Solar Radio Bursts with LWA-1

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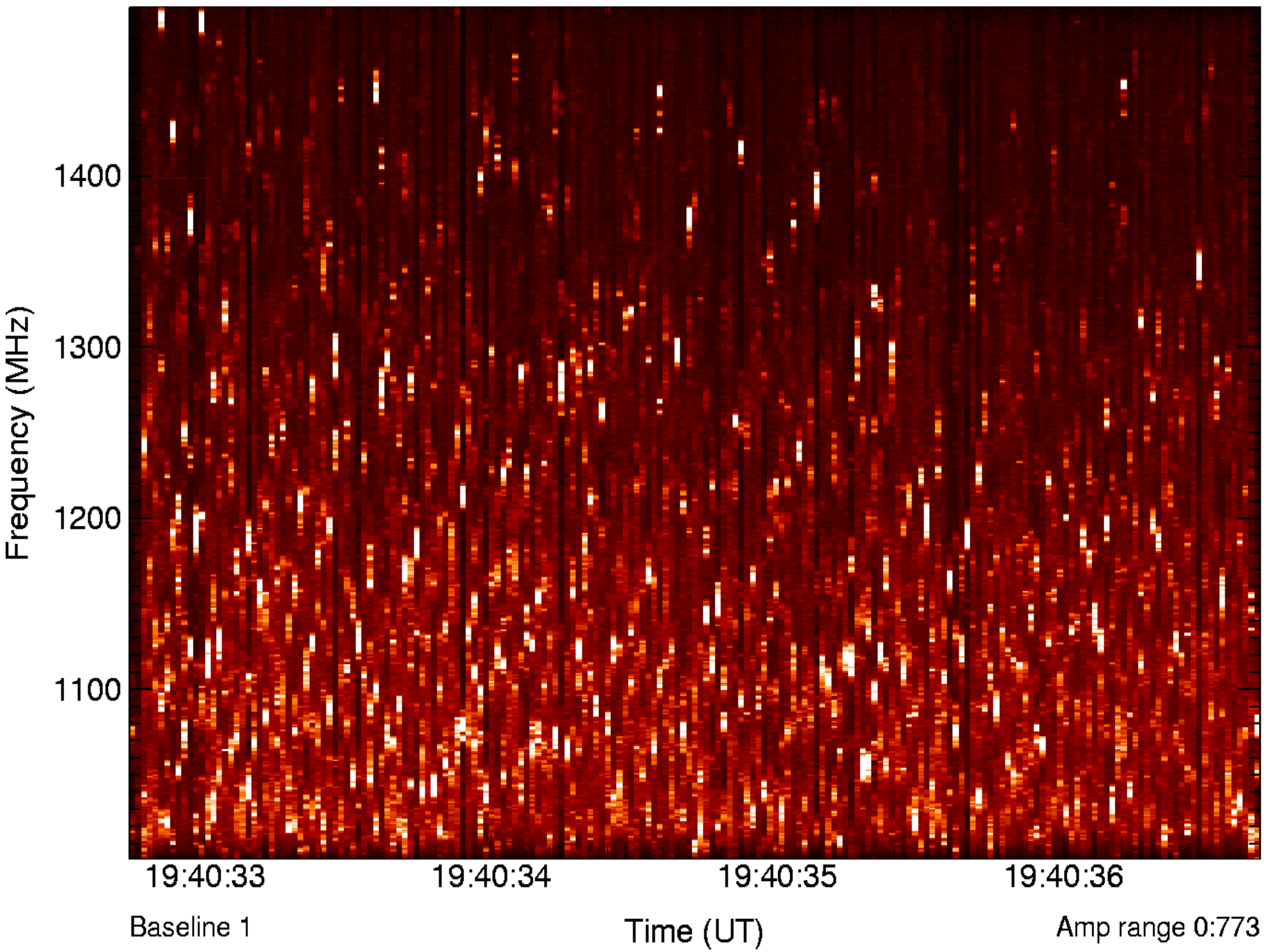
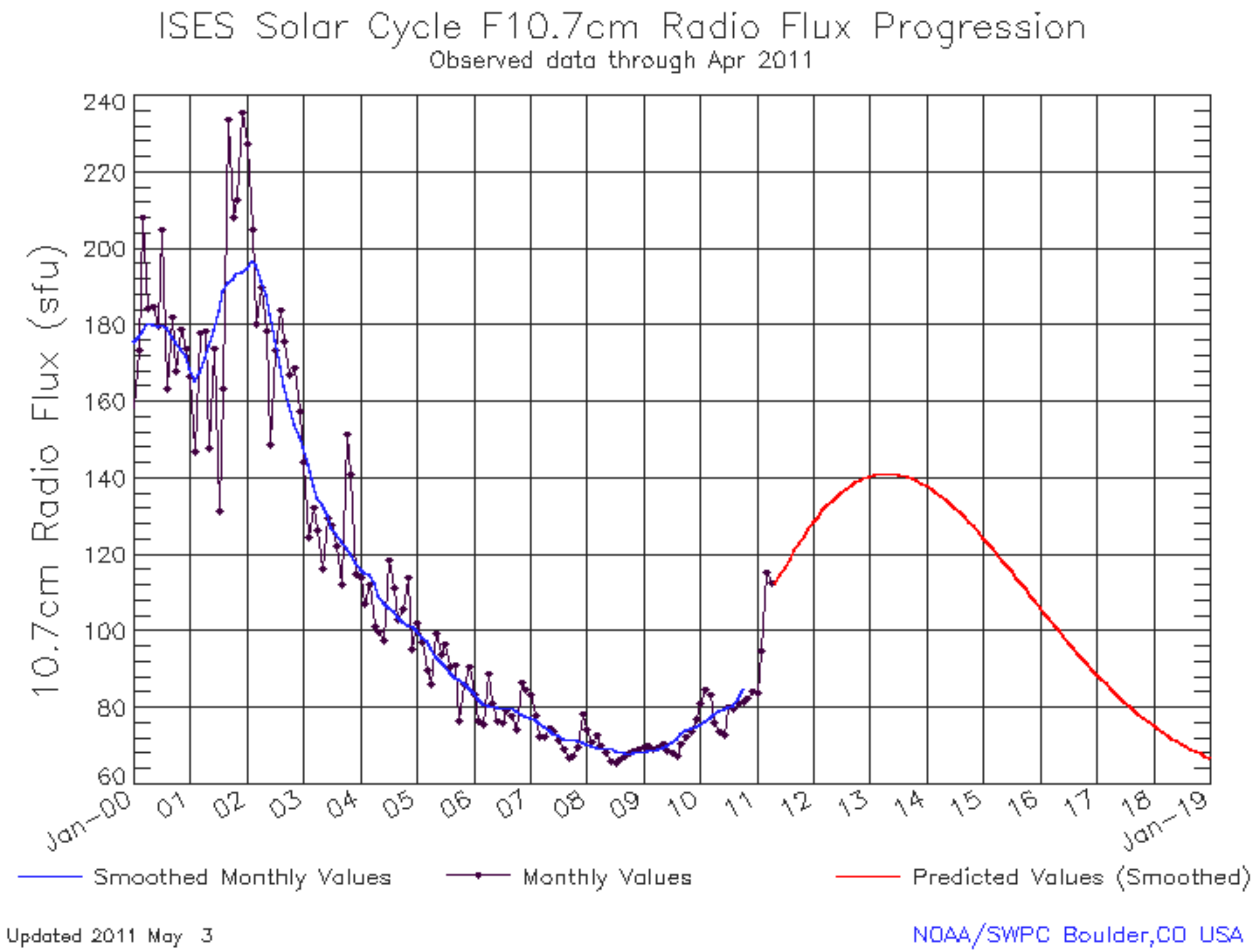
10^{10} Jy in the GPS band:: “spike bursts”

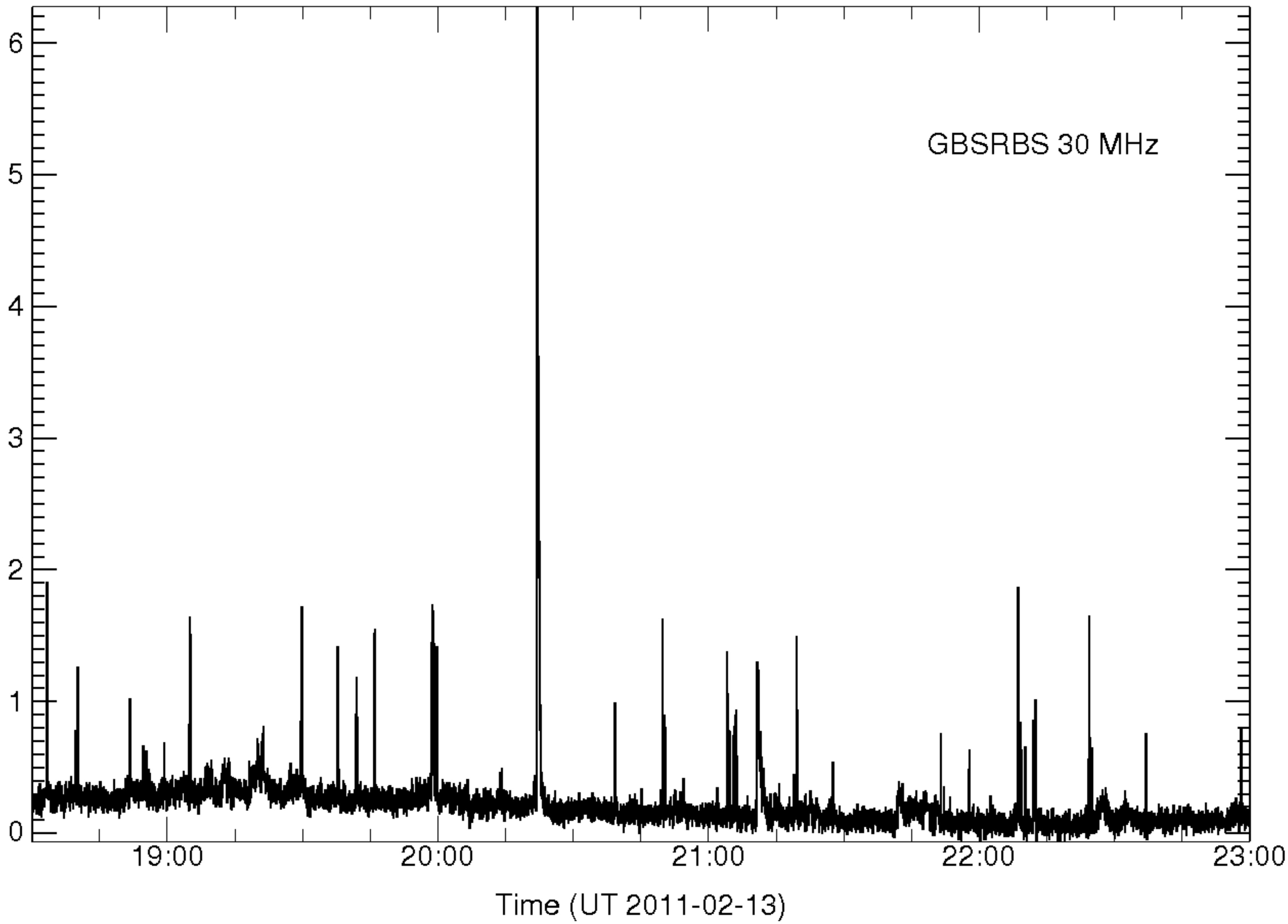


TBN data

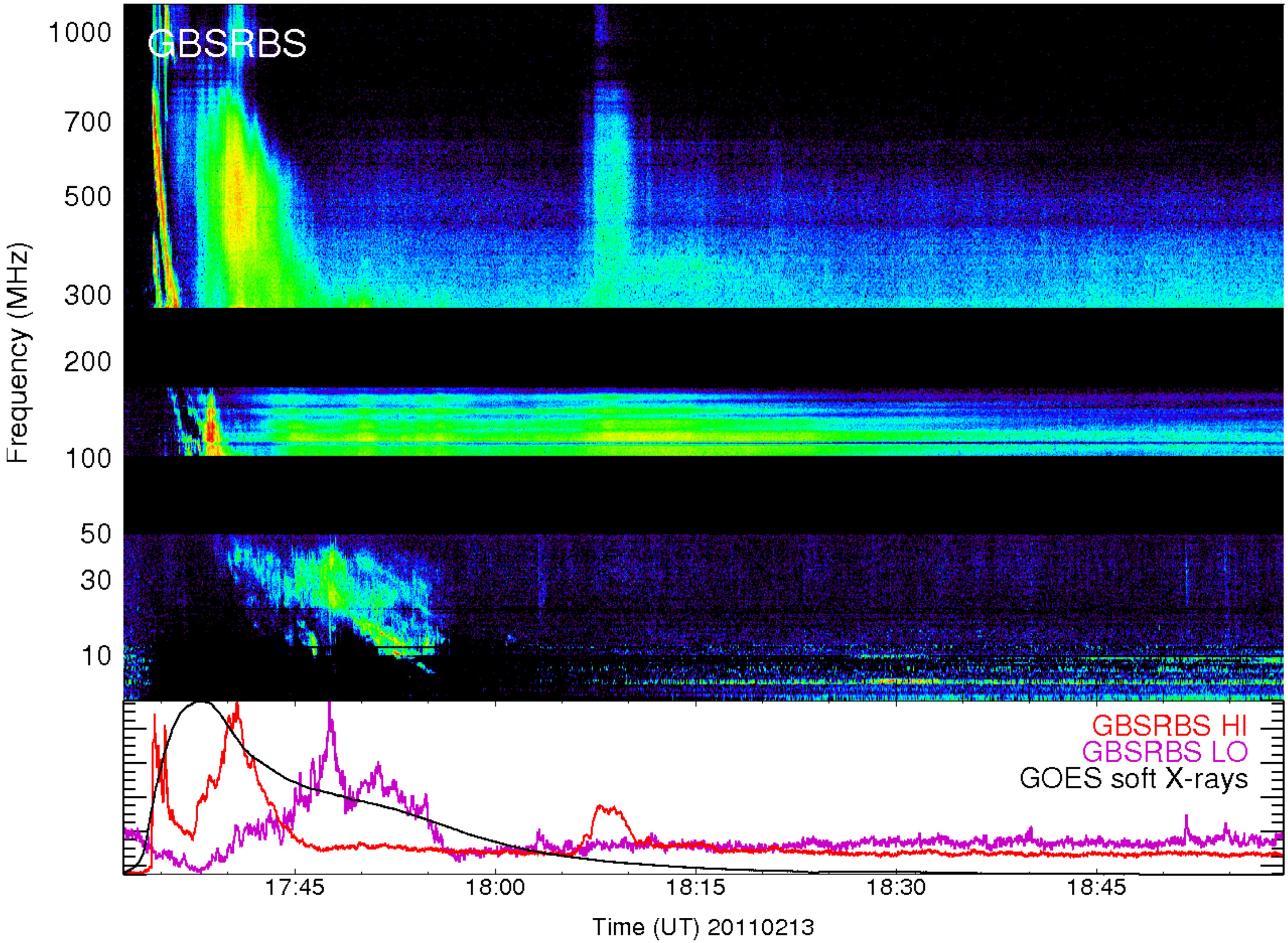
2011 Feb 13
2011 Feb 14

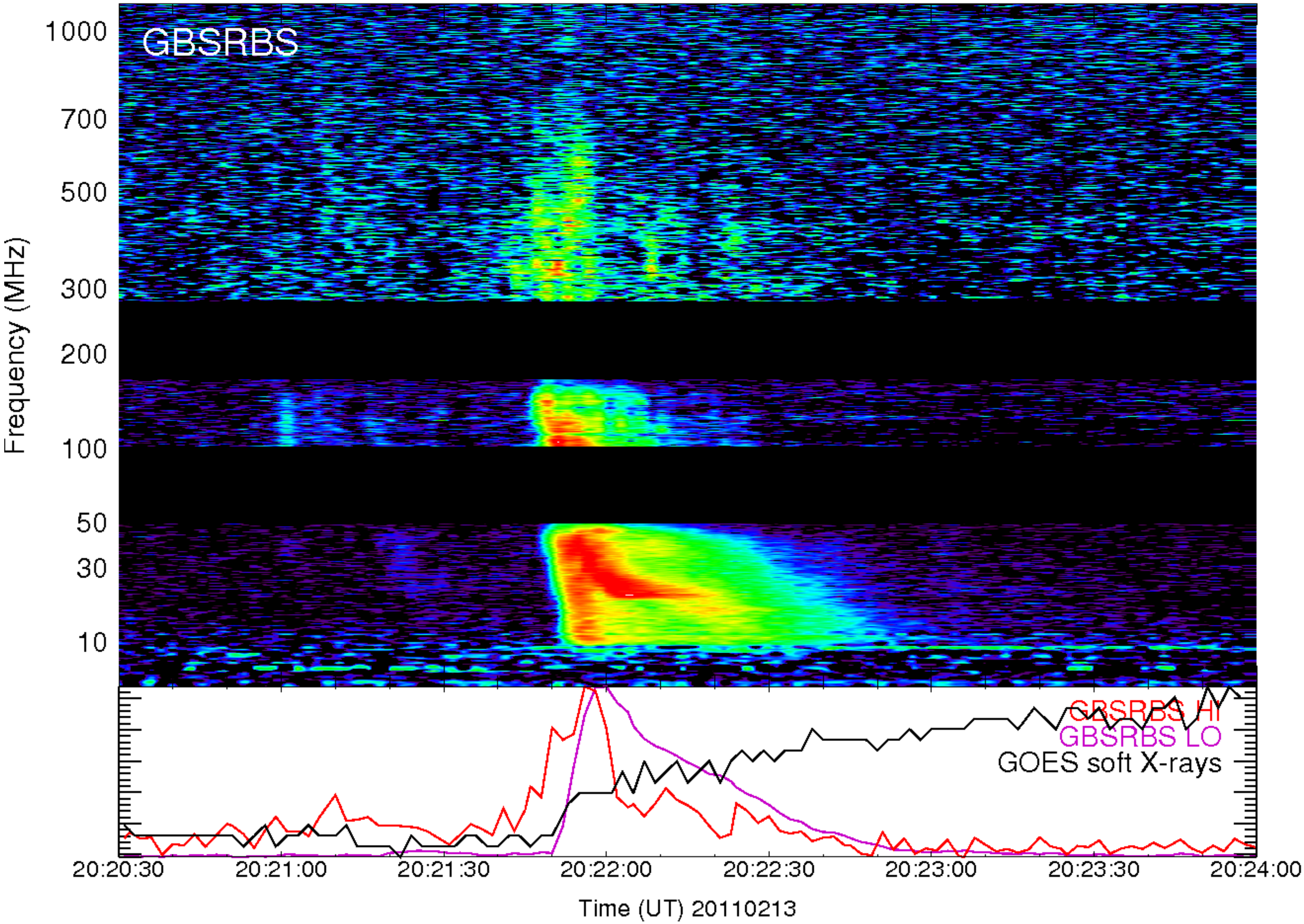

ISES Solar Cycle F10.7cm Radio Flux Progression
Observed data through Apr 2011
10.7cm Radio Flux (sfu)
240
220
200
180
160
140
120
100
80
60
Jan-00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
Jan-19
Smoothed Monthly Values
Monthly Values
Predicted Values (Smoothed)
Updated 2011 May 3
NOAA/SWPC Boulder,CO USA

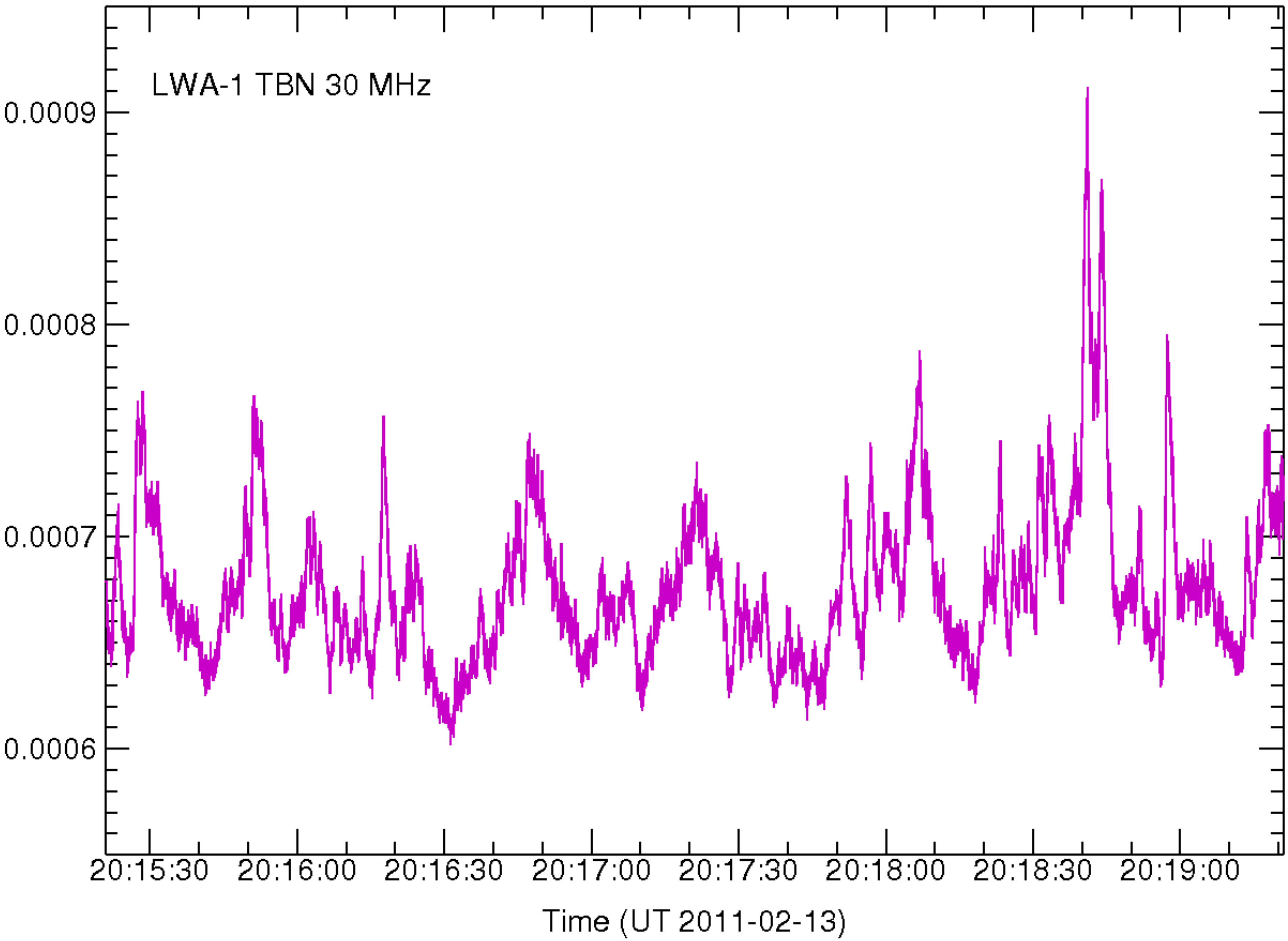
GBSRBS 30 MHz light curve (2011-02-13)



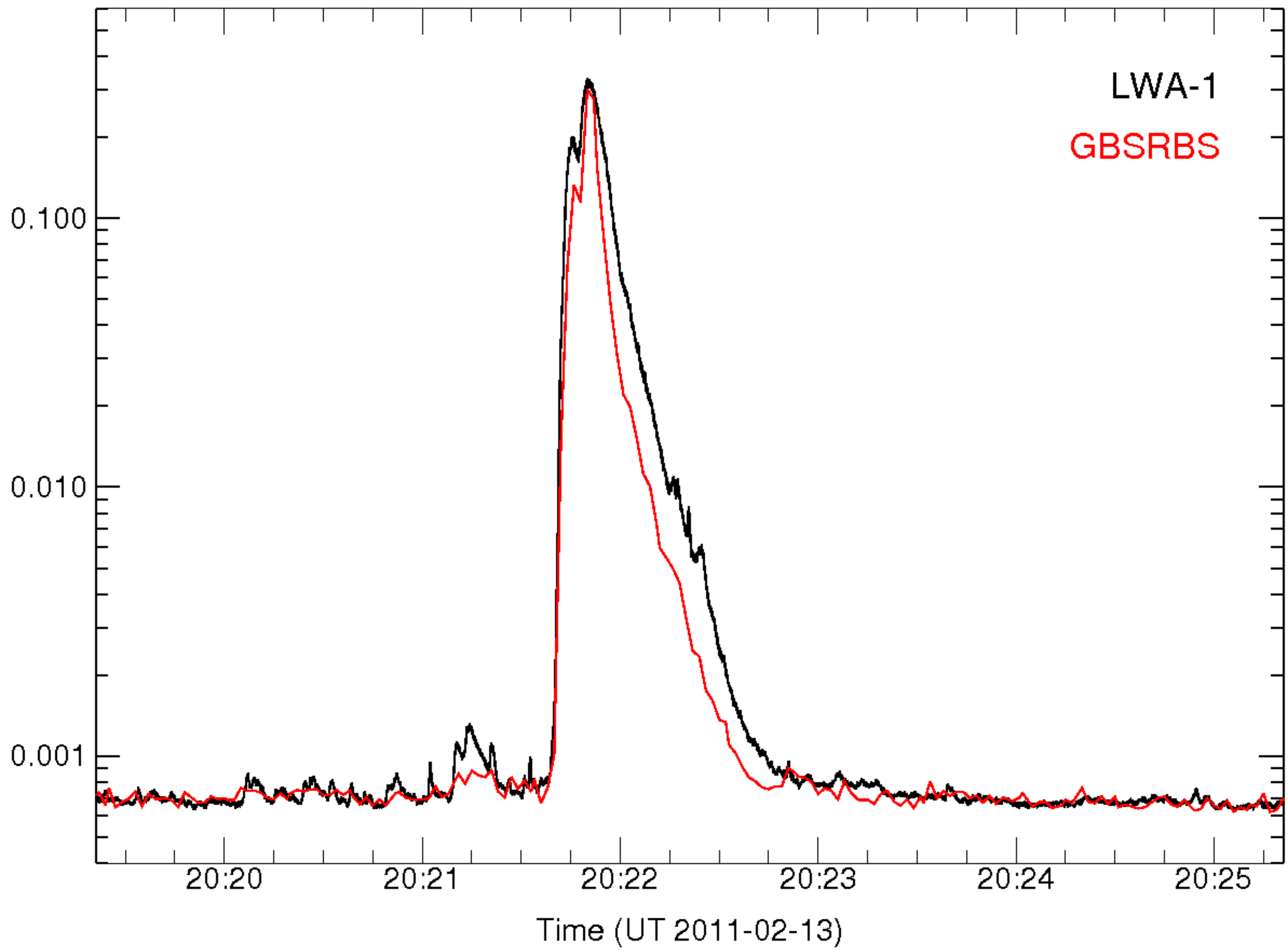
The first big flare of the cycle rise



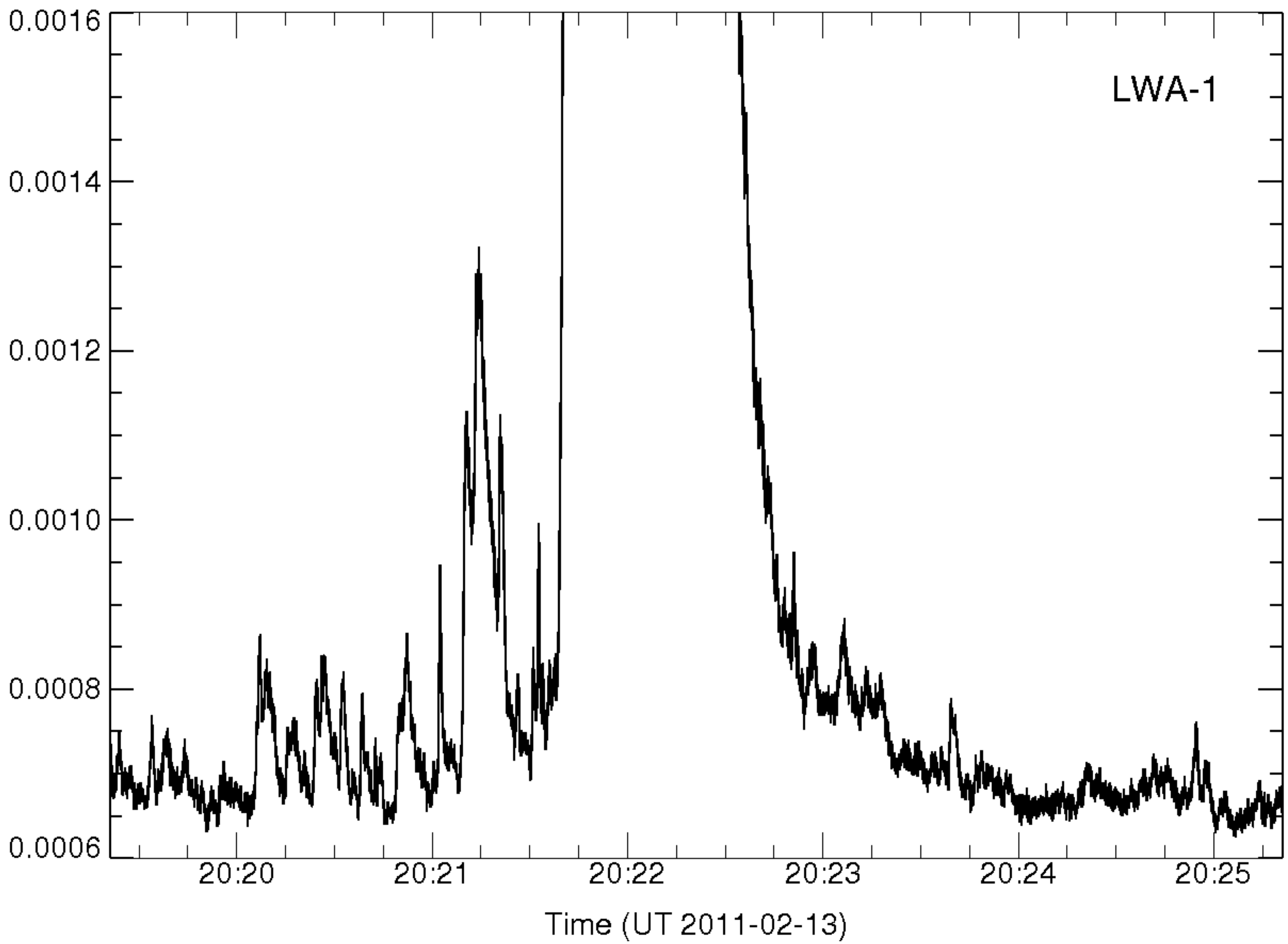

GBSRBS
1000
700
500
300
200
100
50
30
10
Frequency (MHz)
GBSRBS HI
GBSRBS LO
GOES soft X-rays
20:20:30
20:21:00
20:21:30
20:22:00
20:22:30
20:23:00
20:23:30
20:24:00
Time (UT) 20110213

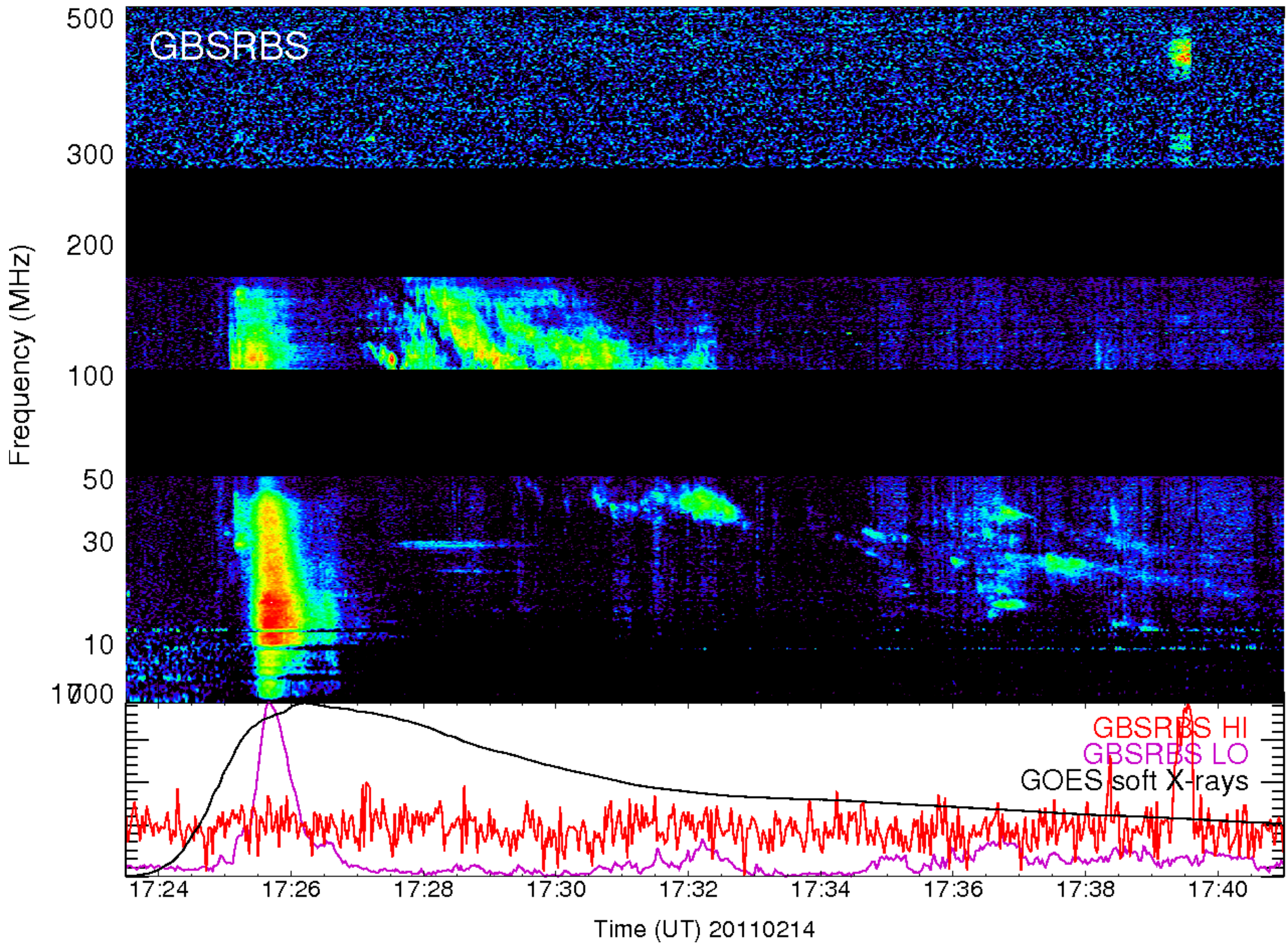

LWA-1 TBN 30 MHz
0.0009
0.0008
0.0007
0.0006
20:15:30
20:16:00
20:16:30
20:17:00
20:17:30
20:18:00
20:18:30
20:19:00
Time (UT 2011-02-13)

Bright Type III burst at 30 MHz

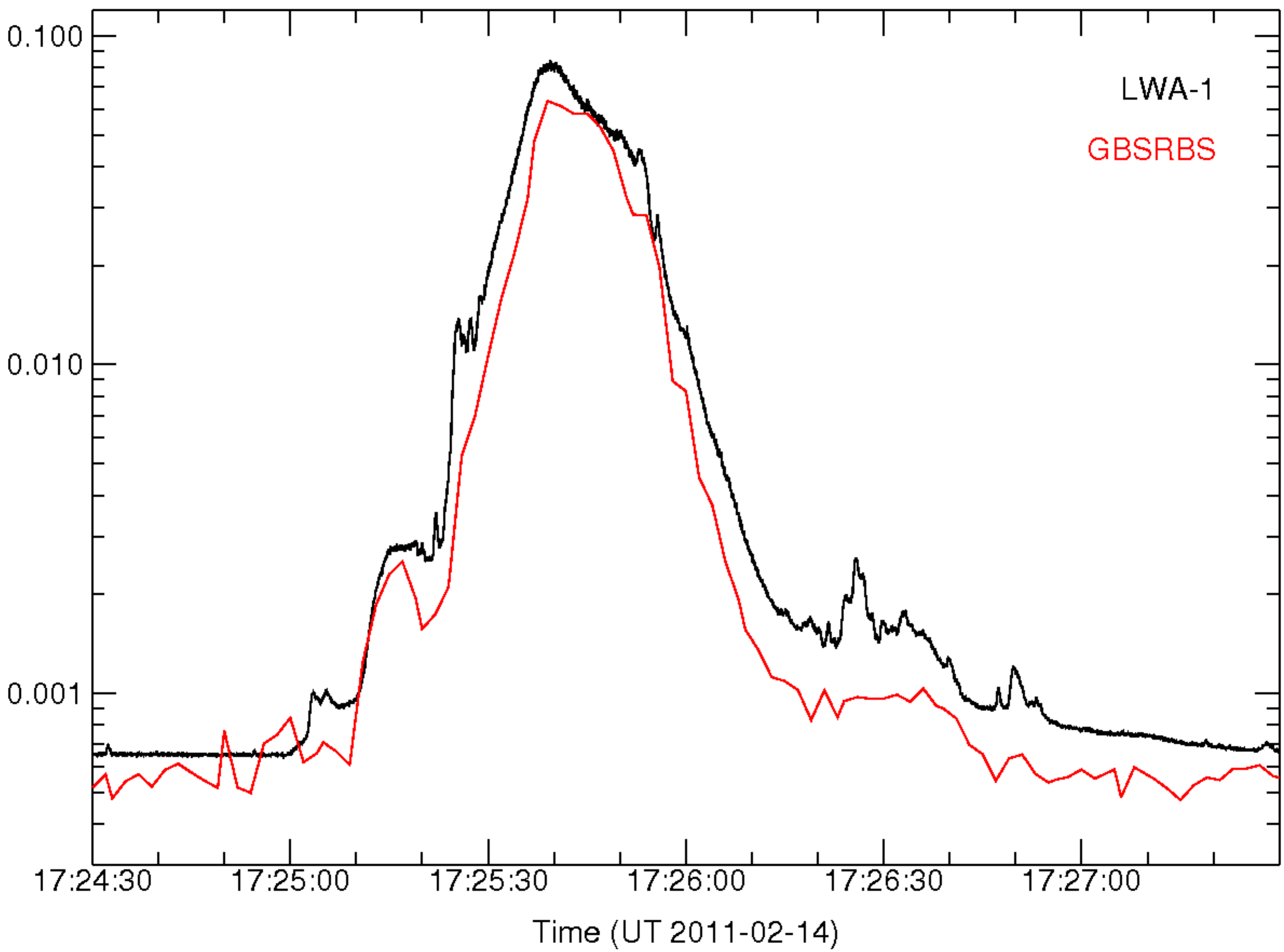


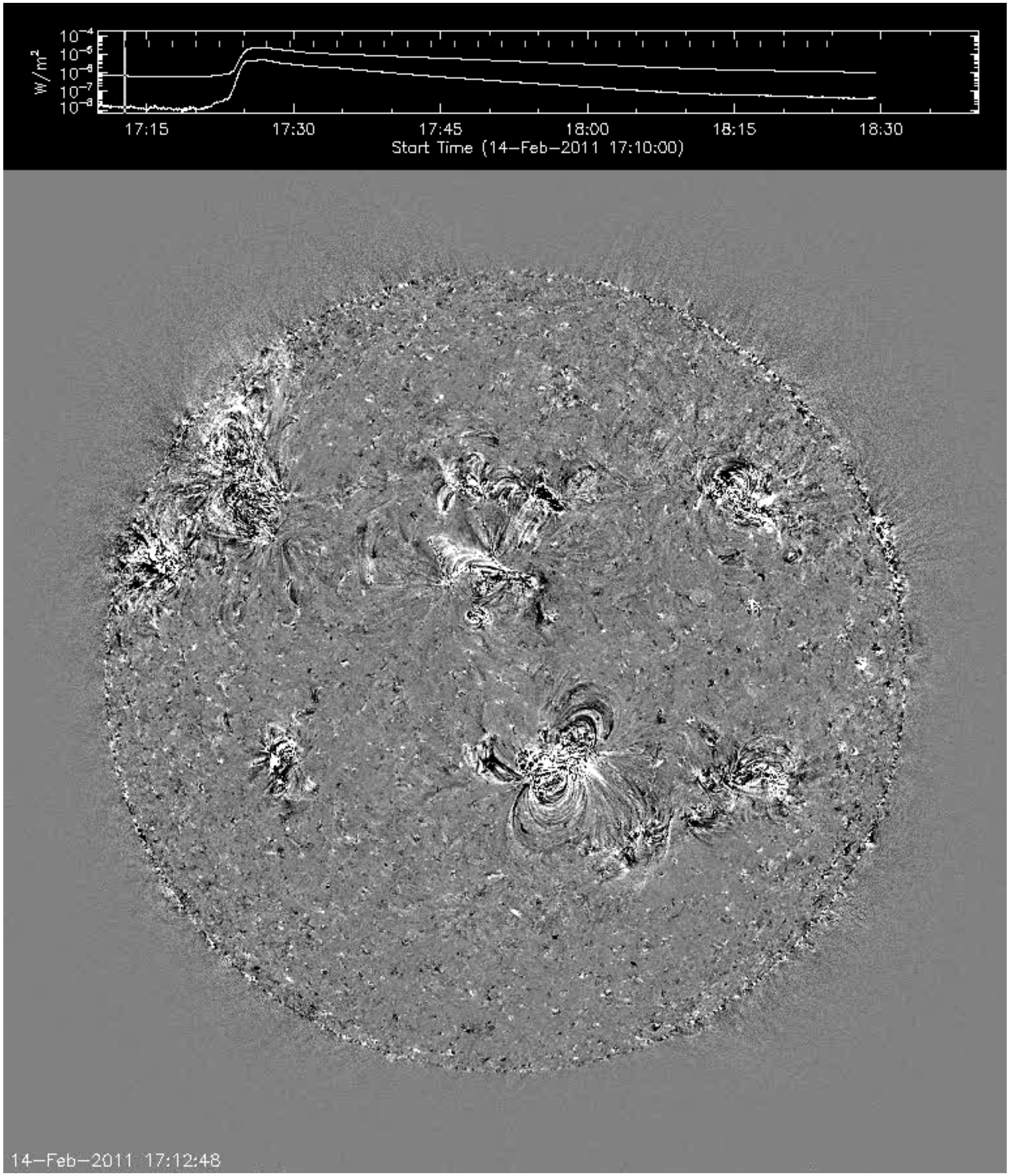
Low-level emission around Type III




GBSRBS
Frequency (MHz)
500
300
200
100
50
30
10
1000
GBSRBS HI
GBSRBS LO
GOES soft X-rays
17:24
17:26
17:28
17:30
17:32
17:34
17:36
17:38
17:40
Time (UT) 20110214

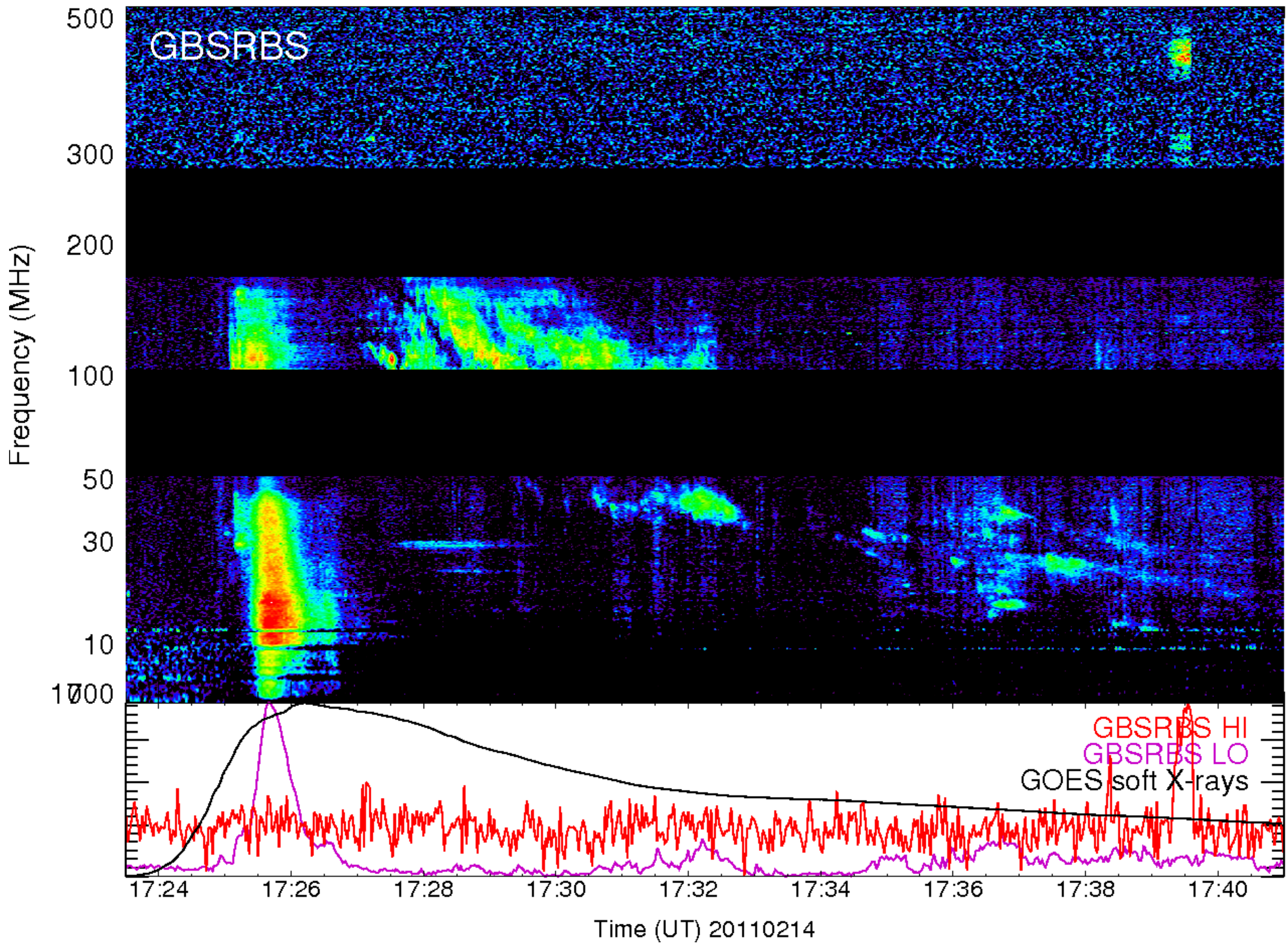
Impulsive phase: type III-like burst



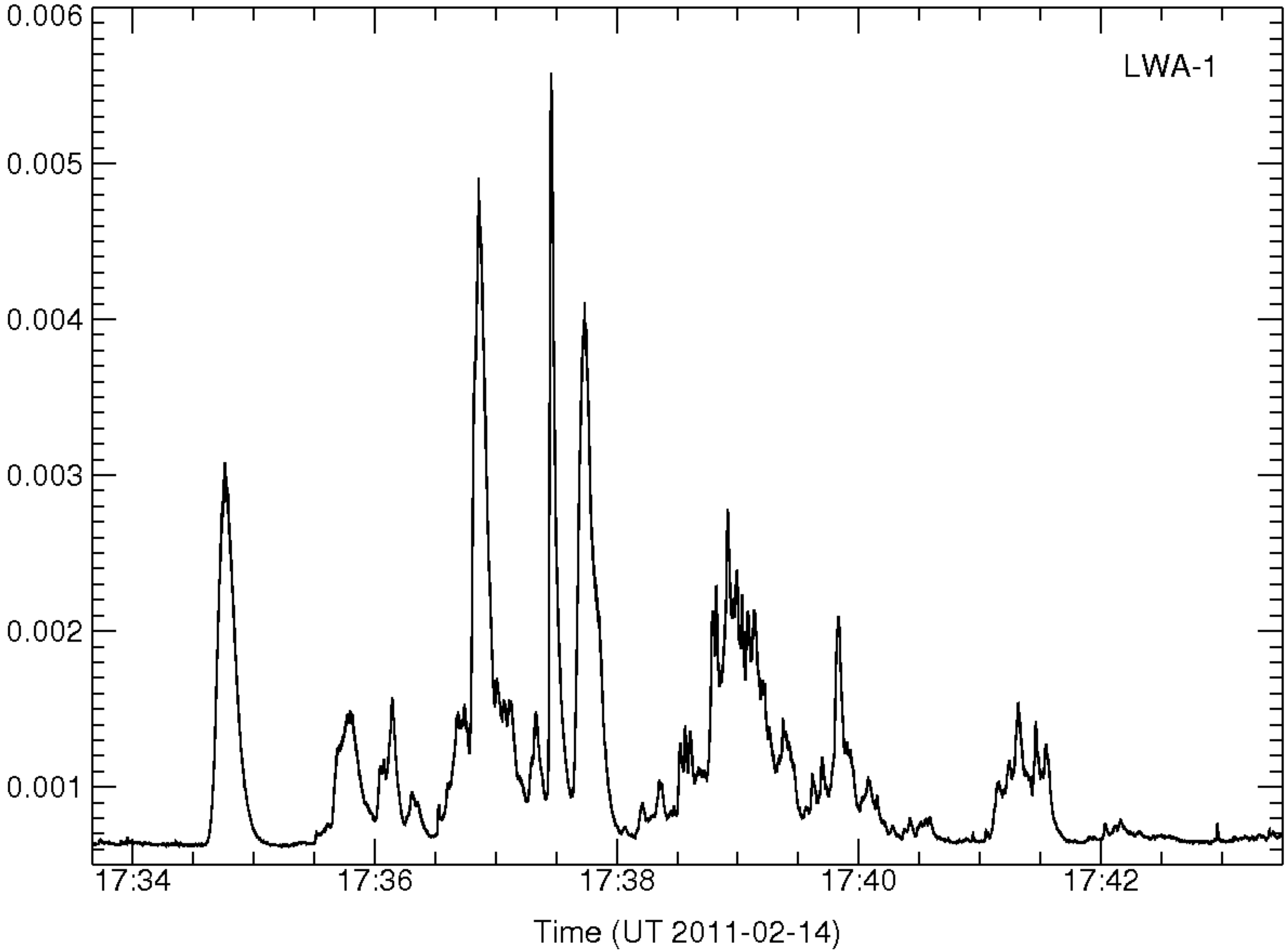


An "EIT" wave from Feb 14

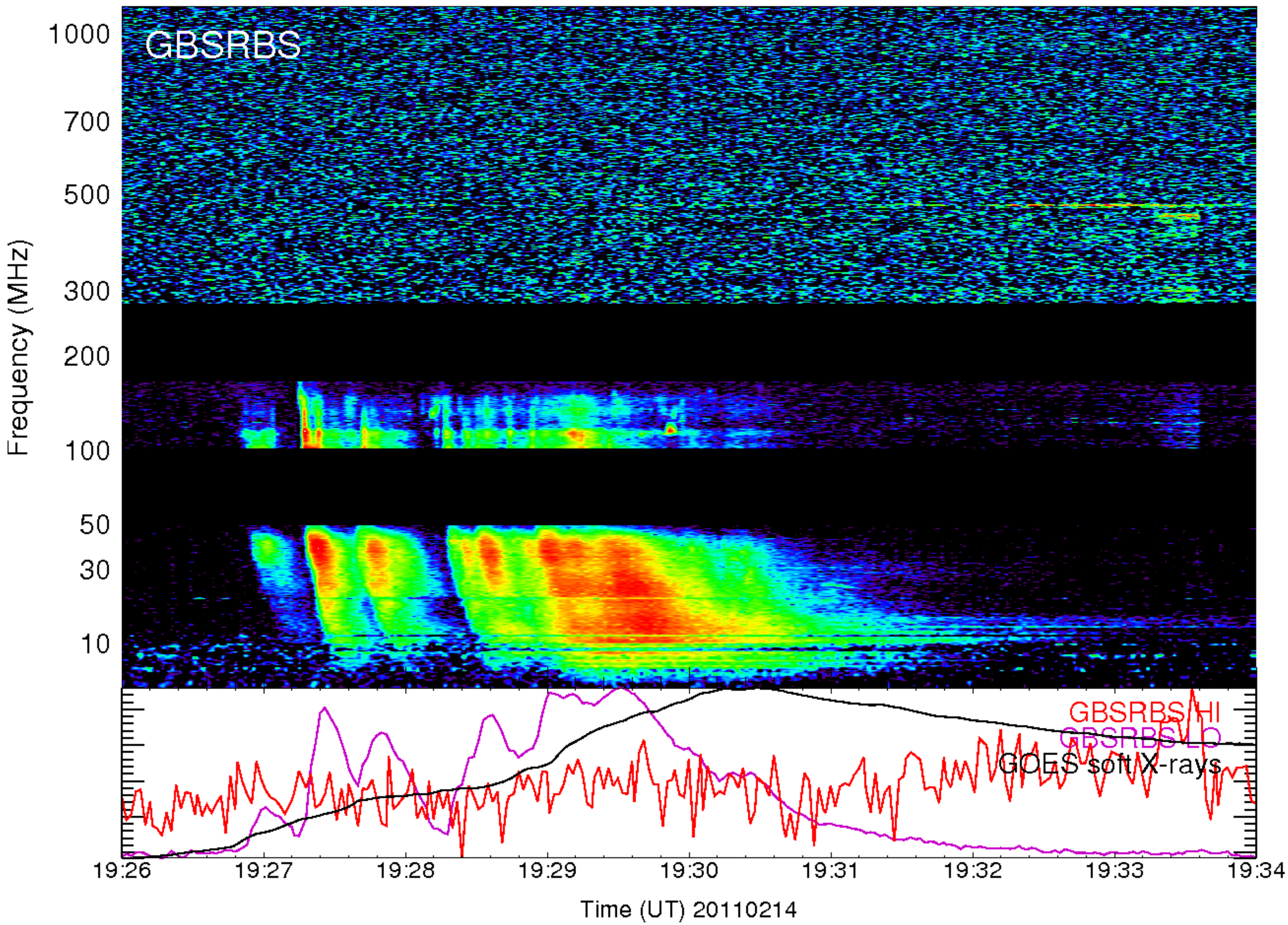
(SDO/AIA)


GBSRBS
500
300
200
100
50
30
10
1700
Frequency (MHz)
GBSRBS HI
GBSRBS LO
GOES soft X-rays
17:24
17:26
17:28
17:30
17:32
17:34
17:36
17:38
17:40
Time (UT) 20110214

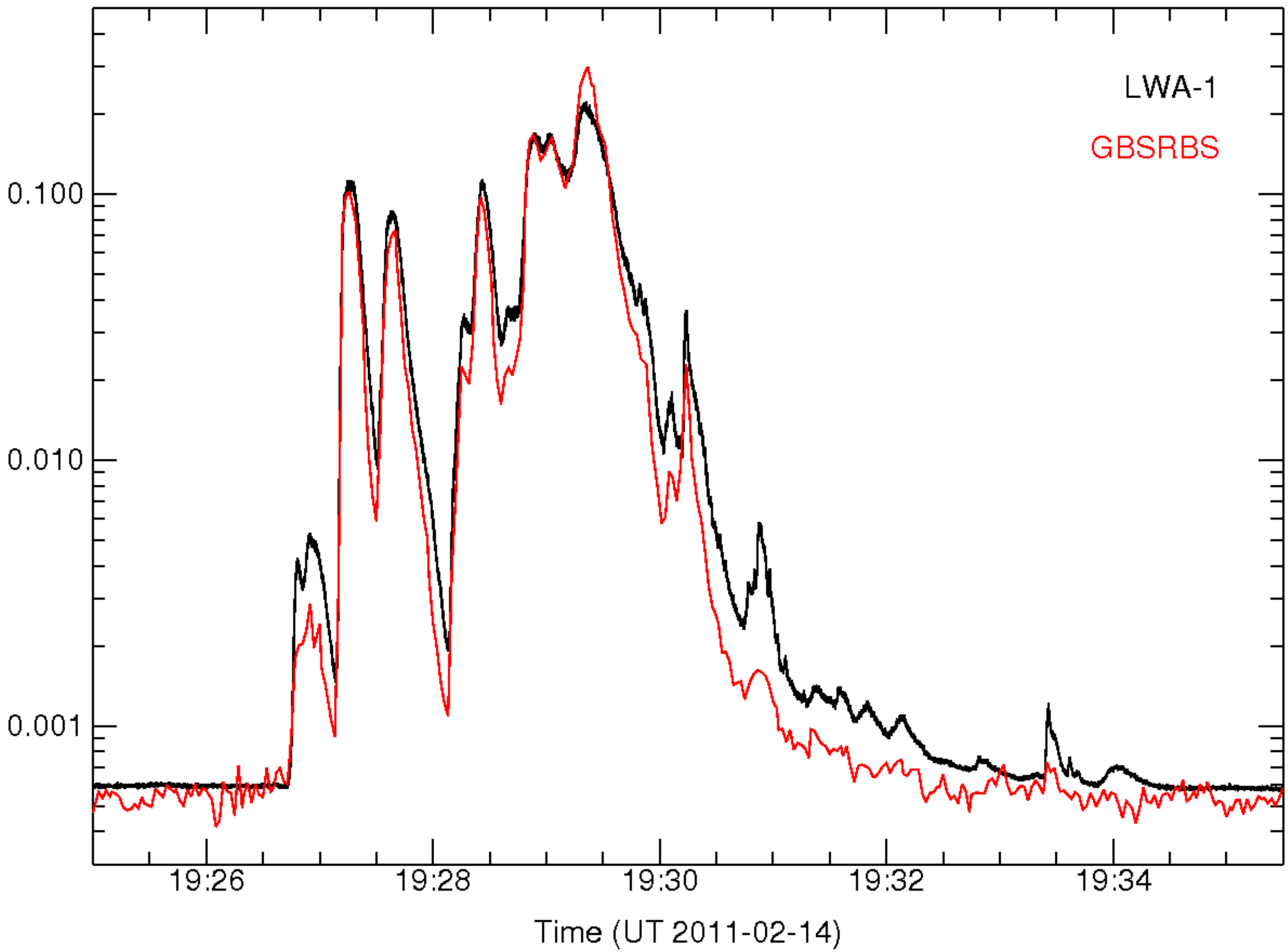
Bursty Type II emission



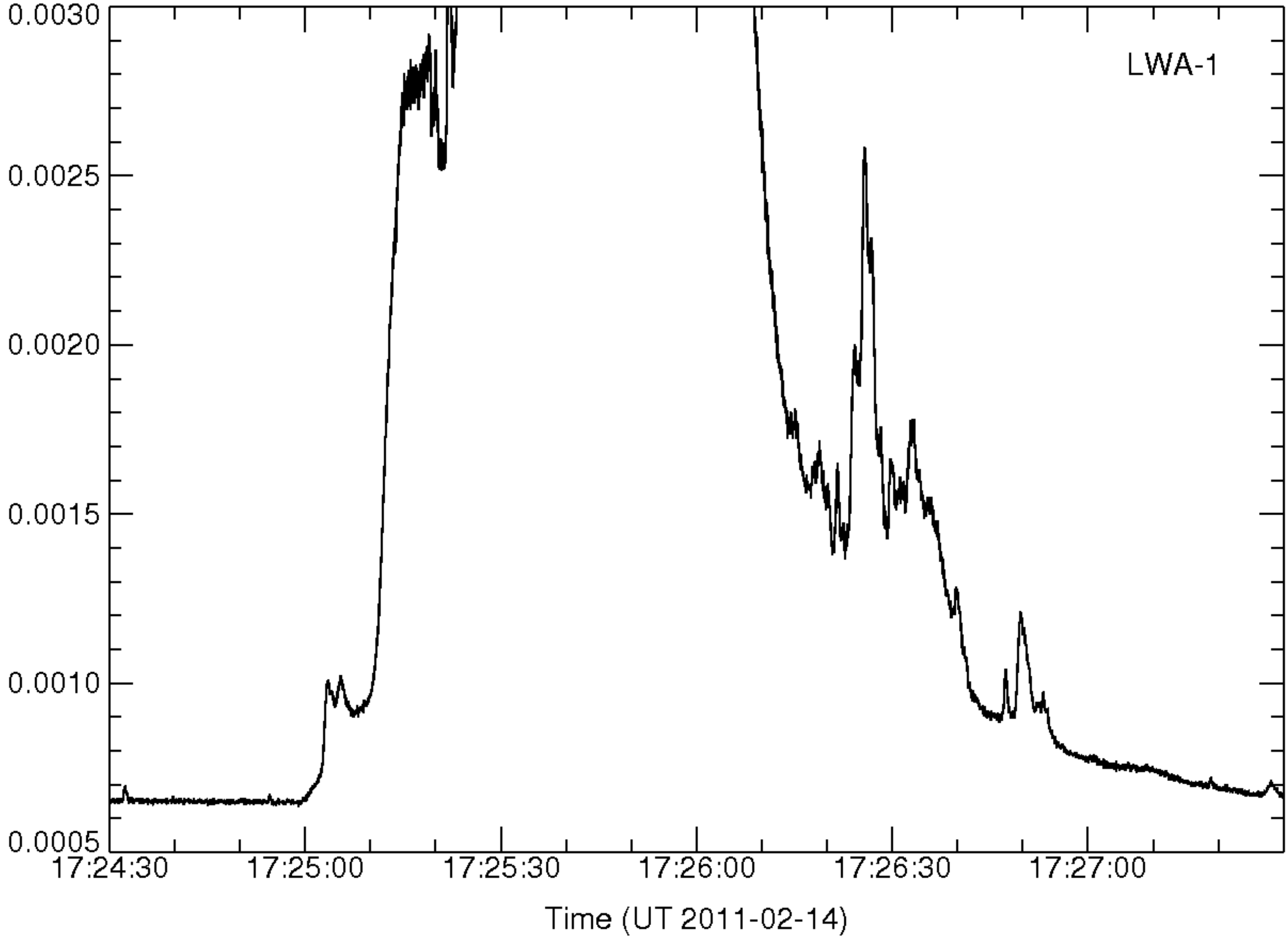
C flare with multiple type III bursts



Multiple IIIs



Low-level emission



Science with LWA-1 TBN data

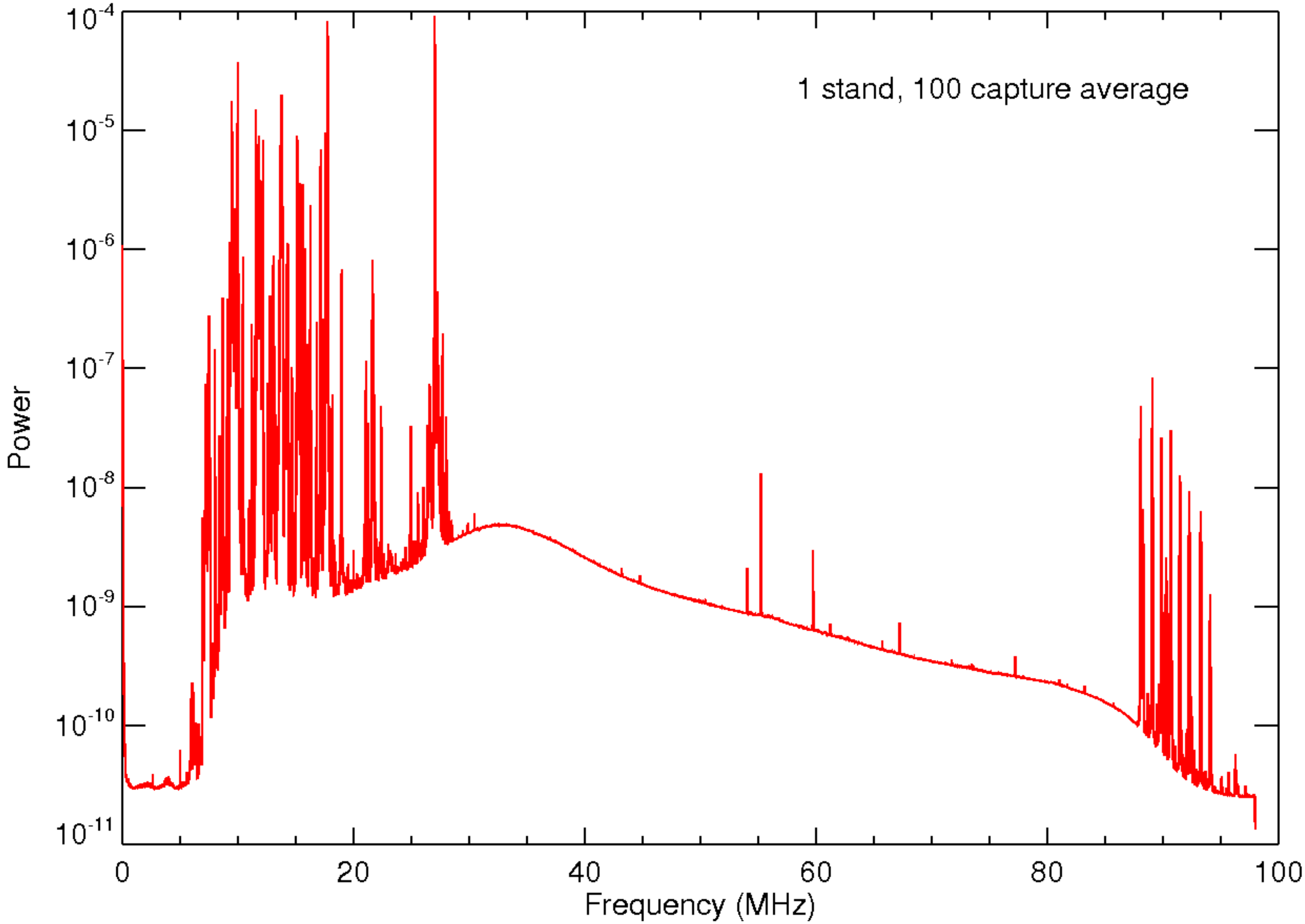
- TBN data provide basically rapid sampling of the waveform at a fixed frequency
- Big push by the Sydney group (Cairns, Robinson, Li) to interpret low-frequency plasma emission with "stochastic growth theory" (SGT): electron beams are not uniformly saturated but are dominated by density fluctuations in the medium, results in marginally unstable beams with very bursty emission.
- SGT predicts a log-normal distribution of intensities when averaged, power-law at high time resolution
- Complicated for coronal work by large sources and multi-path propagation

TBW data

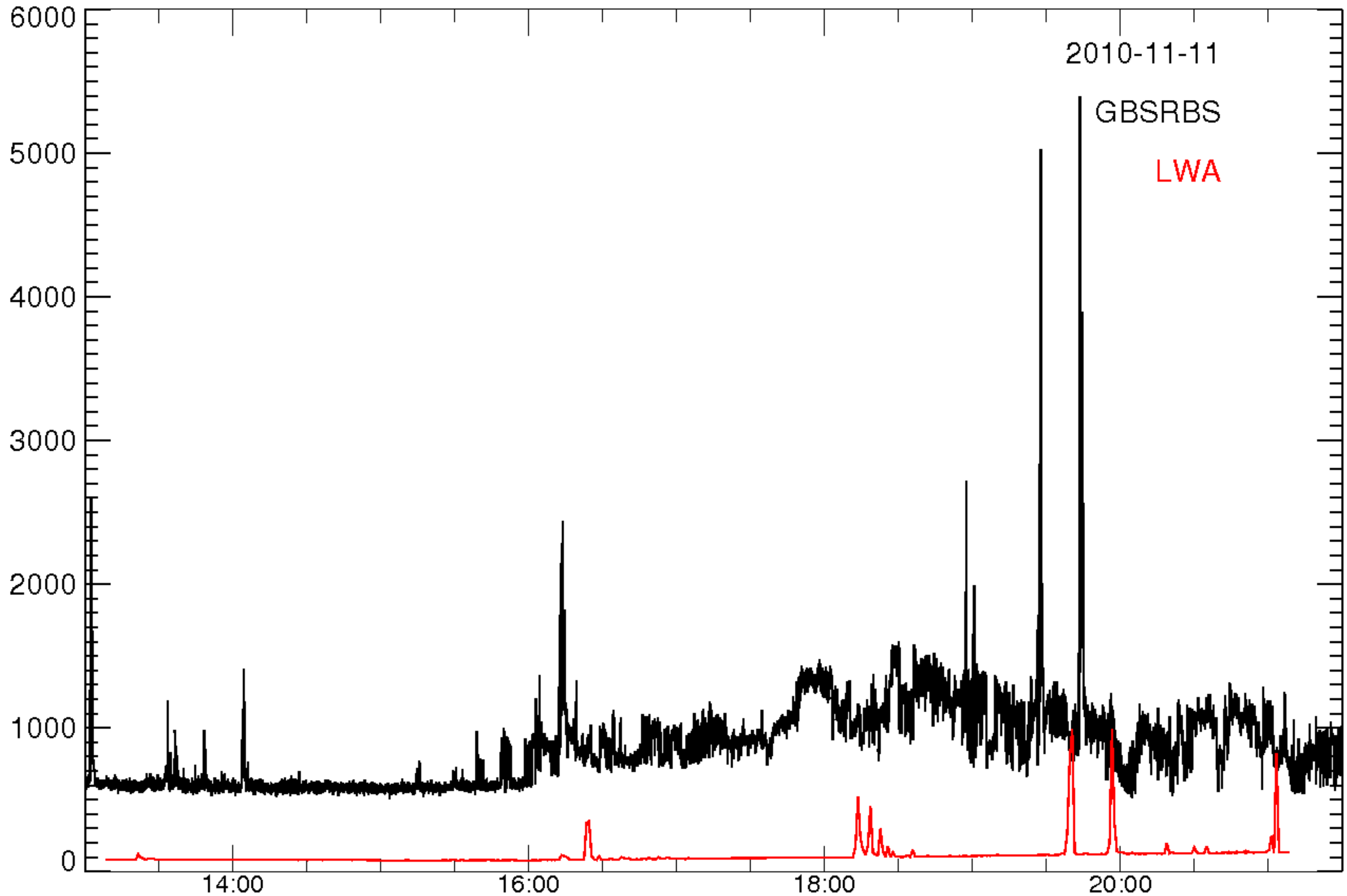
2010 Nov 11

(also 2010 Nov 10, 2011 Jan 21, 22)

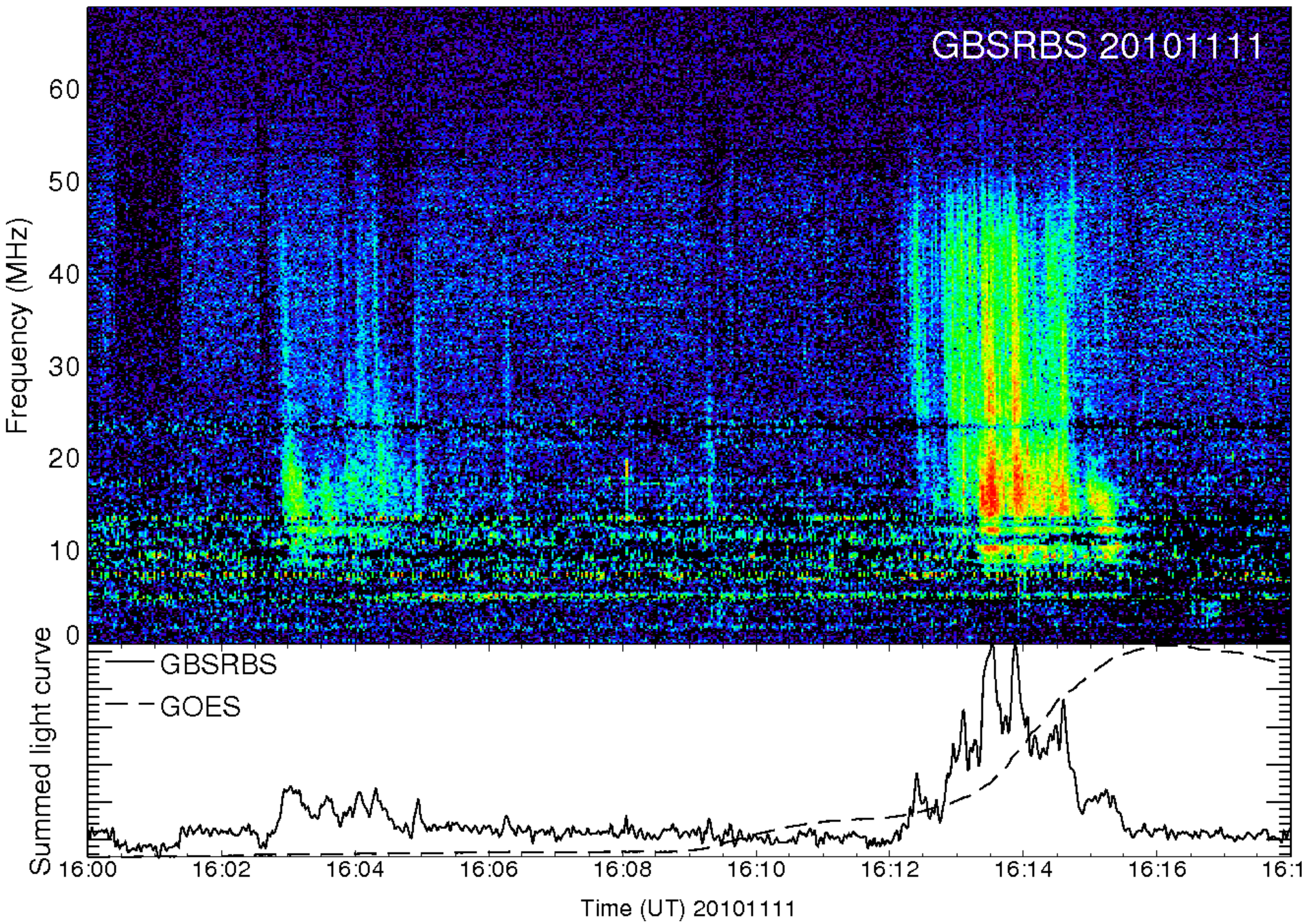
Normal TBW spectrum



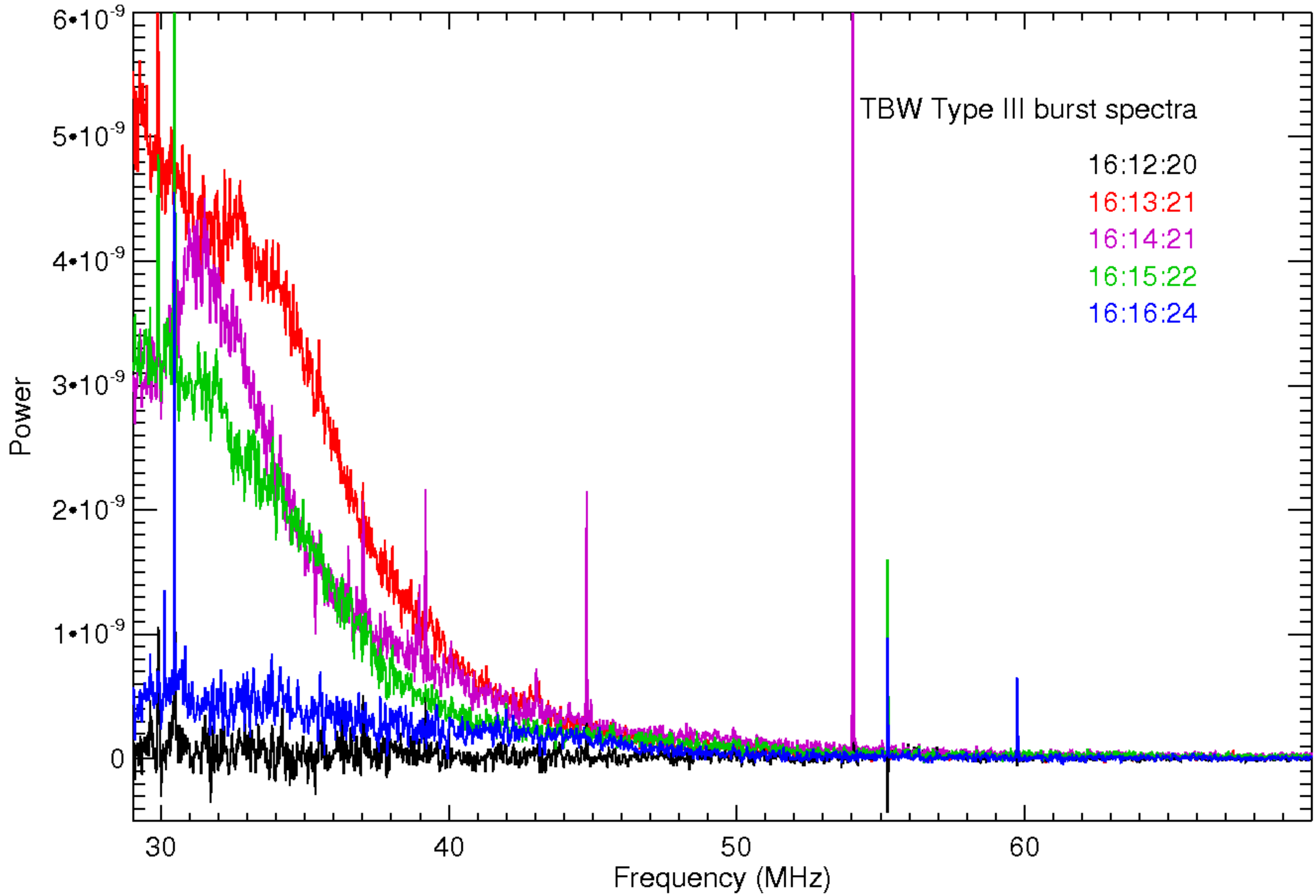
Timing issues

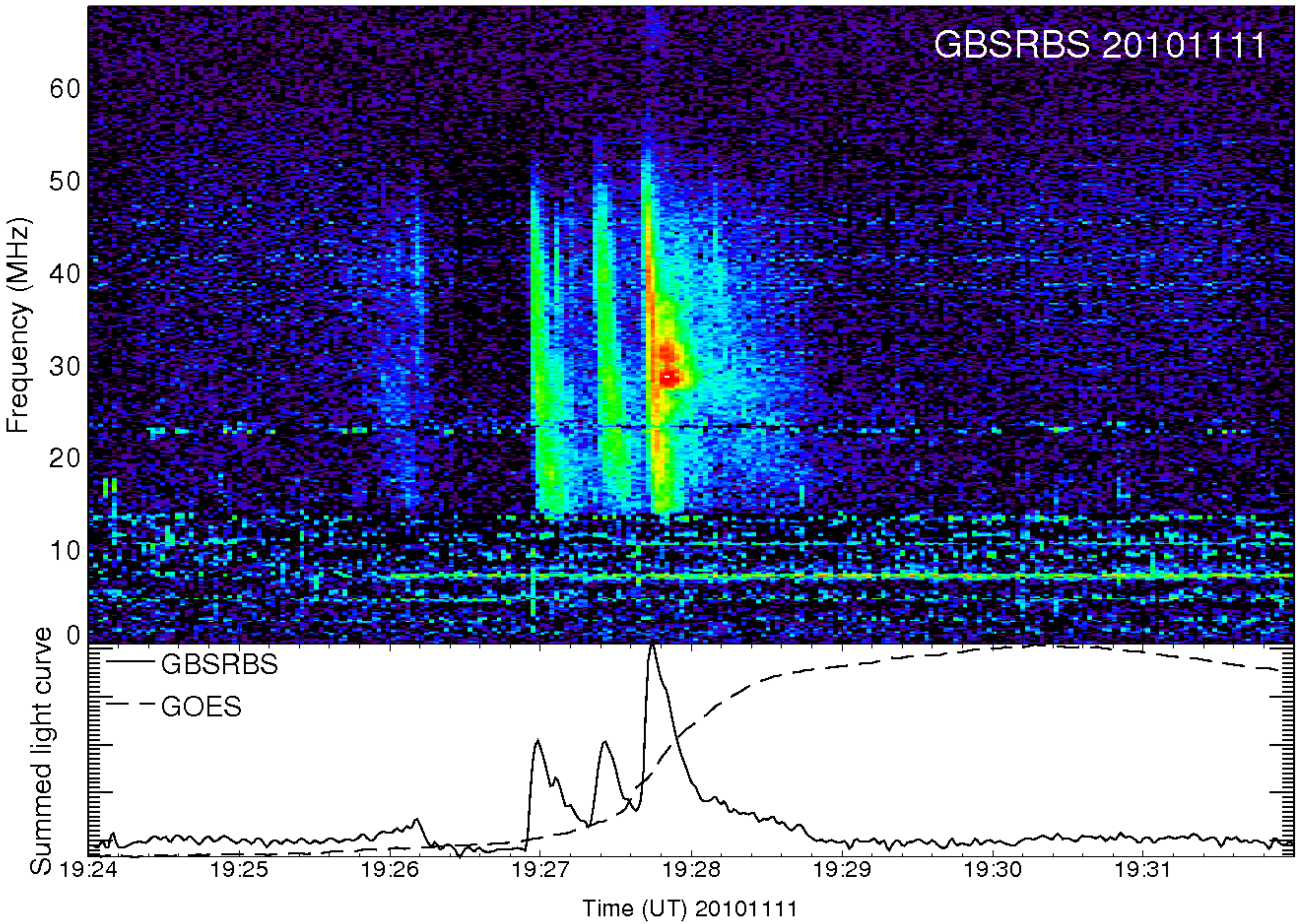


Cluster of Type IIIs



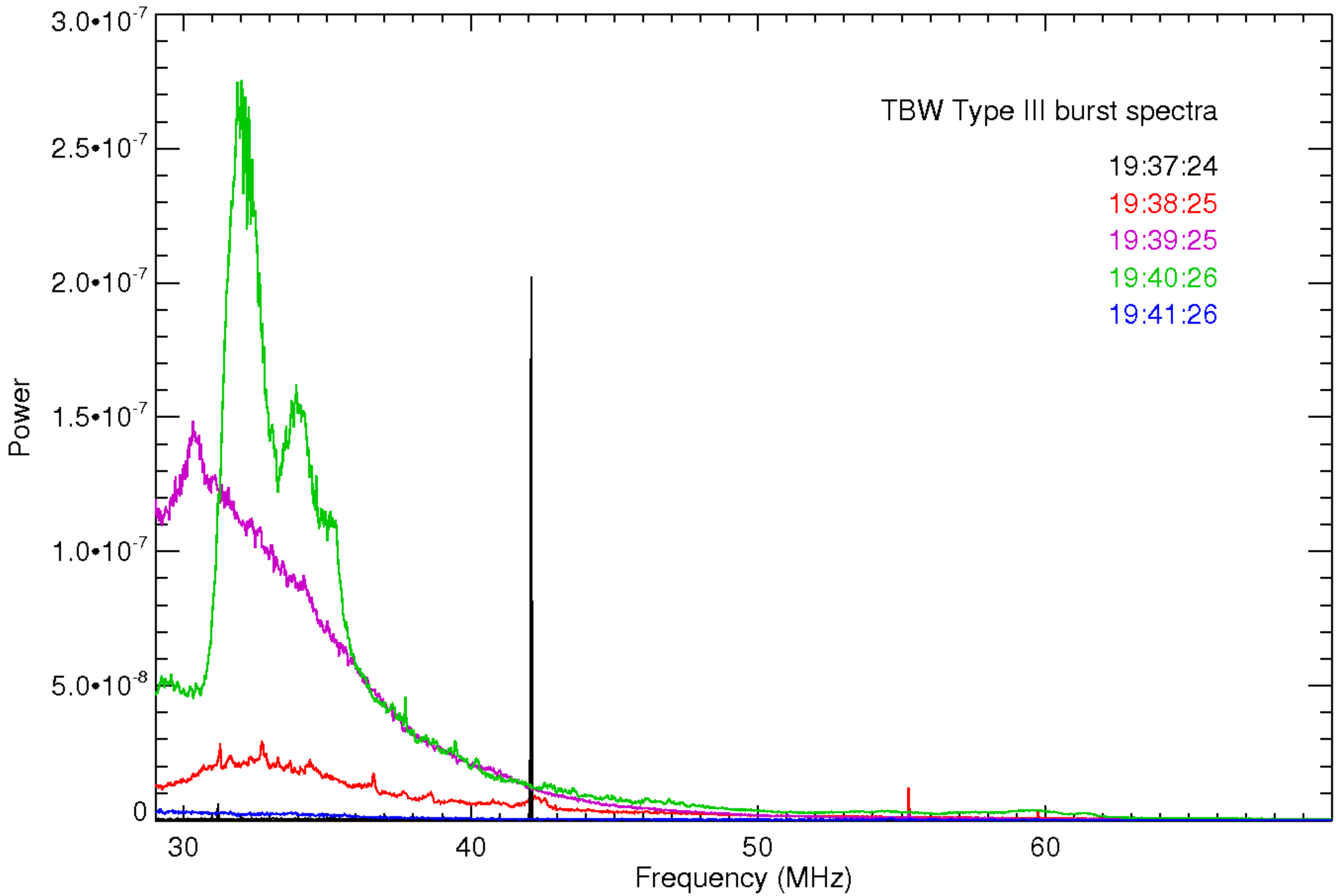
TBW spectra of Type IIIs





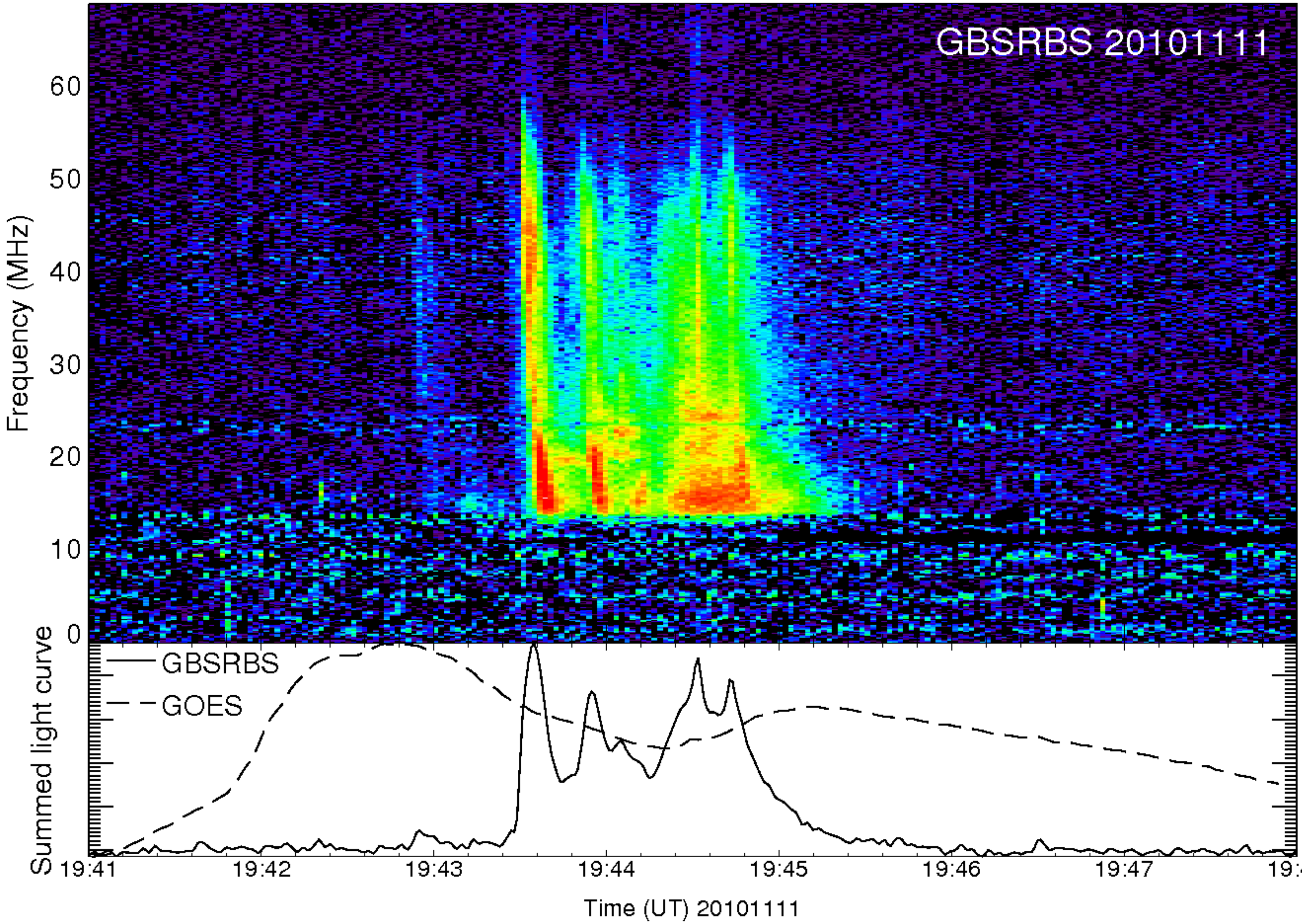
GBSRBS 20101111
Frequency (MHz)
60
50
40
30
20
10
0
Summed light curve
GBSRBS
GOES
19:24
19:25
19:26
19:27
19:28
19:29
19:30
19:31
Time (UT) 20101111

TBW spectra

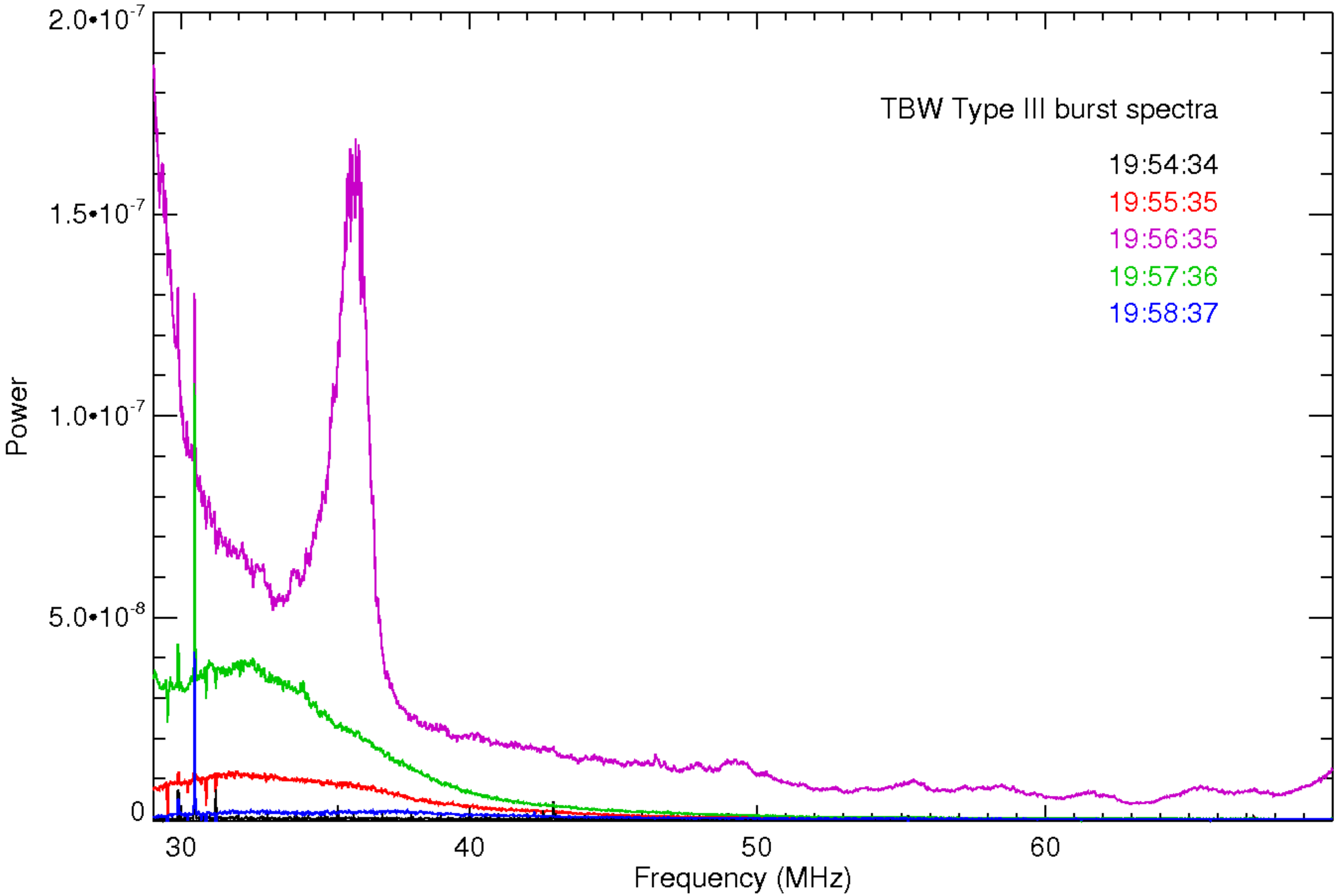


TBW Type III burst spectra
19:37:24
19:38:25
19:39:25
19:40:26
19:41:26
Power
Frequency (MHz)
3.0•10-7
2.5•10-7
2.0•10-7
1.5•10-7
1.0•10-7
5.0•10-8
0
30
40
50
60

Type IIIs with frequency structure



TBW spectra



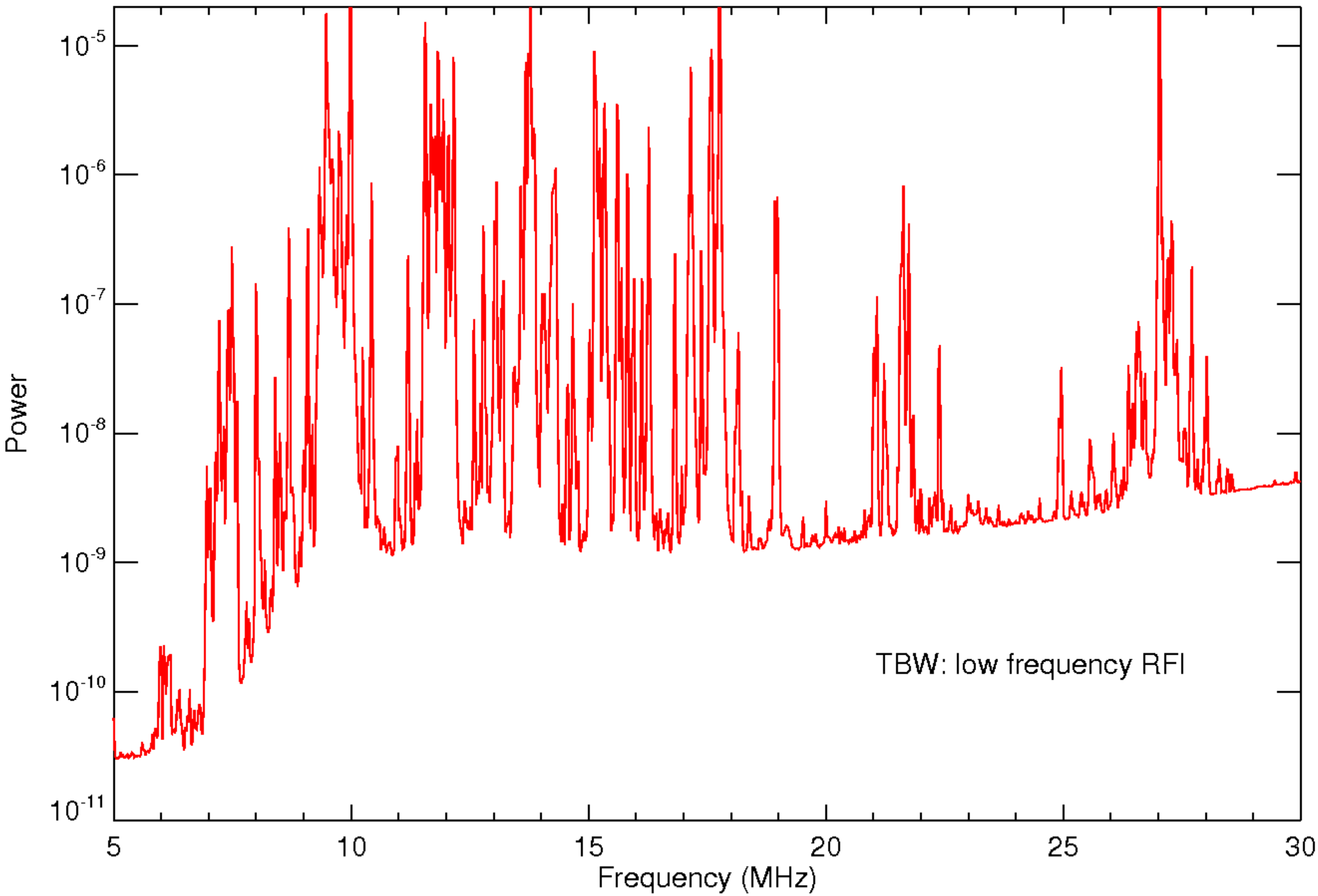
TBW Type III burst spectra
19:54:34
19:55:35
19:56:35
19:57:36
19:58:37
2.0•10^-7
1.5•10^-7
1.0•10^-7
5.0•10^-8
0
Power
30
40
50
60
Frequency (MHz)

Science with LWA-1 TBW data

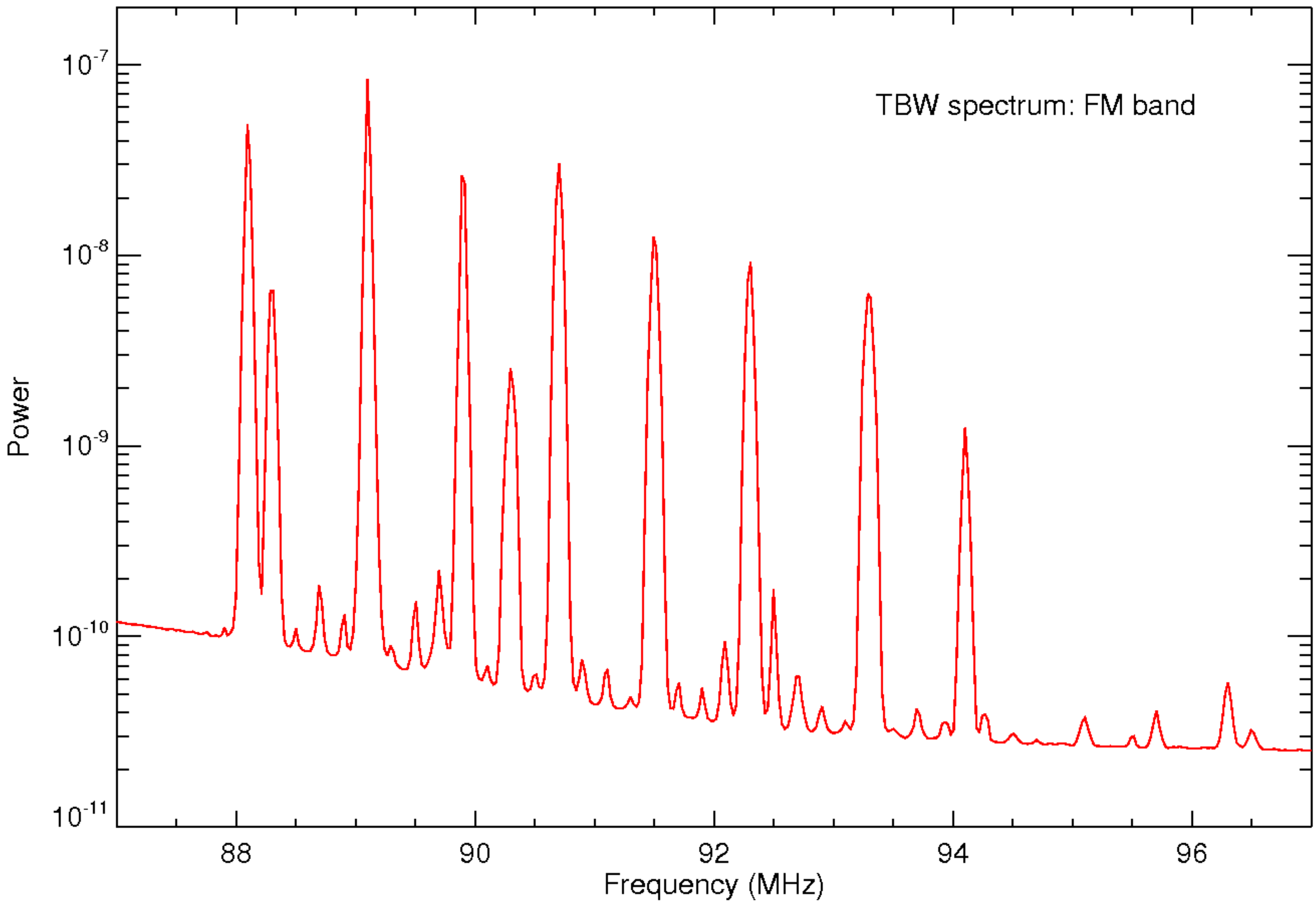
- TBW data provide snapshot spectra (60 msec) every minute: basically "luck" as to which portion of a burst you get
- What they do is confirm spectral structure that isn't always "believable" in dynamic spectra
- Existing data already indicate interesting structure: need to interpret in terms of coronal inhomogeneity and electron beam properties.

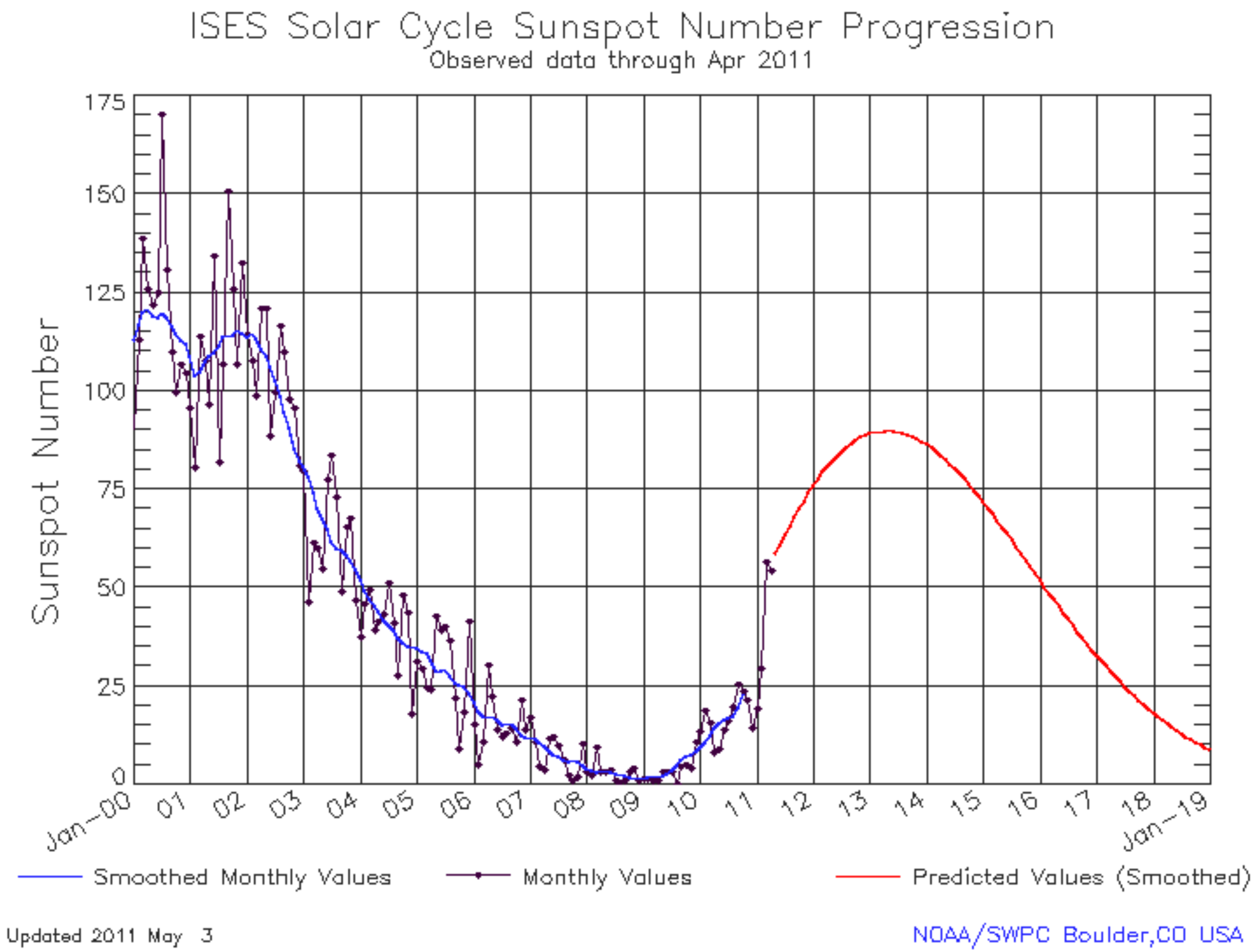
The

Low-frequency RFI



The FM band in the TBW spectrum




ISES Solar Cycle Sunspot Number Progression
Observed data through Apr 2011
Sunspot Number
175
150
125
100
75
50
25
0
Jan-00
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16
17
18
Jan-19
Smoothed Monthly Values
Monthly Values
Predicted Values (Smoothed)
Updated 2011 May 3
NOAA/SWPC Boulder,CO USA