CONTINUING THE KF6XA/W3NRG PROPNET EXPERIMENT
NON RECIPROCAL BEACON CAPTURE

by Ed Sack, W3NRG

In June 2002, we reported an unusual propagation phenomenon observed in the process of participation in the Beaconet/Propnet* program on 10 meters. In an article published in QST[1], we documented fairly consistent reception of KF6XA's beacon signals at W3NRG even though the distance and the terrain between the two stations would not lead one to expect regular communications on that frequency. KF6XA is located at Murrieta, CA and W3NRG is located at Coronado, CA. The stations are on an almost exact north-south line, 63 miles apart, with several high peaks along the path.

In September 2003, we noted that a phenomenon similar to what we were witnessing had been reported in a World War II study of propagation along a similar path.[2,3] The authors of that study hypothesized that a sharp demarcation between cold and moist air at lower levels over San Diego and very dry warm air at higher levels was responsible for the unusual propagation conditions that were being observed.

In a paper published in the Proceedings of the 2003 ARRL/TAPR Communications Conference[4], we provided monthly profiles on the reception of the KF6XA beacon at W3NRG for the period of May 2002 through April 2003. Some interesting changes in the reception profile month to month were noted. Figure 1 shows the monthly profiles reported in that article for reference.

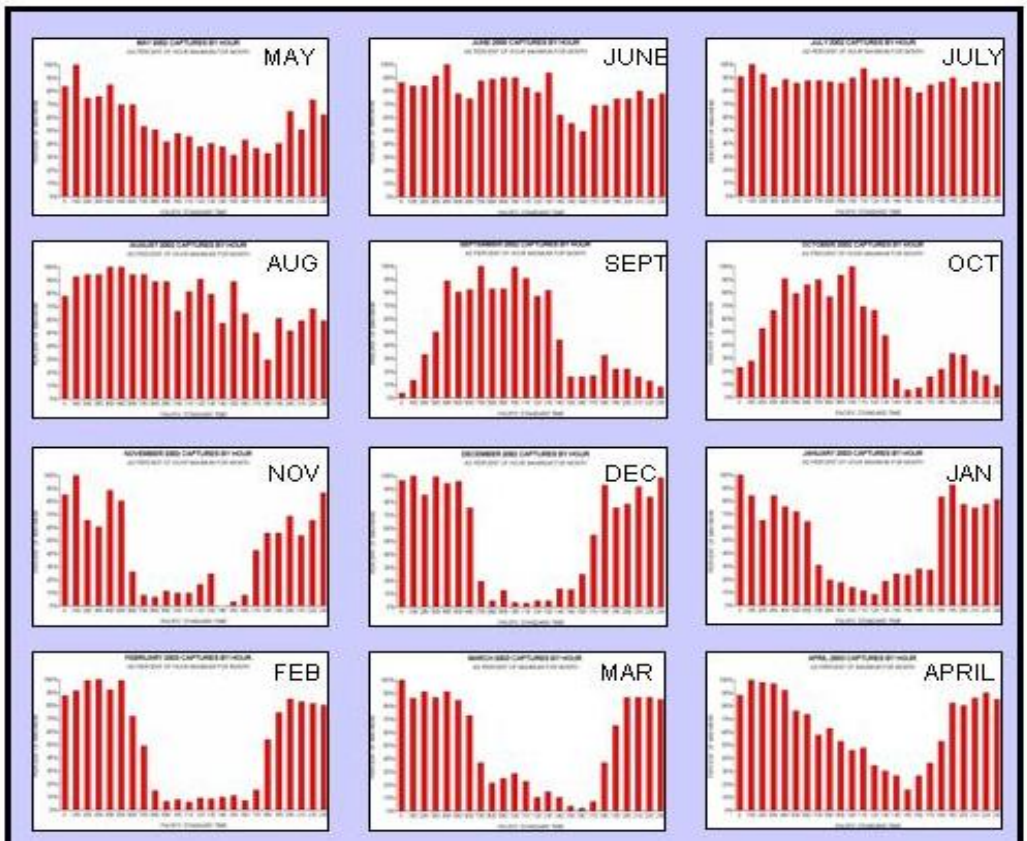

Figure 1. BEACONet Signal Captures by Hour as Percent of Hour Maximum for Month for Period May 2002 through April 2003

As an aside, the World War II study referenced above reported also seeing the phenomenon we are witnessing at frequencies much higher than 30 MHz. However, attempts by KF6XA and W3NRG to repeat their 10 meter results at 6 meters have not been met with success to date.

We have continued to collect the monthly data. The profiles for the period of May 2003 through April 2004 are shown in Figure 2. Comparison of the Figures 1 and 2 indicates months in which the profiles are quite similar, as well as months in which they are significantly different. In particular, the shape of the profile for the first four months of 2004 appears to be approximately the same as was recorded in 2003. (Insufficient data was collected in November 2003 to provide a good profile due to extensive travel on the part of one of the participants.)

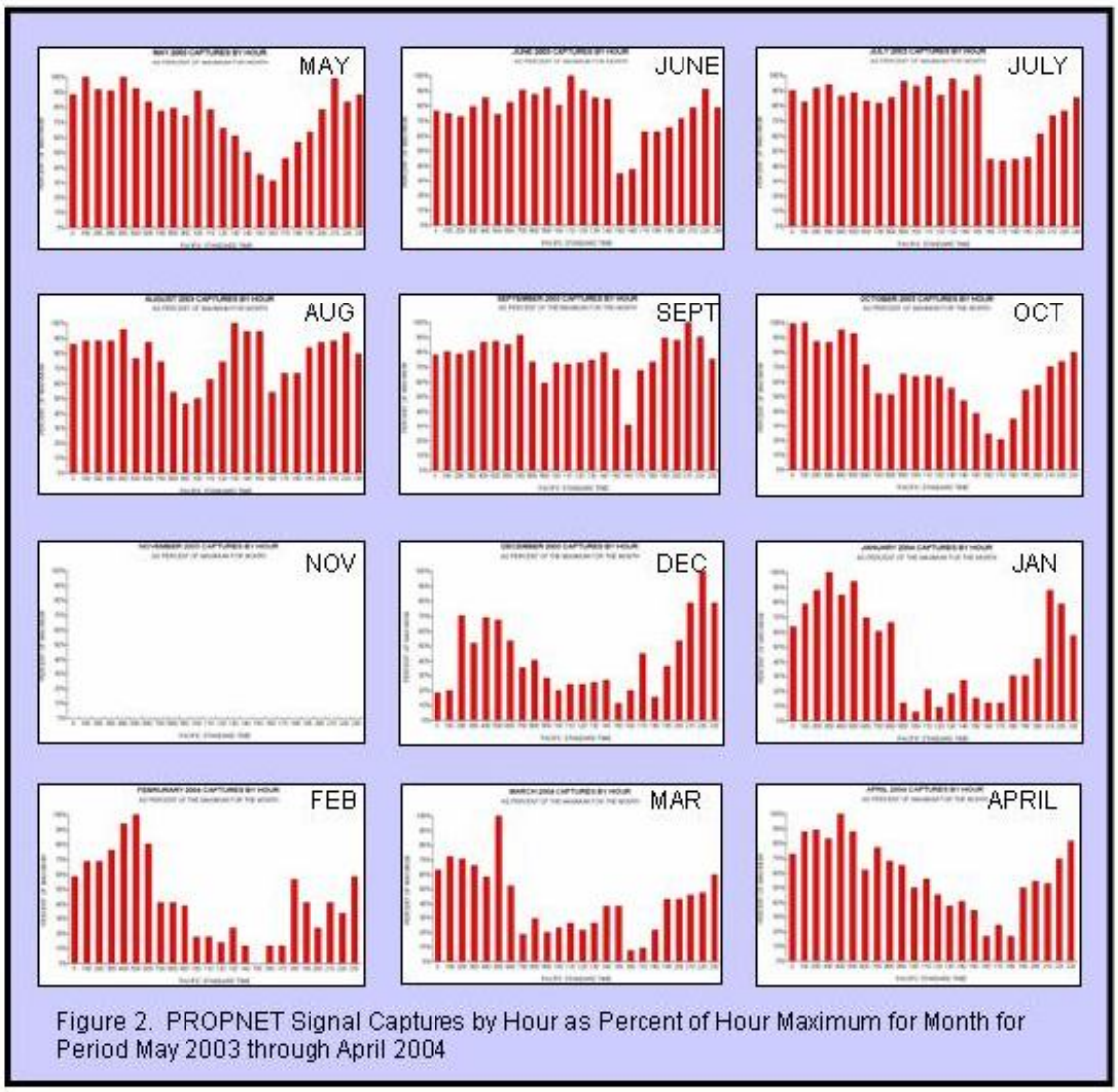

Figure 2. PROPNET Signal Captures by Hour as Percent of Hour Maximum for Month for Period May 2003 through April 2004

Prior to the first quarter of 2004, we had not kept comprehensive records on the reverse path, from W3NRG to KF6XA. MS-PSK, a new program made available by Jeff Steinkamp, N7YG[5], provided a convenient way of recording a daily comparison of W3NRG's Propnet signals at KF6XA versus KF6XA's reception of W3NRG's Propnet beacon. We have been recording the reciprocal data since early April 2004. This data continues to be posted on the Internet in the daily Propnet Catch Reports.[6]

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Comparative Propnet CRC Captures for KF6XA>W3NRG and W3NRG>KF6XA JUNE 2004
| Catches per UTC hour |
Call     Grid    Azm   Dist First                                Last  Config
          SQ           (KM) Heard 012345678901234567890123 Heard PHGVRA
-------------------------------------------------------------------------------
06-15-04
KF6XA    DH13J0     0    101 01:58  131 1   131  2   21 11  18:09 HY-PHG540087
W3NRG    DH12JQ   179   101 00:42 25 6711243634321l3       17:43 HY-PHG520182

06-13-04
KF6XA    DH13J0     0   101 12:48             11 1         15:56 HY-PHG540087
W3NRG    DH12JQ   179   101 07:33        256554444111l4  2 23:52 HY-PHG520182

06-12-04
KF6XA    DH13J0     0   101 20:02                     1  1 23:54 HY-PHG540087
W3NRG    DH12JQ   179   101 01:02  21     431  2651  21    20:07 HY-PHG520182

06-11-04
KF6XA    DH13J0     0   101 00:34 21  524542632441l1 11  4 23:59 HY-PHG540087
W3NRG    DH12JQ   179   101 04:24     2 1432463 2       14 23:39 HY-PHG520182

06-10-04
KF6XA    DH13J0     0   101 06:25       21  11  21 2     1 23:11 HY-PHG540087
W3NRG                                 none

06-09-04
KF6XA    DH13J0     0   101 02:22   2 12 224313 11         15:16 HY-PHG540087
W3NRG    DH12JQ   179   101 09:19          2               09:36 HY-PHG520182

06-08-04
KF6XA    DH13J0     0   101 08:33         143314266562153  22:29 HY-PHG540087
W3NRG    DH12JQ   179   101 08:24         134   11553      18:30 HY-PHG520182

06-07-04
KF6XA    DH13J0     0   101 04:58     14641   673275724112 23:47 HY-PHG540087
W3NRG    DH12JQ   179   101 04:44     2213   242  365 332  22:11 HY-PHG520182

06-06-04
KF6XA    DH13J0     0   101 00:28 442331225475334676l5   2 23:57 HY-PHG540087
W3NRG    DH12JQ   179   101 01:56   115433462453 14121     19:15 HY-PHG520182

06-05-04
KF6XA    DH13J0     0   101 00:00 2745536446376763l2  2342 23:20 HY-PHG540087
W3NRG    DH12JQ   179   101 00:14 464311 642643332 1   43  22:18 HY-PHG520182

06-04-04
KF6XA    DH13J0     0   101 00:03 3675141363377666133l2  1 23:15 HY-PHG540087
W3NRG    DH12JQ   179   101 00:32 1 5   1353374135312135l5 23:57 HY-PHG520182

06-02-04
KF6XA    DH13J0     0   101 00:00 6655557775763585745333l3 23:43 HY-PHG540087
W3NRG    DH12JQ   179   101 01:04  623525363311553514132l1 23:58 HY-PHG520182
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Figure 3. Data collected during the first half of June 2004.

Examination of the reports collected to date shows considerable non-reciprocal behavior in the capture times and rates around the clock and day to day. Figure 3 shows the data collected during the first half of the month of June 2004, as example. (Data is missing for a couple of days in the period due to

W3NRG's computer failing to make its 2359 UTC handshake with the Propnet Catches site at Yahoo Groups.) Figure 4 adds the data collected during the last half of June.

As an explanation to Figures 3 and 4, for each day noted, the first line shows the CRC (cyclical

Comparative Propnet CRC Captures for KF6XA>W3NRG and W3NRG>KF6XA JUNE 2004

| Catches per UTC hour |

Call	Grid SQ	Asm	Dist (KM)	First Heard	012345678901234567890123	Last Heard	Config PHGVRA
06-30-04							
KF6XA	DH13J0	0	101	09:23	1 6366444 11	20:09	HY-PHG540087
W3NRG	DH12JQ	179	101	13:57	1111 1	20:05	HY-PHG520182
06-29-04							
KF6XA	DH13J0	0	101	03:57	1 3 53 1	22:36	HY-PHG540087
W3NRG	DH12JQ	179	101	17:57	11	18:05	HY-PHG520182
06-28-04							
KF6XA	DH13J0	0	101	12:25	13 3232	18:41	HY-PHG540087
W3NRG	DH12JQ	179	101	15:19	121 1	19:38	HY-PHG520182
06-27-04							
KF6XA	DH13J0	0	101	14:52	111 21 1	22:01	HY-PHG540087
W3NRG	DH12JQ	179	101	03:22	2 11 11 22 1	20:22	HY-PHG520182
06-26-04							
KF6XA	DH13J0	0	101	01:32	21124724654737333 34	19:41	HY-PHG540087
W3NRG	DH12JQ	179	101	03:17	1131 2141 111 1 1	22:38	HY-PHG520182
06-25-04							
KF6XA	DH13J0	0	101	08:44	234522267	16:46	HY-PHG540087
W3NRG	DH12JQ	179	101	08:24	1 141 1	16:23	HY-PHG520182
06-24-04							
KF6XA	DH13J0	0	101	09:34	26541	13:49	HY-PHG540087
W3NRG	DH12JQ	179	101	01:01	1 1 21 221	19:50	HY-PHG520182
06-23-04							
KF6XA	DH13J0	0	101	09:31	31421 331	20:40	HY-PHG540087
W3NRG					none		
06-21-04							
KF6XA	DH13J0	0	101	06:39	35547532311	16:55	HY-PHG540087
W3NRG	DH12JQ	179	101	07:47	12 11 61	14:54	HY-PHG520182
06-20-04							
KF6XA	DH13J0	0	101	00:35	32353363 21142	13:29	HY-PHG540087
W3NRG	DH12JQ	179	101	07:15	1 1 1 1	23:08	HY-PHG520182
06-19-04							
KF6XA	DH13J0	0	101	06:17	347677733213 4 5	23:50	HY-PHG540087
W3NRG	DH12JQ	179	101	07:06	1 11 13 1	19:06	HY-PHG520182
06-17-04							
KF6XA					no report		
W3NRG	DH12JQ	179	101	07:39	21 1241 1	17:07	HY-PHG520182

Figure 4. Data collected during the second half of June 2004.

redundancy check) captures of the KF6XA beacon at W3NRG and the second line shows the CRC captures of the W3NRG beacon at KF6XA. The columns "Grid SQ, Azm and Dist." are self explanatory. The next column is the UTC time when the beacon was first recorded and the next to last column is the time it was last recorded. The numbers under the designation "Catches per UTC hour" are the number of CRC confirmed captures from UTC hours 0000 to 2300. (UTC hour 7 is, of course, Pacific Standard time 2300.) Both stations are transmitting 8 times per hour.

The last column in this report is the Propnet PHG configuration for the station. The Propnet PHG code is similar but not identical to the APRS code and the explanation may be found on the Propnet web site and a related link.[7]

Immediately the question arises as to "why the differences?" Why don't the two stations show an approximately reciprocal profile in beacon captures over the propagation path?

First the similarities. Both stations are using the Radio Shack HTX-10 as the transceiver. Both stations are using the same decoding software, the MS-PSK program noted above. Both stations transmit 24/7 and at a rate of 8 beacons per hour. The two stations receive east coast Propnet beacon transmissions at about the same rate and in similar periods.

Of course, there are also significant differences between the two stations. W3NRG is using a 10 meter Ham Stick as its antenna and KF6XA is using an Antron A99. KF6XA is located "in the mountains" at approximately 1470 feet above sea level. W3NRG is located on the shore of the Pacific with an antenna approximately 40 feet above sea level. The antenna at W3NRG is radiating between the gaps in tall buildings that surround it to the east, south and northwest. The terrain around KF6XA is hilly, whereas the terrain around W3NRG is more or less flat. The elevation profile between the two stations as reported by the Delorme "Topo" program is shown in Figure 5.

Figure 5. Elevation profile between two stations, W3NRG and KF6XA

Anyone who has worked with PSK^31 signals knows that the decoding is very dependent upon the sound card used, the decoding software and the selection of those sound card parameters which the decoding software permits to be adjusted. The MS-PSK application has a number of variables available in the set up screens. The two stations are using the same sound card settings but there is no guarantee that the two different sound cards used handle these settings the same way.

The search range set for the detection and decoding software as well as the length of the preamble before the beacon "payload" can have an effect on the rate of good CRC captures. (Typical search ranges used by Propnet participants are 1500 cps +/- 150 cps to +/- 50 cps.) If there is non-PSK^31 interference within the search range and the preamble before the payload is too short, the software may be examining the non-PSK^31 signal before moving on through the search range and may miss the beginning of the beacon payload. This will result in a failure to report a CRC catch even though the reception was strong enough for a solid capture. To reduce this effect, we have found it best to make the search range as narrow as possible (but wide enough to assure seeing all beacons active in the Propnet program.) We also attempt to make the preamble long enough that the application has time to abandon any non-PSK^31 interference and lock on to the beacon signal before the payload begins. It would probably be worthwhile for the two stations to repeat their work on comparative capture rates with each station locked on the PSK^31 audio frequency of the other rather than operating in the search mode.

Local noise could be a factor. W3NRG sits within sight of high power radar and communications stations. There is a major highway about 200 feet from the antenna. KF6XA is about a mile or so from a commercial broadcasting installation. One can often hear a PSK^31 warble before the software is able to record a CRC capture. At least at W3NRG, watching the capture take place and listening to the warble does not appear to correlate strongly with interference heard or witnessed on the computer screen provided that the abovementioned cautions as to scan range and preamble length are observed..

As already noted, the two stations receive other Propnet stations with equal or similar success. Cross country propagation conditions on 10 meters have been very poor during the past several months but there is longer term evidence that the two stations receive stations to the east about equally well. Propnet stations W2EV, KD5LWU, WD4RBX, W3GYK, K4RKM, N7YG and K4EPS, among others, have all been recorded by both KF6XA and W3NRG and more often than not, when one station reports the receipt of the Propnet beacon signal, the other does as well.

We need to point out that the current Propnet requirement for a CRC confirmed capture places a rather stringent condition on capture success. The receiving program must get every byte of the payload correct as well as getting the CRC signature correct before a confirmed capture is logged. Contrary to the protocol in certain packet communications, there is no provision for a re-transmit if the receiver does not get a near perfect replica of the beacon payload.

Anyone who has watched PSK^31 QSO's on 14.070 MH can attest to the fact that successful contacts are logged every day even when conditions are such that there are a significant number of byte errors in the QSO exchanges. Similarly, voice SSB voice QSO's can be termed "successful" when band conditions and interference result in the need for repeats of calls, names, locations, etc. Perhaps the following statement is a bit too strong but it is the impression of this writer that conditions that result

in, say 5 to 7 successful Propnet CRC captures per hour out of 8 beacon transmissions would result in very satisfactory ham communications during the period with either conventional voice SSB or PSK^31 QSO activity. This is probably an issue that is worthy of some quantitative evaluation.

In previous publications, we have disclaimed any expertise at analyzing propagation. We reinforce that admission here. Is it possible that there is a non-reciprocal effect in the refraction conditions that permit these two stations to communicate? Or is the difference in the terrain having an effect? Of course, differences in the sensitivity of the two stations to decoding of the PSK^31 signals cannot be ignored in spite of the evidence to date that they are similar with regard to the reception of other Propnet signals.

One might ask why the two stations do not exchange setups. That possibility is under consideration. However, it would be difficult to exchange antennas. Moreover, there is no way to reproduce the special topological and structural conditions that exist in the two locations.

There is a feature of the MS-PSK software which may also offer some clue as to what is going on. The software has a "Partials" setting in which Propnet signals that do not fulfill the complete CRC test are none-the-less recorded for analysis. We need to spend some time analyzing that data on days when the non-reciprocal captures are most evident.

This is clearly a "work in progress" and we look forward to ideas from those more skilled in propagation science as to how to best proceed.

*The name of this activity was recently changed from BEACONet to Propnet.

References

1. "Collecting Propagation Data on 10 Meters using BEACONet^31," by Ed Sack, W3NRG, QST June 2002, pages 37-39

2. "Radio Wave Propagation, Consolidated Summary Technical Report of the Committee on Propagation of the National Defense Research Committee," Charles R. Burrows, Chair. Academic Press Inc. 1949

3. "New Old Data on Beaconet^31," by Ed Sack, W3NRG, Technical Correspondence, QST September 2003, page 74.

4. "Southern California Coastal Propagation Phenomenon," by Ed Sack, W3NRG, Proceedings of the 22nd ARRL and TAPR Digital Communications Conference, pages 198-205.

5. see "http://home.earthlink.net/~n7yg/," Steinkamp Software Solutions, MSPSK 31/63

6. see "CATCHes@yahoogroups.com"

7. see "http://www.go.to/BEACONet," Propnet, and "http://www.apritch.myby.co.uk/phgracalc.htm"