The Mystery of the Missing States:
What Happened to Pennsylvania, WV and Kentucky on 40m with an 80m OCF?
N2UJN

Beginning of this Mystery Story: A 40 m Dipole Opens my Station to the SW and NE.

I entered HF with access to 10m, 12m, 15m and 17m only, for about a year from 2012-2013. These bands, at that time, were amazing and during the 10m contest in December of 2012 my antenna, a 22 ft vertical, was only 6' off the ground but the signals were routinely 20 over S9 during that contest. In fact, I was gratified to here one WA station, during the contest, tell me, BIG SIGNAL. Who does not want to hear that? But, time passed, and, my desire to expand band access grew.

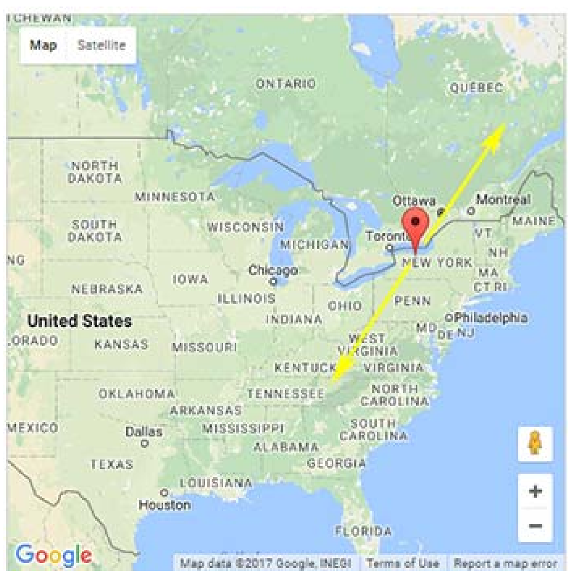
Hence, I pursued additional HF bands, beyond 10m-17m, and, after talking with K2FX and a few other experienced Amateur's, I added, at my house, a 40m Dipole in inverted V format about 35' off the ground at center and about 9' at ends. This antenna worked remarkably well, was easy to build, and easy to tune to the center of the band. The orientation of the antenna was along a line North-West to South-East thereby making the broadside directions of the antenna point as shown by the yellow arrows in Figure 1 below (South-West to North-East).

At that time I did not put a choke at the antenna feed-point so to my wife's chagrin, I knocked out the wireless router for the house whenever I transmitted due to common mode current return to the house, but, as I told her (every time it happened), this was a small price to pay for the band access (I now use a choke that Dean, NW2K, provided specs for that avoids that problem).

After adding this 40m Dipole, unlike the higher frequency bands with my vertical antenna, I could hear both sides of QSO contacts, for the most part, and, communicate long distances in the US, and Canada, and often, at that time, hear a European station since the broadside direction was directly pointed at Europe.

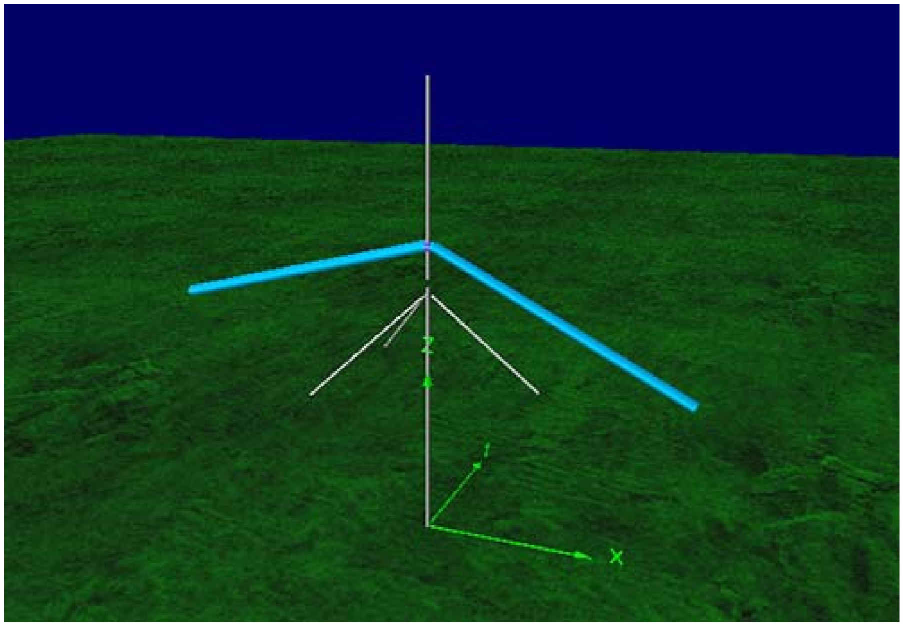
In particular, stations from Pennsylvania, West Virginia, Kentucky, Tennessee and Mississippi to the SW and Vermont, Connecticut and Quebec to the NE, were often big signals at my location with the 40m Dipole. Hearing both sides of a QSO, and, getting access to these southern states where folks really enjoy rag-chew, was a wonderful experience for me on HF.

Figure 1: Broadside Directions of My 40m Dipole (yellow arrows)



A 4NEC model (more detail later) of the 40m Dipole is shown below with exact dimensions/approximate orientation to the antenna placed in my backyard including insulated wire with the type and thickness of THHN wire 14 gauge.

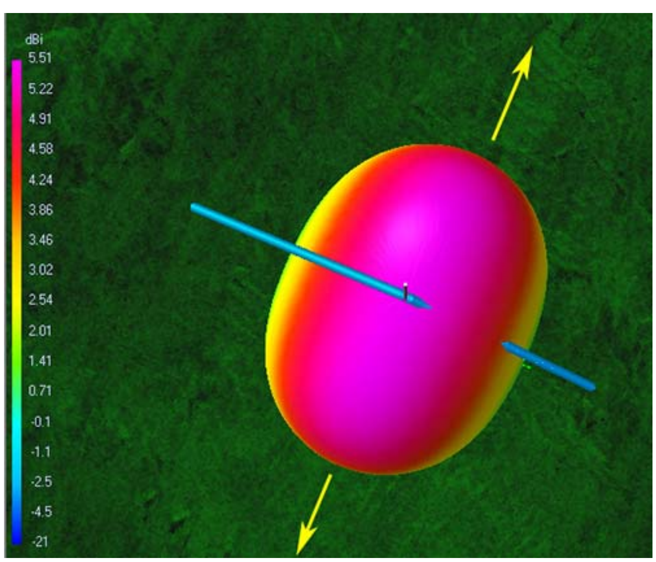
Figure 2: 40m Dipole in Backyard (attached at bottom of a vertical and above vertical's elevated radials).



For this 40m Dipole the far field propagation is shown in in Figure 3 below. As can be seen, the main propagation lobes for my 40m Dipole point Northeast and Southwest, enabling direct access to PA, KY, TN, MS and relatively frequently TX and LA, and VT, CT, etc. In addition, sometimes Quebec City stations and nets are strong….and once in a while the rare Iceland station can be heard.

Hence, for the 40m Dipole, it is clear, from the below far field propagation pattern, how I was so enabled in communicating with the above states. The dipole was also reasonably effective along the parallel direction, in line, with the dipole itself so I often pulled in IL, and NJ.

Figure 3: 40m Dipole Far Field Propagation Pattern and Main Directions.

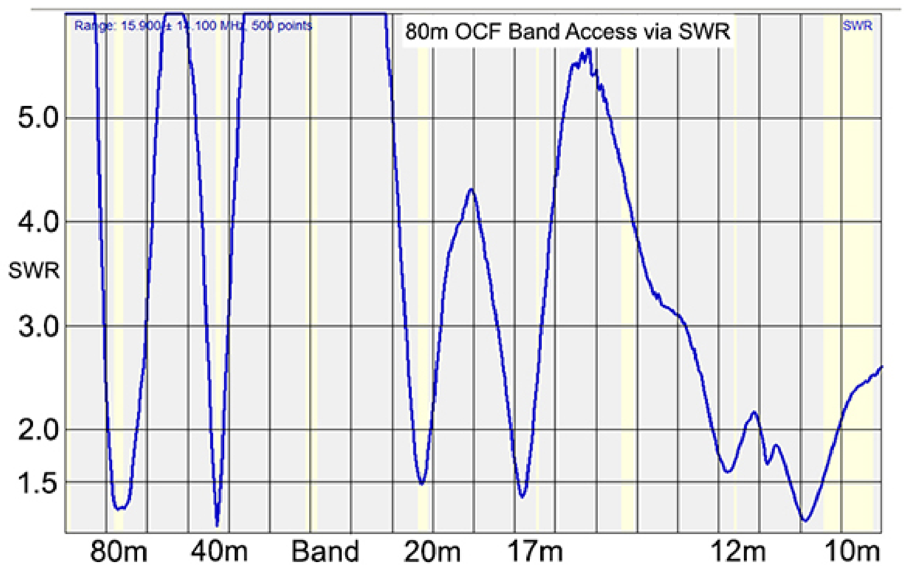


Expanding Band Access to 80m While Preserving Access to 40m

However, as Amateurs are wont to do, after a year with the 40m Dipole, I desired even more band access that included 80m. Eventually, stumbling around the internet I ran across an 80m OCF reference, and, eventually, built the 4:1 Guanella balun and erected an <u>80m OCF which replaced</u> the 40m Dipole.

Band access (see Figure 5 below) with the 80m OCF is actually pretty spectacular for a newcomer to antenna building like me. It is one thing to read reviews on various 80m OCF's, which are pretty positive, but, entirely another to build one, tune it a little and have the below band access unfold before one's own eyes (or RigExpert AA-54 as the case may be).

Figure 4: 80m OCF Band Access via Low SWR – kind of amazing really



Once my 80m OCF was in operation I was easily able to operate across 80m, 40m, and 20m essentially without an antenna tuner. This outcome was amazing to me, and, broadened my operating in 20m PSK-31 as well. Early morning listening to the 80m Band is always interesting, and, sometimes, I pick up a DX contact here and there during those early hours that I sometimes find myself awake during.

In particular, sometimes I join K2ZX very nice net that brings many local, enthusiastic, amateur operators together. Always a good topic, always good participants, and, always benchmark net management by Joe. ☺

The Mystery: What happened to PA, KY and TN on 40m after installing the 80m OCF??

So begins a mystery that took me 18 months, and a little free time, to solve. The 80m OCF opened lots of doors, 20m PSK-31, 80m rag chew and DX, and, some higher band access and even enables me to listen to 160m.

However, on 40m I had been very used to big signals coming in from PA, KY, TN and VT, and CT routinely. Big signals. <u>**After I installed the OCF, for the most part, those states just disappeared from my contact list as time passed**</u>. ***How could such a nice antenna result in such a massive change in contacts, and, how could such big signals just go away??*** This puzzled me. I knew the antenna was working because I still made 40m contacts, but, now I would sometimes get Montana, and, intermittently, Idaho, which, almost never occurred before. Hmmmm……..a radio mystery.

Exploring the Mystery: Genesis

In September 2015, after many, many years of too many hours spent working, and, lots more hours spent working, and, lots of vacations and weekends working……..while amassing professional "success" such as it was/is……I was blessed with some quality time at home. This came with a little bit of overhead, however, in the main, I was granted some quality time at home, without my normal workload of programming, testing, explaining complicated code/algorithmic outcomes to managers, not all of whom have the attention span of a gnat, instructing others, and, driving new stuff. What do do??? Reading was interesting for a while……and walking a mile inside my house was interesting for a while. Carefully avoiding opioid addiction was easy……and…..I did a little radio sometimes…..that was OK.

However, one morning I awakened with a start. What about my radio mystery?? How did I lose big signals from PA, etc., by simply replacing one piece of wire with another bit of longer wire both of which had great SWR on the 40m band?? Surely I could solve that mystery in my free time? But, how?

4NEC2: Building a Simulator.

I decided one interesting way to explore the mystery would be to build a simulator. I had previously taught myself the free version of EZNEC, but, was limited to a mere 20 segments with that. To get more segments, which I would need, I would have to pay $90 bucks. Thank goodness I have a cheap bone, carried with me from my East Texas farm to adulthood, which made me look around to see what else might be available before springing $90 bucks to get EZNEC.

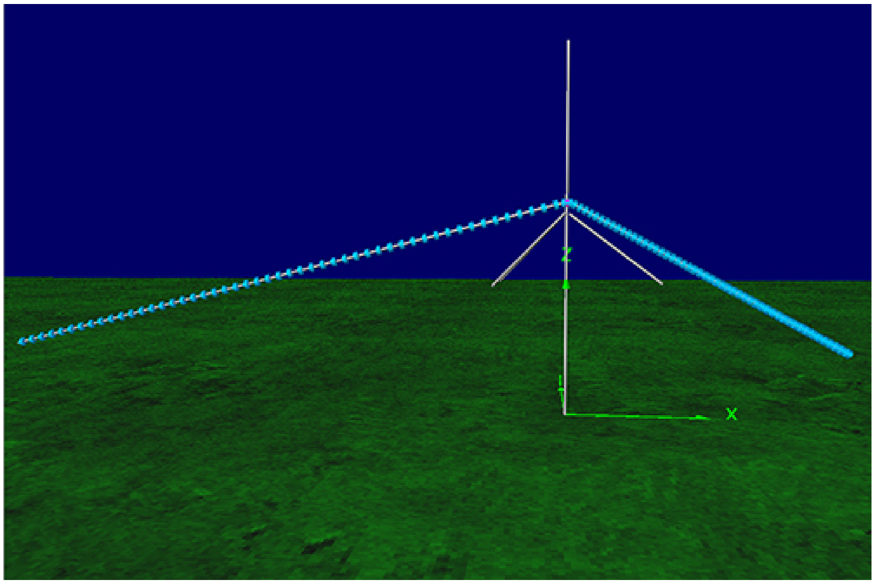
A quick web search returned a lonely set of links to something called 4NEC2. Apparently, the genius programmer Arie Voors spent from 1992 to 2008 building a progressively more formidable C++ wrapper around the NEC2 code. Then, in a profoundly generous donation to the Amateur Radio world, he placed it on the web, for us to use, FOR FREE.

Let me summarize without getting too enthusiastic. 4NEC2 is an incredibly powerful C++ wrapper around, primarily, the NEC2 Fortran code from Lawrence Livermore National Labs. Note: It is also possible to use NEC4 with the same C++ wrapper, although I have not done that. And, when I say incredibly powerful that is a BIG UNDERSTATEMENT. I have a review on eham if you want to read more about what I think of this C++ wrapper, now, having spent some of my free time really learning how to use it. Lastly, for complex operations, Arie actually answers my emails. In one case he debugged one of my code segments for me. Be assured that won't happen if you use EZNEC.

At any rate, for FREE, I downloaded 4NEC2 which allows me to use up to 11,000 segments. I figured that would be enough for my OCF model. And so I started building the model in between ramming around my house for a bit of convalescent exercise.

That initial model was a little long in coming because, instead of using the Geometry editor, I chose to learn each of the NEC2 Fortran Card formats, which 4NEC2 elevates for use, for each part of the model and code the entire model in the variable format enabled by the 4NEC2 C++ interface. Having learned that, and, built the model in variables, the result is similar to simply writing code in is a somewhat arcane programming language, but, an effective programming language which enables specifying a single variable that can be re-used throughout the program. In the end, I have the model shown below for my OCF all coded up in variables.

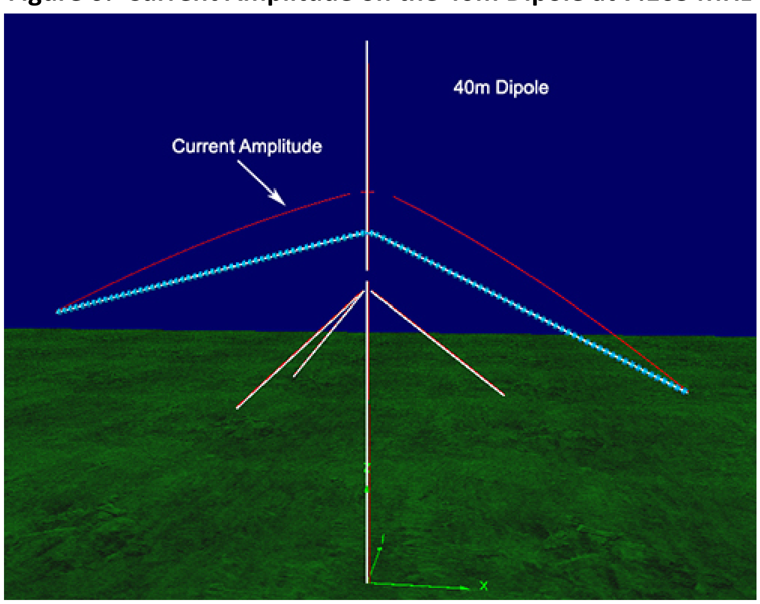
Figure 5: 80m OCF in my Backyard



Current Amplitude, at 7.163 MHz, for the 40m Dipole and the 80m OCF

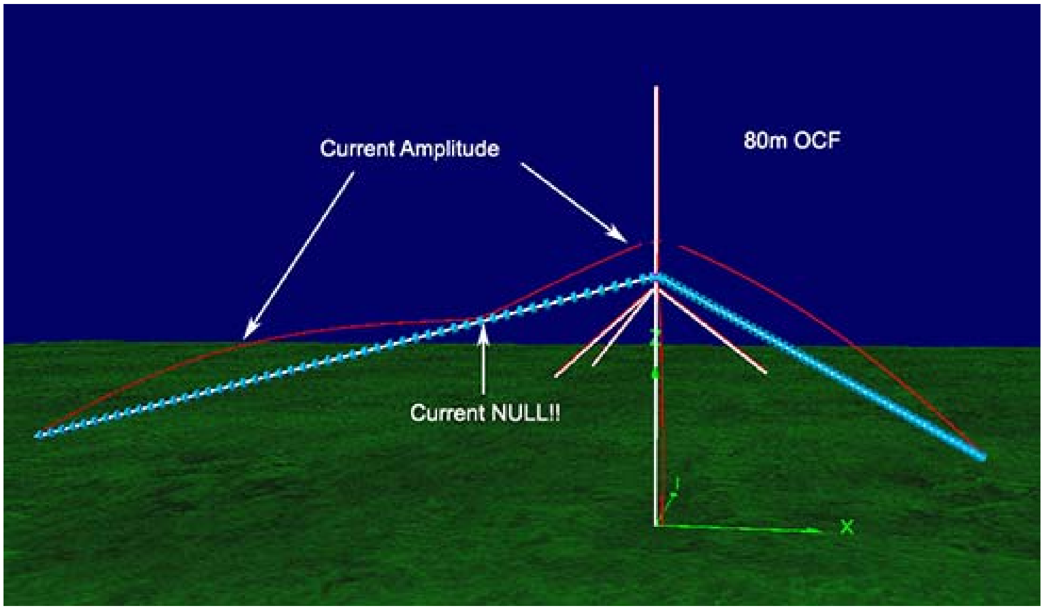
Both the 40m Dipole and the 80m OCF have low SWR at the 40m frequency of 7.163 MHz. So, I can transmit power equally well. But, let's take a look at the current amplitude on those two antenna systems below. First, the 40m Dipole.

Figure 6: Current Amplitude on the 40m Dipole at 7.163 MHz



And, the current amplitude on the 80m OCF for 7.163 Mhz is shown below in Figure 8

Figure 7: Current Amplitude on 80m OCF at 7.163 MHz

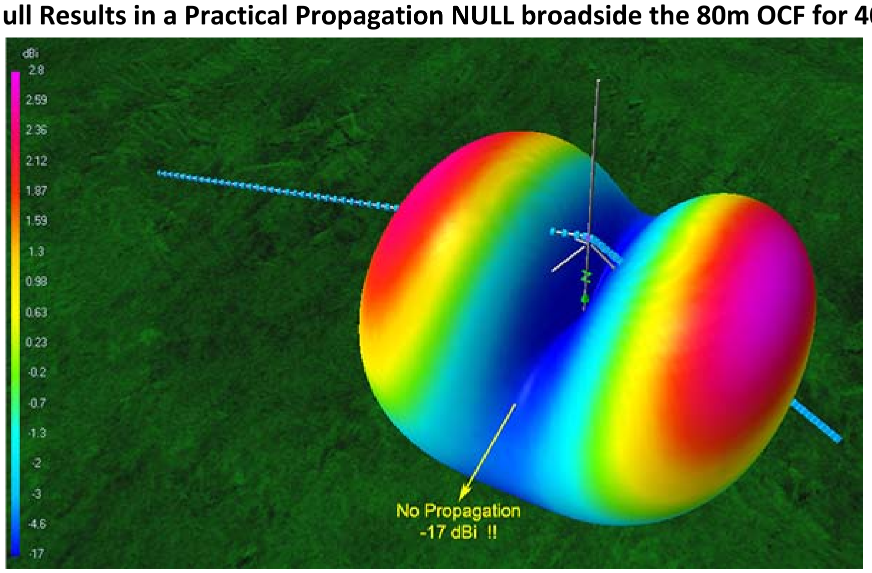


Above, in Figure 7 and Figure 8, we can see the beginnings of and window of light into our mystery. In the above figures the 40m Dipole has its current peak for 40m right in the center of the dipole. On the other hand, at the center of the 80m OCF, there is a current null at the center of the OCF. However, because the OCF is resonant on 40m at around 200 ohms, I can use this dipole just fine with a 4:1 Balun at 50 ohms where the SWR perspective is relevant as previously noted.

MYSTERY SOLVED: Far Field Propagation Pattern on the 80m OCF

The current peaks above produce two propagation peaks at 7.163 MHz as shown below***. It turns out that the current null above produces a profound propagation null at the center of the OCF, for the 40m Band, thereby completely eliminating propagation toward PA, KY, TN and VT, and CT.*** As the below propagation pattern shows, the 80m OCF has NO propagation in the broadside direction thereby eliminating reception and outbound propagation to the southwest.

Figure 8: MYSTERY SOLVED.
Current Null Results in a Practical Propagation NULL broadside the 80m OCF for 40m Band.



So, our mystery of the missing states on 40m with an 80m OCF is solved.   We have, through real antenna testing, learned that a broadside null exists on 40m with an 80m OCF by having almost no contacts on PA, KY and TN with that antenna where formerly, on a 40m Dipole, big signals boomed in from those states. Simulation confirms this propagation and reception null.

We can now proceed to resolve this lack of propagation toward PA by using simulation to explore options.

But, that is a mystery for another day.

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