Institute of cosmophysical research
and radio wave propagation FEB RAS

Simultaneous lithospheric-atmospheric signals of acoustic emission at “Karymshina” site in Kamchatka

Igor Larionov, Yuriy Marapulets,
Mikhail Mishchenko

ACOUSTIC
RESEARCHES
LABORATORY

Investigations of geoacoustic emission dynamics at the final stage of earthquake preparation have been carried out at IKIR FEB RAS since 1999. During the investigation the acoustic-emission effect was discovered. It consists in the increase of geoacoustic emission intensity in the frequency range from hundreds of hertz to the first tens of kilohertz during rock massive deformation rate increase. It was shown that the effect manifests the most clearly in the earthquake preparation zone 1–3 days before a seismic event and is generated by geomechanics stress field change as a result of the transformation: stress – near-surface rock deformation.

One of the further directions of the investigation in this area is the consideration and confirmation of the possibility of output of the acoustic emission preceding earthquakes into the atmosphere. In view of this, complex lithospheric-atmospheric investigations of acoustic emission have been carried out at IKIR FEB RAS since 2015. To make such monitoring, we use a laser strainmeter-interferometer, a geophone, wide-band acoustic system and a microbarometer. Rock deformation, acoustic emission in the near-surface rocks and in the atmosphere by the ground surface are under the study.

Initially, in the course of the investigations it was shown that P and S waves from earthquakes enter the atmosphere and are recorded above the ground surface.

The investigations are carried out at Karymshina site, IKIR FEB RAS (52.83º N, 158.13º E), located in the zone of different-rank tectonic faults.

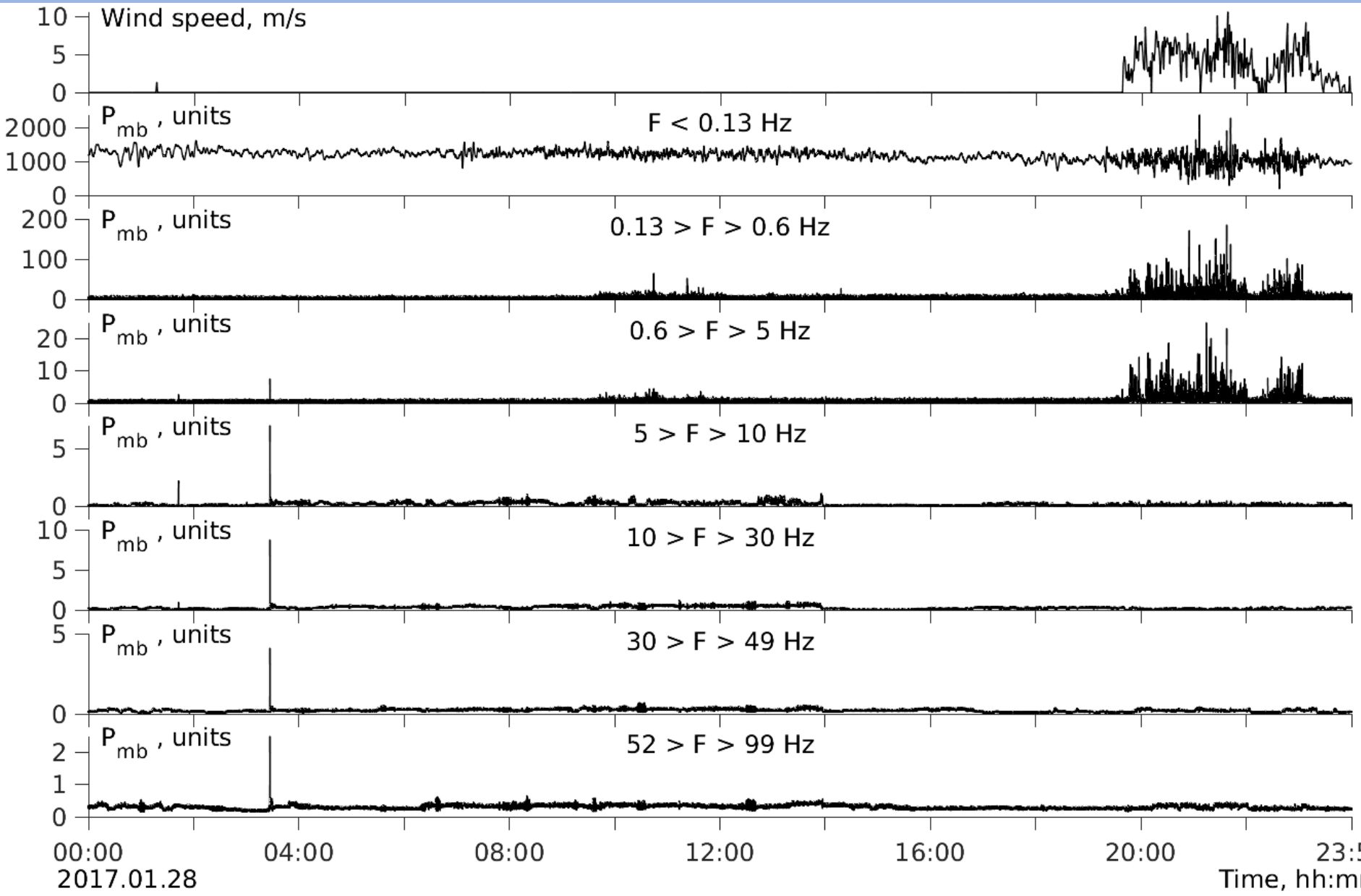
Equipment

1. Laser strainmeter-interferometer is used to record local deformation process in sedimentary rocks

2. Three-component piezoceramic geophone, it was mounted on the streinmeter optical bench end surface, It converts acoustic signals into electric voltage proportional to oscillatory acceleration

3. System of four piezoceramic hydrophones is used for high-frequency geoacoustic measurements

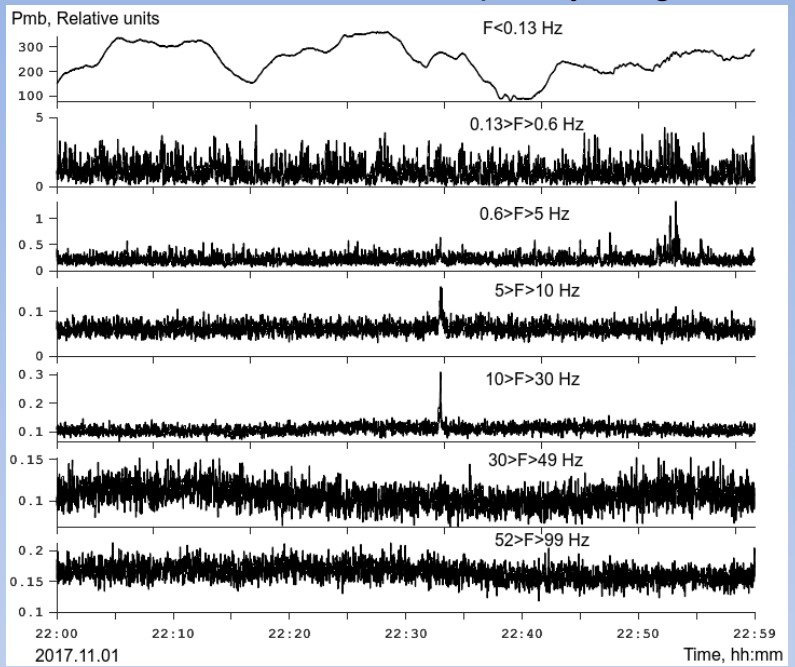
4. Microbarometer ISGM-03M is used to measure atmospheric acoustic emission



Wind speed and microbarometer data in the frequency ranges

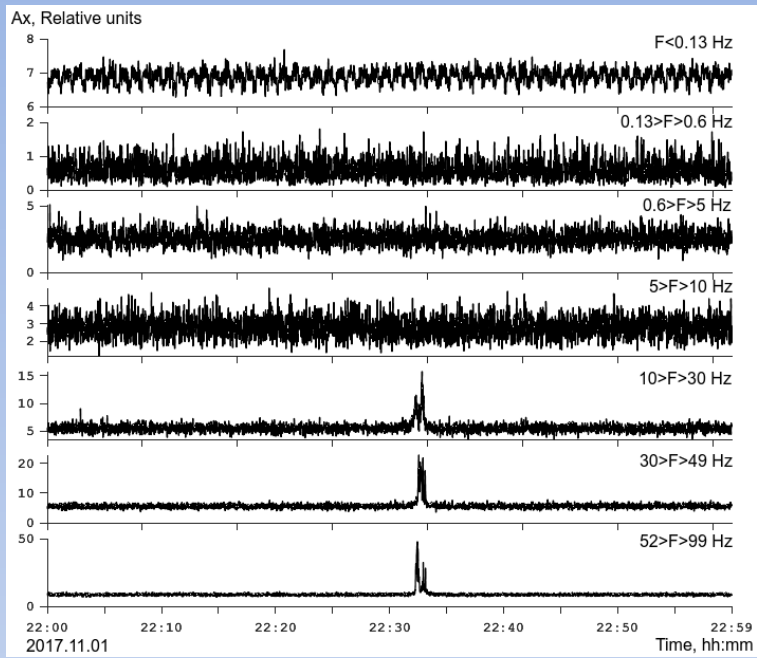
microbarometer data in the frequency ranges

a)



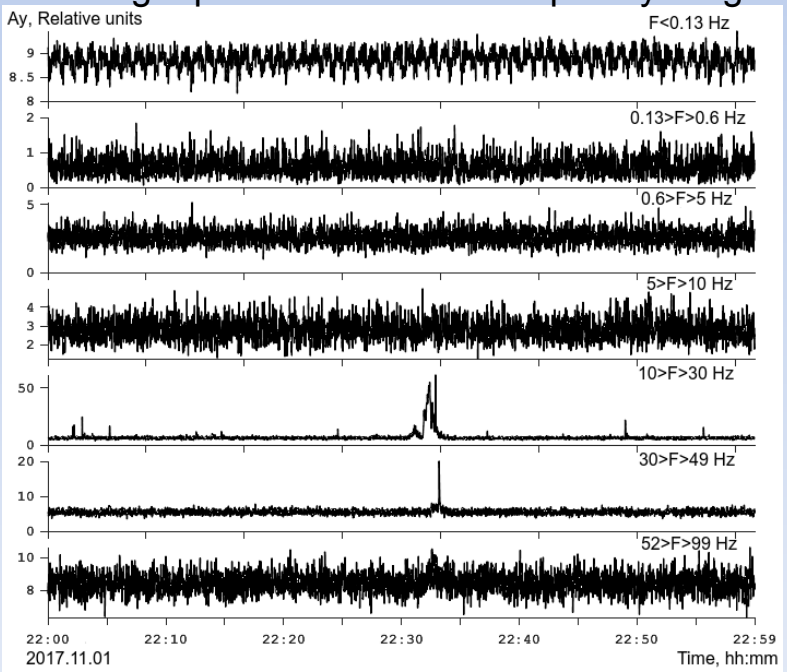
X-component of geophone data in the frequency ranges

b)



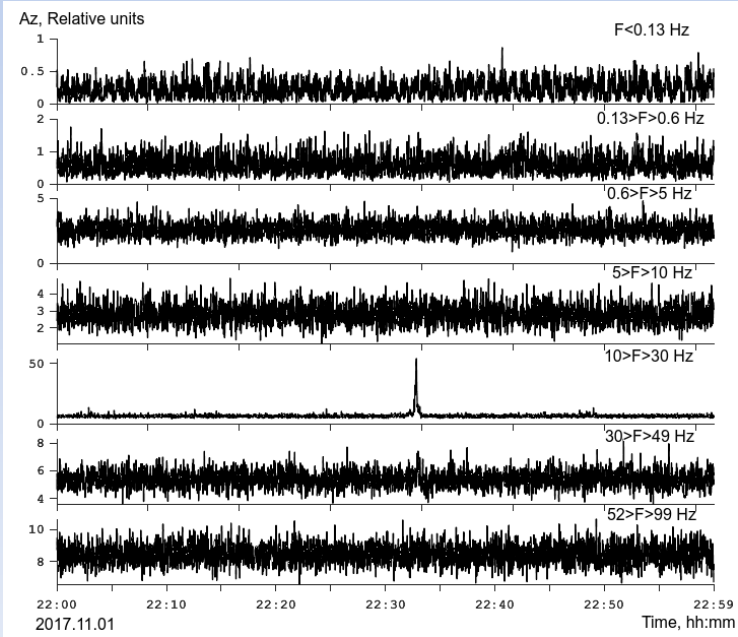
Y-component of geophone data in the frequency ranges

c)

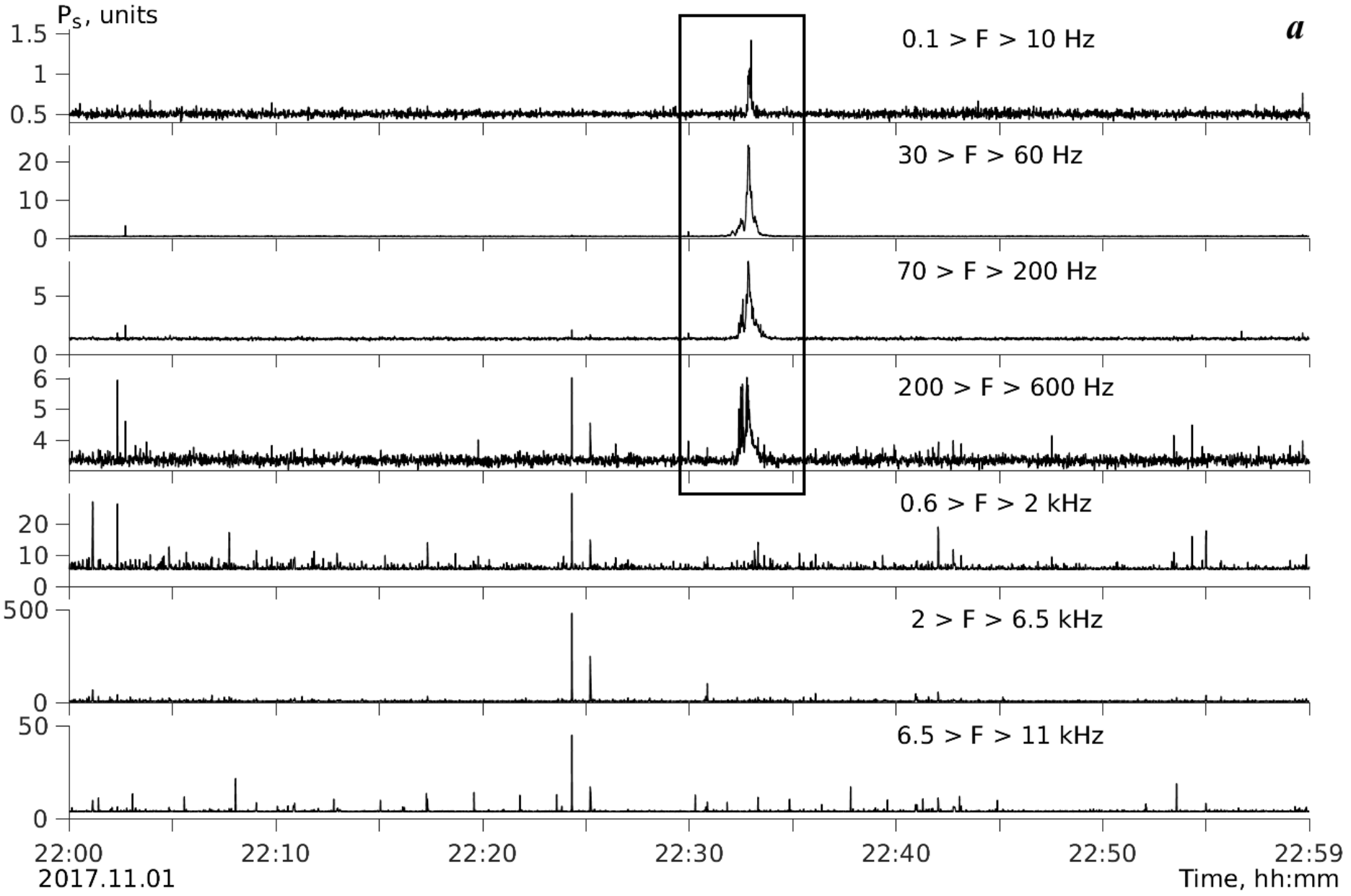


Z-component of geophone data in the frequency ranges

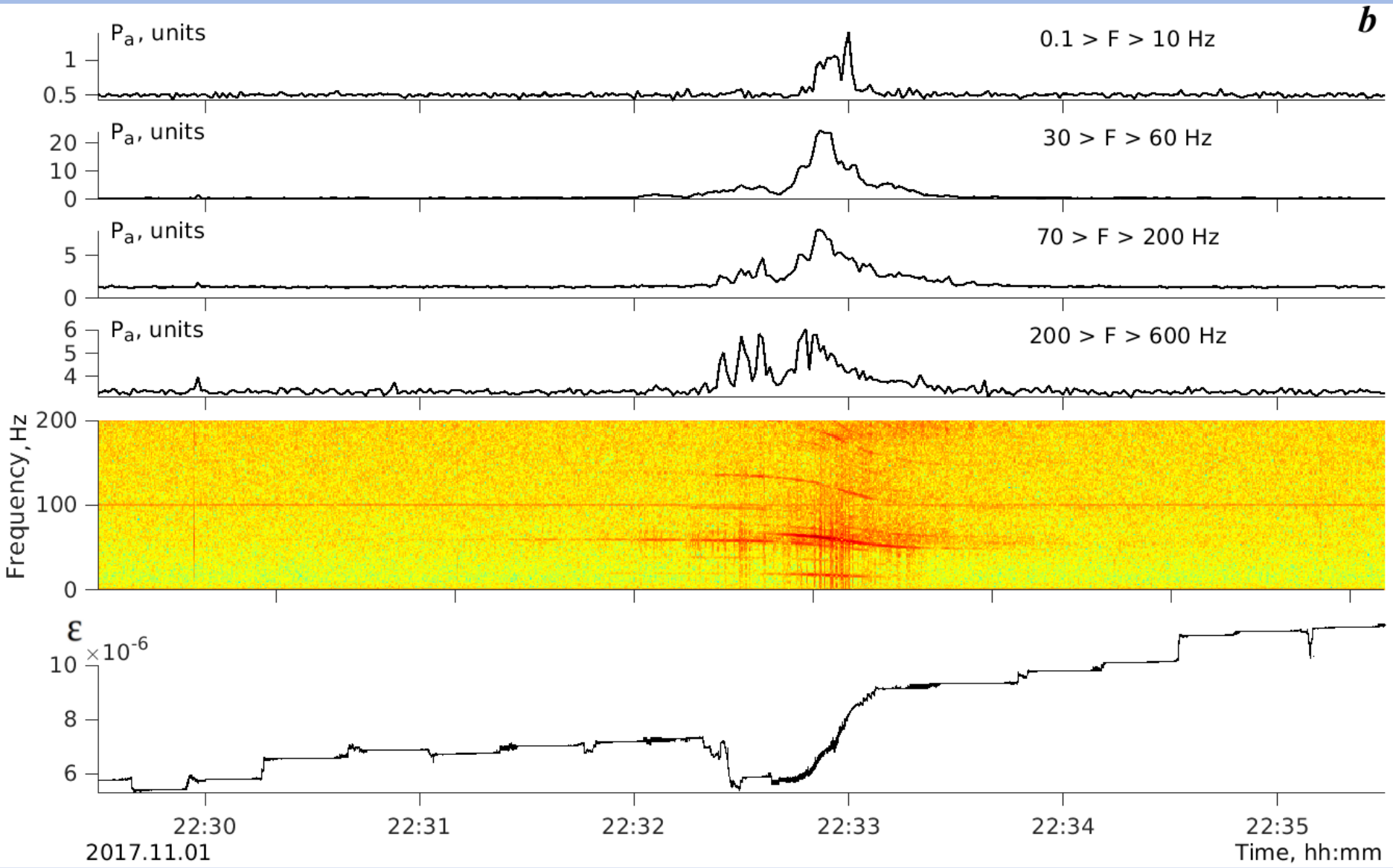
d)



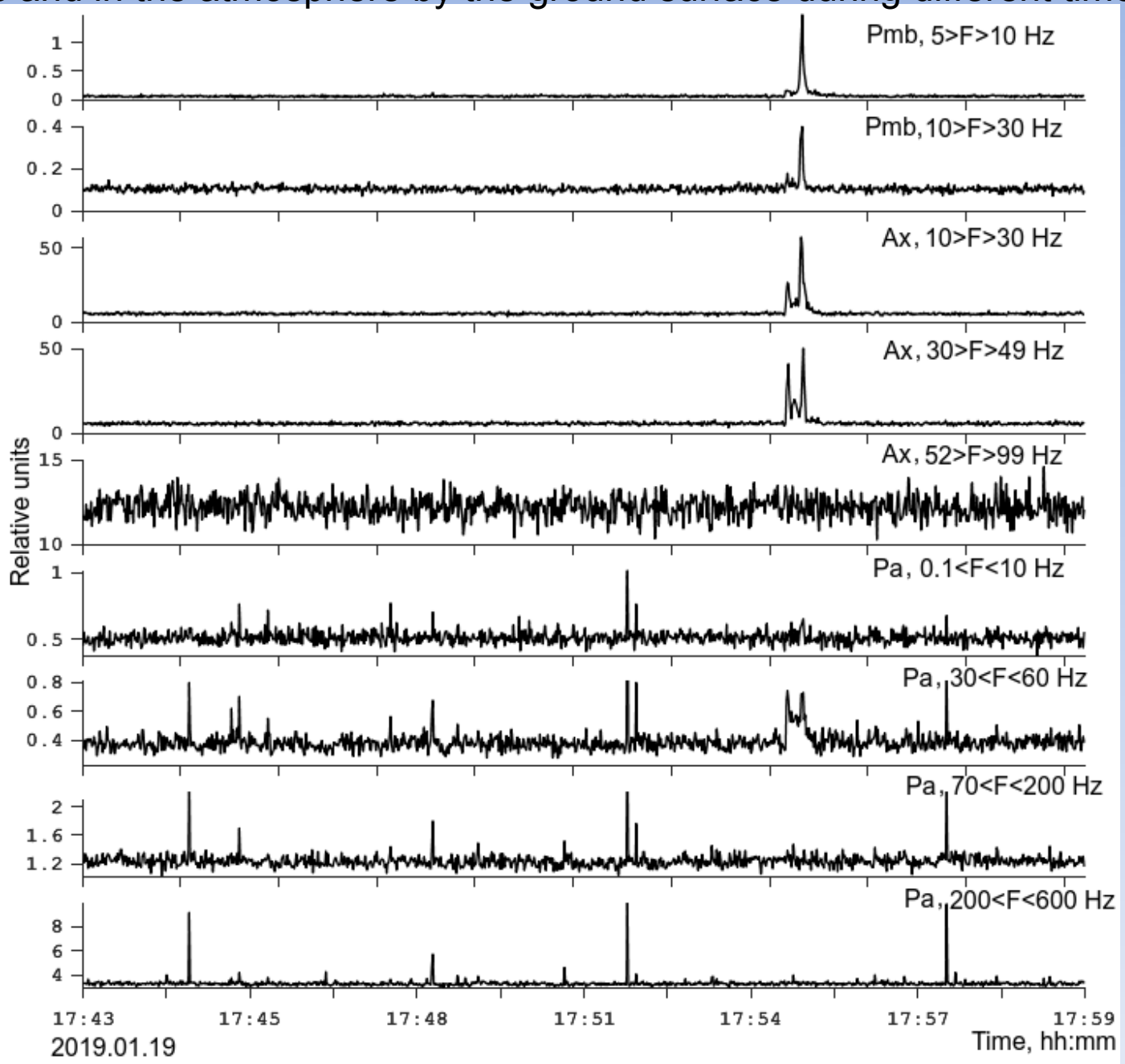
High-frequency geoacoustic system data, the disturbances are recorded by the hydrophone in the frequency ranges

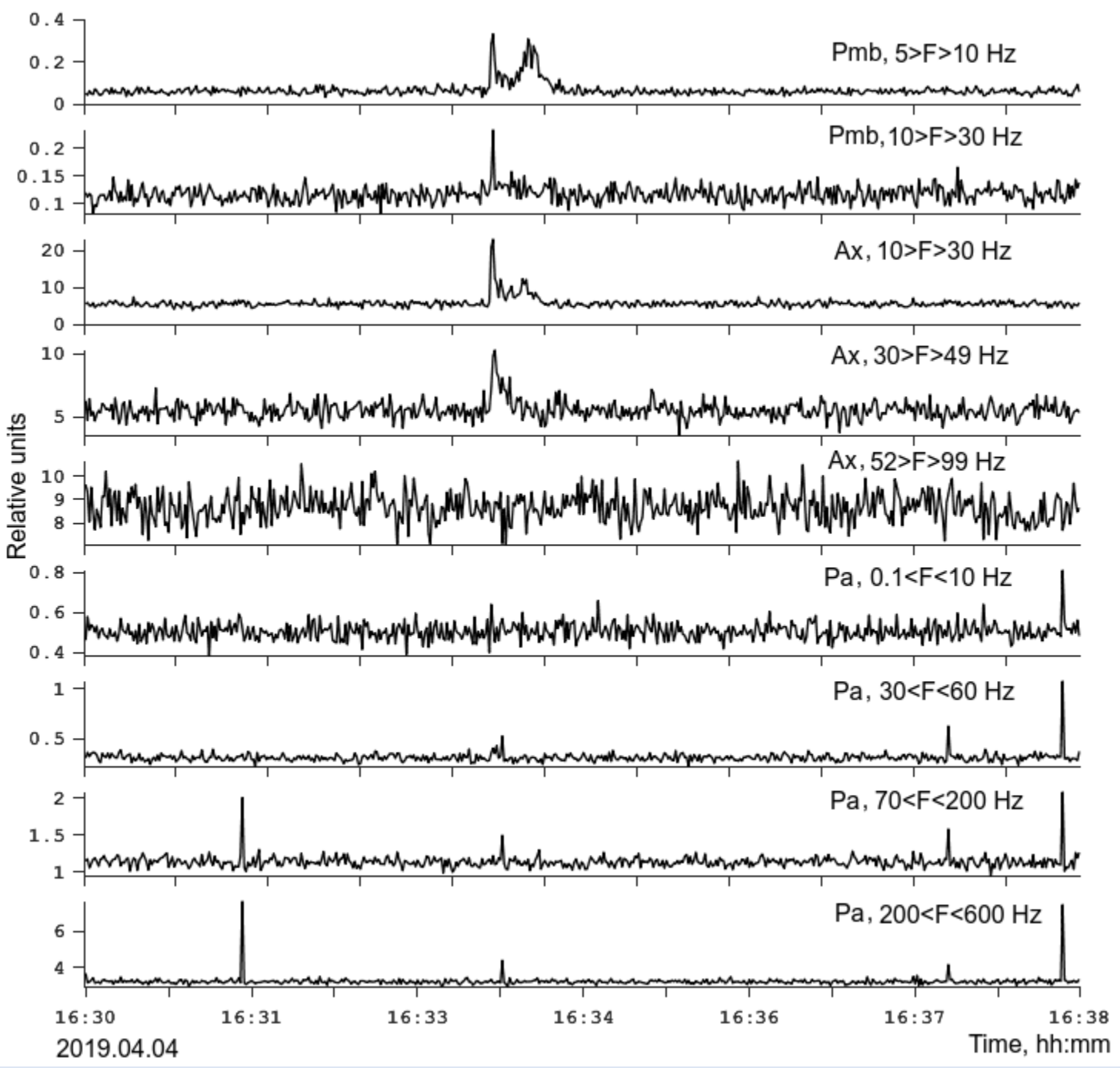


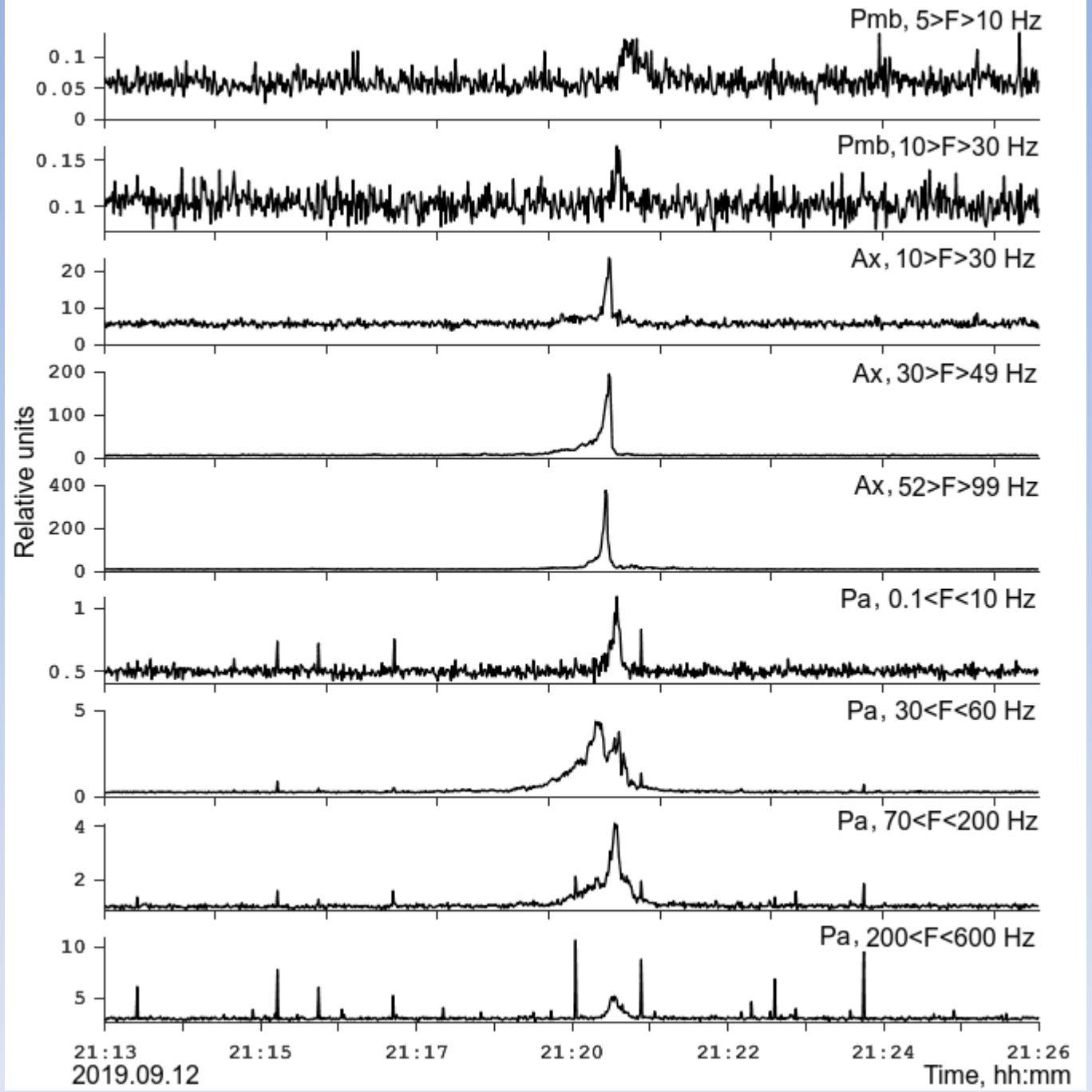
Deformations generating those signals are recorded both in wide-band data of high-frequency acoustic system and by the strainmeter-interferometer



examples of simultaneous records of acoustic signal disturbances in the near-surface rocks and in the atmosphere by the ground surface during different time periods




Pmb, 5>F>10 Hz
Pmb,10>F>30 Hz
Ax, 10>F>30 Hz
Ax, 30>F>49 Hz
Ax, 52>F>99 Hz
Pa, 0.1<F<10 Hz
Pa, 30<F<60 Hz
Pa, 70<F<200 Hz
Pa, 200<F<600 Hz
Relative units
16:30
16:31
16:33
16:34
16:36
16:37
16:38
2019.04.04
Time, hh:mm


Pmb, 5>F>10 Hz
0.1
0.05
0
Pmb, 10>F>30 Hz
0.15
0.1
Ax, 10>F>30 Hz
20
10
0
Ax, 30>F>49 Hz
200
100
0
Ax, 52>F>99 Hz
400
200
0
Relative units
Pa, 0.1<F<10 Hz
1
0.5
Pa, 30<F<60 Hz
5
0
Pa, 70<F<200 Hz
4
2
Pa, 200<F<600 Hz
10
5
21:13
21:15
21:17
21:20
21:22
21:24
21:26
2019.09.12
Time, hh:mm

Conclusions

Thus, as the result of long-term lithospheric-atmospheric observations in the seismically active region, it was shown that acoustic emission in the range of units-tens of Hz occurs in the near-surface sedimentary rocks during deformation intensification. It penetrates into the atmosphere and is recorded by the ground surface. Such emission is not affected significantly by season or time of a day. Further direction of the investigation is the detection of possible relation between geoacoutic emission penetrating into the atmosphere and activation of seismotectonic process in the region.

The investigation is of interest for constructing a model of lithospheric-atmospheric relation in the seismically active region.

Thank you for your attention

The work was carried out as part of the implementation of the state task
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