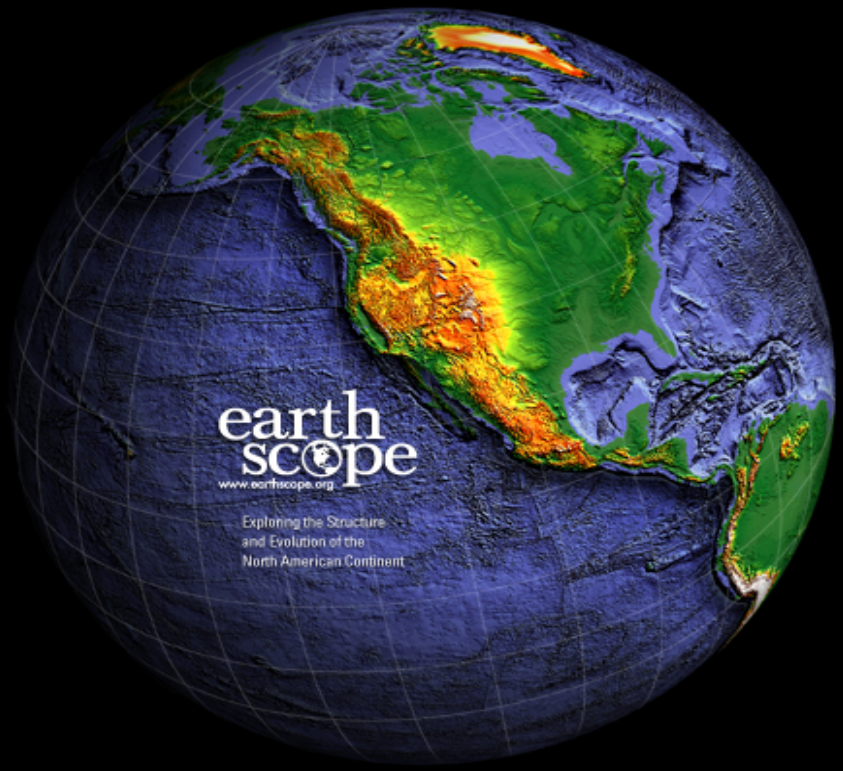
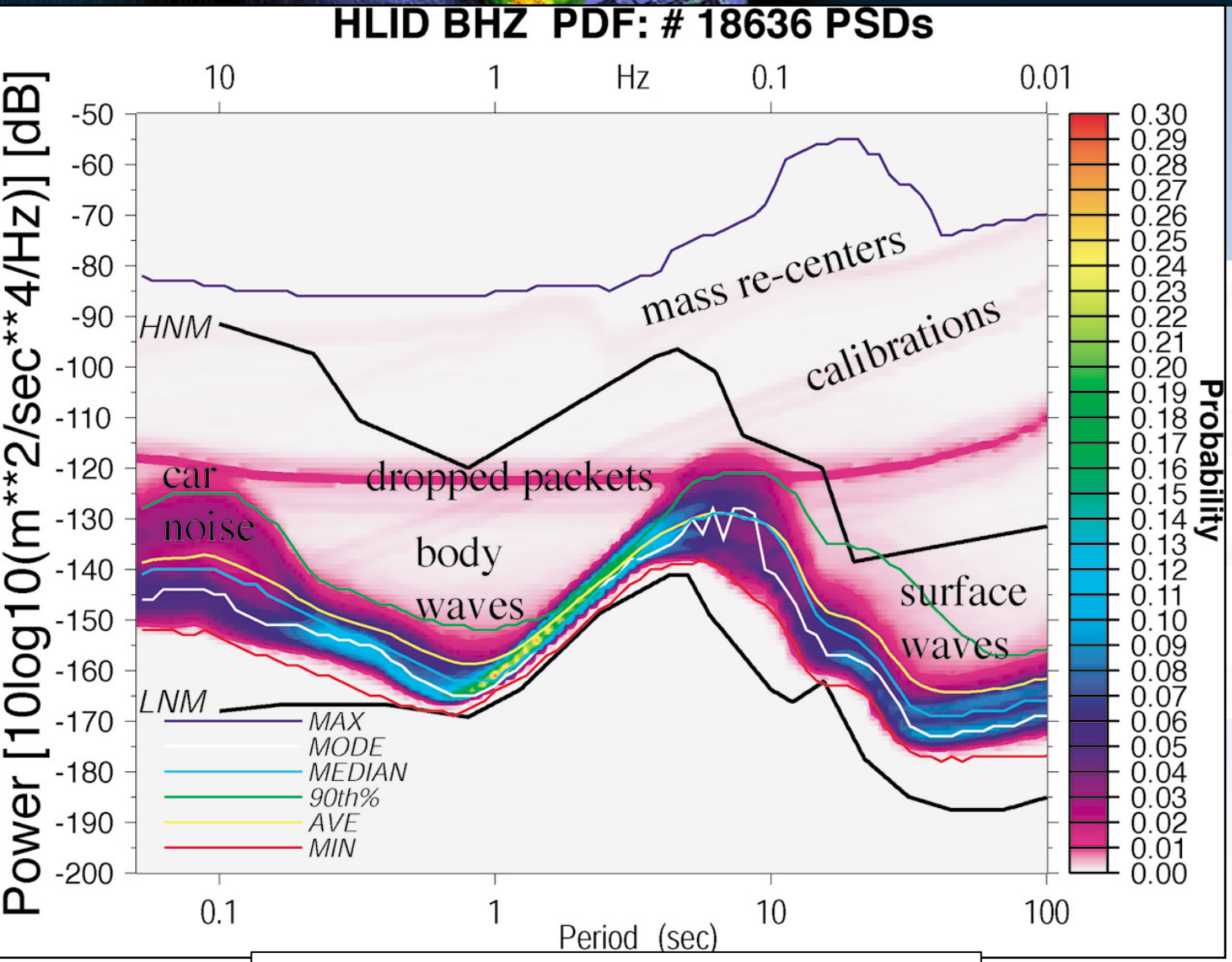
Evaluating Station Performance Using Seismic Noise Analysis from USArray and CSN



Andy Frassetto
Bob Busby
Frank Vernon

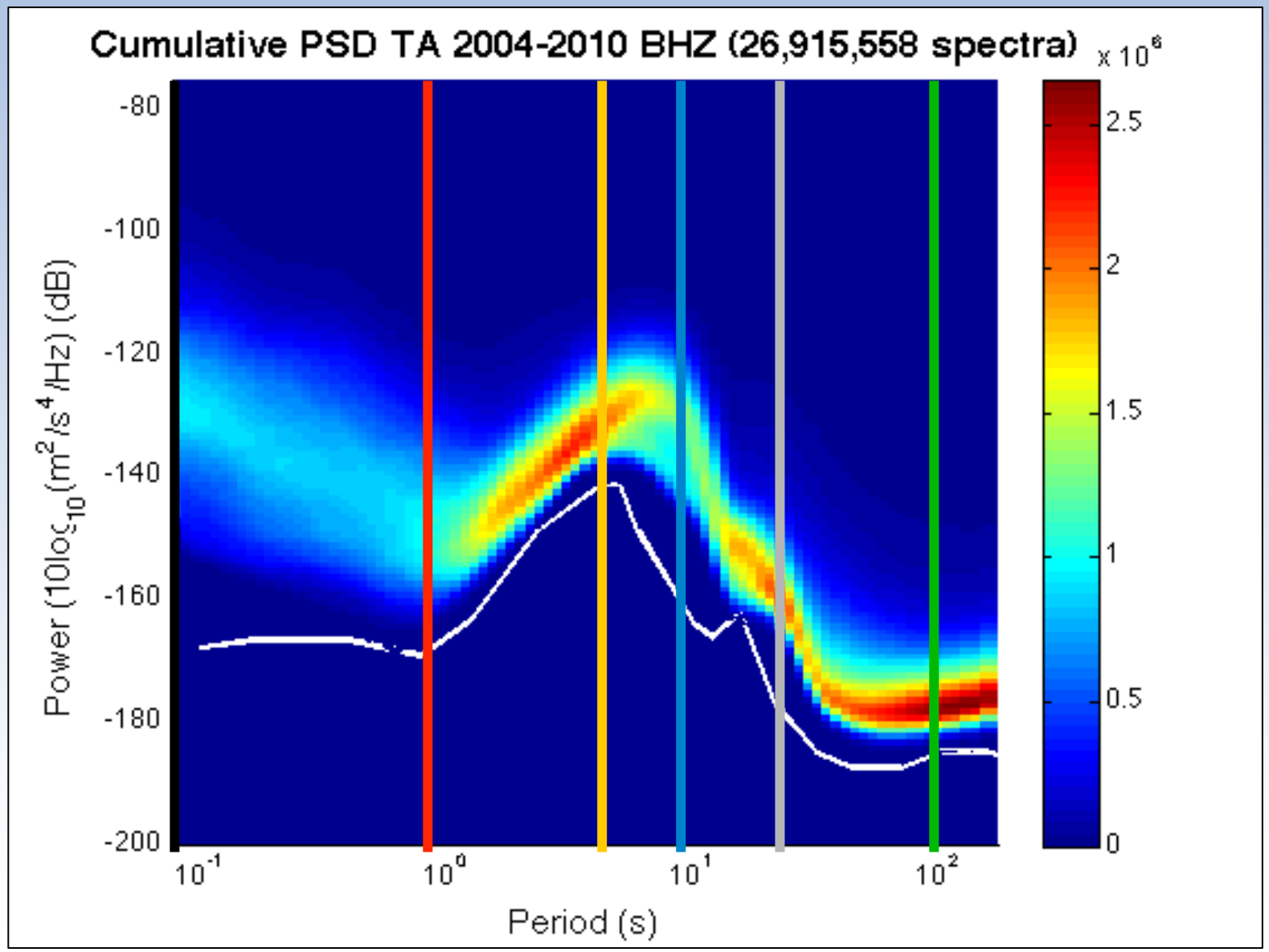
Sustainable Networks Workshop
Universidad de Chile
May 26, 2015

PSD-PDF Analysis

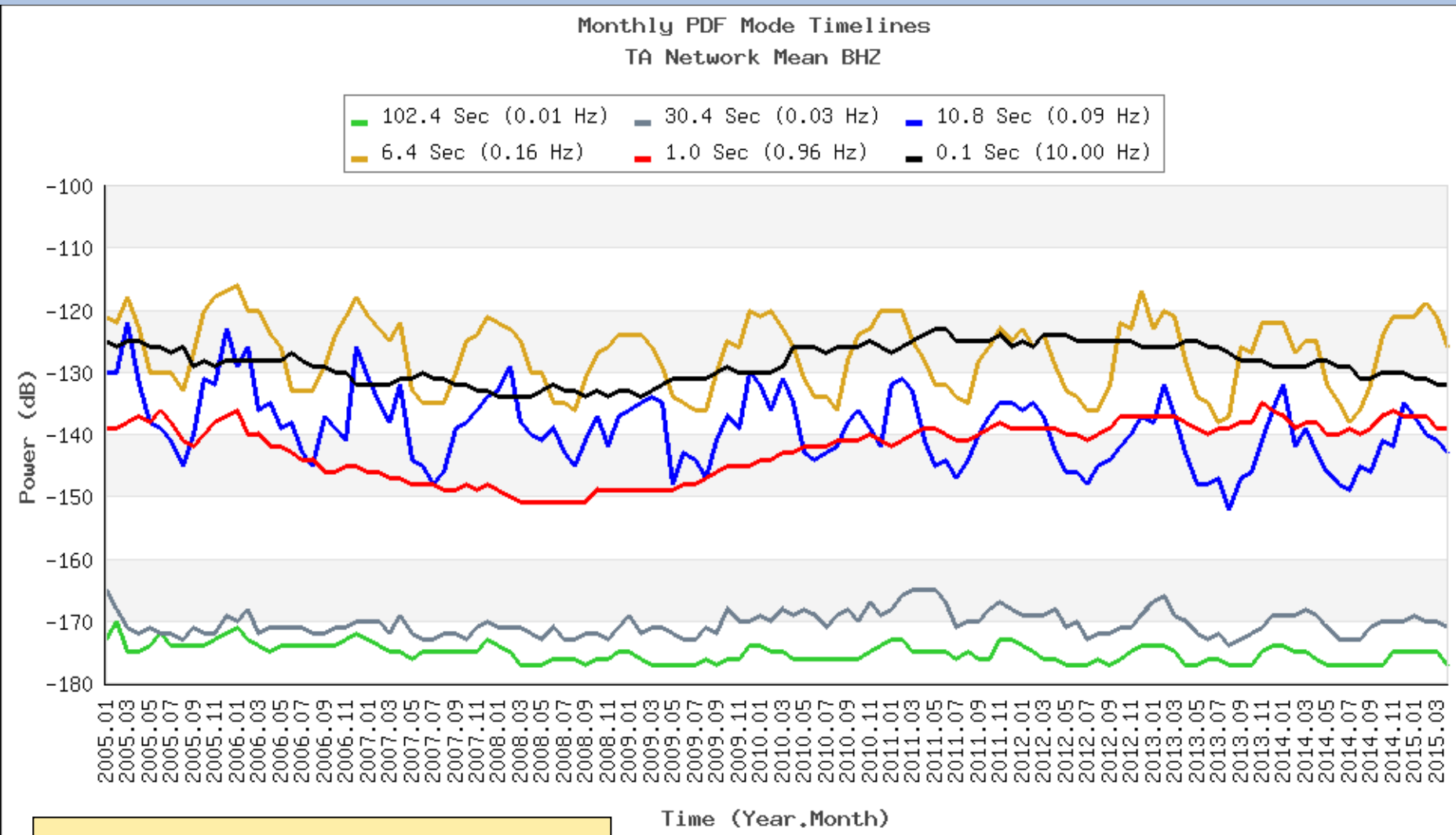


McNamara and Buland, 2004

TA Performance

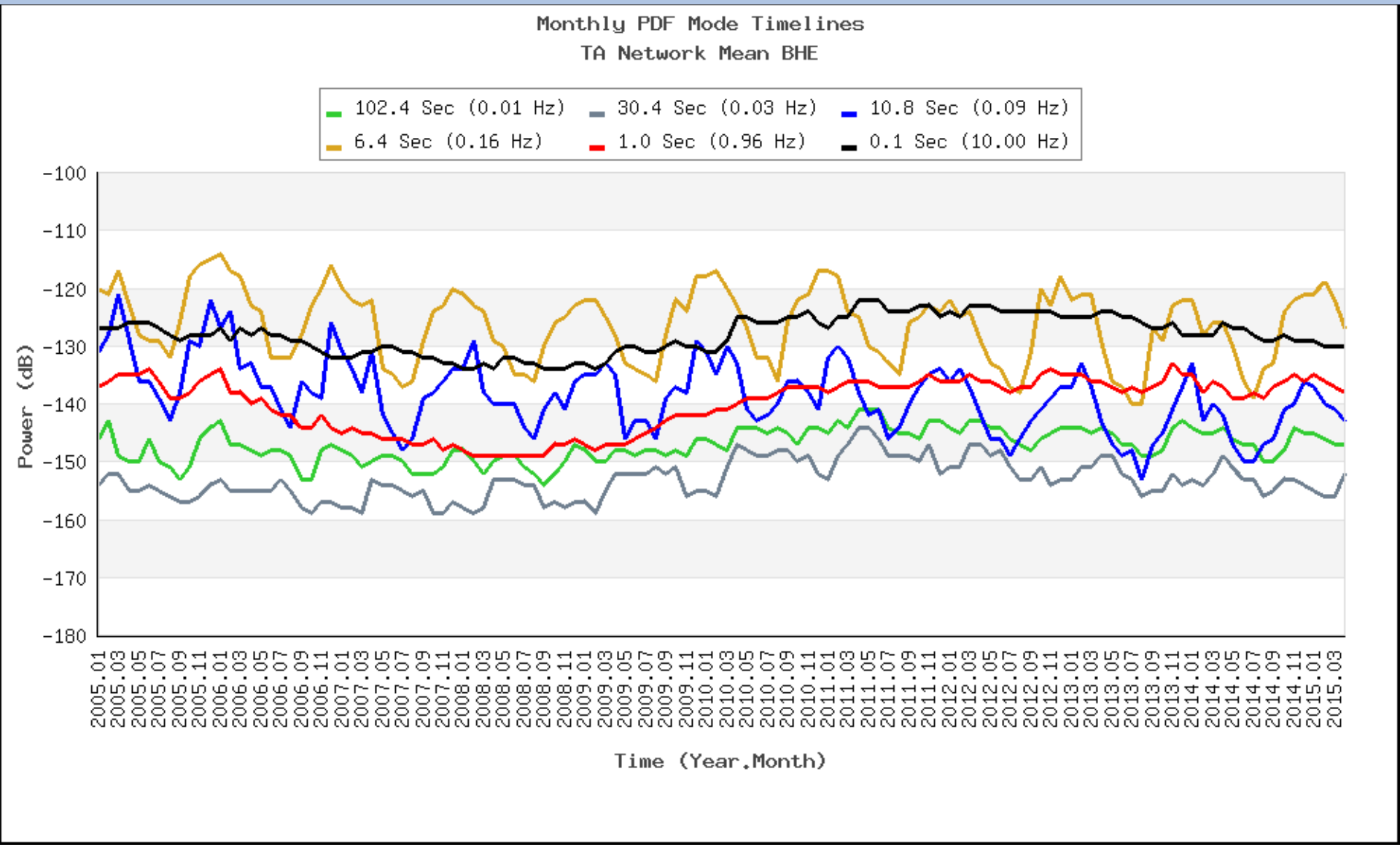


TA Noise Levels

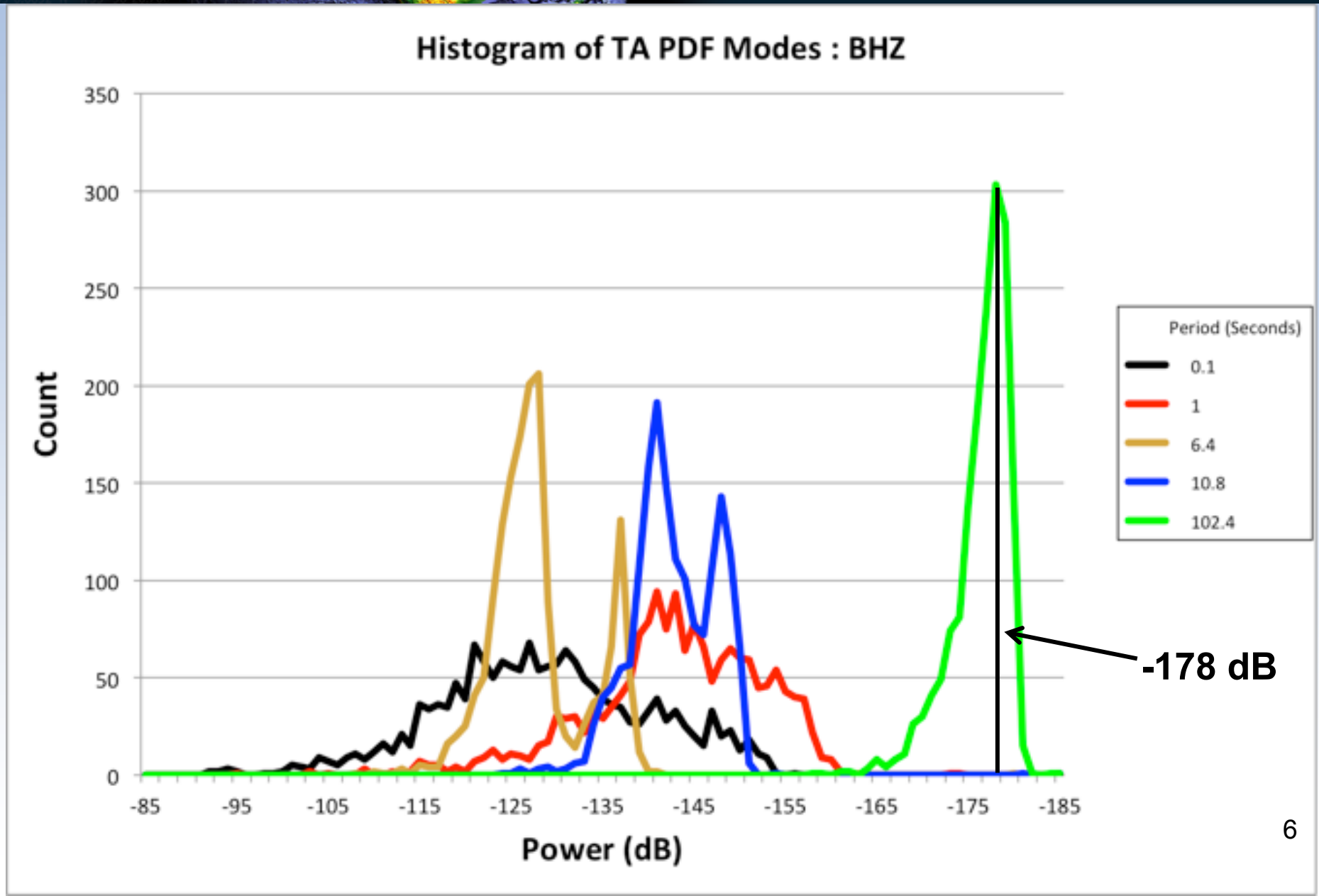


Mode - amplitude most often observed at a frequency

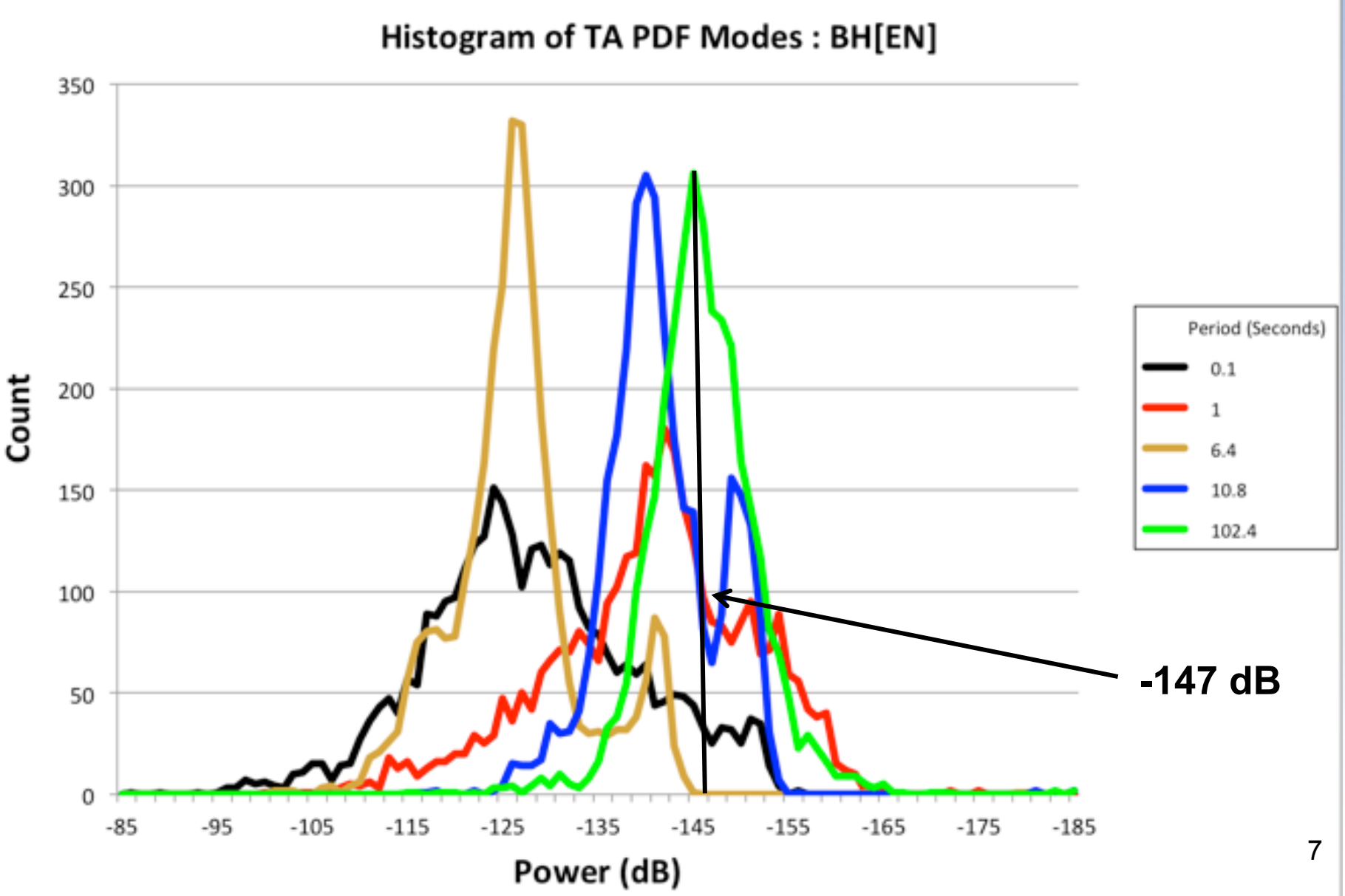
TA Noise Levels



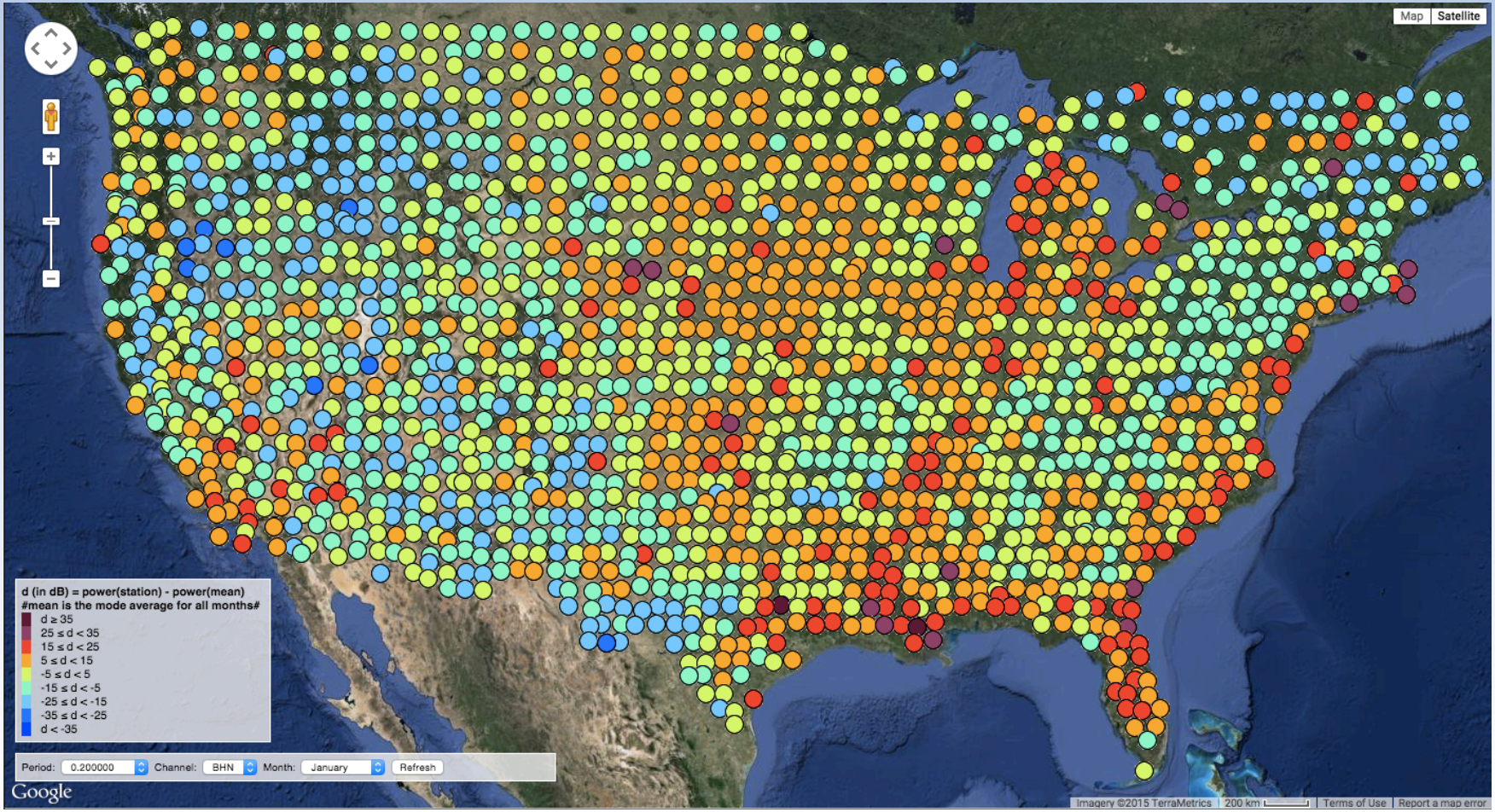
Histograms


Histogram of TA PDF Modes : BHZ
Count
350
300
250
200
150
100
50
0
-85
-95
-105
-115
-125
-135
-145
-155
-165
-175
-185
Power (dB)
Period (Seconds)
0.1
1
6.4
10.8
102.4
-178 dB

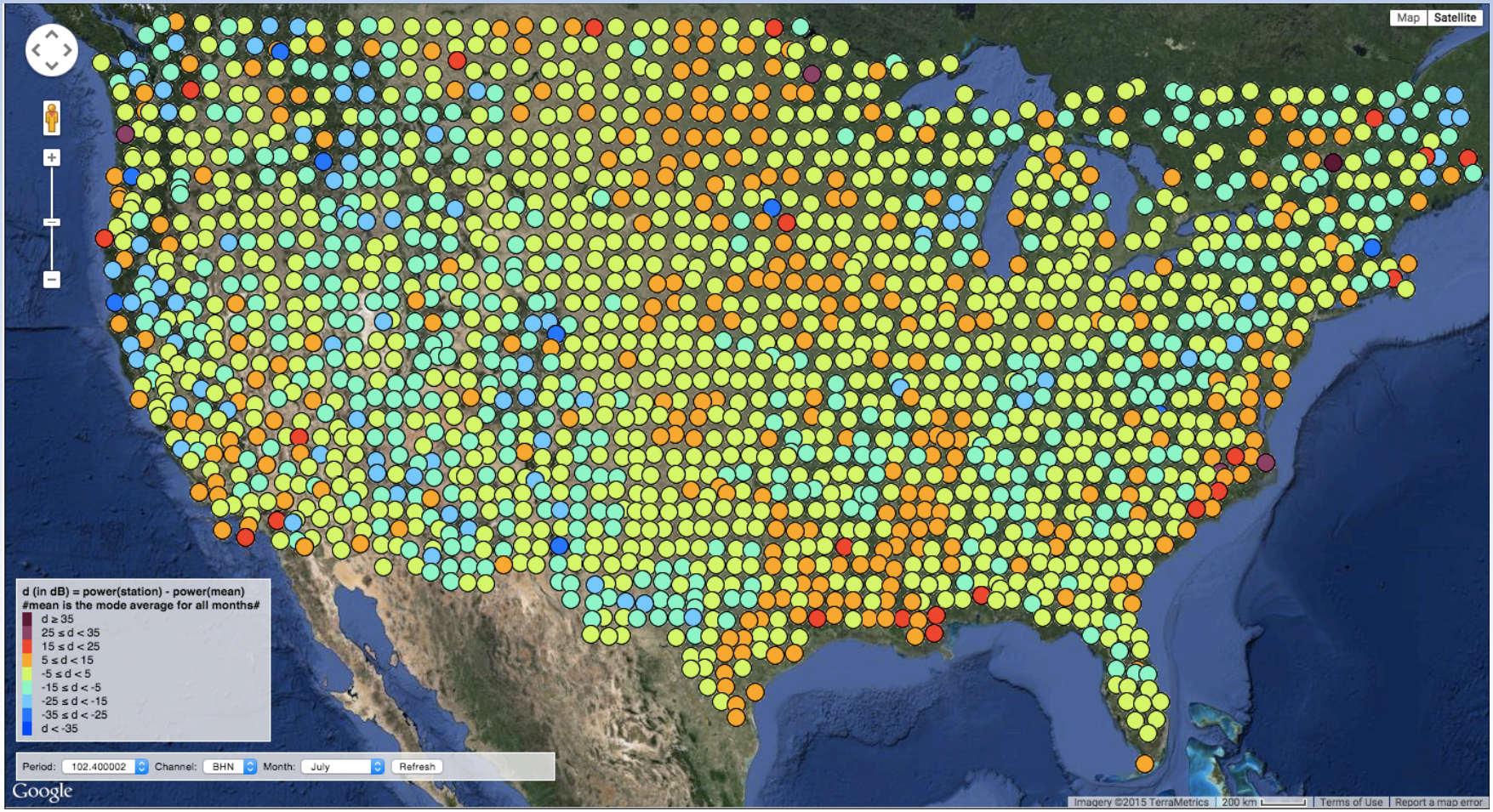
Histograms


Histogram of TA PDF Modes : BH[EN]
Count
350
300
250
200
150
100
50
0
-85
-95
-105
-115
-125
-135
-145
-155
-165
-175
-185
Power (dB)
Period (Seconds)
0.1
1
6.4
10.8
102.4
-147 dB

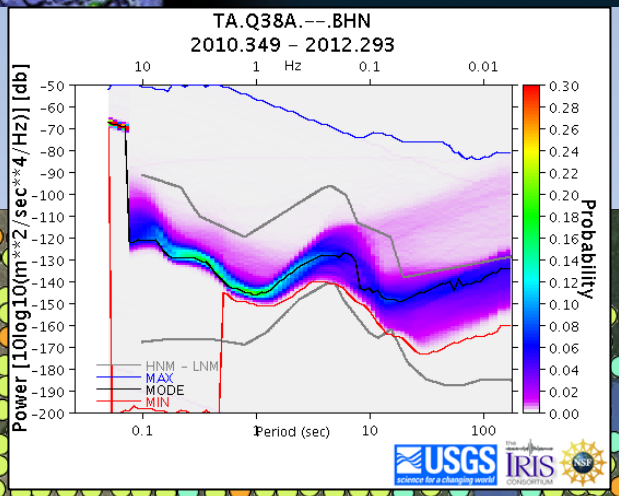
Geographic Variation (5 Hz)

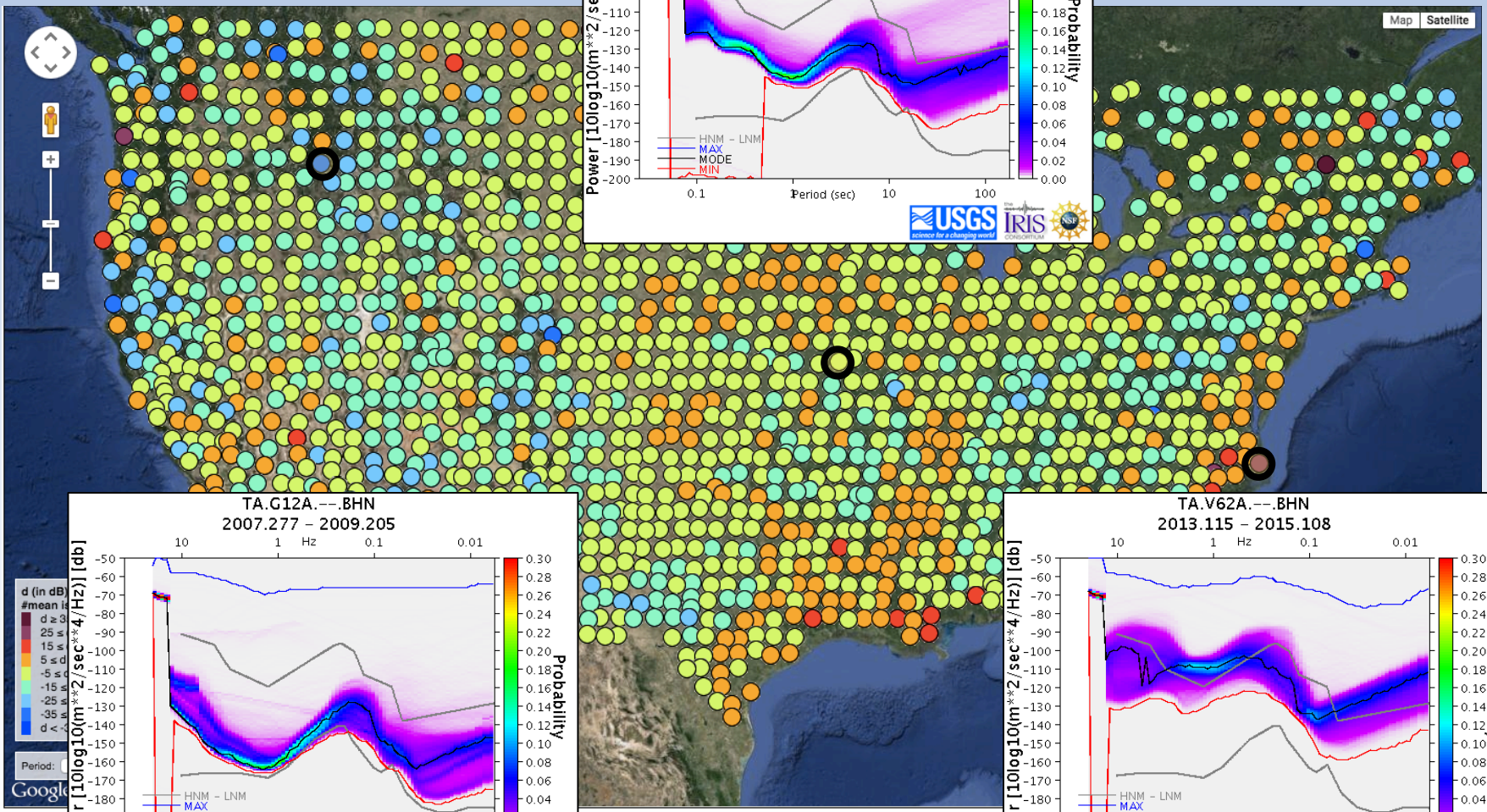


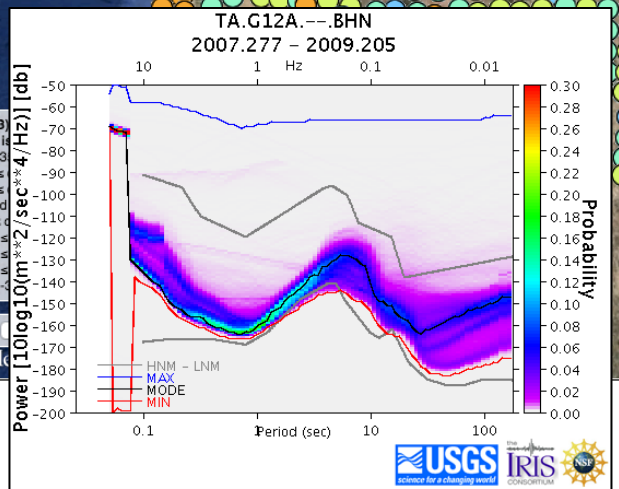
Geographic Variation (100 s)

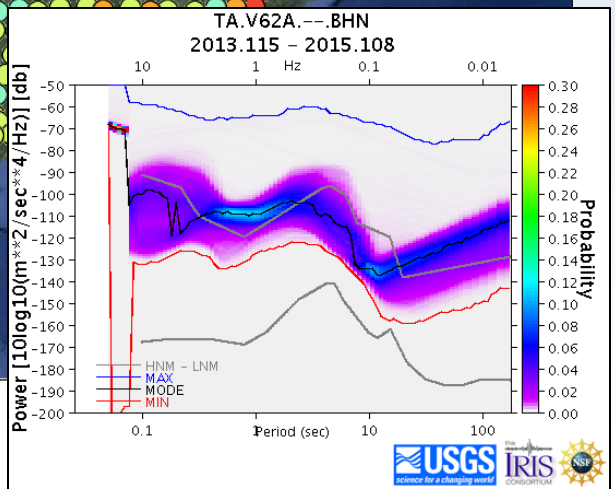


Good, Average, Bad

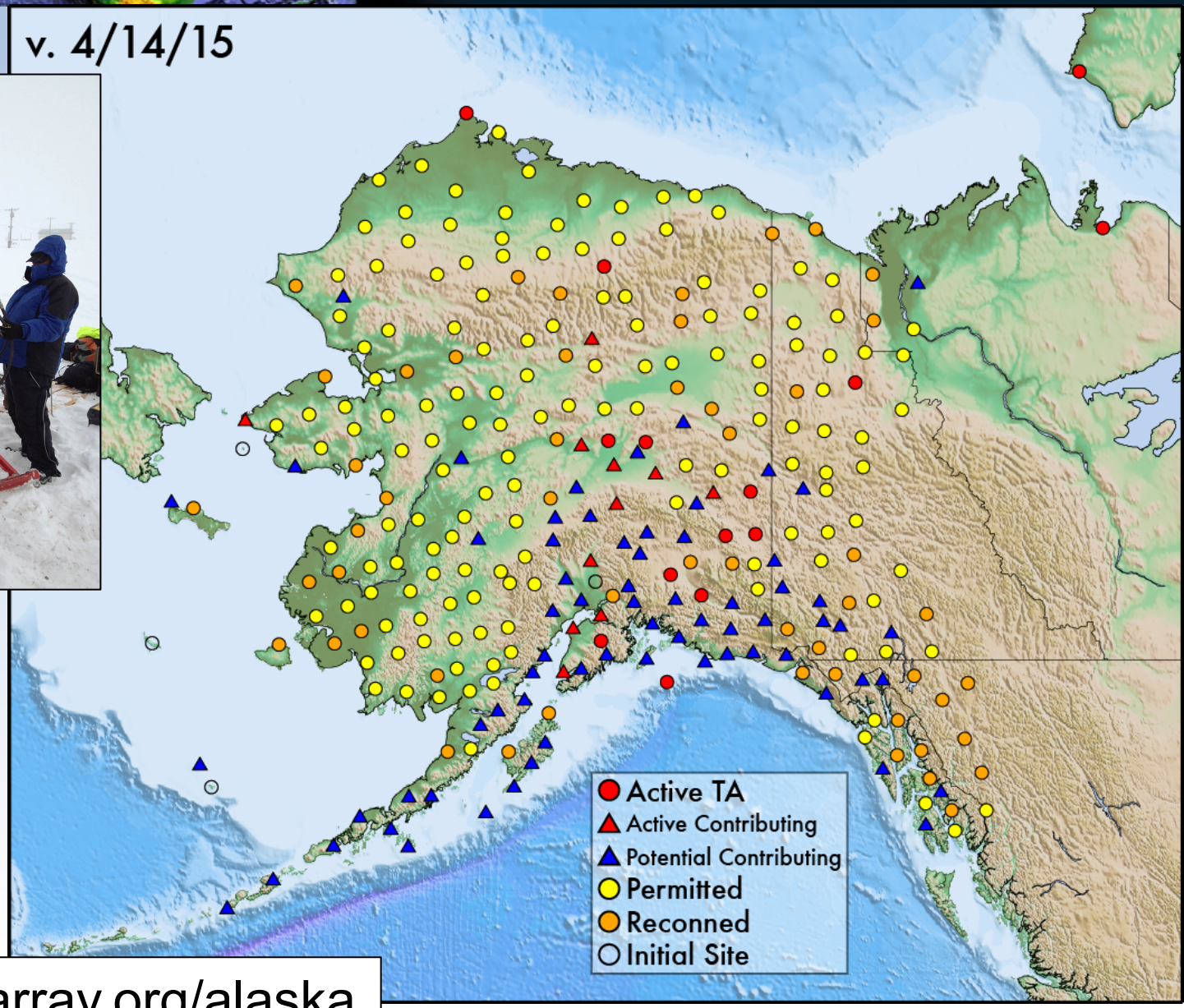






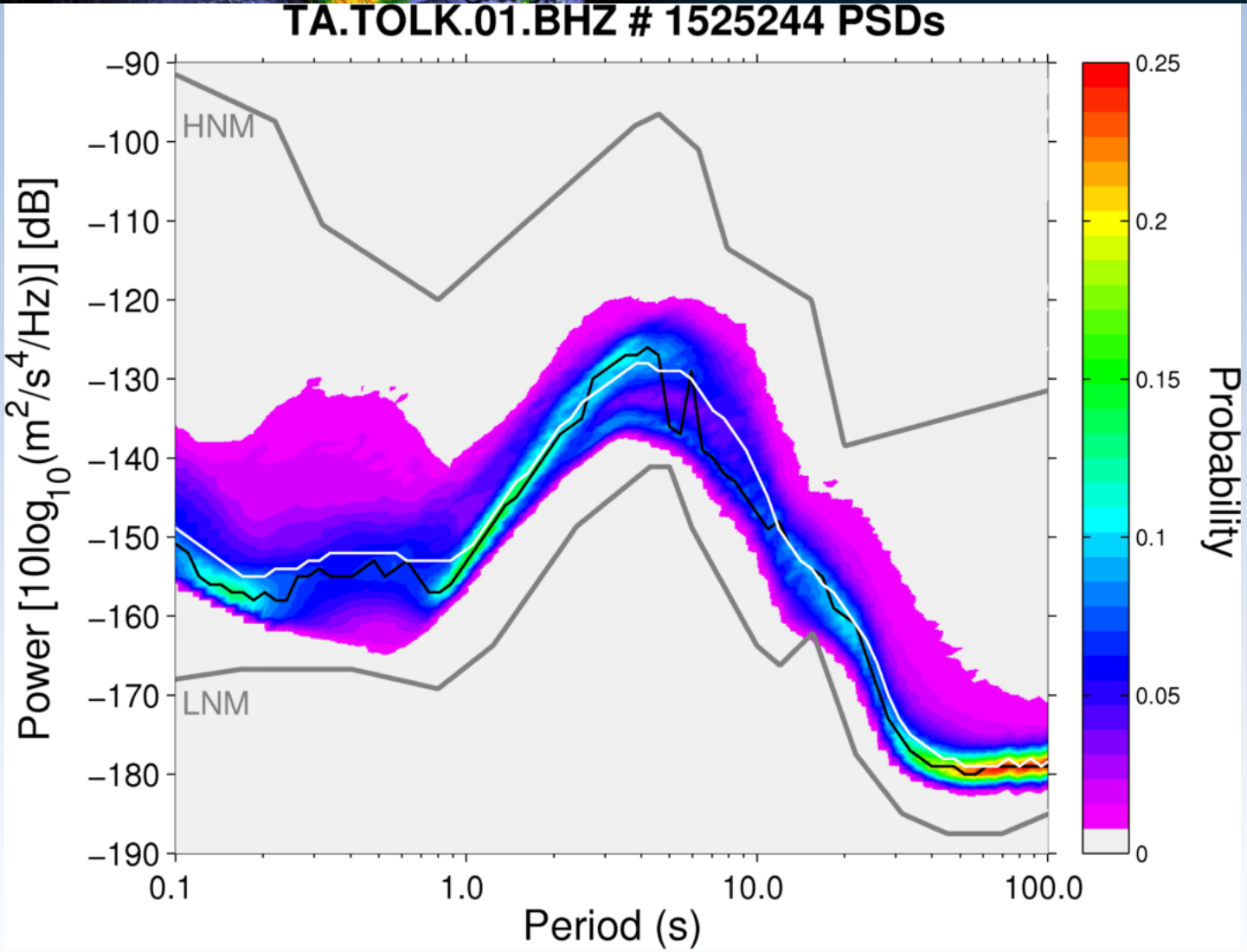


TA in Alaska (and Canada)



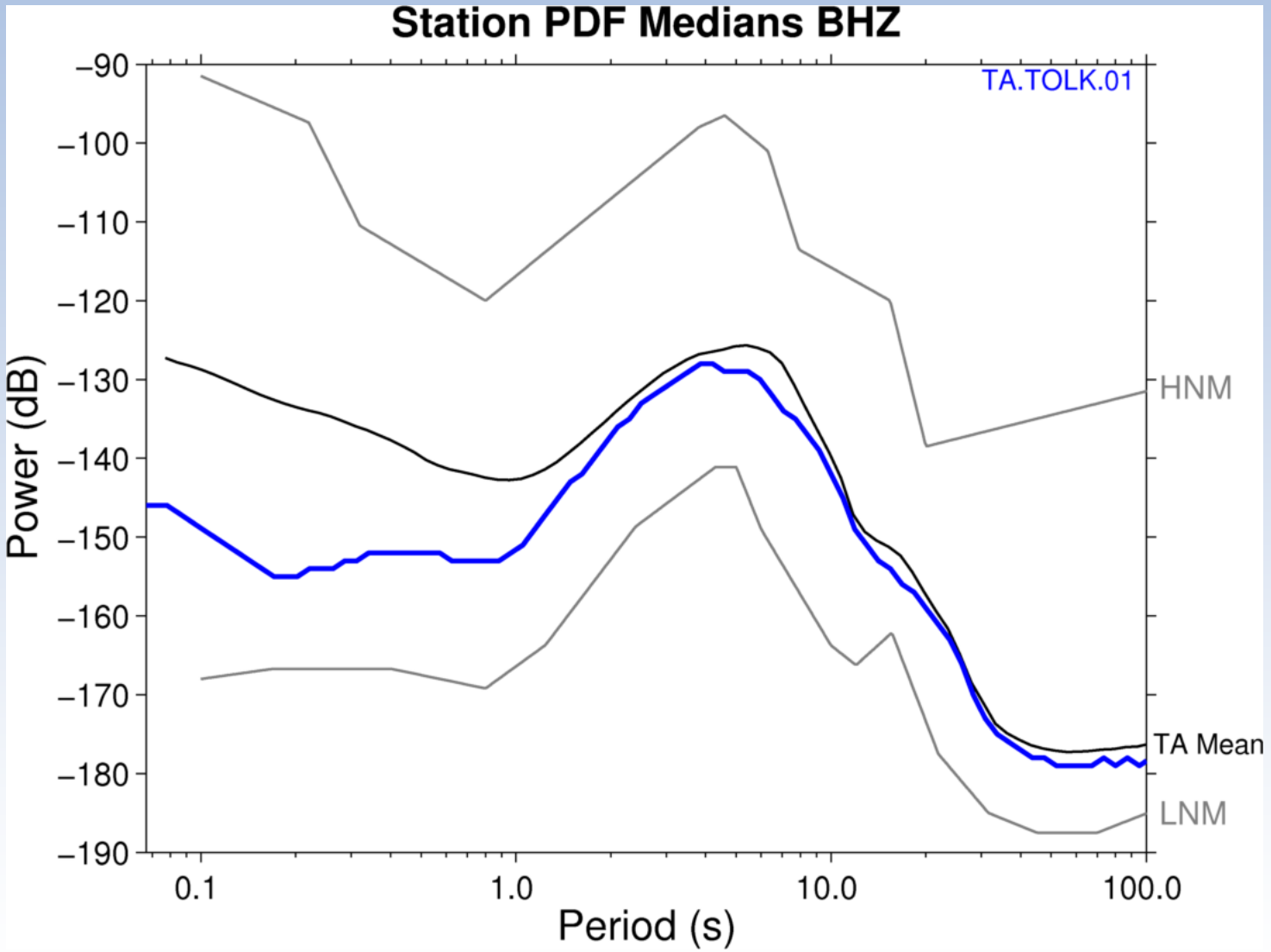
www.usarray.org/alaska

Viewing PDFs

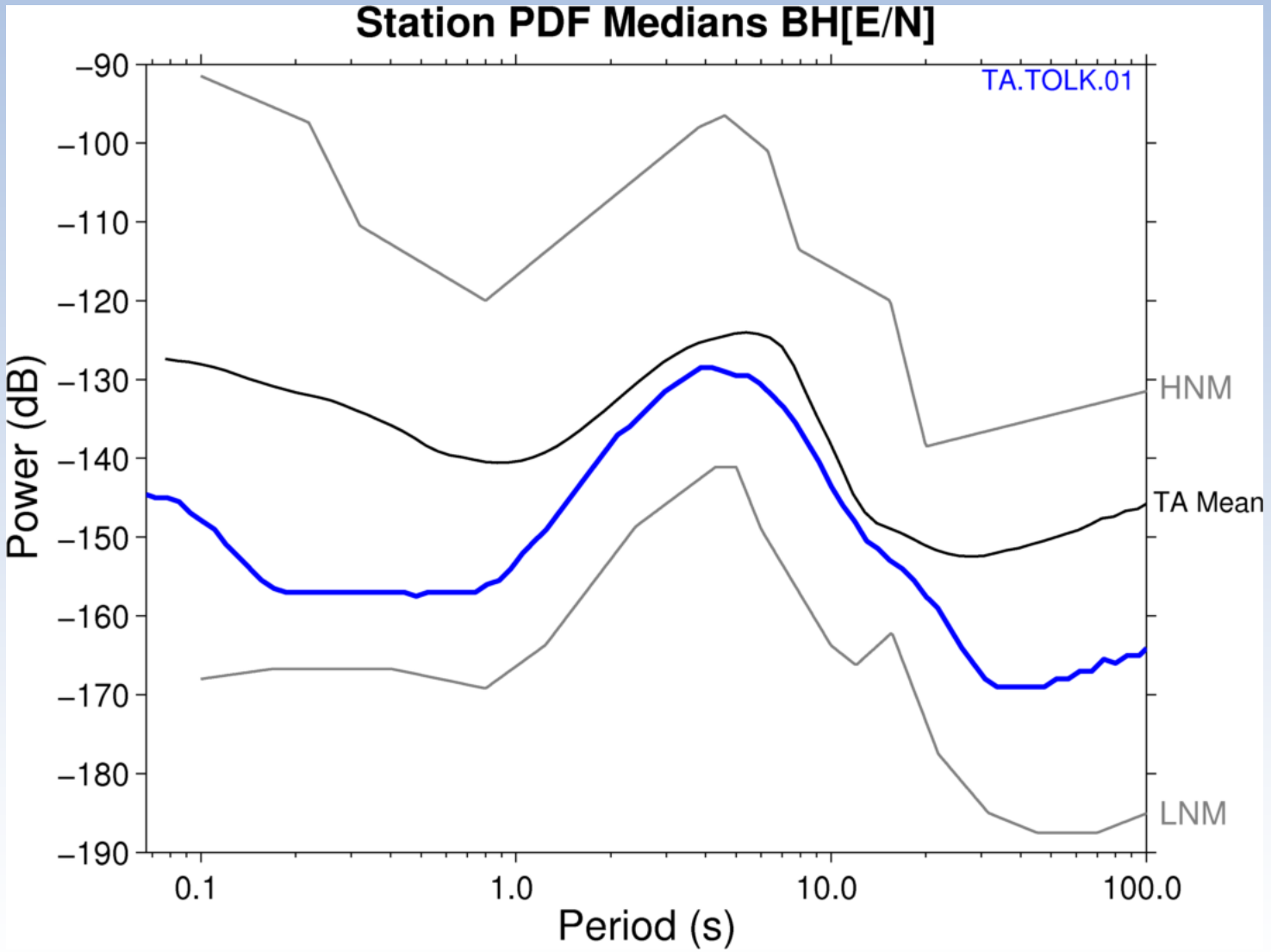


Mode (black) – power level most observed for each frequency	Median (white) – power separating upper and lower halves of measurements

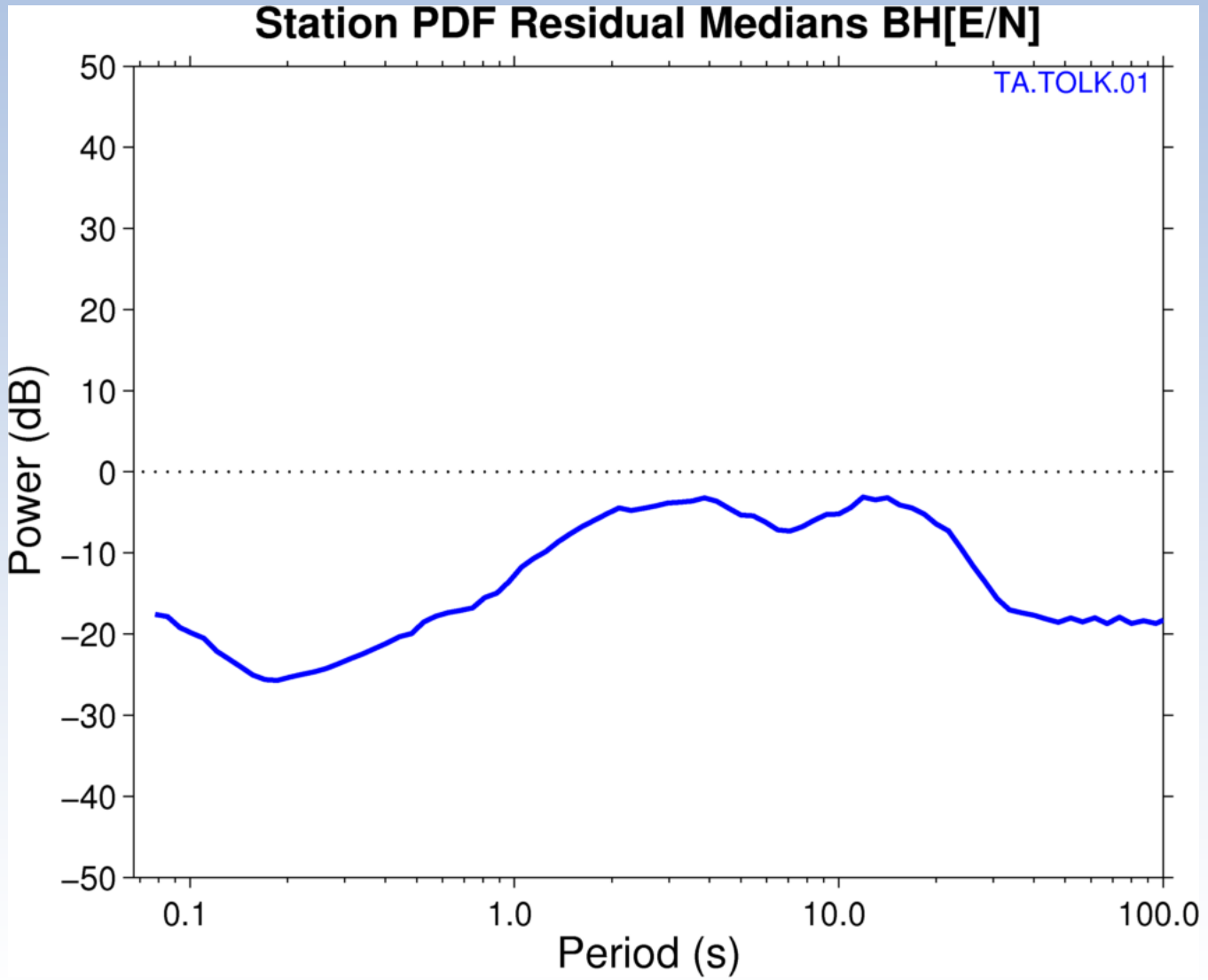
Example - TOLK



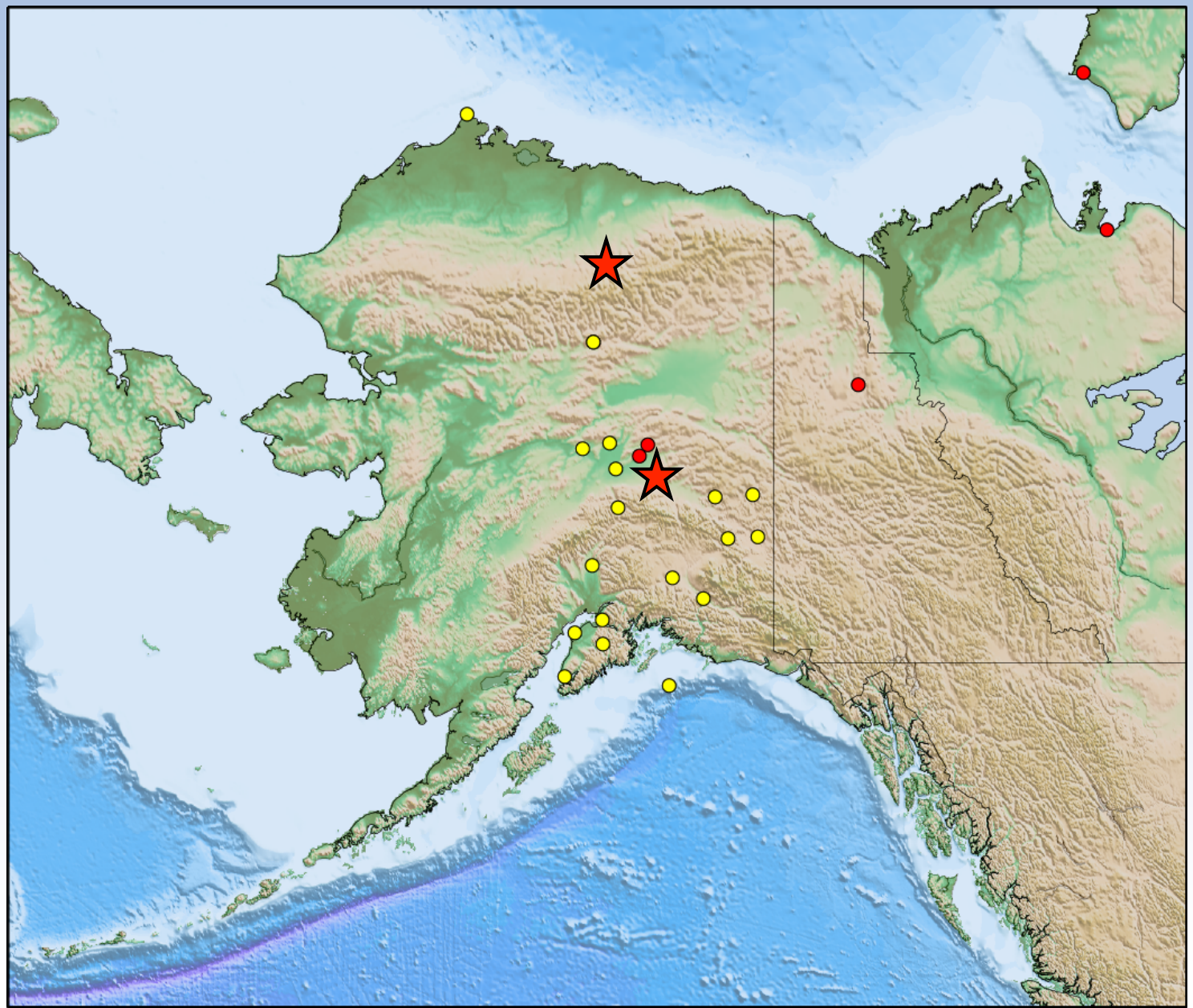
Example - TOLK



Example - TOLK

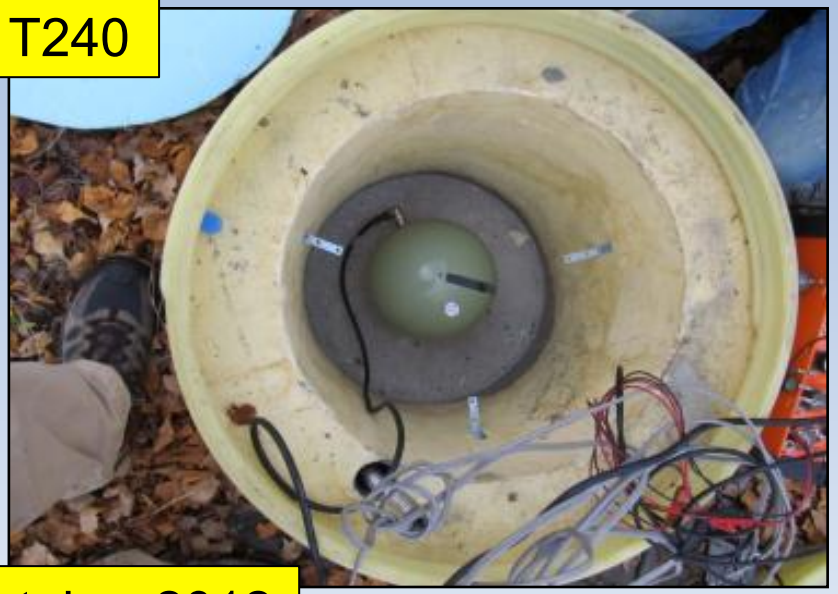


TA in Alaska (and Canada)

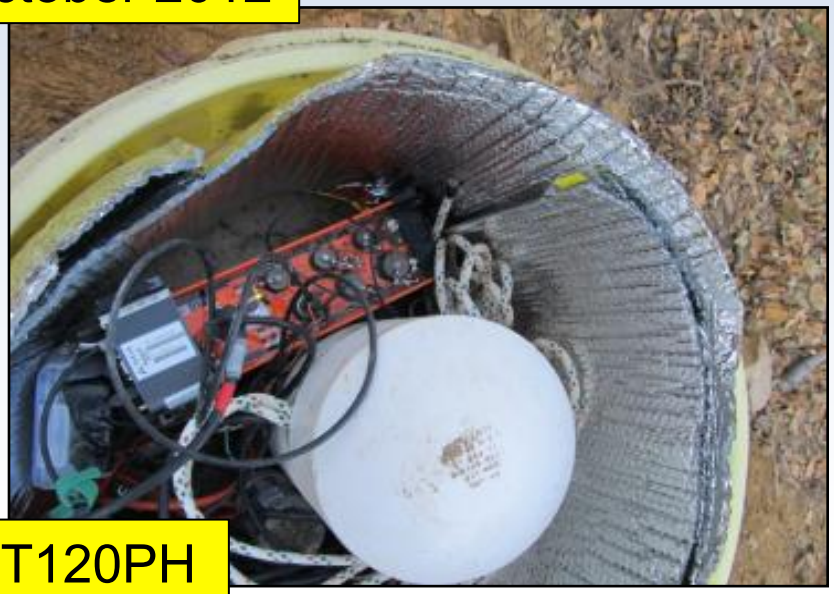


Harding Lake (HDA)

AEC Tank, T240

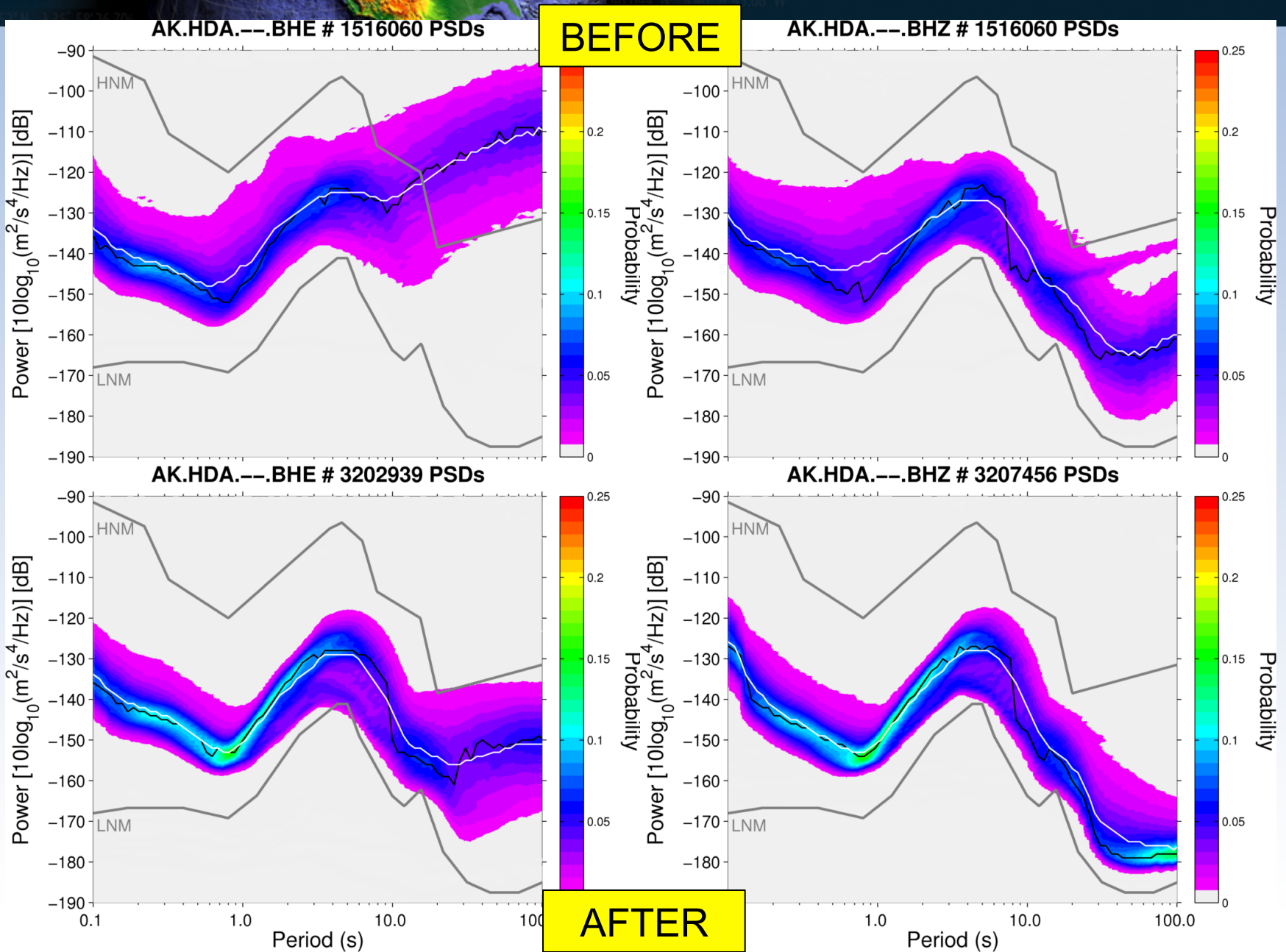


REINSTALLED October 2012

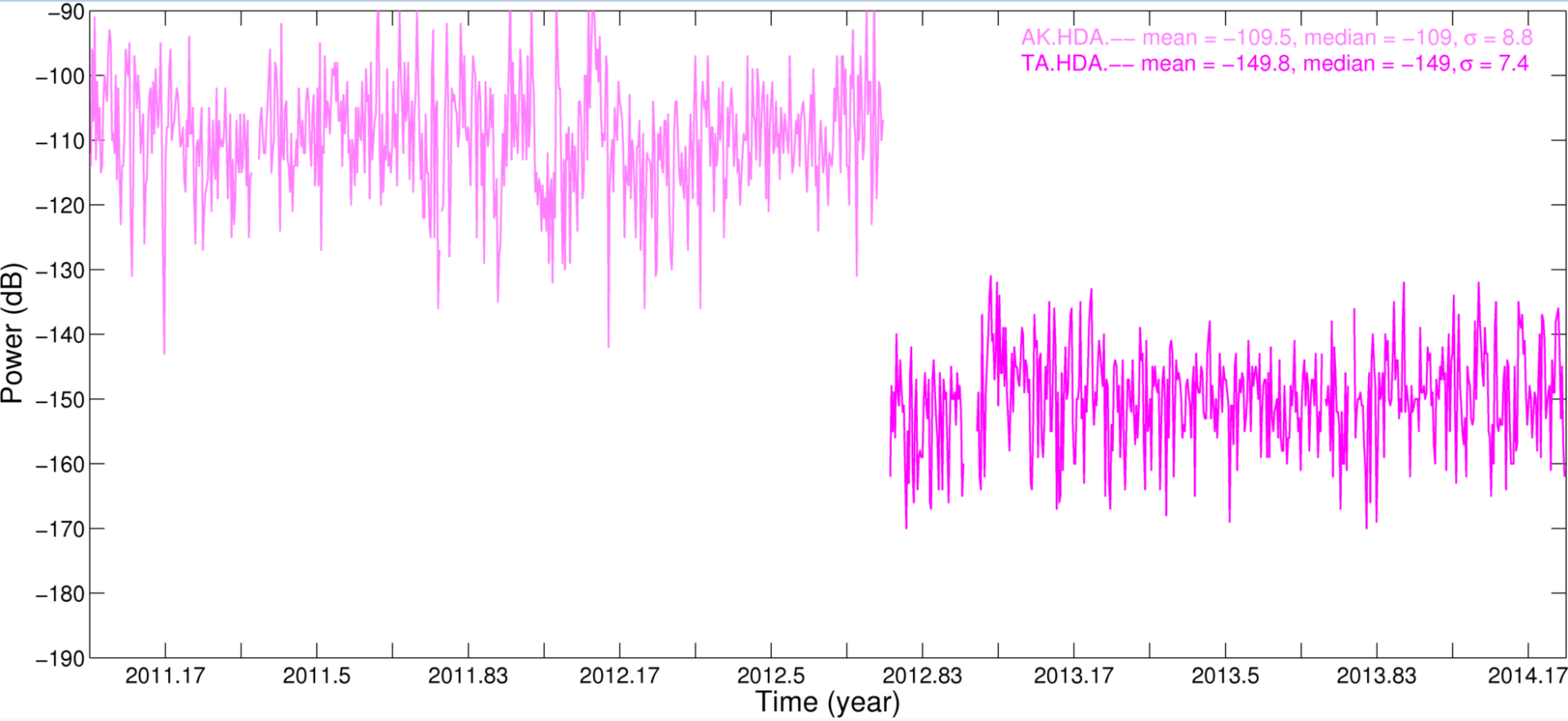


5M posthole, T120PH

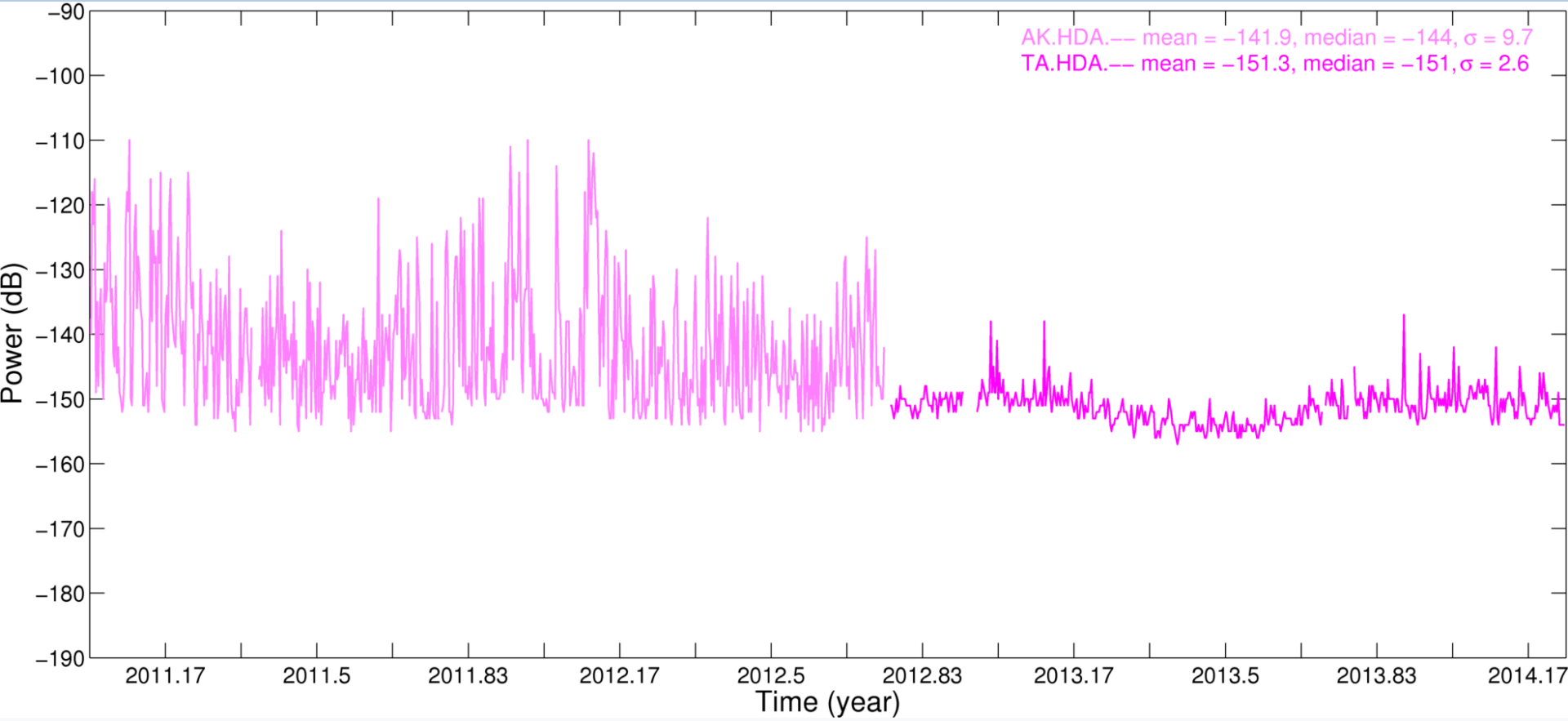
HDA Performance



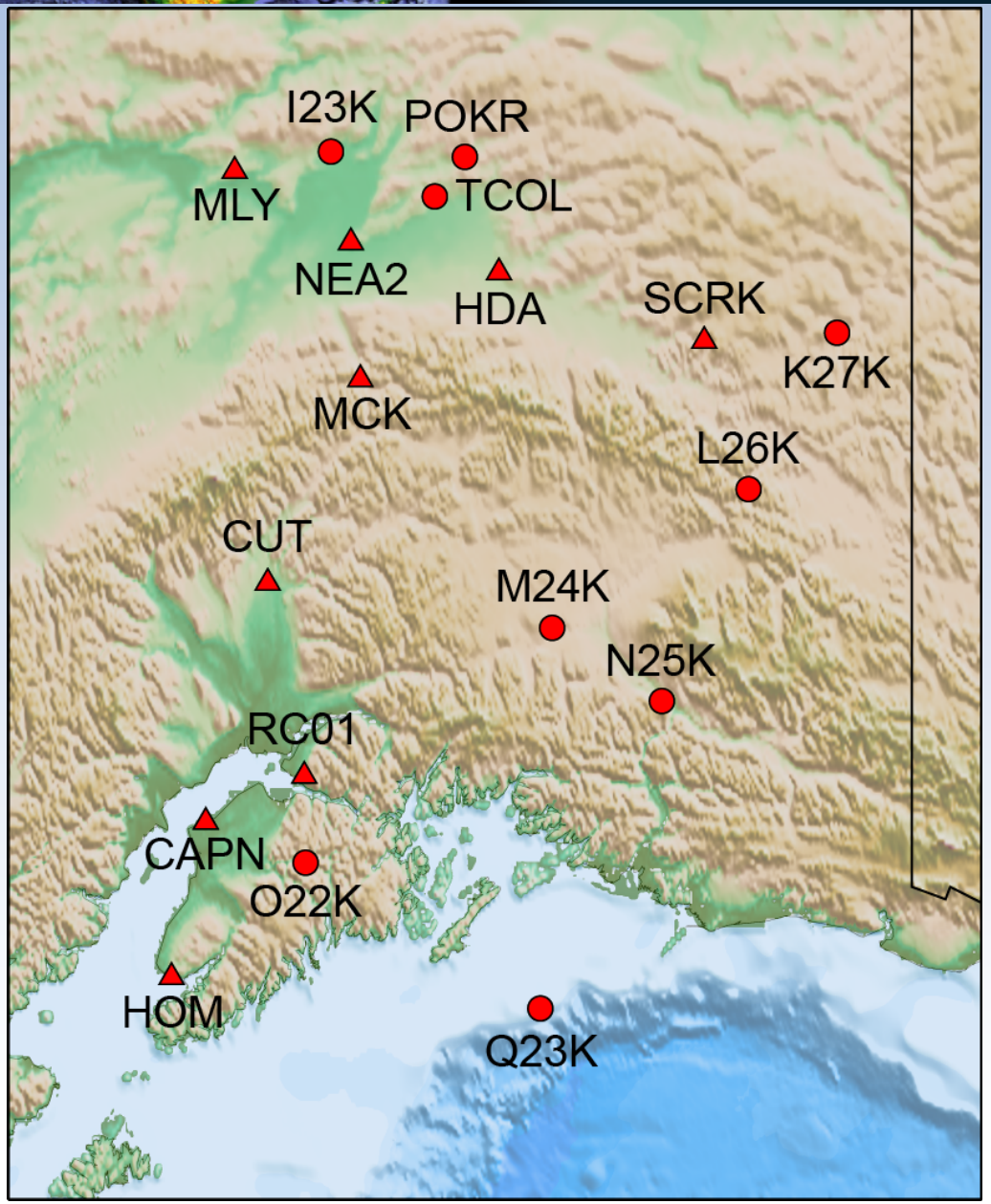
HDA Performance



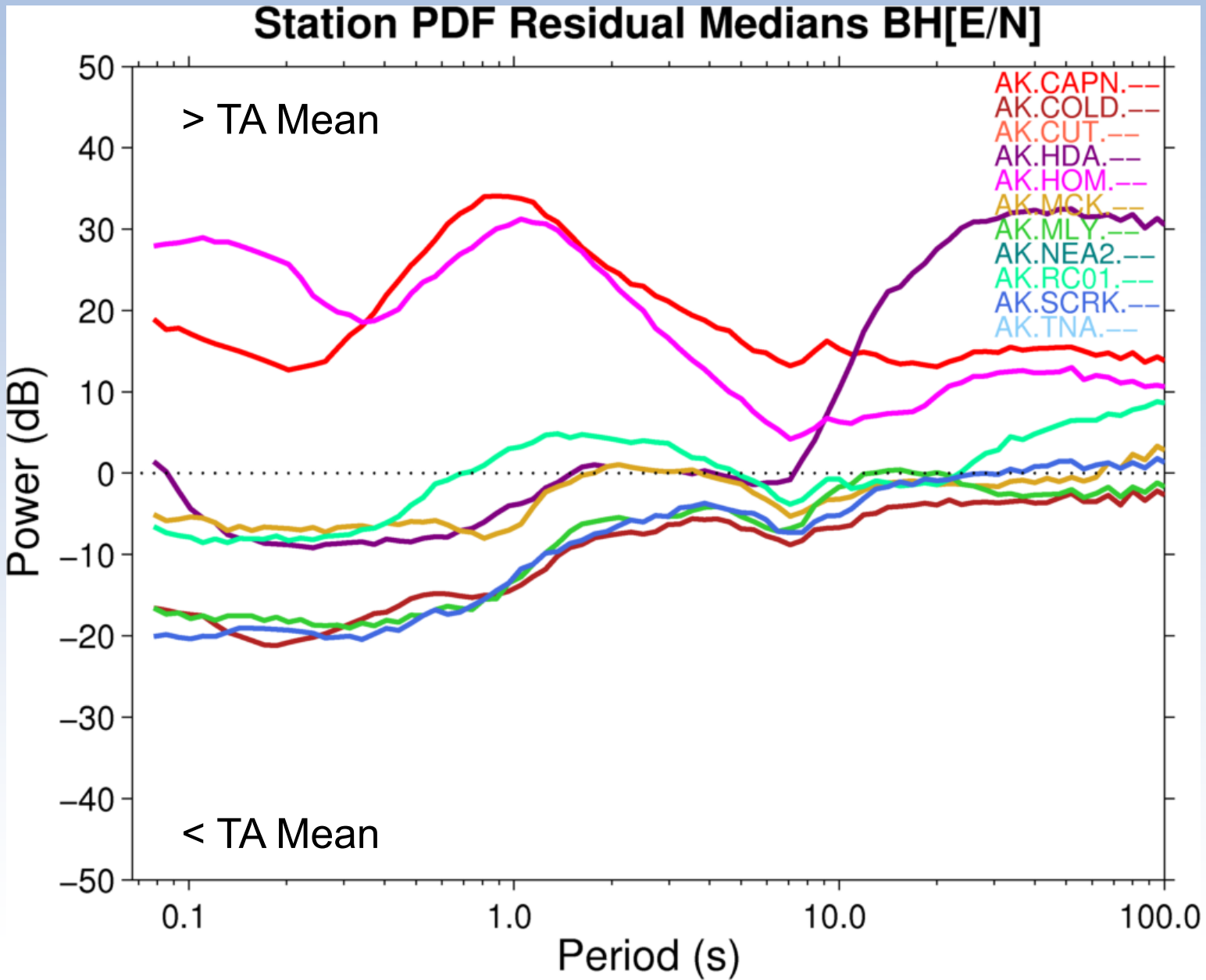
HDA Performance



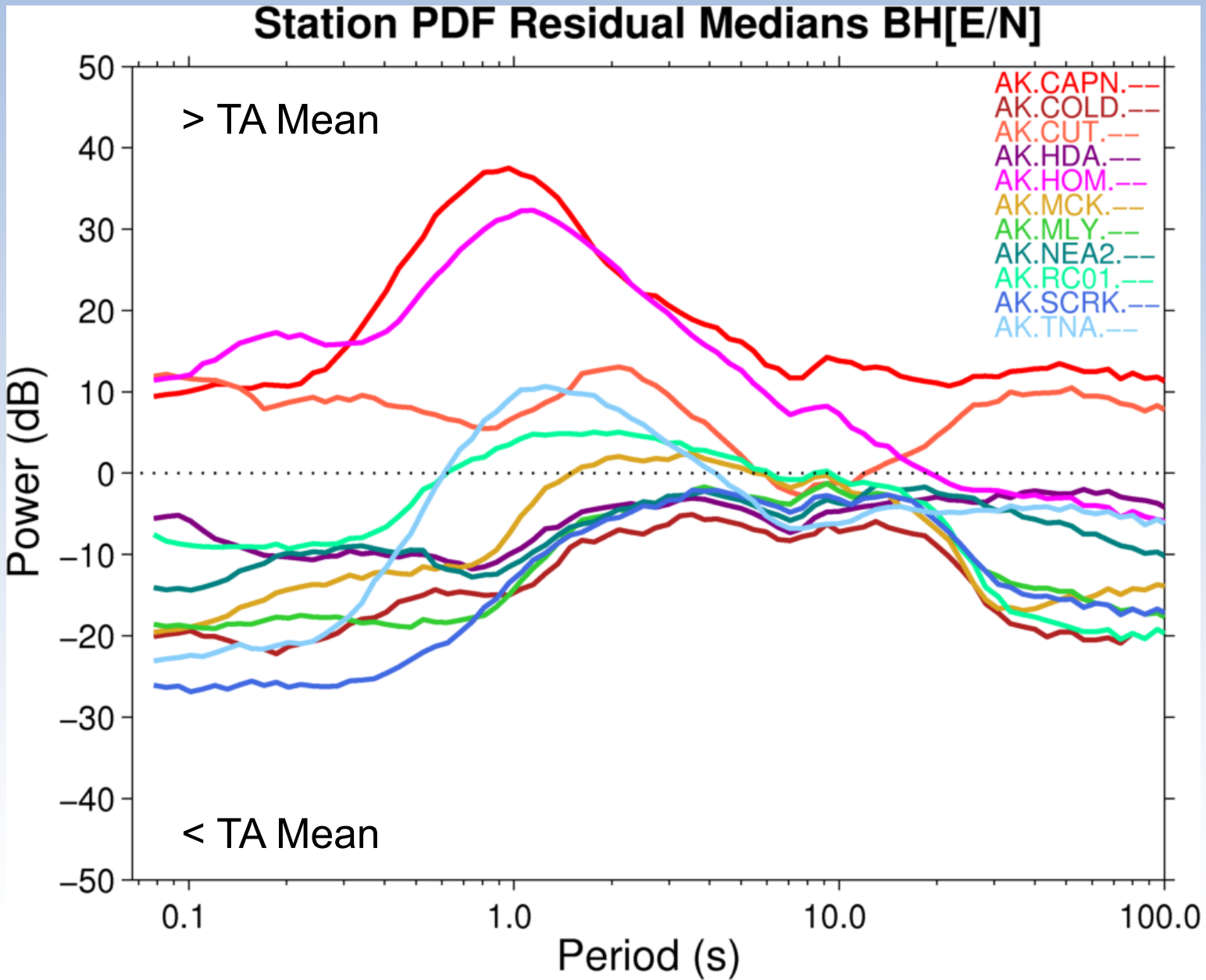
TA in 2014


I23K
POKR
MLY
TCOL
NEA2
HDA
SCRK
K27K
MCK
L26K
CUT
M24K
N25K
RC01
CAPN
O22K
HOM
Q23K

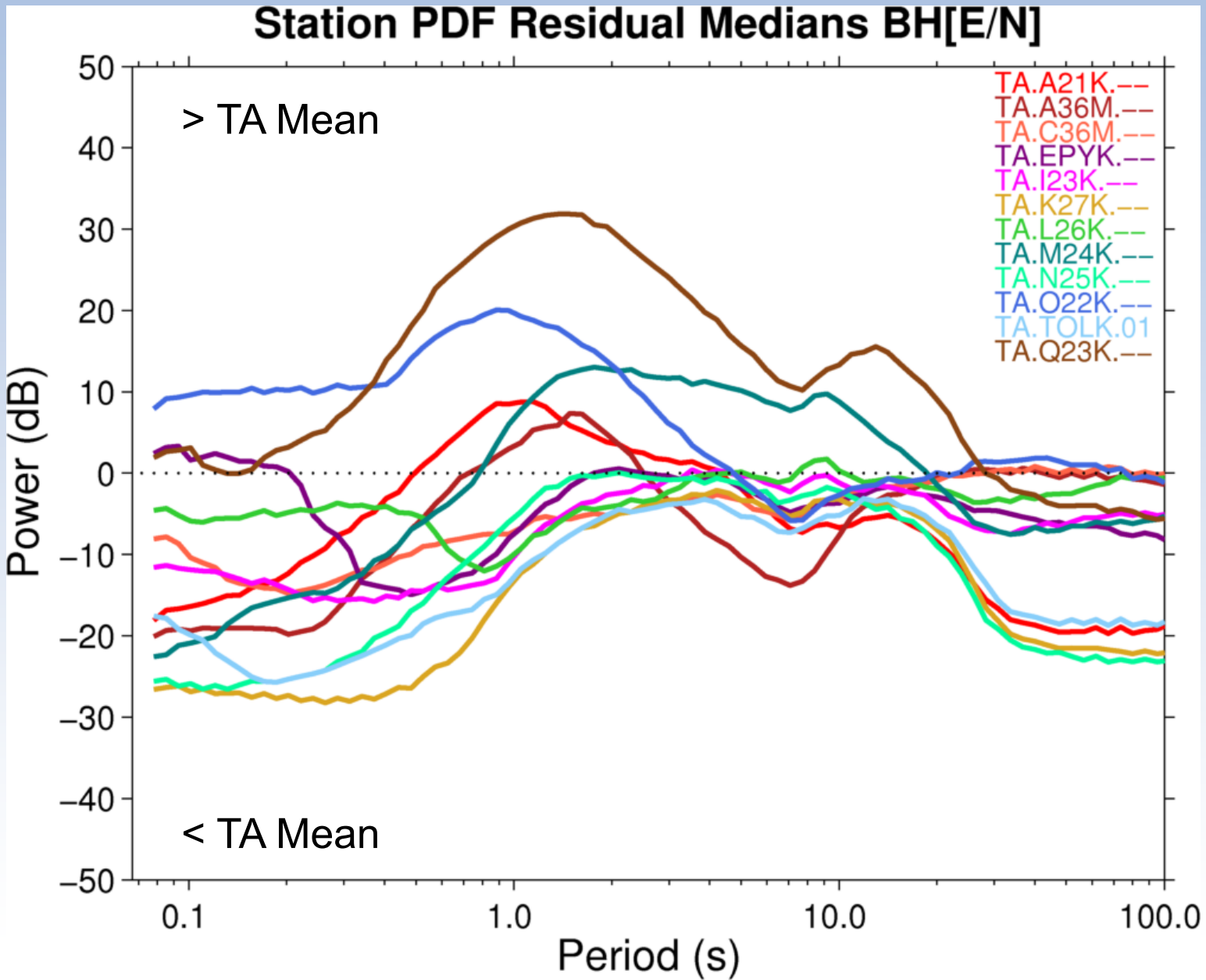
AK – 1 Year Before



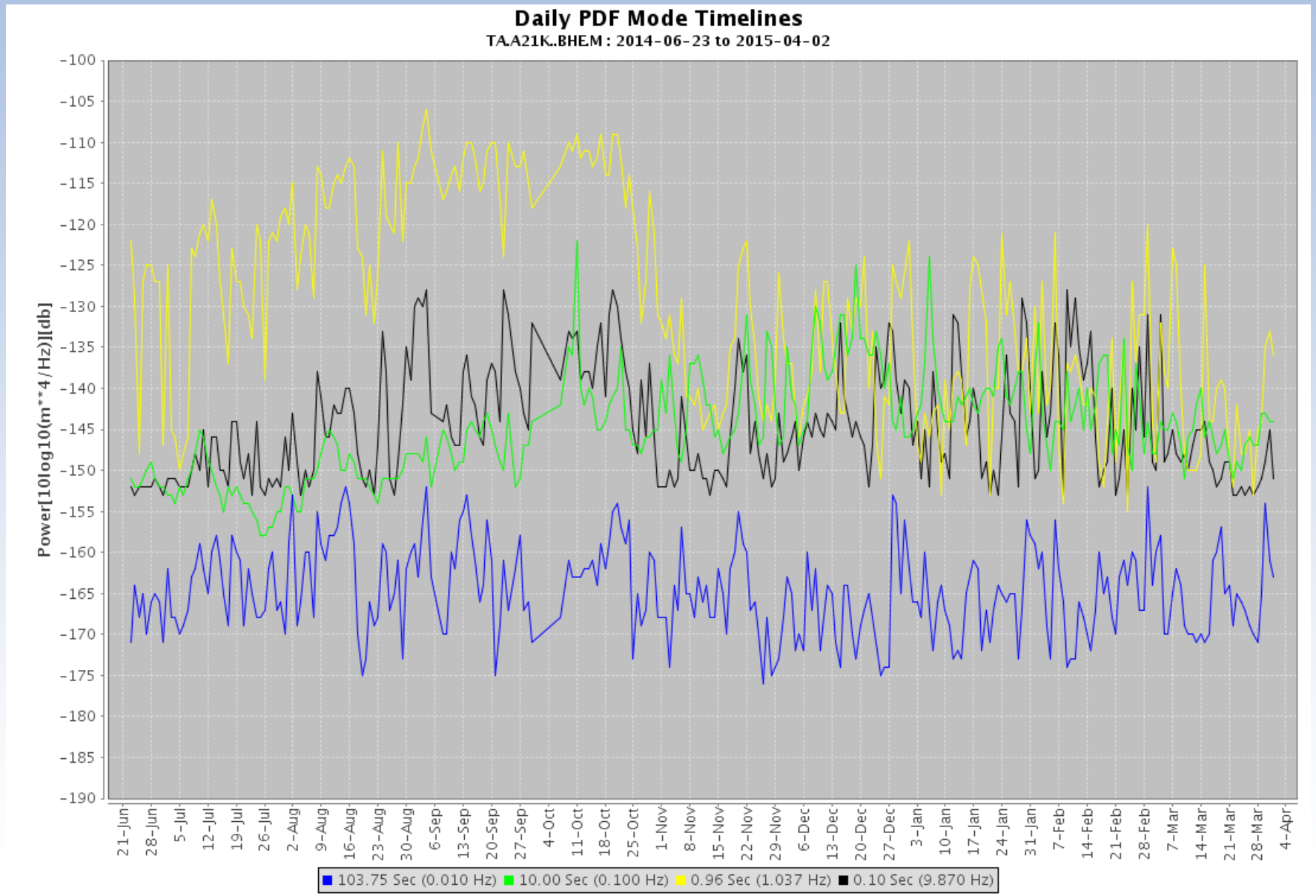
AK – To Present



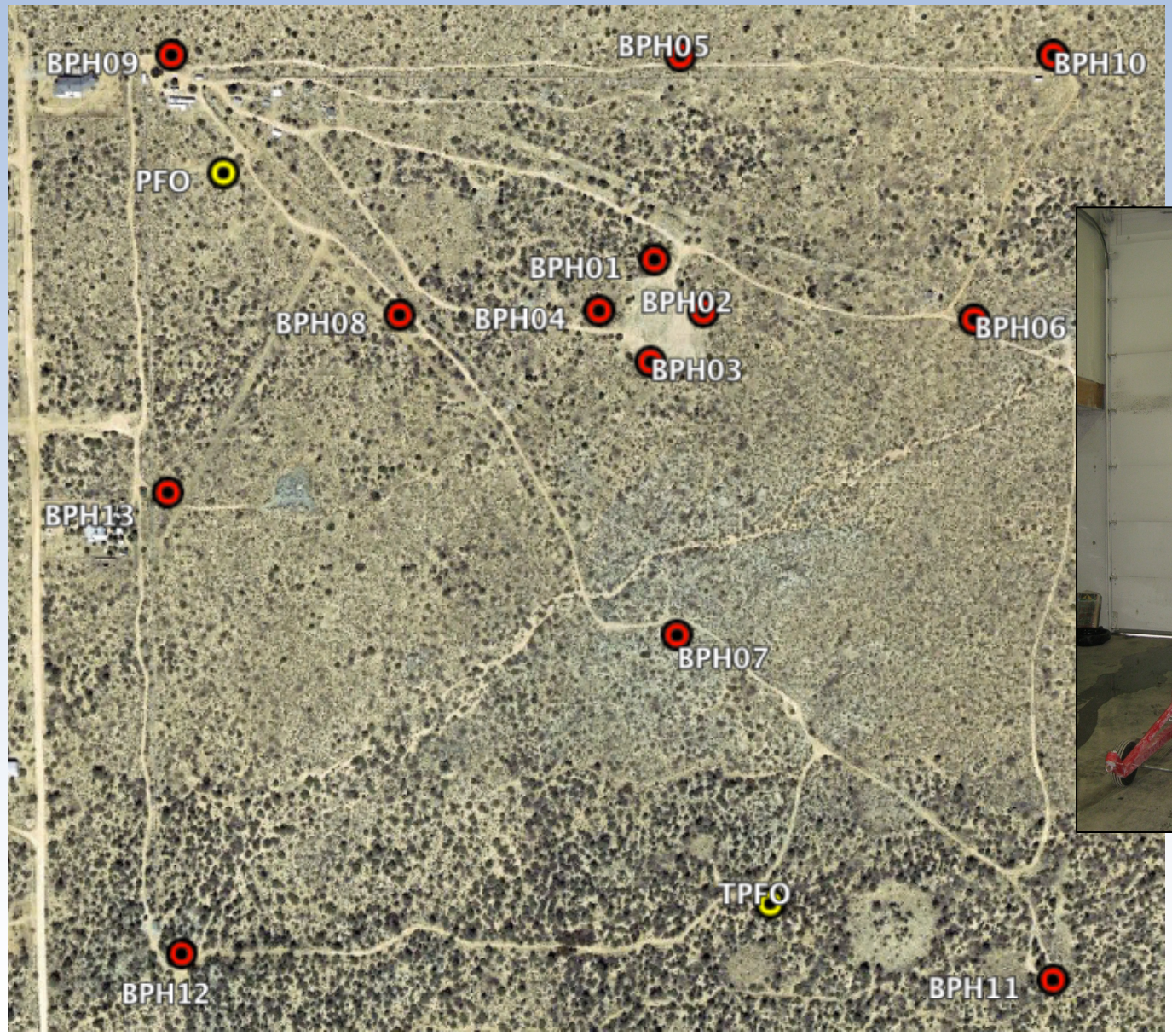
New TA sites


Station PDF Residual Medians BH[E/N]
> TA Mean
< TA Mean
Power (dB)
Period (s)
50
40
30
20
10
0
−10
−20
−30
−40
−50
0.1
1.0
10.0
100.0
TA.A21K.--
TA.A36M.--
TA.C36M.--
TA.EPYK.--
TA.I23K.--
TA.K27K.--
TA.L26K.--
TA.M24K.--
TA.N25K.--
TA.O22K.--
TA.TOLK.01
TA.Q23K.--

Station Seasonality



2014 Piñon Flat Tests



Downhole Tests

Epoch A (April 10 – July 6): 9 TA posthole broadbands, many grouting/hole packing types

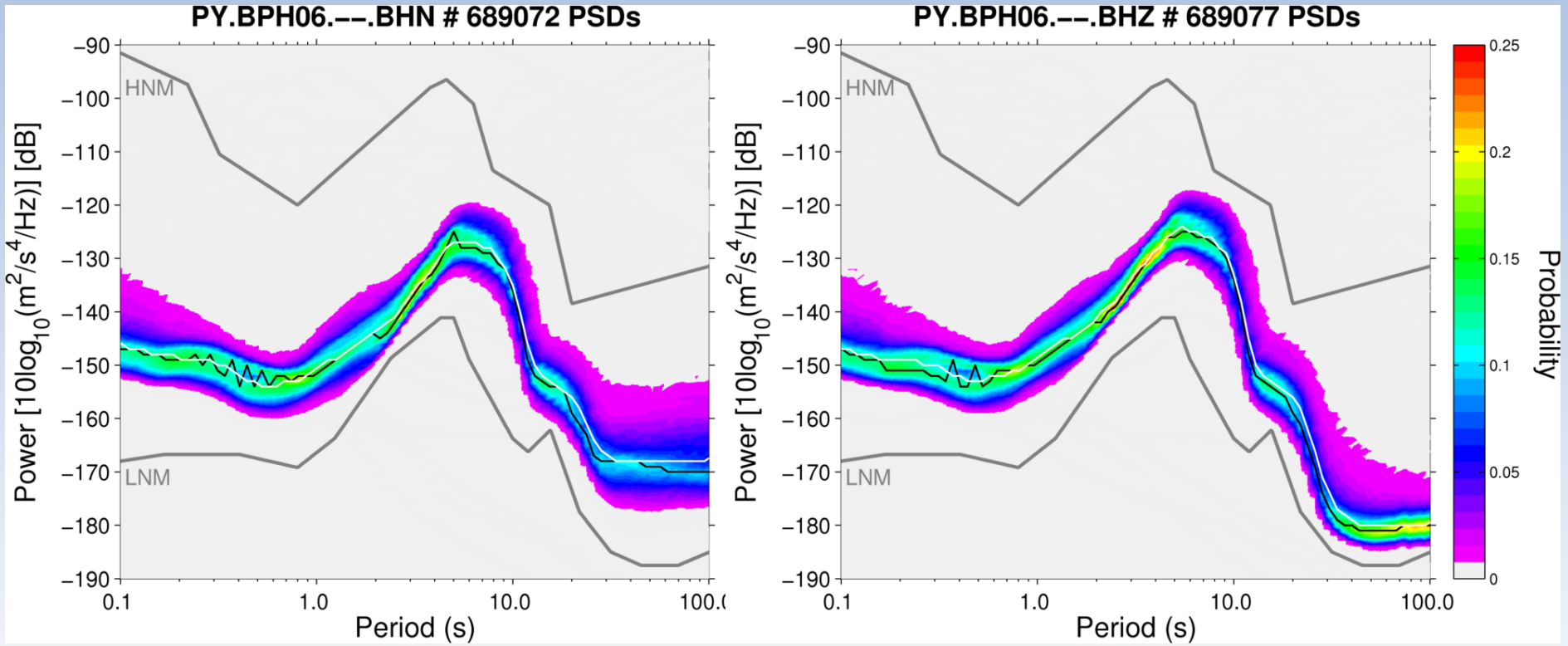
Epoch B (July 7 – November 13): 4 UCSD sensors added, packing changed

Epoch C (November 14 – Present): Some sensors swapped, all now packed with sand

Grout Methods

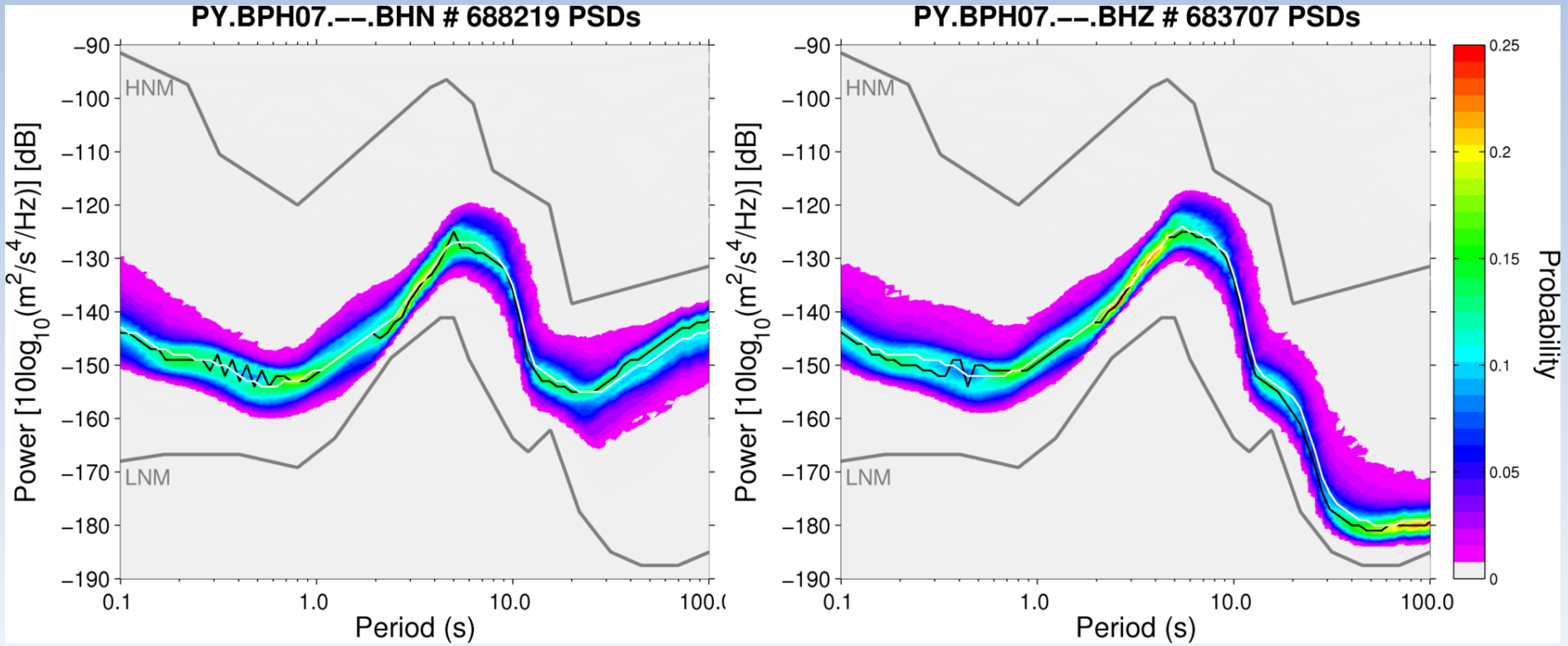
1) plunger from base
2) fill around annulus from surface
3) pump at 30-100 PSI through base

Examples – Epoch C



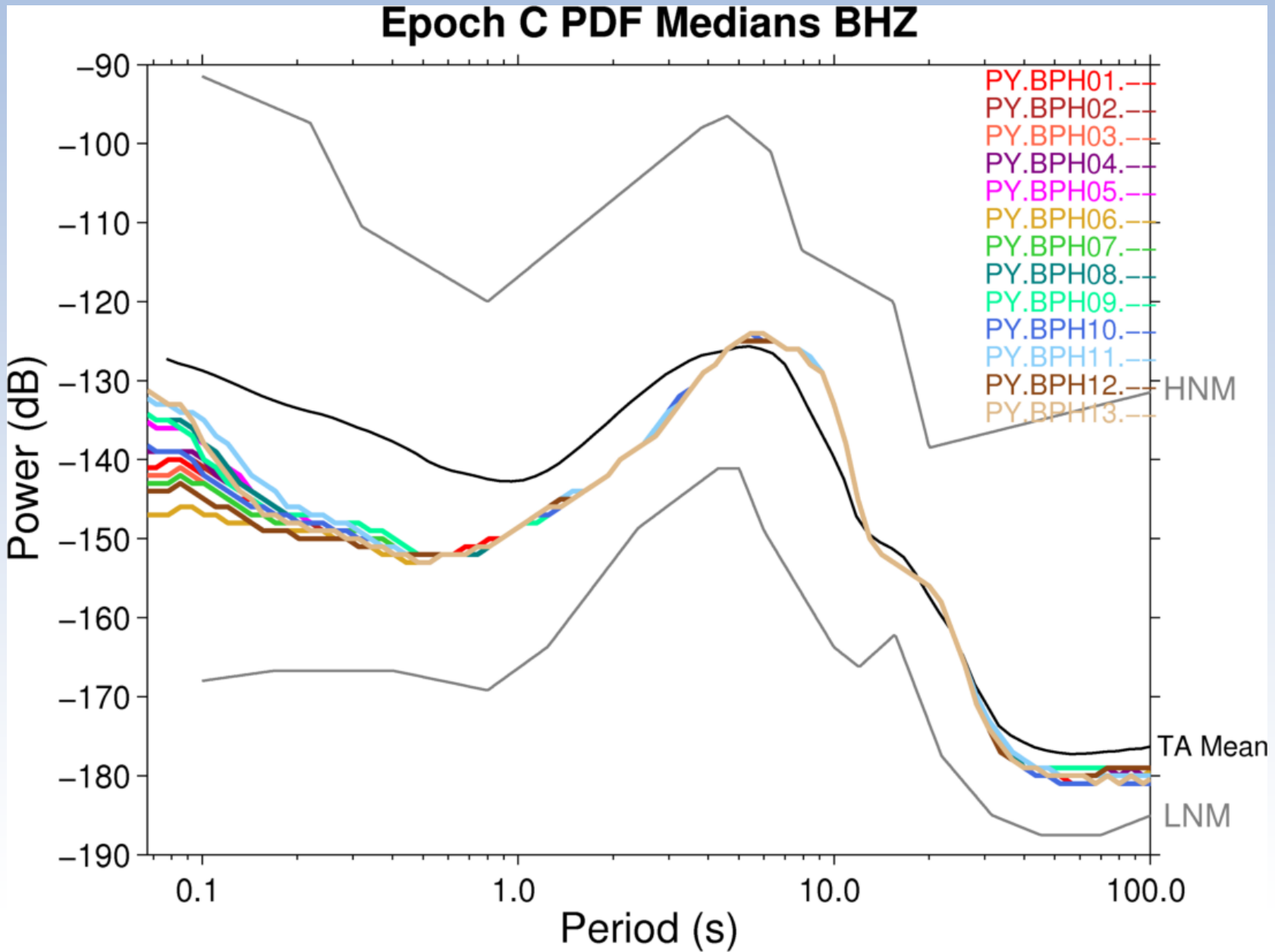
Installation: PVC case, sand fill, grouted annulus

Examples – Epoch C

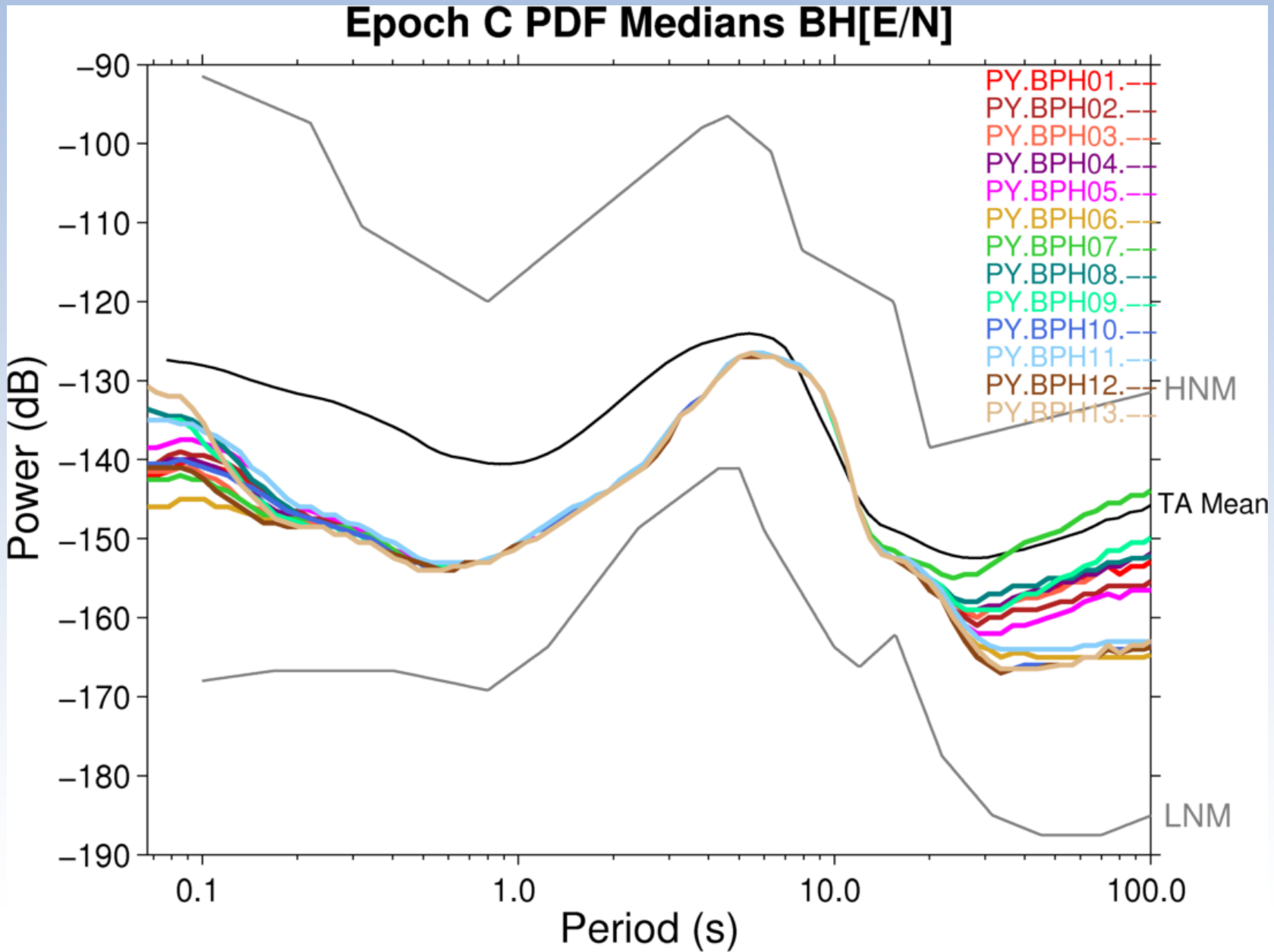


Installation: Steel case, sand fill, loose grouting at bottom of case

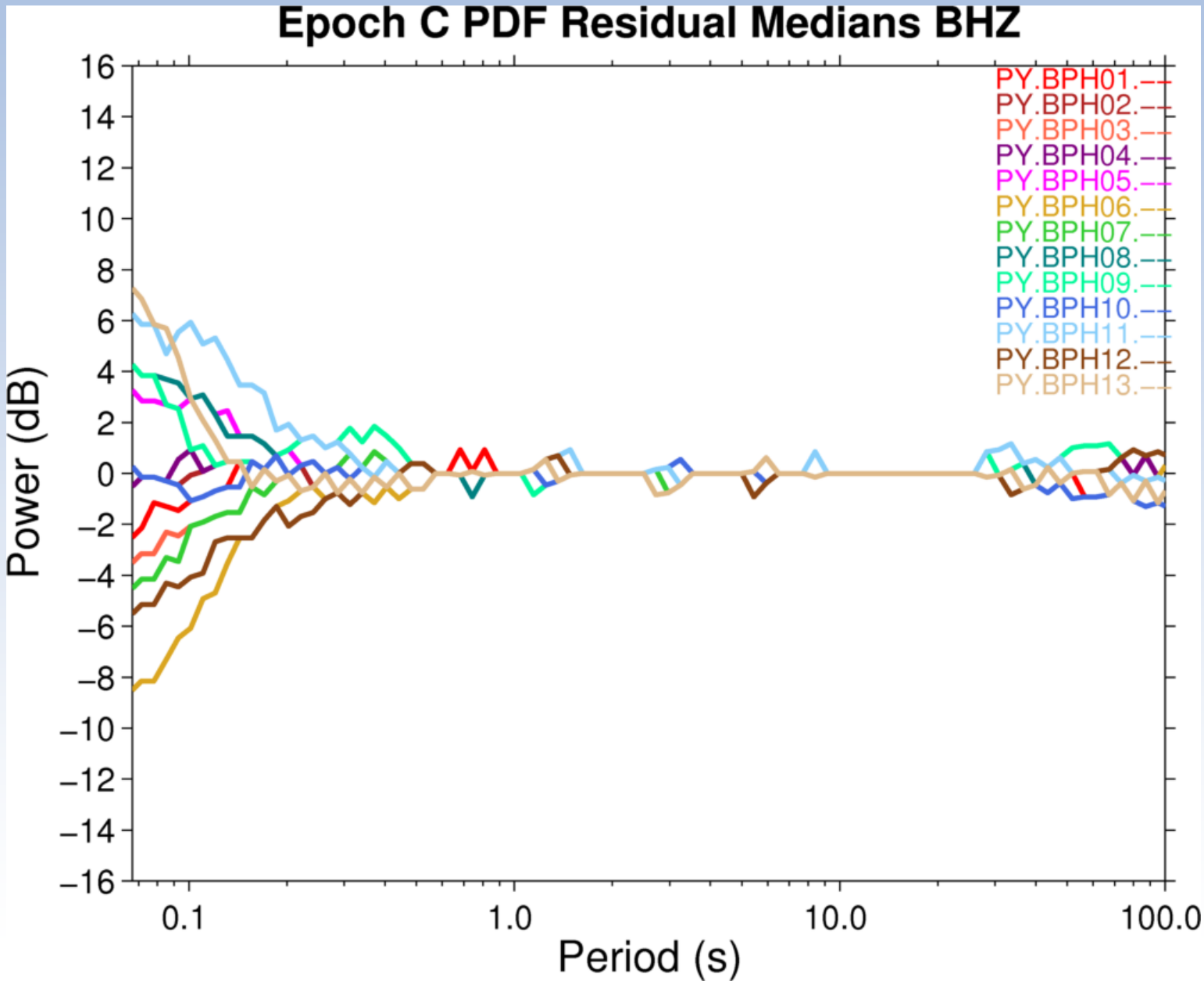
Epoch C


Epoch C PDF Medians BHZ
Power (dB)
−90
−100
−110
−120
−130
−140
−150
−160
−170
−180
−190
0.1
1.0
10.0
100.0
Period (s)
PY.BPH01.--
PY.BPH02.--
PY.BPH03.--
PY.BPH04.--
PY.BPH05.--
PY.BPH06.--
PY.BPH07.--
PY.BPH08.--
PY.BPH09.--
PY.BPH10.--
PY.BPH11.--
PY.BPH12.--
PY.BPH13.--
HNM
TA Mean
LNM

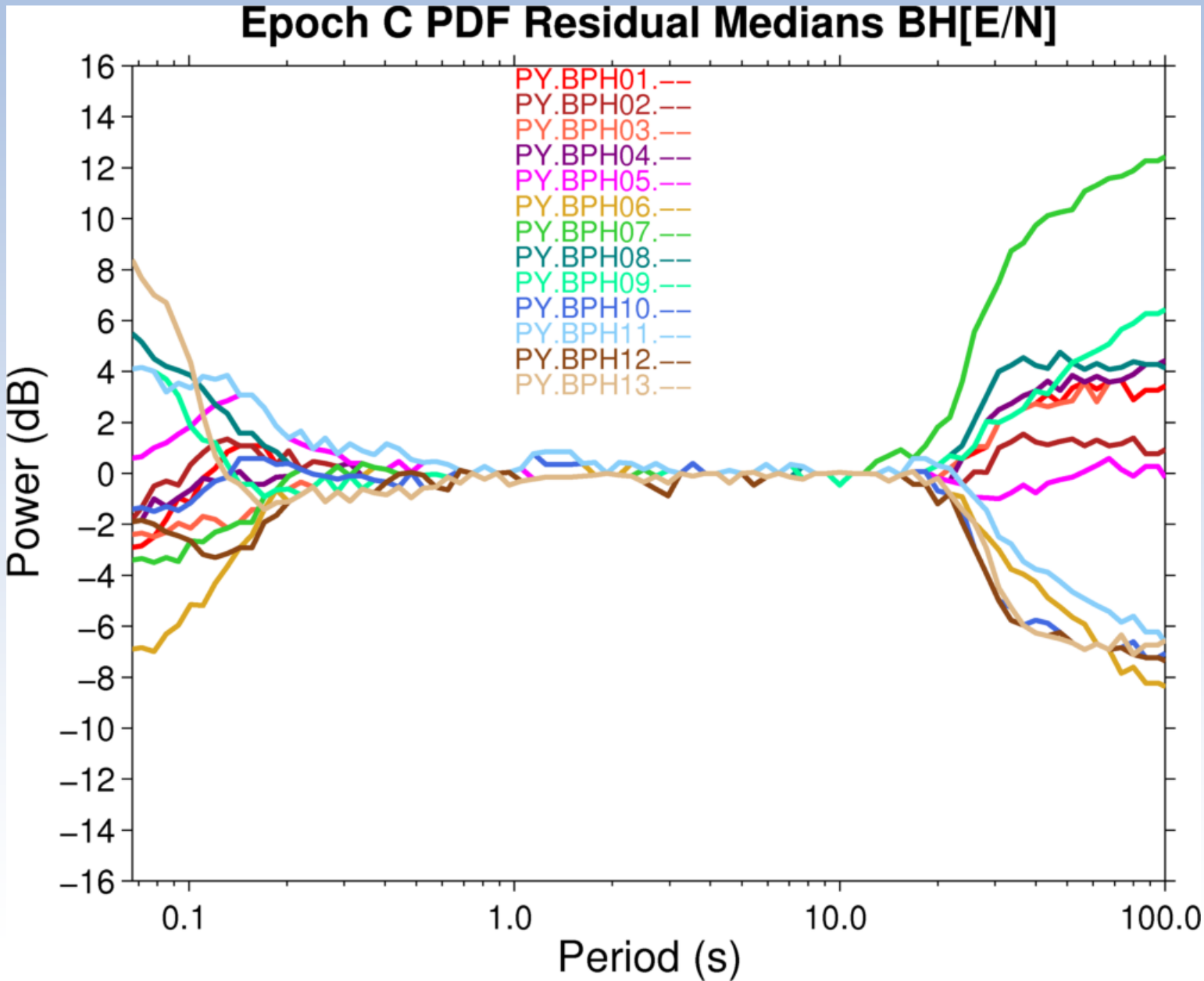
Epoch C


Epoch C PDF Medians BH[E/N]
Power (dB)
Period (s)
−90
−100
−110
−120
−130
−140
−150
−160
−170
−180
−190
0.1
1.0
10.0
100.0
PY.BPH01.--
PY.BPH02.--
PY.BPH03.--
PY.BPH04.--
PY.BPH05.--
PY.BPH06.--
PY.BPH07.--
PY.BPH08.--
PY.BPH09.--
PY.BPH10.--
PY.BPH11.--
PY.BPH12.--
PY.BPH13.--
HNM
TA Mean
LNM

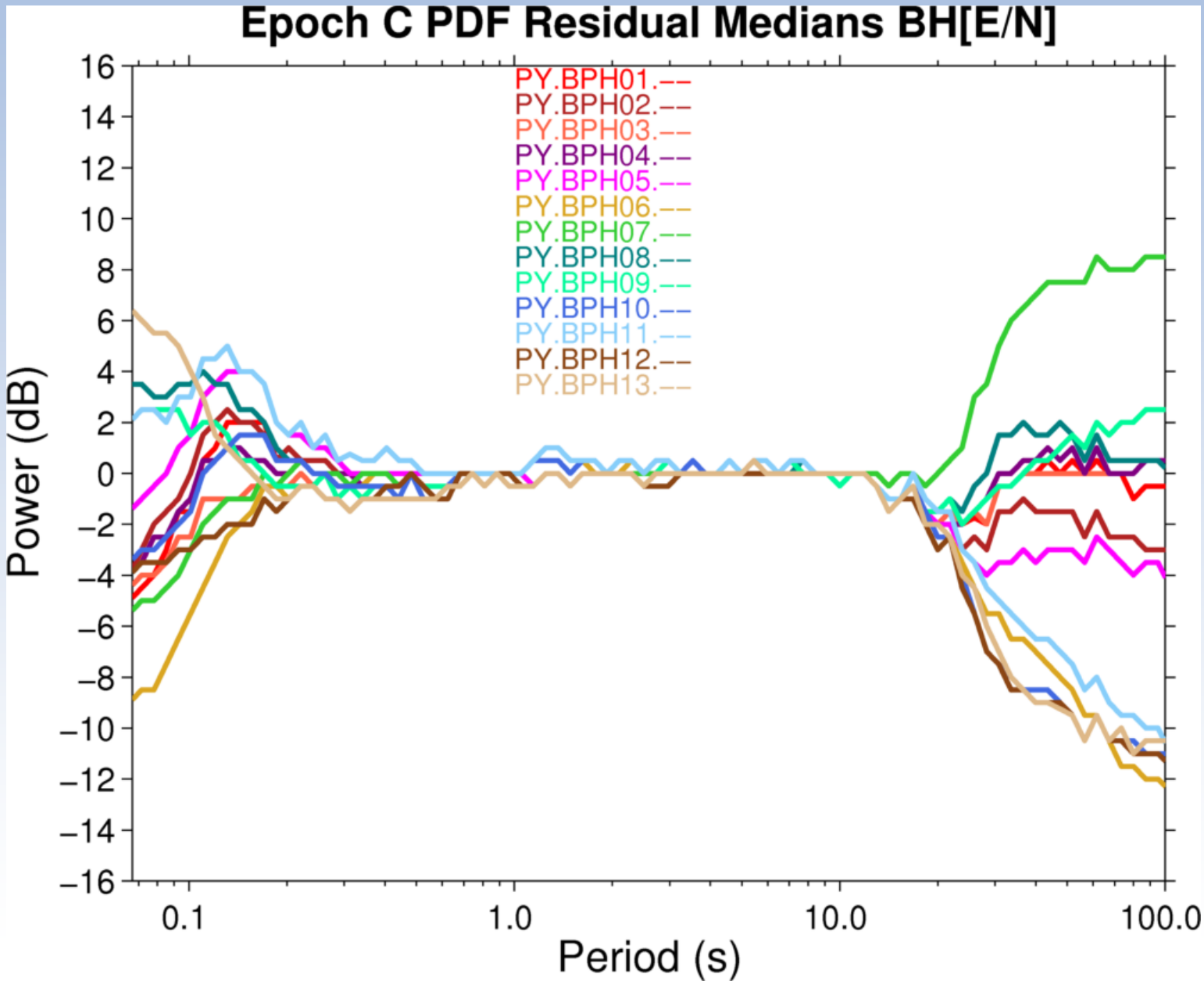
Epoch C – PY Mean Ref.



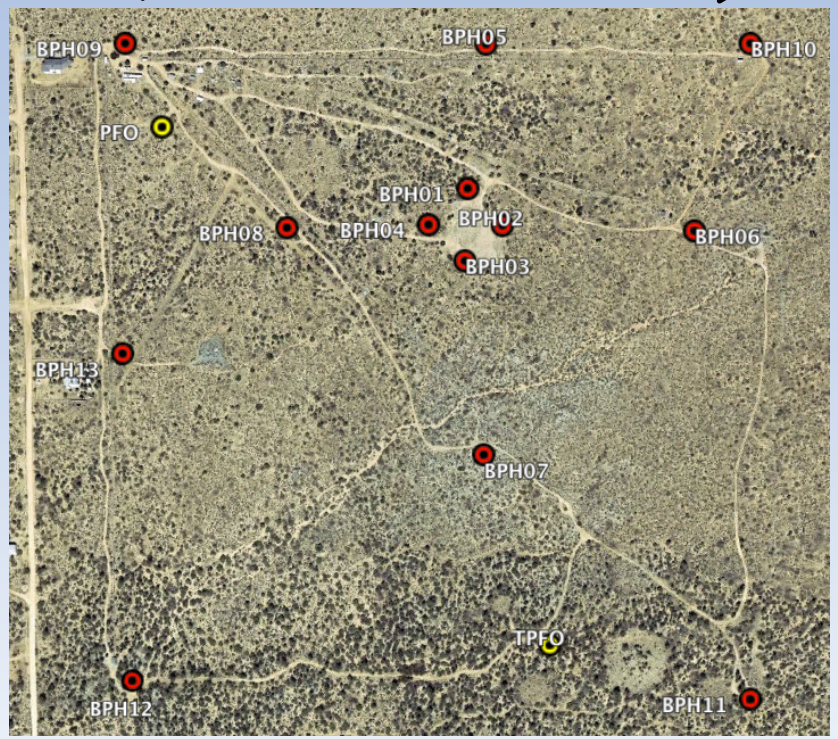
Epoch C – PY Mean Ref.

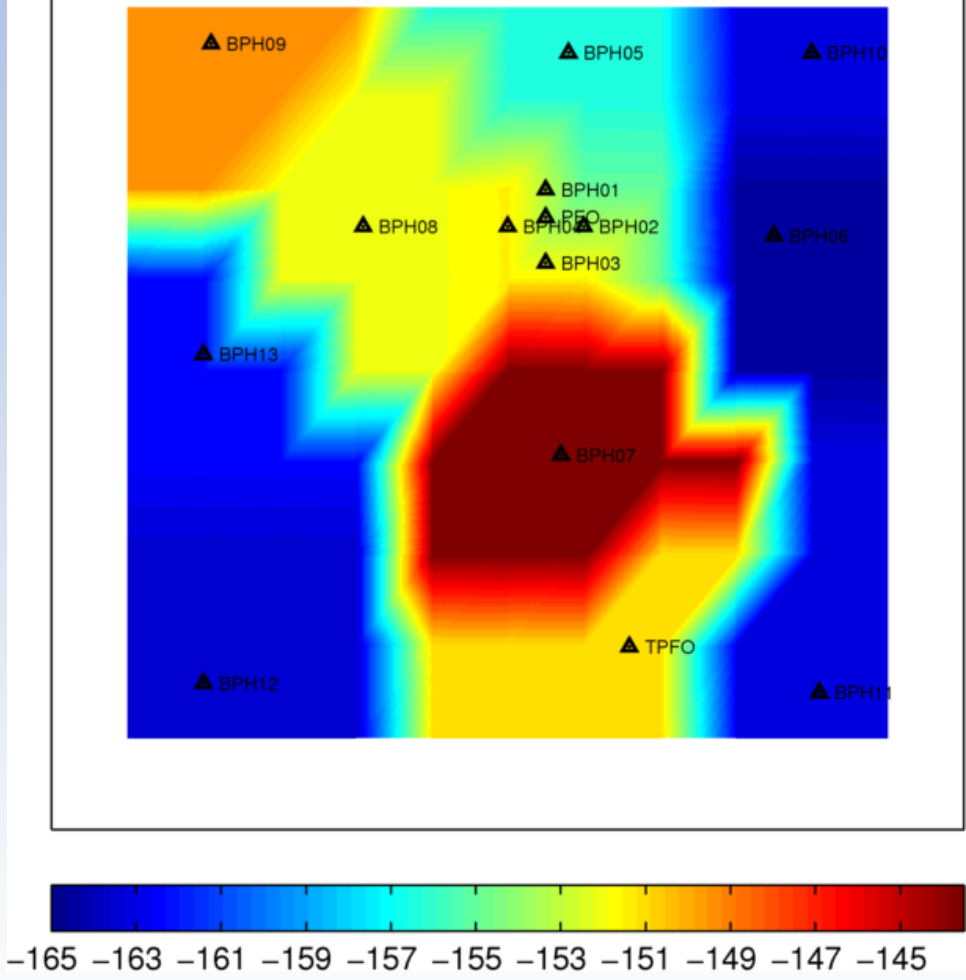


Epoch C – TA.TFPO Ref.



Median Noise Levels

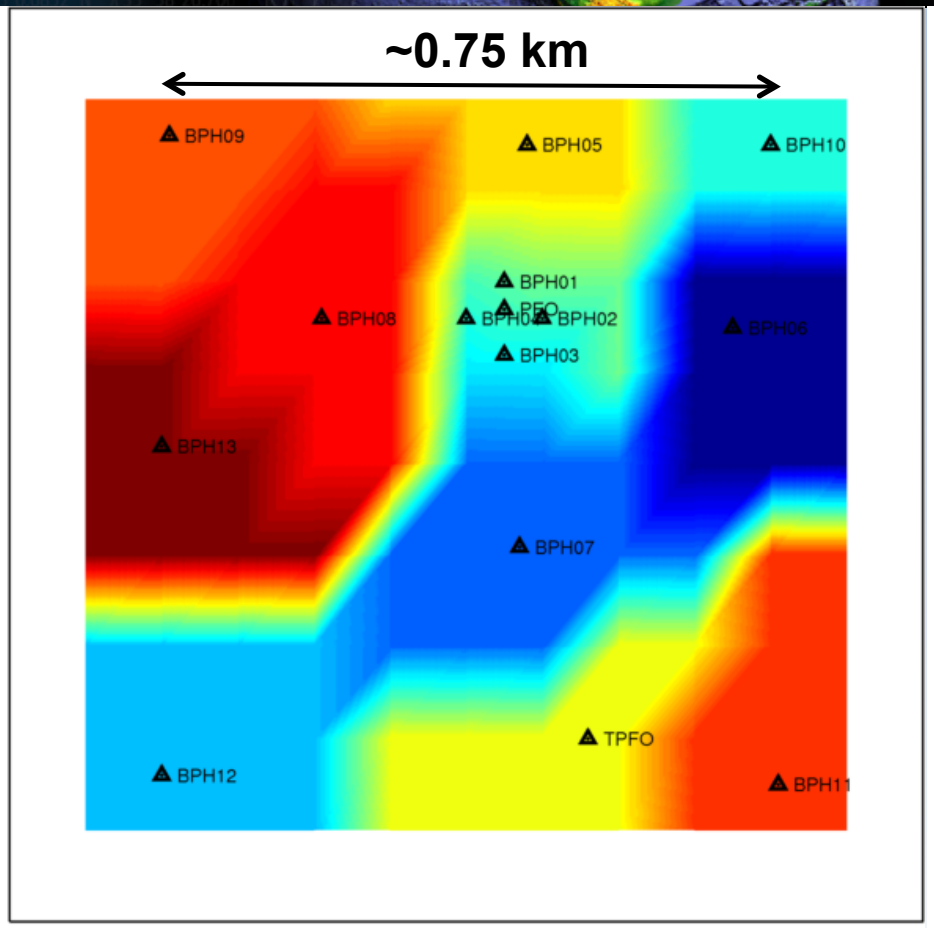


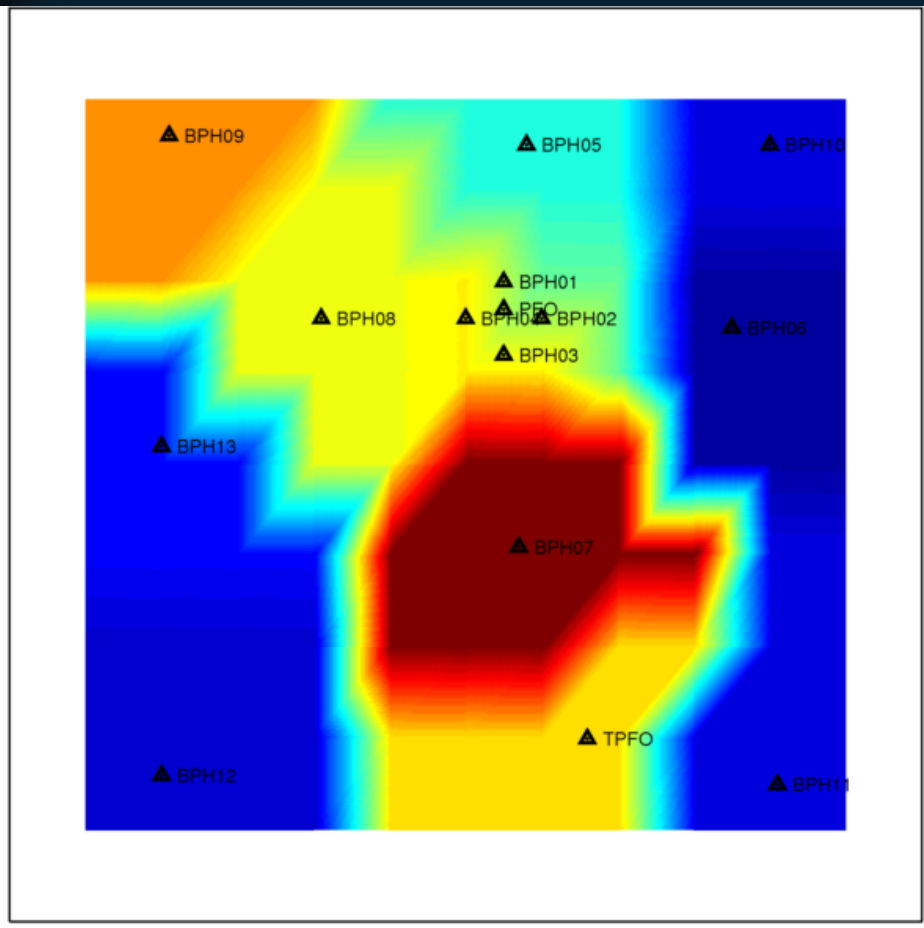


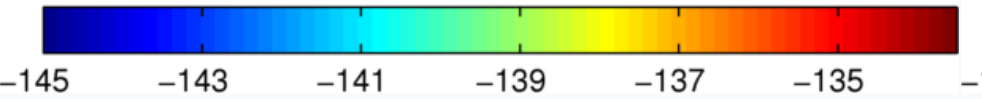
~100 seconds

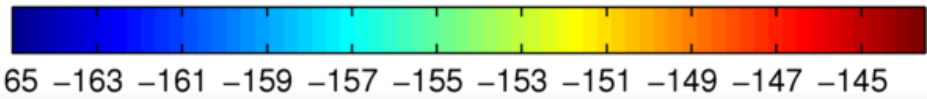
Good correlation w/grouting type at long periods.

Median Noise Levels







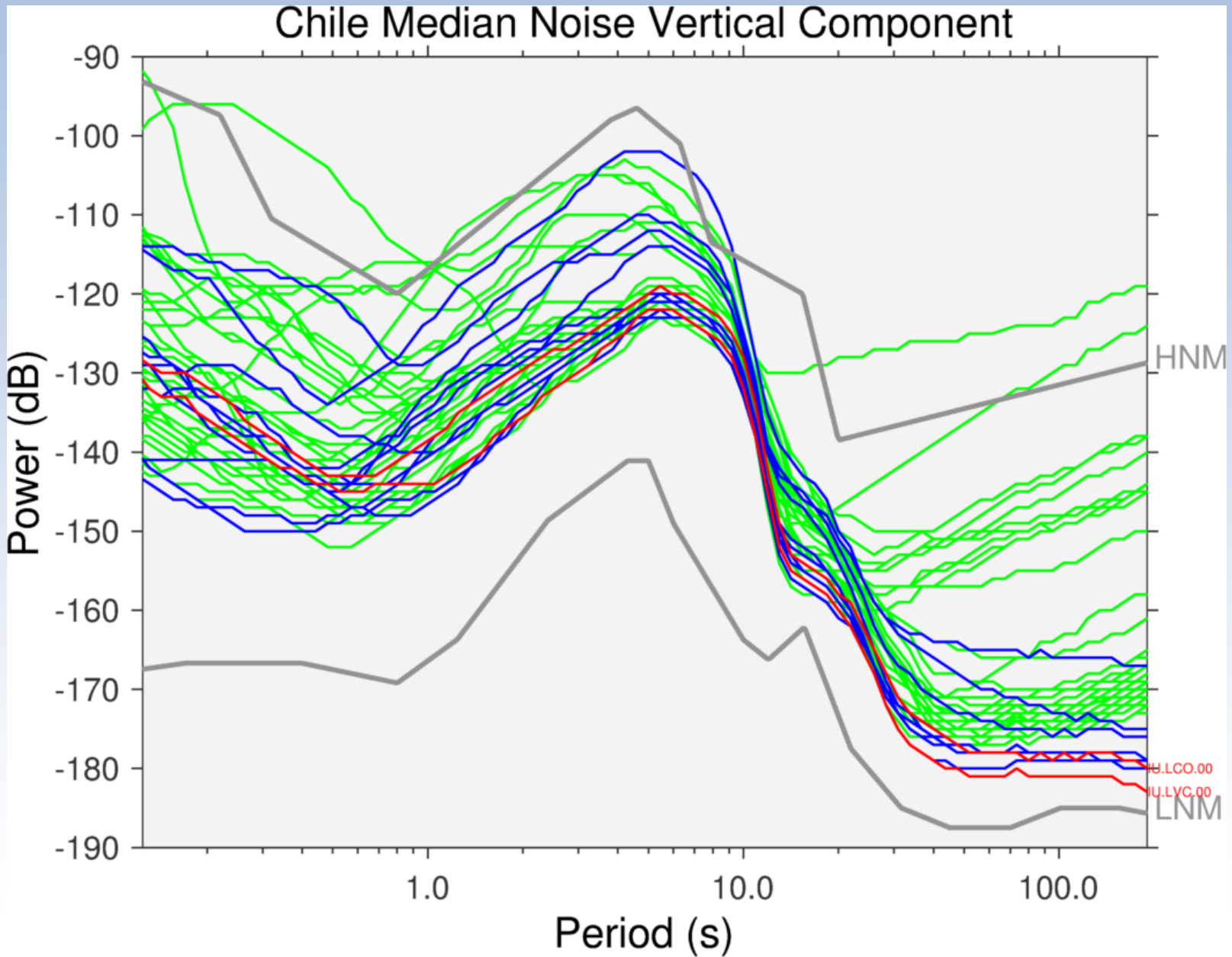


~11 Hz

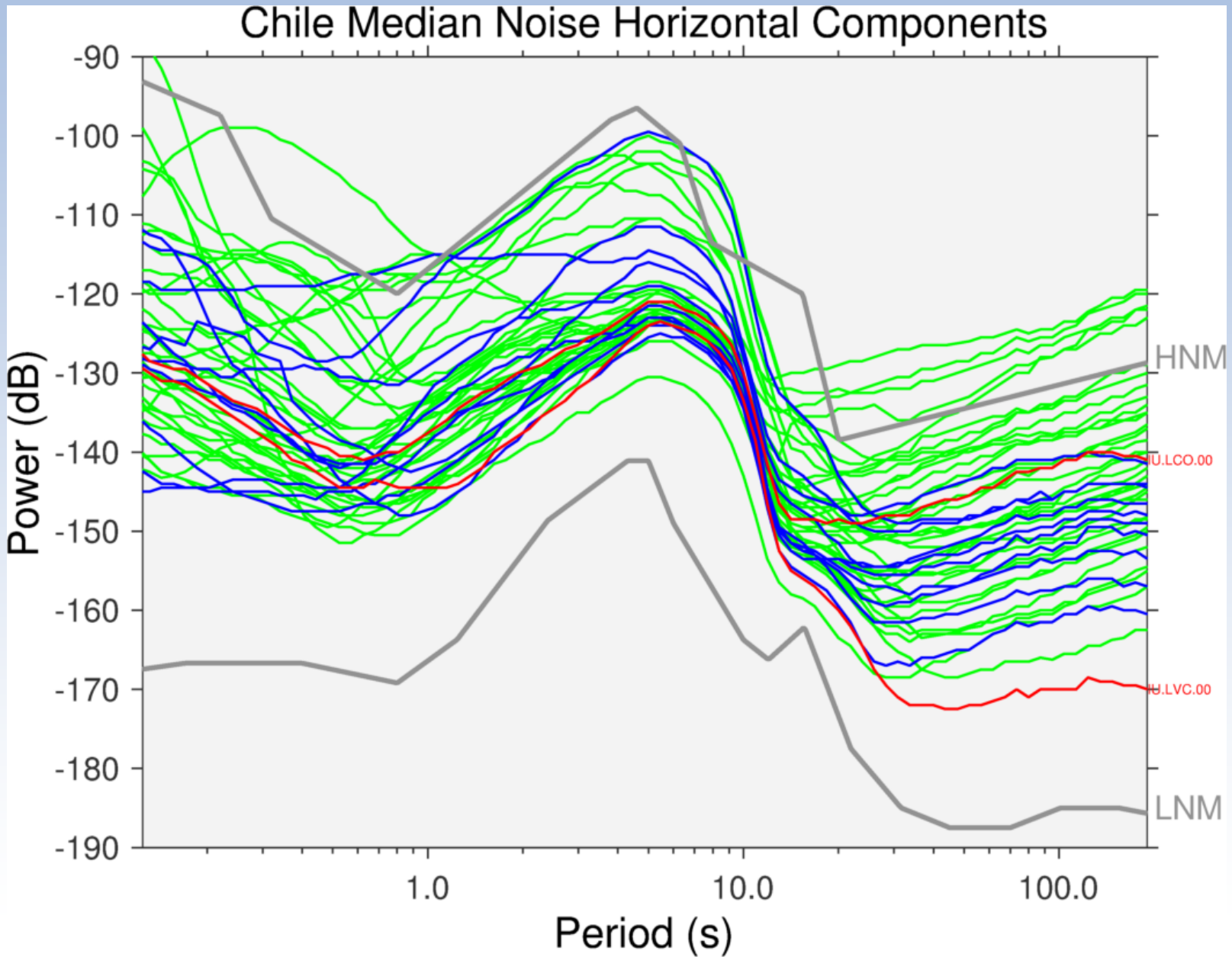
~100 seconds

Good correlation w/grouting type at long periods.

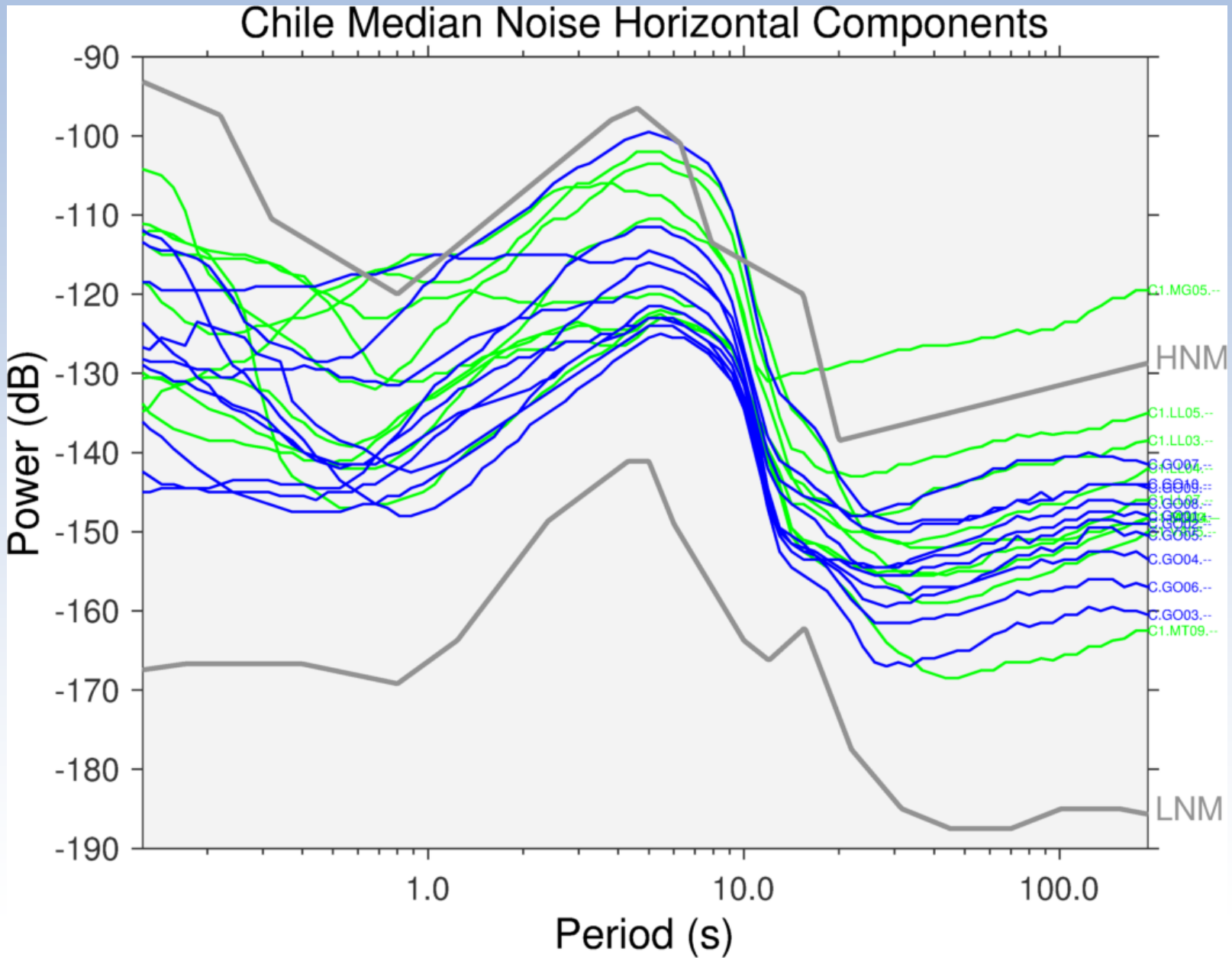
Looking at Chile



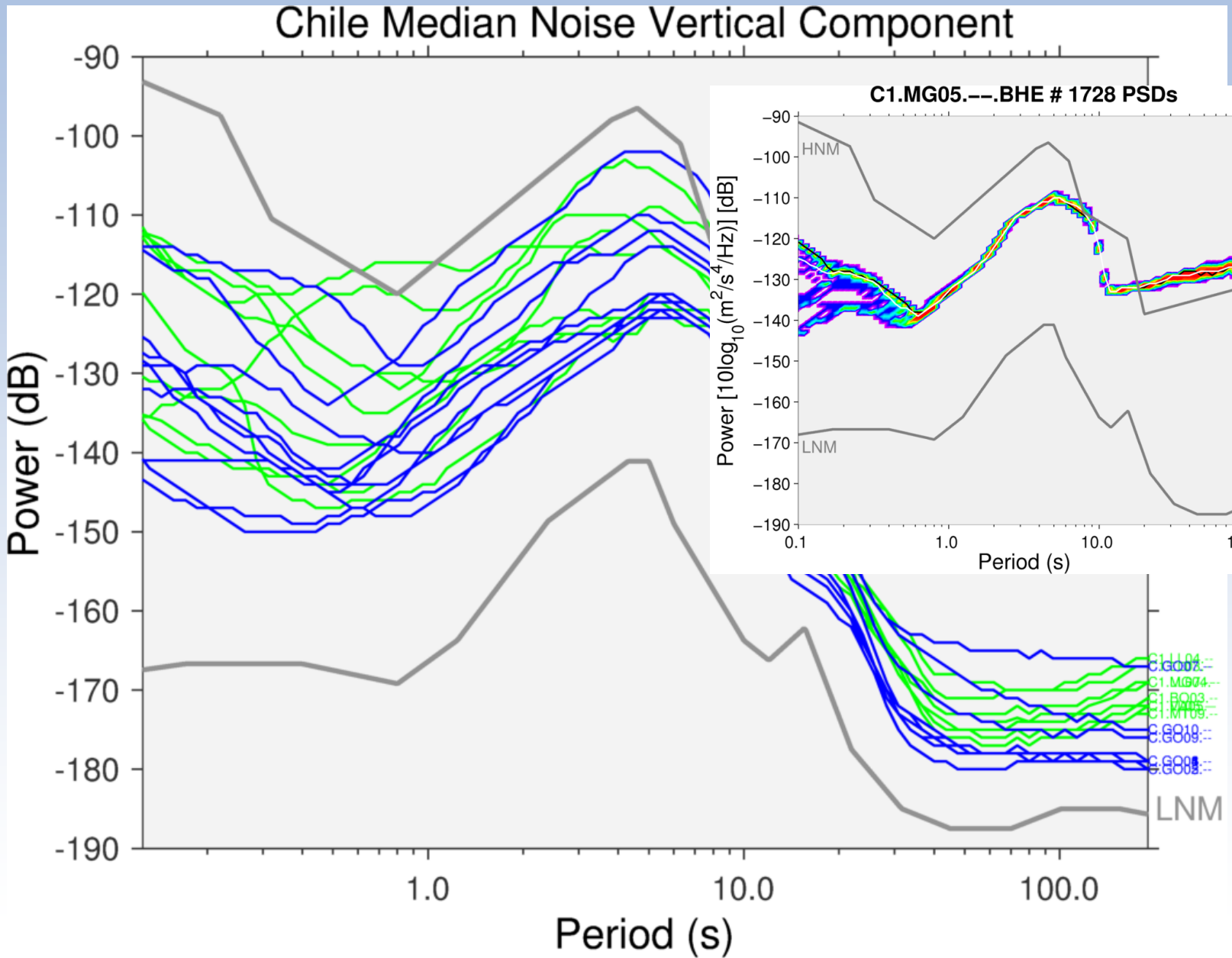
Looking at Chile



Just C and C1 (TA-like)



Just C and C1 (TA-like)

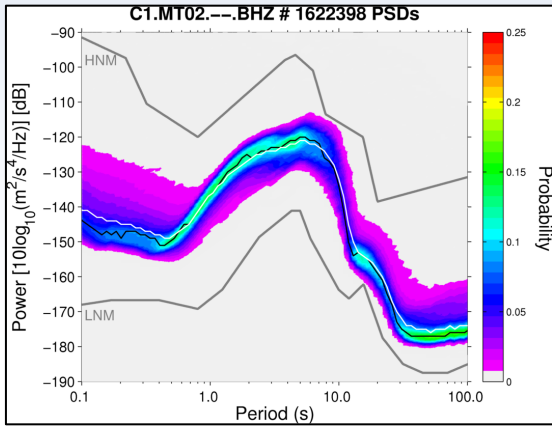


Making a C1 Example

grab_pdf_all_C1.bash — Edited

```
#!/bin/bash
#
home=`pwd`

#START="2011-01-01"; END="2016-01-01"
START="2013-05-01"; END="2015-05-01"

curl "http://service.iris.edu/fdsnws/station/1/query?net=C1&sta=*&loc=--&cha=BH?&starttime=${START}T00:00:00&endtime=${END}T00:00:00&level=channel&format=text&nodata=404" > temp
tail +2 temp > GRO_Chile2.txt; rm temp

if [ ! -d "PDFPSD" ]; then
    mkdir PDFPSD
fi

while read line; do
   name=$line;
   NET=`echo $name | awk -F'|' '{print $1}'`;
   STA=`echo $name | awk -F'|' '{print $2}'`;
   LOC=`echo $name | awk -F'|' '{print $3}'`;
   CHA=`echo $name | awk -F'|' '{print $4}'`;

   case $LOC in
   "")
      LOC="--";;
   *)
   esac

   echo $NET.$STA.$LOC.$CHA
   curl "http://service.iris.edu/mustang/noise-pdf/1/query?net=${NET}&sta=${STA}&loc=${LOC}&cha=${CHA}&quality=M&starttime=${START}&endtime=${END}&format=text" > temp
   tail +7 temp > PDFPSD/${NET}.${STA}.${LOC}.${CHA}.bin
done < GRO_Chile2.txt
```

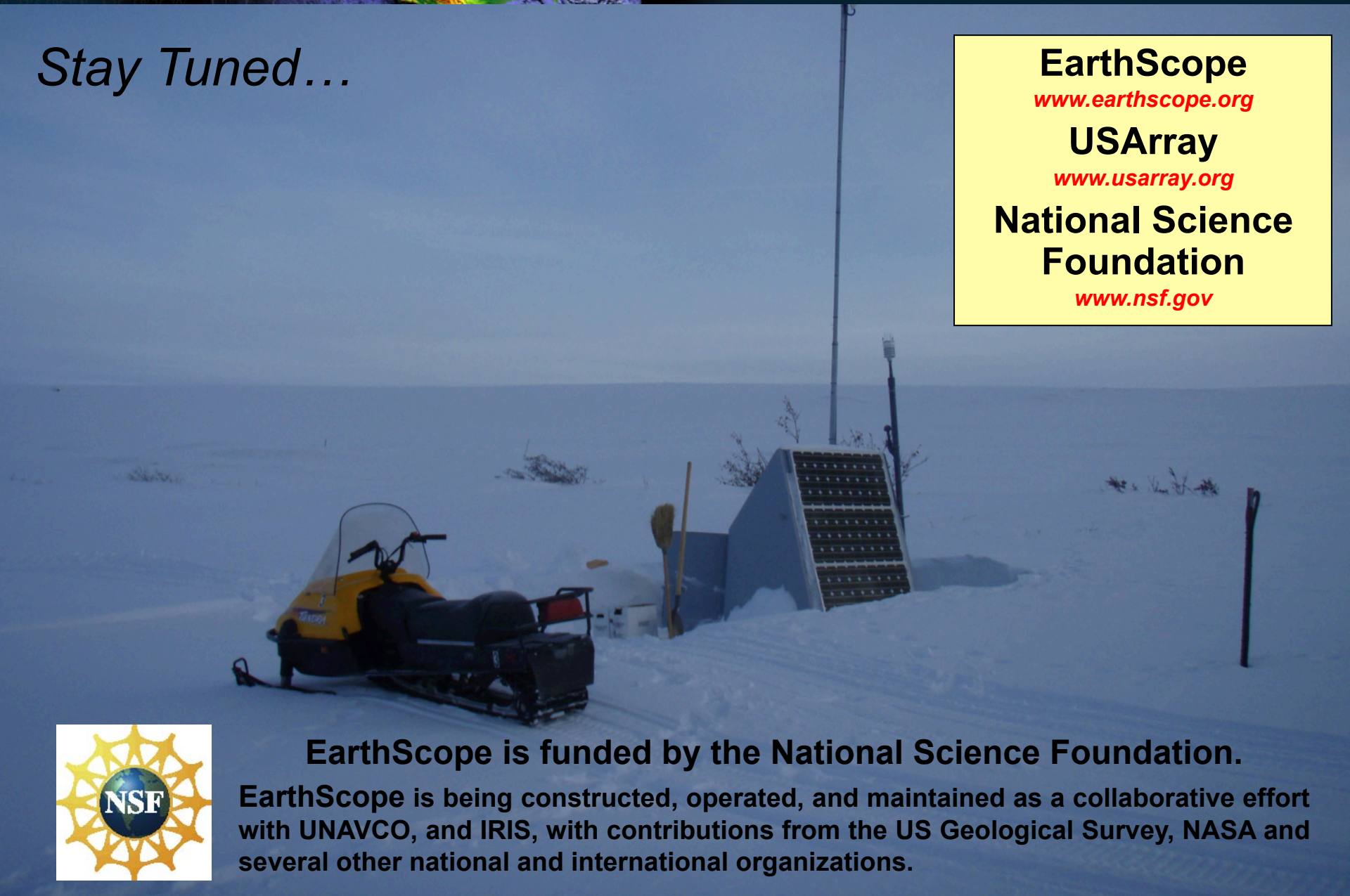
.bin file → MATLAB (or whatever you like) →



Thanks!

Stay Tuned…

EarthScope
www.earthscope.org
USArray
www.usarray.org
National Science Foundation
www.nsf.gov



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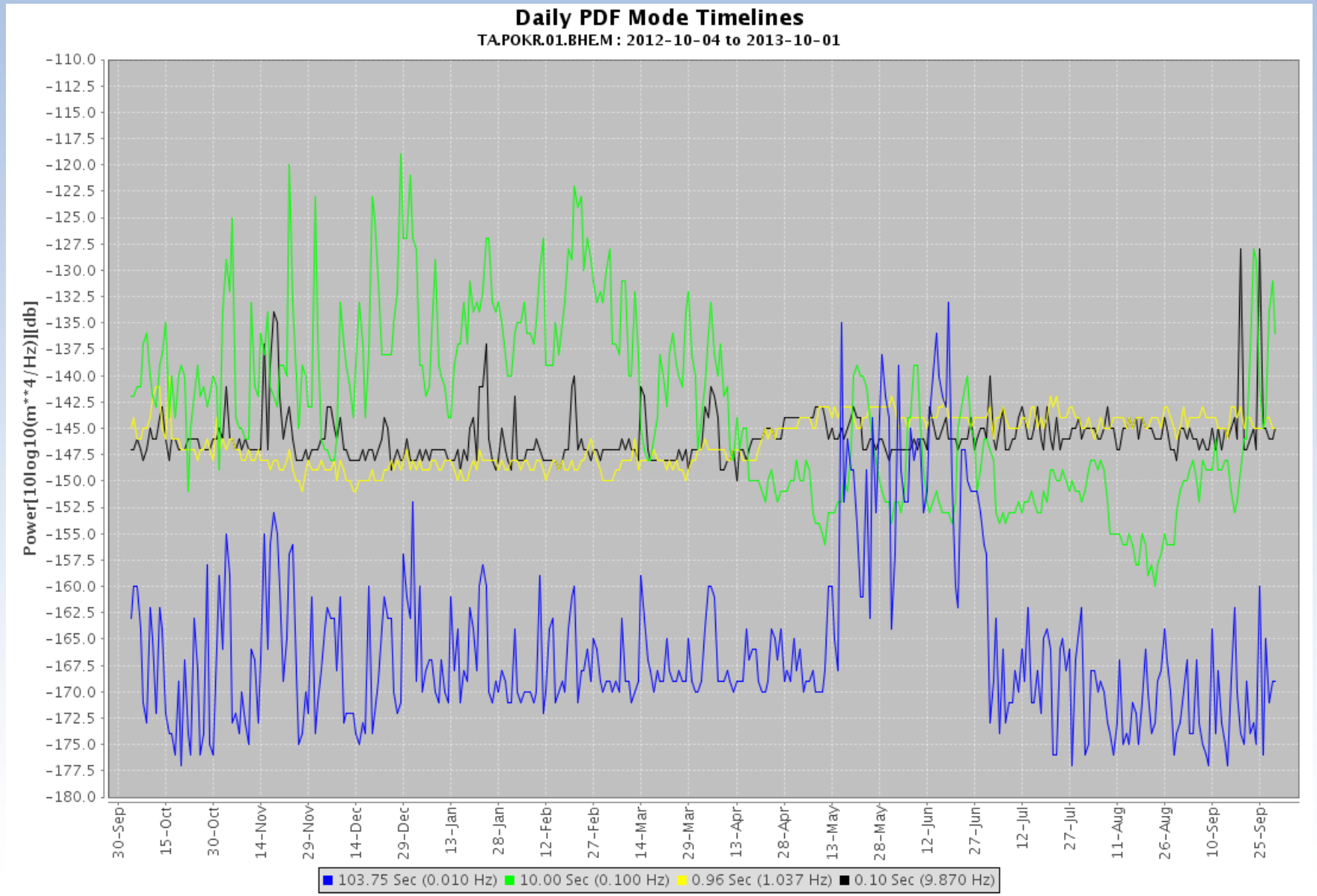
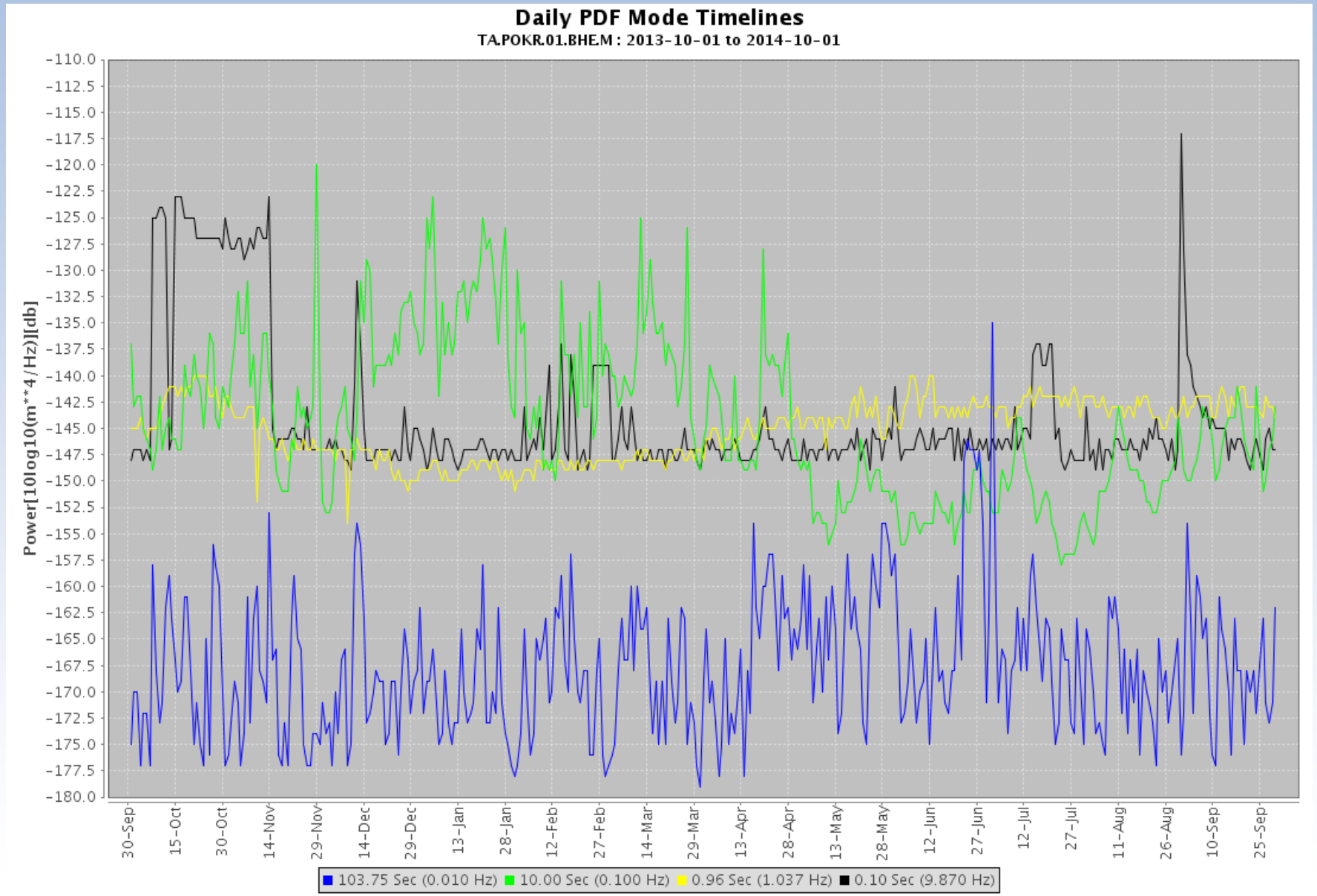
Station Seasonality



Station Seasonality