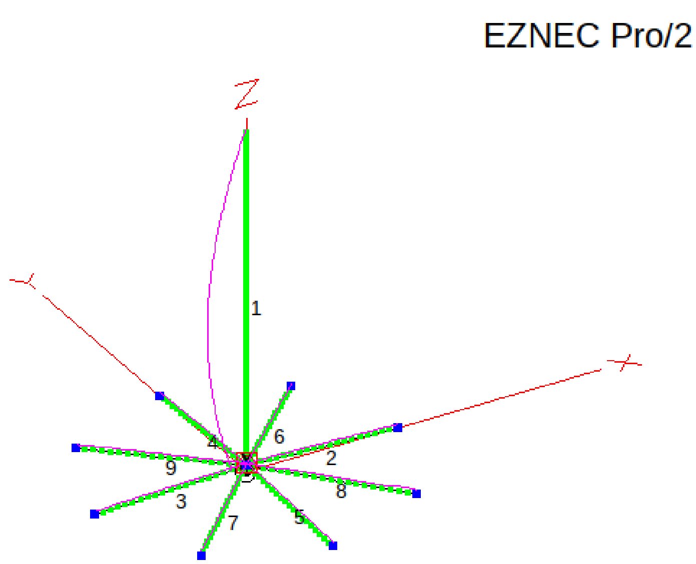
A quarter-wave vertical antenna for 7.2 MHz is very close to 32.5 feet tall. The impedance of this antenna would exhibit an impedance close to 36 ohms, yielding a satisfactory 50-ohm SWR of less than 1.5:1. Over average ground, this antenna yields the radiation pattern on the right.



As you can see, the major portion of the radiation is between the ground and an elevation of 45 degrees. Max gain is at about 15 degrees. The better the ground system, the better the radiation pattern becomes at the very lowest angles. This is perfect for DX communications - getting out 1000, 2000, or more miles. With a great ground radial system expect to see routine DX to the US west coast and well into Europe.

Unfortunately, zenith radiation for regional communications is nearly absent. Within an area of a few hundred miles, signals will be very weak. This is a DX antenna, and not helpful for this application.

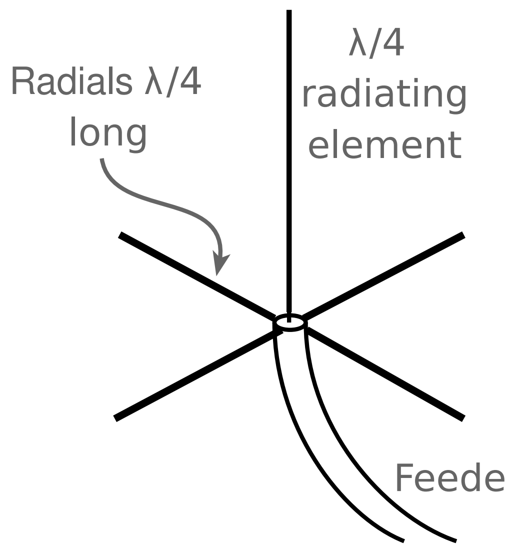
So, a vertical antenna is not appropriate for this regional application. But, they are popular and have easily fixable issues, that I would like to briefly discuss.



A vertical antenna, seen right, can be either ground mounted or elevated. Like any circuit, the vertical requires a return current path. The coax center conductor connects to the vertical and the coax braid (shield) connects to ground.

A **ground-mounted vertical** requires a robust ground radial system, consisting of 16, 32, or more radial wires either laying on the ground or buried shallow - otherwise, loss from ground absorption will be significant. These radial wires are untuned, so their length is not critical, though a quarter-wavelength is considered minimum. The installation effort for a vertical antenna lies mostly in its ground system - poor ground systems are common. An inadequate ground system adds considerable loss, especially at low angles. The penalty for a poor ground system could easily add 10 dB of attenuation. Your 100 watt transmitter now only radiates 10 watts!

An **elevated vertical** can be mounted on a rooftop or tower. The "ground" is replaced by a counterpoise consisting of 2 to 4 quarter-wavelength radial wires or rods extending from the antenna base. The coax braid connects to these wires. As these wires are resonant at the operating frequency, their length must be close to 32.5 feet.



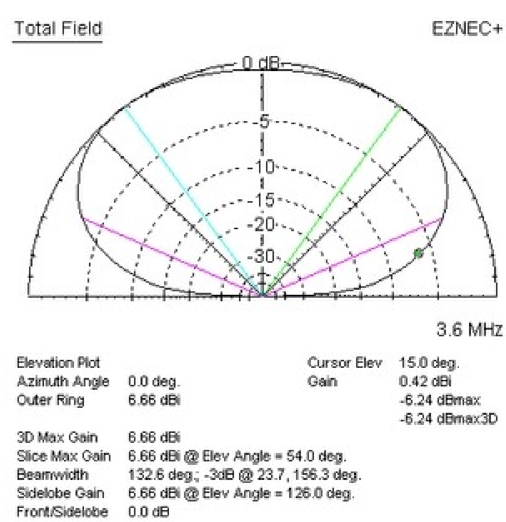
Most commercially produced vertical antennas have more than their share of compromises - primarily in two areas.

1. Commercially produced verticals typically are short (18 to 24 feet), requiring a base inductor for tuning. This shorter antenna exhibits a lower impedance at resonance, worsening the SWR. Still, the SWR may not exceed 2.0:1.

2. More importantly, the user-supplied counterpoise frequently is overlooked or is installed haphazardly. If the antenna is both short and has no counterpoise, its low radiator impedance may be "offset" by the increased ground impedance causing what appears to be a resonable 50-ohm match. But, the losses will be tremendous!

Your takeaway: If your vertical antenna lacks counterpoise radials, adding just one or two 32.5-foot radial wires to the coax braid at the base of the antenna may make a sustantial improvement in its efficiency. The counterpoise wires do not need to be symmetrical or look nice - just connect the wire and pull the opposite end to stretch it away from the antenna - in most any direction. In rooftop installations, laying the wires on or under the roof, or in a gutter, may be sufficient.

The Horizontal Antenna

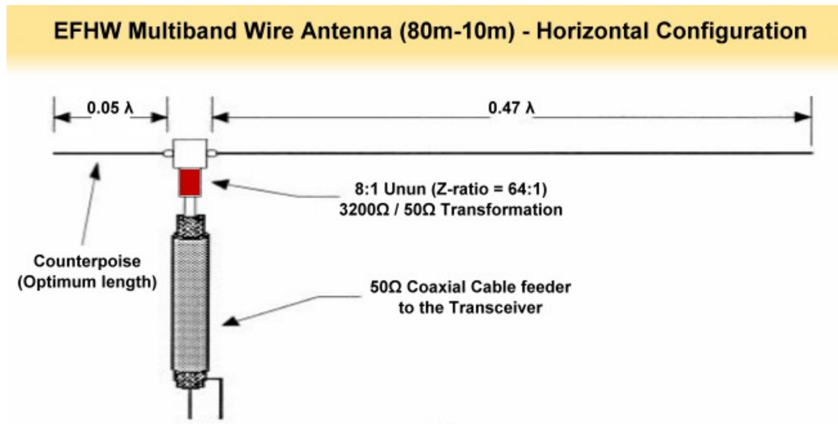


There are many variants of the horizontal half-wave antenna. The horizontal wire can be implemented as a simple center-fed dipole, an end-fed half-wave (EFHW), an off-center fed half-wave, etc. Differences generally concern bandwidth, multi-band usage and driving impedance - none of these are important for our discussion. All of these produce a similar radiation pattern, shown to the right. The broad vertical lobe of radiation is just where we need it, covering the zenith down to about 40 degrees - ideal for our needs. This satisfies our antenna requiement.

Center-fed and off-center fed dipoles have a coax connection hanging from a location out on the wire, which is awkward to mechanically support and tough to hide from the neighbors.

On the other hand, the End-Fed Half-Wave (EFHW) is different - the coax connects, through a small transformer interface box (called an Unun), to just one end of the wire - it's easy to implement and disguise. The wire can be thin, since it supports nothing more than its own weight. The EFHW is arguably the most popular horizonal wire antenna, due to its good performance and easy installation.

For 7.2 MHz, the EFHW antenna is approx 65 feet long. Its height above ground may be as low as 15 feet or up to 35 feet, with only a small performance difference. The wire should be substantially horizontal, but it is not critical. Unlike the vertical, the horizontal wire needs no ground or counterpoise to operate. The only adjustment required is to assure its length is correct to minimize SWR - even that is not overly critical.



The EFHW antenna, shown above, indicates a 0.05 wavelength (7-foot-long) counterpoise. Typically this is omitted, as the coax braid serves that function.

The bottom line

Start by adding one or two 32.5-foot radial wires, attached to the coax braid at the bottom of **your vertical antenna**. That should improve DX communications, and may help somewhat for your regional communication issue. But, a better solution for your regional communications is to install a horizontal wire antenna - such as the **End-Fed Half-Wave (EFHW)**. It is simple to install, performs amazingly well, and can be easily hidden from nosey neighbors. Lots of folks are using one of these with success!