SnT 2021
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

CTBTO
PREPARATORY COMMISSION

Infrasound processing at Romanian NDC using NDC-in-a-Box

Daniela Ghica

INFP

Infrasound processing at Romanian NDC using NDC-in-a-Box

Daniela Ghica, daniela@infp.ro, National Date Centre/National Institute for Earth Physics

PTS/CTBTO Technical Assistance

➢ NDC Software — NDC-in-a-Box SHI Software Package

➢ PTS Training

- *Intermediate Level Infrasound Data Analysis Training* (15 to 19 July 2019, Bucharest, Romania)
- *NDC Advanced Training on Infrasound Data Analysis* (14 to 18 October 2019, Bruyères-le-Châtel, France)

➢ PTS expertise sharing — Valuable technical advices received from the PTS staff

Infrasound processing at Romanian NDC using NDC-in-a-Box

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NDC-in-a-Box Virtual Machine

Data Processing

Run DTK-PMCC in automatic mode from command line (Python scripts)

- detection lists (one-day bulletins)
- results (one-day NetCDF4 files)

Results Analysis

DTK-GPMCC 6.3.0
visualize the detections in results file

- Interactively display/check results

DTK-DIVA 3.4.3
visualize the detections in bulletin files

- Identify and characterize sources of coherent noise/typical sources (station detection background): microbaroms, industrial noise, aircraft activity etc.
- Identify detections of interest, i.e., special infrasound source, occasionally detected at station: accidental explosions, exploding meteorites, volcanic eruptions etc.
- Recognize station detection patterns (diurnal, weekly, seasonal)

Infrasound processing at Romanian NDC using NDC-in-a-Box

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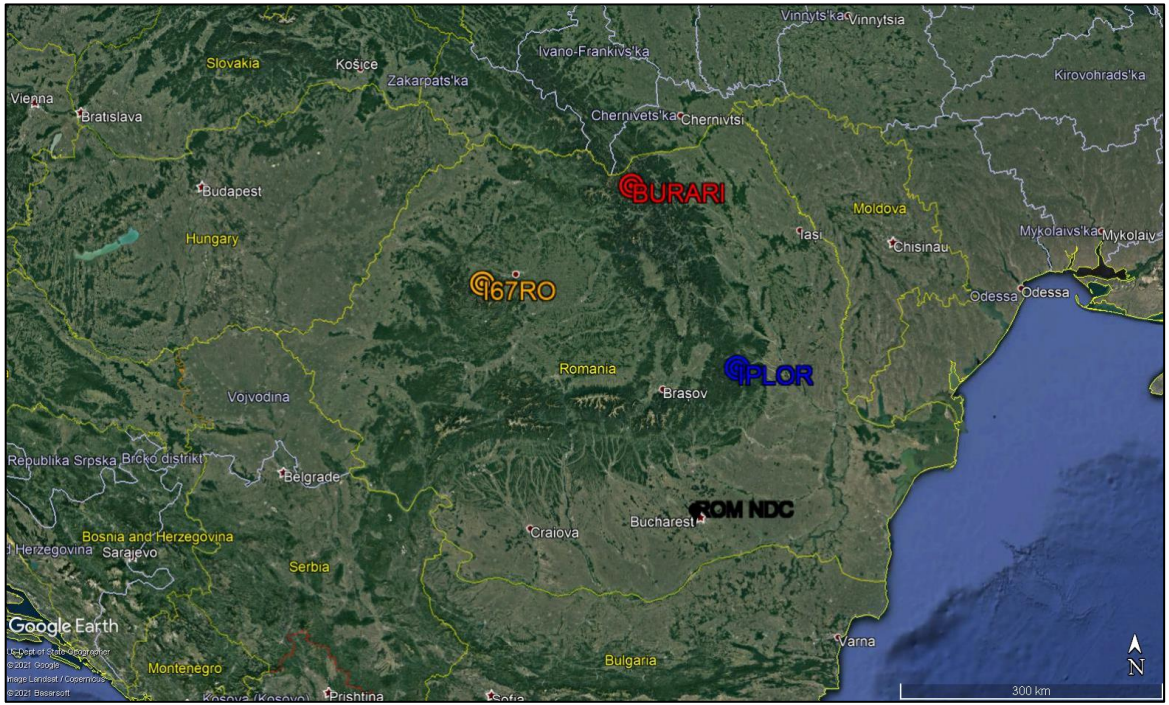
Infrasound stations in Romania



Code	Location	No. of elements	Aperture (km)	Operation period	Status
IPLOR	Plostina, Vrancea County	6	2.5	May 2009 – November 2018	Permanent
		4	0.5	December 2019 – Now	
BURARI	Benea, Suceava County	4	1.2	July 2016 – September 2019	Temporary
		6	0.7	September 2019 – Now	Permanent
I67RO	Marisel, Cluj County	4	0.9	September 2016 – October 2018	Temporary

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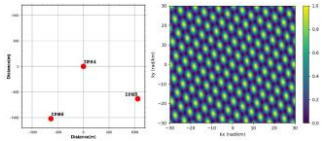
IPLOR infrasound array

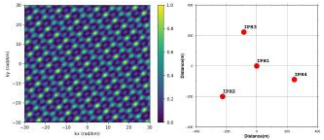


28/05/2009 **IPH4, IPH5, IPH6**

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019

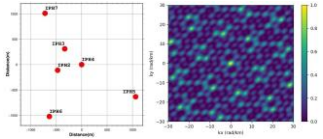
23/04/2010

IPH4, IPH5, IPH6, IPH7



23/08/2012

IPH4, IPH5, IPH6, IPH7, IPH2, IPH3



06/11/2018

6-element array has been discontinued

07/11/2018 - 12/12/2019

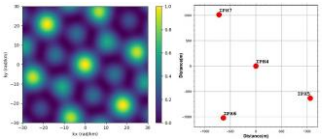
New 4-element array designing

13/12/2019

New 4-element array deployment

13/12/2019

IPH1, IPH2, IPH3, IPH4



Infrasound processing at Romanian NDC using NDC-in-a-Box

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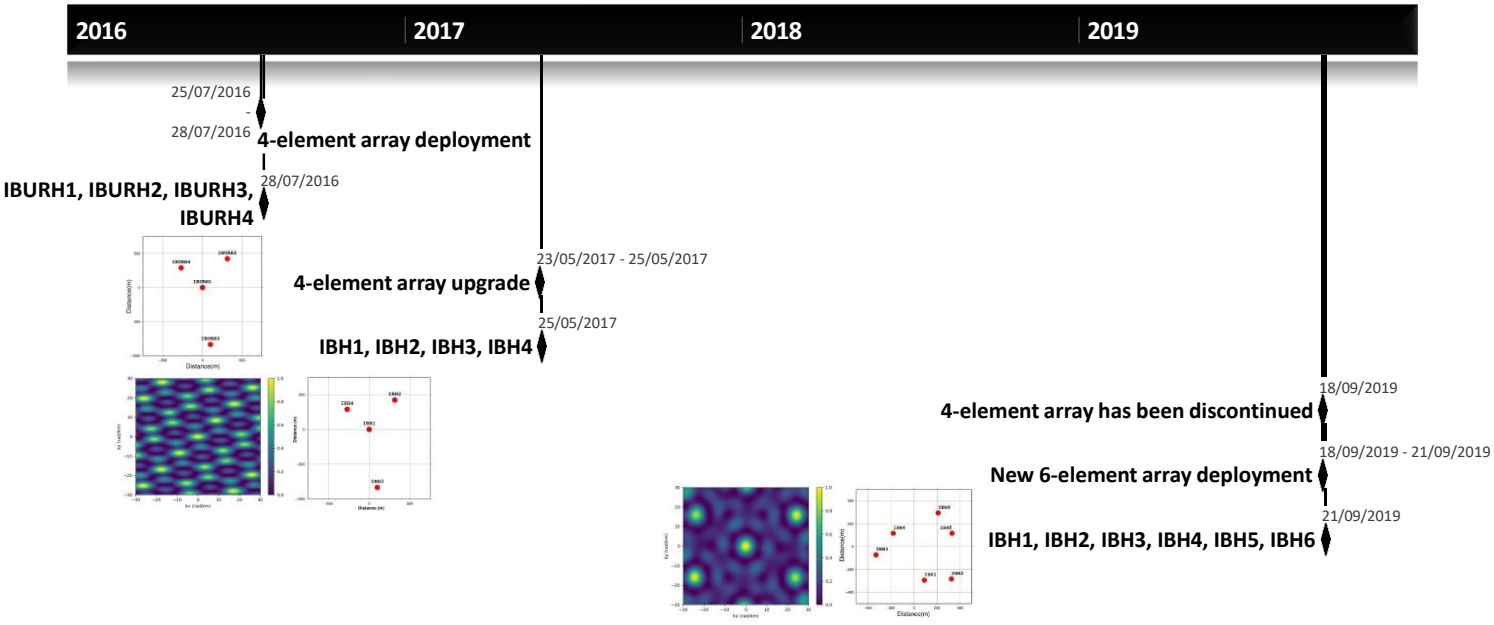
BURARI infrasound array



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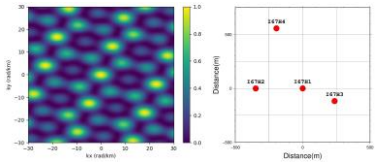
I67RO infrasound array

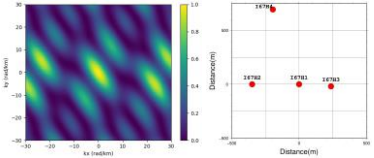
2016 | **2017** | **2018**

26/09/2016 - 28/09/2016 **4-element array deployment**

28/09/2016 **I67H1, I67H2, I67H3, I67H4**



15/06/2017 **Relocation of I67H1 element**



17/10/2018 **4-element array removal from the site**

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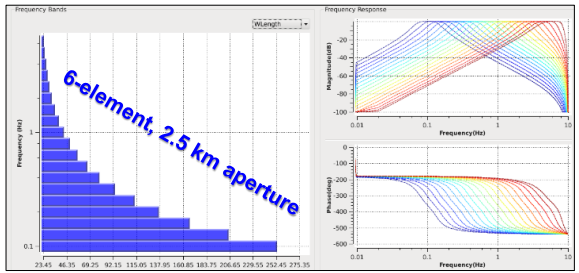
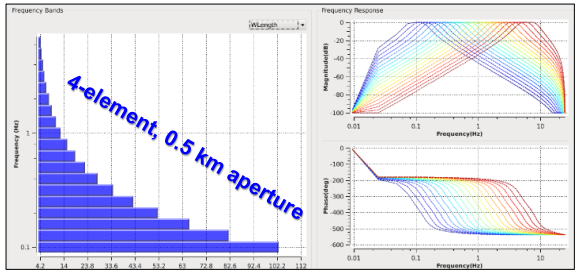
Infrasound data processing

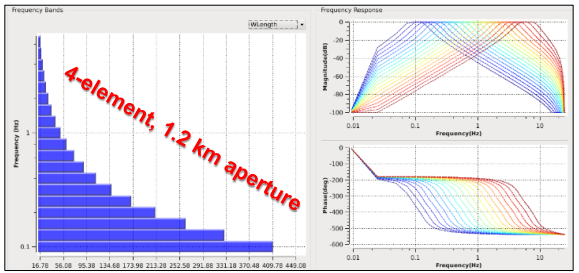
Infrasound data are automatically processed at the Romanian NDC by running PMCC detector (DTK-PMCC) using ***one-third octave band scheme:*** 19 log spaced frequency bands (center frequencies between 0.1 Hz and 6.0 Hz); time window lengths vary proportionally with array aperture

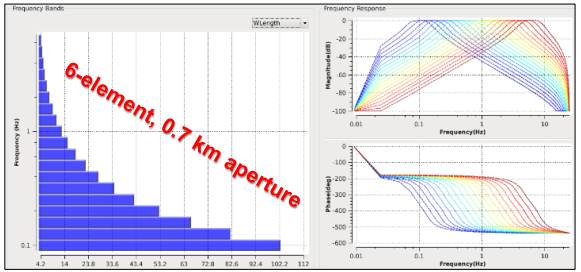
IPLOR array



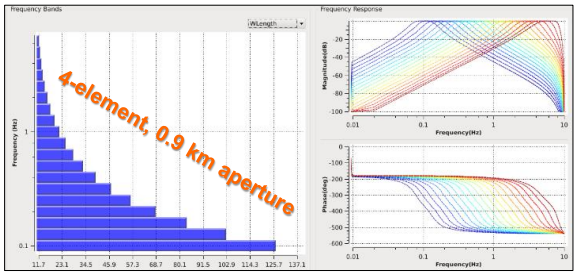


BURARI array





I67RO array



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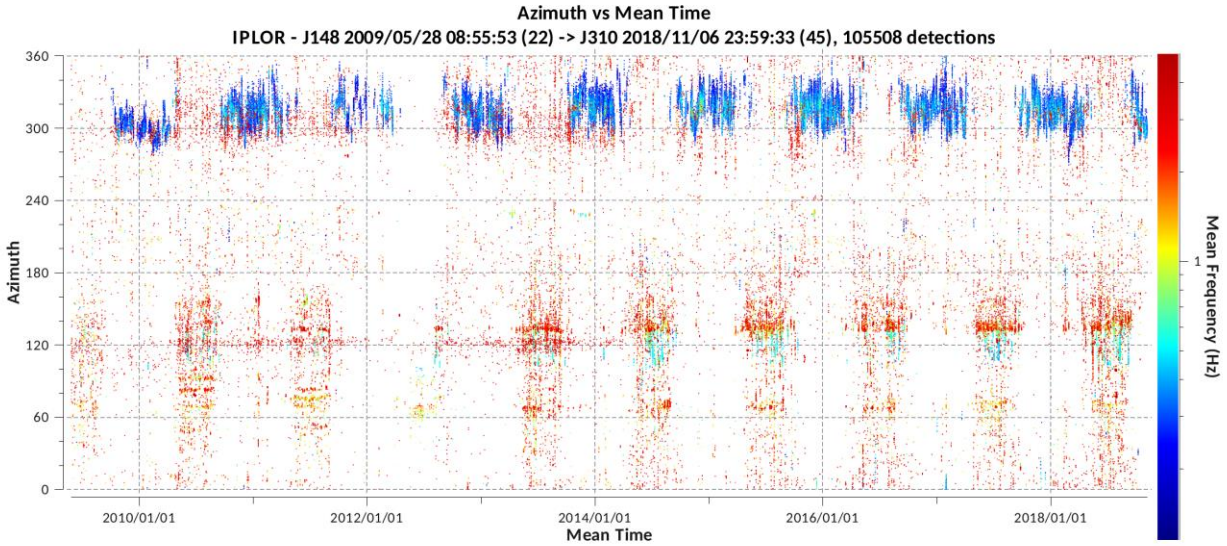
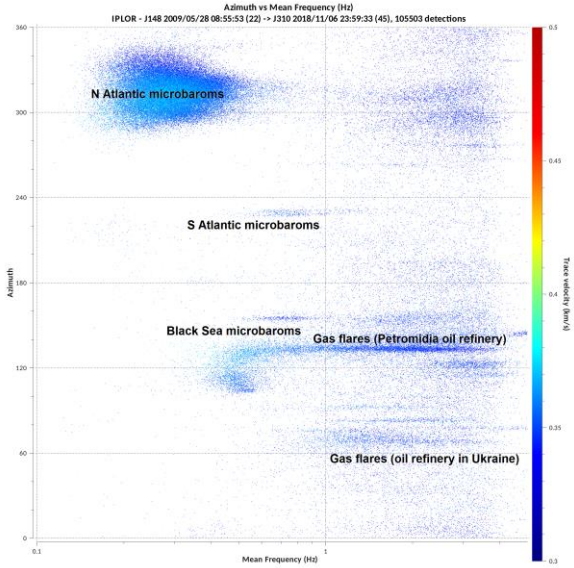
Infrasound detections analysis

IPLOR 6-element array, 2.5 km aperture



PMCC detection results



Main sources of coherent noise

Infrasound processing at Romanian NDC using NDC-in-a-Box

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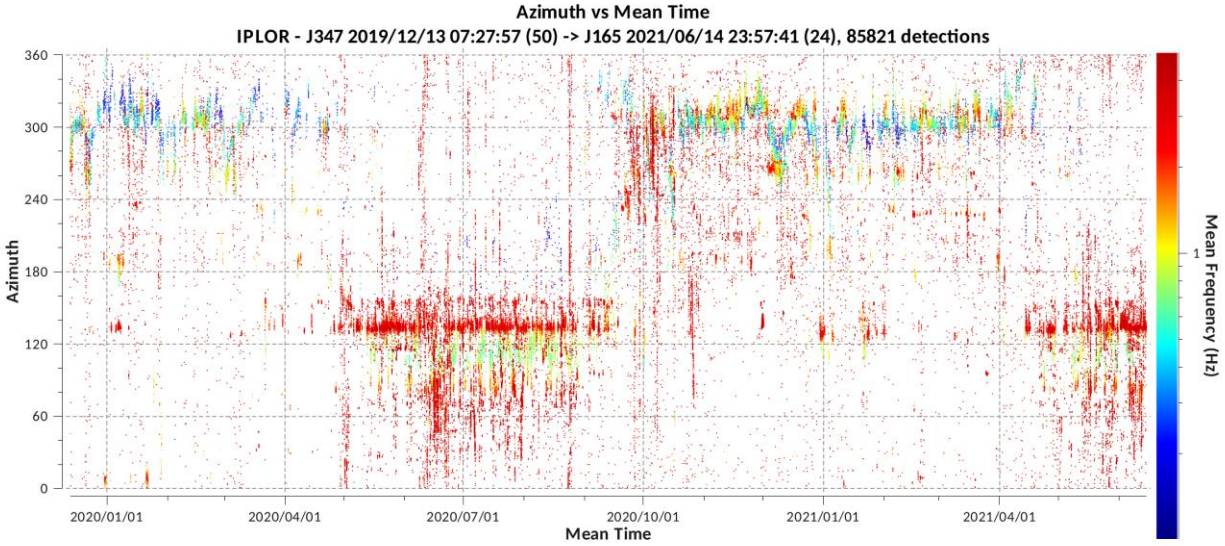
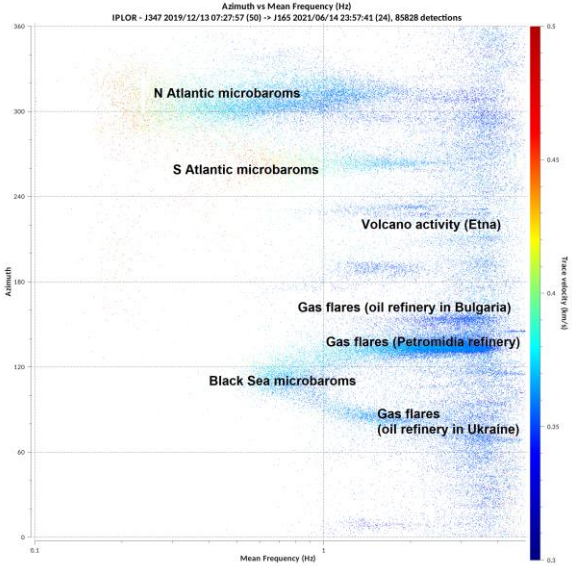
Infrasound detections analysis

IPLOR 4-element array, 0.5 km aperture



PMCC detection results



Main sources of coherent noise

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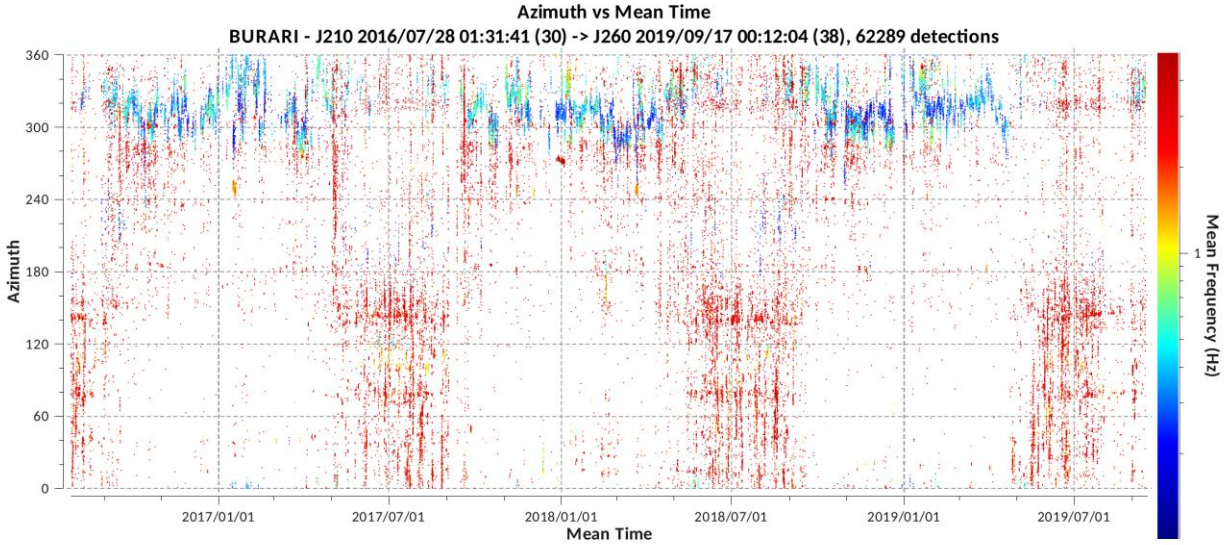
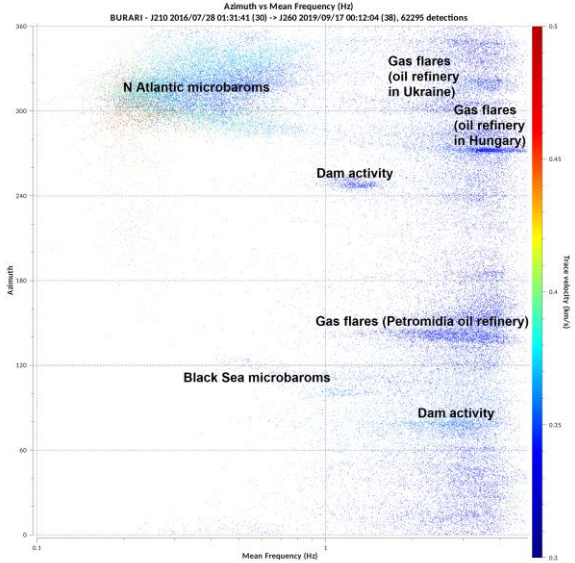
Infrasound detections analysis

BURARI 4-element array, 1.2 km aperture



PMCC detection results



Main sources of coherent noise

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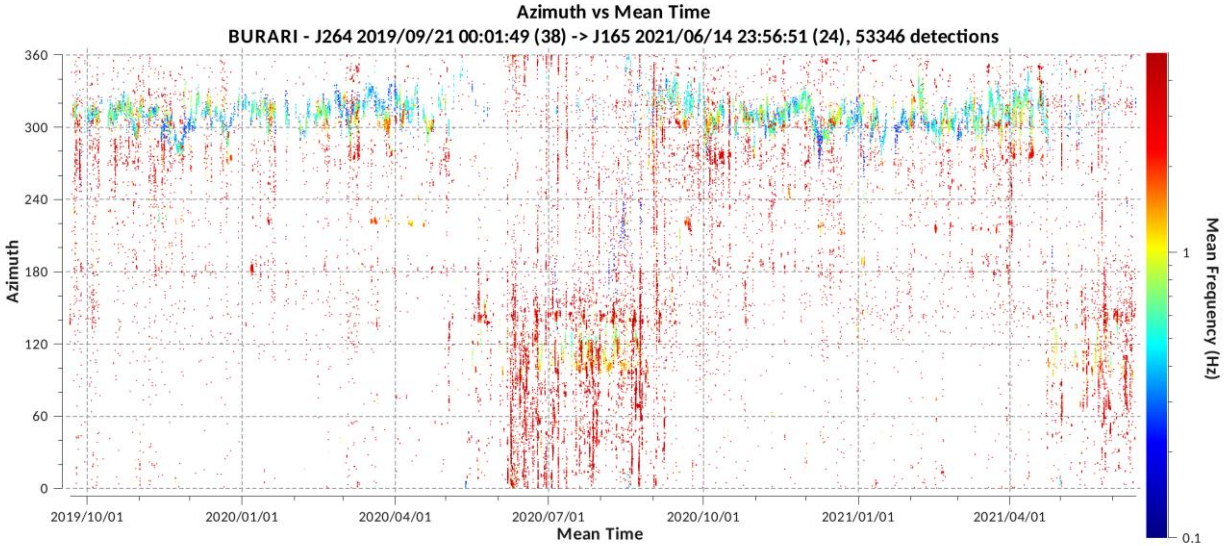
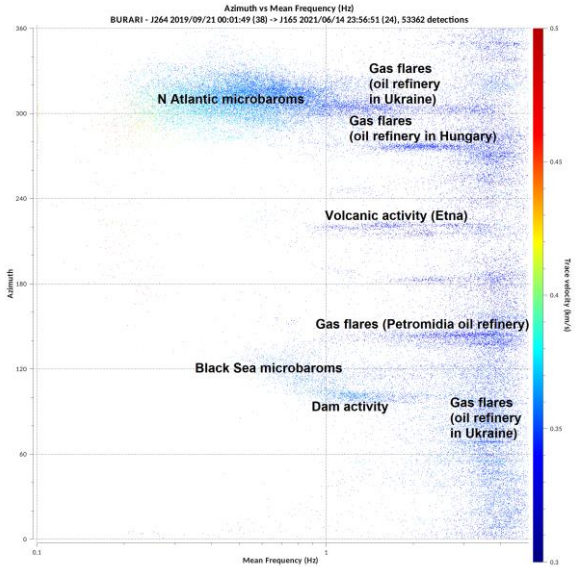
Infrasound detections analysis

BURARI 6-element array, 0.7 km aperture



PMCC detection results



Main sources of coherent noise

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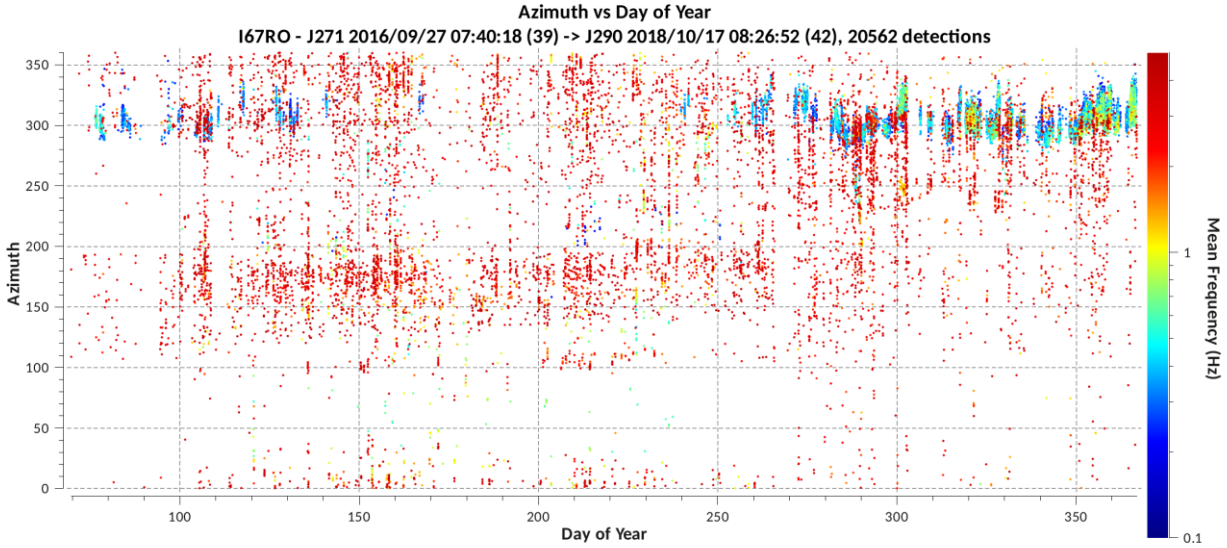
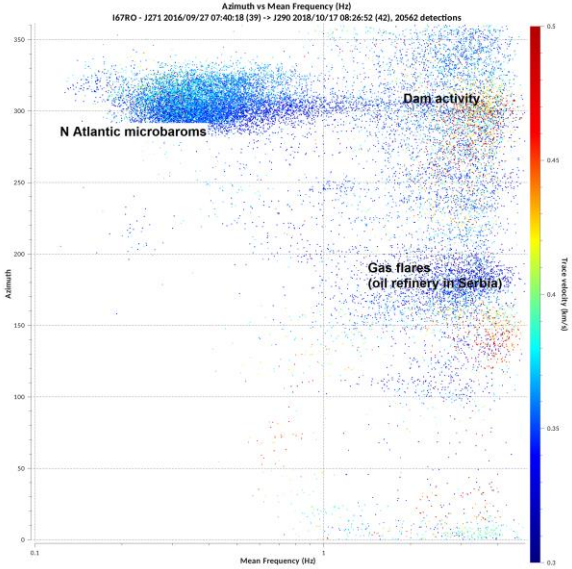
Infrasound detections analysis

I67RO 4-element array, 0.9 km aperture



PMCC detection results



Main sources of coherent noise

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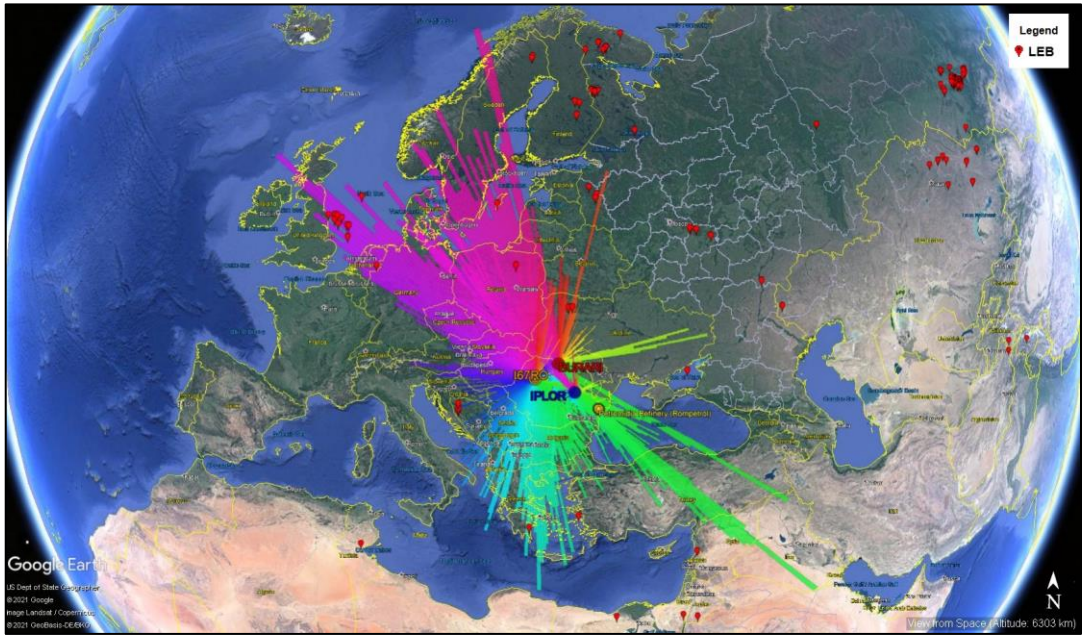
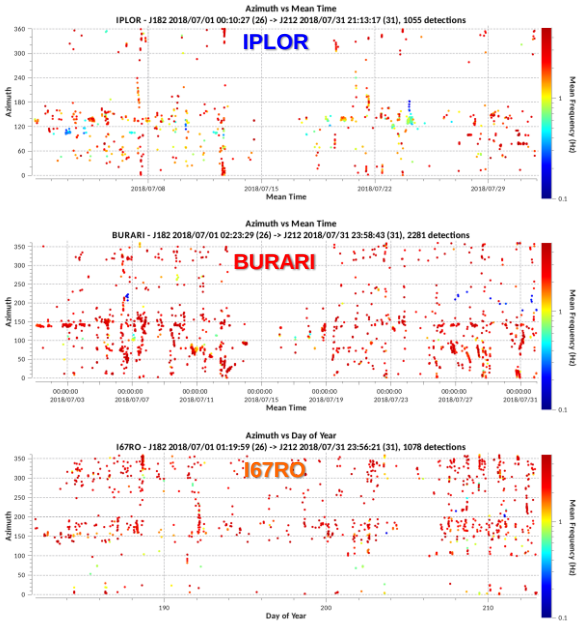
Infrasound detection analysis





- IDC products such as LEB bulletins proved to be very useful to identify the detections observed with the Romanian infrasound stations
- An example of PMCC detections visualized with Google Earth tool (left) is presented for all the three stations (July 2018); LEB locations are showed as well on the map with red pinpoints

Infrasound processing at Romanian NDC using NDC-in-a-Box

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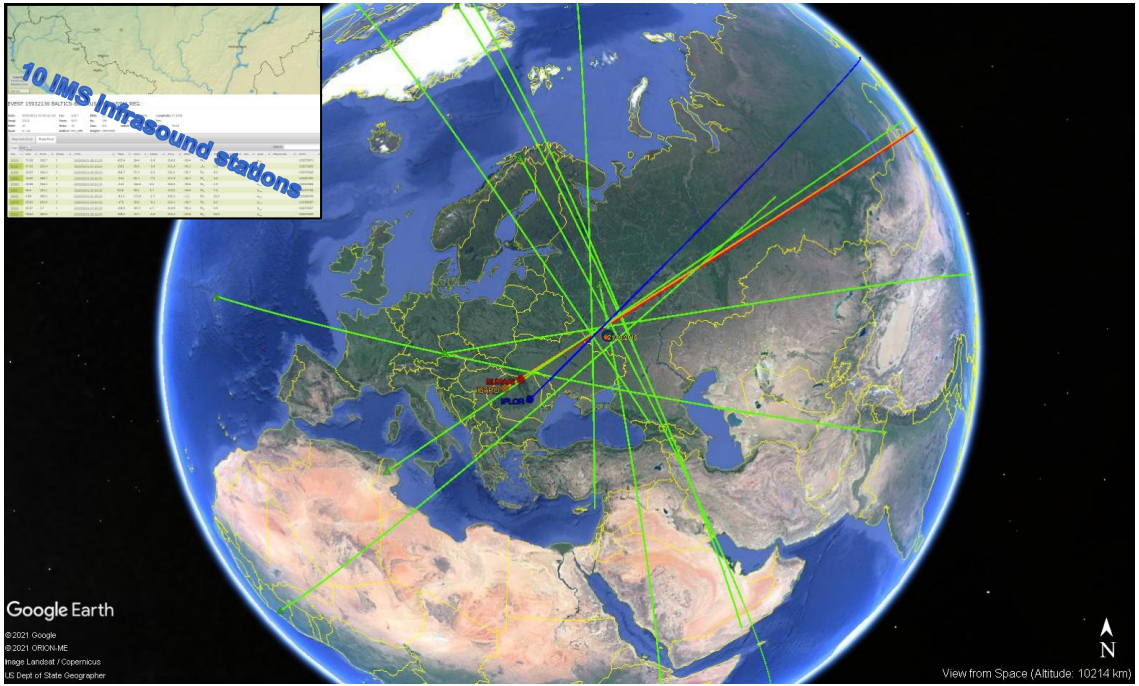
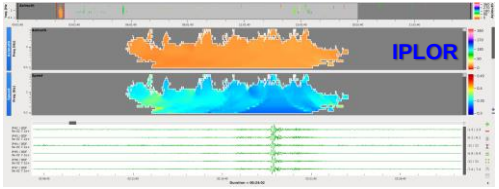
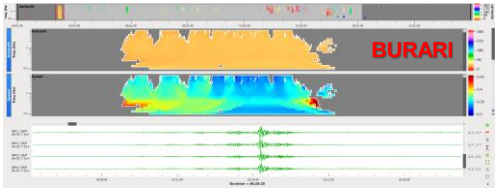
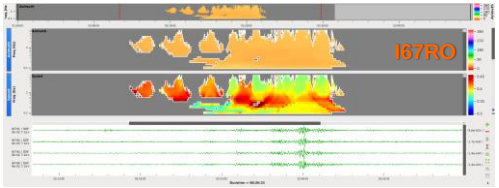
Data fusing (Romanian and IMS)

Large bolide over Russia (near city of Lipetsk) / 21.06.2018









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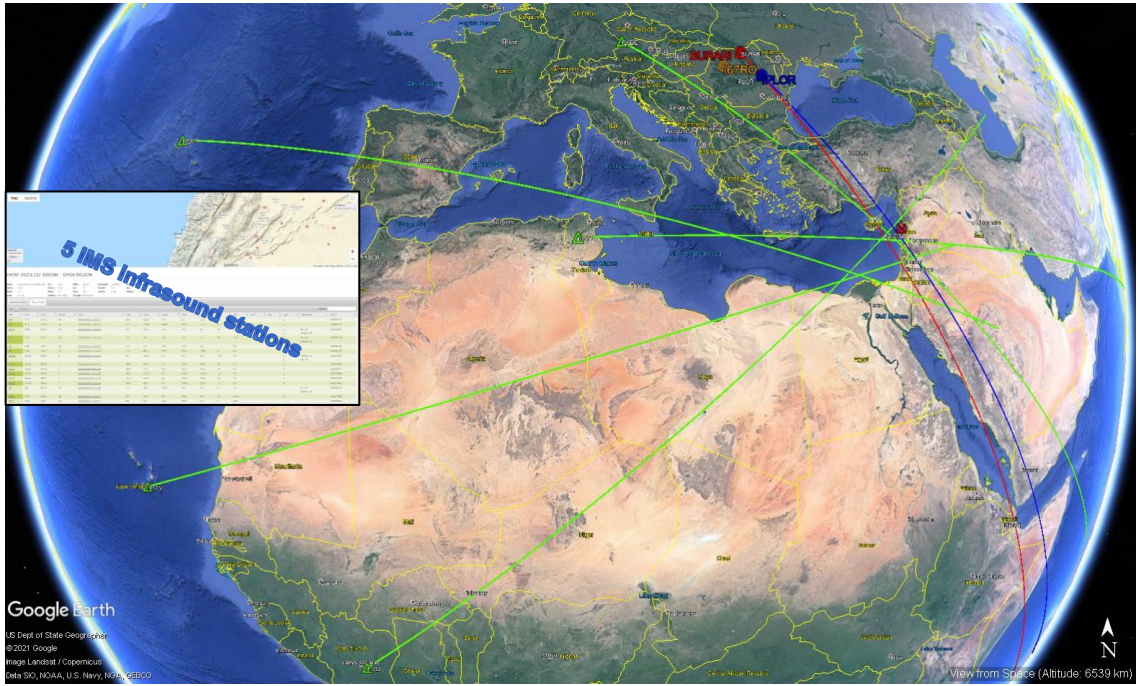
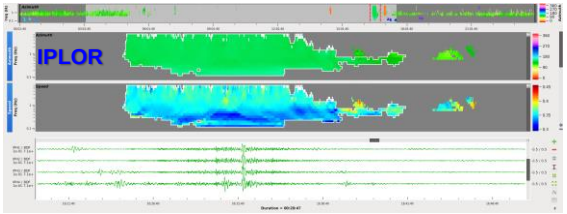
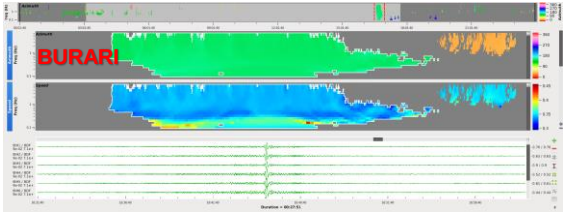
Data fusing (Romanian and IMS)

Beirut accidental explosion / 04.08.2020







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Conclusions

- At Romanian NDC, the infrasound data processing capabilities of NDC-in-a-Box are used since 2016, when the duo of infrasound detection-oriented software – DTK-GPMCC and DTK-DIVA – has been packaged into the system.
- Starting with 2009, three infrasound stations have been deployed on the Romanian territory by the National Institute for Earth Physics (NIEP): (1) IPLOR (in the central Romania), (2) BURARI (in the northern Romania), under the cooperation with Air Force Technical Application Center AFTAC (USA), and (3) I67RO temporary PTS portable array (in western Romania) as two-year experiment (2016-2018), within a collaboration project with PTS/CTBTO.
- Data recorded with the Romanian infrasound stations are automatically processed at Romanian NDC by running PMCC detector (DTK-PMCC). DTK-GPMCC is applied to study in detail the detected signals, including the capacity of fusing them into approximate source location by cross bearing. DTK-DIVA is used to investigate the array monitoring performance. i.e., detection capability, types of sources observed, ambient noise conditions etc.
- In addition to the data recorded with the local stations, data from IMS infrasound network are processed at Romanian NDC, in order to jointly characterize large events (bolides, explosions). Furthermore, IDC products such as LEB bulletins proved to be very useful to identify the detections observed with the Romanian infrasound stations.
- Infrasound processing at Romanian NDC benefited from the technical assistance kindly provided by PTS/CTBTO and consisting of NDC-in-a-Box SHI Software Package, trainings (Intermediate Level Infrasound Data Analysis Training, July 2019, Bucharest, Romania; NDC Advanced Training on Infrasound Data Analysis, October 2019, Bruyères-le-Châtel, France), as well as of valuable advices from the PTS staff.

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