

travtime = evttime-evtstarttime

Delta4syn: a modification, assure
the difference of two time above
is integer multiples of delta;

evttime-eventcutb

scntimestart+travtime-redundance-delta4syn

first point of segment that
correlate with tp well

same point

evtst->evttime_cutb + travtime - offset

scntimestart

scnsac[i]

sacCC[i]

sacstack

sacstack(weak)

position of
true max

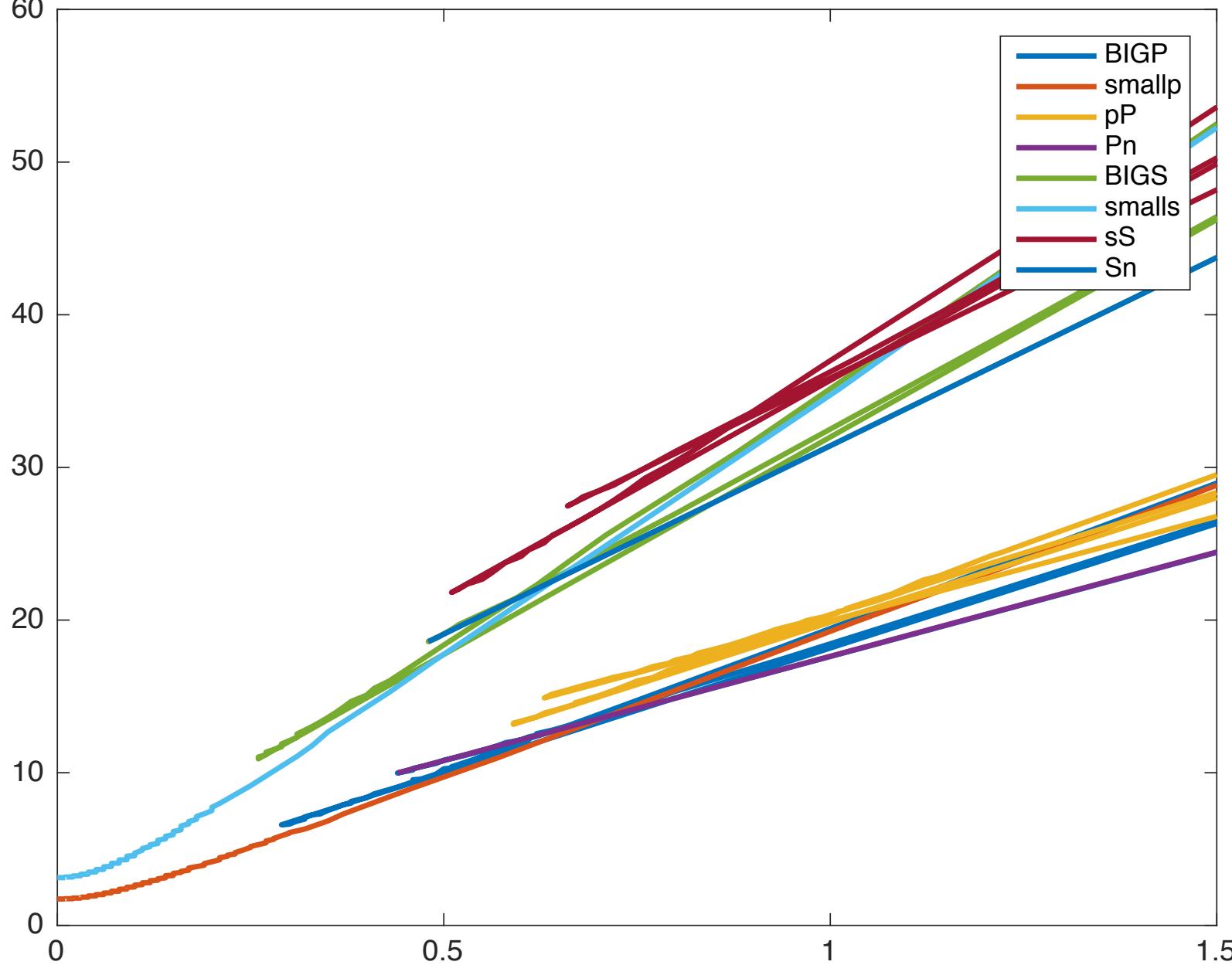
Remove tp->npts - 1
points from end

- Traveltme
compared with up two line

Remove weak_nMAX-1
points from begin

N: n_point(n_point_bak) count from 0
T: evtst->evttime_cutb

Travel Time Map



Time-Frequency Analysis (1hz+) length=40s

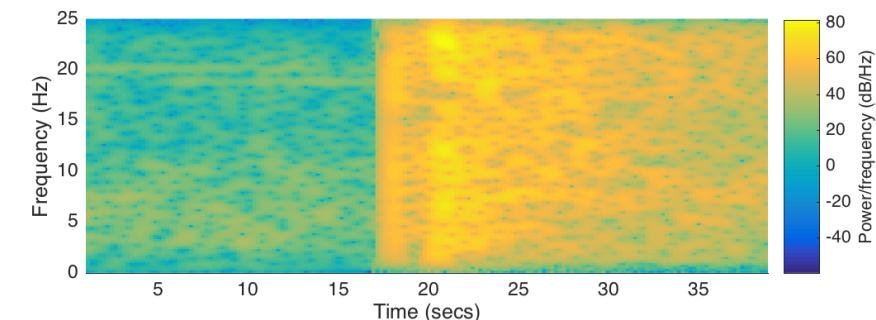
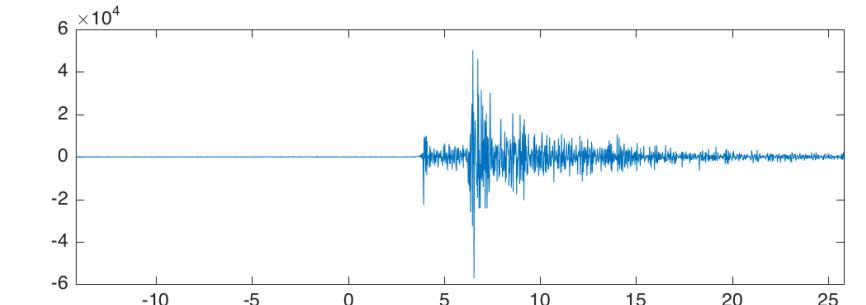
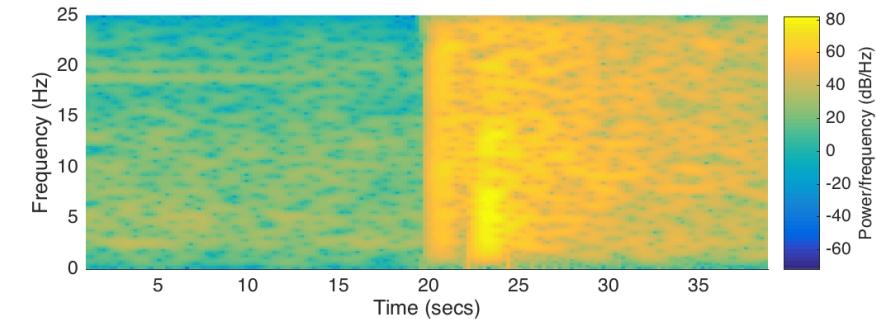
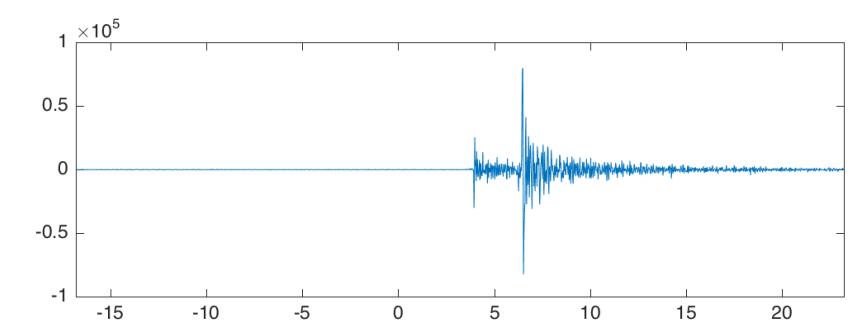
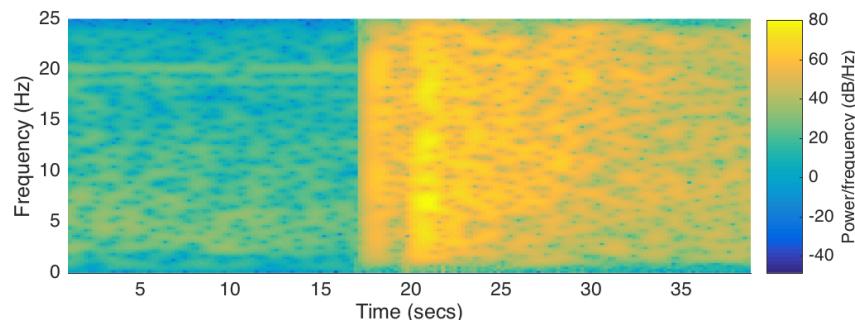
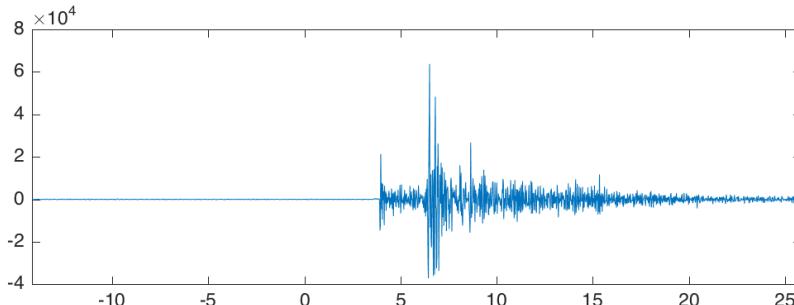
```
spectrogram(y,round(numel(y)/4.5/4),round(n  
umel(y)/4.5/4*0.9),[],1/delta,'yaxis');
```

CSN130604034404

LN.DDO

Z

N E



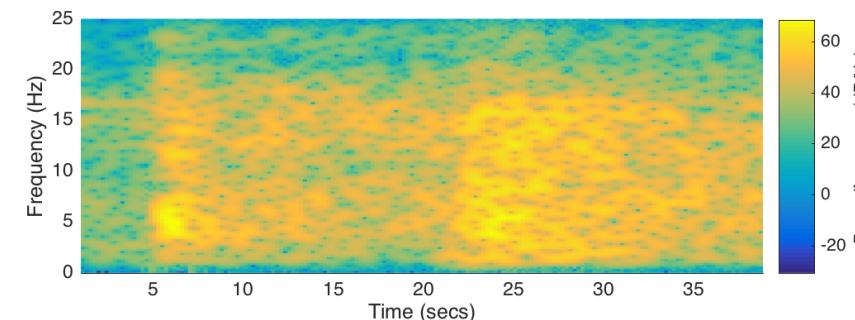
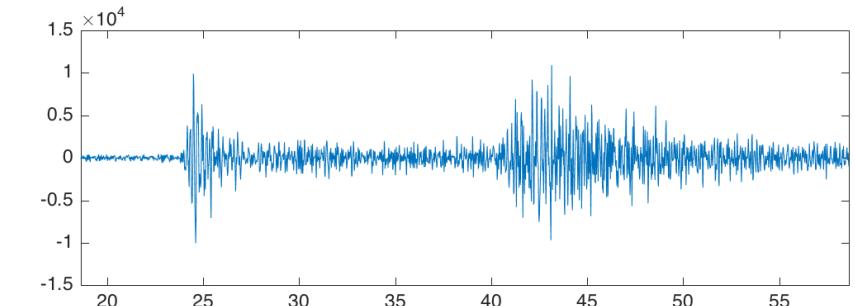
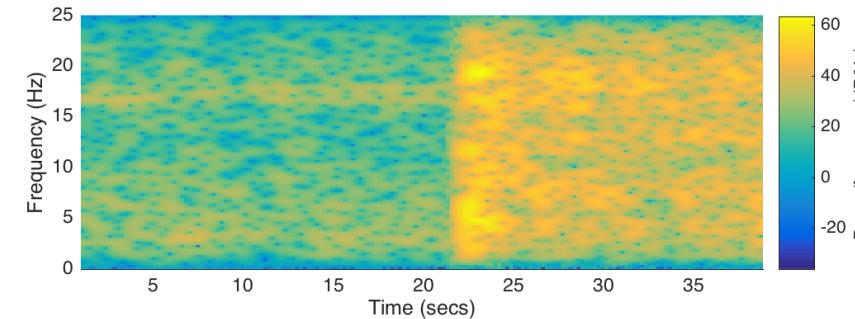
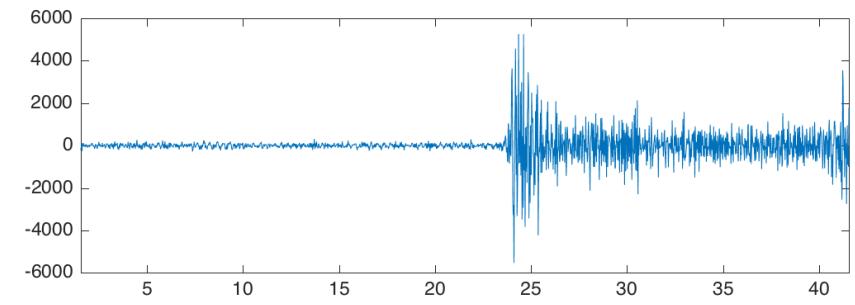
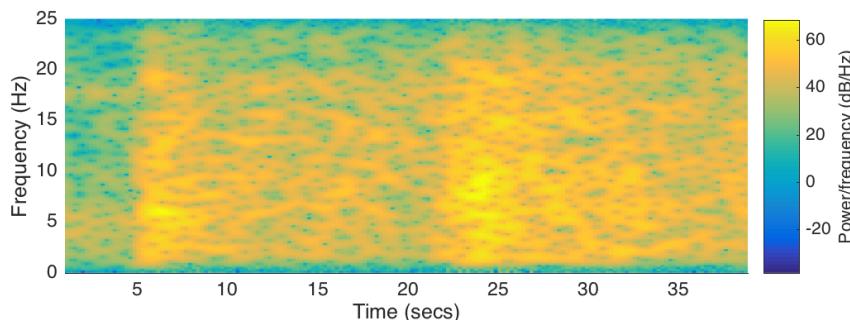
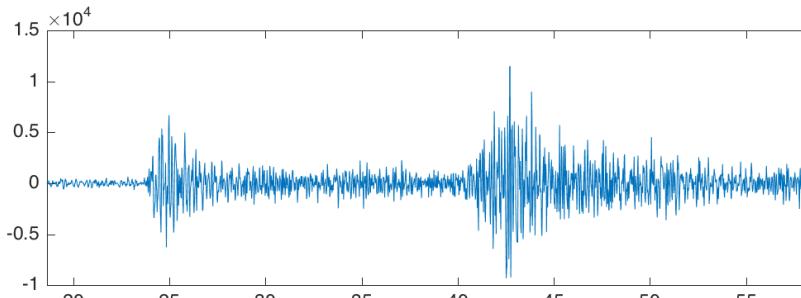
Time-Frequency Analysis (1hz+)

CSN130604034404

LN.BXI

Z

N E



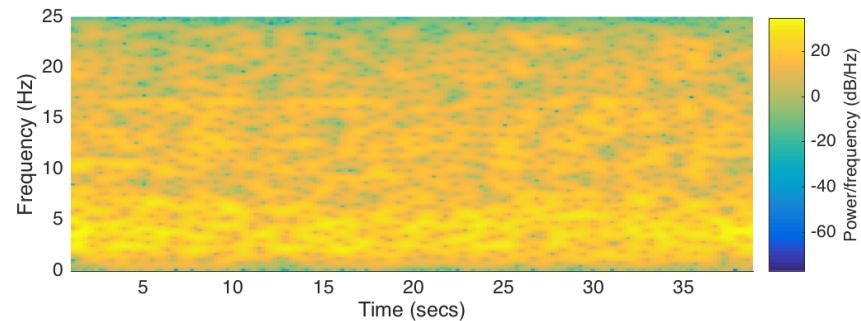
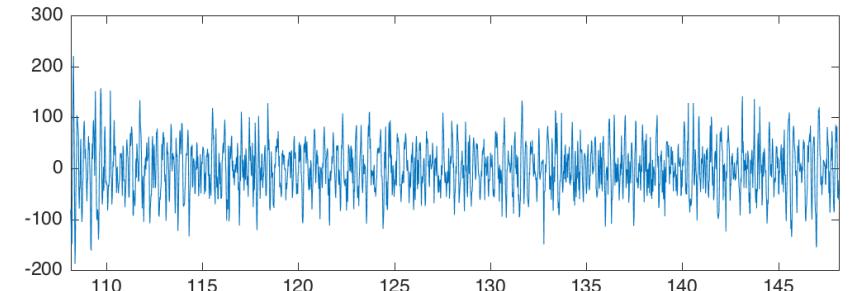
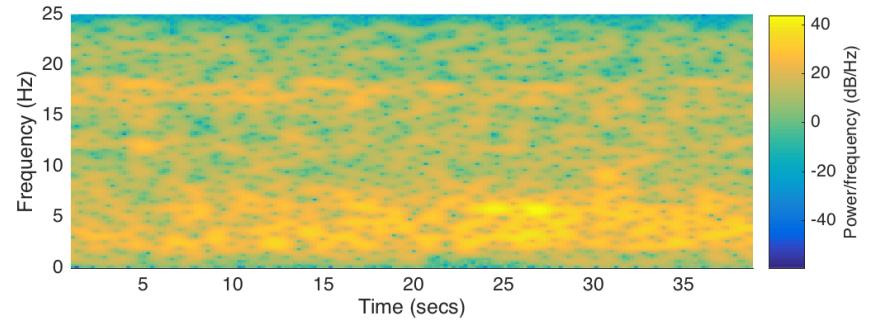
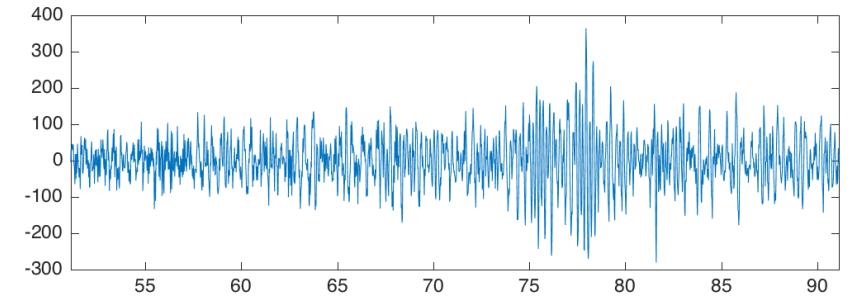
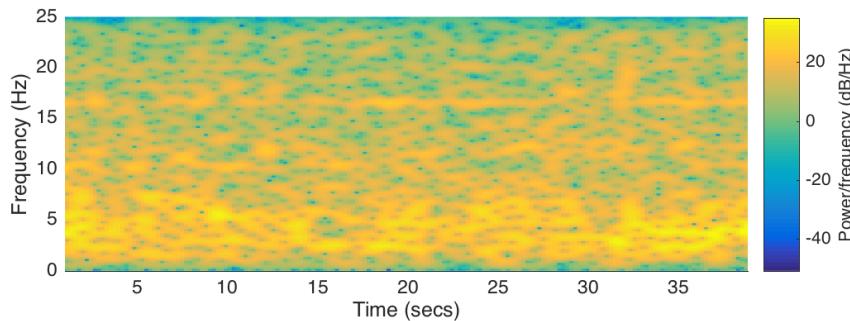
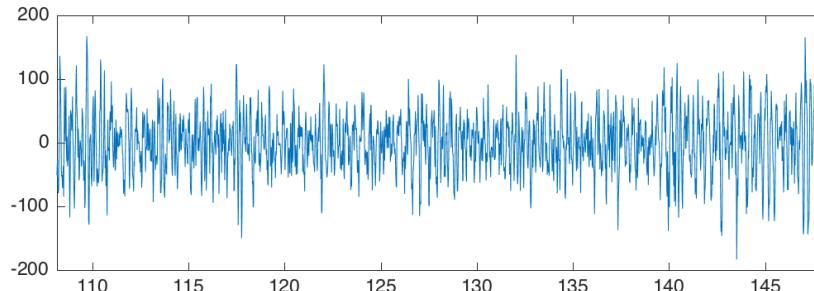
Time-Frequency Analysis (1hz+)

CSN130604034404

BU.CDT

Z

N E



Problems about cross correlation

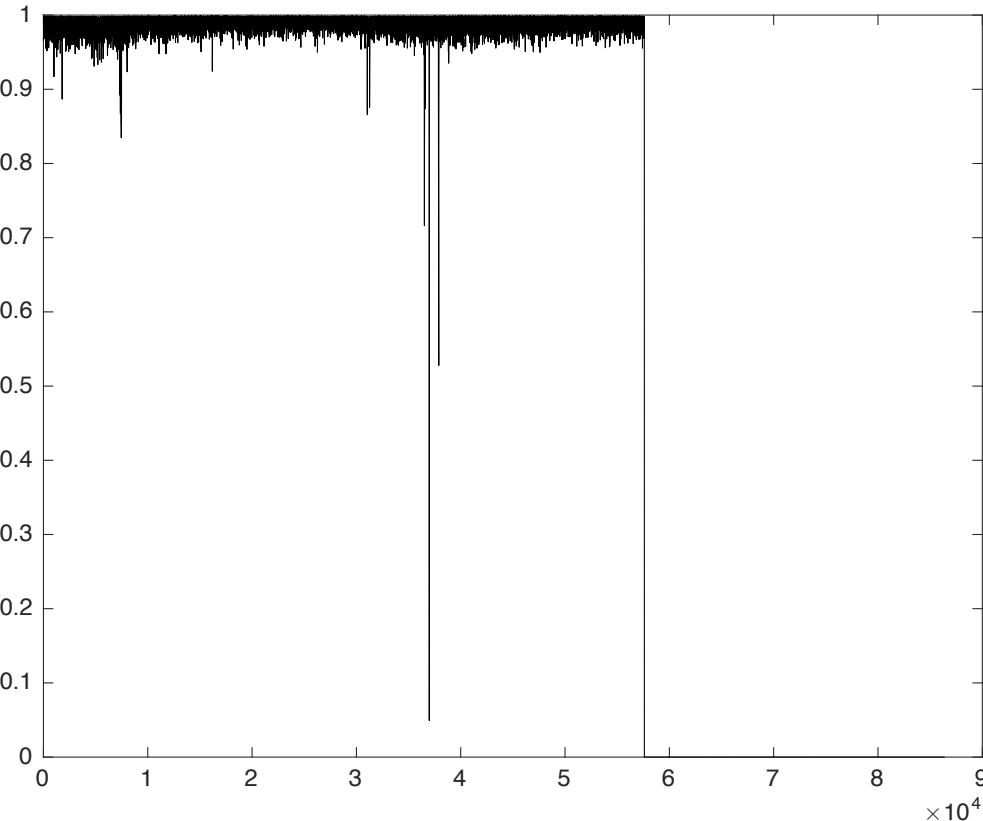
$$A_i = a_i + \bar{A}$$

$$B_i = b_i + \bar{B}$$

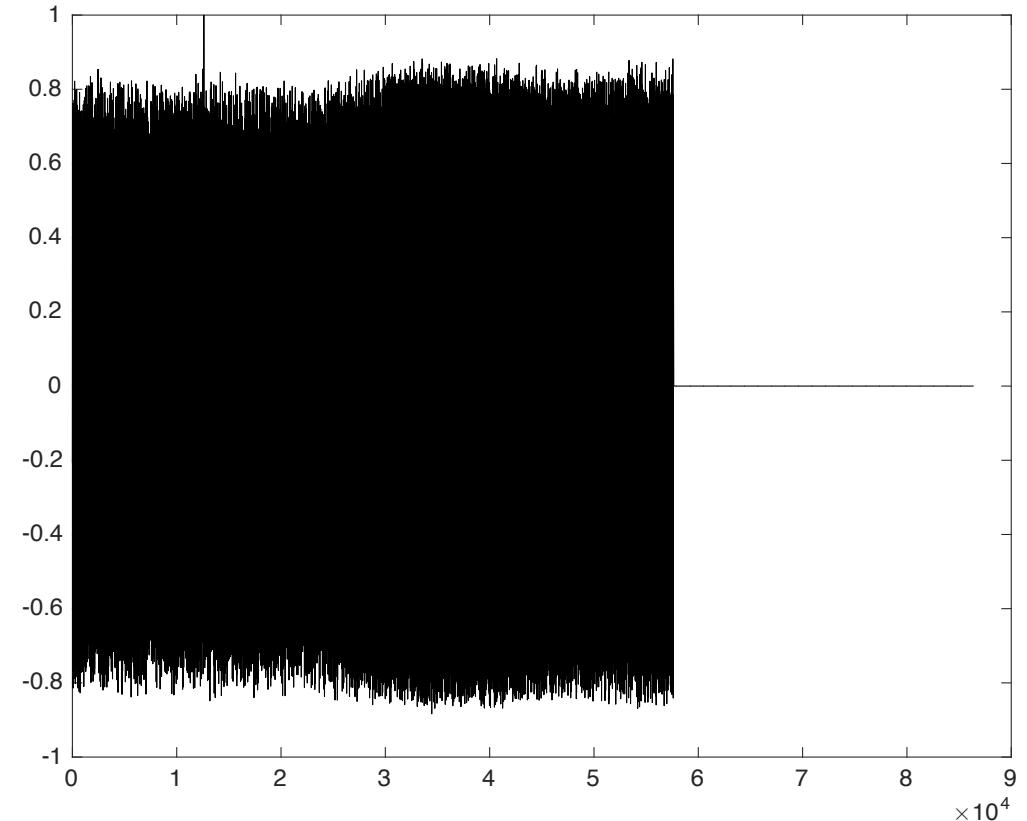
$$CC = \frac{\sum a_i b_i + n\bar{A}\bar{B}}{\sqrt{(\sum a_i^2 + n\bar{A}^2)(\sum b_i^2 + n\bar{B}^2)}}$$

$$CC_{True} = \frac{\sum a_i b_i}{\sqrt{\sum a_i^2 \sum b_i^2}}$$

Problems about cross correlation – no filter

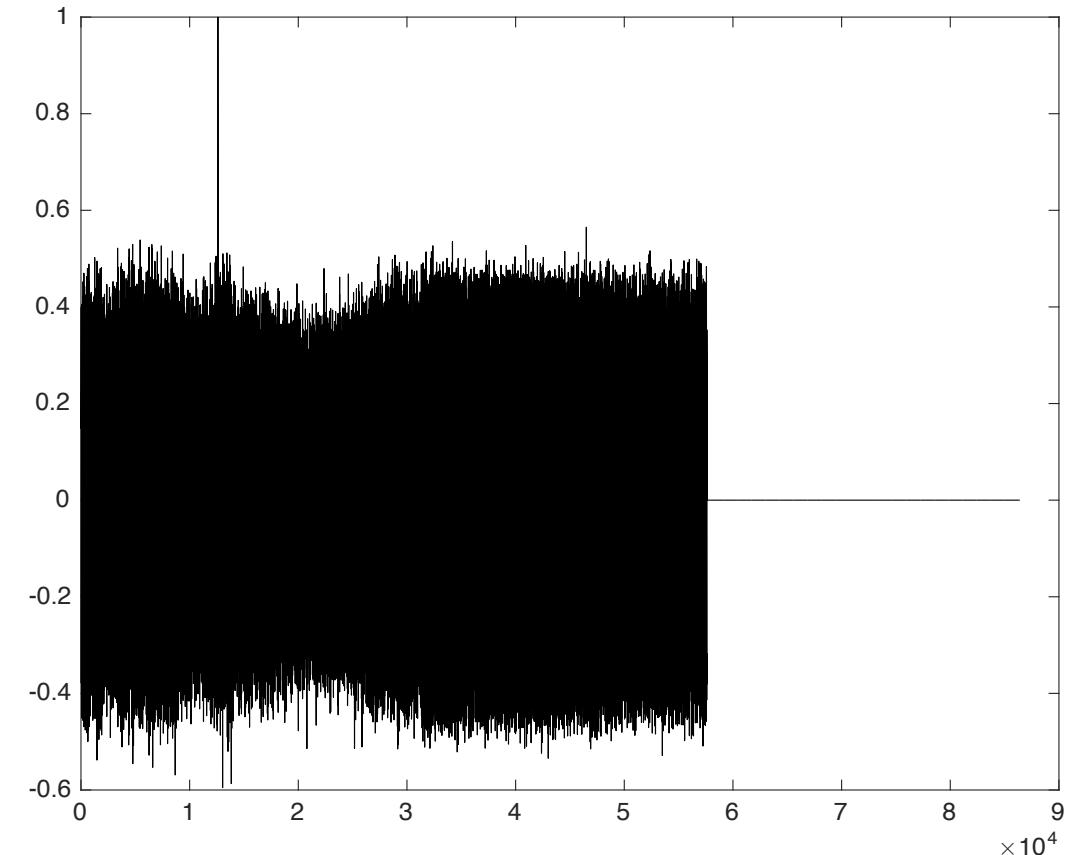
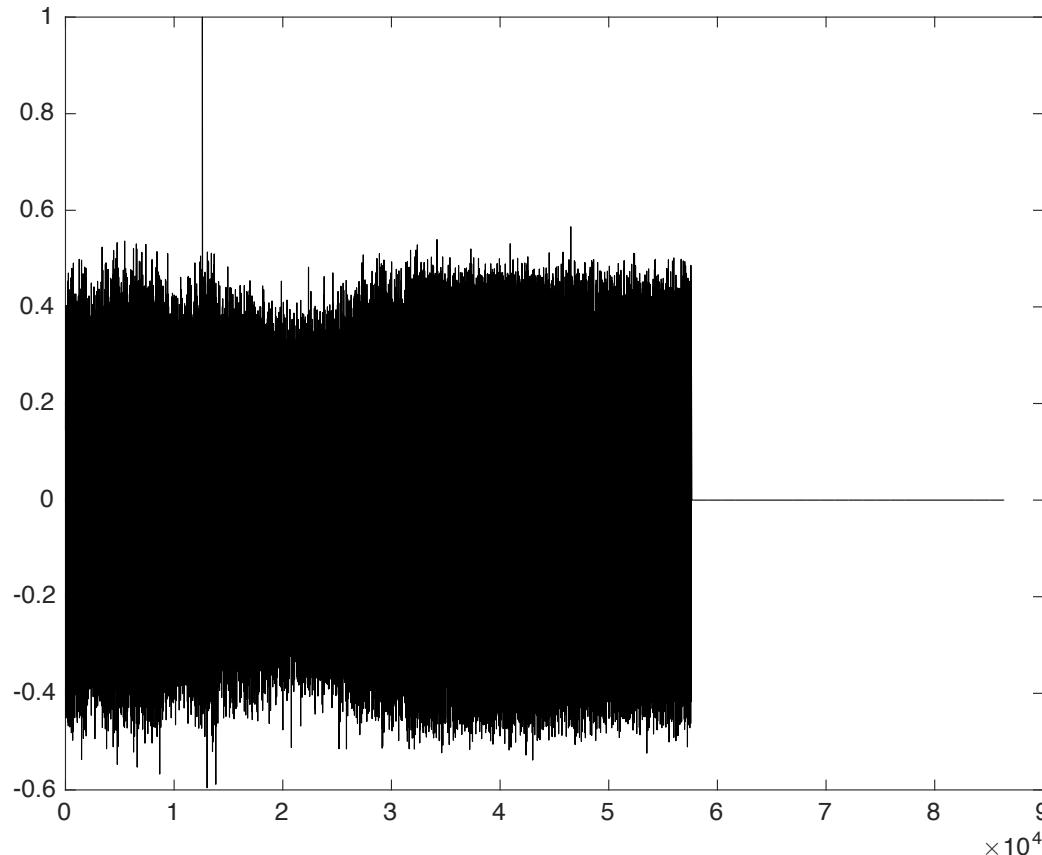


$$CC = \frac{\sum a_i b_i + n\bar{A}\bar{B}}{\sqrt{(\sum a_i^2 + n\bar{A}^2)(\sum b_i^2 + n\bar{B}^2)}}$$



$$CC_{True} = \frac{\sum a_i b_i}{\sqrt{\sum a_i^2 \sum b_i^2}}$$

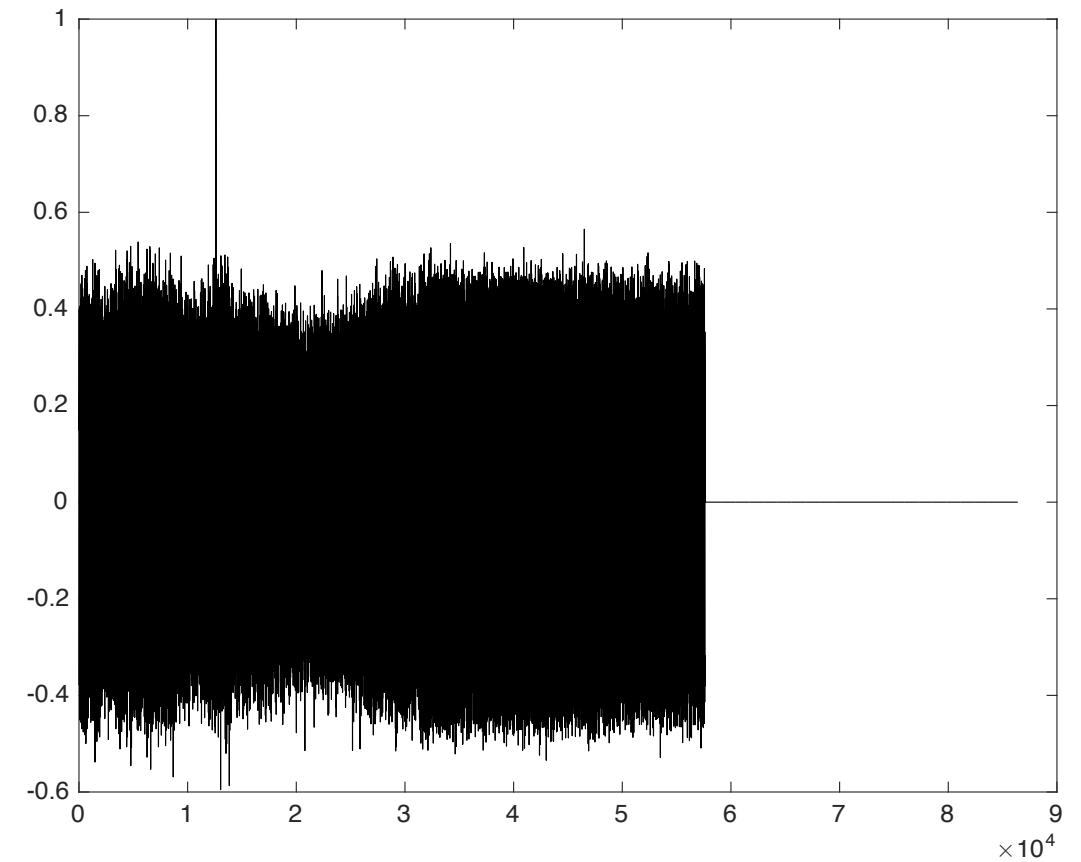
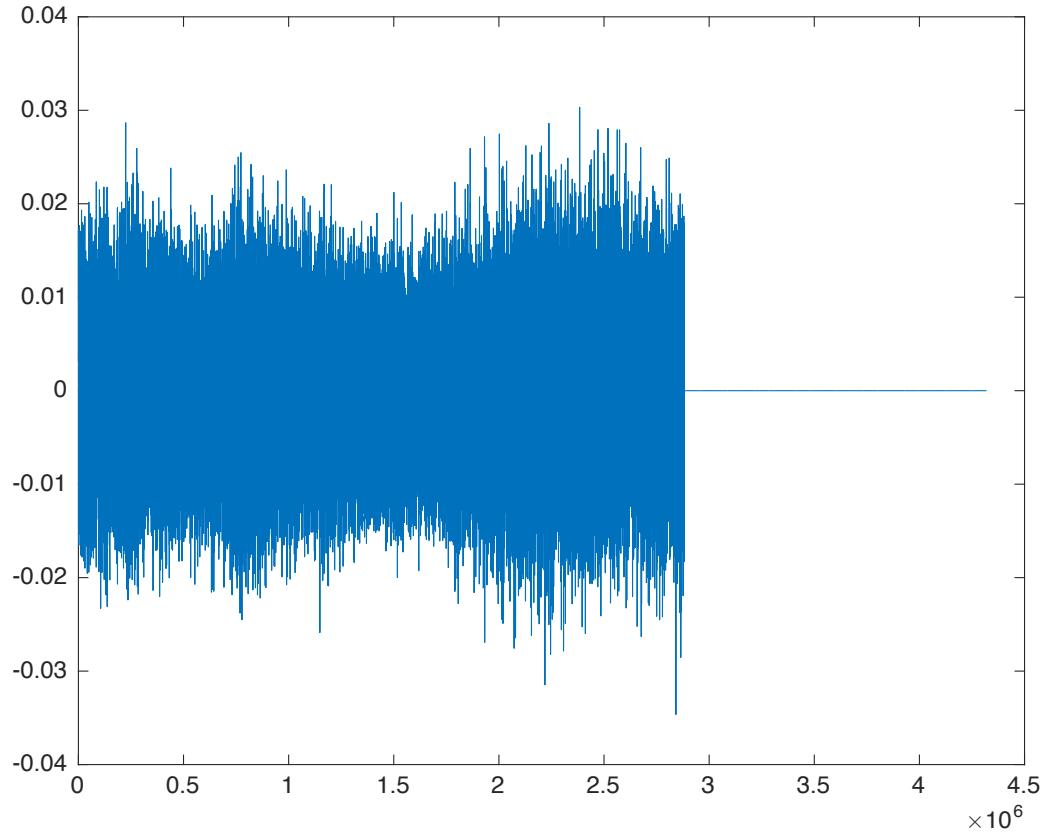
Problems about cross correlation – filter 1hz-20hz



$$CC = \frac{\sum a_i b_i + n\bar{A}\bar{B}}{\sqrt{(\sum a_i^2 + n\bar{A}^2)(\sum b_i^2 + n\bar{B}^2)}}$$

$$CC_{True} = \frac{\sum a_i b_i}{\sqrt{\sum a_i^2 \sum b_i^2}}$$

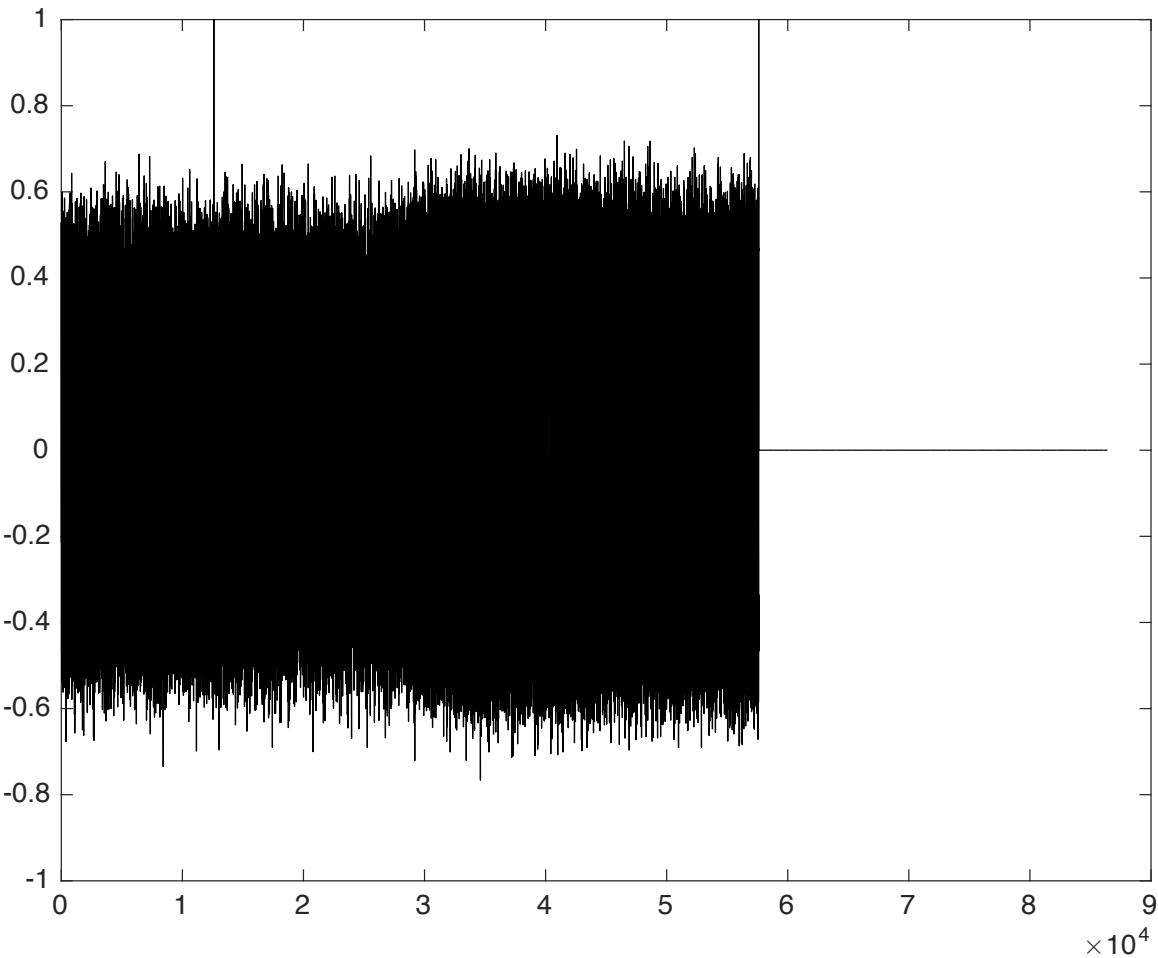
Problems about cross correlation – filter 1hz-20hz



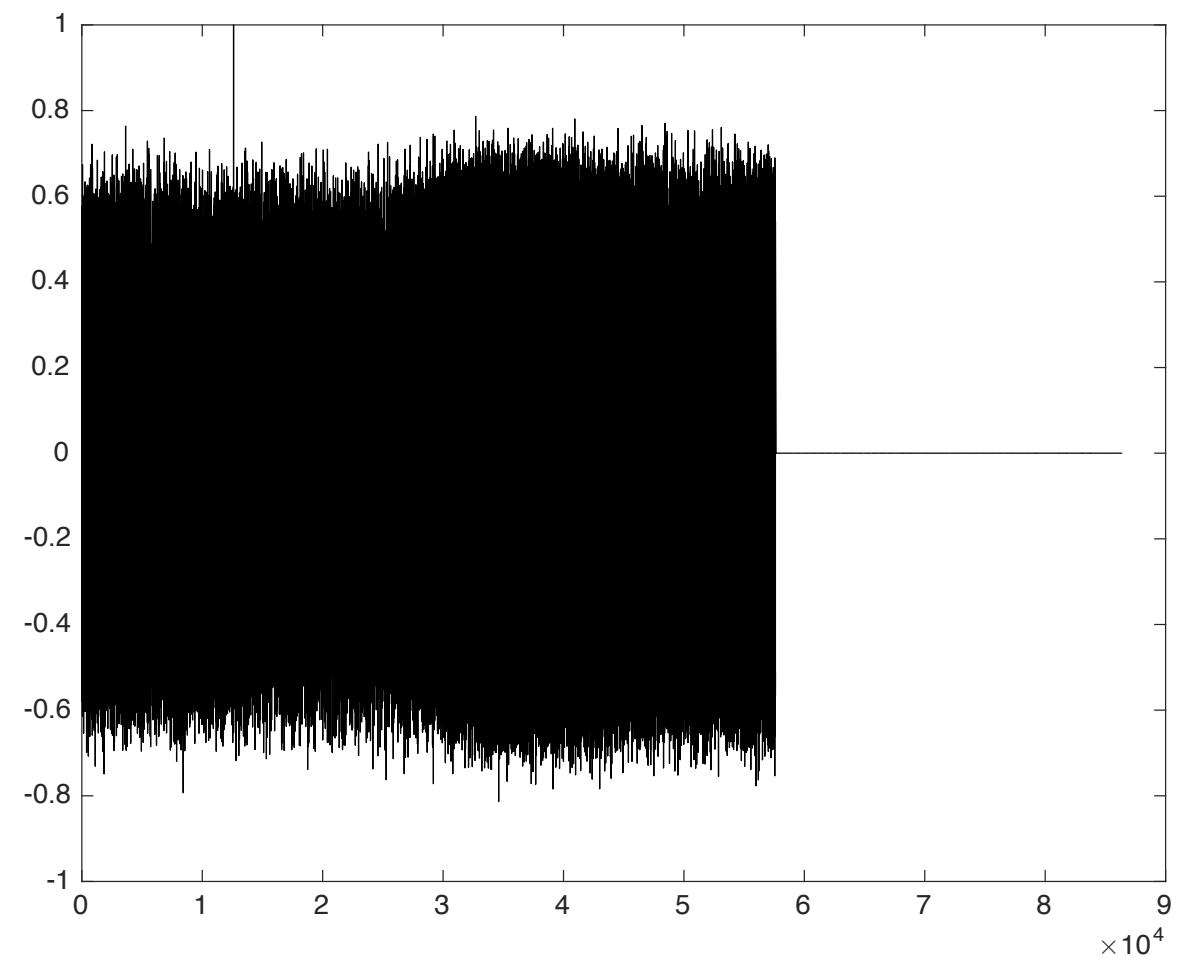
$$CC = \frac{\sum a_i b_i + n\bar{A}\bar{B}}{\sqrt{(\sum a_i^2 + n\bar{A}^2)(\sum b_i^2 + n\bar{B}^2)}}$$

$$CC_{True} = \frac{\sum a_i b_i}{\sqrt{\sum a_i^2 \sum b_i^2}}$$

Problems about decimate(1-4.9hz)

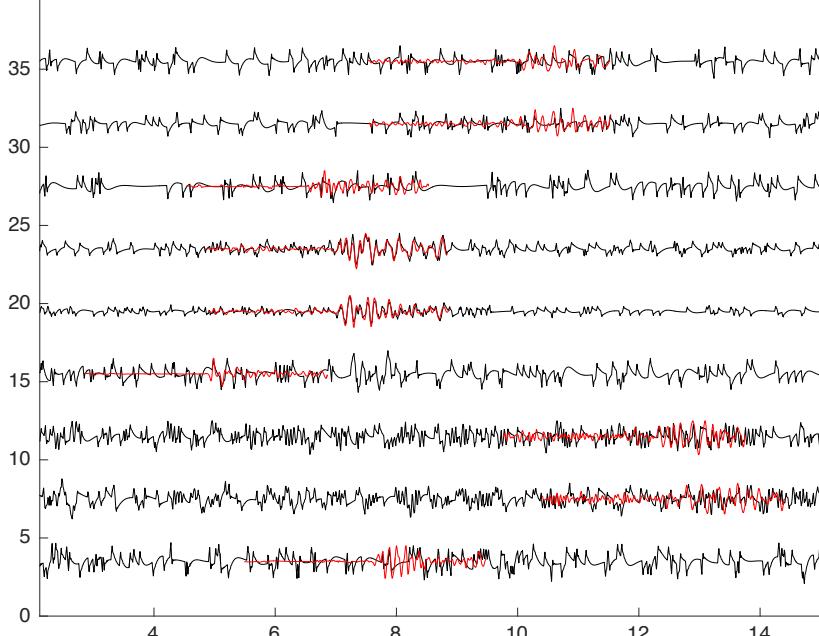
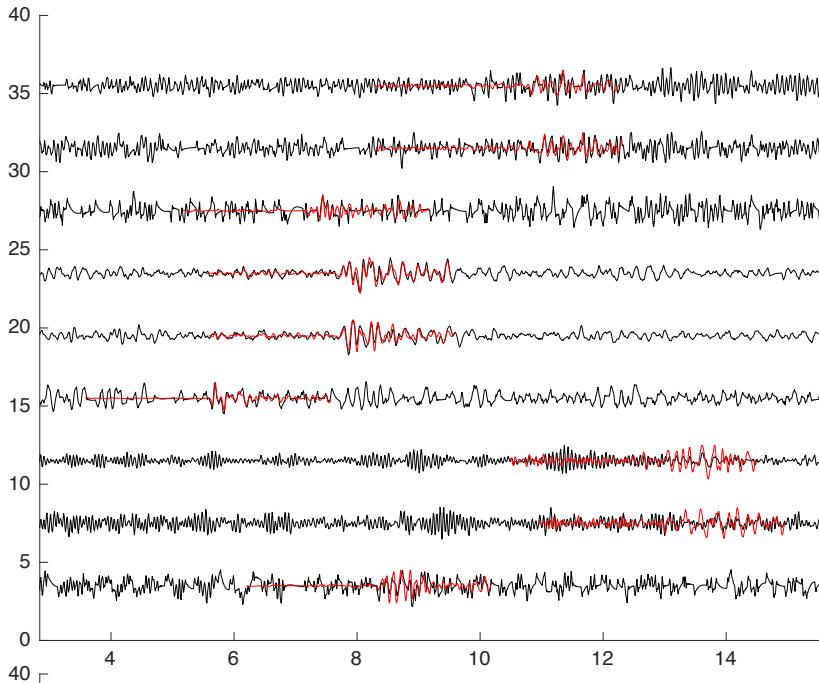
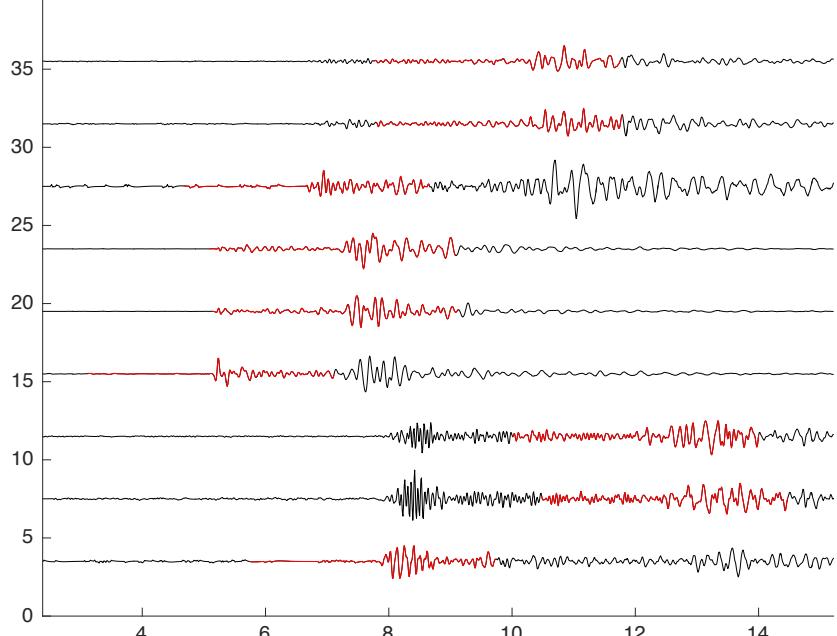
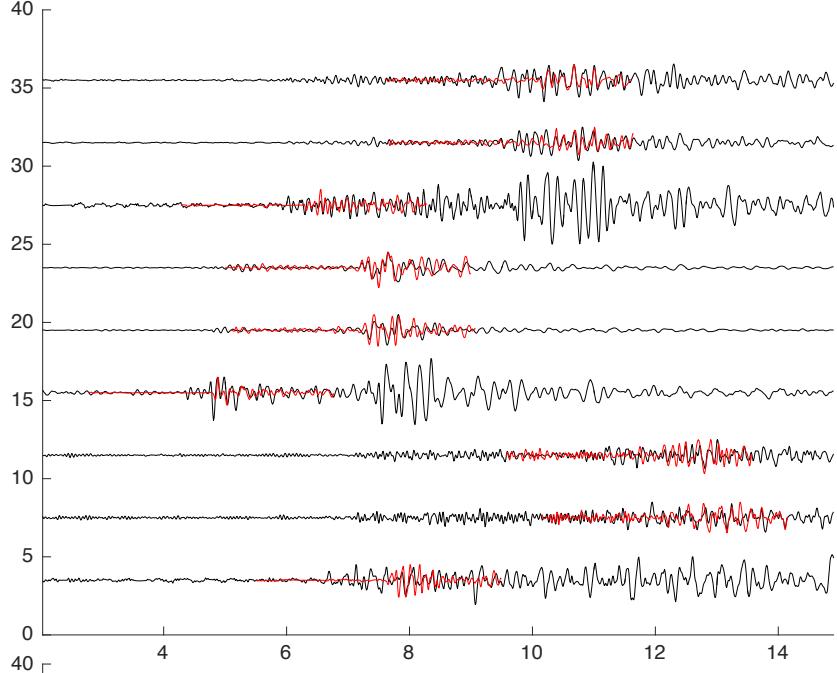


Sample rate = 50hz

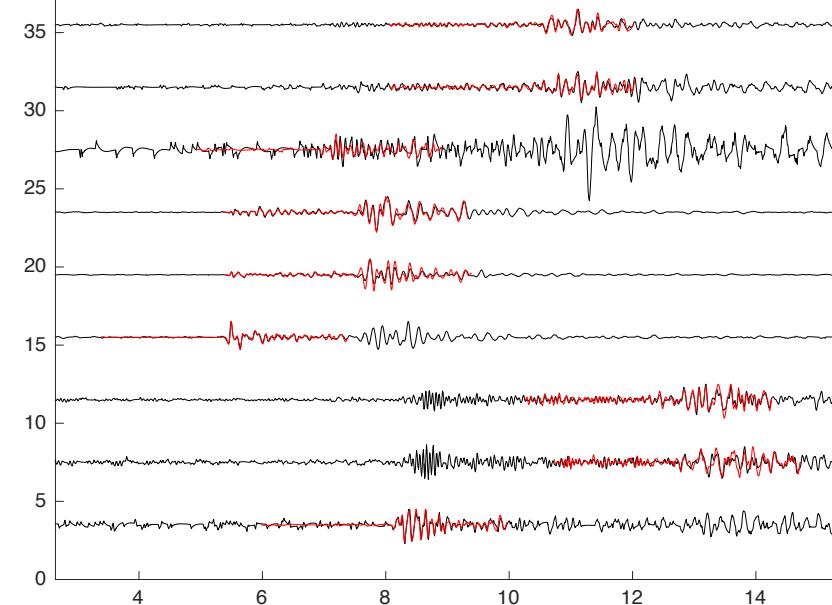
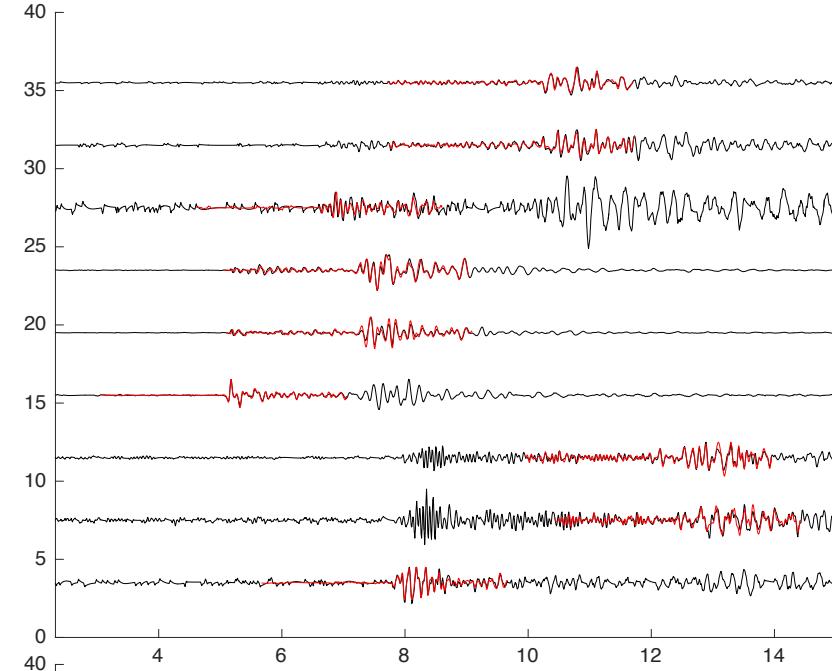
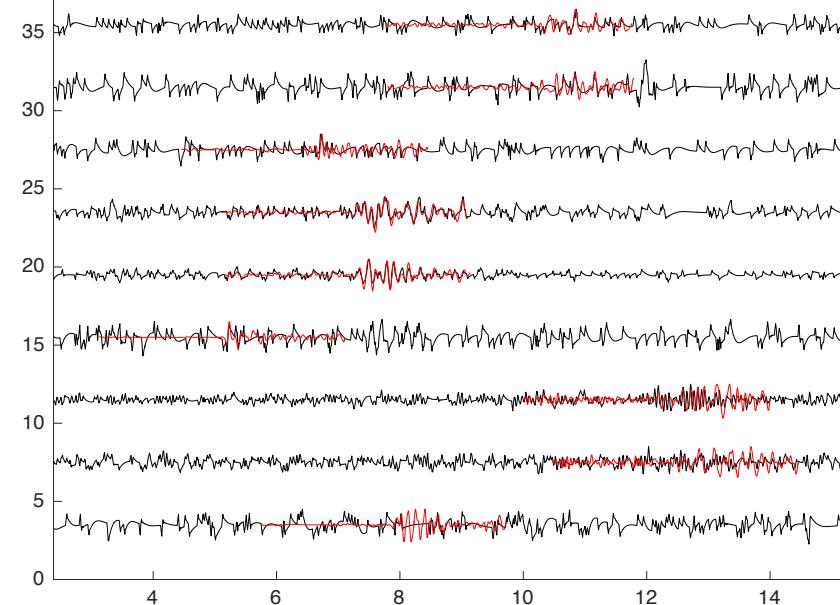
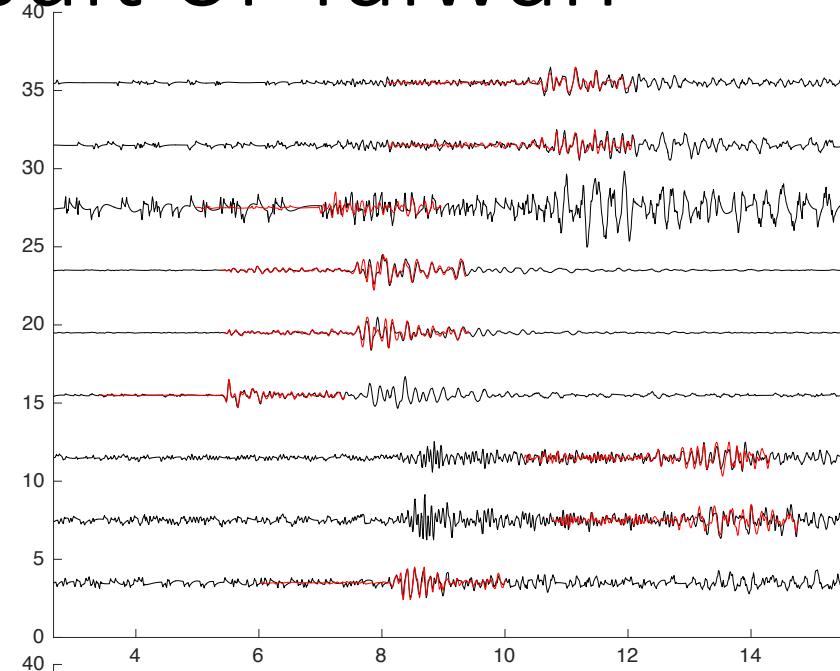


Sample rate = 10hz

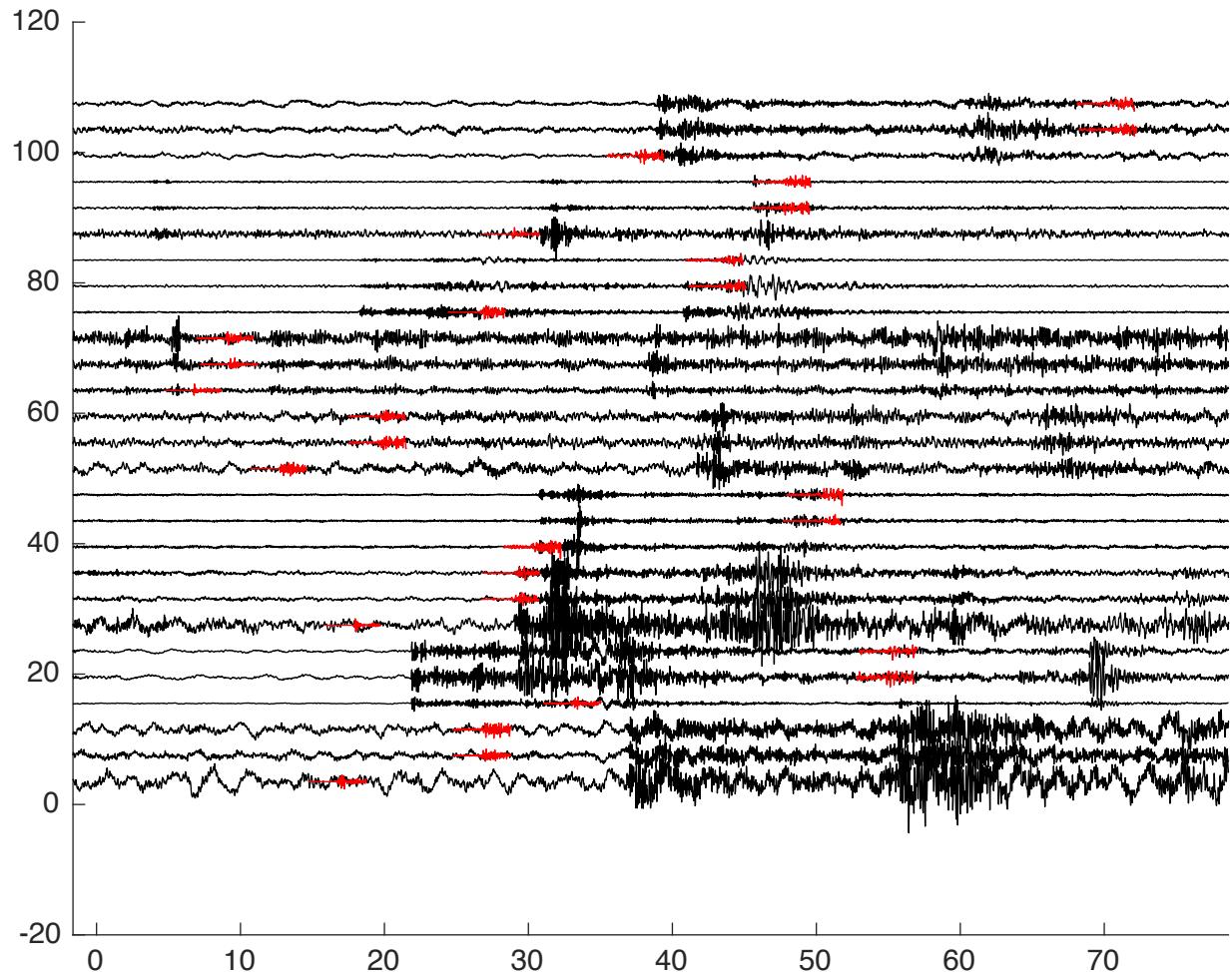
Result of Taiwan 2-40hz



Result of Taiwan

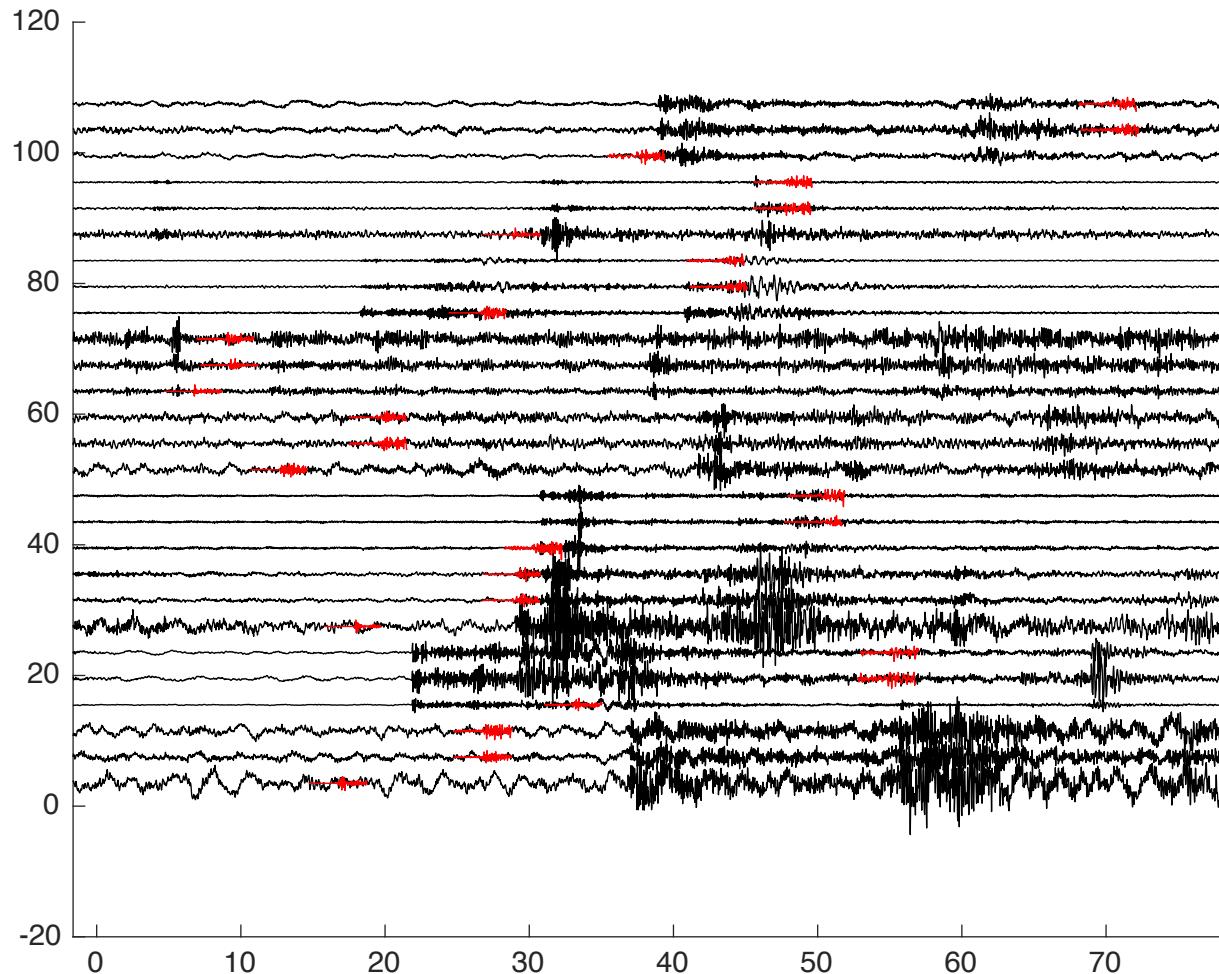


Result of CSN130604034404



NEWEVENT	110227031638	2011	02	27	03	16	38.93
CSN130604034404	0.1770	0.0119	0.1686				
JL.THT.BHE.SAC	67.44	0.26	8.1222	0.2515			
JL.THT.BHN.SAC	67.40	0.06	8.9001	0.1934			
JL.THT.BHZ.SAC	34.76	0.28	0.9186	0.1656			
LN.ANS.BHE.SAC	45.01	0.32	1.6660	0.0590			
LN.ANS.BHN.SAC	45.01	0.38	1.8285	0.1866			
LN.ANS.BHZ.SAC	26.11	0.26	12.2021	0.1978			
LN.BXI.BHE.SAC	40.27	0.30	1.8598	0.2996			
LN.BXI.BHN.SAC	40.43	0.22	2.2902	0.2505			
LN.BXI.BHZ.SAC	23.53	0.04	2.9043	0.2261			
LN.DDO.BHE.SAC	6.34	0.34	247.9947	0.1737			
LN.DDO.BHN.SAC	6.40	0.12	362.3353	0.0771			
LN.DDO.BHZ.SAC	3.91	0.12	79.9205	0.1161			
LN.GUS.BHE.SAC	16.85	0.30	95.5972	0.1866			
LN.GUS.BHN.SAC	16.59	0.00	50.6518	0.1806			
LN.GUS.BHZ.SAC	9.79	0.06	33.8677	0.1265			
LN.HUR.BHE.SAC	47.28	0.32	9.0209	0.1353			
LN.HUR.BHN.SAC	47.04	0.28	7.3866	0.0713			
LN.HUR.BHZ.SAC	27.60	0.26	1.6391	0.2979			
LN.KDN.BHE.SAC	25.88	0.00	80.3334	0.3873			
LN.KDN.BHN.SAC	25.88	0.06	47.7732	0.3731			
LN.KDN.BHZ.SAC	15.22	0.38	96.8436	0.0520			
LN.MQI.BHE.SAC	52.15	0.10	2.8734	0.1557			
LN.MQI.BHN.SAC	52.20	0.36	2.9378	0.1714			
LN.MQI.BHZ.SAC	30.44	0.32	0.4309	0.1789			
LN.XYN.BHE.SAC	24.03	0.12	122.2167	0.1001			
LN.XYN.BHN.SAC	23.95	0.08	116.1315	0.1065			
LN.XYN.BHZ.SAC	14.09	0.28	58.0098	0.0591			

Result of CSN130604034404



CSN130604034404 0.1770 0.0119 0.1686
CSN130604034404 0.1725 0.0125 0.1720
CSN130604034404 0.1920 0.0131 0.1867
CSN130604034404 0.1928 0.0133 0.1912

Problems about relocate_1

Station i

$$\Delta T' = T_s' - T_p'$$

$$\Delta T = T_s - T_p.$$

$$DDT = \Delta T' - \Delta T.$$

$$\frac{\ell' - \ell}{\ell} = \frac{DDT}{\Delta T}.$$

$$\ell = \sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}.$$

$$\ell' = \sqrt{\Delta x'^2 + \Delta y'^2 + \Delta z'^2}$$

suppose: $\Delta x = \Delta x + dx$ $\Delta y = \Delta y + dy$
 $\Delta z = \Delta z$.

$$\frac{\ell' - \ell}{\ell} = \frac{\ell' - \ell}{\ell} - 1$$

$$\approx \frac{\sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2 + 2\Delta x dx + 2\Delta y dy}}{\sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}} - 1$$

$$\approx \frac{\Delta x dx + \Delta y dy}{\Delta x^2 + \Delta y^2 + \Delta z^2}.$$

$$\therefore C = \frac{DDT}{\Delta T} (\Delta x^2 + \Delta y^2 + \Delta z^2).$$

$$\Delta x dx + \Delta y dy = C.$$

结合所有台站.

$$\Delta x_i dx + \Delta y_i dy = C_i.$$

$$\text{设 } A \begin{pmatrix} dx \\ dy \end{pmatrix} = \vec{C} \quad \text{其中 } A = \begin{pmatrix} \Delta x_1 & \Delta y_1 \\ \Delta x_2 & \Delta y_2 \\ \vdots & \vdots \\ \Delta x_n & \Delta y_n \end{pmatrix} \quad \vec{C} = \begin{pmatrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{pmatrix}$$

$$\Rightarrow \begin{pmatrix} dx \\ dy \end{pmatrix} = (A^T A)^{-1} A^T \vec{C} \quad \text{其中 } A^T A = \begin{pmatrix} \sum \Delta x_i^2 & \sum \Delta x_i \Delta y_i \\ \sum \Delta x_i \Delta y_i & \sum \Delta y_i^2 \end{pmatrix}$$

$$A^T \vec{C} = \begin{pmatrix} \sum C_i \Delta x_i \\ \sum C_i \Delta y_i \end{pmatrix}$$

$$\Rightarrow dx = \frac{\sum \Delta y_i^2 \sum C_i \Delta x_i - \sum \Delta x_i \Delta y_i \cdot \sum C_i \Delta y_i}{\sum \Delta x_i^2 \sum \Delta y_i^2 - (\sum \Delta x_i \Delta y_i)^2}$$

$$dy = \frac{-\sum \Delta x_i \Delta y_i \sum C_i \Delta x_i + \sum \Delta y_i^2 \sum C_i \Delta y_i}{\sum \Delta x_i^2 \sum \Delta y_i^2 - (\sum \Delta x_i \Delta y_i)^2}$$

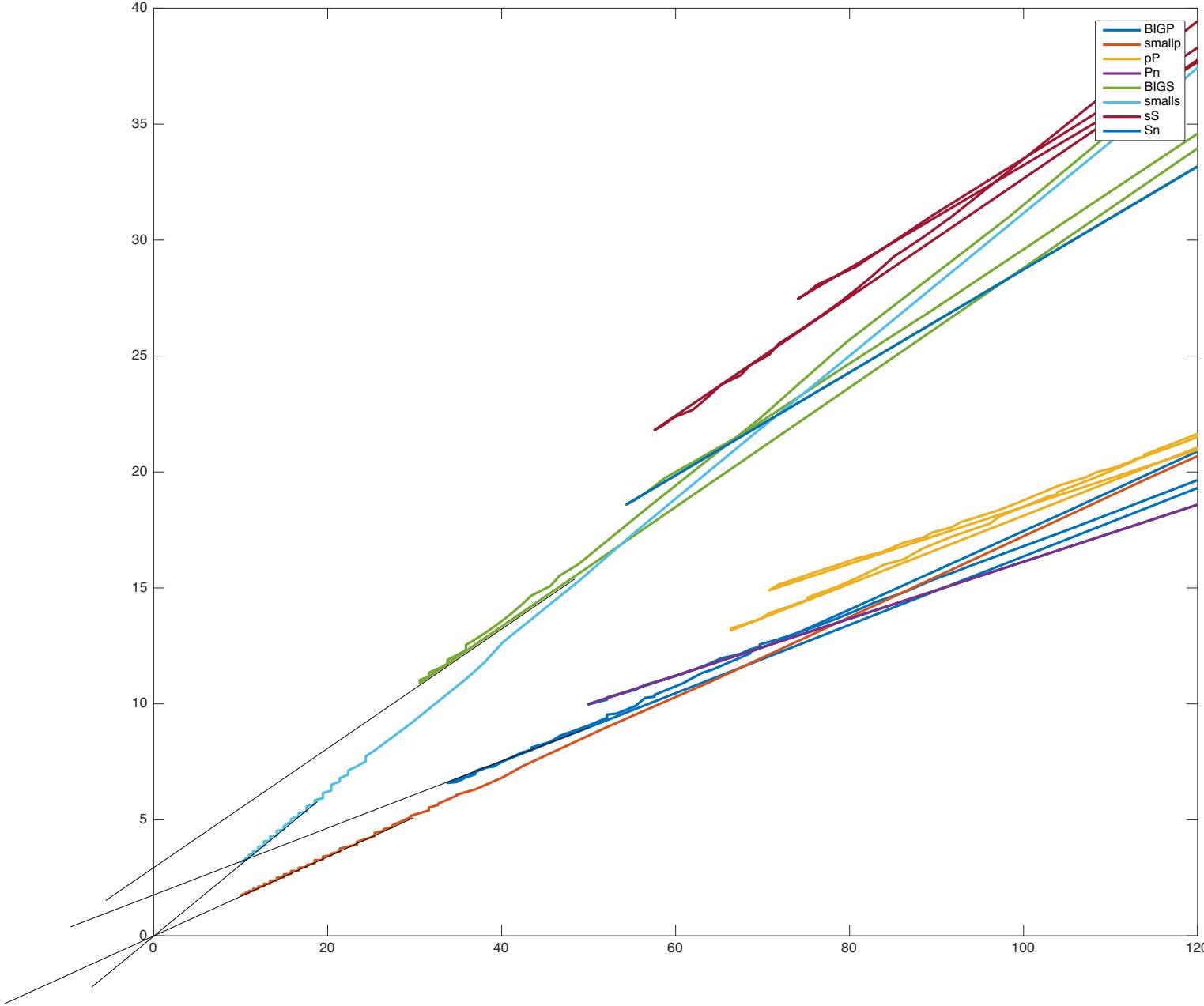
Problems about Relocate

Dx[i],Dy[i],C[i],DDT,DT,Dist2

dx,dy,magnitude

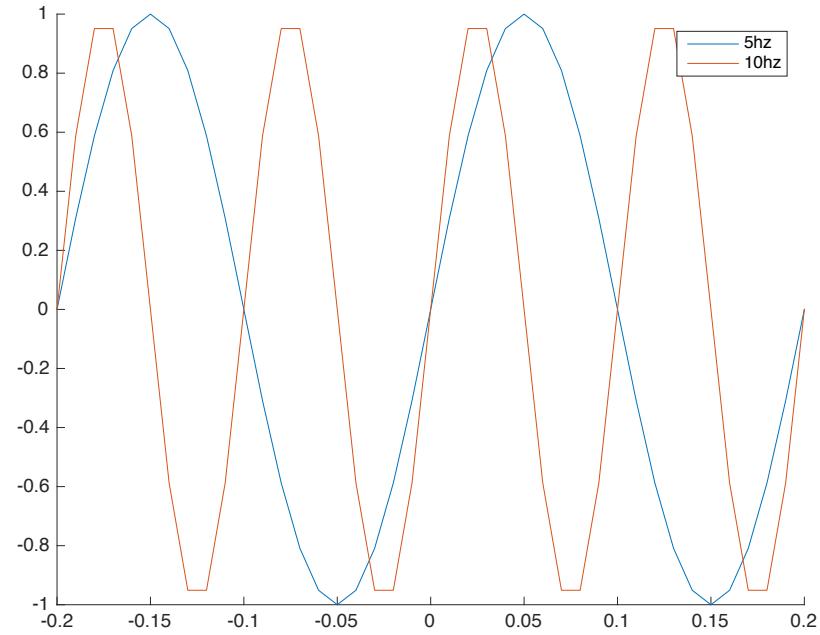
6.037943 -18.013578 -36.246653 0.230000 -3.115000 490.905755 -0.409352 -6.382589 -23.552821 0.275000 -1.995000 170.865009 -3.581831 -24.540720 23.153186 -0.140000 -4.505000 745.036465 -5.86 0.13 1.42	6.037943 -18.013578 -0.787971 0.005000 -3.115000 490.905755 -0.409352 -6.382589 0.428233 -0.005000 -1.995000 170.865009 -3.581831 -24.540720 -2.480699 0.015000 -4.505000 745.036465 0.11 0.08 2.52	6.037943 -18.013578 -0.000000 0.000000 -3.115000 490.905755 -0.409352 -6.382589 -0.000000 0.000000 -1.995000 170.865009 -3.581831 -24.540720 -0.000000 0.000000 -4.505000 745.036465 0.00 0.00 1.57	6.037943 -18.013578 18.123326 -0.115000 -3.115000 490.905755 -0.409352 -6.382589 -0.000000 0.000000 -1.995000 170.865009 -3.581831 -24.540720 -14.884191 0.090000 -4.505000 745.036465 3.33 0.10 2.94	6.037943 -18.013578 -0.000000 0.000000 -3.115000 490.905755 -0.409352 -6.382589 -0.000000 0.000000 -1.995000 170.865009 -3.581831 -24.540720 -3.307598 0.020000 -4.505000 745.036465 0.27 0.09 2.23	6.037943 -18.013578 -0.000000 0.000000 -3.115000 490.905755 -0.409352 -6.382589 -1.712932 0.020000 -1.995000 170.865009 -3.581831 -24.540720 -3.307598 0.020000 -4.505000 745.036465 0.29 0.10 1.97	6.037943 -18.013578 -33.094770 0.210000 -3.115000 490.905755 -0.409352 -6.382589 -0.856466 0.010000 -1.995000 170.865009 -3.581831 -24.540720 0.826900 -0.005000 -4.505000 745.036465 -3.90 0.53 2.89	6.037943 -18.013578 -1.575941 0.010000 -3.115000 490.905755 -0.409352 -6.382589 -0.000000 0.000000 -1.995000 170.865009 -3.581831 -24.540720 -1.653799 0.010000 -4.505000 745.036465 -0.05 0.07 2.02
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Problems about Relocate



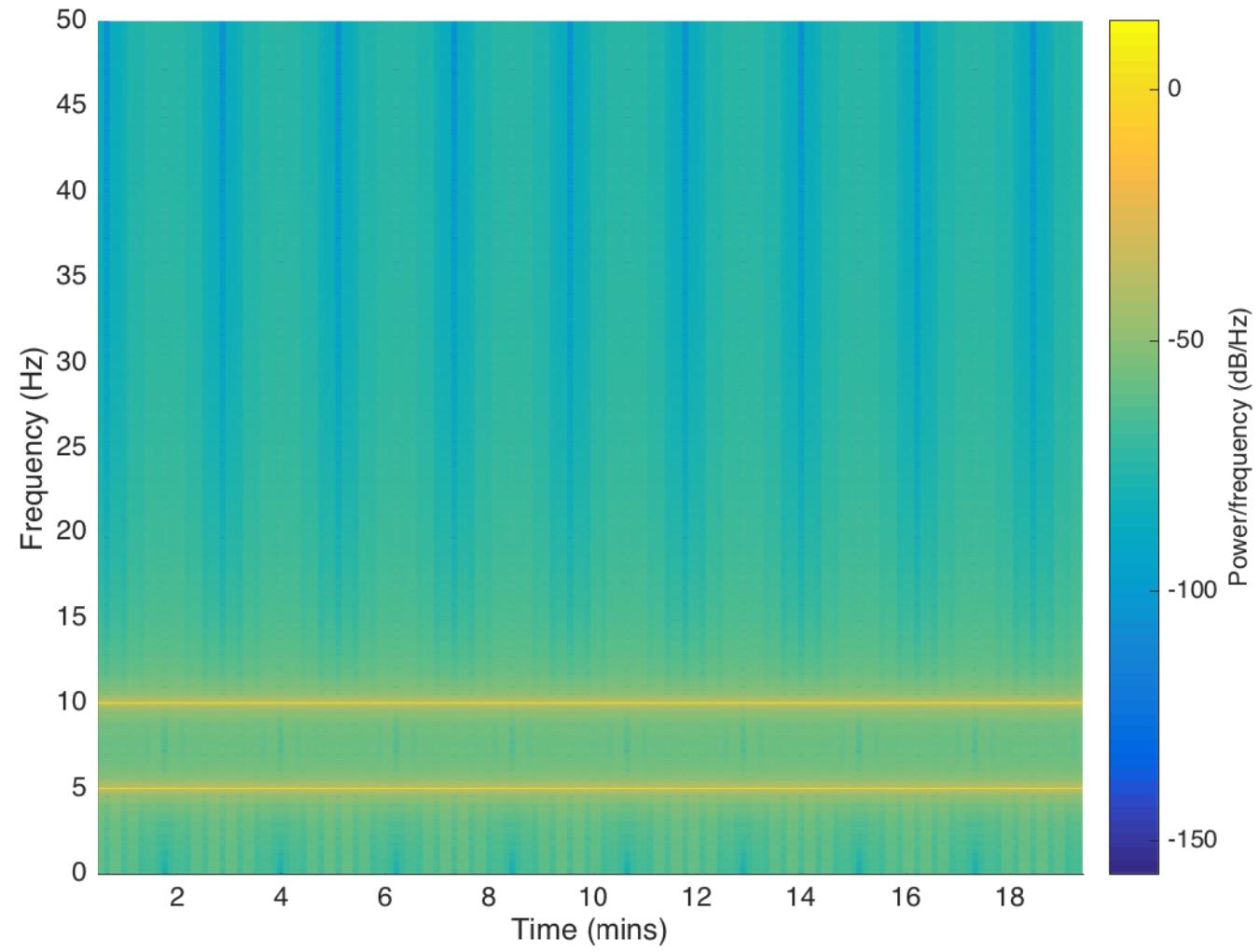
Spectrogram—Energy?Altitude?

Both!



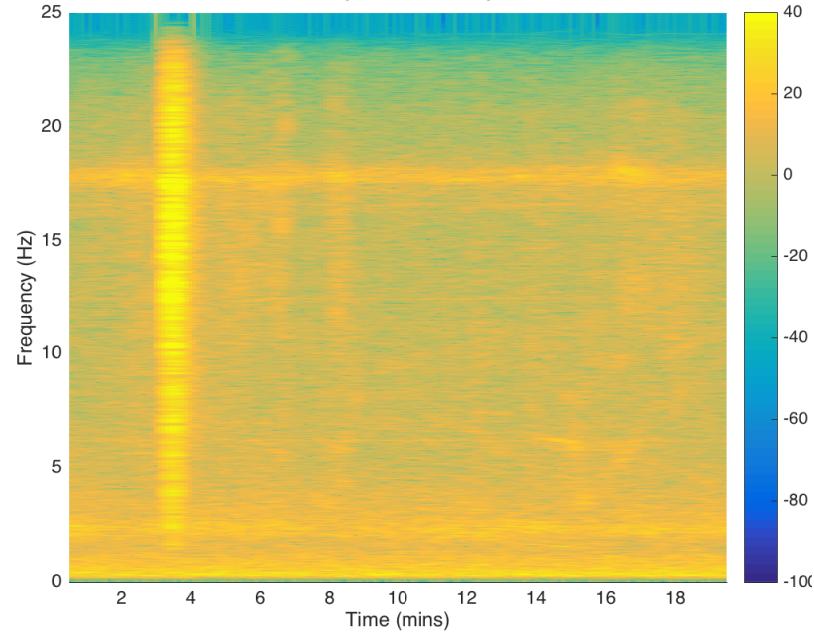
$$E = C_1 \Sigma \sin^2 \omega t dt$$

$$E = C_2 \Sigma F^2(\omega) d\omega$$

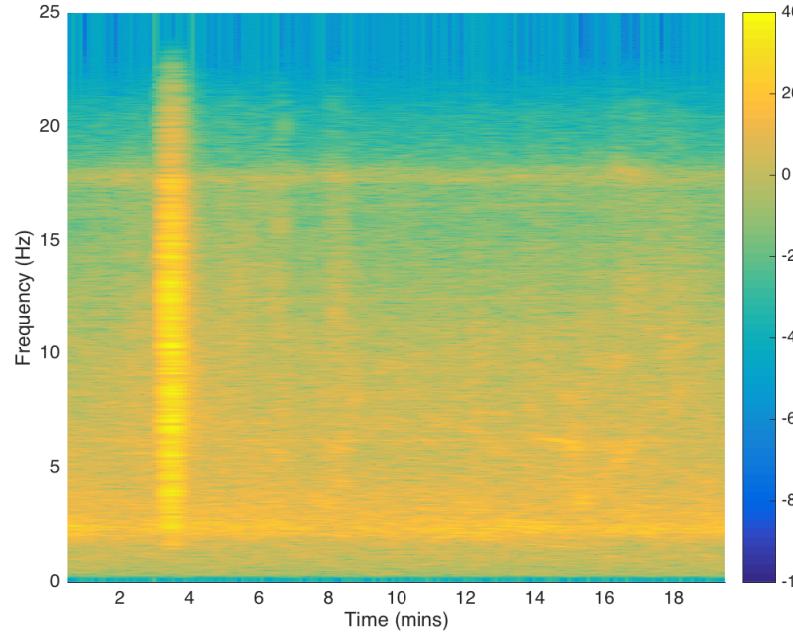


Performance of Butterworth Filter

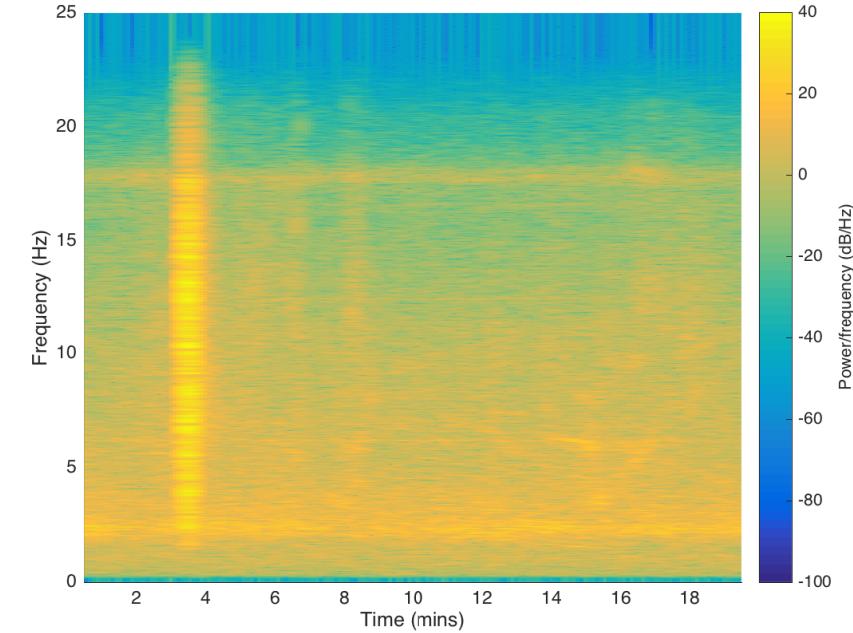
Raw (1-20hz)



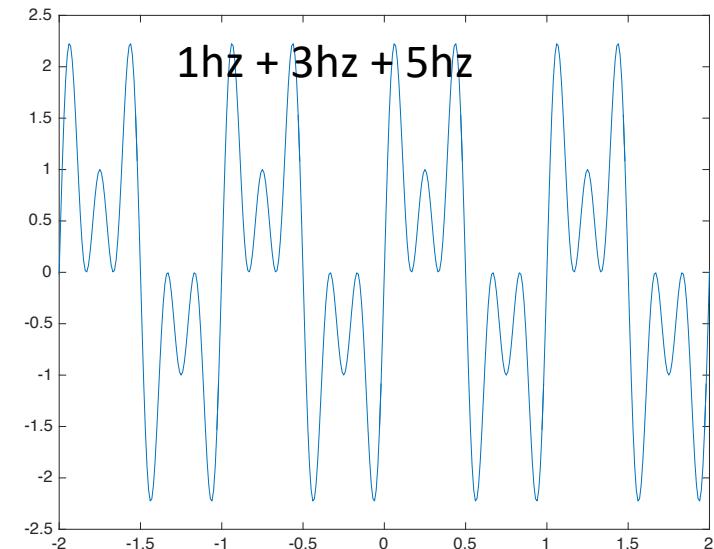
Band Pass (2-10hz)



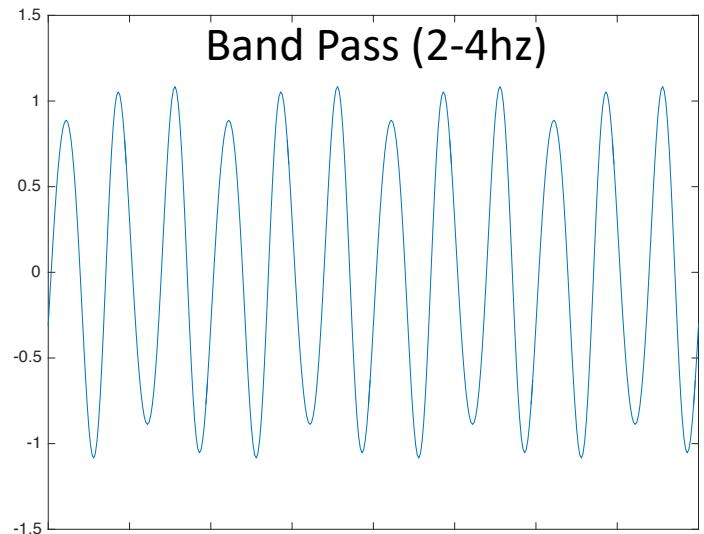
High Pass + Low Pass (2-10hz)



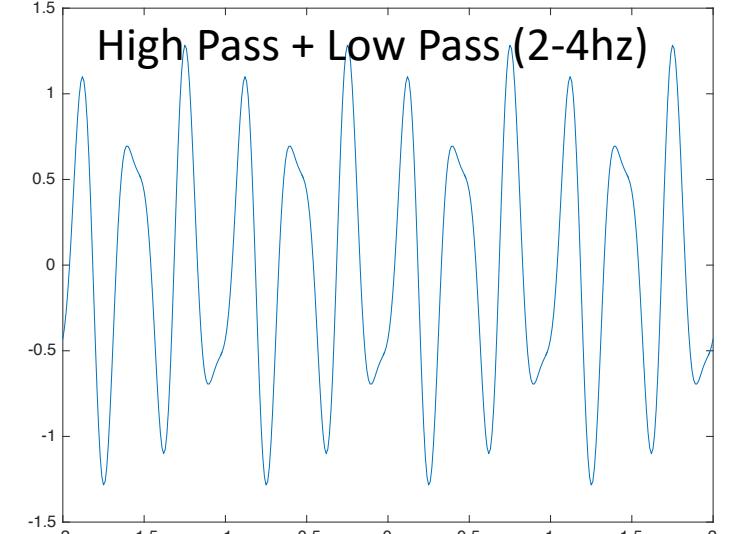
1hz + 3hz + 5hz



Band Pass (2-4hz)



High Pass + Low Pass (2-4hz)

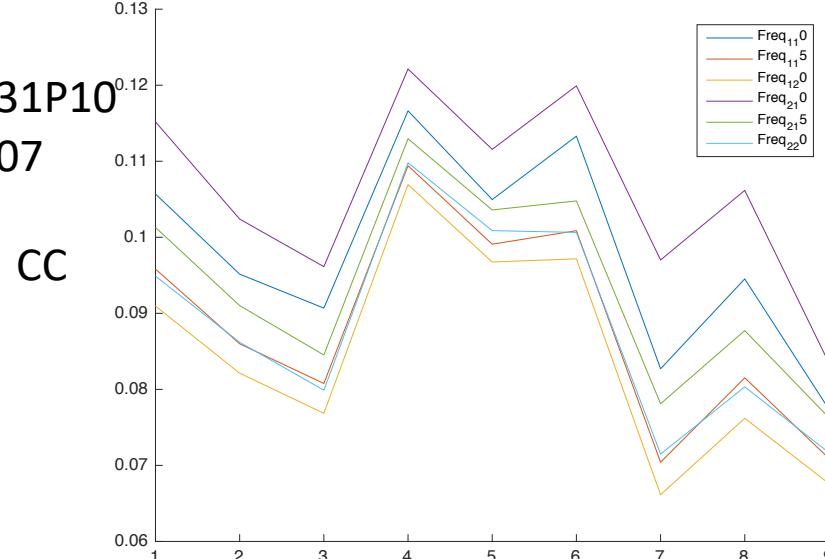


Determine Filter Band

Taiwan

15071631P10

20100307



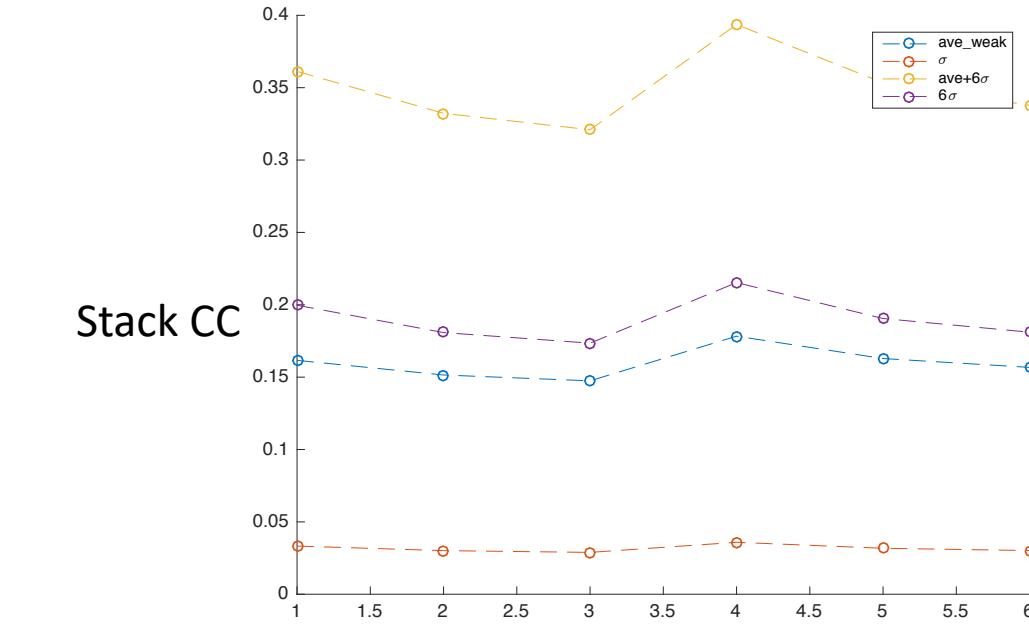
Bohai

CSN110301180245

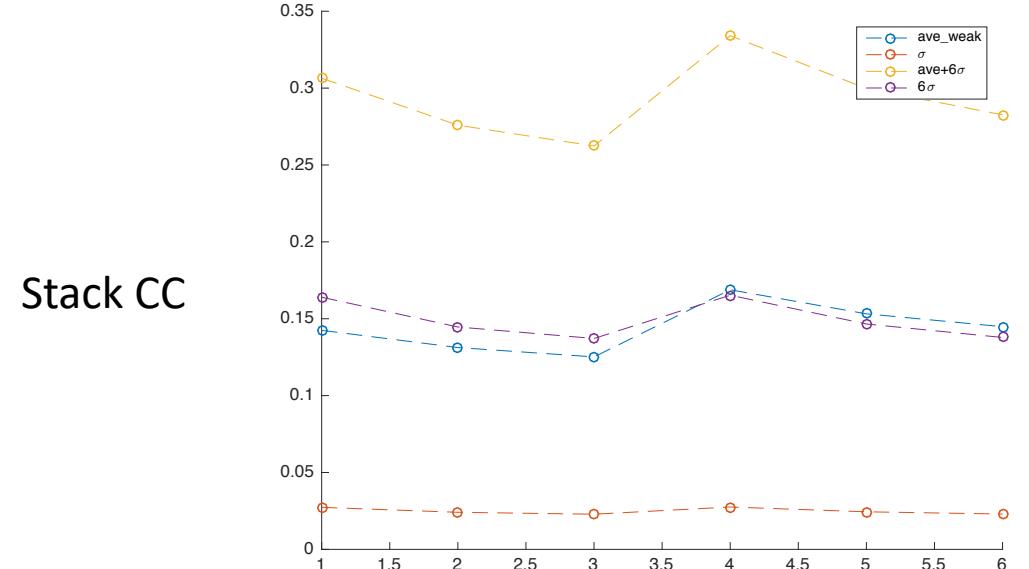
20110301

Component num

Stack CC



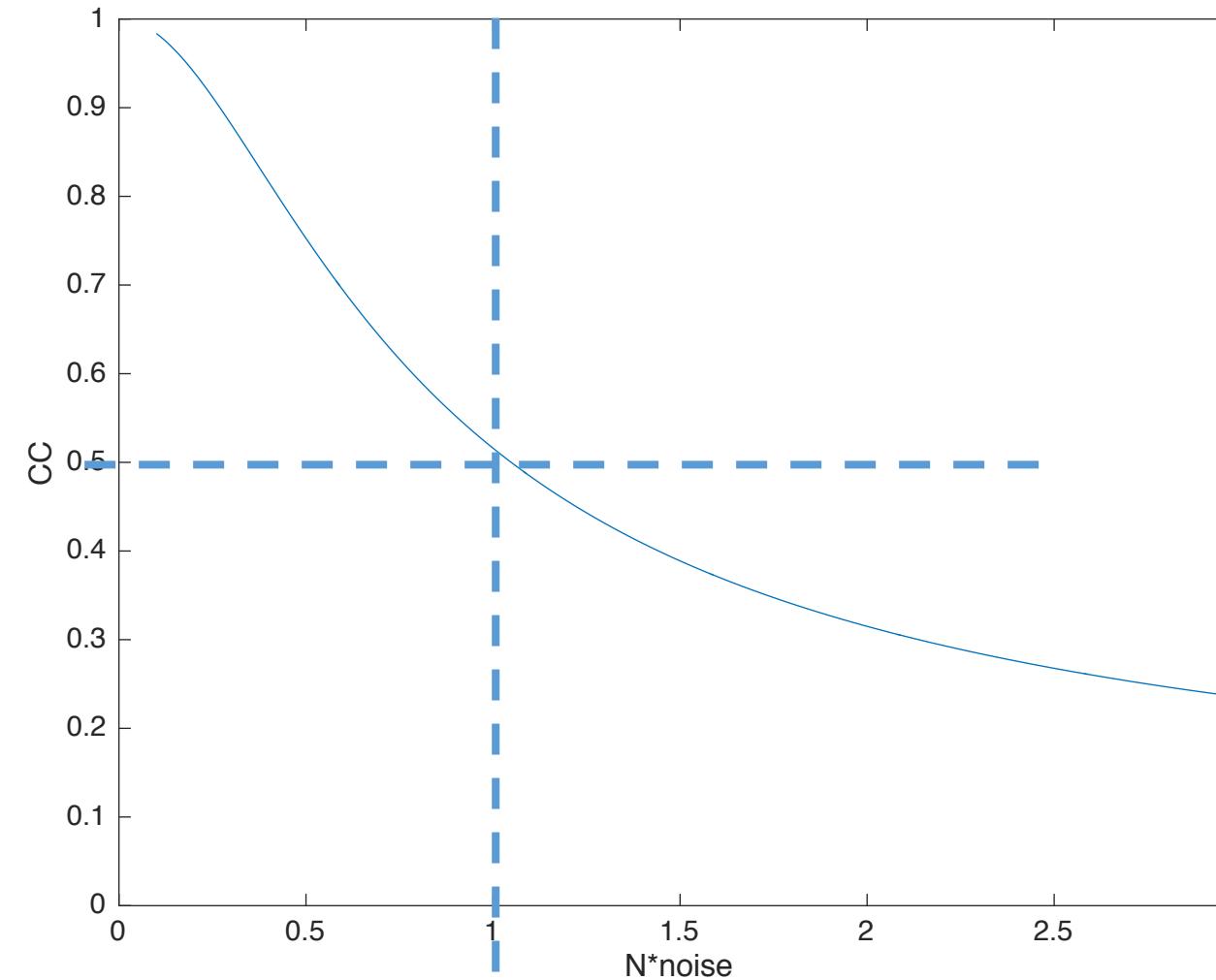
Stack CC



Filter Band num

Determine Partweak limit (2-15hz)

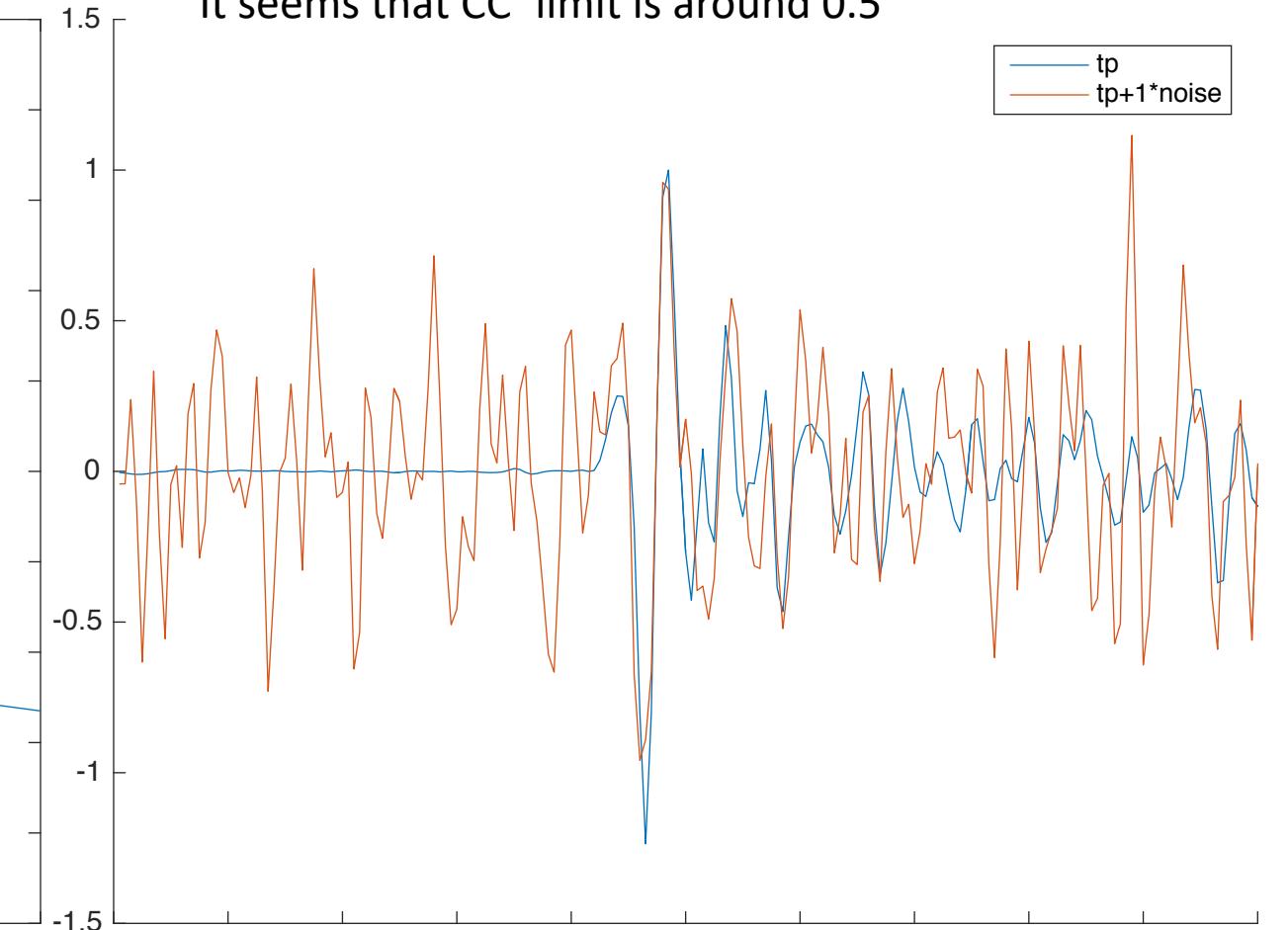
Template Vs Template + N*noise



Determine CC_limit

If CC>CC_limit, we can recognize template from noise

It seems that CC_limit is around 0.5



For 1-8hz the CC_limit is a little higher, around 0.55

What Next?

Filter Band?

2-15hz

1-8hz

Min Distance?

Tp>5s
Relocation only

Threshold?

Noweak
6sigma

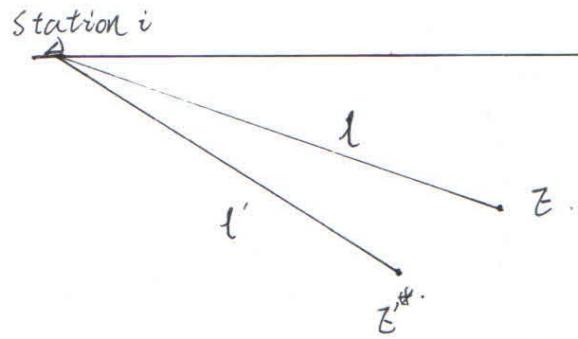
Partweak
0.5
6sigma

Relocation?

$$\frac{l' - l}{DDT} \approx \frac{l}{\Delta T}$$

Regress

Relocation_2



$$\Delta T = T_S - T_P \quad \text{if} \quad \frac{l' - l}{l} = \frac{DDT}{\Delta T}$$

$$\Delta T' = T'_S - T'_P \quad \text{其中} \quad l = \sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}$$

$$DDT = \Delta T' - \Delta T \quad (\Delta x, \Delta y, \Delta z) = Z - \text{stati} \\ (\Delta x', \Delta y', \Delta z') = Z' - \text{stati}.$$

$$\therefore dx = \Delta x' - \Delta x \quad dy = \Delta y' - \Delta y \quad \Delta z' = \Delta z.$$

$$\frac{l' - l}{l} = \frac{DDT}{\Delta T} \Rightarrow l'^2 - l^2 = \frac{DDT}{\Delta T} l \cdot (l' + l) \\ \approx \frac{DDT}{\Delta T} \cdot 2l^2$$

$$\Rightarrow dx^2 + dy^2 + 2\Delta x dx + 2\Delta y dy \approx \frac{DDT}{\Delta T} \cdot 2l^2.$$

最速下降法降

Relocation_2

Output:

Input:

```
NEEVENT100307043413 2010 03 07 04 34 13.87
15071631P10 0.5164 0.0333 0.3612
CWB.CHN1.EHE.SAC 7.41 0.10 12.0483 0.5306
CWB.CHN1.EHN.SAC 7.44 0.00 9.1072 0.4844
CWB.CHN1.EHZ.SAC 4.31 0.10 5.2602 0.2816
CWB.SGS.EHE.SAC 4.73 0.50 16.2657 0.8591
CWB.SGS.EHN.SAC 4.78 0.60 12.8196 0.7423,
CWB.SGS.EHZ.SAC 2.76 0.50 9.7535 0.5566
CWB.WTP.EHE.SAC 9.65 0.30 8.5238 0.5968
CWB.WTP.EHN.SAC 10.12 0.30 6.9642 0.4129
CWB.WTP.EHZ.SAC 5.38 0.50 6.6170 0.1834
#####
```

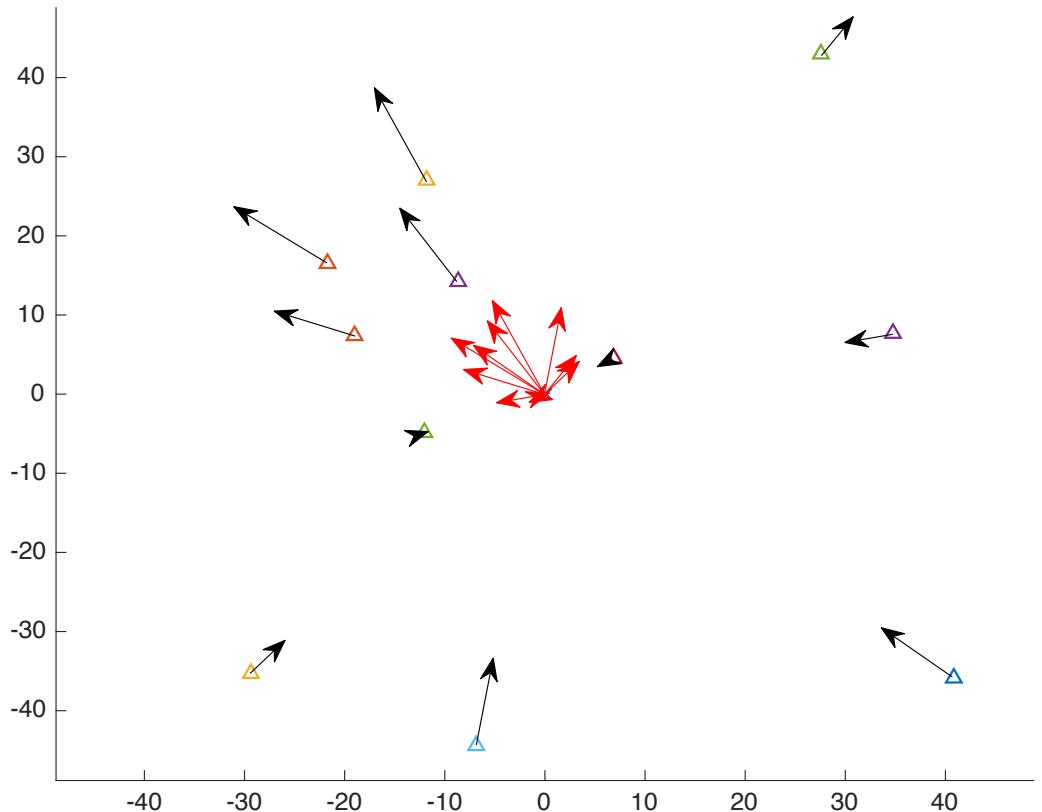
Name travelttime offset magratio CC

```
1 step:0.1000000 theta:4.63788498 F:3991.79391541
2 step:0.1000000 theta:4.62753954 F:3360.69362637
3 step:0.1000000 theta:4.61452943 F:2805.47341453
4 step:0.1000000 theta:4.59765382 F:2327.02667326
5 step:0.1000000 theta:4.57486411 F:1926.09247103
6 step:0.1000000 theta:4.54236699 F:1603.11207817
7 step:0.1000000 theta:4.49232180 F:1357.88329805
8 step:0.1000000 theta:4.40584894 F:1188.55928236
9 step:0.1000000 theta:4.22688473 F:1087.92889472
10 step:0.1000000 theta:3.76401889 F:1028.15707919
11 step:0.1000000 theta:3.05183099 F:972.66412111
12 step:0.1000000 theta:3.19490158 F:921.72845838
13 step:0.1000000 theta:3.10561951 F:875.37976779
14 step:0.1000000 theta:3.16166110 F:833.63146018
15 step:0.1000000 theta:3.09873340 F:796.46024574
16 step:0.1000000 theta:3.16179647 F:763.87522912
17 step:0.1000000 theta:3.05241655 F:735.89576596
18 step:0.1000000 theta:3.25006700 F:712.86878005
19 step:0.1000000 theta:2.74008991 F:697.45152262
20 step:0.05060000 theta:4.02219509 F:690.29491445
21 step:0.05810000 theta:2.45211309 F:684.56642761
22 step:0.04040000 theta:4.02355720 F:679.98161641
23 step:0.04660000 theta:2.45205554 F:676.31979215
24 step:0.03220000 theta:4.02311235 F:673.39194711
25 step:0.03740000 theta:2.45294748 F:671.05162934
26 step:0.02570000 theta:4.02392120 F:669.18197705
27 step:0.02990000 theta:2.45239168 F:667.69041784
28 step:0.02050000 theta:4.02309794 F:666.49954661
29 step:0.02390000 theta:2.45130514 F:665.54993065
30 step:0.01630000 theta:4.02299209 F:664.79113442
31 step:0.01920000 theta:2.45554775 F:664.18364558
32 step:0.01300000 theta:4.02543578 F:663.69974566
33 step:0.01540000 theta:2.45626194 F:663.31332766
34 step:0.01040000 theta:4.02918786 F:663.00471586
35 step:0.01220000 theta:2.45270765 F:662.76037237
36 step:0.00830000 theta:4.02518127 F:662.56519627
37 step:0.00960000 theta:2.44675050 F:662.41080290
38 step:0.00660000 theta:4.01586391 F:662.28771964
39 step:0.00770000 theta:2.44422431 F:662.18949487
40 step:0.00530000 theta:4.02011647 F:662.11064167
41 step:0.00610000 theta:2.43898158 F:662.04834420
42 step:0.00420000 theta:4.01518791 F:661.99826788
43 step:0.00490000 theta:2.44675665 F:661.95818218
44 step:0.00340000 theta:4.01606355 F:661.92623562
45 step:0.00380000 theta:2.42709026 F:661.90113520
46 step:0.00270000 theta:3.99821558 F:661.88100650
47 step:0.00300000 theta:2.42632936 F:661.86488885
48 step:0.00220000 theta:3.98461755 F:661.85209209
49 step:0.00230000 theta:2.39644641 F:661.84193084
50 step:0.00180000 theta:3.95178196 F:661.83381318
```

```
51 step:0.00180000 theta:2.36172226 F:661.82731330
52 step:0.00150000 theta:3.93045843 F:661.82206185
53 step:0.00140000 theta:2.31910520 F:661.81784921
54 step:0.00120000 theta:3.89493402 F:661.81442731
55 step:0.00110000 theta:2.32959393 F:661.81165143
56 step:0.00100000 theta:3.85911965 F:661.80940153
57 step:0.00090000 theta:2.29834279 F:661.80757538
58 step:0.00080000 theta:3.86884407 F:661.80609297
59 step:0.00070000 theta:2.31463646 F:661.80489193
60 step:0.00070000 theta:3.82040652 F:661.80390626
61 step:0.00060000 theta:2.23936940 F:661.80310709
62 step:0.00050000 theta:3.87749779 F:661.80246662
63 step:0.00050000 theta:2.37498464 F:661.80193567
64 step:0.00040000 theta:3.90071593 F:661.80151331
65 step:0.00040000 theta:2.39429301 F:661.80116249
66 step:0.00030000 theta:3.88319078 F:661.80089053
67 step:0.00040000 theta:2.48665108 F:661.80063729
68 step:0.00030000 theta:4.03718570 F:661.80044710
69 step:0.00020000 theta:2.25883079 F:661.80030868
70 step:0.00040000 theta:3.57615361 F:661.80015504
71 step:0.00020000 theta:1.95547282 F:661.80002577
72 step:0.00020000 theta:3.62323968 F:661.79995131
73 step:0.00010000 theta:2.21011212 F:661.79990497
74 step:0.00050000 theta:3.31162489 F:661.79978842
75 step:0.00010000 theta:1.76134356 F:661.79973950
76 step:0.00030000 theta:2.91535004 F:661.79970640
77 step:0.00000000 theta:4.46305466 F:661.79970640
78 DiffDist: 22.53986095 22.15639309 0.05000000 15.75941428
79 DiffDist: 13.66404852 13.07153429 -0.05000000 -8.56466209
80 DiffDist: 28.34030582 27.29535610 0.20000000 66.15196135
81 661.79970640 0.00000000 77 -1.52 -0.90 2.56
```

DiffDist: $l^2_{new} - l^2_{old}$ DDT $\frac{DDT}{\Delta T} * 2l^2$
FinalF Finalstep steps dx dy newmag

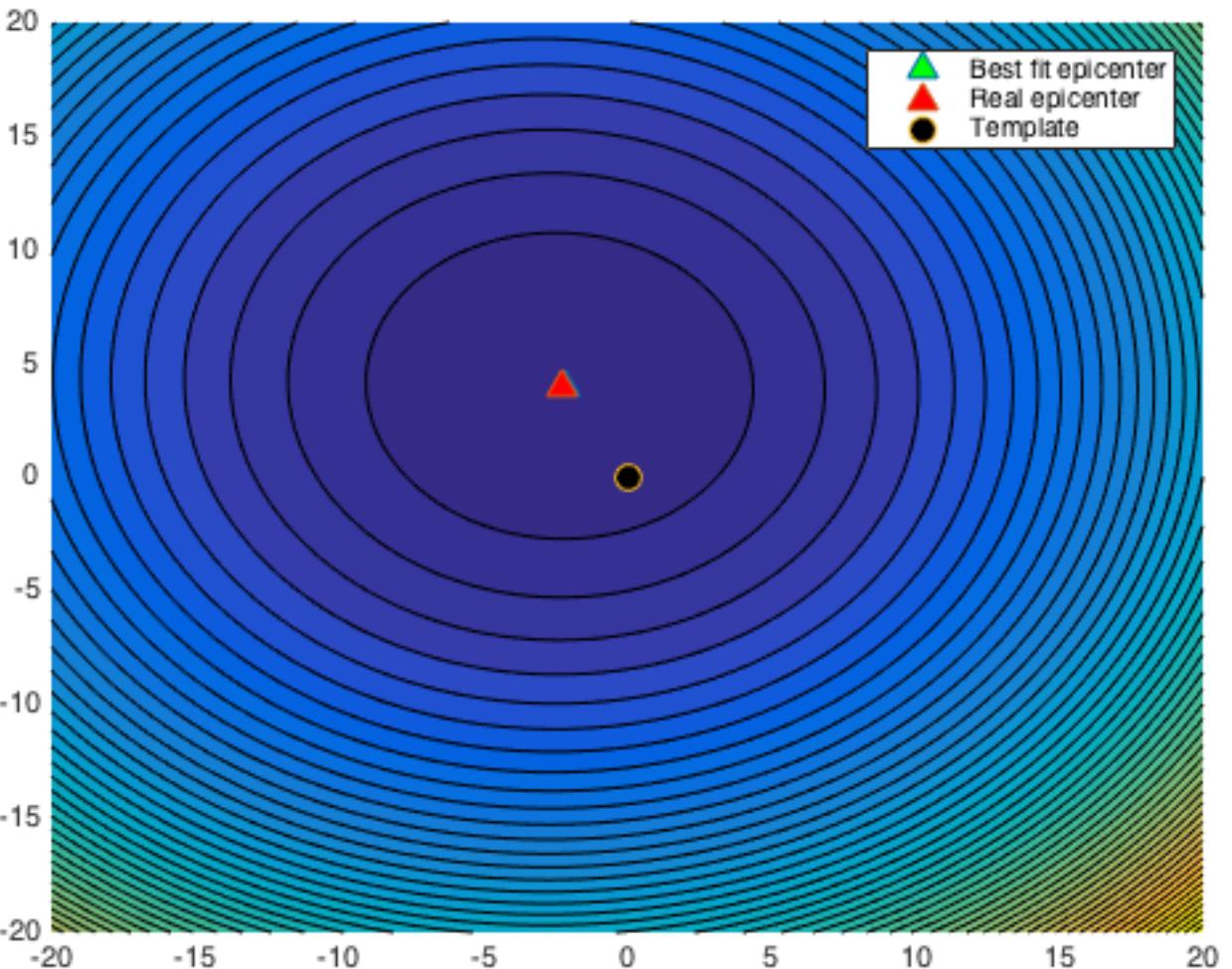
Relocation_2



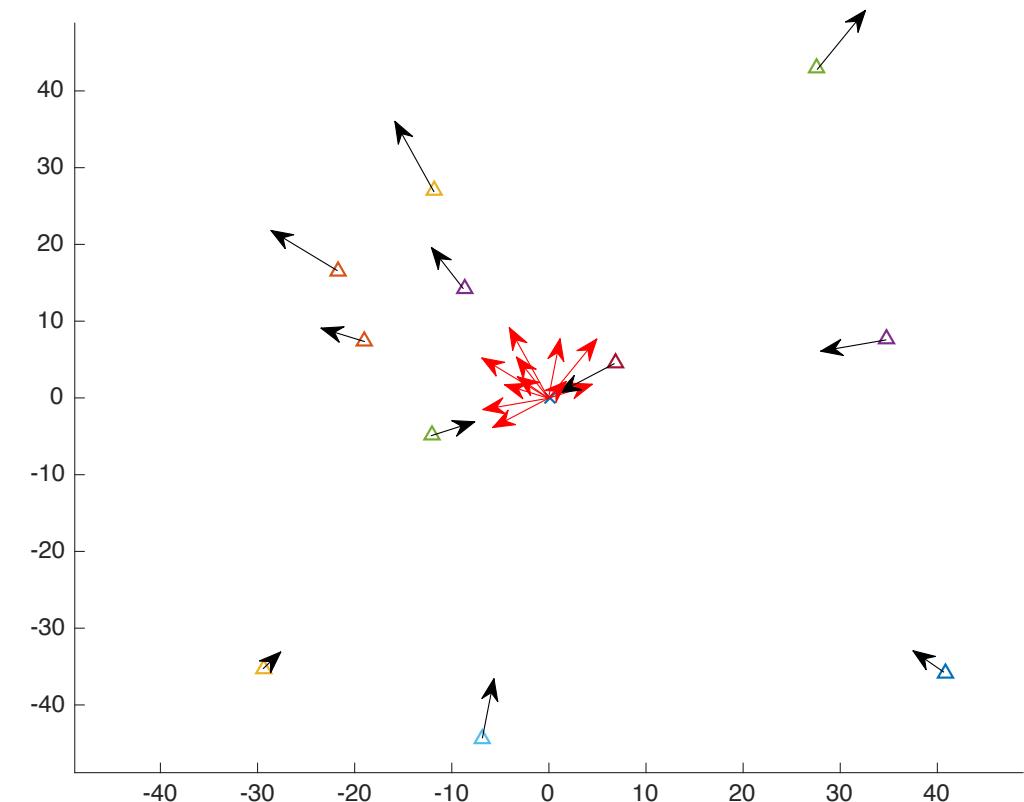
Template: $x,y,z = 0\ 0\ 10$

New_real: $x,y,z = -2.3\ 4\ 10$

New_Found: $x,y,z = -2.1384\ 4.0365\ 10$ (fixed) diff from real, might due to suppose in relocate_2



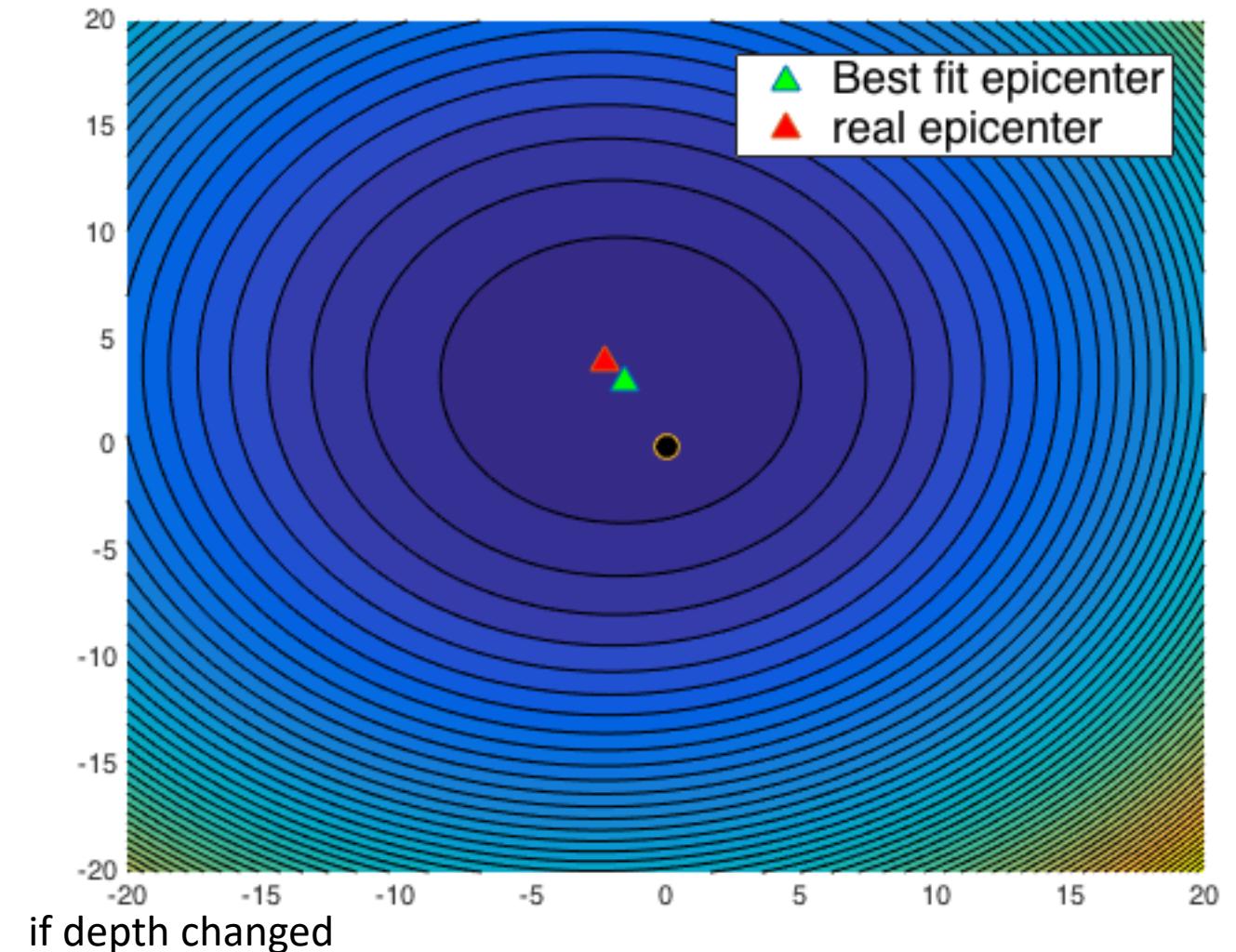
Relocation_2



Template: $x,y,z = 0\ 0\ 10$

New_real: $x,y,z = -2.3\ 4\ 12$

New_Found: $x,y,z = -1.4034\ 3.0737\ 10$ (fixed)



Result(2017.03.01)

No weak: 6 sigma

Parameters:

Filter: 2-15hz

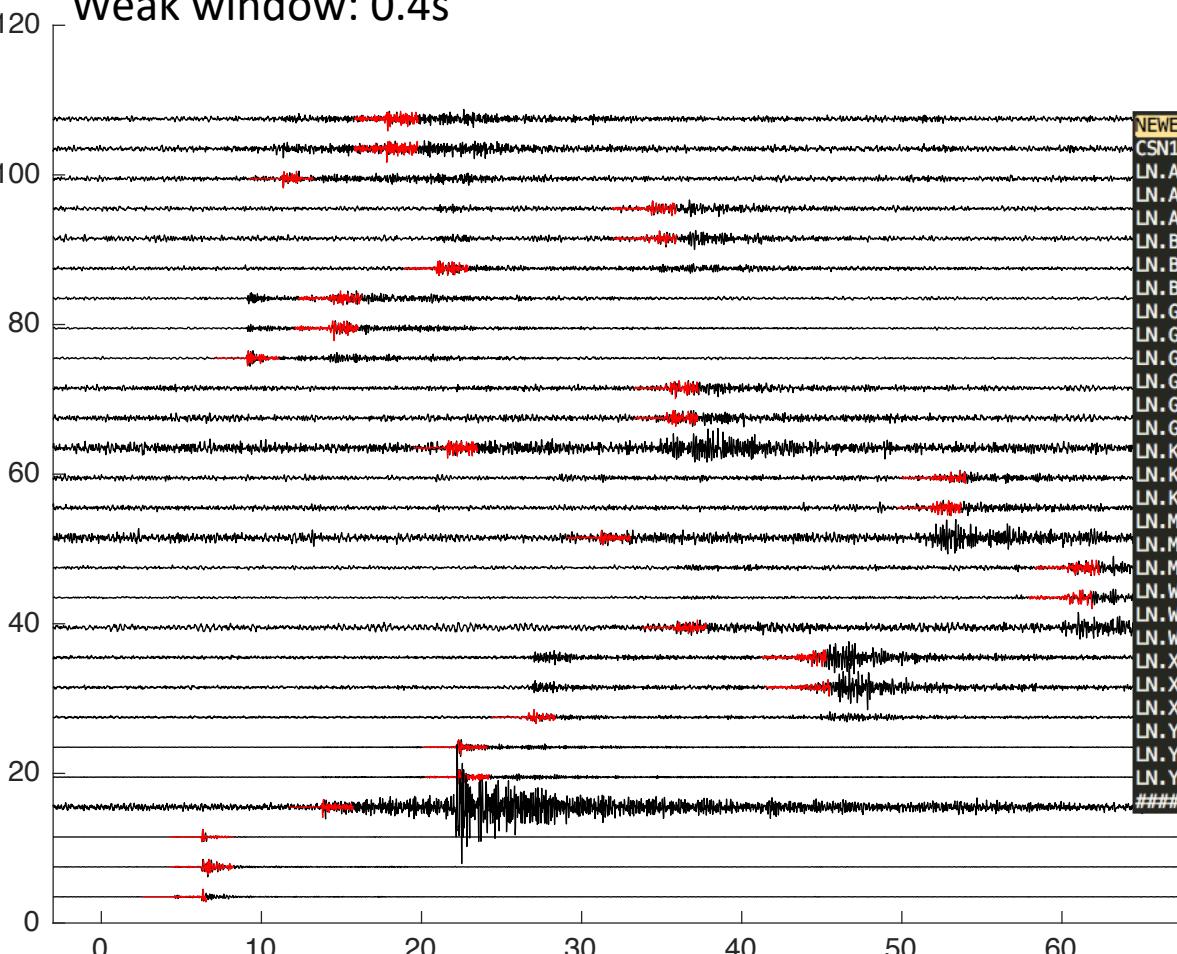
Template: 2011.2.19-27 16

Scnday: 2011.2.19-2011.3.30

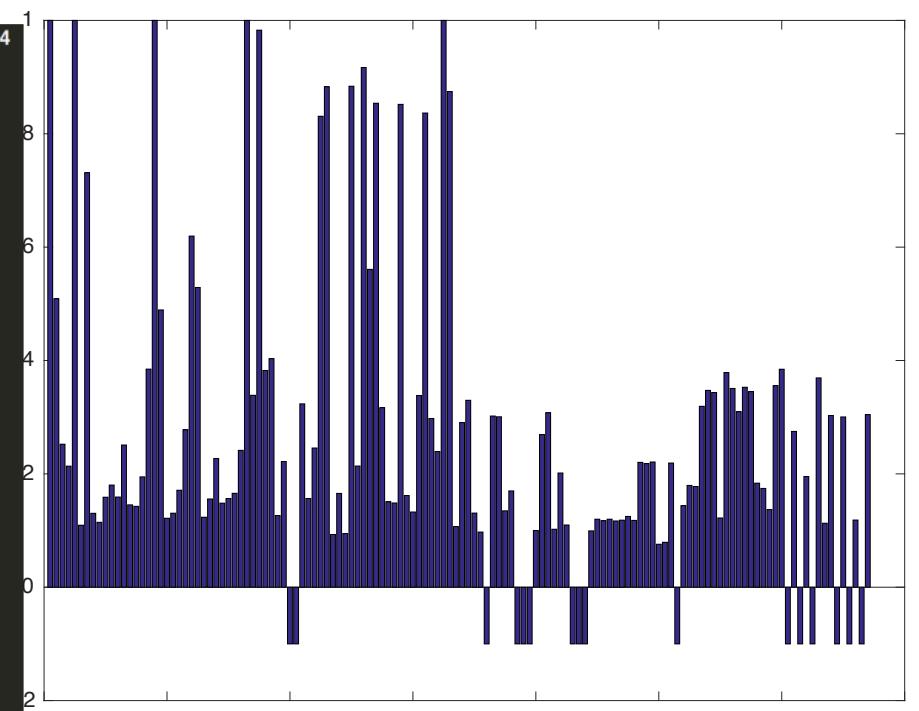
Weak window: 0.4s

N_findself: 5 Evt_find: 118
>0.7 15
>0.5 19
>0.4 21

NEVENT110219011535 ---- CSN110219011430
NEVENT110219191132 ---- 0.4892
NEVENT110220045308 ---- 0.5288
NEVENT110221094101 ---- CSN110221094019
NEVENT110224112804 ---- Known event



NEVENT110220045308 2011 02 20 04 53 08.04
CSN110223141819 0.5288 0.0184 0.1104
LN.ANS.BHE.SAC 15.77 0.00 2.8005 0.3660
LN.ANS.BHN.SAC 15.73 0.00 2.6816 0.4495
LN.ANS.BHZ.SAC 9.21 0.00 2.4713 0.5267
LN.BXI.BHE.SAC 31.87 0.00 3.0302 0.6636
LN.BXI.BHN.SAC 31.92 0.00 2.9998 0.7708
LN.BXI.BHZ.SAC 18.87 0.00 2.1710 0.6683
LN.GAX.BHE.SAC 12.28 0.00 2.7753 0.4607
LN.GAX.BHN.SAC 12.04 0.00 2.7057 0.7216
LN.GAX.BHZ.SAC 7.04 0.00 2.6965 0.8490
LN.GUS.BHE.SAC 33.24 0.00 3.1382 0.2989
LN.GUS.BHN.SAC 33.24 0.00 2.8118 0.6589
LN.GUS.BHZ.SAC 19.47 0.00 2.4637 0.4766
LN.KDN.BHE.SAC 49.96 0.00 2.8265 0.4600
LN.KDN.BHN.SAC 49.70 0.00 2.4810 0.4682
LN.KDN.BHZ.SAC 29.01 0.00 1.9944 0.3678
LN.MQI.BHE.SAC 58.32 0.00 3.0738 0.7296
LN.MQI.BHN.SAC 57.88 0.00 2.6350 0.7361
LN.MQI.BHZ.SAC 33.77 0.00 2.6619 0.2852
LN.WFD.BHE.SAC 41.23 0.00 2.4590 0.7065
LN.WFD.BHN.SAC 41.47 0.00 2.7999 0.7769
LN.WFD.BHZ.SAC 24.33 0.00 2.9985 0.8466
LN.XYN.BHE.SAC 20.08 0.00 3.5224 0.5538
LN.XYN.BHN.SAC 20.18 0.00 3.1639 0.4513
LN.XYN.BHZ.SAC 11.71 0.00 4.2187 -0.0755
LN.YKO.BHE.SAC 4.21 0.00 2.3911 0.4649
LN.YKO.BHN.SAC 4.23 0.00 2.0018 0.2585
LN.YKO.BHZ.SAC 2.53 0.00 2.5843 0.3386
#####



Result(2017.03.01)

Weak: weakmean+5sigma

Parameters:

Filter: 2-15hz

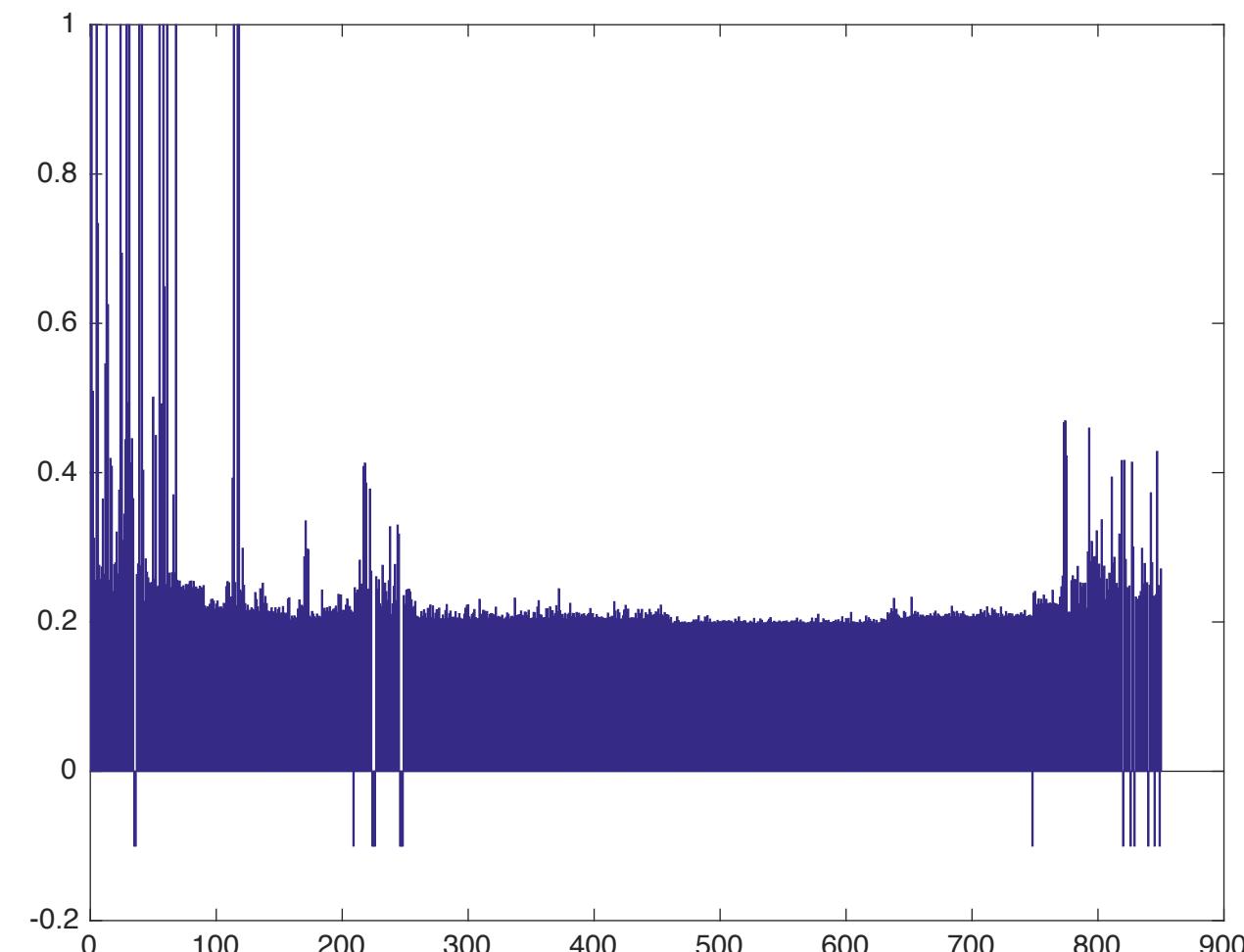
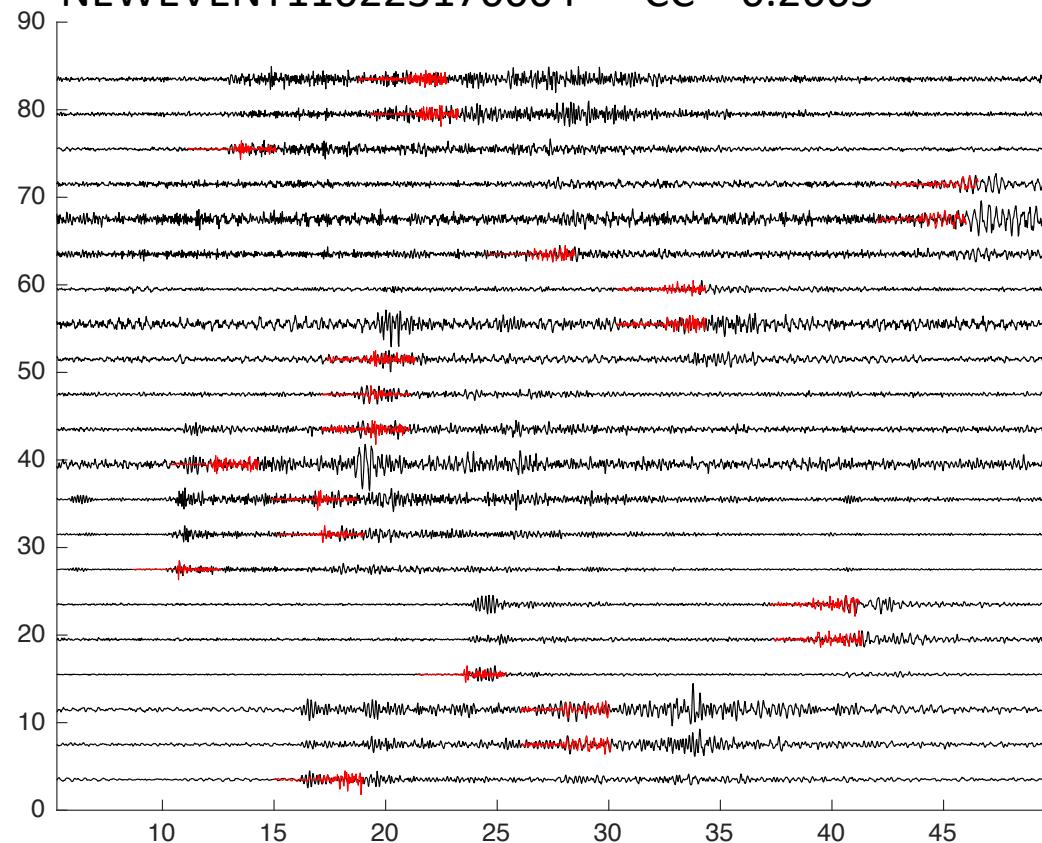
Template: 2011.2.19-27 16

Scnday: 2011.2.19-2011.3.30

Weak window: 0.4s

N_findself: 15 Evt_find: 834
>0.7 16
>0.5 22
>0.4 41

NEWEVENT110223170004 CC = 0.2665



Result(2017.03.01)

Part Weak: 6sigma
weaklimit 0.45

Parameters:

Filter: 2-15hz

Template: 2011.2.19-27 16

Scnday: 2011.2.19-2011.3.30

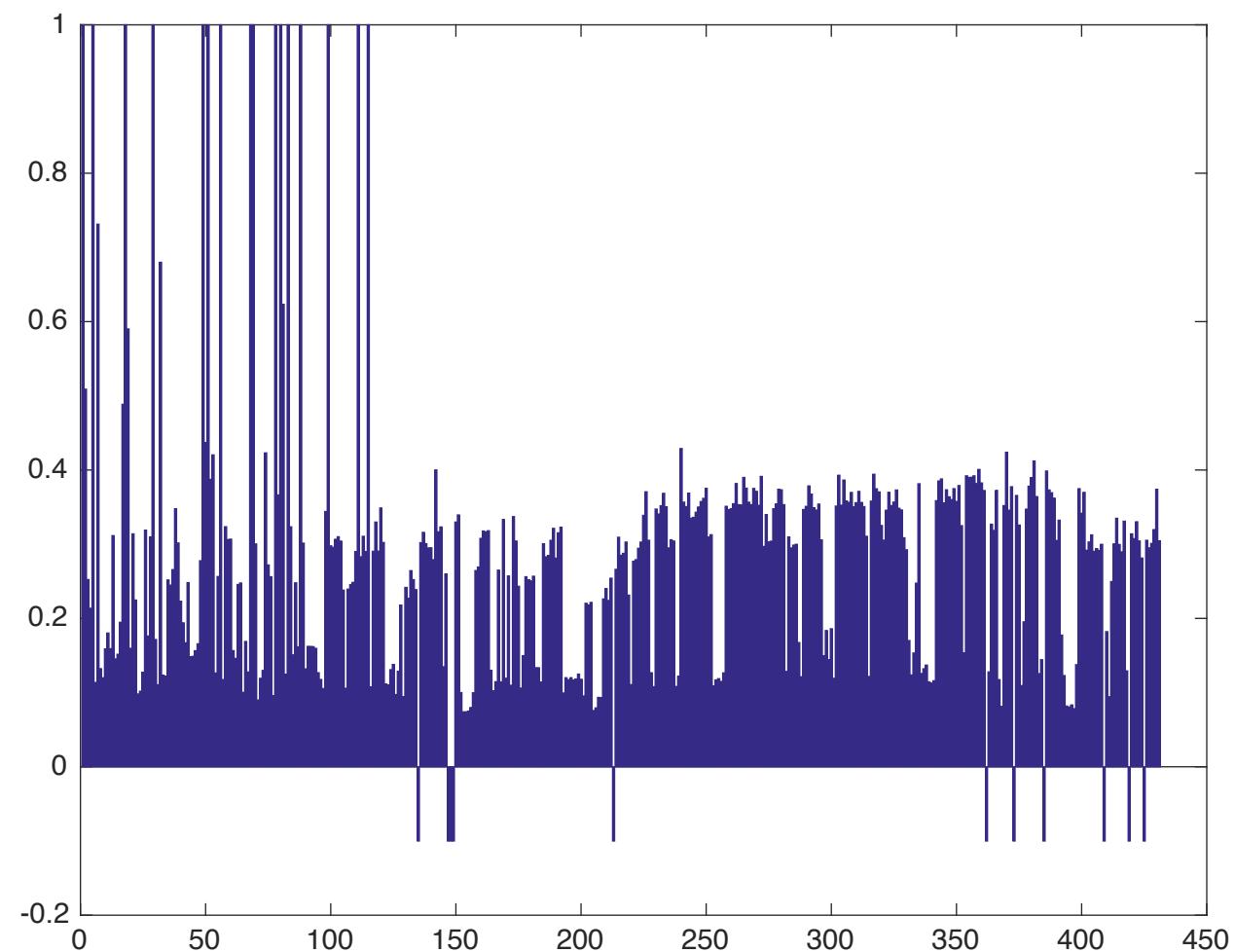
Weak window: 0.4s

N_findself: 16 Evt_find: 420

>0.7 17

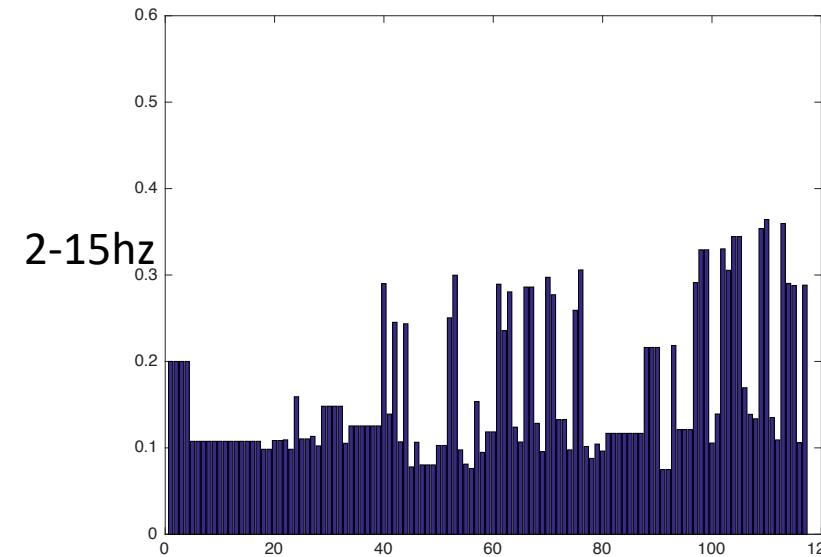
>0.5 21

>0.4 30

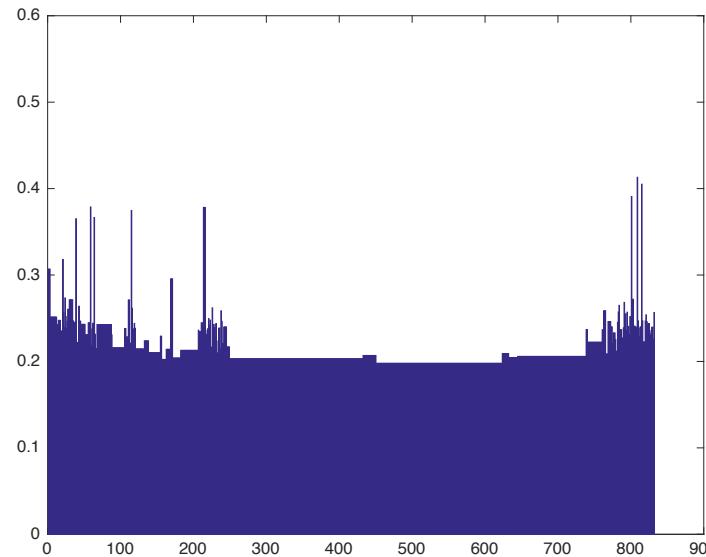


Threshold

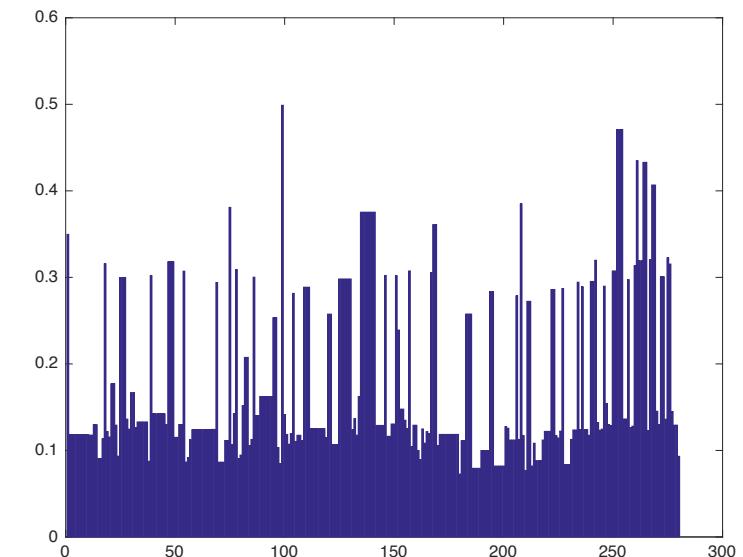
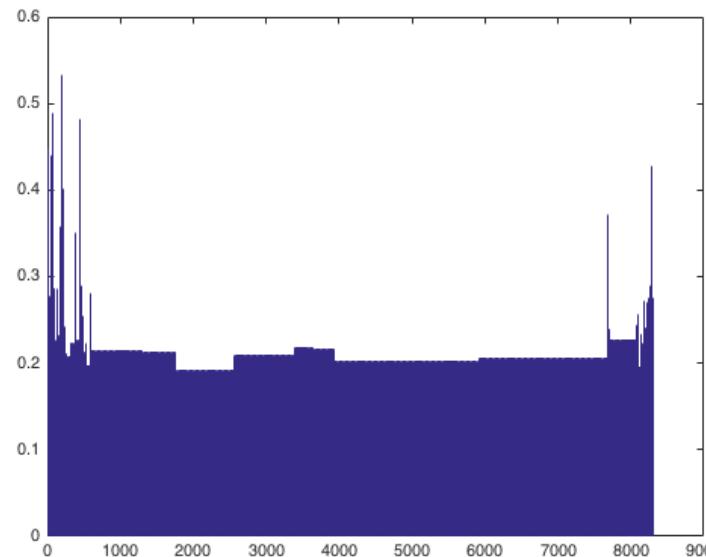
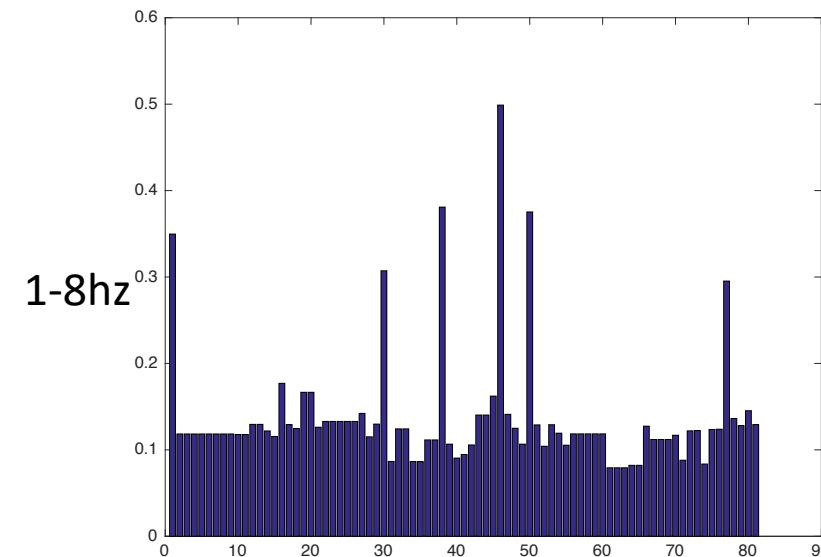
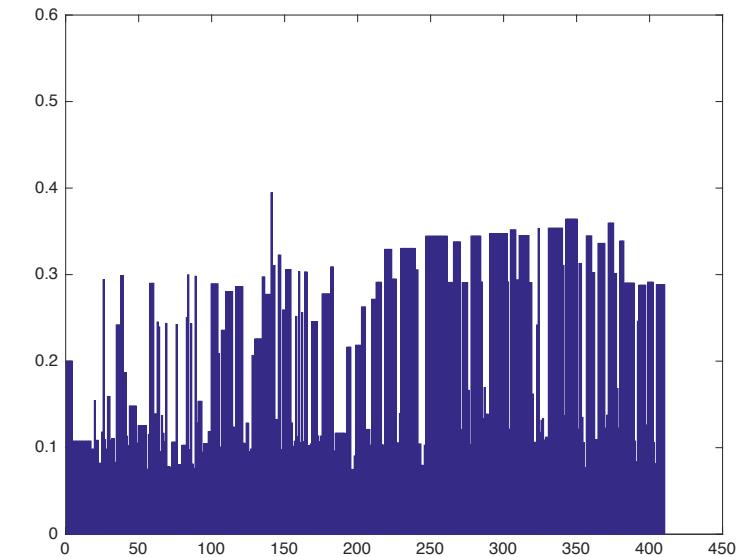
No Weak



Weak



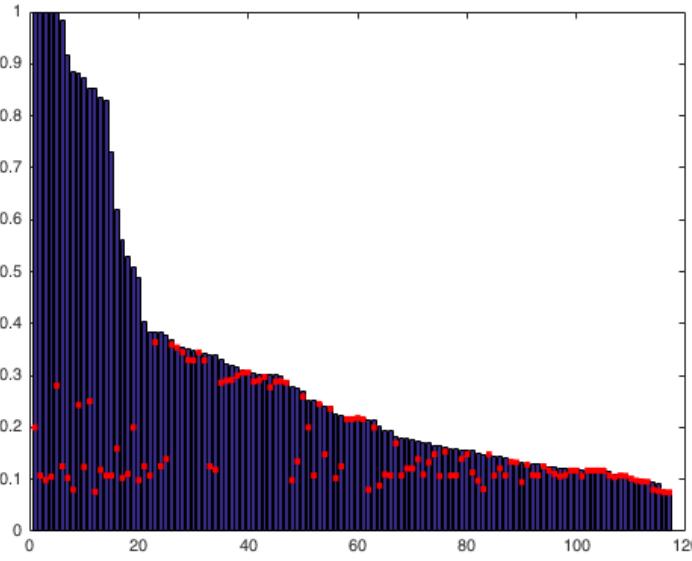
Part Weak



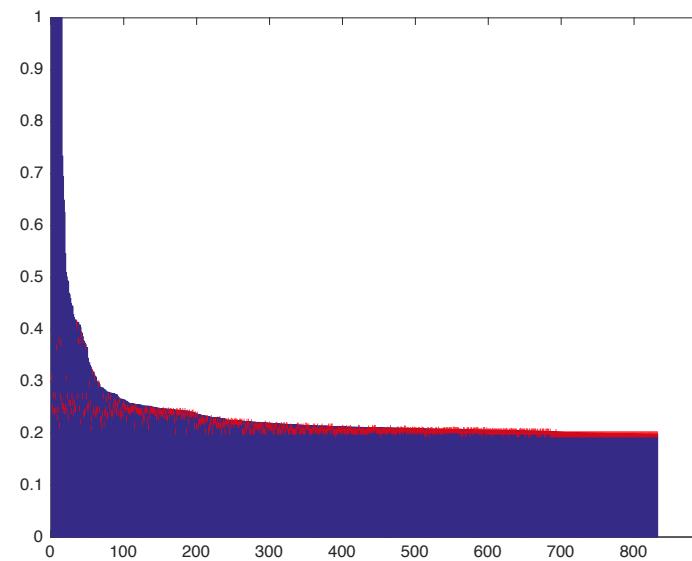
New event CC

No Weak

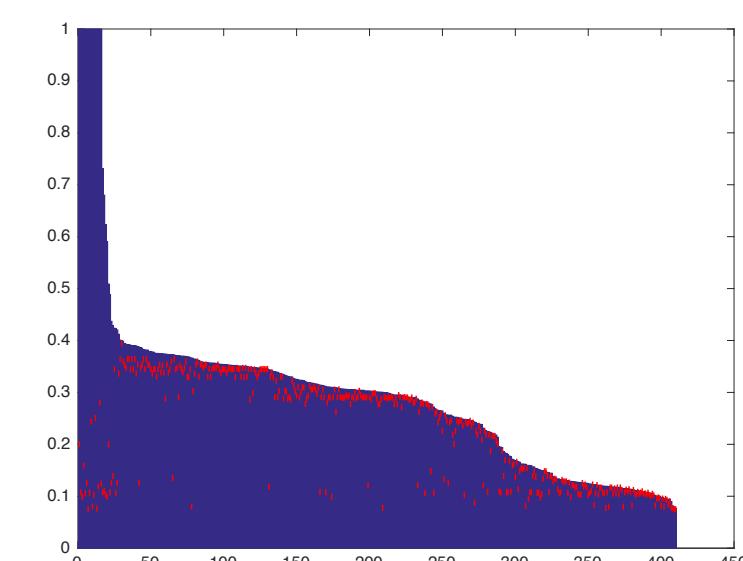
2-15hz



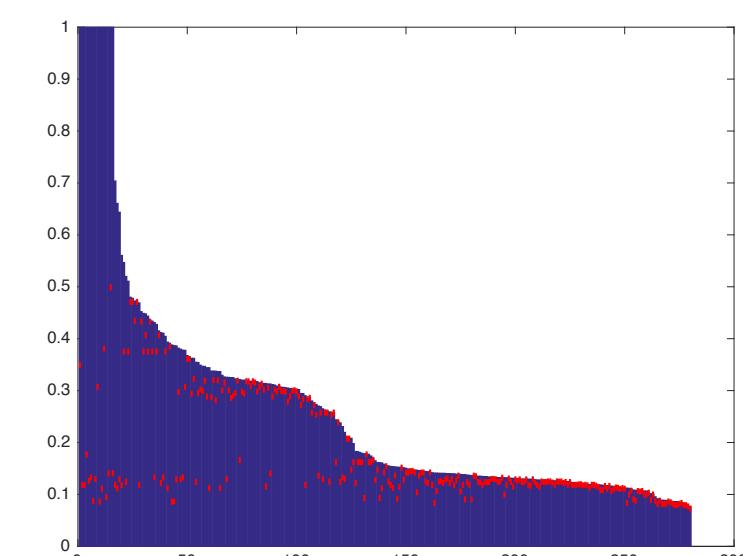
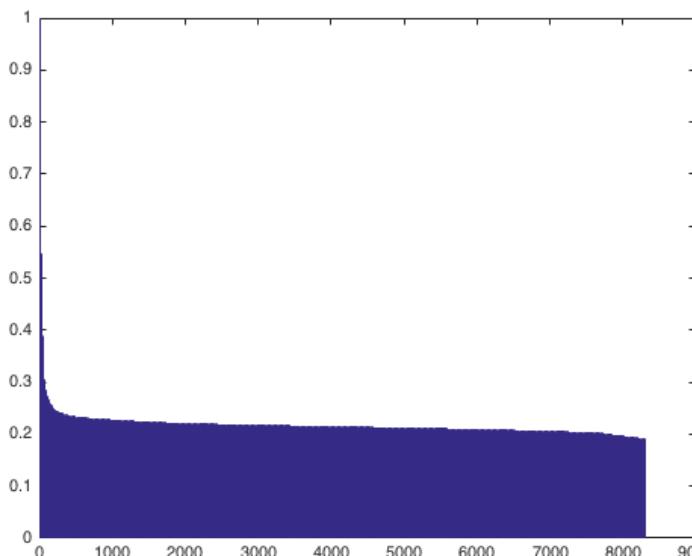
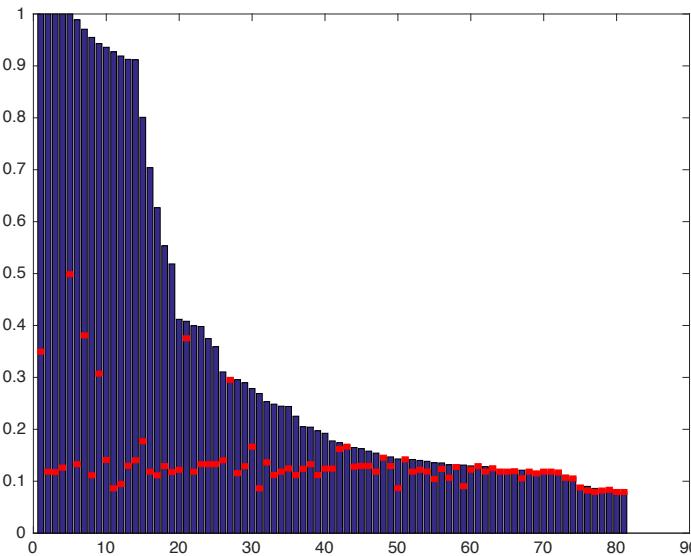
Weak



Part Weak

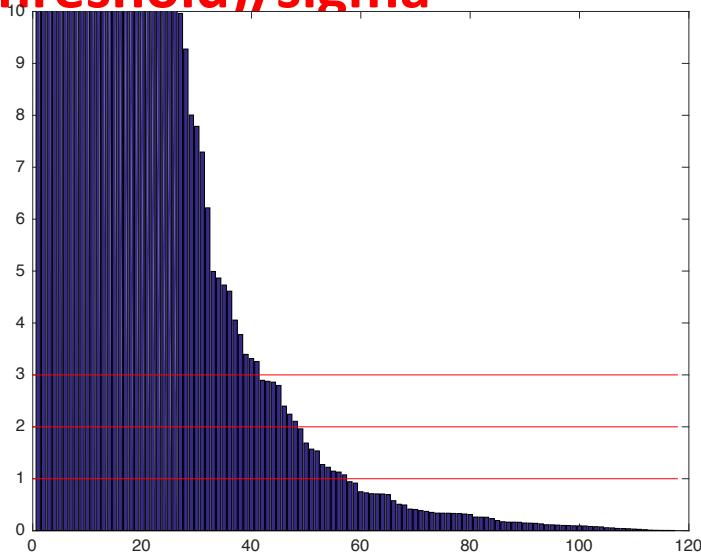


1-8hz

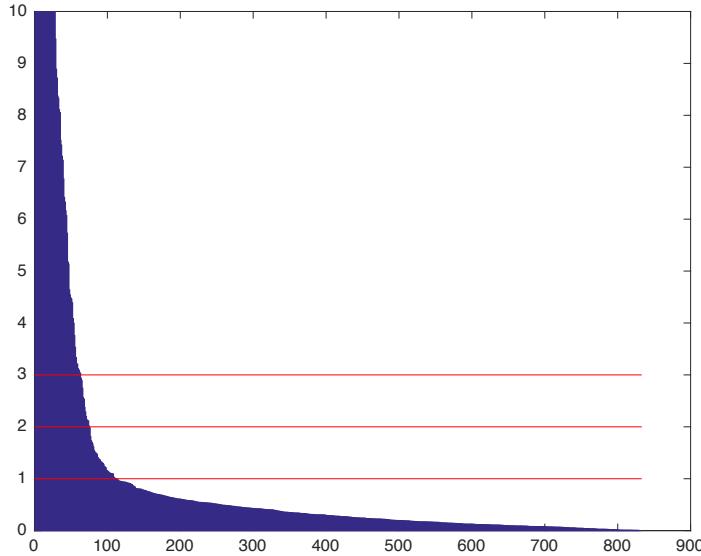


No Weak
(CC-Threshold)/sigma

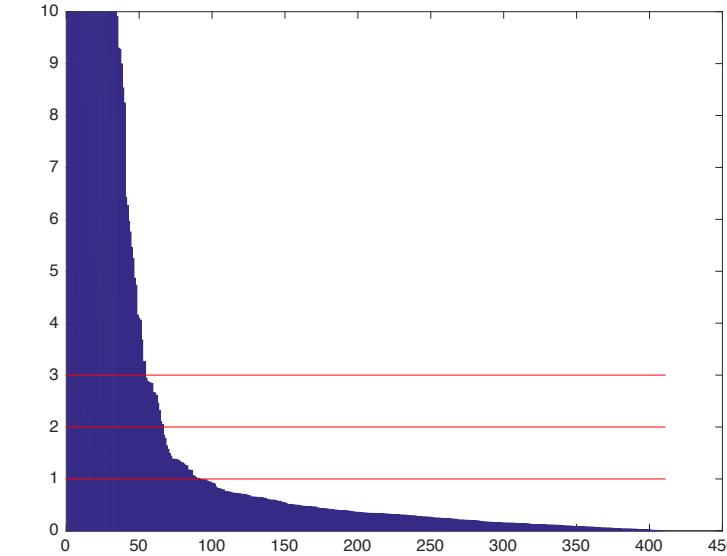
2-15hz



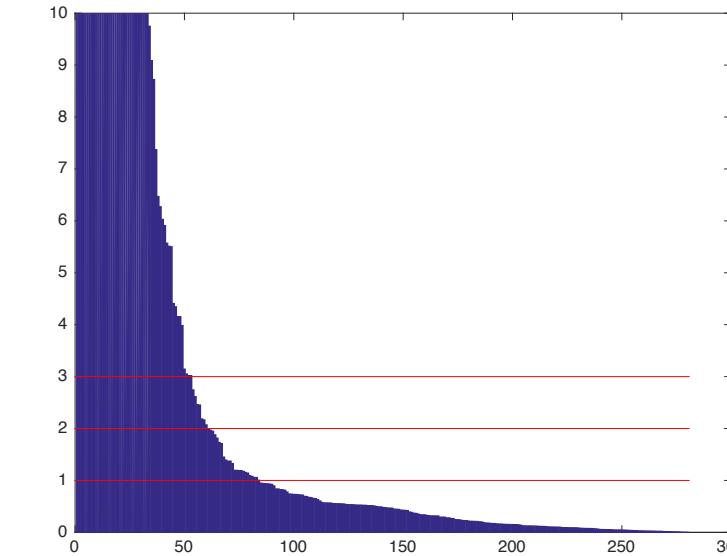
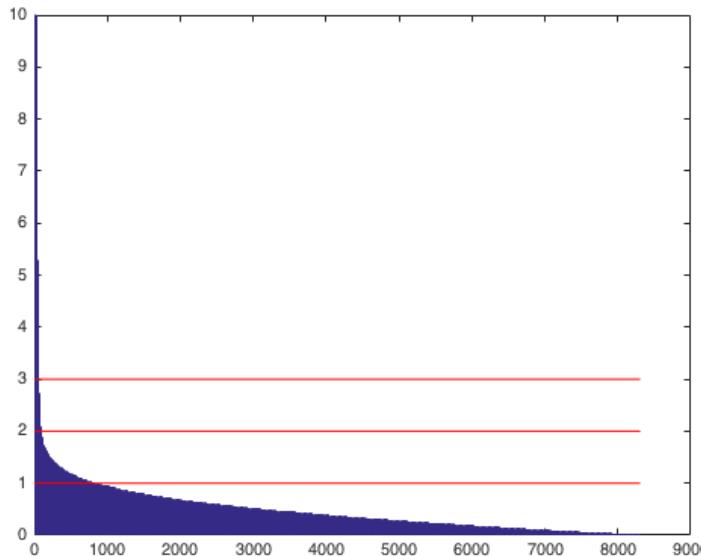
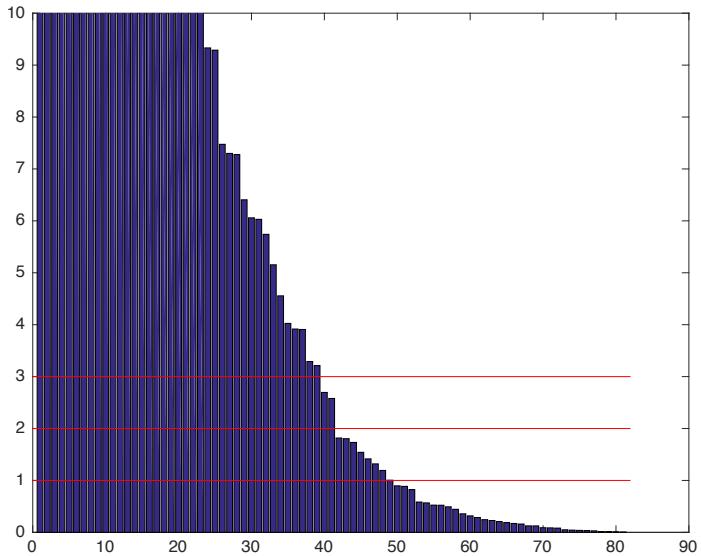
Weak



Part Weak



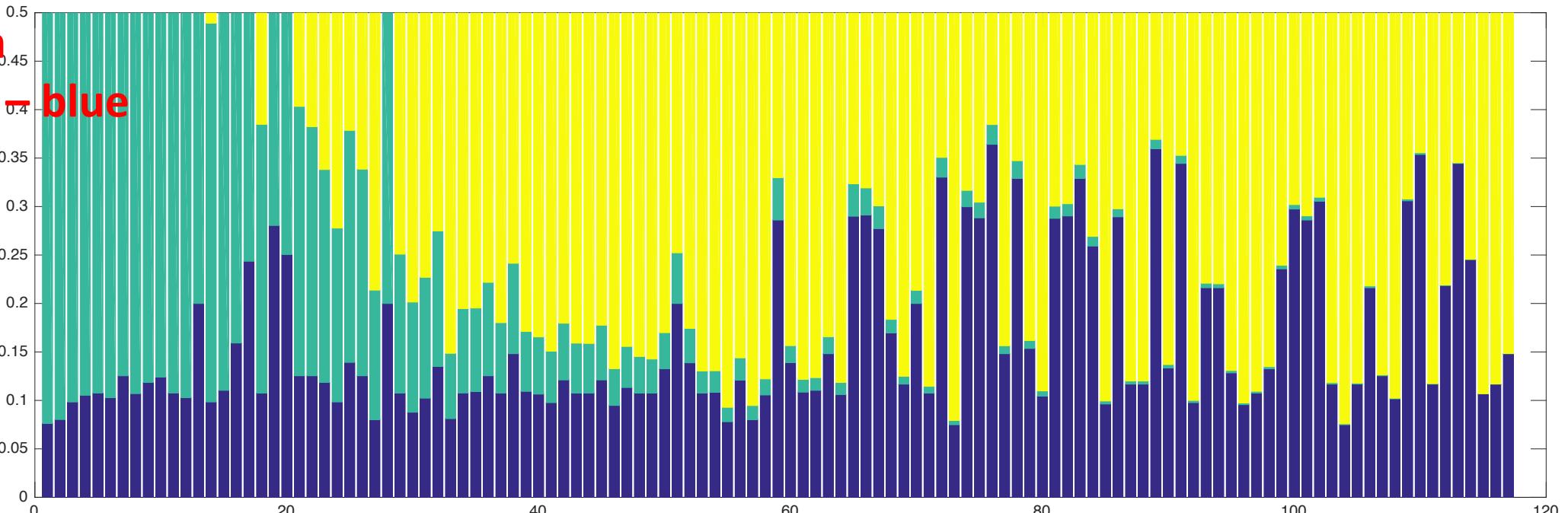
1-8hz



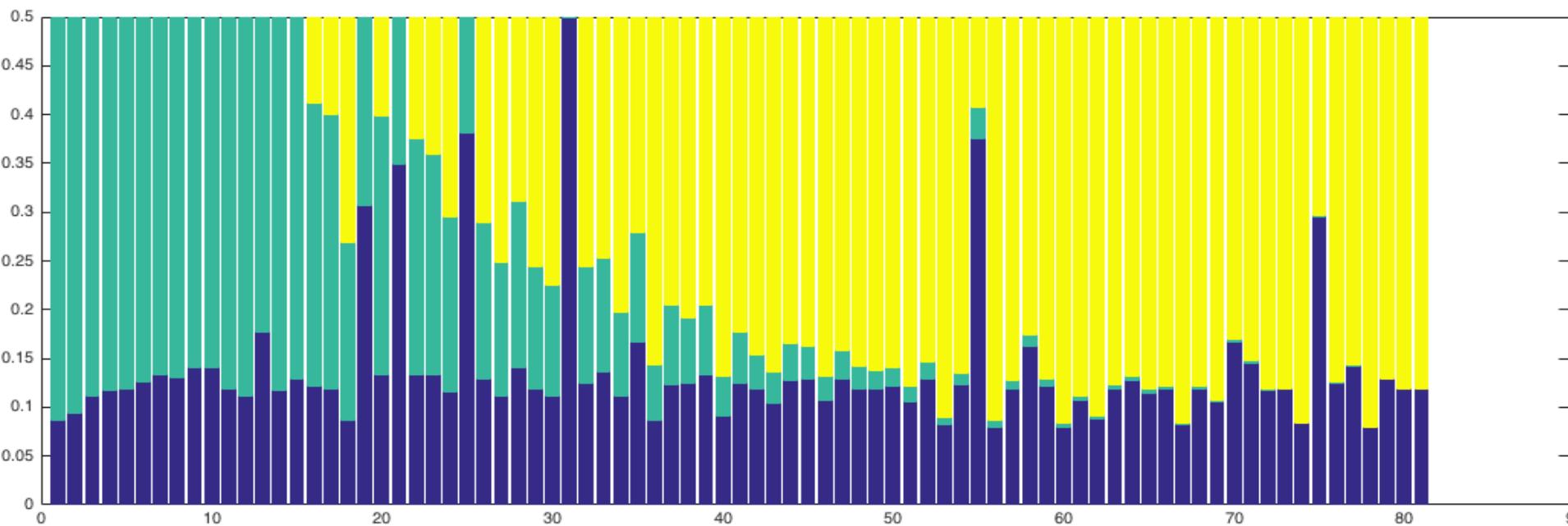
No Weak

CC – green
Threshold – blue

2-15hz



1-8hz

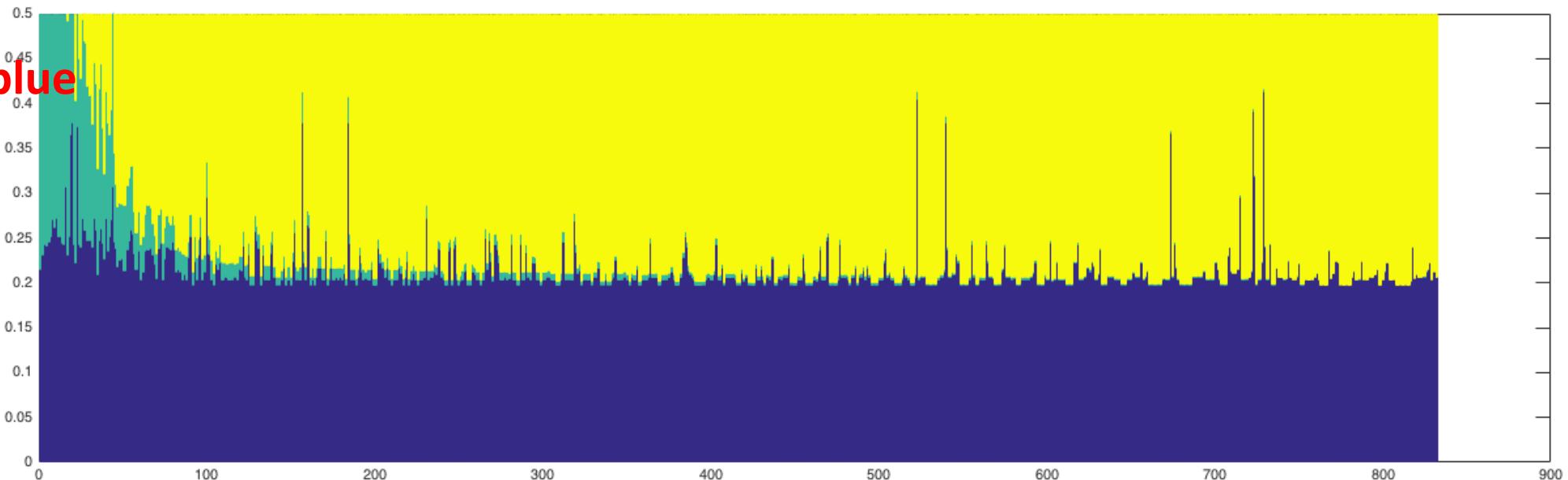


Weak

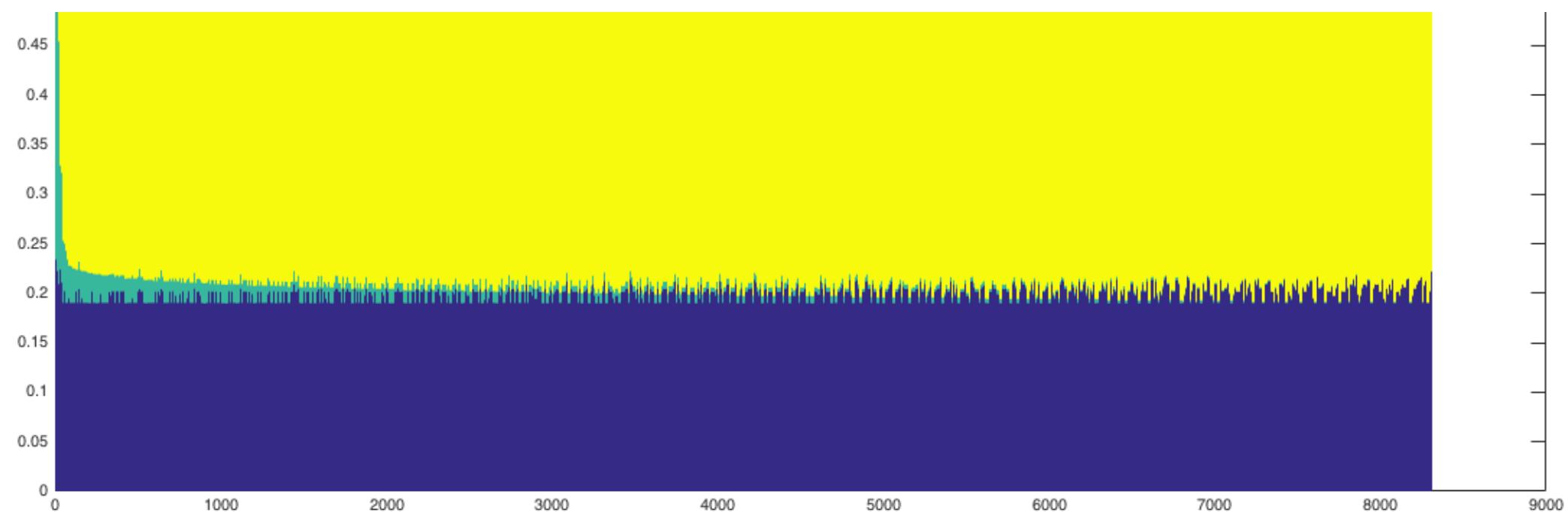
CC – green

Threshold – blue

2-15hz



1-8hz

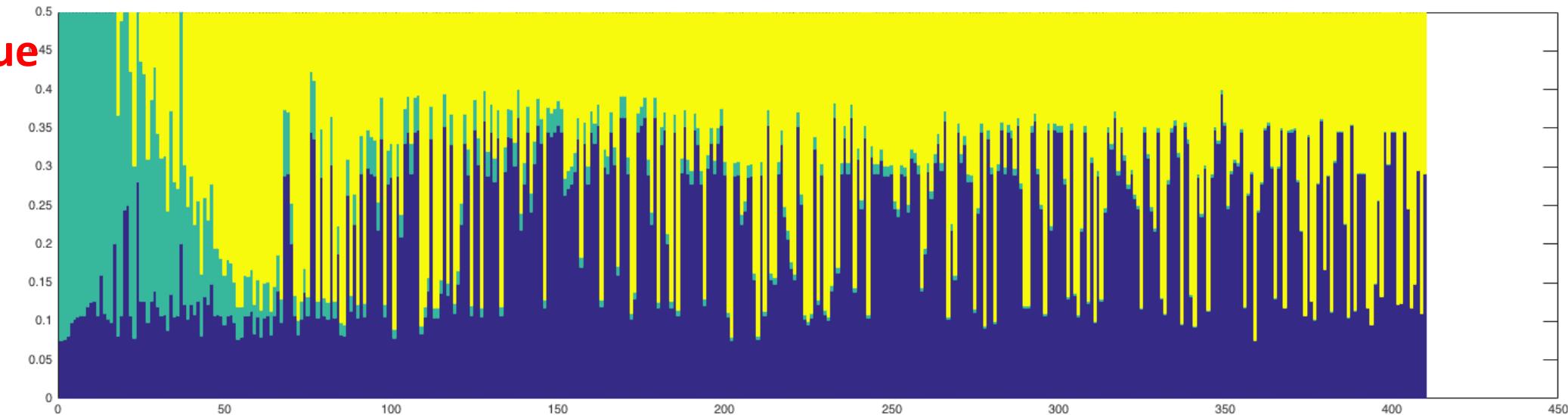


Part Weak

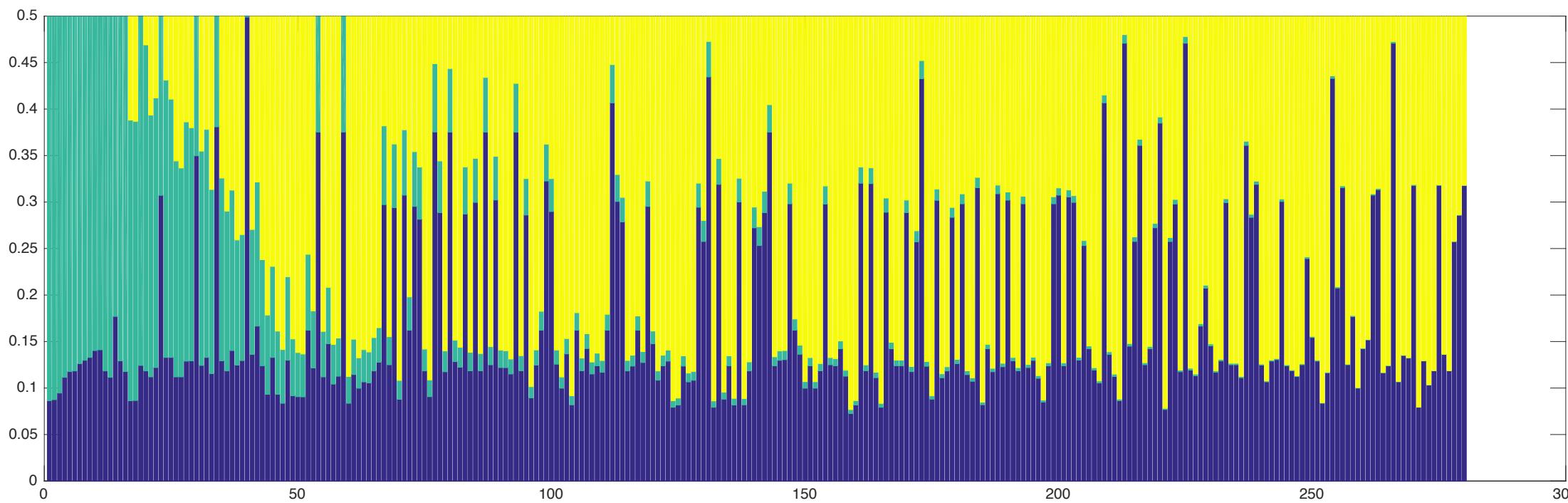
CC – green

Threshold – blue

2-15hz

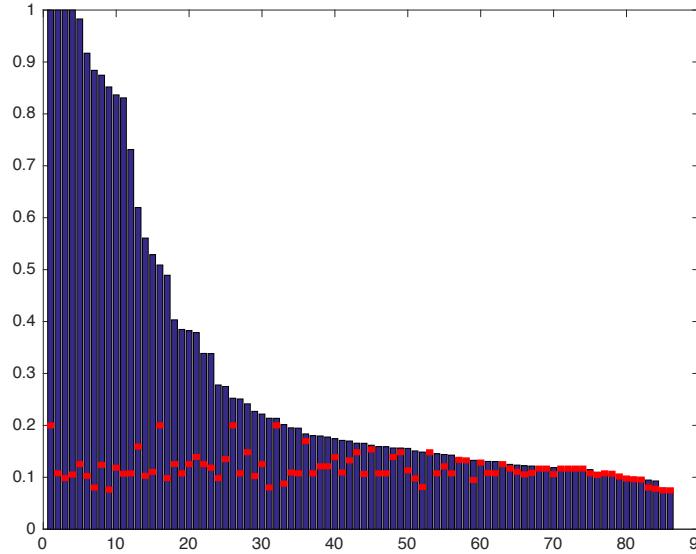


1-8hz

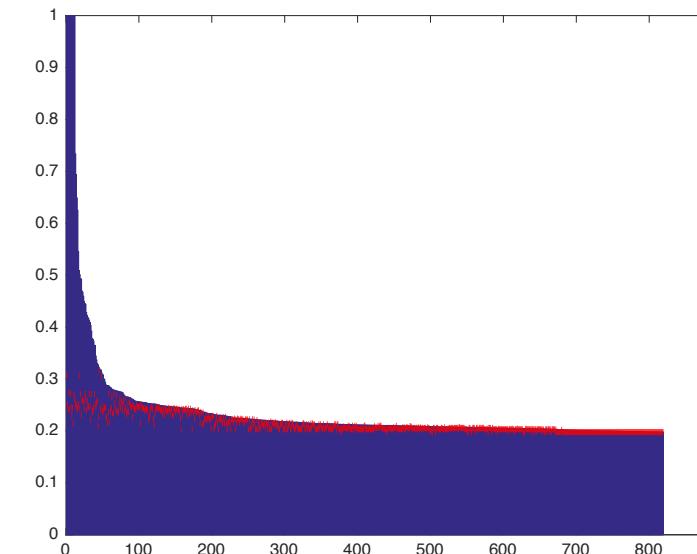


New event CC
no Weak
no less than 3 stations

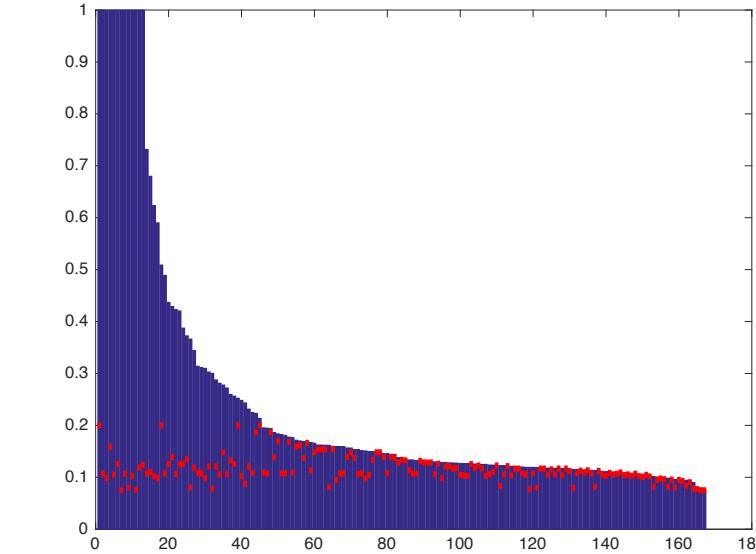
2-15hz



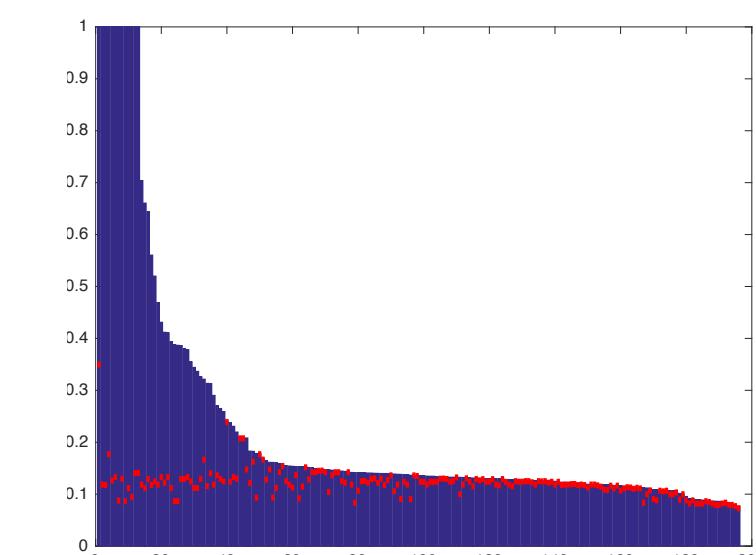
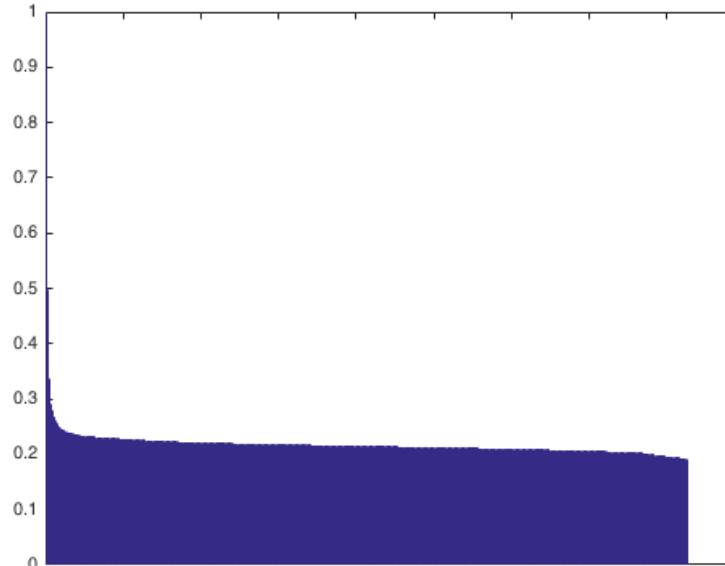
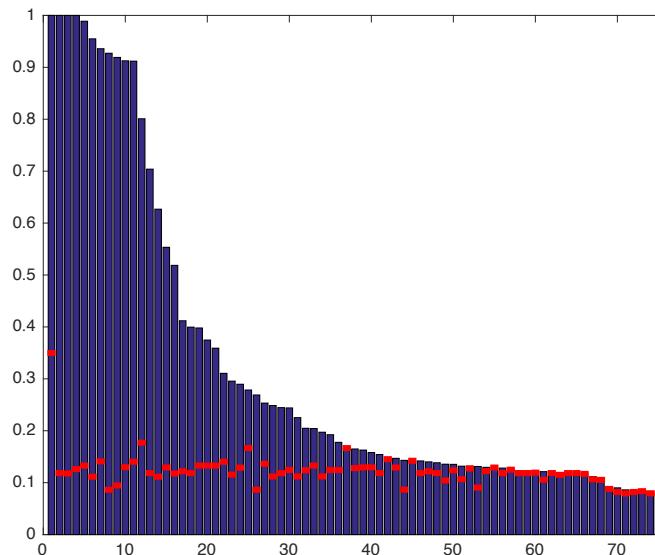
Weak



Part Weak

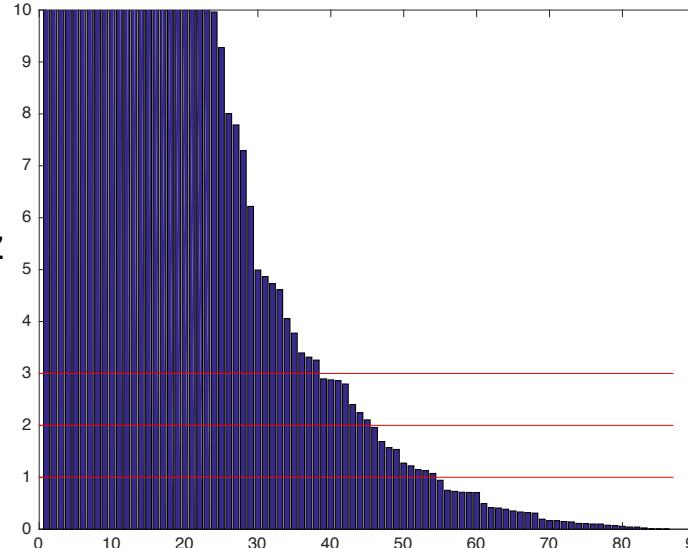


1-8hz

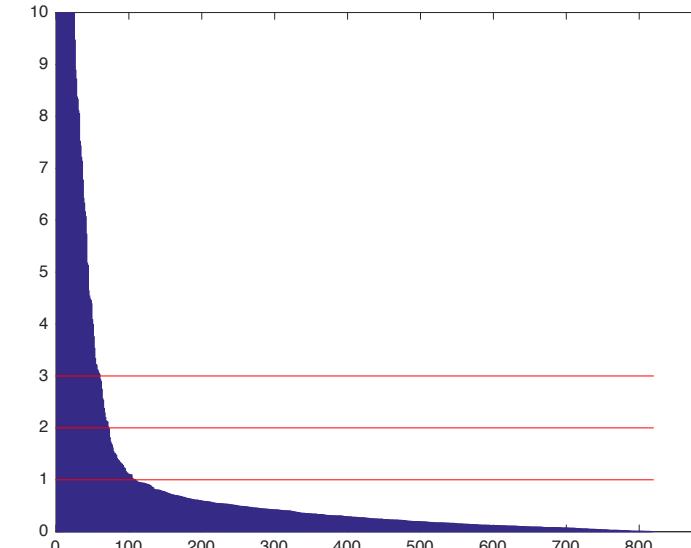


No Weak
(CC-Threshold)/sigma

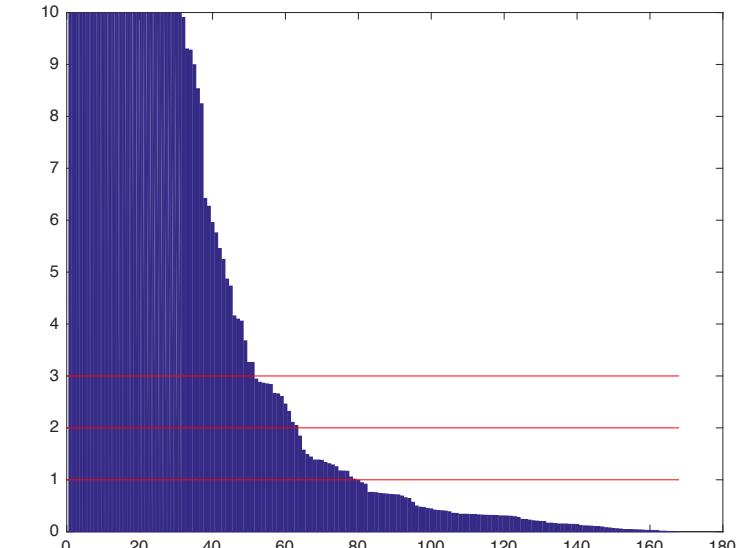
2-15hz



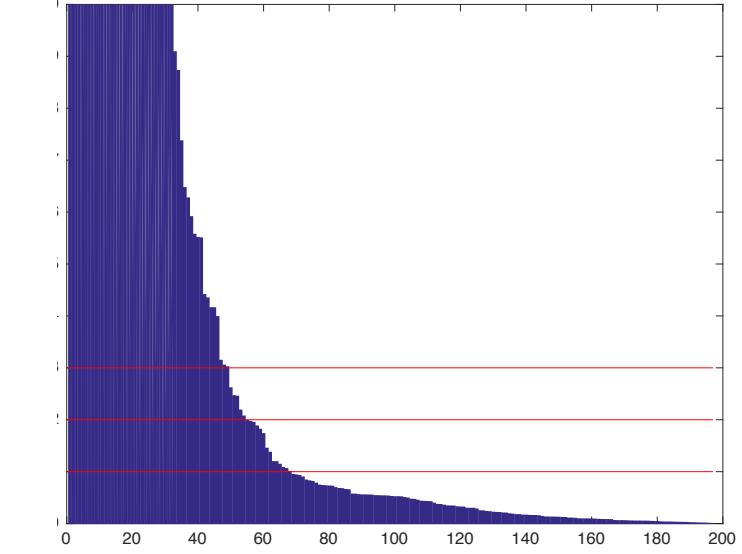
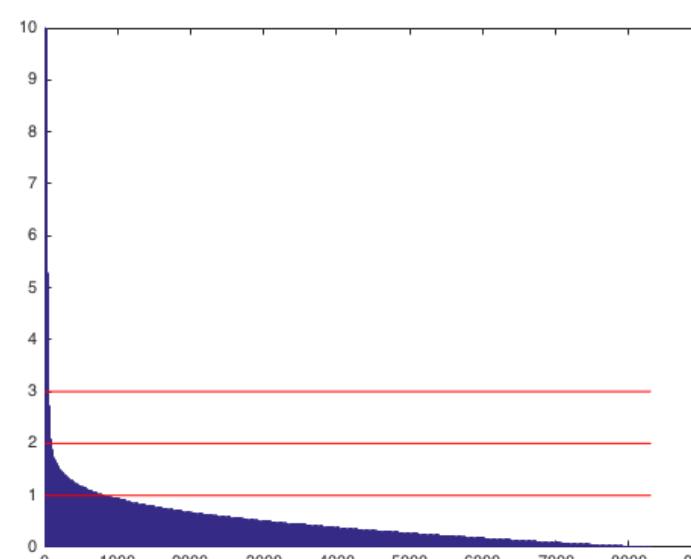
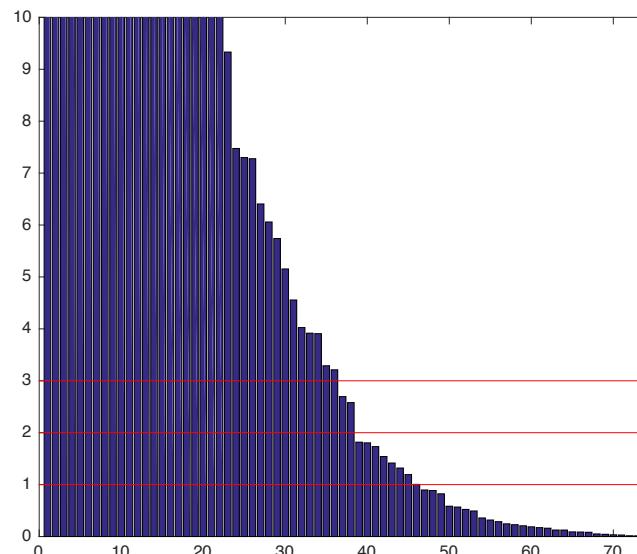
Weak



Part Weak



1-8hz

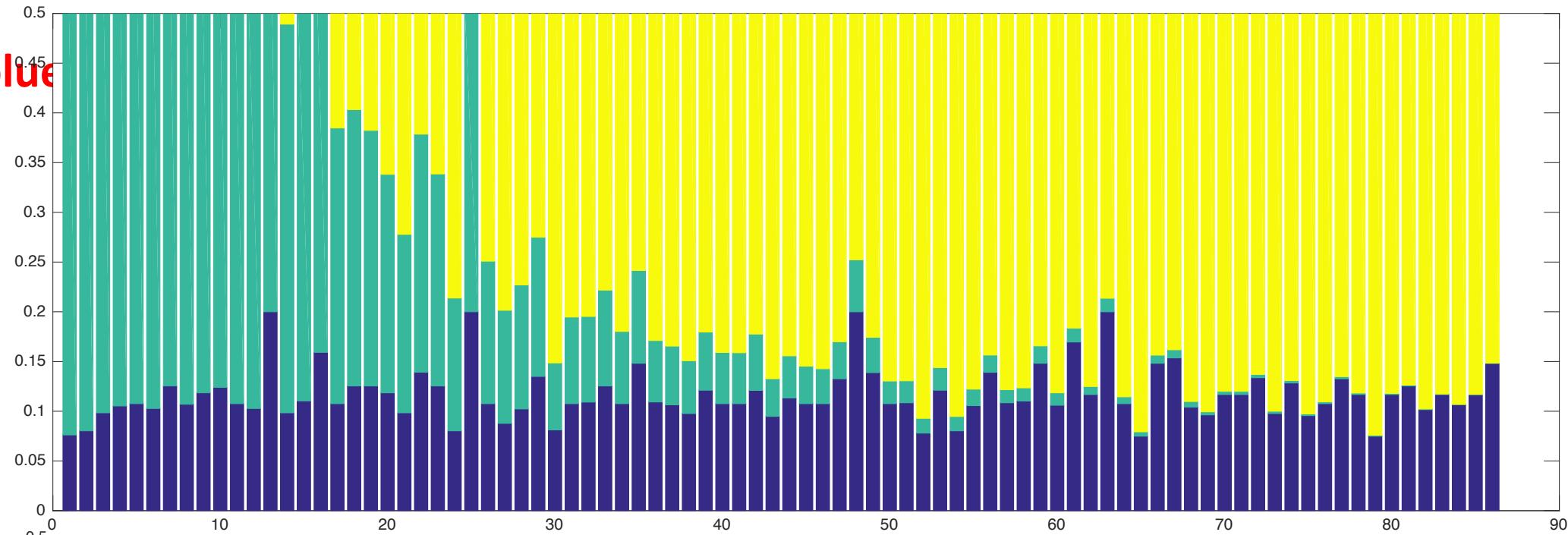


No Weak

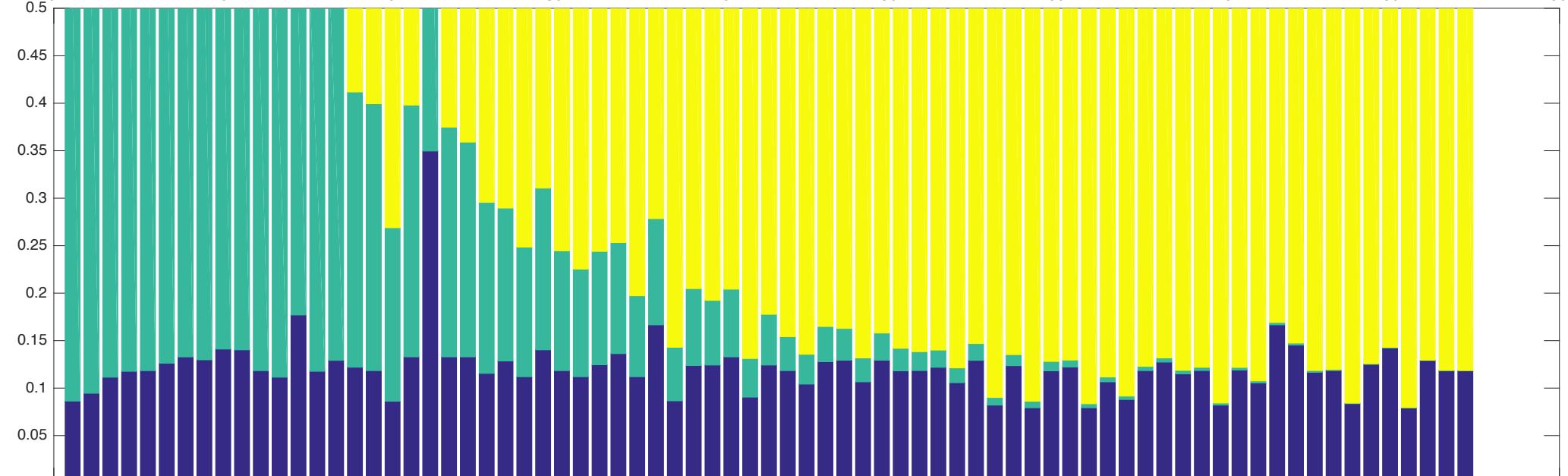
CC – green

Threshold – blue

2-15hz



1-8hz



Weak

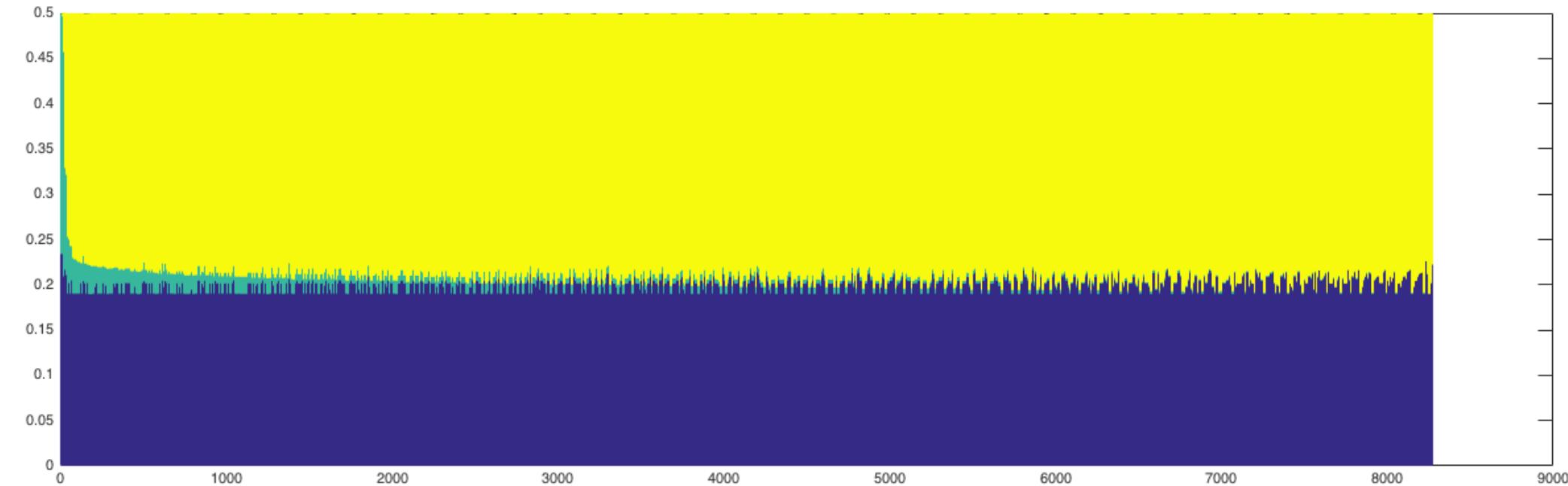
CC – green

Threshold – blue

2-15hz



1-8h

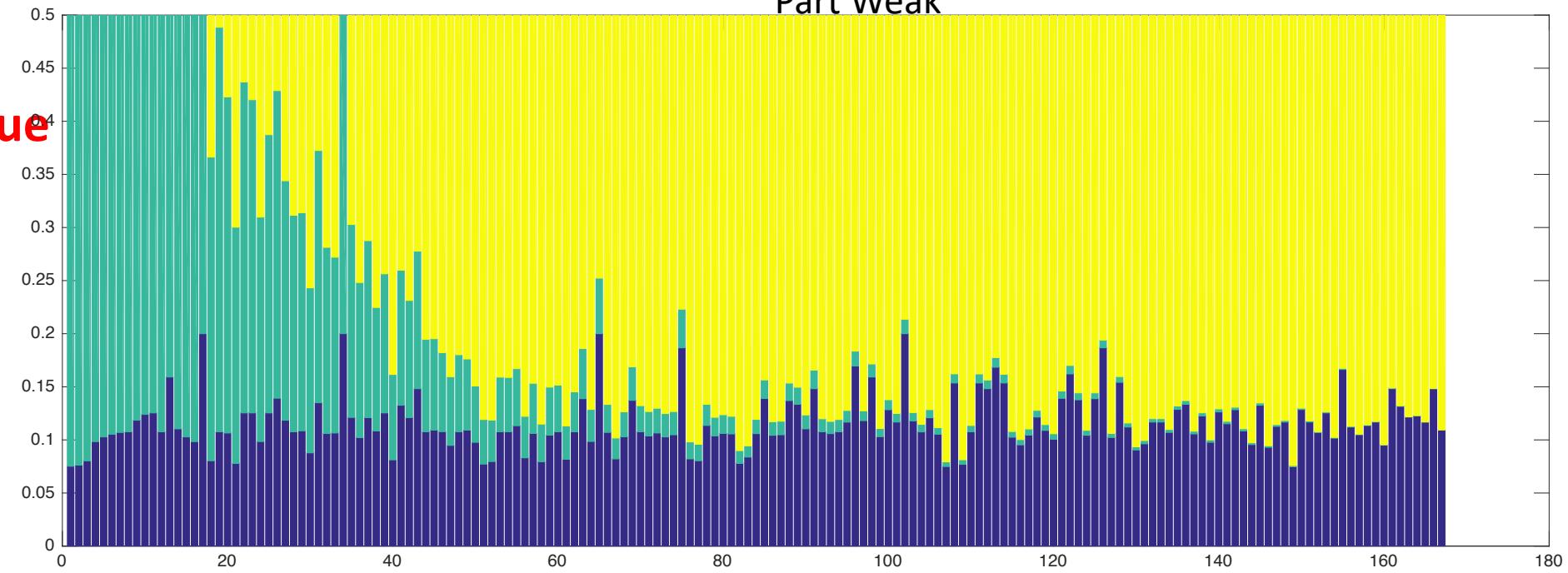


Part Weak

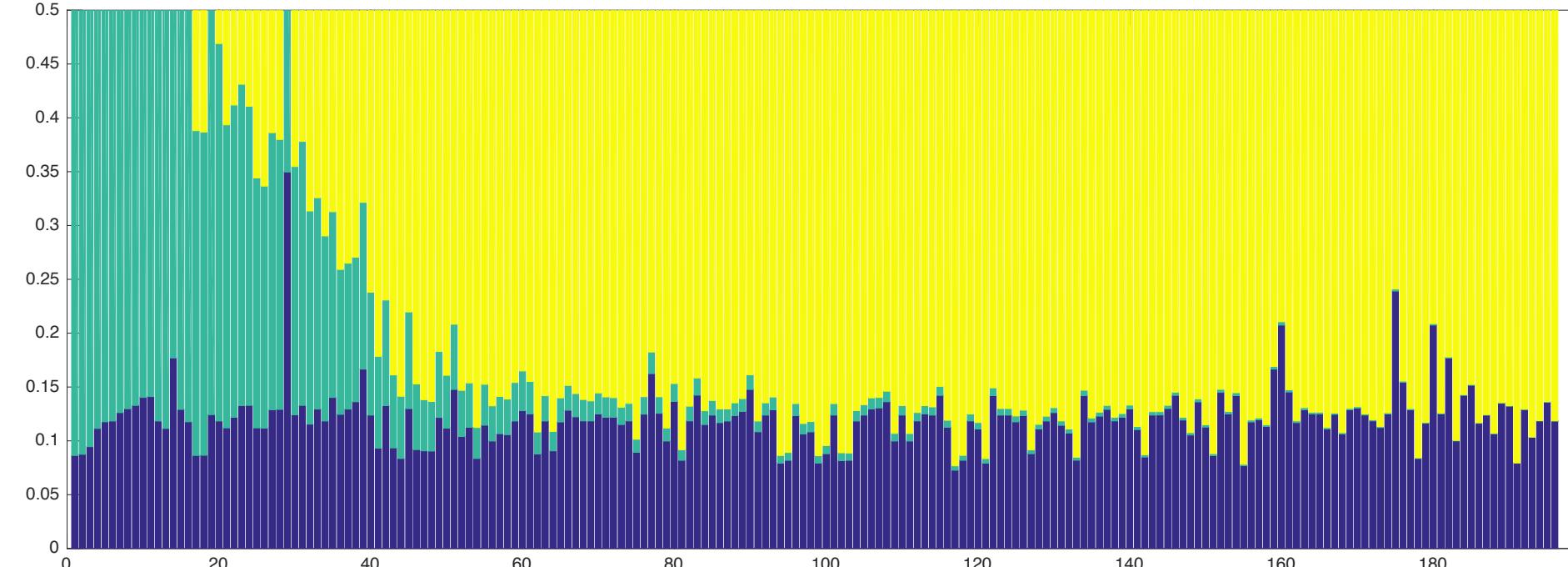
CC – green

Threshold – blue

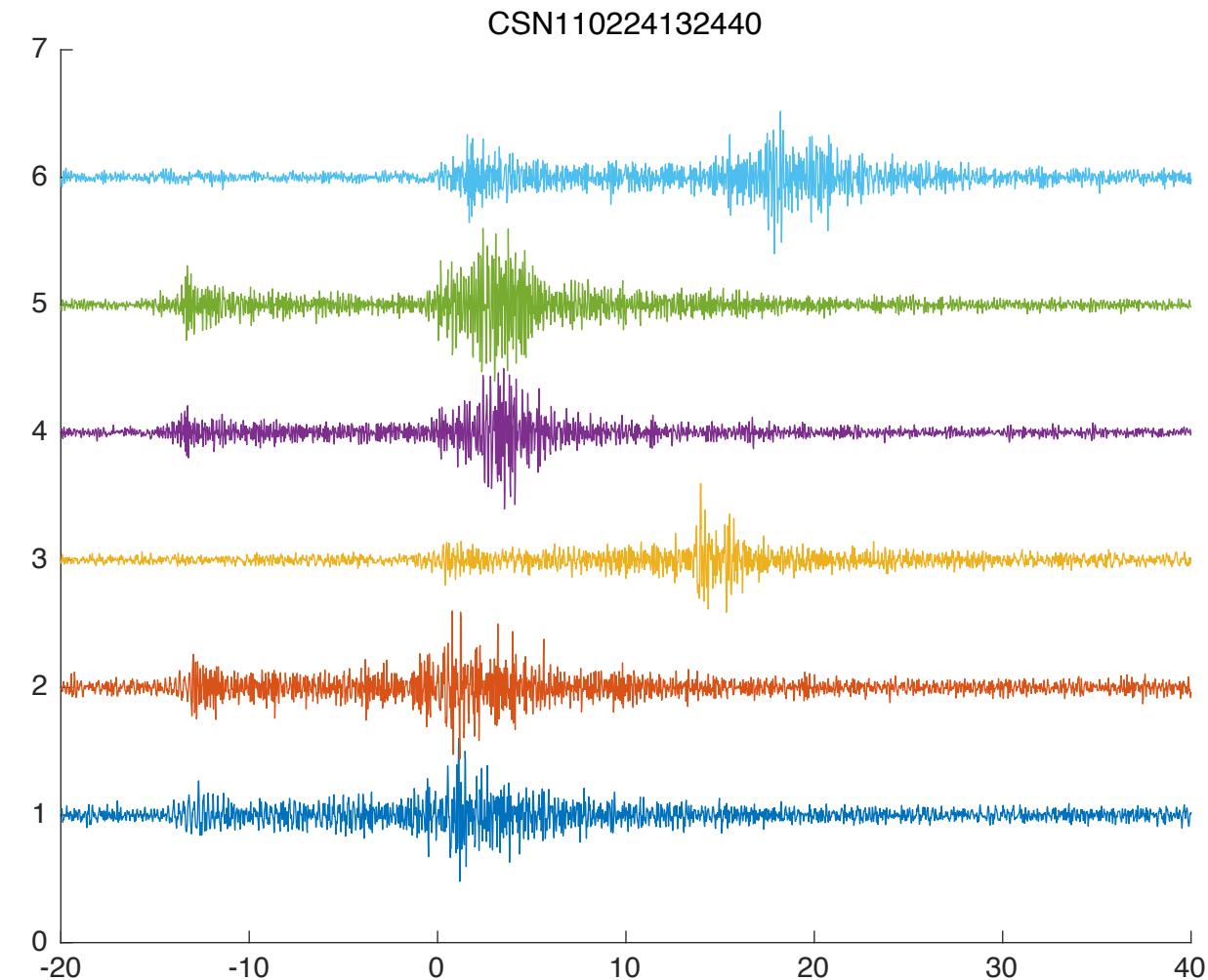
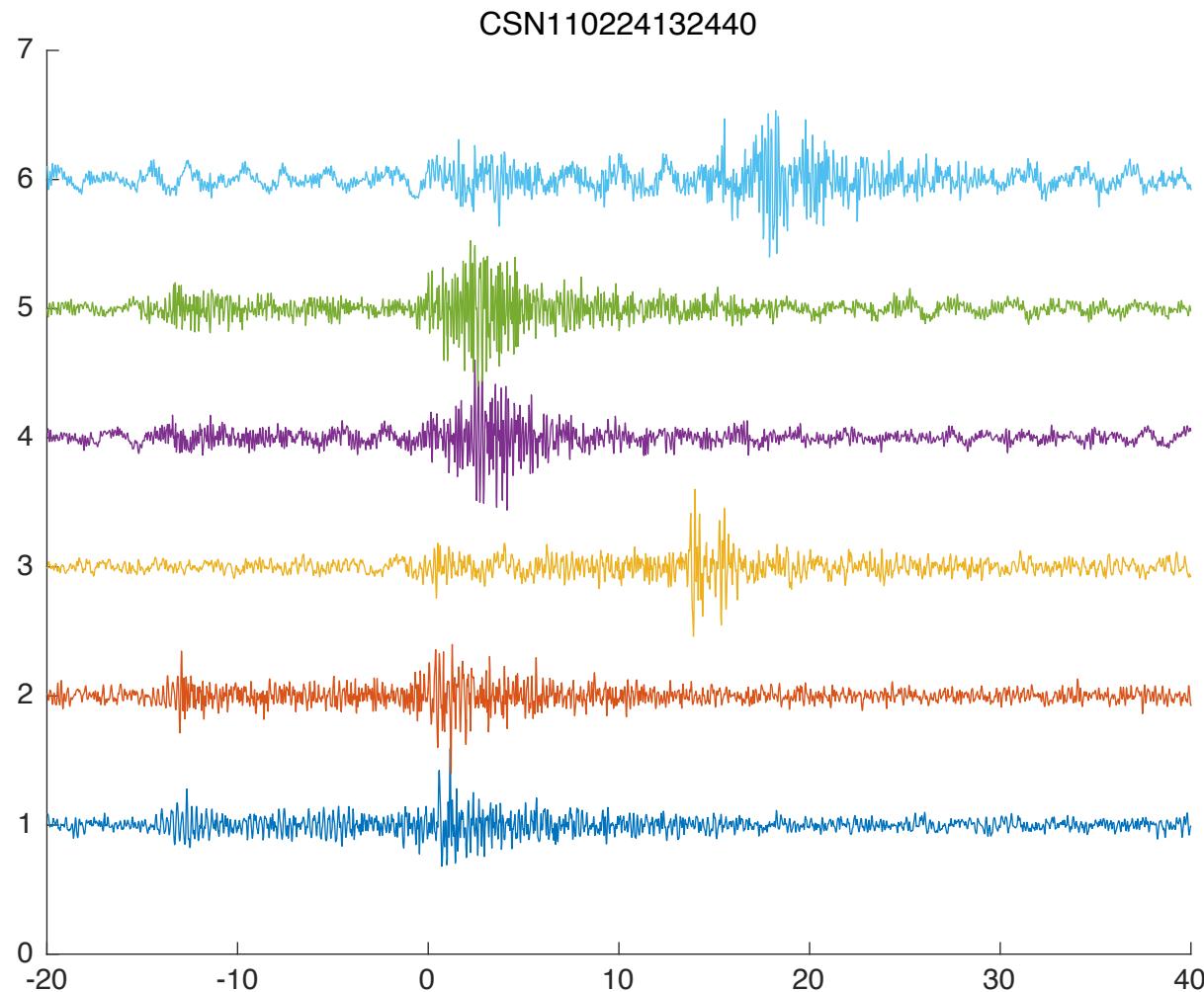
2-15hz



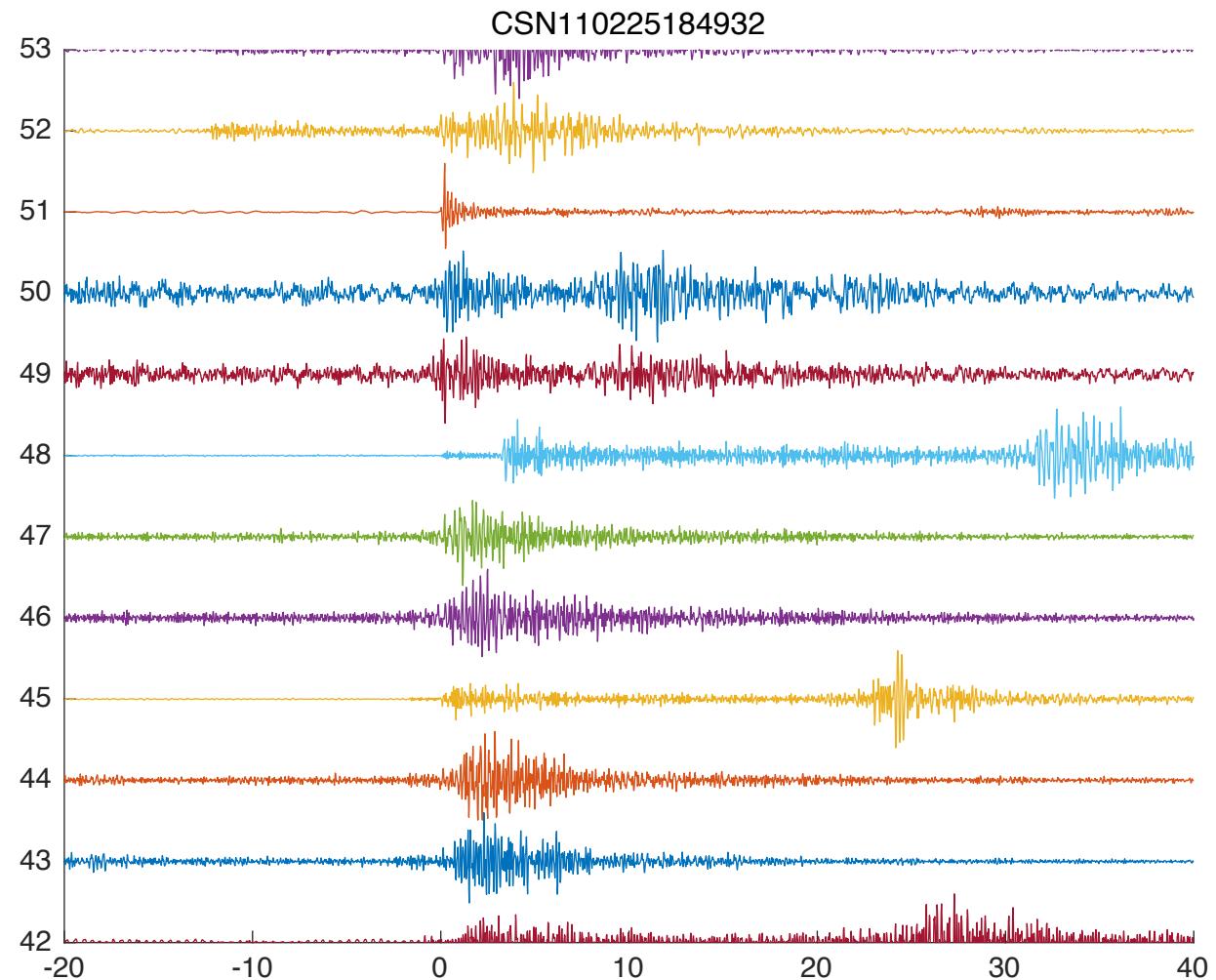
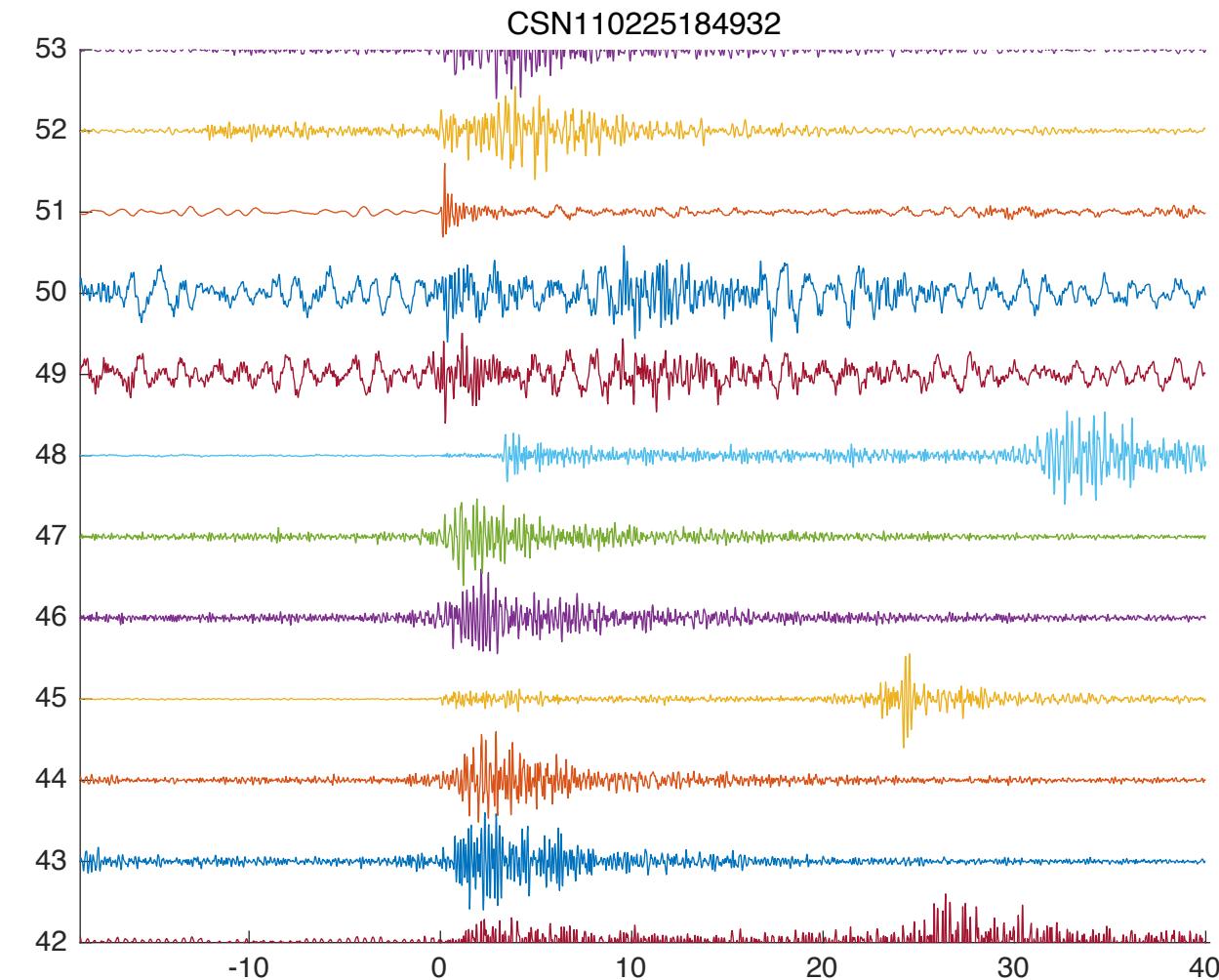
1-8hz



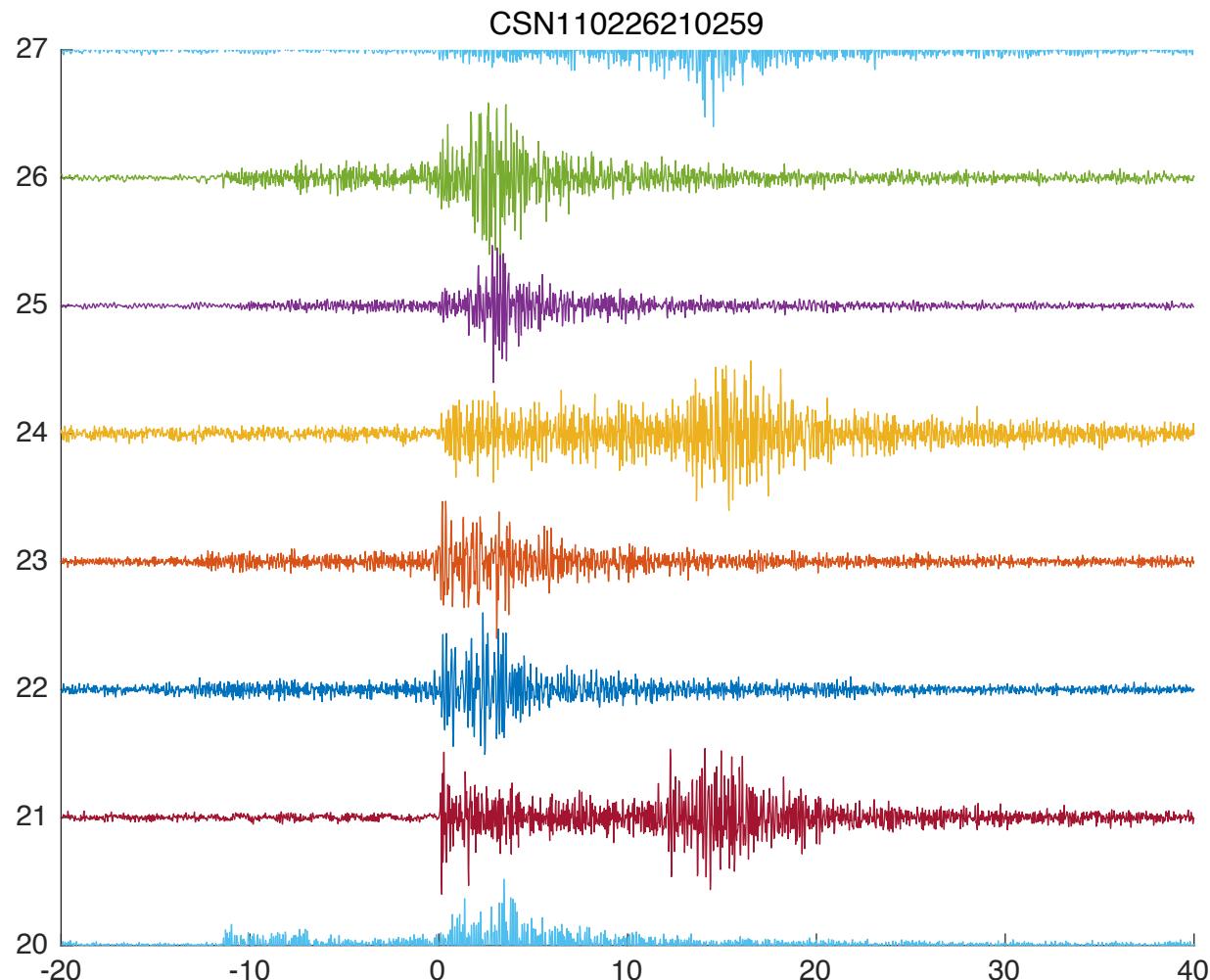
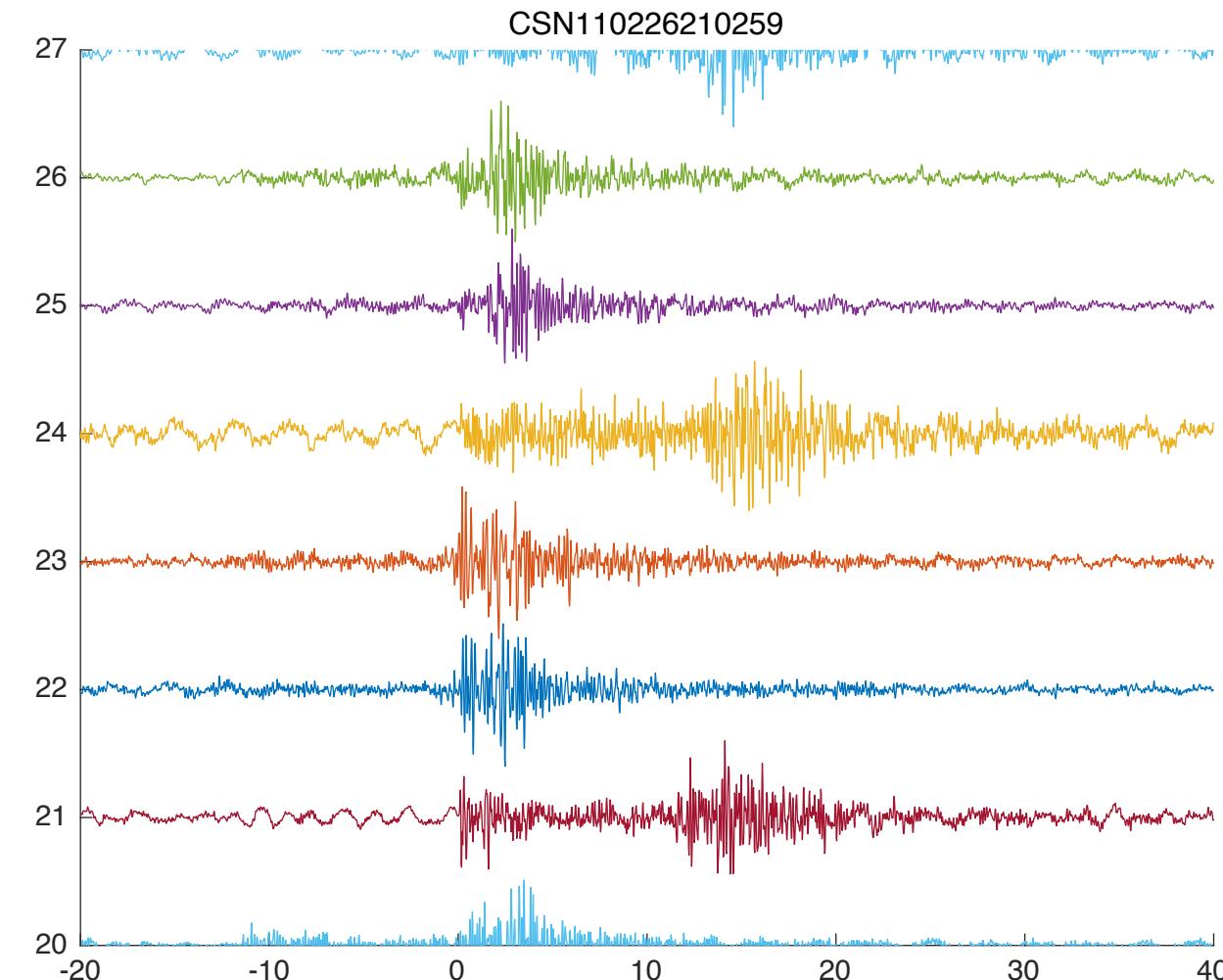
Template Compare 1-8hz vs 2-15hz



Template Compare 1-8hz vs 2-15hz



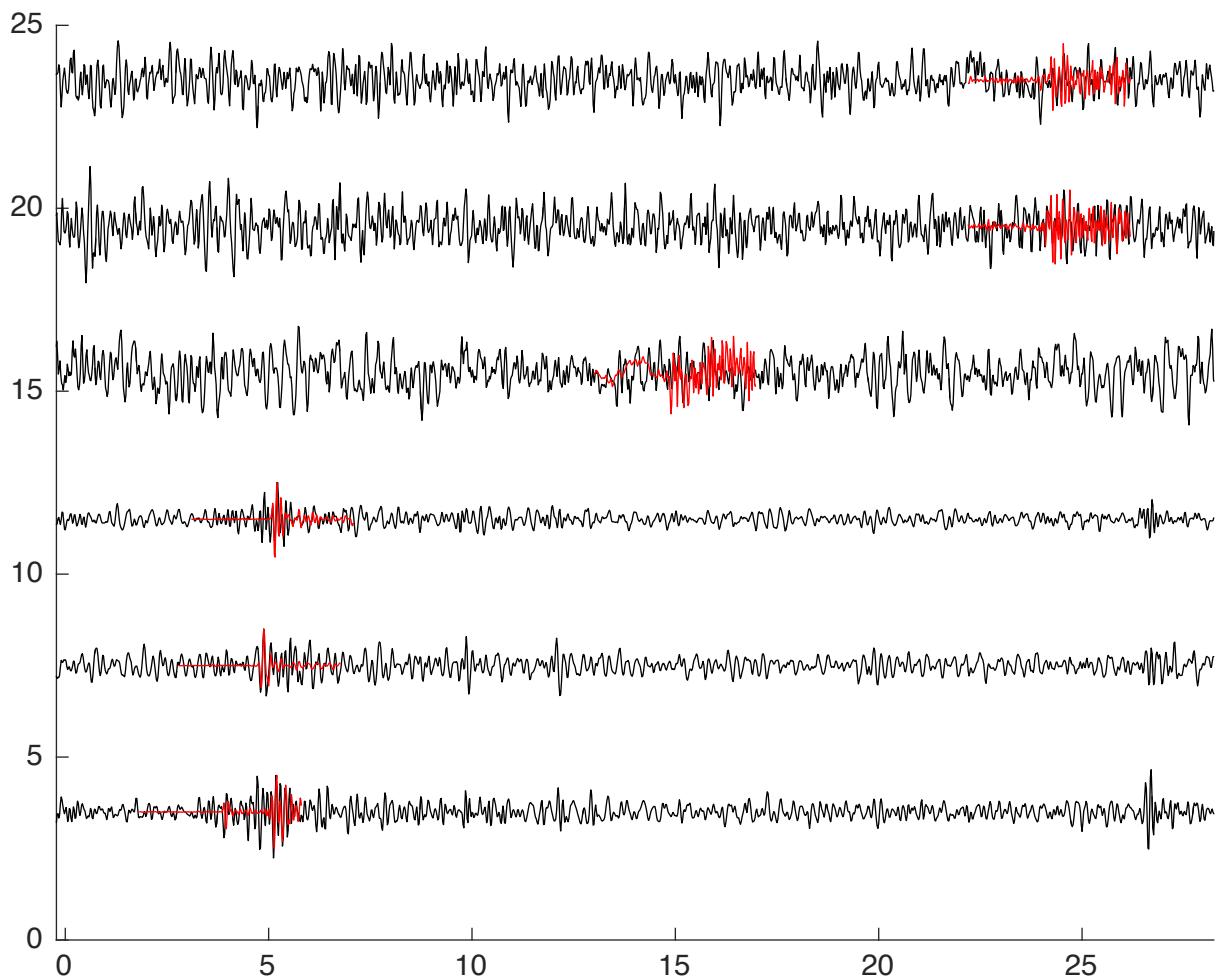
Template Compare 1-8hz vs 2-15hz



ReMFT10hz

Using result of 10 hz, rescan in 50 hz

20088 -> 661

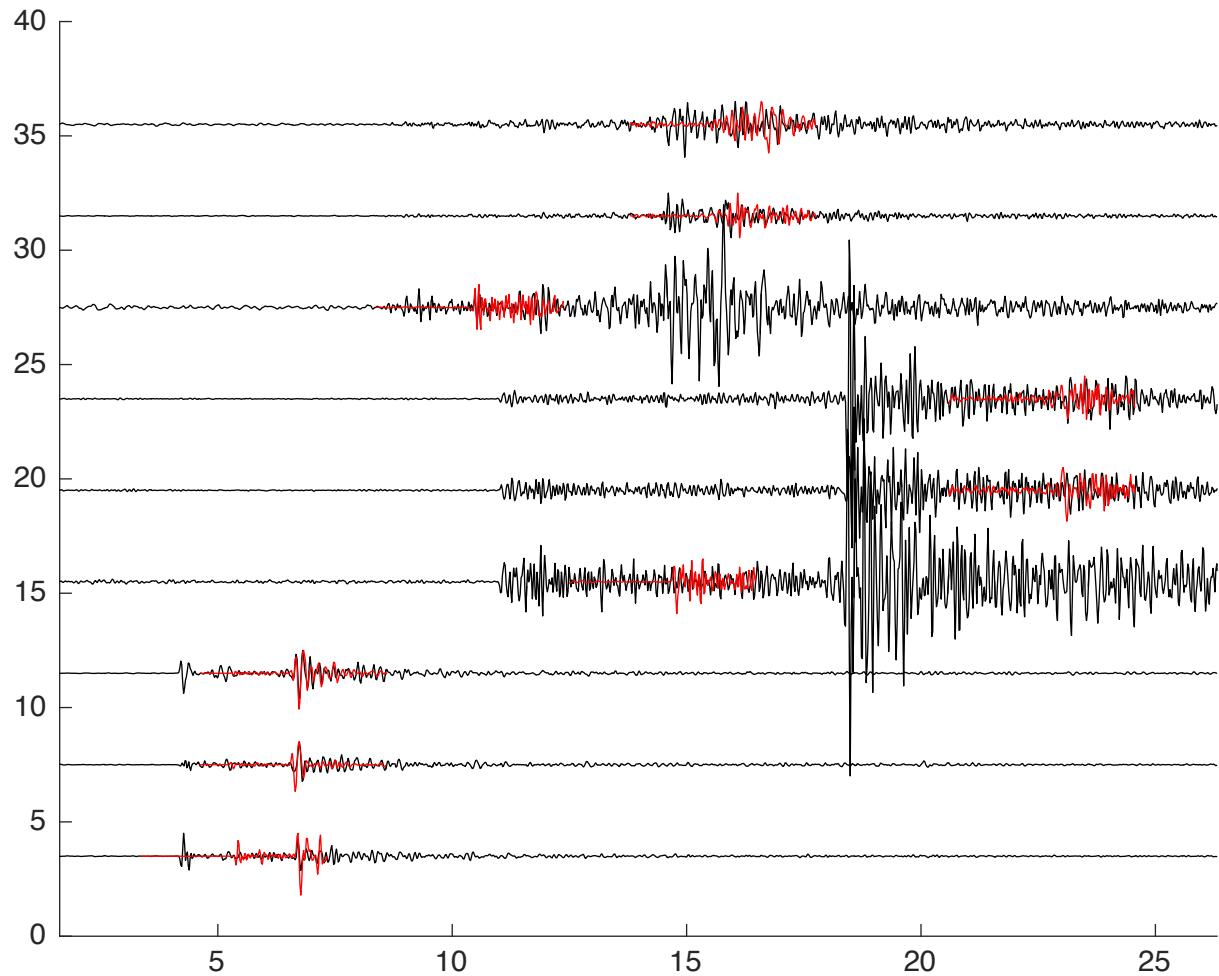


ReMFT10hz

Using result of 10 hz, rescan in 50 hz

20088 -> 661

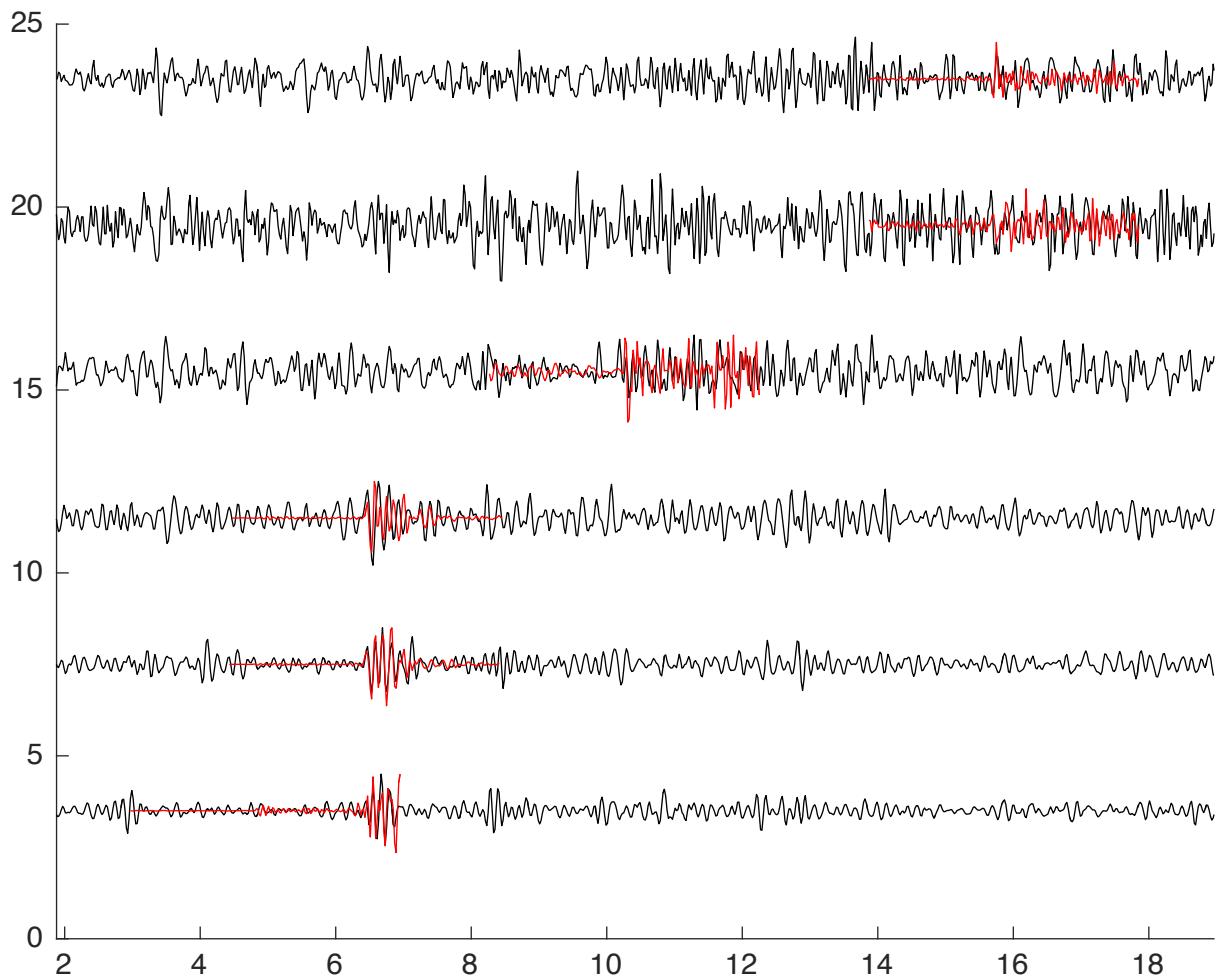
CSN110219033705



ReMFT10hz

Using result of 10 hz, rescan in 50 hz

20088 -> 661

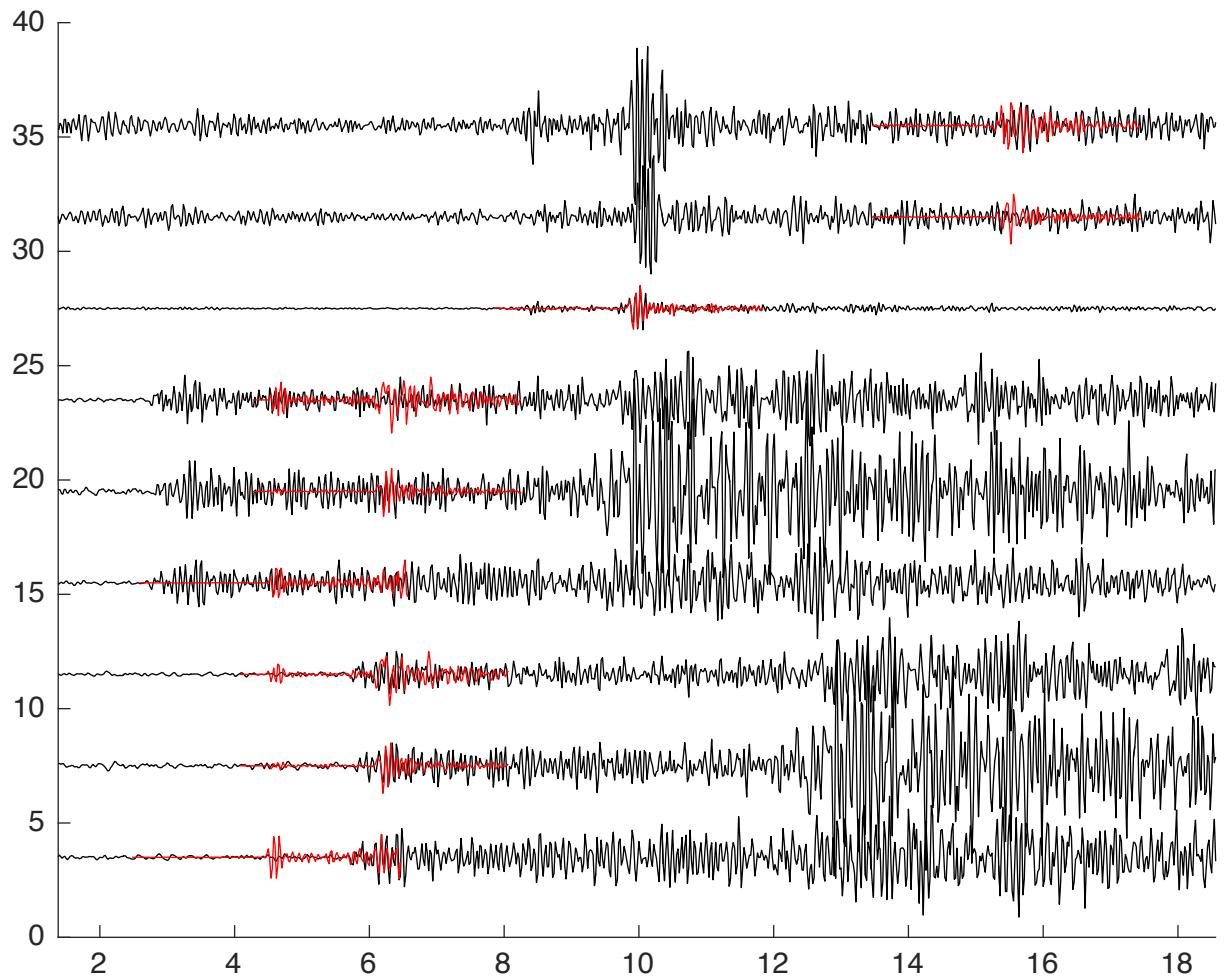


ReMFT10hz

Using result of 10 hz, rescan in 50 hz

20088 -> 661

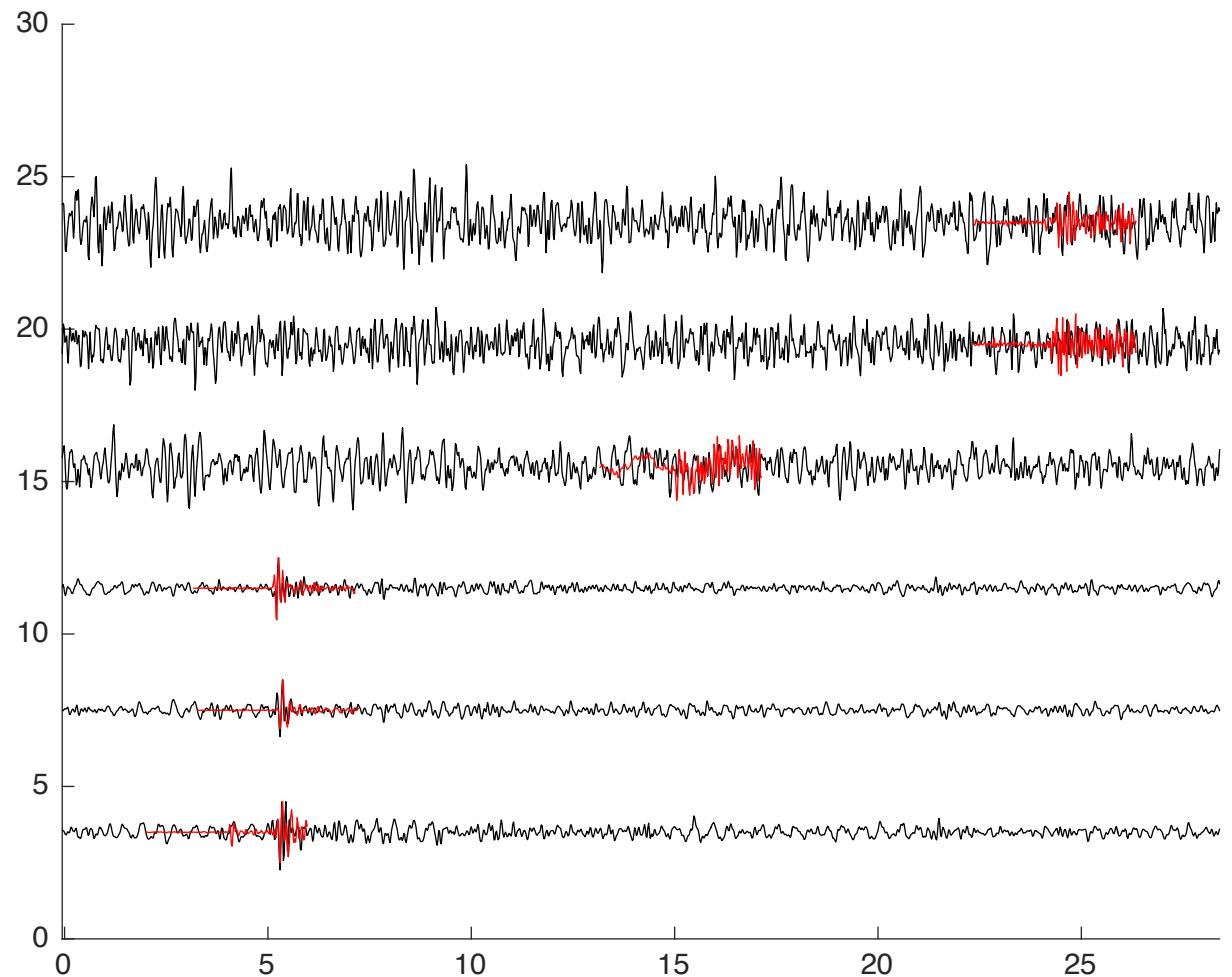
CSN10221002355



ReMFT10hz

Using result of 10 hz, rescan in 50 hz

20088 -> 661

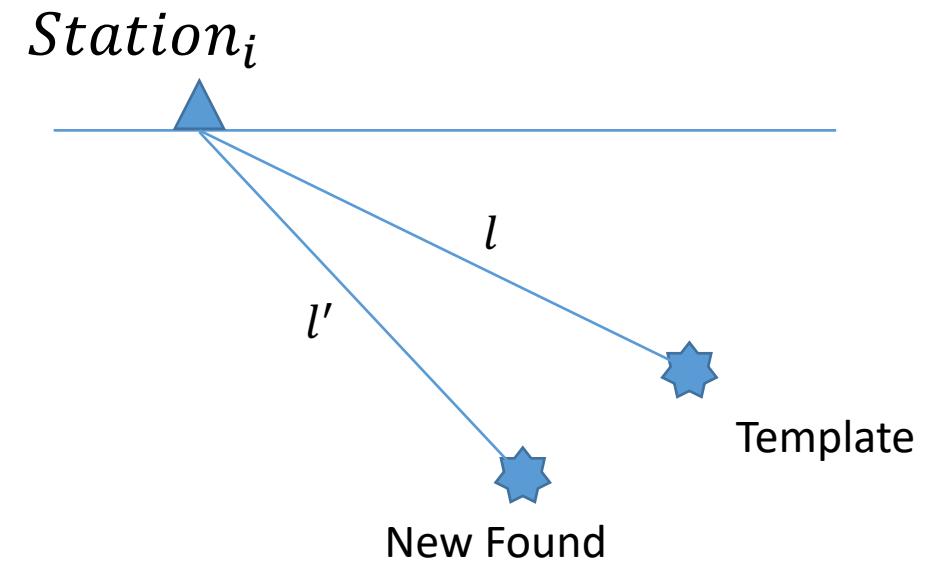


ReLocation_3

$$DT_i = T_{s,i} - T_{p,i}$$

$$DT'_i = T'_{s,i} - T'_{p,i}$$

$$DDT_i = DT'_i - DT_i$$



$$\text{minimum } \sum_i \left(l'_i - l_i - \frac{DDT_i}{DT_i} * l_i \right)^2$$

predicted $l'_i - l_i$

ReLocation_3

Template: x,y,z = 0 0 10

New_real: x,y,z = -1.2 2 9

New_Found: First S and First P: x,y,z = 1.2284 2.0896 10-1.0381
smalls and small p only: x,y,z =

Synthetic Test

Template: x,y,z = 0 0 10

New_real: x,y,z = -2.3 4 10

New_Found: First S and First P: x,y,z = -2.1317 3.95 10-0.1719
smalls and small p only: x,y,z = -2.3787 4.1723 10.0376

Template: x,y,z = 0 0 10

New_real: x,y,z = -2.3 4 12

New_Found: First S and First P: x,y,z = -1.58 3.14 11.1
smalls and small p only: x,y,z = -2.3677 4.1673 12.1612

Select Good New Event

- Condition:
1. $CC > 0.3$ and more than 3 stations used
 2. Relocation: $\text{misfit} < \text{distance}(\text{template}, \text{newevent})$
 3. good station distribution

Details: For all events, we remove those stations with bad CC, until $CC > 0.3$

Select Good New Event

Condition: 1. CC > 0.3 and more than 3 stations used

2. Relocation: misfit $<\text{distance}(\text{template}, \text{newevent})$
3. good station distribution

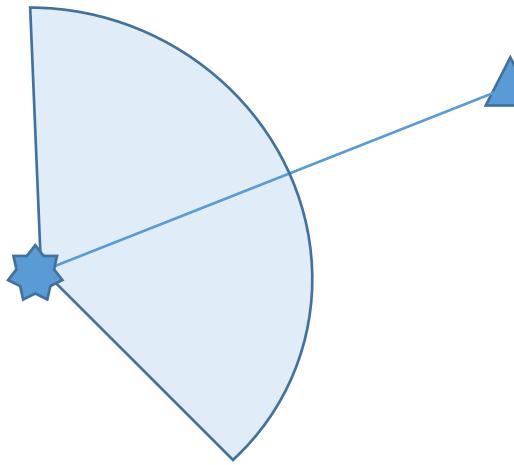
$$\text{sqrt}\left(\frac{\sum_i \left(l'_i - l_i - \frac{DDT_i}{DT_i} * l_i \right)^2}{n}\right) < \text{distance between template and newevent}$$

Remove event with high misfit

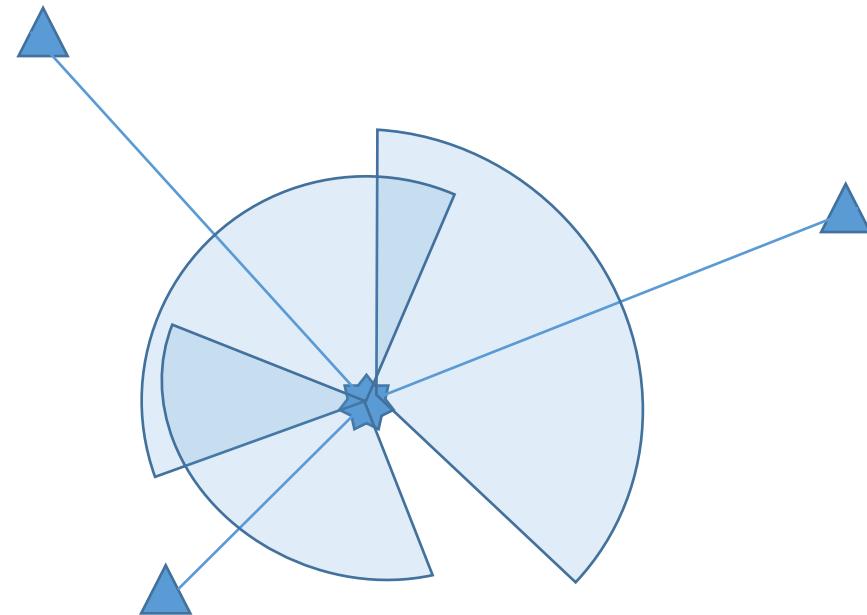
Select Good New Event

Condition:

1. $CC > 0.3$ and more than 3 stations used
2. Relocation: $\text{misfit} < \text{distance}(\text{template}, \text{newevent})$
3. **good station distribution**



120° for each station



Consider all station, the blank should less than 90°

Select Good New Event

- Condition:
1. $CC > 0.3$ and more than 3 stations used
 2. Relocation: $\text{misfit} < \text{distance}(\text{template}, \text{newevent})$
 3. good station distribution

Using 101 templates from 20110410-20110531, we get 917 events
(partweak, 2-15hz)

After Condition 1: 917 -> 180

After Condition 2&3: 180 -> 47

Select Good New Event

Condition: 1. $CC > 0.3$ and more than 3 stations used

2. Relocation: misfit

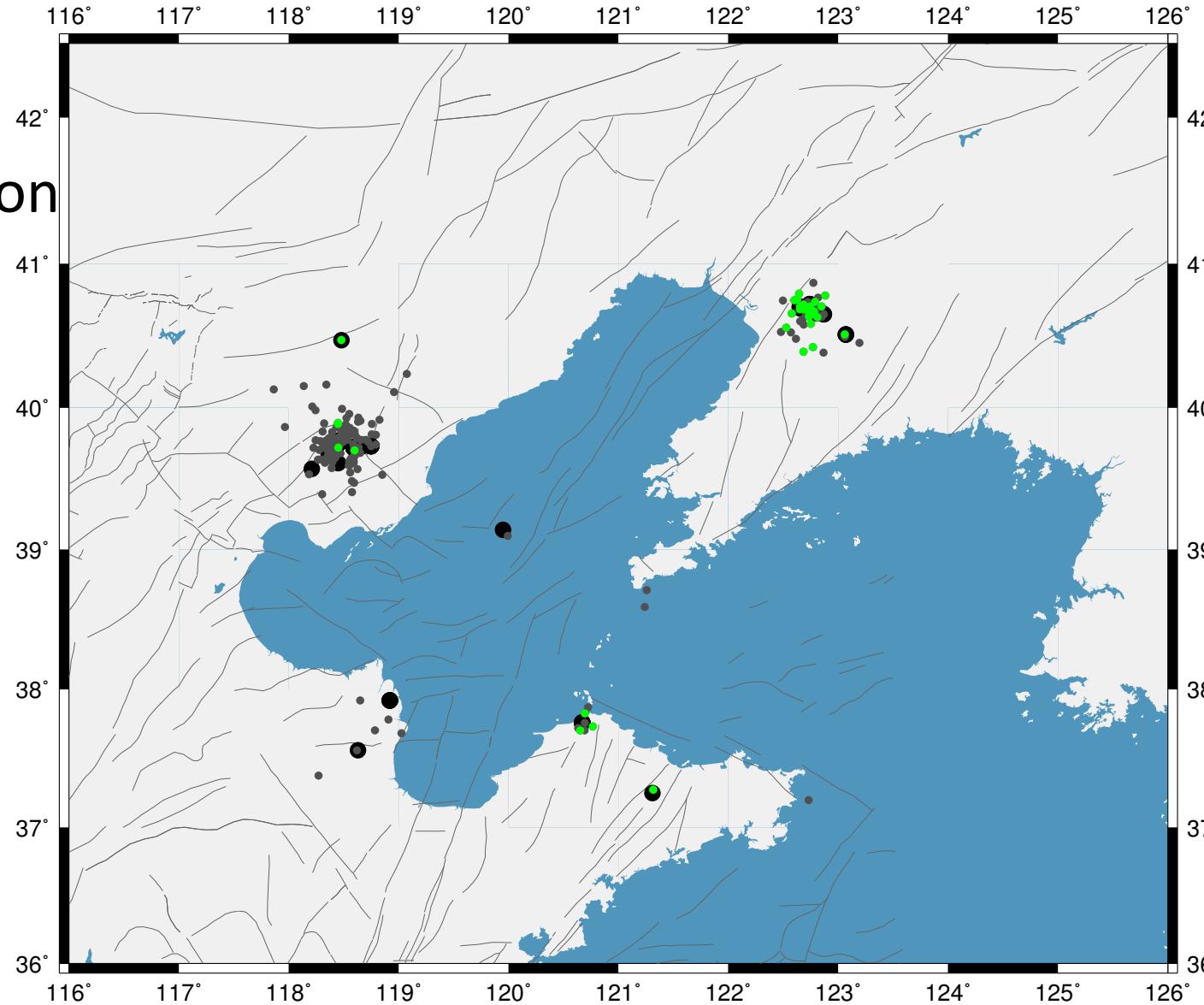
$< distance(template, newevent)$

3. good station distribution

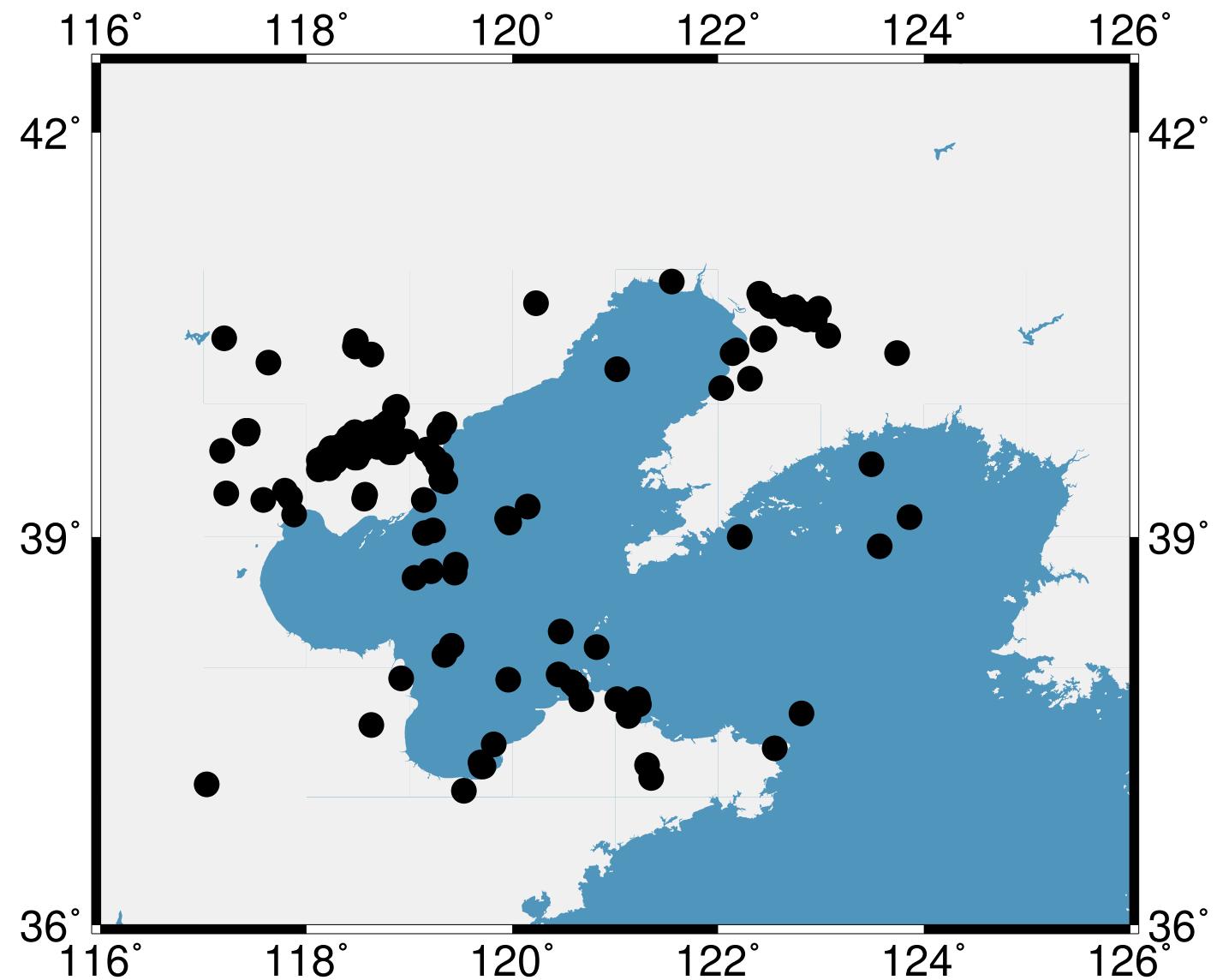
Big black circles: Templates, found new events only

Grey small circles: New events meet condition 1

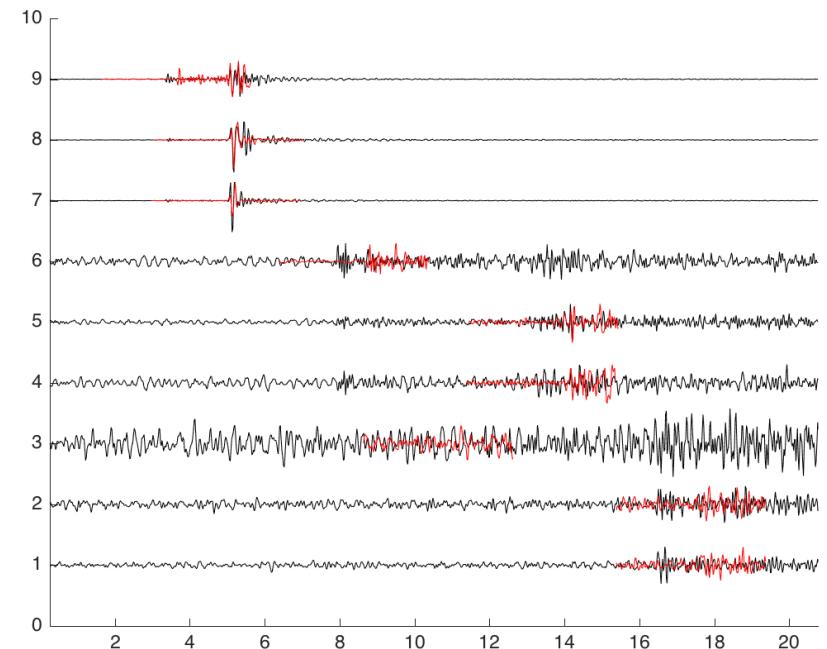
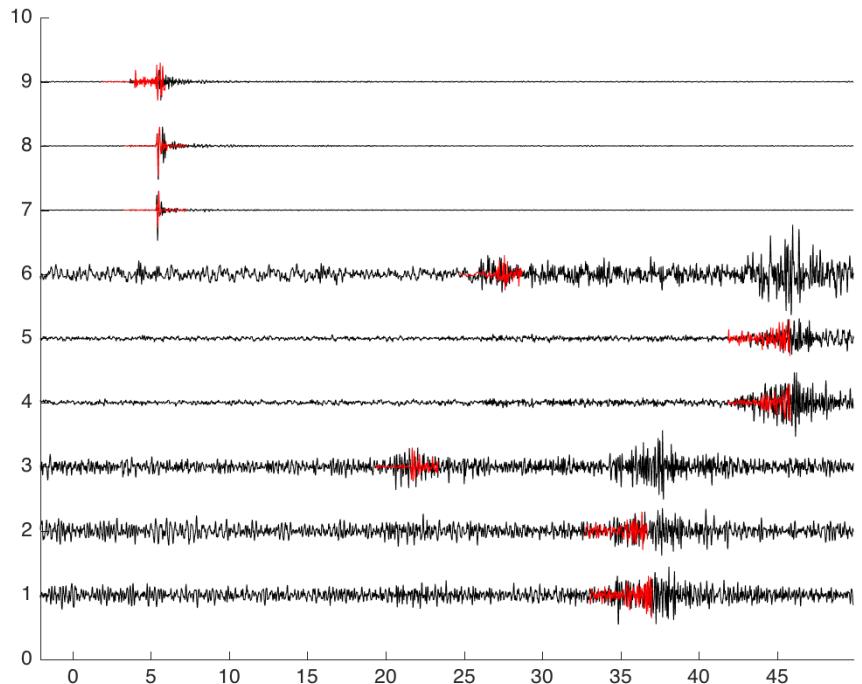
Green small circles: New events meet all conditions



Template Used

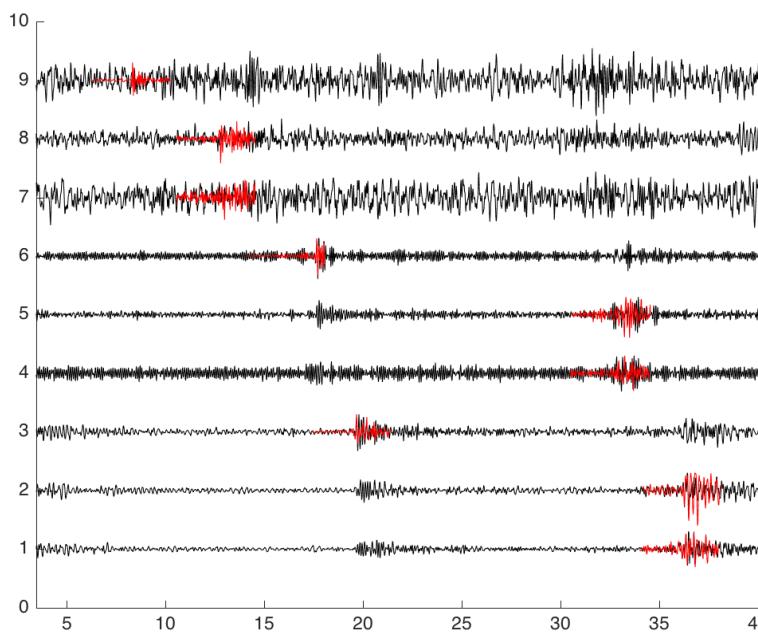


Some Example(meet condition1):

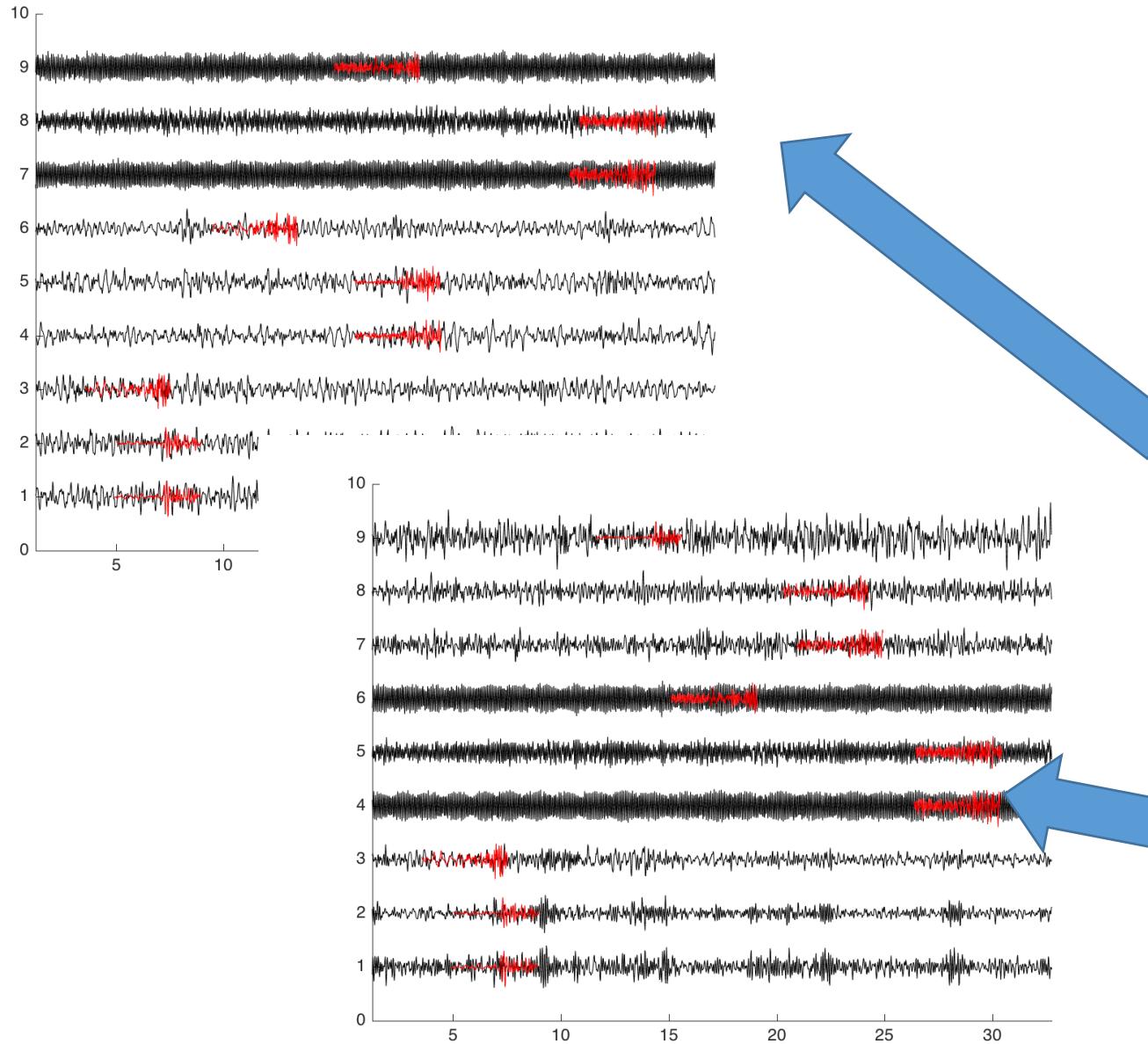


Red for template

Black for records near new found



Problem Station: HE.QIL



NEWEVENT110220060218	2011	02	20	06	02	18.750
CSN110508163527	0.3052	0.0172	0.1033			
BU.CHL.BHE.SAC	17.10	0.00	6.3482	0.0431		
BU.CHL.BHN.SAC	17.15	0.00	9.4595	0.0330		
BU.CHL.BHZ.SAC	10.51	0.00	1.5923	-0.1005		
BU.SZL.BHE.SAC	35.30	0.00	1.7224	0.2674		
BU.SZL.BHN.SAC	35.36	0.00	2.3993	0.2028		
BU.SZL.BHZ.SAC	20.38	0.00	1.9434	0.1189		
HE.QIL.BHE.SAC	26.51	0.28	1.6854	0.6226		
HE.QIL.BHN.SAC	26.58	0.34	1.3891	0.5490		
HE.QIL.BHZ.SAC	15.16	0.06	3.2432	0.4958		
#####						
NEWEVENT110220111034	2011	02	20	11	10	34.810
CSN110508163527	0.3228	0.0172	0.1033			
BU.DOH.BHE.SAC	4.94	0.00	6.0605	-0.0096		
BU.DOH.BHN.SAC	5.02	0.00	4.6984	0.0226		
BU.DOH.BHZ.SAC	3.57	0.00	2.2964	-0.2076		
HE.QIL.BHE.SAC	26.51	0.38	1.3897	0.6351		
HE.QIL.BHN.SAC	26.58	0.36	4.1715	0.5871		
HE.QIL.BHZ.SAC	15.16	0.34	3.3169	0.6191		
HE.XLD.BHE.SAC	23.59	0.04	3.5824	0.4507		
HE.XLD.BHN.SAC	23.86	0.00	7.7391	0.2080		
HE.XLD.BHZ.SAC	14.53	0.00	3.5261	0.0068		
#####						

Full Size

Template: 20110101-20110531 277

Event found:

Above 6sigma:

4277

Remove component not complete and bad station:

4023

Remove sta<2:

3119

Remove Known Template:

2969

After remove low CC station:

CC>0.3 330

CC>0.27 478

CC>0.25 651

Full Size

no weak

Template: 20110101-20110531 277

Event found:

Above 6sigma: 947

Remove component not complete and bad station: 930

Remove sta<2: 707

Remove Known Template: 620

After remove low CC station:

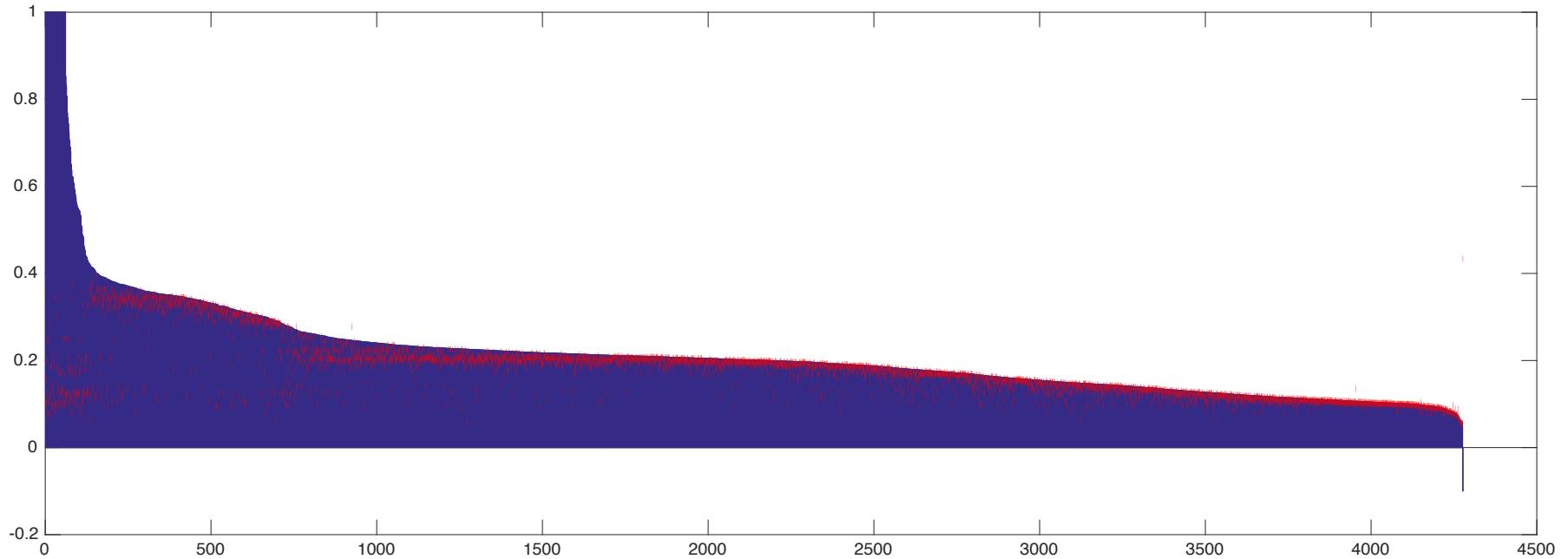
CC>0.3 146

CC>0.27 174

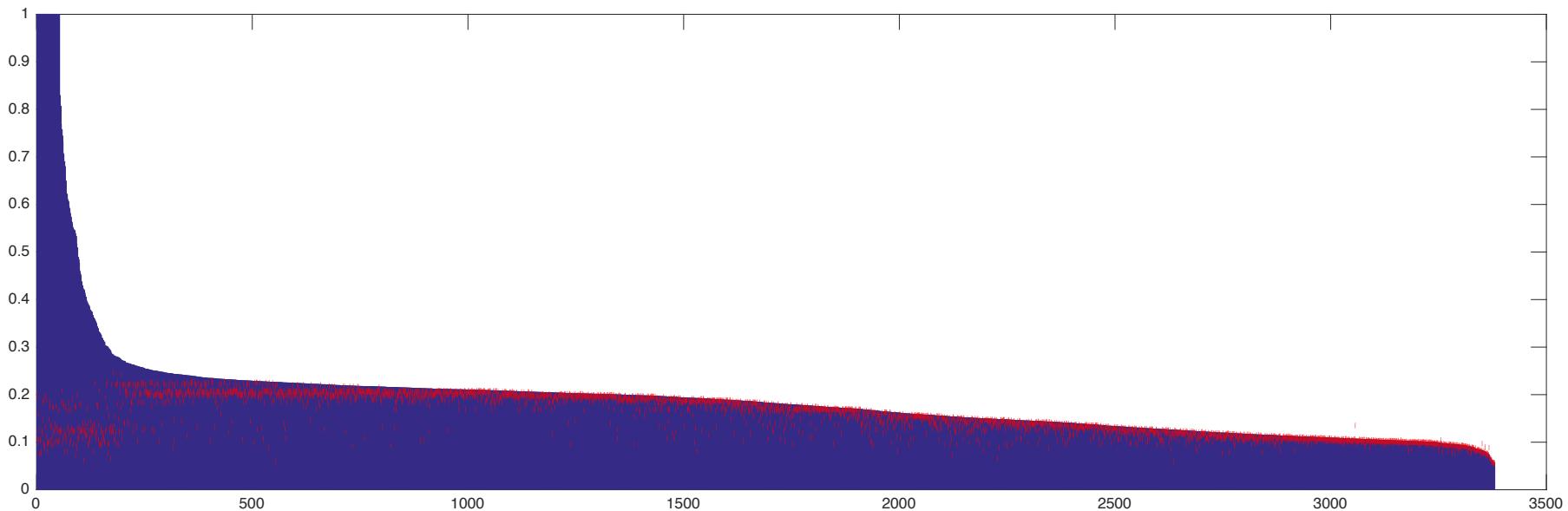
CC>0.25 198

Full Size

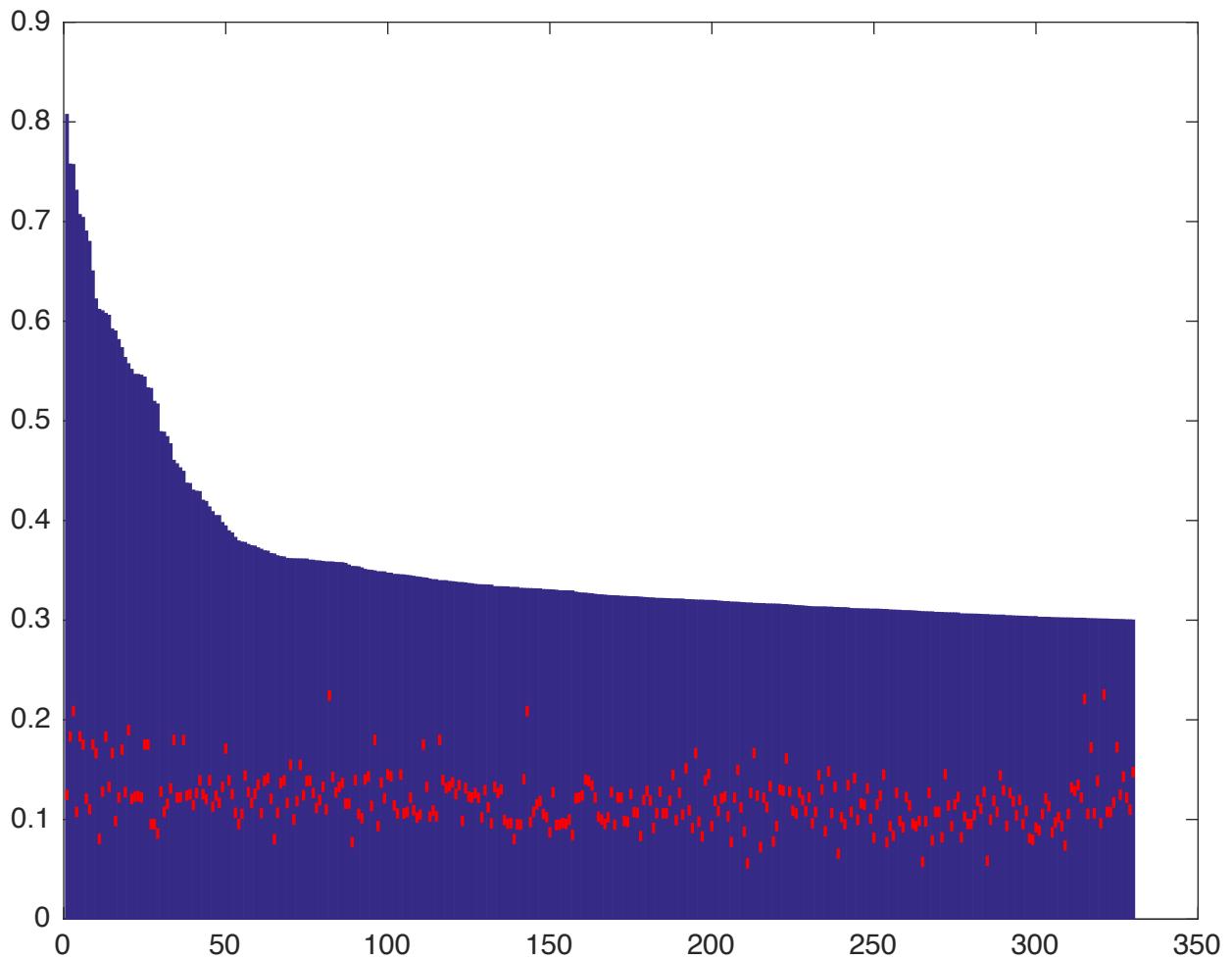
Above 6sigma



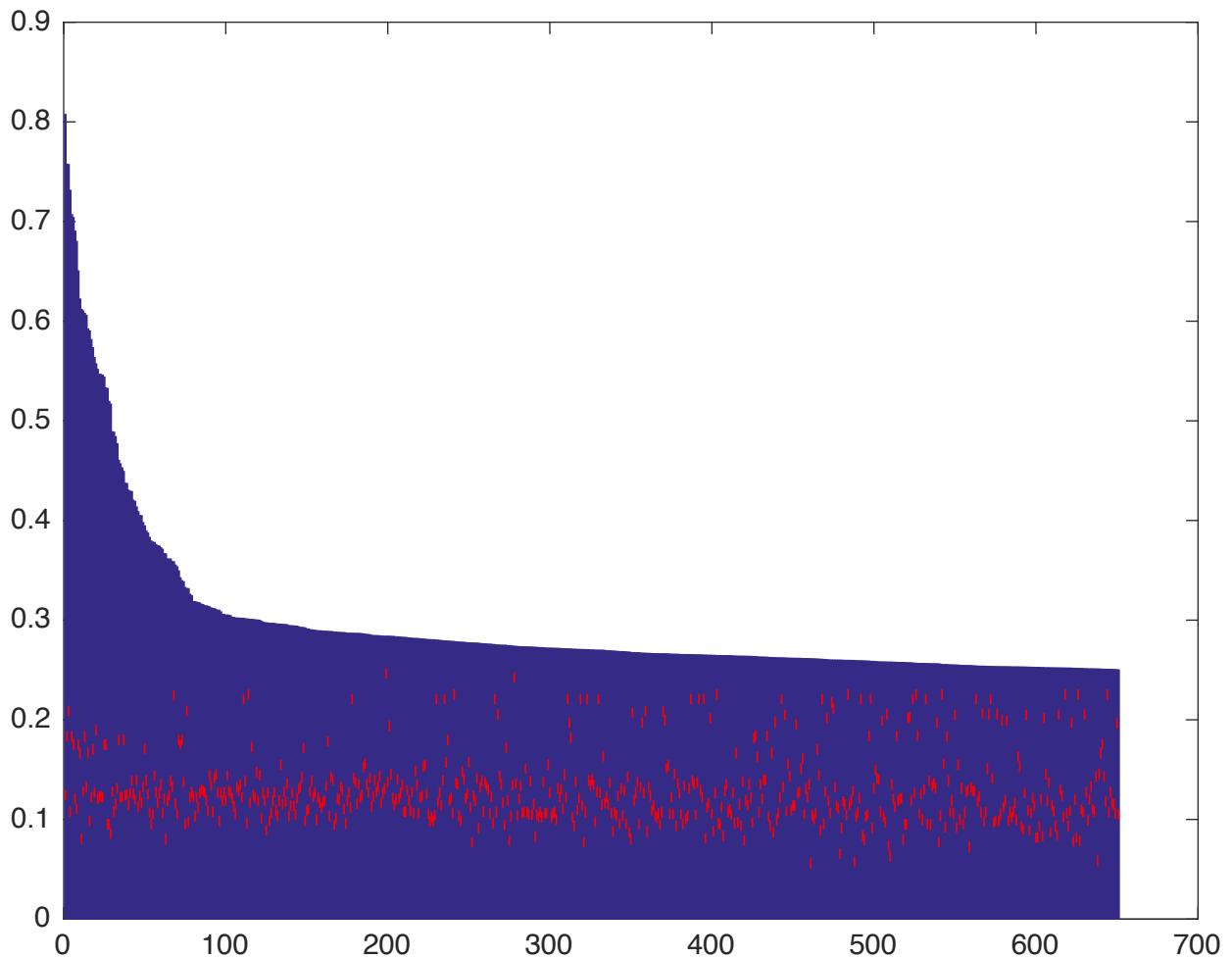
Station ≥ 3



Full Size CC > 0.3



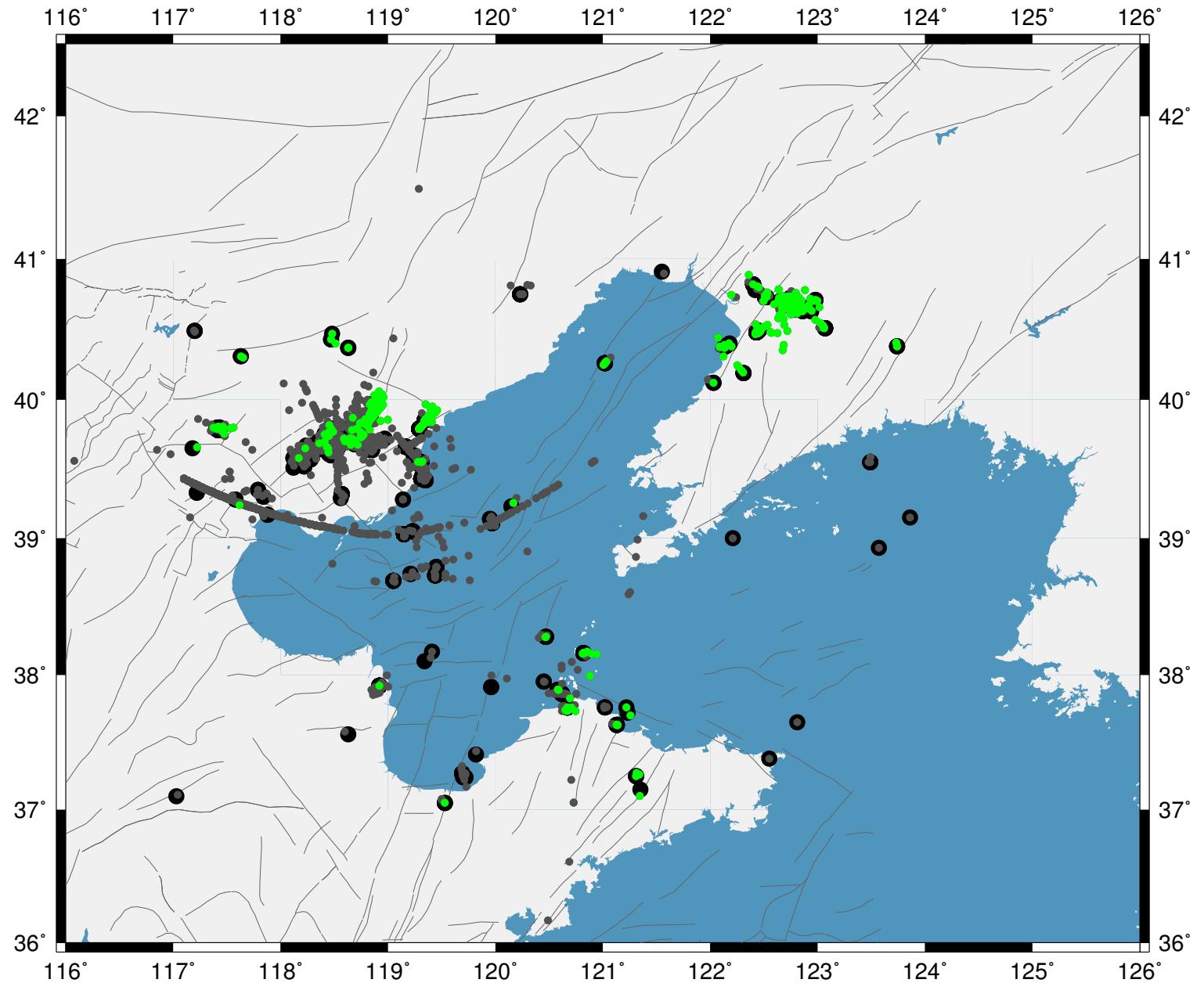
Full Size CC > 0.25



Full Size

All 2969

Green dots 761



Full Size

All before 3.11

after 3.11

Green dots(before)

Red dots(after)

1709

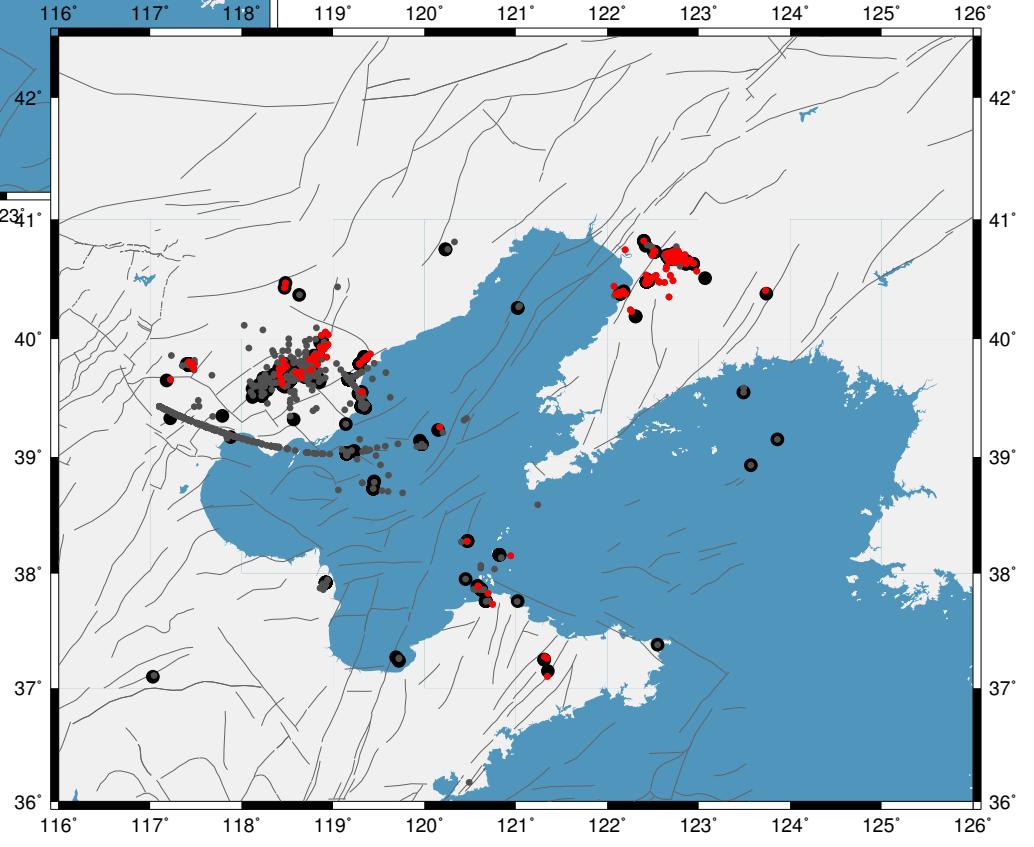
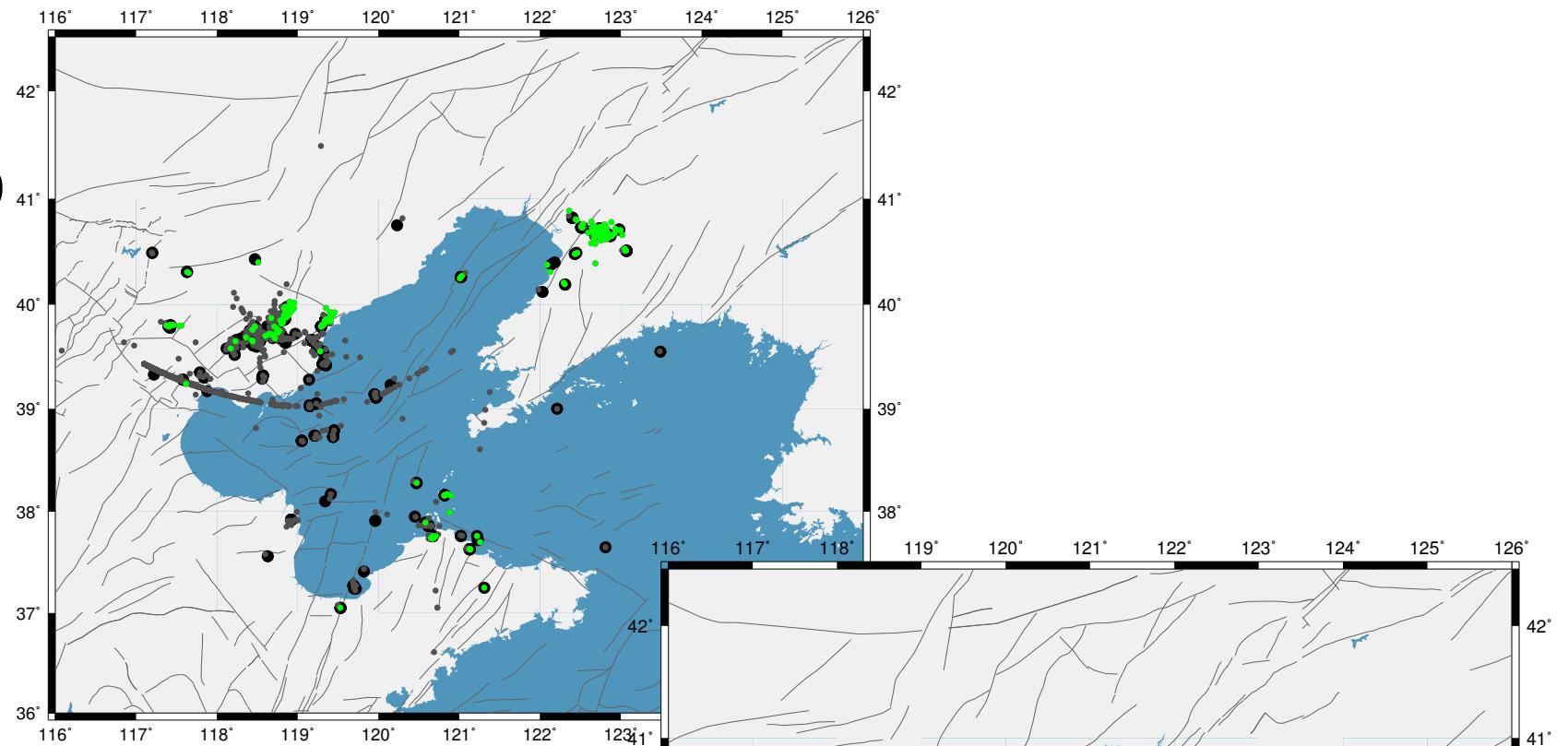
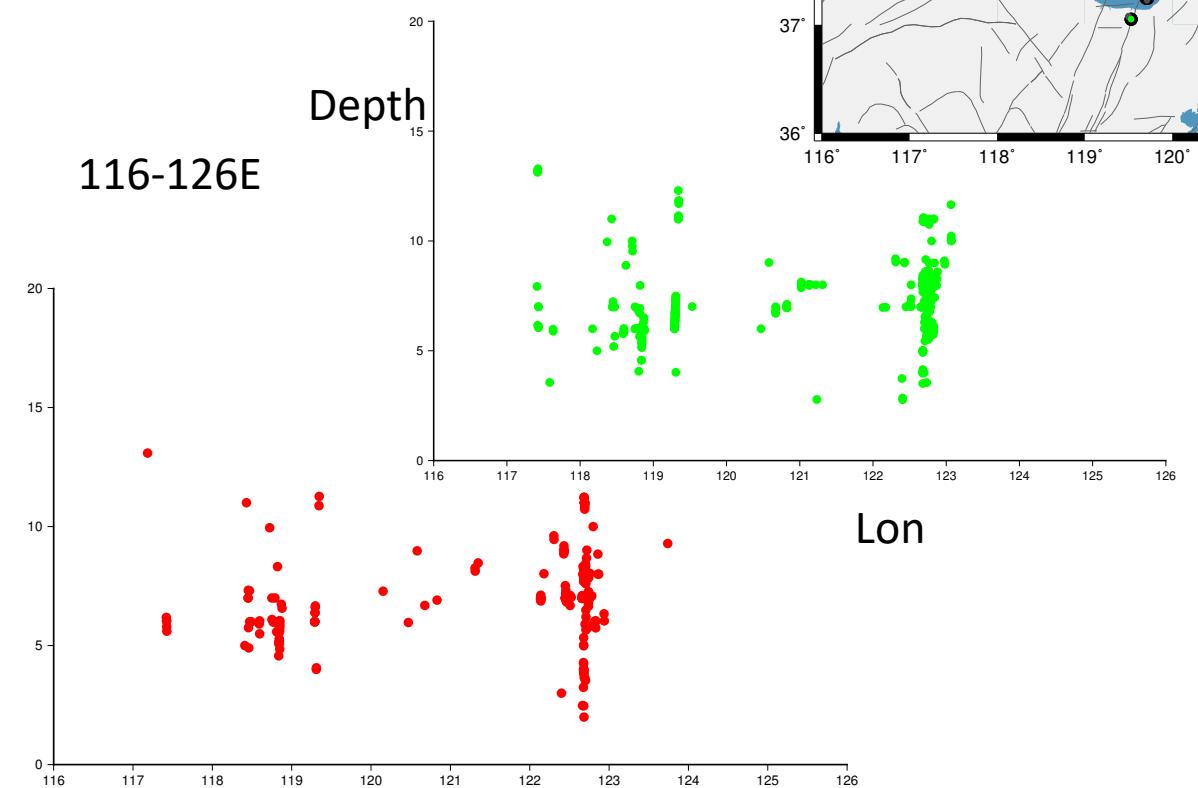
985

392

306

Depth

116-126E



Full Size

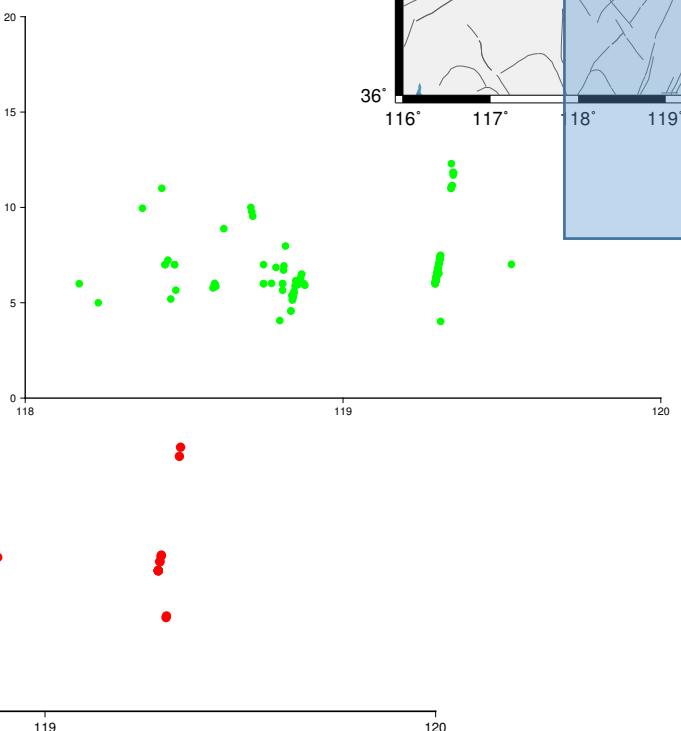
All before 3.11

after 3.11

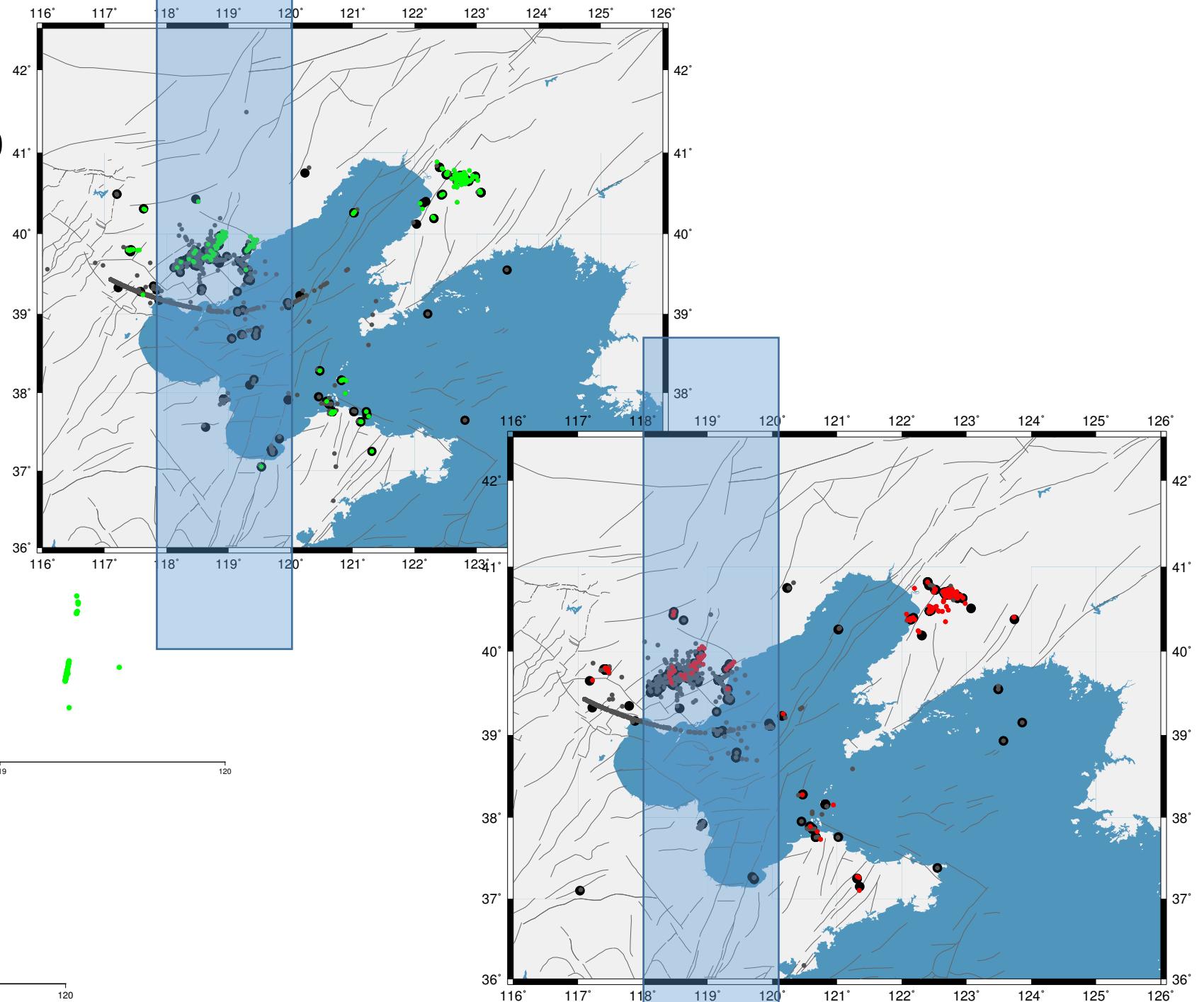
Green dots 392

Red dots 306

118-120E



1709
985



Full Size

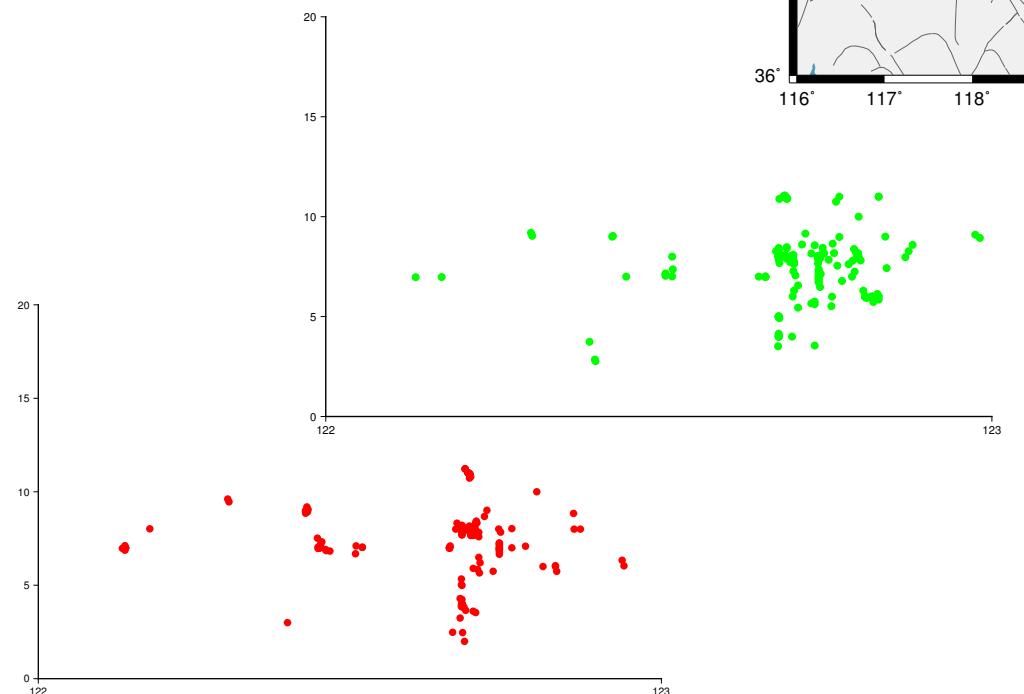
All before 3.11

after 3.11

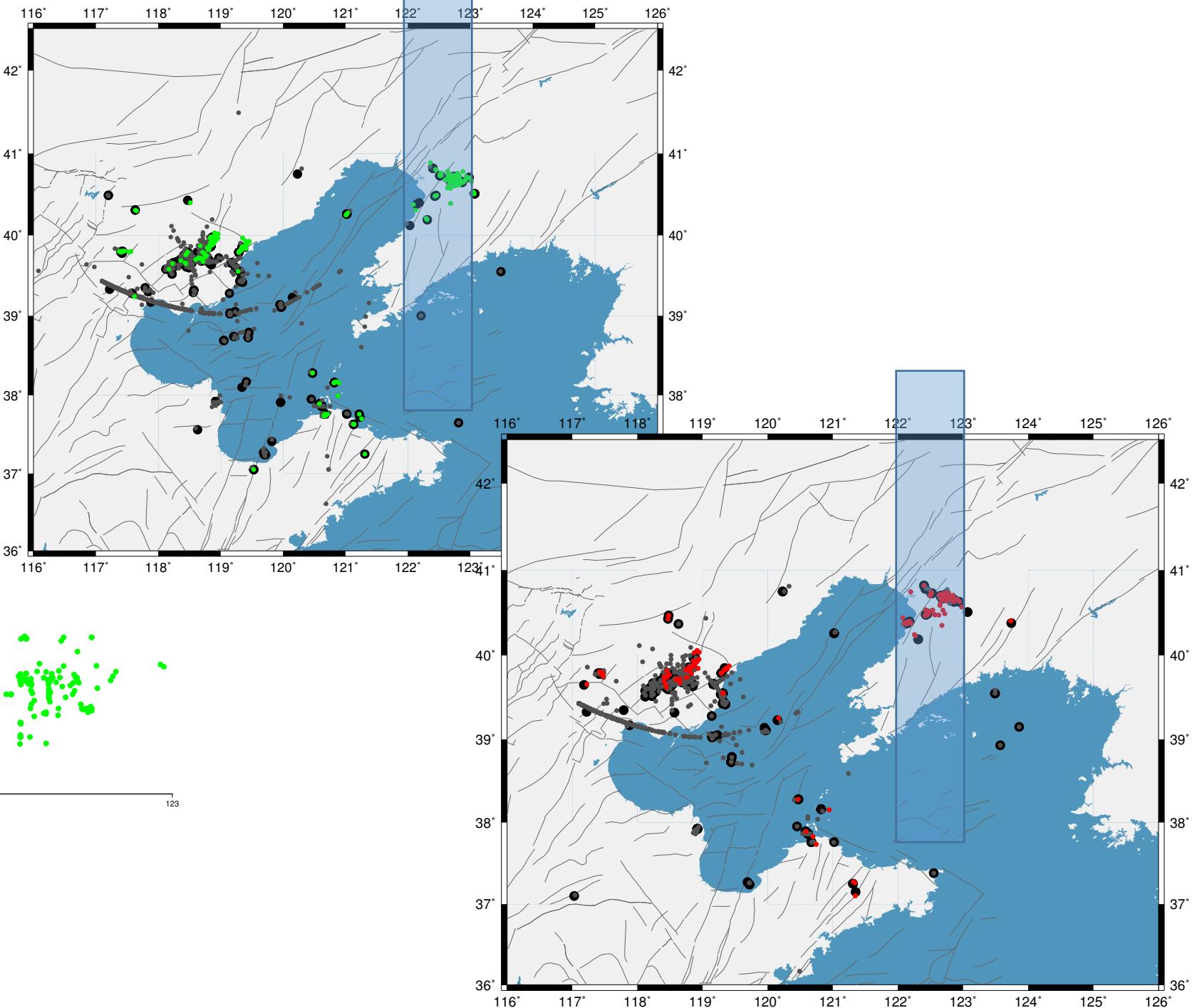
Green dots 392

Red dots 306

122-123E



1709
985

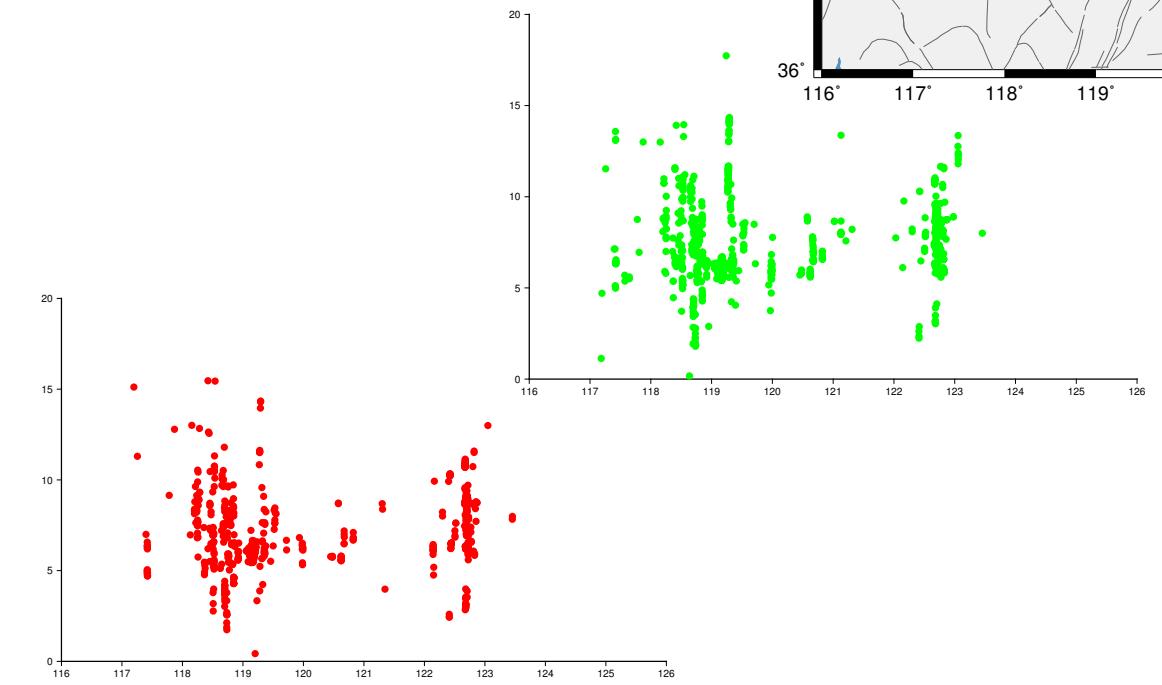


Full Size(DD)

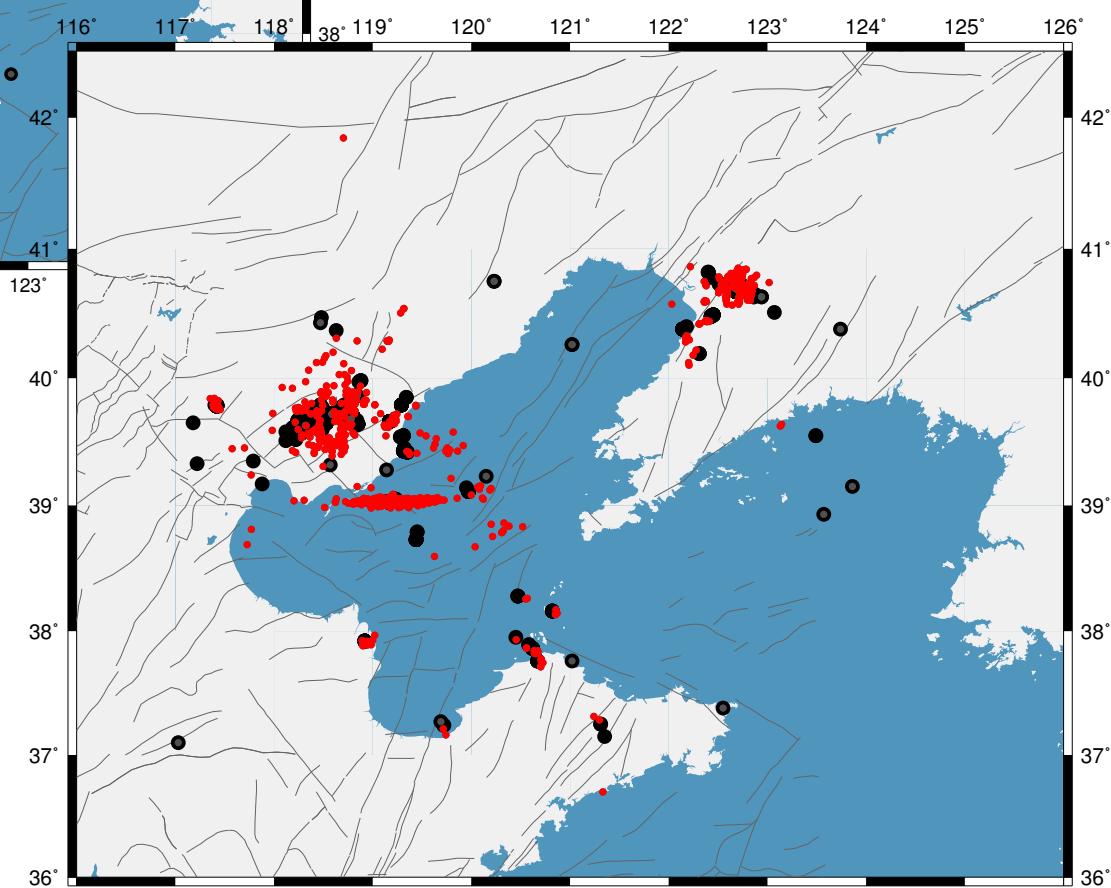
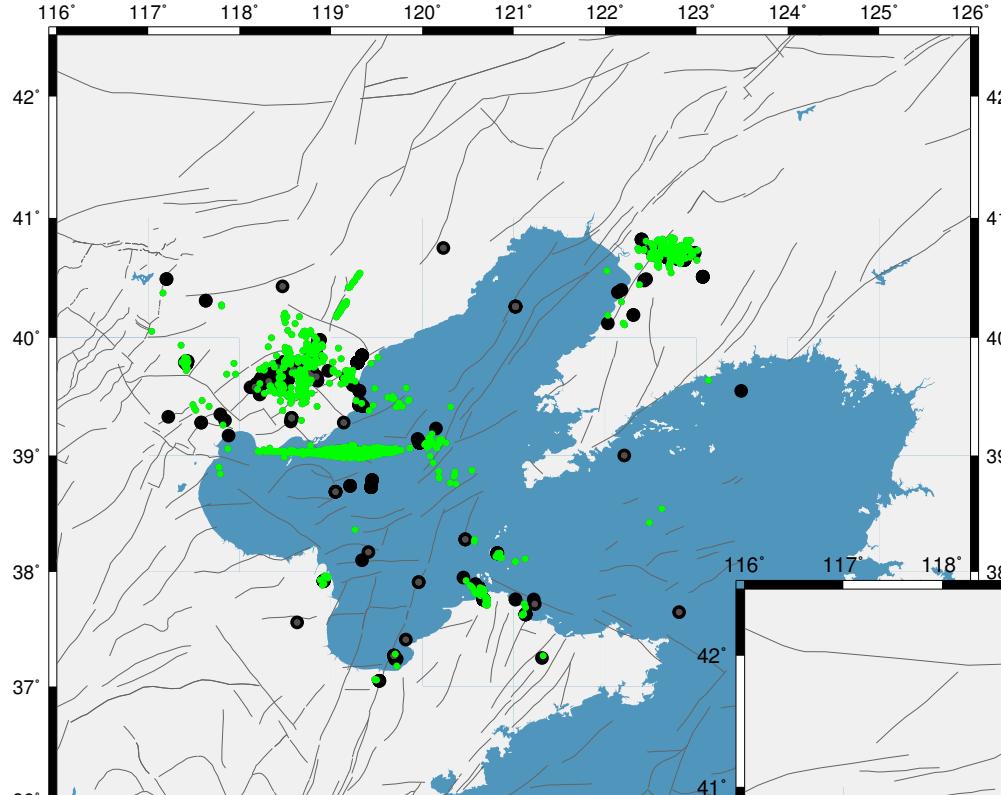
All before 3.11
after 3.11

Green dots 1527
Red dots 884

116-126E



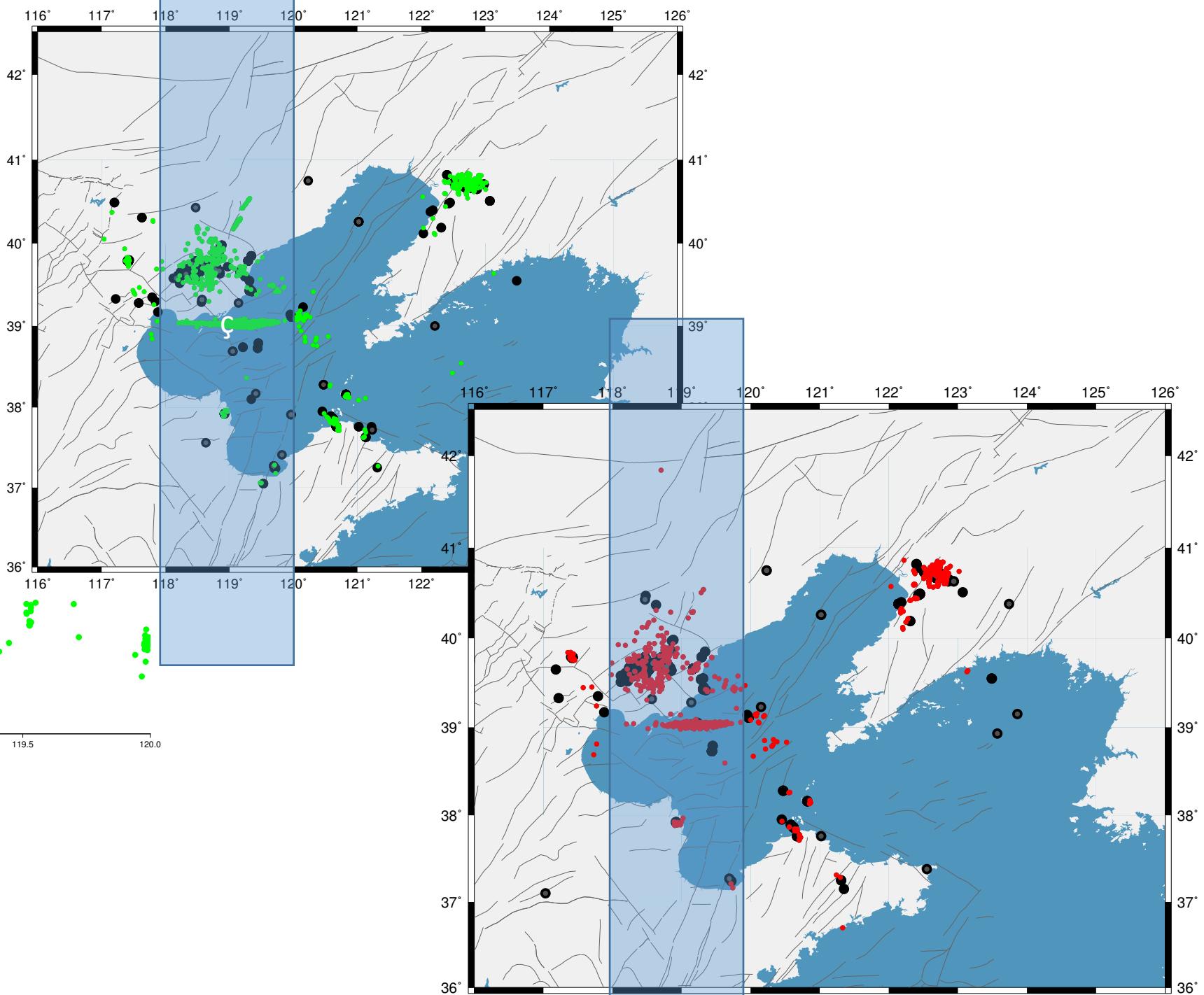
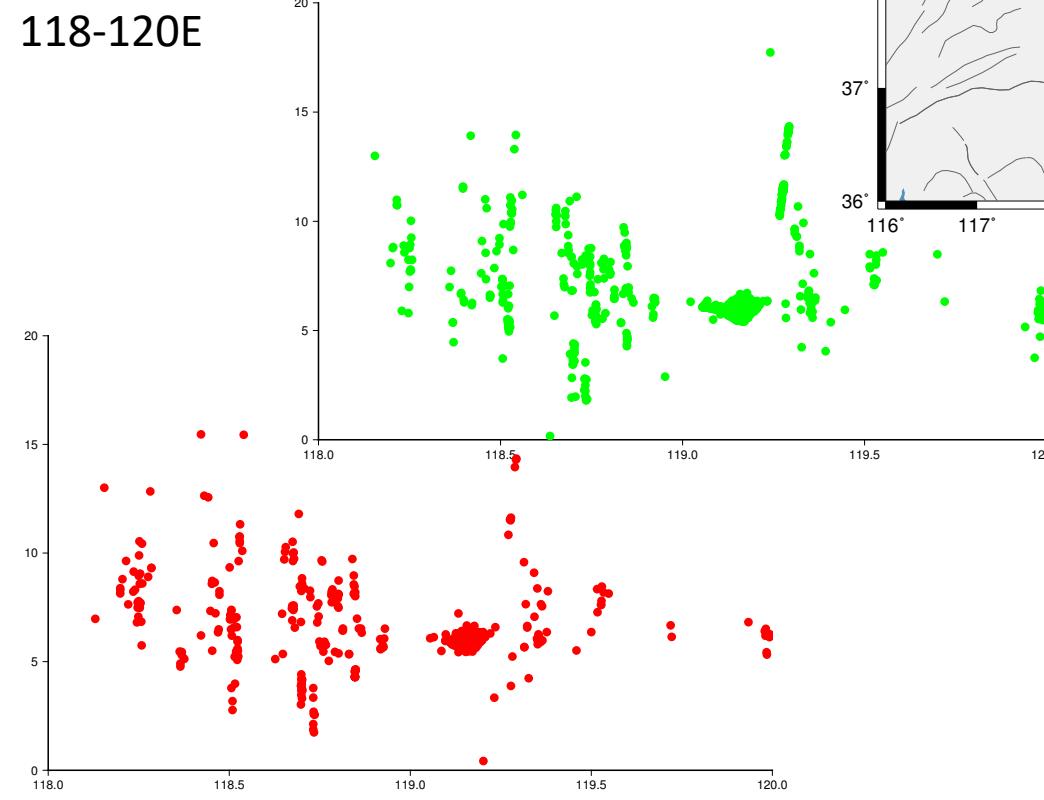
1709
985



Full Size(DD)

All before 3.11 1709
after 3.11 985

Green dots 1527
Red dots 884

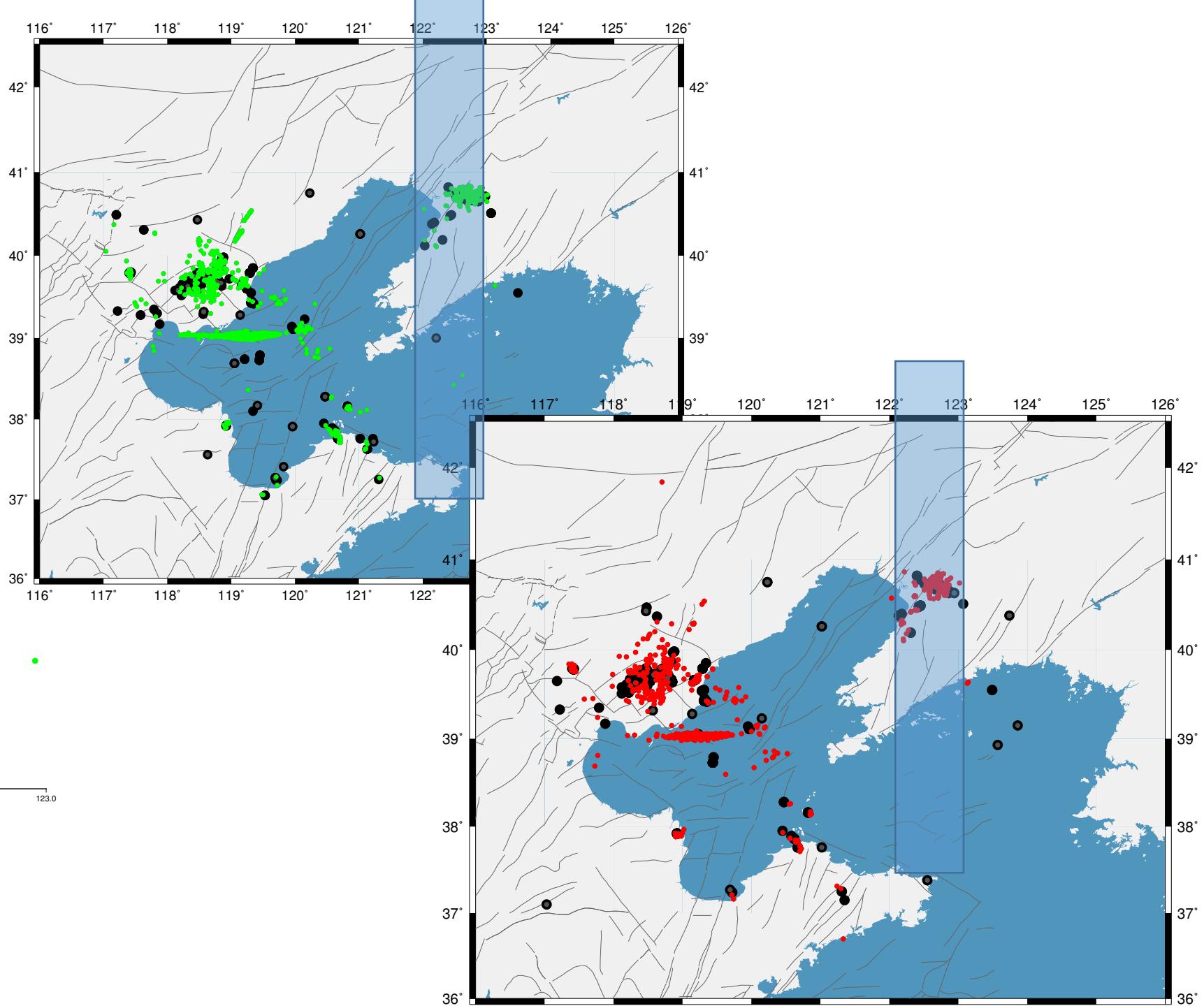
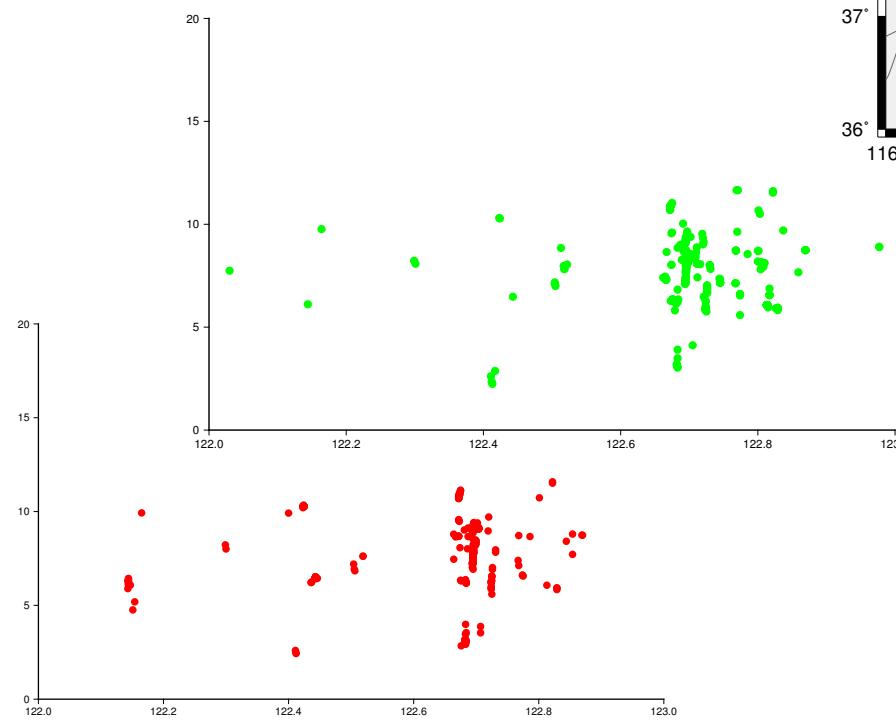


Full Size(DD)

All before 3.11 1709
after 3.11 985

Green dots 1527
Red dots 884

122-123E



Full Size CC>0.27

After remove low CC station:

CC>0.27 478

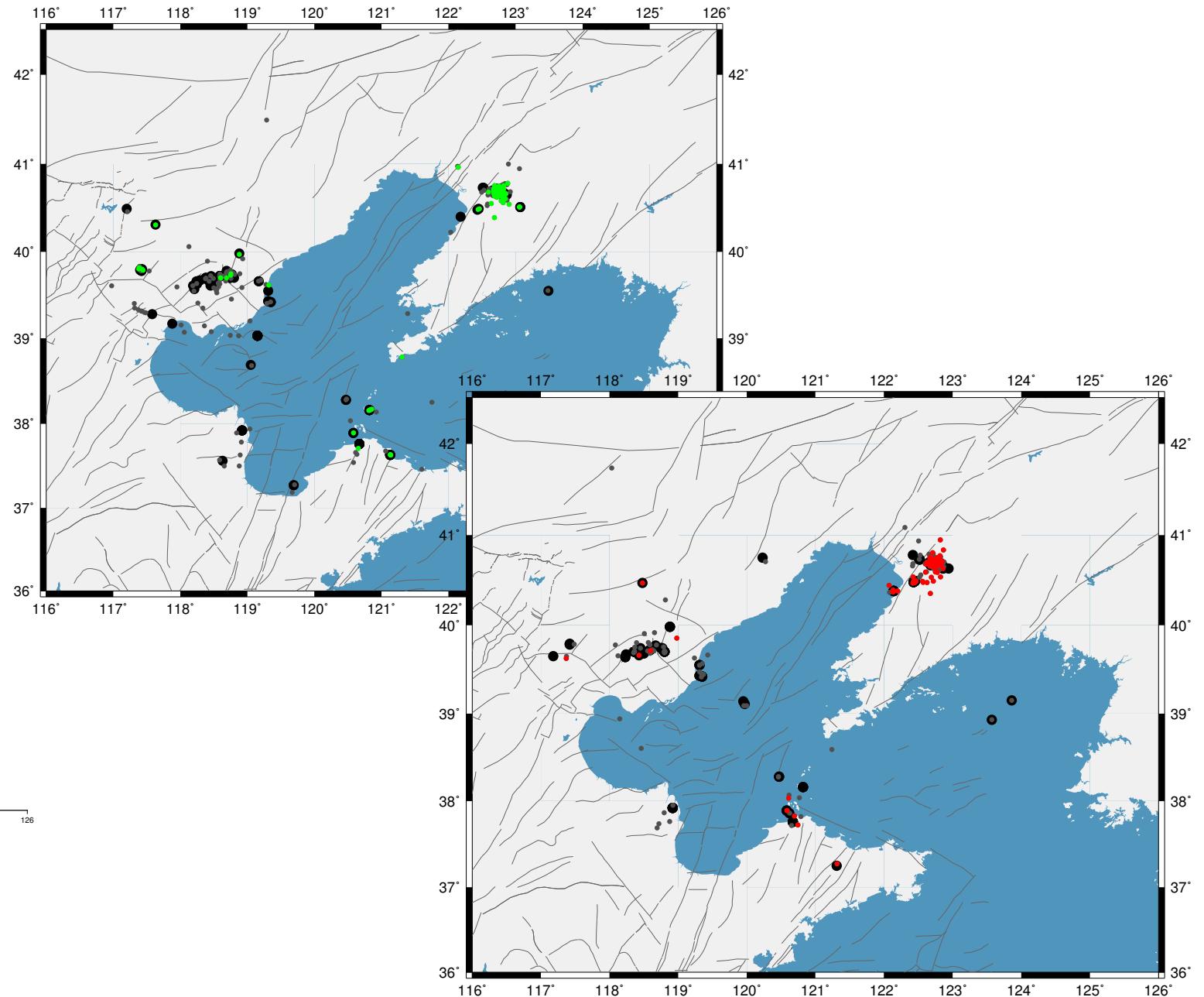
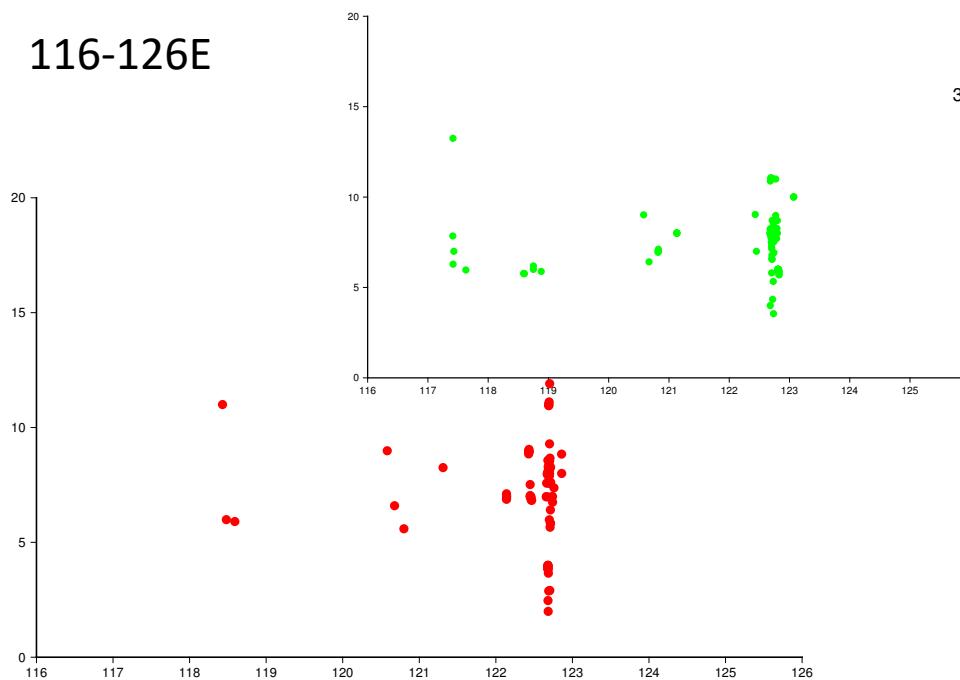
Before 3.11 245

After 3.11 226

Green dots 104

Red dots 117

116-126E



Full Size CC>0.27

After remove low CC station:

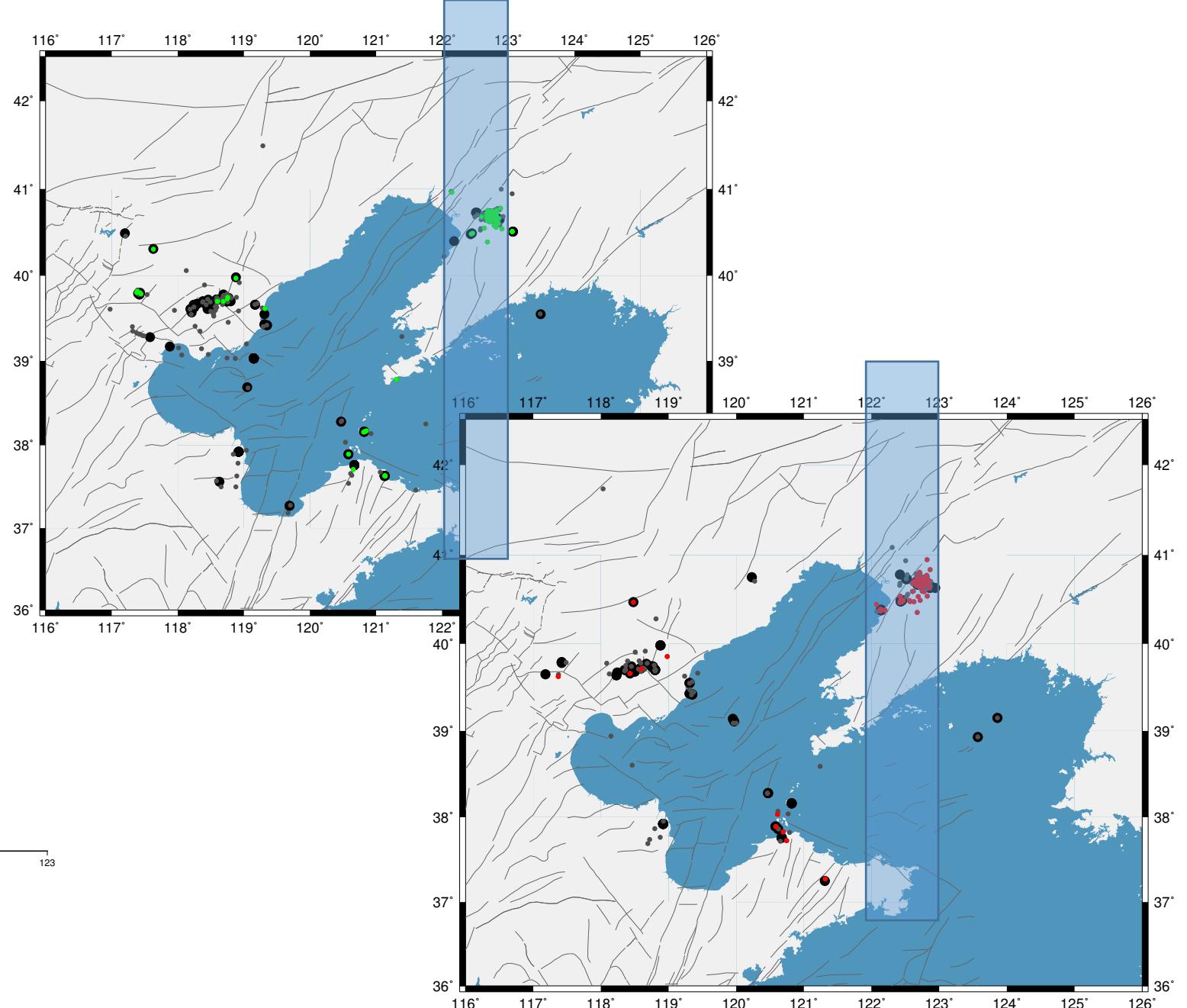
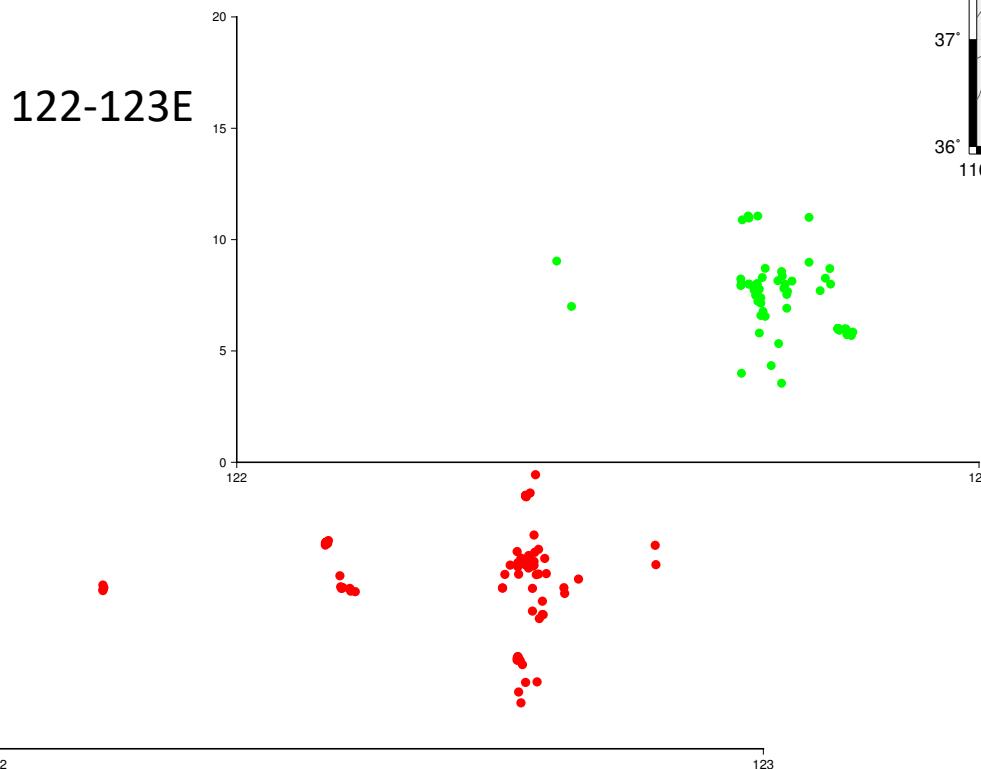
CC>0.27 478

Before 3.11 245

After 3.11 226

Green dots 104

Red dots 117



Full Size(DD) CC>0.27

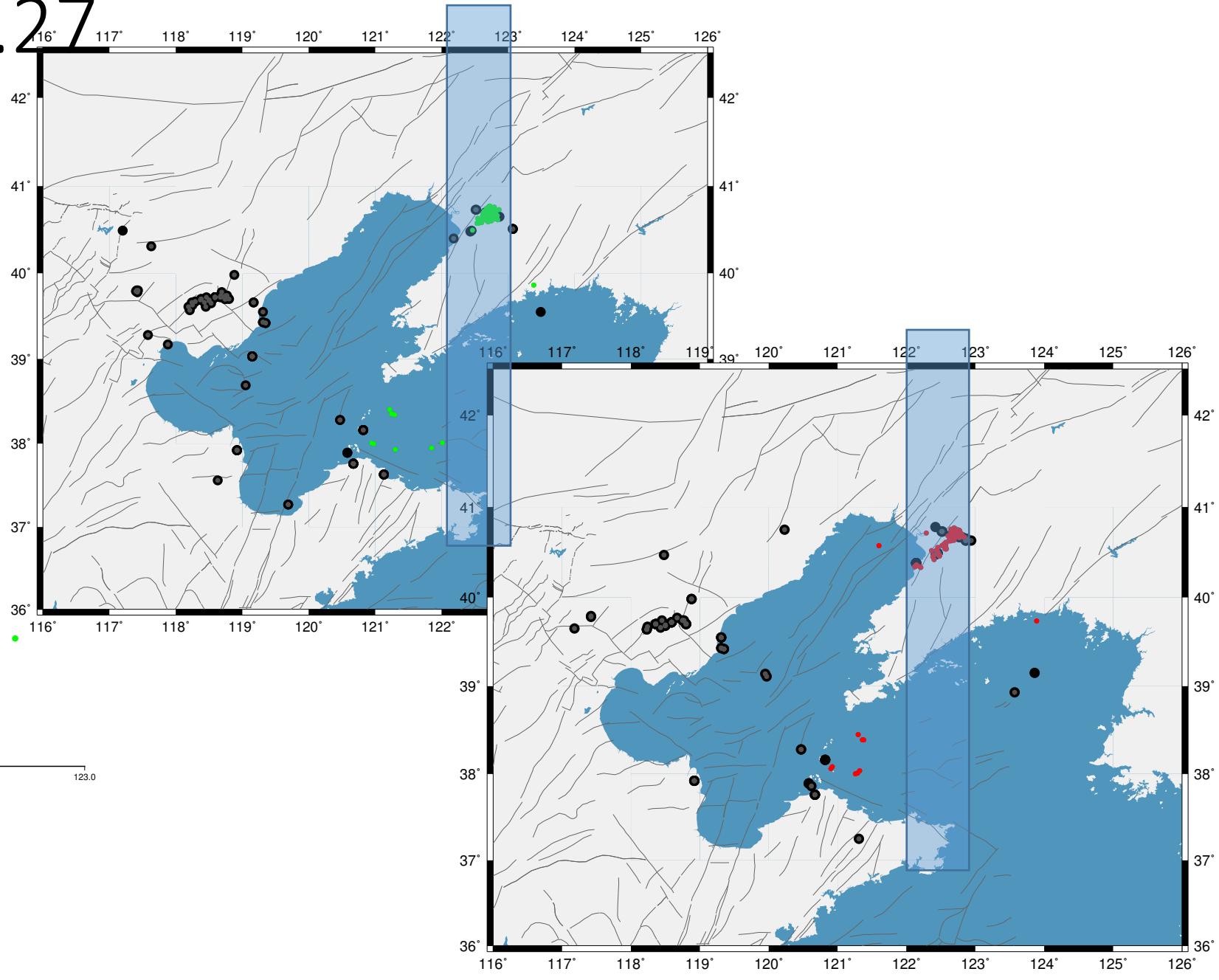
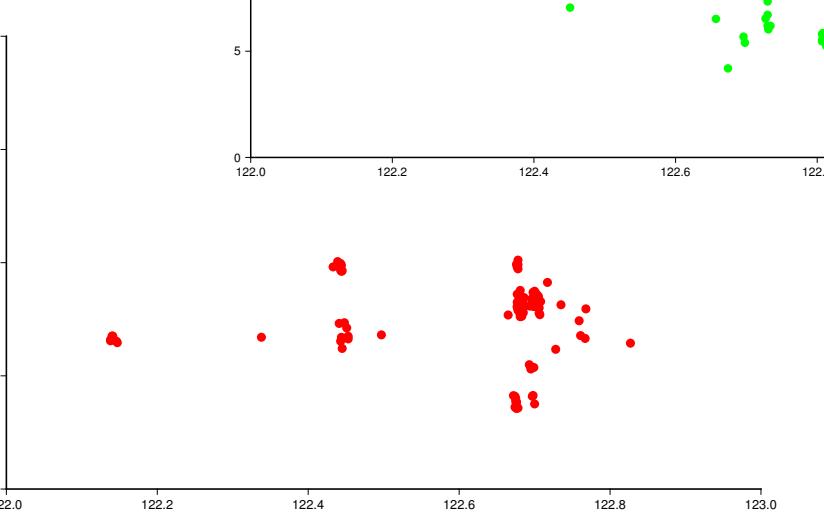
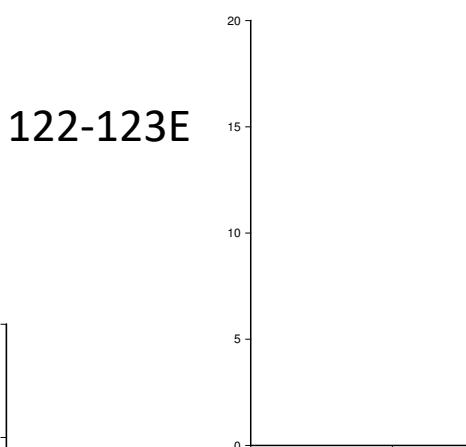
After remove low CC station:

CC>0.27

478

Green dots 84

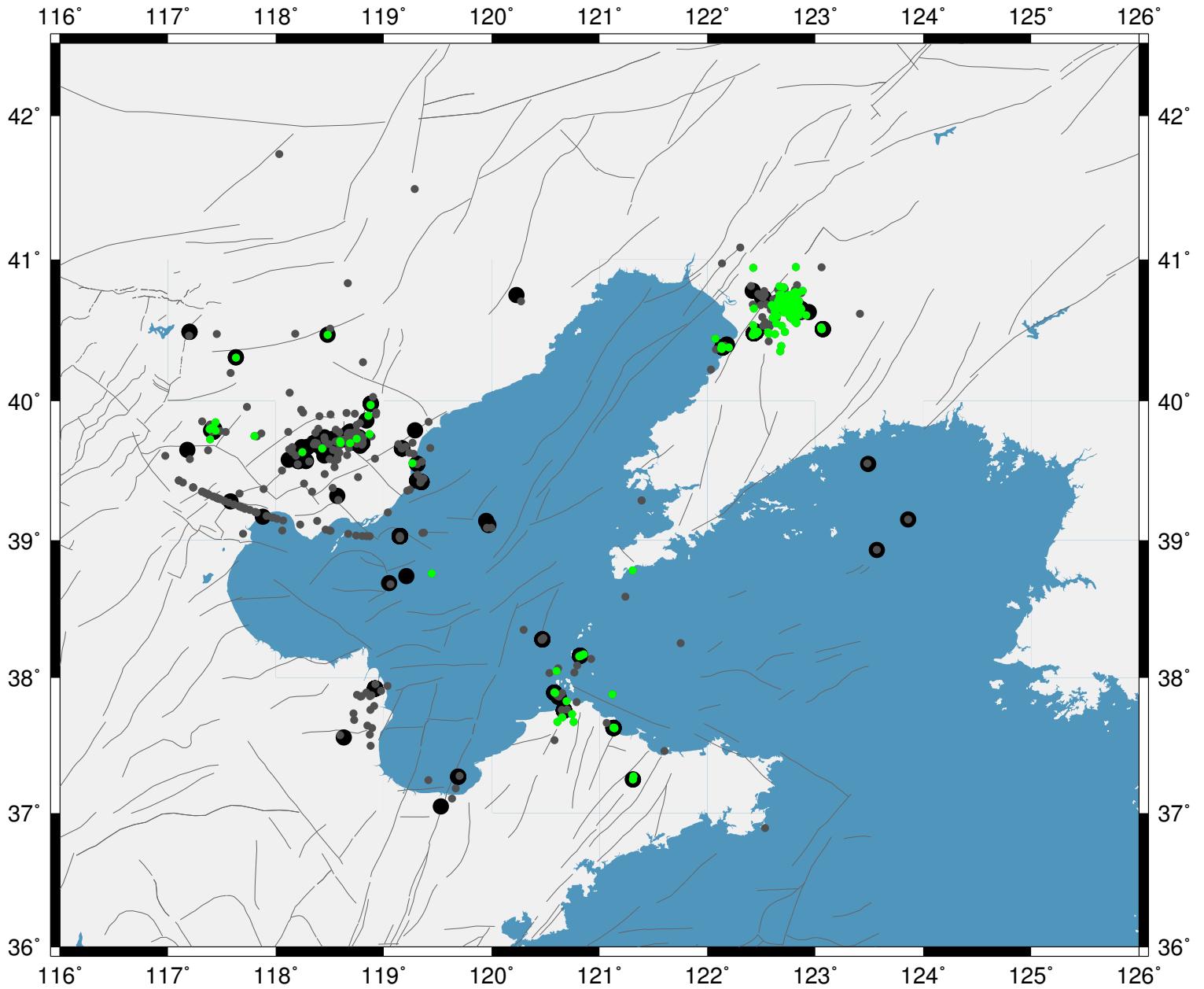
Red dots 119



Full Size

After remove low CC station:
CC>0.25 651

Green dots 278

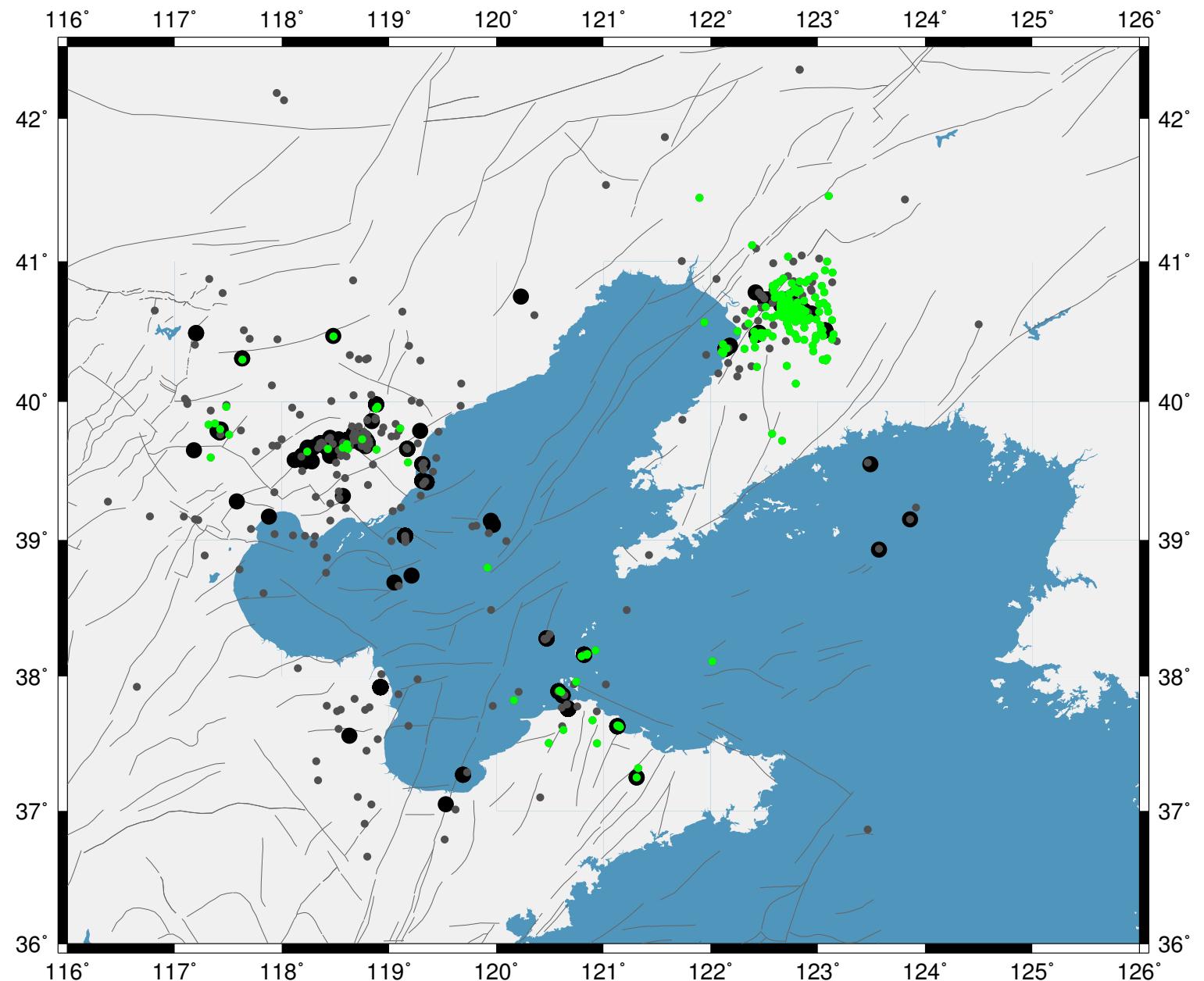


Full Size zoom in=30

After remove low CC station:

CC>0.25 651

Green dots 278



Problem in relocation 3

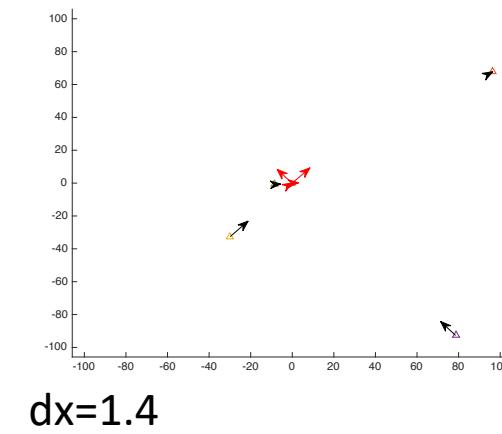
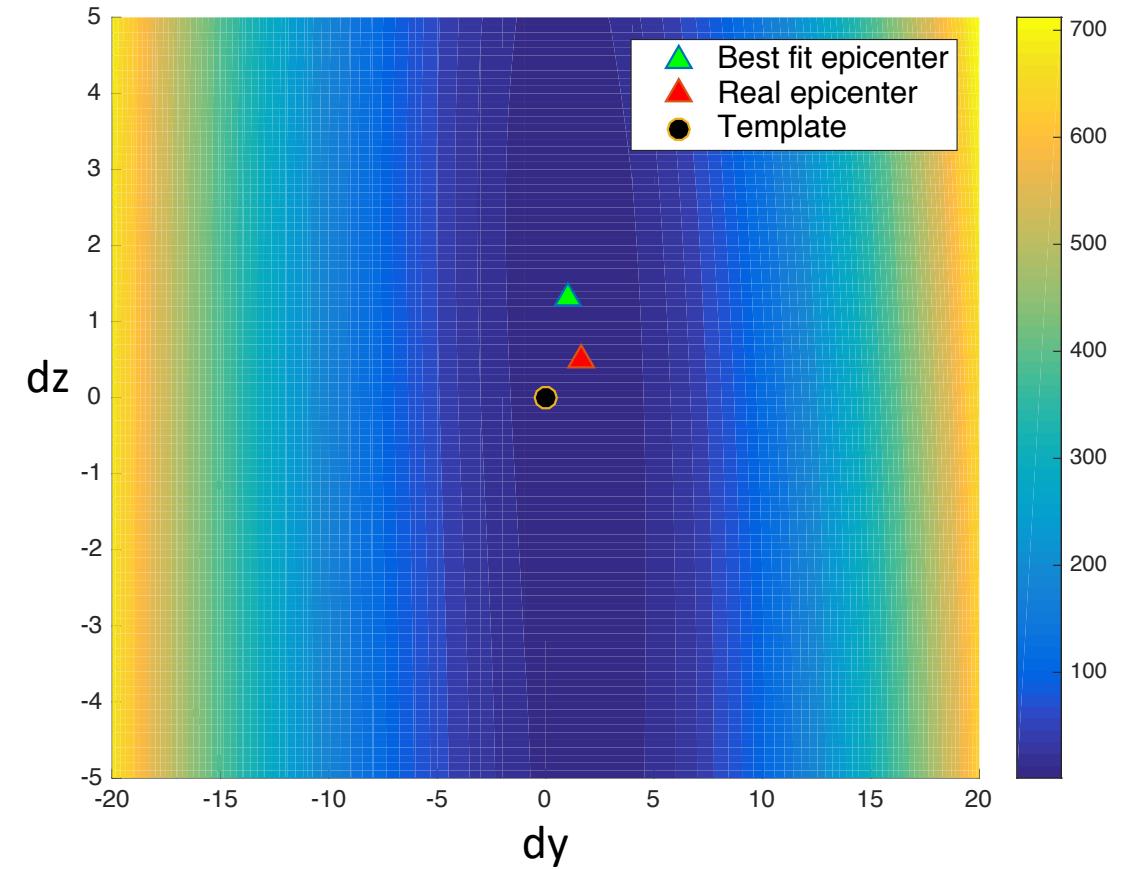
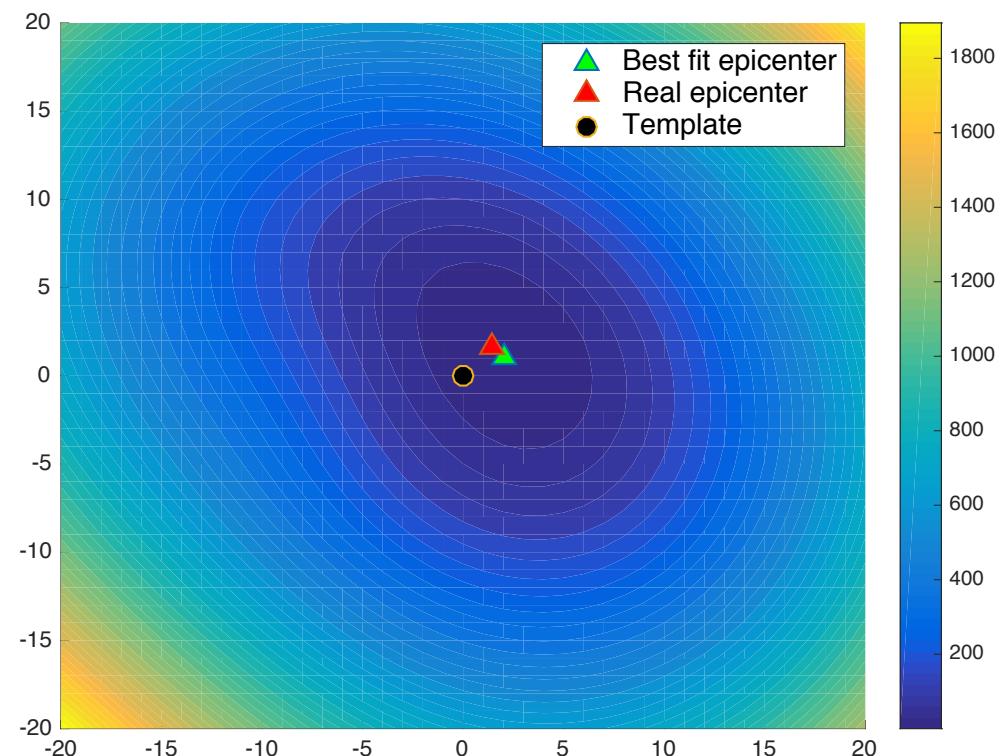
NEVENT110328152602 CSN110110085534

depth=6

dx=1.393 dy=1.612 dz=0.534

Result

dx = 1.7669 dy = 1.3261 dz = 0.2046



dx=1.4

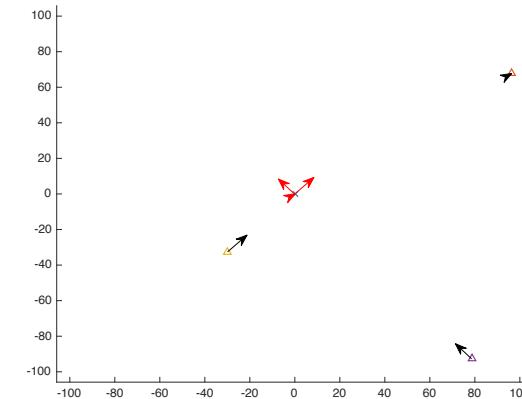
Problem in relocation 3

NEVENT110328152602 CSN110110085534

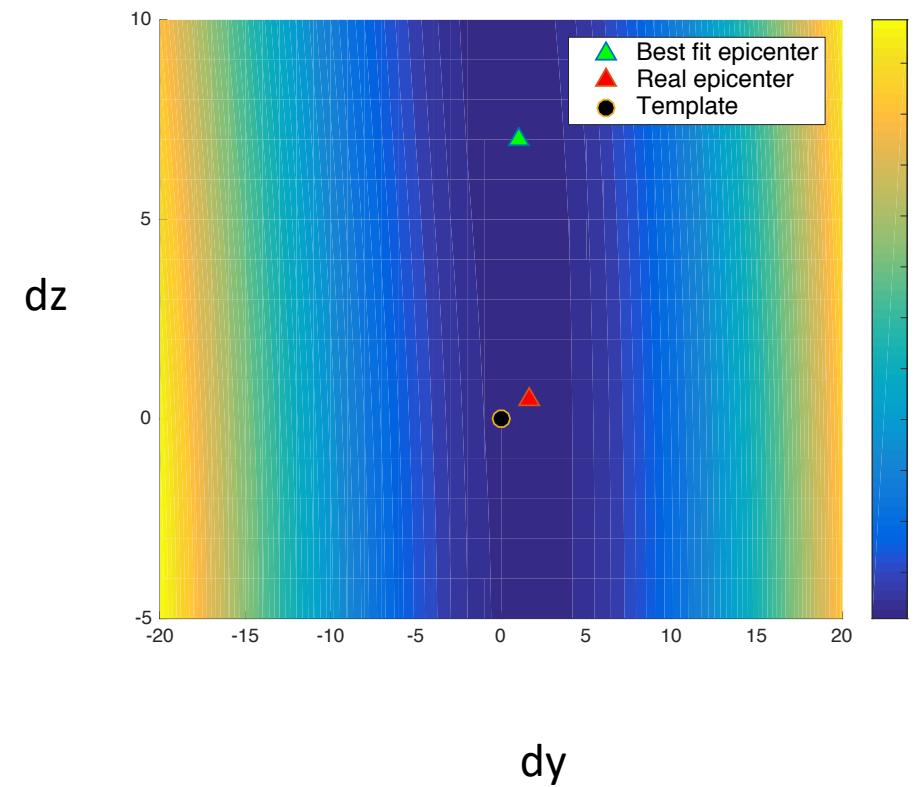
$dx=1.393$ $dy=1.612$ $dz=-2$

Result

Dz 持续增大



$dx=1.4$

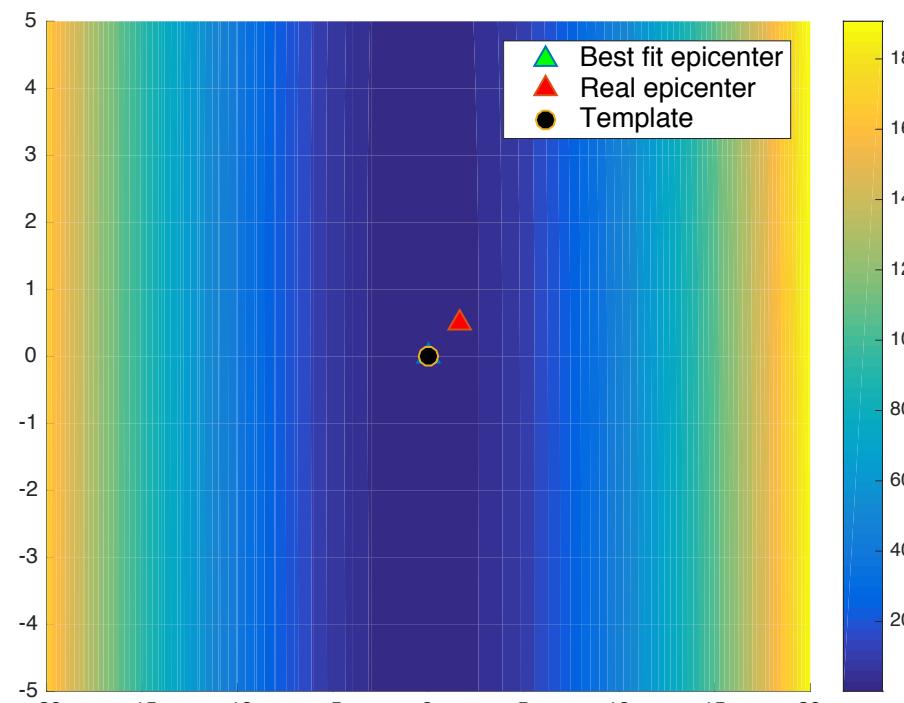
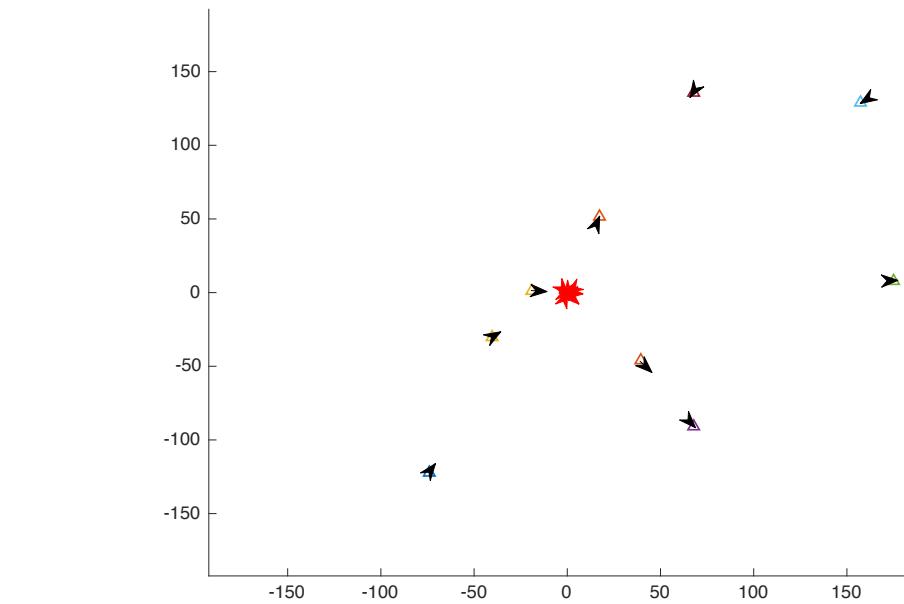
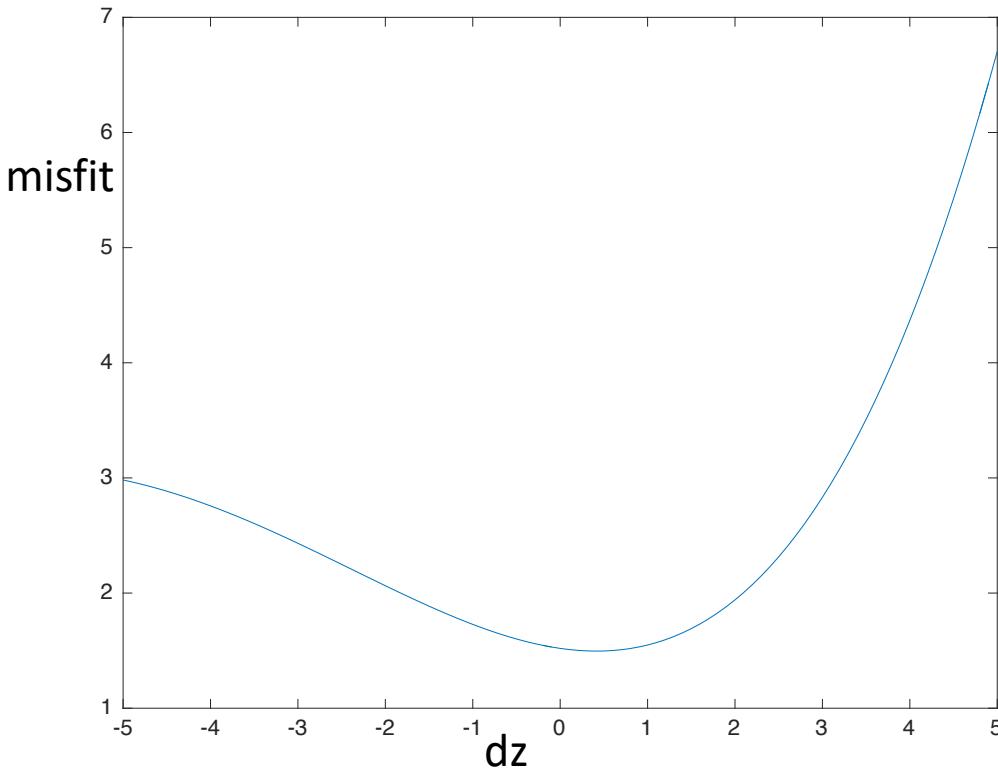


Problem in relocation 3

NEVENT110328152602 CSN110110085534
 $dx=0.89$ $dy=-0.26$ $dz=-0.562$

Result

$dx = 0.5070$ $dy = -0.1766$ $dz = 0.8734$

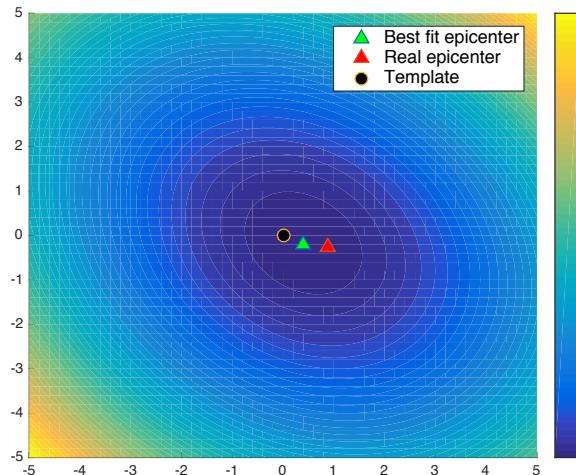


Problem in relocation 3

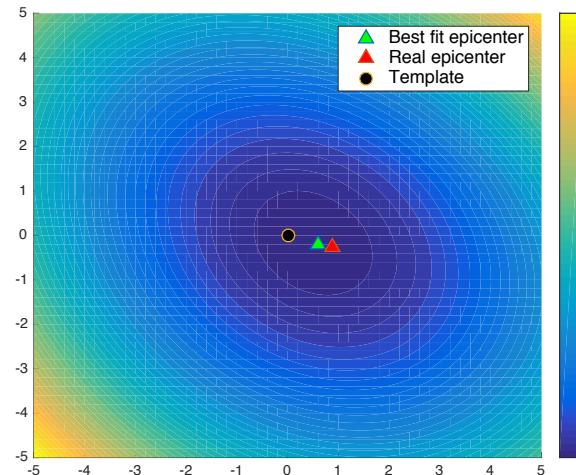
NEVENT110328152602 CSN110110085534

$dx=0.89$ $dy=-0.26$ $dz=-0.562$

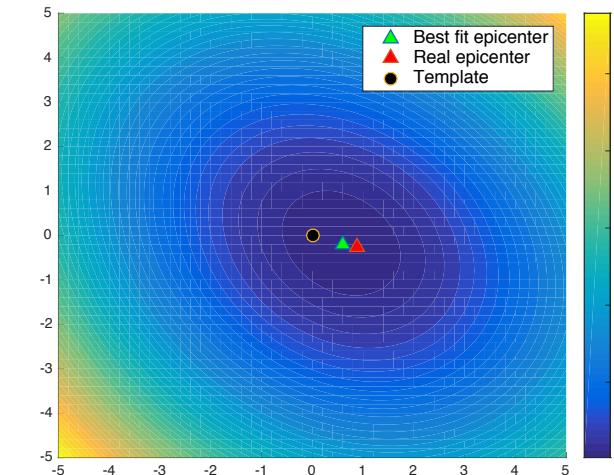
Set $dz=3$



Set $dz=1$



Set $dz=-0.562$



Set $dz=-3$

