Mods, Nulls and Turnstiles

(The view of satellite imaging from a beginner)

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My journey into the world of home weather-satellite imaging began last summer following a partial solar eclipse. I was surfing around the Internet in search of pictures of the eclipse, because I hadn't been able to see it myself (Seattle clouds hid the sun as usual). I came across the web-site of a nearby amateur astronomer who had some images of the eclipse. What caught my attention was the image taken from one of the NOAA weather satellites. "Oh, that's nice, a satellite image," I thought. I then noticed there was a link to a page that showed how he received the image *himself* with a fairly simple setup. Forget the eclipse pictures, this looks more fun! Seeing that he was just using a computer with some free software from the Internet, a small antenna, and a radio, I said to myself. "Hey, I can do something like this", and proceeded to explore the Internet for more on the topic. (I found that a simple police-band scanner could be modified to do this fairly easily)

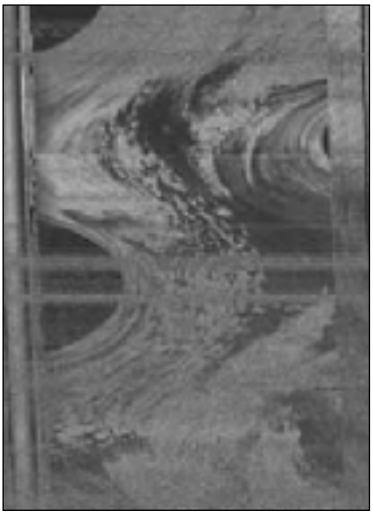
Not long ago, I bought my first home – a condominium – and have kind of been interested in getting back into the ham radio hobby that I was deeply into while I was still living with my parents. I guess the sunspot cycle has caused my interest to flare (pun intended!) again. Unfortunately, being in a condo, there are antenna restrictions, since the neighbors and management don't seem to think a dipole strung across the roof is as pretty as I may think it is. I even had a neighbor complain about the color of my curtains once! My experiments transmitting from a "slinky" dipole antenna located in the upstairs hallway failed miserably, and all I seemed to do was make all my speakers squeal when I keyed the transmitter. What would the curtain-hating neighbor be seeing on TV when I was doing that? Yikes! That thought frightened me.

I followed a few links and did a few searches, and came up with terms such as, APT, 2-line Keps, QFH antennas, turnstiles, pre-amps, Resurs, NOAA, and Meteors. After learning the language of satellite talk, I started asking around about this hobby on the *rec.radio.amateur.space* Usenet group on the Internet. I think I may have irritated a few people by asking so many questions and not even trying out anything with my radio. Finally, I dug out my old Radio

Shack Pro-38 handheld scanner, attached a 5/8 wave, 2-meter whip antenna to it, and took a listen. Since I didn't have any tracking software I connected to the J-Pass web site to find when one of these "NOAA" things was going to pass over my house. Right on time I heard a scratchy sounding "chirp, chirp, chirp" sound, and realized that I was listening to a spacecraft in orbit as it was passing overhead! Fantastic! I needed to build an antenna to clear up this signal and see what I could get.

This isn't my first time experimenting with orbiting spacecraft. Years ago, I tried to contact the cosmonauts on board the Mir space station (on 2 meters) when it passed overhead. I did hear U2MIR calling, but of course he didn't hear me. (My friend in Seattle chatted with him on his Icom 02AT with a rubber duck antenna from his back yard – I was envious of his contact!).

Back to the Internet, the newsgroups, and web sites in search of a cheap antenna that is easy to build. I finally decided on constructing a turnstile antenna out of cheap PVC water pipe, some coax, and TV twin lead antenna cable. All together the parts cost me about $30. I spend an evening constructing the device and set it up inside my patio area, being careful that it didn't extend above the 6-foot fence (I didn't want that curtain-complaining neighbor to know what I was doing!). I did break the rules a little bit by tossing a coax feed-line outside my upstairs window and running it neatly down the wall to connect it to the antenna.

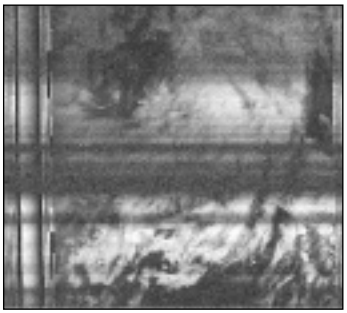


The first image (Meteor 3-05)

Okay. Now I just need a satellite to receive. I hooked up my little scanner to my computer line-in port for the sound card only later discovering that you should split the two stereo channels and only use the left channel input for Wxsat. I started out with a Micron laptop that I borrowed from work – which worked very well for this I may add. Finally a satellite came over - it happened to be the Russian Meteor 3-5. I was able to record the full pass, processed it using the WxSat software, and got some very skewed image. I couldn't make anything out, but I could see that there really was something in there!

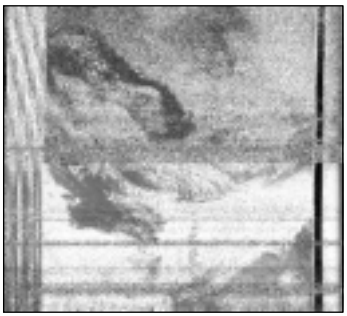
After some more postings on *rec.radio.amateur.space* I was told to fiddle around with the *fs Correction* setting until the image was in sync. Finally after a lot of adjusting, I had my first image. I can see that it is the Earth with clouds, but I always thought Columbus proved the Earth to be round? I posted the image up on the web page and asked for comments. I found out that I had done everything correctly, and it was just a problem with the satellite itself! So I figured I could call this a success after all. (This image was obtained at a time when Meteor 3-05 had lost sync. – Ed.)

Ok, the image is pretty gray, and the bright clouds have static where they should show up a bright white color. Time to make the mod. to the scanner to widen the bandwidth and get the full picture. Again, more questions on the newsgroups till I learned that a simple replacement of the IF filter with a .01uF capacitor should do the trick. So I heated up my soldering iron, removed a .01 capacitor from one of my old projects that never got working properly, and set to work. I was relieved to find that my work didn't kill the radio since it still made sounds when I was done. I put the antenna back and waited for a satellite to pass again.



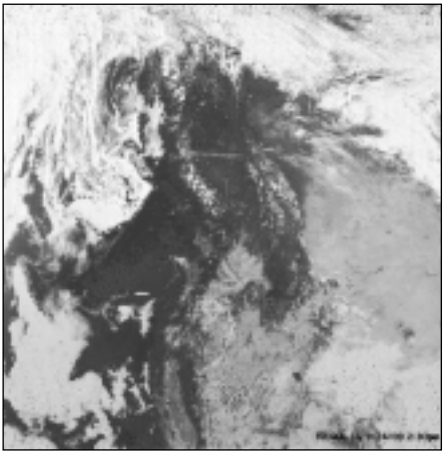
Success! I obtained an image that looked much better than with the previously unmodified scanner. I now had clouds showing up as white, just as they should (of course I had to adjust the scanner volume correctly too – another long story). Contrast in the image was improved, but nulls, a characteristic of my turnstile antenna, were still showing up across the image.

I played around with this for a few weeks, trying out different locations for the antenna, and different software and volume settings. I then went to a nearby hamfest and picked up a Radio Shack Pro-2038 scanner that was in new condition for $55. I read on a web page that the IF filter in some of the Radio Shack scanners can be modified simply by bypassing it with a capacitor. I rigged up a socket so that I could easily swap capacitors. I would wait for a satellite pass, and quickly swap all kinds of capacitors in the 10 minutes or so during which the satellite was audible. This method didn't work well at all, so I removed the IF filter completely, and soldered the capacitor in place across the input/output pins for the filter. The next satellite pass showed some improvements.



Of course my satisfaction was short lived when I started thinking about improving things even more by ordering a pre-amp for my antenna. Although running only 25 to 30 feet of RG-58 coax, I figured a little boost in the signal couldn't hurt anything. I ordered the pre-amp from Hamtronics, and about a week later a small box showed up at my door. I spent the evening trying to power it up before the final NOAA satellite pass of the day came over. I was nearing the point of frustration when I discovered that the power supply I was using was worn out, and couldn't handle a load of any kind. I quickly swapped the supply with another one that I had lying around (don't all ham operators have a closet full of these things?) and got it powered up halfway through the NOAA pass. I was able to copy a somewhat sharp image of the sunset clouds over the Pacific. Once again I was very excited about my latest results, and couldn't wait to see what I would get the next day. I started to obtain some much larger images now that I had "lowered" my horizons due to the stronger signals. I worked on this arrangement for a while and tried to record some images from different times of the day including late at night using the IR signals from the NOAA satellites.

I had been reading about the QFH antennas on the Internet, and decided that would be the next step to try, since they were supposed to eliminate the problems with the nulls. I checked out my attic and found that at the peak of the roof, I had about 30 inches of vertical clearance. This will work! There is a design for a QFH that is 550mm tall (which is somewhere around 20 inches for us non-metric Americans!). I found a design that used coax for the elements (I still had a roll of about 75 feet of RG-58 left) and figured this would be the best one to try. I built the support for the elements out of a chunk of wooden broom handle and drilled holes through it to slide a smaller dowel through for the crossed elements. I was a little concerned when I found that the co-ax loops weren't quite the right size when attaching them to the wooden frame. The smaller loop came out to be just a little too short and the longer loop was too long. I added some extensions to the short cable and connected everything up and gave it a try (with the pre-amp in the circuit). Success again! Another improved image, this time with no nulls, just some diagonal lines from the nearby power lines. I was now able to see most of the western half of the United States in a single image, from Baja almost to Alaska!

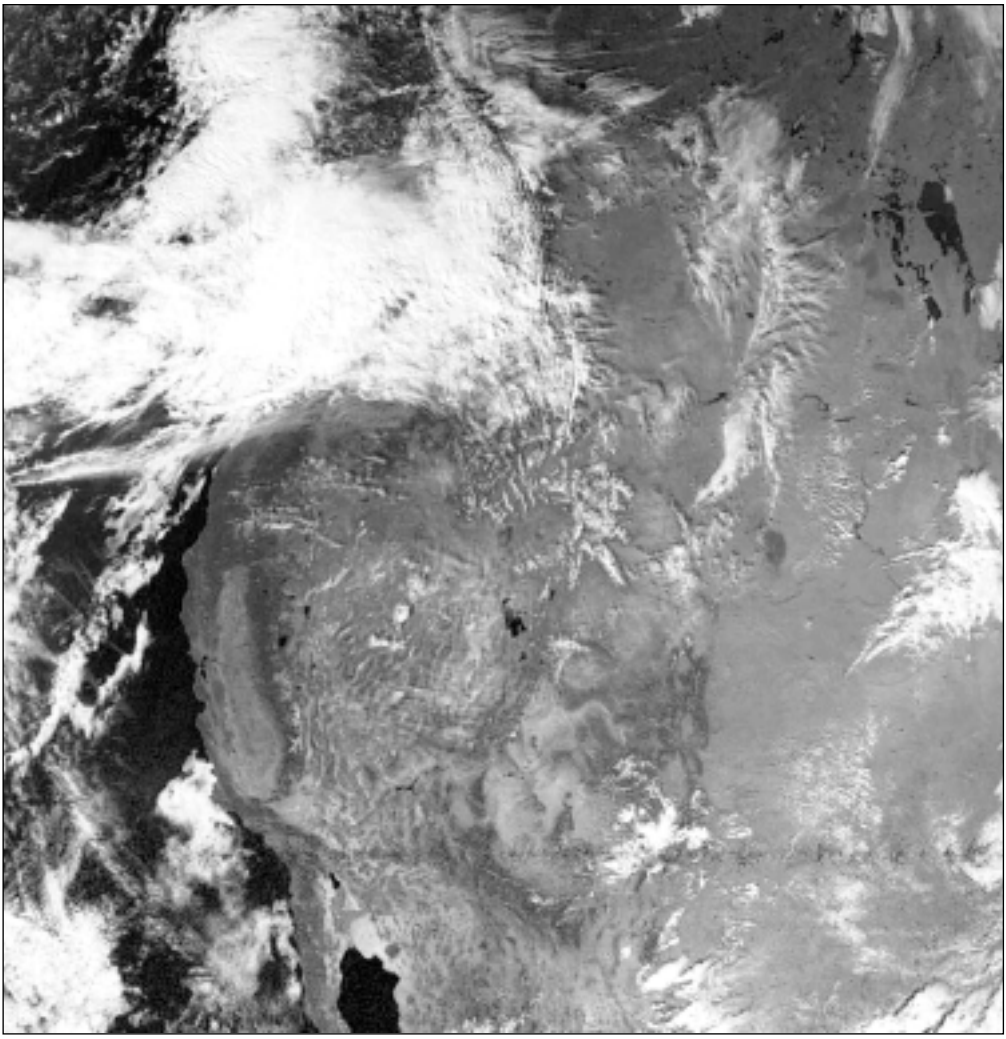


I ran into more problems powering my pre-amp with a single wire which ran alongside the feed-line for the B+ voltage. I was using the co-ax itself for a ground, and when I moved it around, I would hear all kinds of strange noises that distorted the images. Again, after consulting with the friendly group on the Internet, I found that I should have used a twisted pair to power the pre-amp, since it shields itself better than a single wire. I then used some spare Cat-5 Ethernet cable that I found at work (yes, it was just unused cable - I didn't steal it!) to run the power to the amp. That helped the situation a lot. I figured maybe if I put a ground wire on the pre-amp, that might also get rid of some of the noise. I grounded the amp to a metal vent-pipe that goes up through the roof, but didn't have good results with that. At that point I had the radio grounded through the power supply, with a second ground at the pre-amp. If figured that two different grounds was probably a bad thing, so I removed the pre-amp ground.

Up till this point, most of my images had been processed using the WxSat 2.59 software. I had also tried David Taylor's SatSignal program but found that although all the Resurs pictures processed without problems, only about 10% of the NOAA passes worked out. I sent out more email questions, and found that the SatSignal problems most likely resulted from bandwidth problems in my modified scanner. For tracking, I like to use SatScape to find out the best passes from the satellites, and then record the .WAV files on to my computer using Satmon.

I had been having so much fun with this, that I thought I might as well upgrade my radio onece more. I was thinking of building the Hamtronics radio kit, but was kind of nervous about that since it seemed that a signal generator and frequency counter were needed. I enjoy building kits, but was afraid of creating a $139 door-stop! I ordered the pre-built and tested Hamtronics radio, which is so sensitive that I no longer needed the pre-amp in the circuit (it would just amplify the powerline noise along with the satellite signals). I pulled out the pre-amp and eagerly waited for a satellite to pass over. After a short wait, I recorded a signal that sounded clearer than anything that I had heard before. SatSignal was able to process the image in full color, and I ended up with my first color composite NOAA-16 image. Nice! Full color without tweaking or messing around with the images using Photoshop. Now this was exciting!

I played around with these images for a few weeks, processing everything I could, including overnight IR images from the NOAA's which worked out really well. Recently, I figured out how to add the country/state overlays to the images to make it easier to figure out whether Arizona or New Mexico was getting that nasty storm that's showing up. Another thing I have been playing with is taking images from 2 orbits and creating kind of a mosaic by splicing them together to form a much larger image covering a greater area.



The ultimate image - NOAA 16 at 20:52 UT on October 16, 2000

My current station now consists of the following

- Hamtronics R139 Receiver
- 233 MHz / 128 Mb RAM computer for recording the images
- Homemade QFH antenna in the attic (with no pre-amp)
- SatSignal, SatMon, and SatScape software for tracking and processing

When I am not home I leave the radio scanning. When it picks up a signal, it locks on to the frequency and the computer starts recording automatically at the correct time to save the satellite signals on the hard drive for later processing. I usually come home in the evening to find about 10 to 15 WAV files from various satellites awaiting processing. I find that I can usually tell if the image is going to be good by looking at the file size; the best ones are usually about 19 Mb long.

Sure, you can find images very similar to these on many weather web pages on the Internet, see them on TV or look at the really blurry ones on the back page of the newspaper. But there is something much more exciting about processing these images yourself. If you have an interest in weather, radios, and computers this might be a good hobby for you to try out.

Tom Gwilym (KA7VIK) lives in Bellevue, Washington State with his two rabbits and cat. He has been tinkering with ham radio projects since first licensed in 1986. He works as a computer technician for a company in Seattle. After work his hobbies include flying, computers, playing computer games, watching DVD's and collecting astronaut autographs.