Propagation
NCJ March/April 2006
Carl Luetzelschwab K9LA

Low Band Antennas and Trees

Putting up a competitive low band antenna can be tough for those without a suitable man-made support. One solution, taking the lead from K5AF's Contesting on a Budget column in the May/June 2005 issue of NCJ, is to utilize a tree.

I use a tree to support my 80m/160m wire antenna system. The vertical wire starts at 7 feet above ground and goes up to about 65 feet. I have an 80m trap at the top of the vertical wire, and a wire from the top of the trap runs back toward the house to resonate the system on 160m. Thus it's a full size quarter-wave vertical on 80m (it has a small inductor at the bottom for resonance and for switching from PH to CW), and an inverted-L on 160m. I use six elevated radials - three 60 footers and three 120 footers.

I've always wondered how the tree I use to support my 80m/160m antenna, and the surrounding trees, affect the performance. Thus the goal of this column is to discuss the effect of trees on low band antennas. I would expect that, for the most part, the discussion is applicable to the higher HF bands, too.

There appears to be two areas of concern with respect to trees affecting low band antennas: the trunk portion of the tree and the leaves (foliage).

With respect to the trunk portion, the Technical Correspondence column in the November 1991 issue of QST had some interesting observations by KF4IX (call now unknown) and K4OQK (now W3BZ). They had a single 75m quarter-wave monopole hanging in a tall pine with seven radials raised 15 feet off the ground. The distance from the trunk of the tree to the bottom portion of this antenna was about 1 foot. The distance from the trunk of the tree to the top portion of the antenna was about 3 feet. The resistance at resonance (3.74 MHz) was measured to be 50 ohms. A model of this antenna indicated the resistance at resonance should have been about 32 ohms.

To determine where the extra 18 ohms of resistance came from, they first moved the bottom portion of the antenna farther away from the trunk of the tree (from 1 foot to about 15 feet). Nothing changed. Then they moved the top portion of the antenna farther away from the trunk of the tree (from 3 foot to 6 feet). Resonance moved up to 3.77 MHz and the resistance was now about 35 ohms. Their conclusion was that the tree trunk, being a lossy dielectric, introduced significant loss due to the close proximity to the high voltage portion (top portion) of the antenna.

With respect to foliage, we'll use the work of Tamir [reference 1]. Tamir developed equations to calculate the additional loss on HF propagation by foliage in a forest. Figure 1 shows the basic model used by Tamir.

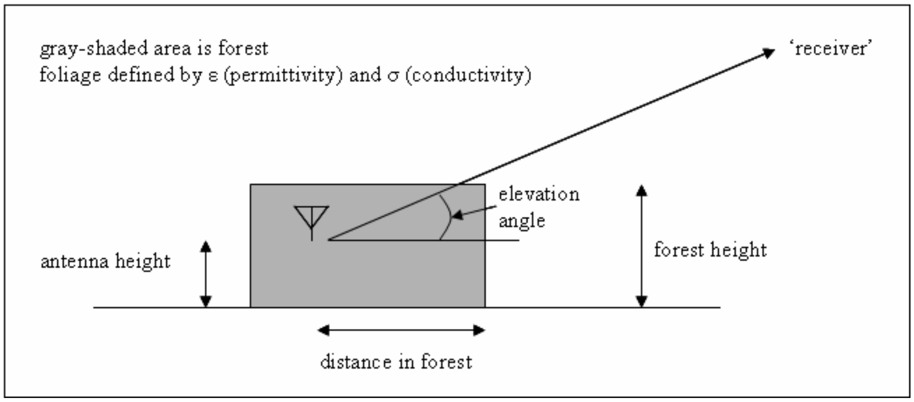

Figure 1 – Tamir's model of an antenna in a forest

My specific situation has the forest extending north and east of our property for about one quarter mile - thus I set the 'distance in forest' parameter to 402 meters. The trees are about 75 feet high - thus I set the forest height to 23 meters. The major portion of the foliage is near the top of the trees, and is about 20 feet thick - thus I set the antenna height to 17 meters. Finally, I chose an elevation angle of 20 degrees.

For the relative permittivity and conductivity of the foliage, an earlier work by Tamir [reference 2] gives insight into these values. The relative permittivity of foliage is typically between 1.1 and 1.2, so I used 1.15. The conductivity of foliage is on the order of 1×10^{-4} S/m. As a side note, the value of the conductivity is the major player in the model - varying the relative permittivity resulted in minor change to loss. The additional loss versus frequency due to the foliage is shown in Figure 2.

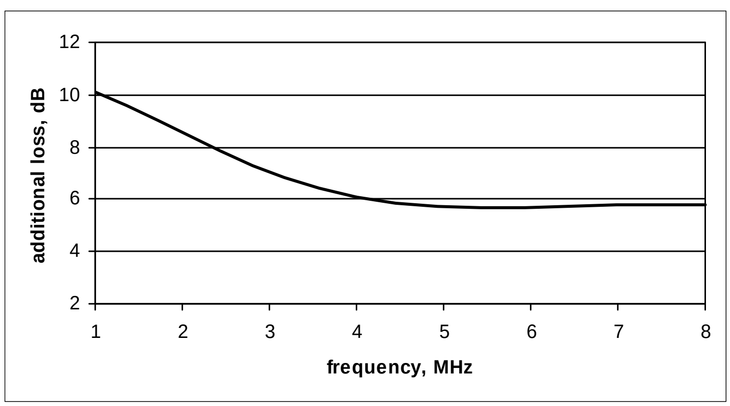

Figure 2 – Additional loss due to foliage

Tamir's model says the additional loss due to foliage incurred by my 80m/160m antenna system at an elevation angle of 20 degrees is on the order of 9dB on 160m and 6dB on 80m. It increases by several dB at lower elevation angles and decreases by several dB at higher elevation angles. Is this amount of predicted loss reasonable? I don't know, as I don't spend too much time on 80m and 160m during the summer months (even if I did, I have nothing to compare it to in order to validate the model).

This brings up an important issue - my trees are deciduous. When I run the model with a relative permittivity of 1.0 and a low conductivity (1 x 10^{-5} S/m) to emulate winter conditions with no foliage, the model predicts no additional loss (as expected). My experience during the winter months with my 80m/160 antenna system tends to confirm this result – I don't think I'm losing much, if any, in the pileups in winter due to the fact that my low band antenna system is in trees.

In summary, if you have to implement your low band antenna in a tree, try to get the top portion away from the trunk by at least 0.023 wavelengths (based on the 1991 Technical Correspondence article). And it would be nice, if possible, to pick a tree with minimal foliage. If the latter recommendation can't be achieved, at least be happy that we do most of our contesting in the winter months – when the foliage has usually disappeared.

References:

1. Tamir, Theodor; *Radio Wave Propagation Along Mixed Paths in Forest Environments*; IEEE Transactions on Antennas and Propagation; AP-25, No 4, July 1977; pp 471-477.

2. Tamir, Theodor; *On Radio-Wave Propagation in Forest Environments*; IEEE Transactions on Antennas and Propagation; AP-15, No 6, November 1967; pp806-817.