The Buzzards Have Landed

EME on a Budget

By Lee Becham – KD4NTS

Sometimes you do things that just make you want to high-five those in the room. The most recent episode of this for me was making my first Earth-Moon-Earth (EME) contact. However, it wasn't just *me* high-fiving the room, and it wasn't just *my* first EME contact. This moment was shared between me and four other operators from the LaGrange Amateur Radio Club who decided to take a mini-Dxpedition to EL79 last June for the June VHF contest. While there, we decided to give EME a go and see what all the hoopla was about. Details of the trip from an EME perspective will be presented, as well as our trials and tribulations leading up to making EME contacts.

Meet the Buzzards

On October 3, 2011, the first official Buzzard Net was held out of LaGrange, Georgia on 6M (50.155 MHz) with net controls being Ed Ekkebus, KE4EE, and Rob Momon, N4VPI, and having the 6M expert assistance of Bob Yates, W4GCB. Bob, who is the original buzzard, is an avid 6M operator and monitors 6M constantly for any hint of an opening, and when such an occurrence arises, he announces it on the local 2M repeater. The buzzard moniker came into existence due to the manner in which the local operators would gather on the announced 6M frequency and, one after another, take turns making contact with the victim as if he were prey to a wake of buzzards. No one ever made just one contact from LaGrange, Georgia on 6M when the band was open!

Figure 1- The EL79 Buzzards

After almost 4 years of the Buzzard Net, there are over 100 buzzards (those who have checked in six times or more) with a total of more than 8300 check-ins, and an average of almost 70 for each net.

Our mini-Dxpedition to EL79 was comprised of five buzzards shown in Figure 1. Standing, from left to right are Bob Yates, Buzzard 1, Ed Ekkebus, Buzzard 3, Don Flynn, K3IMC, Buzzard 9, Lee Becham, KD4NTS, Buzzard 7, and kneeling is Skip Kazmarek, K4EAK, Buzzard 2B. We are known as the Band of Buzzards.

The Planning

Somewhere along the time of June, 2014,

there was serious talk of attempting to get a trip planned, and in July there were emails going between the group with suggestions of location and dates. It was eventually settled that we would make the trip during the June VHF contest and that EL79, a relatively rare grid square with most of it being the waters of the Gulf of Mexico [Figure 2], was a perfect place to go. We found a nice house in a community called Lanark Village, about 5 miles East of Carrabelle, Florida.

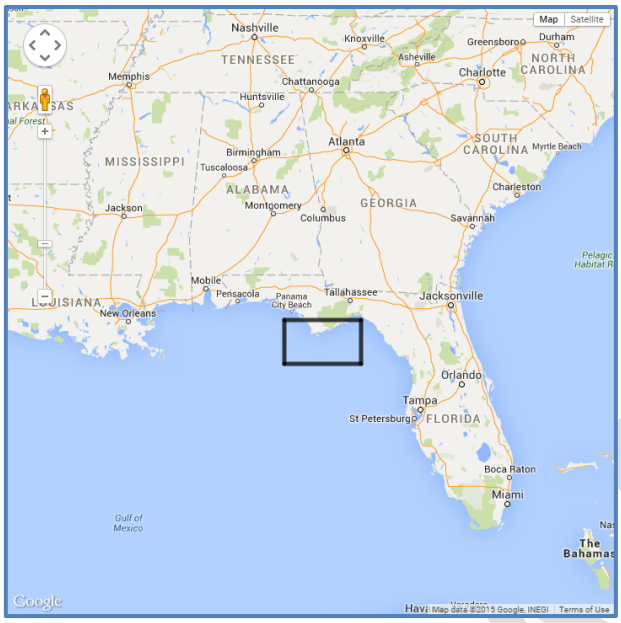

Figure 2 - EL79[2]

Not being content with simply making the trip for contest purposes, we also wanted to make it a special event station, complete with a 1x1 call sign, K4E. Now, we had the task of coming up with the reason for our special event station. After browsing through many web sites related to historical dates, I found an event that falls on the dates of our outing. The event is the landing of Marquis de Lafayette in South Carolina on June 13, 1777. This is significant for two reasons. First, he and the French were instrumental in winning the independence of the American Colonies from England, and second, LaGrange, Georgia was so named during Lafayette's journey through the area; he commented that the rolling hills reminded him of his own farm back in France. Thus, the location became known as "The Farm," but only in French – LaGrange.

Our original plan was to have at least one HF rig setup to communicate with the hams back home, and then set up rigs for 6M, 2M, and 70CM for contest operations. It wasn't until Don mentioned an article from CQ magazine[1] referencing EME that we started thinking about how to accomplish this. The article made us believe that making an EME contact was a possibility with the equipment we collectively had, but we all had doubts with our lacking experience in this realm. None of us were familiar with the digital mode of JT65, and none had ever tried bouncing an RF signal off the moon before, so the whole idea was completely foreign territory for the buzzards. We all had our individual topics to study and prepare in the following 10 months, and we had regularly scheduled meetings at a local BBQ restaurant to work out equipment details.

The Best Laid Plans

The idea of making EME contacts over the ocean is not new. Since none of us had an Az-El antenna rotor, our best chance of success was to take advantage of "ground gain" using the ocean's reflective surface[3]. Without making this very technical, the theory behind ground gain is that a Yagi antenna does not only spray RF energy horizontally with the boom of the antenna, but there are several other lobes at different take-off angles as well. Ground gain occurs when a lobe that is directed towards the ground is reflected upward again such that it converges with another lobe, giving an approximate 6dB of gain over a single lobe (if the RF signals are in phase). Without having an Az-El rotor, our antenna will be horizontal with the ground, which means that we will have to bounce signals off the moon while it is still relatively close to the horizon. This requires an unobstructed, relatively flat area, and the surface of the ocean will work quite nicely.

Don worked with Ray Rector, WA4NJP - Buzzard 32, an EME aficionado, to discuss antenna patterns and to come up with an optimum antenna height above the ocean's surface. There were many

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fascinating emails full of techno-babble explaining ground gain, elevation angles, and wave patterns that would rival any of Einstein's works on Relativity. Ray suggested an antenna height of "the higher, the better," while Don was convinced that "the lower, the better" approach was the way to go to maximize the range of time EME communications would be possible as the moon's elevation increased. In the end, it would be a decision of environmental issues at the site that would dictate the height of the antenna.

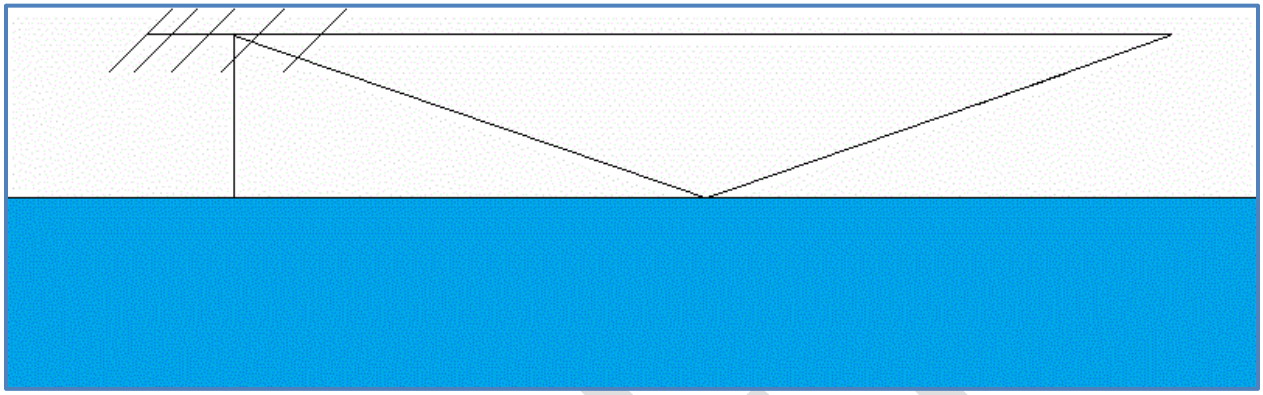

Figure 3 - Ground Gain Illustration

EL79

It is finally here! All the previous months' planning is now to be executed. On the morning of June 11, "Operation Buzzard Beak" commenced. The first wave, or *wake*, of buzzards departed LaGrange at 9:00am singing our Buzzard theme song "Carrion My Wayward Son," while I stayed behind to put in a full eight hours of work at the office before starting "Operation Tail Feather." The lead group arrived at the site at 2:00pm and made some initial antenna surveys. I had received a nice text message on my phone, complete with a grand view of the Gulf of Mexico under clear, blue skies, and an intense feeling of jealousy came over me while I was doing my best to dodge any new work from the boss – thanks guys!

Before I arrived at 9:00pm, the team had already made contacts on 6M and 40M, and the 2M station was operational. Don gave me the nickel tour of the grounds, and was concerned about the placement of the EME antenna on the dock. We chose the dock because it had a wide-open view of the East to give us clean shots to the moon as it came up over the horizon. Don's concerns were that the dock was almost completely covered with a roof and that there was a boat moored there in the direction that we needed to orient the antenna, blocking some of our view to the East. Therefore, Don's plan of keeping the antenna as low as possible was no longer a possibility. As a solution, we used four-foot surplus mast poles and strapped them to a dock post to elevate the antenna above the boat.

By now, it was apparent that sleep was not an option since we had solved our antenna crisis. Moonrise was at 3:43am, and the gang wanted to setup the equipment to attempt our first EME. We staged the radio, an Icom IC-7000, the amplifier and pre-amp, the laptop computer running the WSJT software, and the SignaLink USB interface inside the house and planned to take it to the dock when the time came. I had to make a last minute change to use the IC-7000, because it had a better sensitivity rating than the originally-planned Kenwood TS-2000. Luckily, I already had the module, and switching it in to the SignaLink USB was a piece of cake. We previously had inquired about the dock with the owners of the house to verify AC power was accessible. It was. This was a great relief to know that we did not have to lug a heavy battery down a 200-foot dock to provide power. Now we are off to bed to get a few minutes of sleep before our 3:43 date with the moon.

JT65

If you have never heard of the digital mode JT65[4], this will be a layman's description of it. I will admit that I am no expert using it, but with the help of Steve Mobley, WB4BXO – Buzzard 6, Ray Rector, and some others, I am at least dangerous enough to try it without hesitation. I did go through the tutorials that Joe Taylor provided with the software, but it was a lot to digest in a single sitting. Practice is the key to JT65.

JT65 is a very slow FSK protocol in which the maximum number of characters in a plain-text transmission is 13. Each transmission lasts about 48 seconds, then there are 12 seconds for decoding, the other station transmits for 48 seconds, and you get your 12 seconds for decoding. In order for this to work, your computers' clocks must be synchronized to within a few seconds of each other. A wide discrepancy in times will cause transmission overlaps which will make decoding impossible.

A Typical EME QSO consists of at least four transmissions, with a fifth containing "73" being optional. Here is how a standard EME QSO would be if the two stations had scheduled a QSO on the air. For this example, I will use K4E as my call sign and WB4BXO as the other station, and I will transmit first:

WB4BXO K4E EL79	(This is his call sign, my call sign, and my grid square.)
K4E WB4BXO EM73 000	(This is my call sign, his call sign, his grid square, and an ACK of my Tx.)
RO	(An ACK for receiving the 'OOO' report.)
RRR	(ACK for receiving the 'RO' – Technically, the QSO is over at this point.)
73	(Optional 73)

As you can see from this example, it takes a minimum of four minutes to complete a QSO, with the typical QSO lasting five minutes.

One final and very important note is determining which minute each of you are transmitting and receiving. I failed to take note of Mr. Codianni's advice in his article and was transmitting "off-sequence." There are two methods used when determining which sequence to transmit. If you have already worked out a schedule for making a contact, then chances are you will make the decision of who is transmitting first (on the even minutes) at this time. Otherwise, the typical method is that the Eastern-most stations transmit on the first sequence, and the Western-most stations transmit on the second sequence. How do you know? Well, if you're doing EME with no Az-El rotor at moonrise, then chances are you will be the Western-most station, as in our case.

Point it Towards That Big White Thing

We were up at 3:00am. Skip brewed the coffee, and Don, Ed, and I carried the radios, amplifier, computer, and chairs out to the dock. Bob had told us that if we didn't see him, do not wake him up. The ocean was calm with a high tide, and the smell of sulfur was ever so present. The wind was negligible, allowing a heavy influx of flying insects to add to the experience. Within a few minutes, we had everything connected and operational. Don was using a compass to get the azimuth reading of about 80°, because we were fearful of our ability to see the waning moon so close to the horizon. As luck would have it, he was getting some magnetic interference, because locking in on 80° was becoming a challenge. I offered to make the attempt, and he was correct - there was obviously something magnetically interfering with the compass, because 80° seemed to be way off in the wrong direction of what it was supposed to be. After a few minutes of all of us diligently taking turns with the compass, I looked up and finally said "Hey Don, just point it towards that big white thing." Ten months of research

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and technical discussions, and it all was overtaken by the elementary task of lining up the antenna with a conspicuous moon hanging low on the horizon.

We started sending out CQs every other minute and waited for responses. Finally, at 4:13am, the WSJT software decoded a signal and put it on the screen. It was "K4E ES6RQ KO28," a station in Estonia!

Figure 4 - Lee at the computer. Don finding 80°

The excitement grew as we sent our reply to ES6RQ. We waited for the WSJT decoding and… nothing! We tried a few more times, but apparently we lost him as the first lobe was now becoming a null at the moon's current elevation of about 6°. But this made us full of hope! We had actually *received* a signal that had bounced off the moon, and that alone was exciting!

By this time, Ed was receiving text messages and phone calls from Bob, who was still in bed two hundred feet away in the house. Ray, who lives in Gillsville, Ga, had called Bob to give us some tips and to tell us that stations are hearing us off of the moon. Ray was monitoring the online chat rooms devoted to EME. Meanwhile, Bob never made it out to the dock that night, but he was still a part of our team. We knew he was supporting us and had our backs, even while he was in bed on his back.

The second lobe would peak when the moon's elevation was around 15° according to Don's prediction, which would be about 30 minutes later. Don feverishly kept the antenna pointed at the moon, and it paid off. At 4:49am, WSJT again displayed a message. It was another station calling us! This time it was Franco in Italy. "K4E I2FAK JN45" was the decoded message. He had a decently strong signal at -23dB. We responded with "I2FAK K4E EL79 OOO." You cannot possibly imagine how long 48 seconds can be – the time it takes to send. It was excruciating. The world had stopped spinning, time was standing still, and the sulfur smell of the ocean and the nagging flying insects are practically non-existent. Even the crickets seemed to have stopped chirping! The only sound was the collective cadence of all of our beating hearts. "Hurry up!" we are all thinking to ourselves. But this was only *our* transmission; we still had to wait 48 more second for *his* transmission to see if he heard us! After what

Figure 5 - WSJT Screenshot of QSO with I2FAK

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seemed like 37 days of waiting, WSJT finally presented us with the most glorious two letters possible: "RO." I can almost promise you that if it were not for the celebratory shouting, hollering, and the jumping up and down giving each other high fives, off in the distance you would have heard the musical fanfare from Rocky IV when Rocky defeated Ivan Drago. We were victorious! The buzzards have landed on the moon!

The Disbelief

We have just communicated with another station by sending RF signals approximately 500,000 miles round-trip with the moon. How do we put this in perspective so that one can understand its significance? Consider throwing a handful of BBs at a suspended tennis ball at 20 feet. Only a few will make contact with the tennis ball, and only a few of those might bounce back to make contact with you. The remaining BBs will continue on, unobstructed.

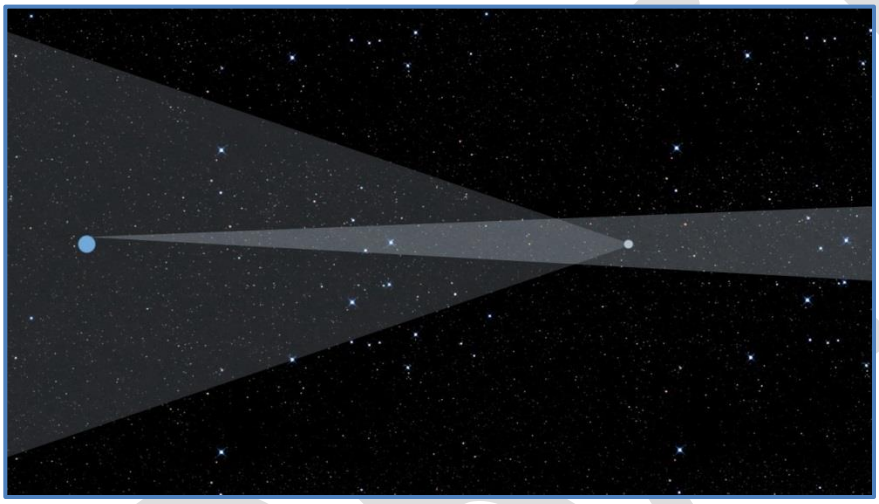

Figure 6 - RF Path To and From the Moon

Figure 6 is a better illustration of what actually happens to RF during our EME contacts. The RF is originated on the Earth with a horizontal path towards the horizon containing the moon. A typical beam antenna has a beam-width of about 20°. By the time the RF reaches the moon, it is spread out much wider than the diameter of the moon, so not all of it actually bounces off the moon, and only a small portion that does actually make the return trip back to Earth. It is also interesting to note that in relative terms, the RF that makes it back to Earth is not that far from the originating position, but the amount of travel to reach that point is tremendous.

We brought the equipment back to the house, and as much as it was possible, we all tried to go back to sleep until a more pleasant hour arrived. Ed cooked us an excellent breakfast at 10:00, and as we all ate in the breakfast nook, we sat in awe looking at "the little antenna that could" that was still standing so proudly at the end of the dock. How is it possible that we could bounce a signal off the moon with the equipment we had? We all determined that it was indeed impossible.

This feeling was reinforced when we received an email from Franco, I2FAK, the next day indicating that his equipment is "32 antennas 16 x 19 Log, Loop, Yagi in H plane plus 16 x 6el Yagi in V plane with adaptive polarization in RX ." He indicated that he was using 1.5KW. One comment in his email really showed how good we were doing on our first EME attempt: "I was surprised to see your signal at -17dB!!! Really did you run with 150w only?" Honestly, the answer is "no." We did not have a slug for the Watt meter that measured more than 100 Watts, so we could have only been outputting 120 Watts for all we know. Figure 7 is an image showing his antenna(s) (left) versus ours.

Our Equipment

Figure 7 - I2FAK vs K4E

As I have alluded to before, what makes this all very impressive is the equipment we used. I had my IC-7000 with the SignaLink USB, and Bob provided a Mirage 150 Watt amplifier with a built-in preamp. Rob Momon, Buzzard 2, graciously loaned us an 11-Element Cushcraft antenna tuned for the FM portion of the 2M band, and Ed provided a standard 25-ft run of LMR 400 low-loss coax. This is all basic equipment with nothing specifically geared towards EME. We were told by some not to even try EME unless we had a 1.5KW amplifier. However, nobody wanted to spend that kind of money, so we settled on trying to do "QRP EME." Joe Taylor once said in an article that making an EME contact was the Mount Everest of amateur radio. I guess this means that we climbed Mount Everest wearing a T-shirt and flip-flops!

The Conclusion

We went on to make four more EME contacts before we came home; each was just as exciting as the first. Bob even made it out to the dock on the second night to help. The remaining contacts were with RK3FG in Russia, OZ1LPR in Denmark, I2FAK again, and we finally made contact with ES6RQ in Estonia, who was our first EME signal received during our first attempt. The buzzards would like to personally thank all of these operators for being so patient with us, and we would also like to apologize to those who tried and could not connect. As I write this, we are planning a second trip for next year.

Our goal was to make just a single EME contact during the mini-Dxpedition. We exceeded this goal, and all of our expectations. I can only hope that the stations we contacted are as happy as we are, as for the Band of Buzzards, it is a trip that will bond us together forever!

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References

1. "EME on the Beach." Cody J Codianni. June, 2014. CQ Magazine.
2. Grid Square Map. http://www.levinecentral.com/ham/grid_square.php
3. Ground Gain Discussion. http://www.qsl.net/oz1rh/gndgain/gnd_gain_eme_2002.htm
4. "The JT65 Communications Protocol." Joe Taylor - 2005. http://www.arrl.org/files/file/18JT65.pdf

Photo Credits

1. Figure 1: Don Flynn
2. Figure 4: Skip Kazmarek
3. Figure 5: Ed Ekkebus
4. Figure 6: Created by Skip Kazmarek
5. Figure 7: Franco Giorgi and Lee Becham

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