

On the infrasound monitoring in Romania

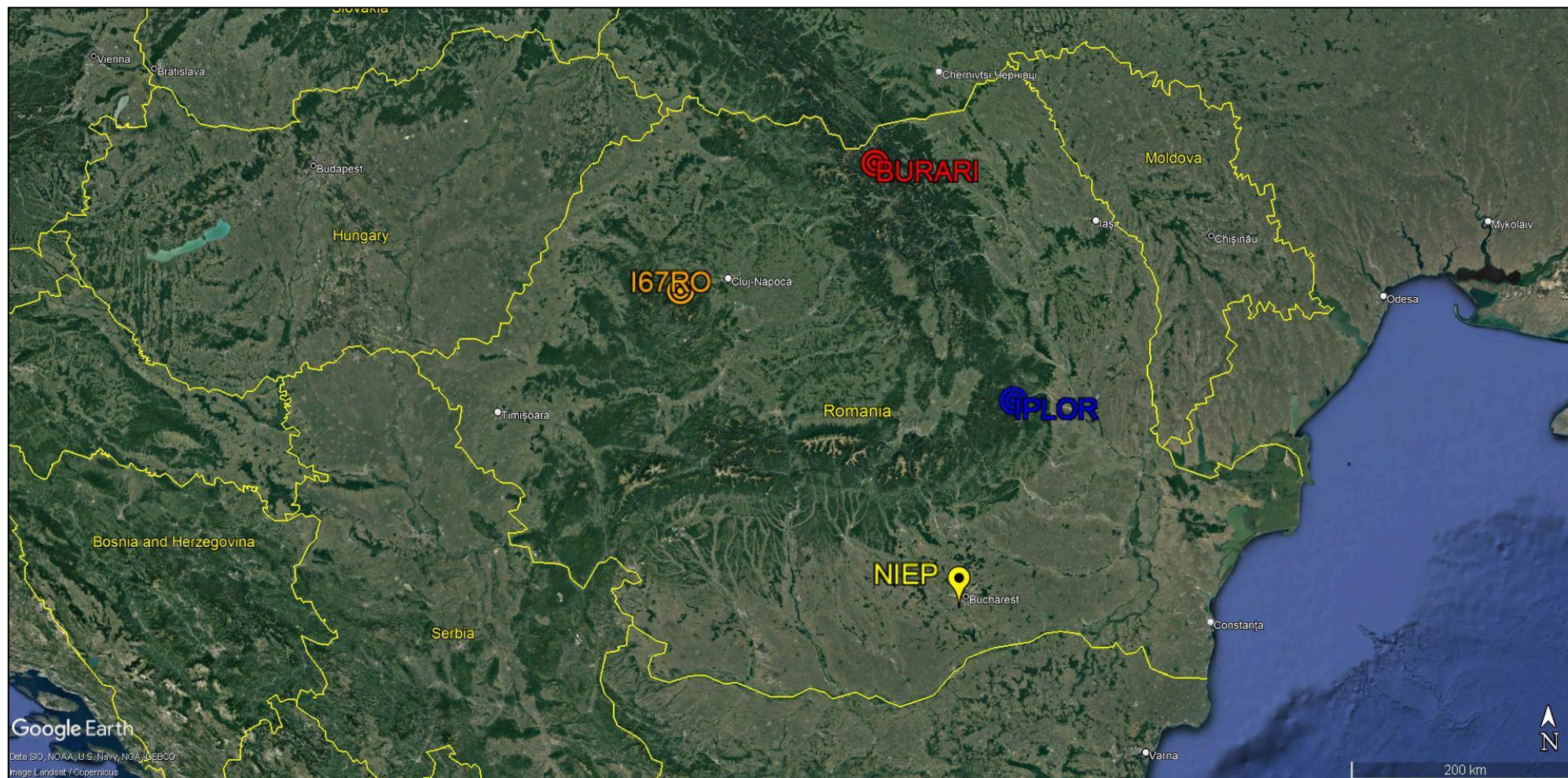


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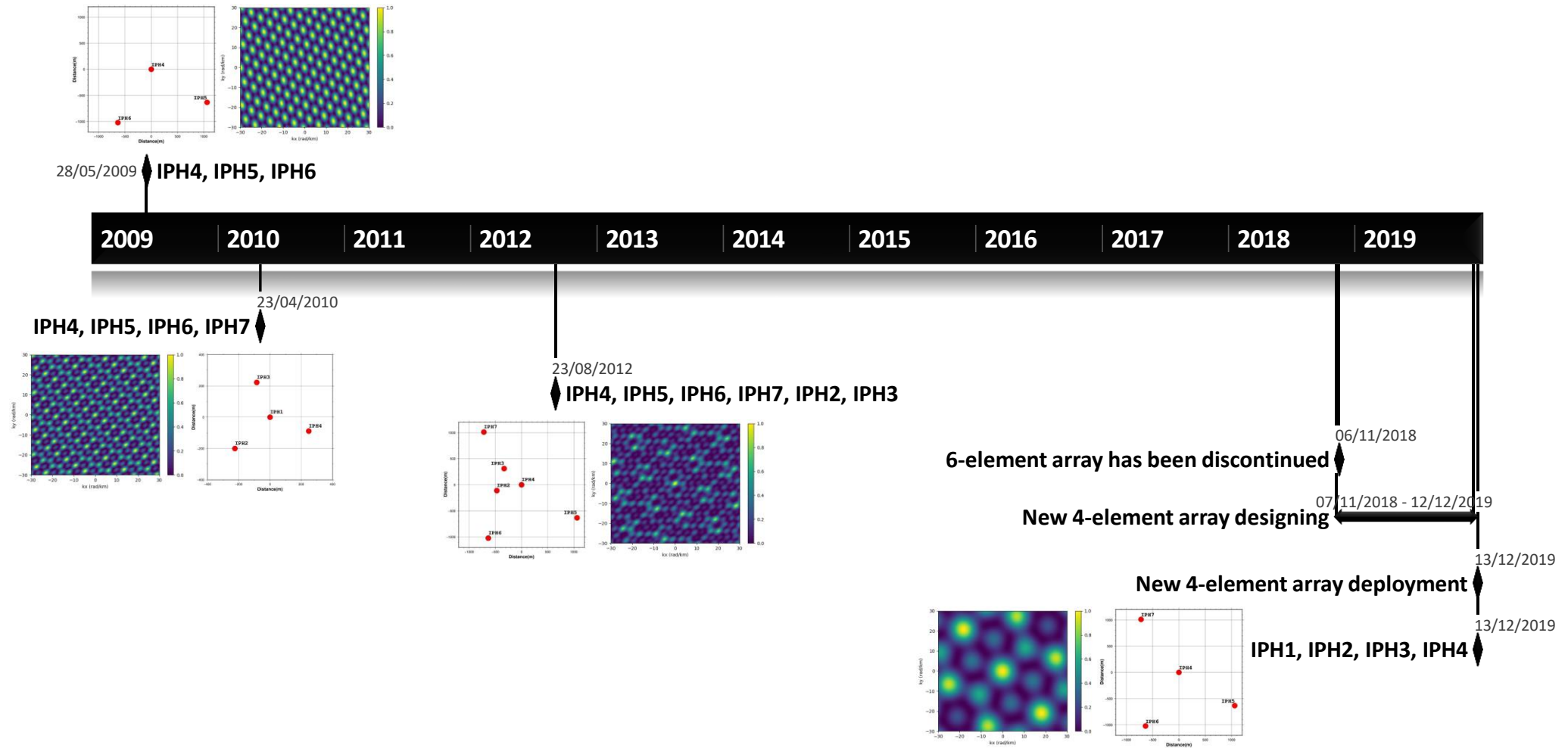
Infrasound stations in Romania



Code	Location	No. of elements	Aperture (km)	Operation period	Status
IPLOR	Ploștina, 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

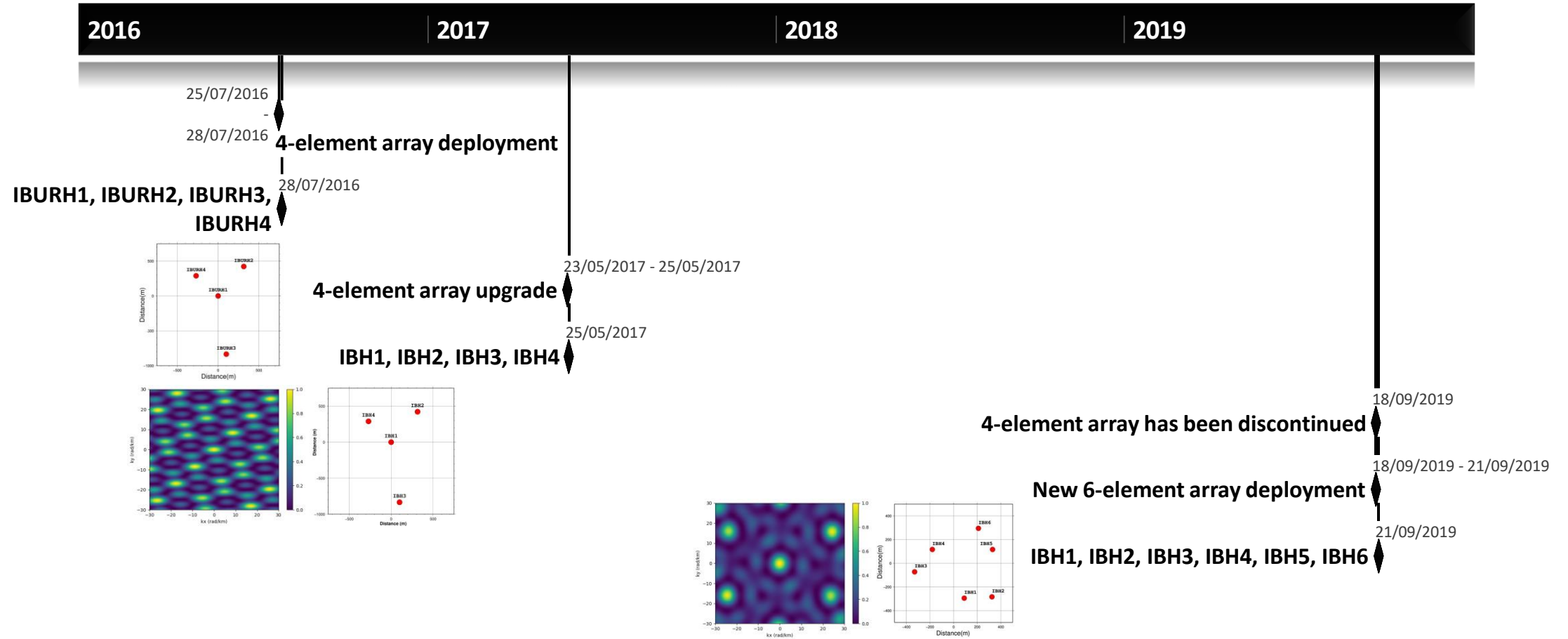
IPLOR infrasound array

(NIEP installation)



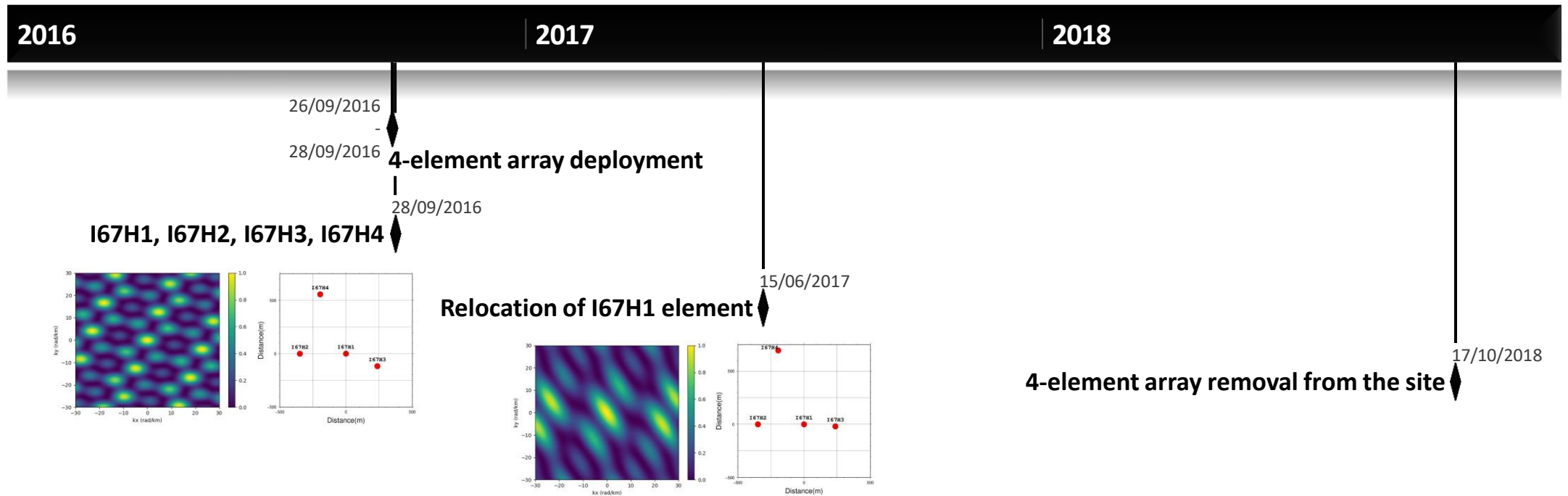
BURARI infrasound array

(cooperation between NIEP and AFTAC, USA)



I67RO infrasound array

(two-year experiment [2016-2018], within a collaboration project with PTS/CTBTO)



Array data processing & analysis

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

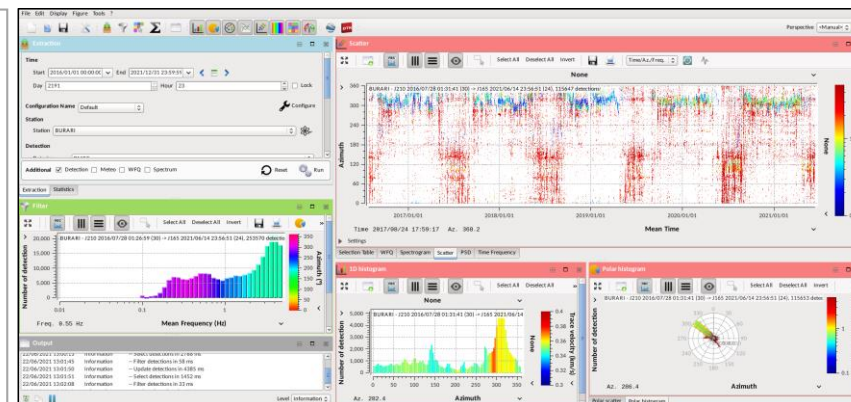
- Interactively display/check results



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)



Two detection-oriented software (**DTK-GPMCC 6.3.0** and **DTK-DIVA 3.4.3**) developed by CEA/DASE and packaged into the **CTBTO NDC-in-a-box** are routinely used at NIEP

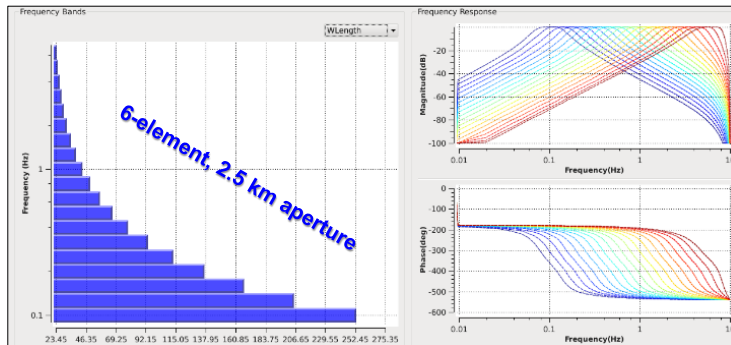
Array data processing & analysis

Automatic configuration of the PMCC detector

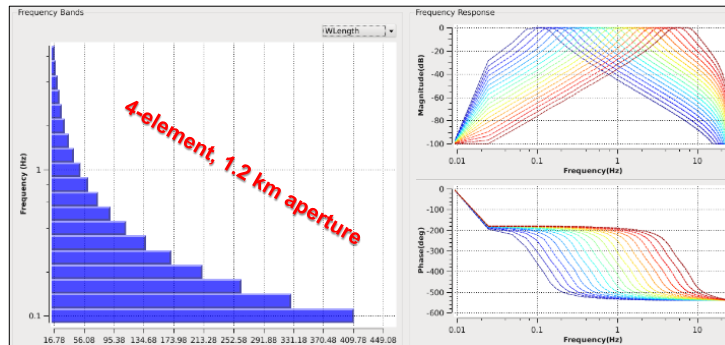
Infrasound data are automatically processed by running PMCC detector (DTK-PMCC) using **one-third octave band scheme**:

- 19 log spaced frequency bands (center frequencies between 0.1 Hz and 6.0 Hz)
- time window lengths vary proportionally with array aperture
- schema repeats every decade

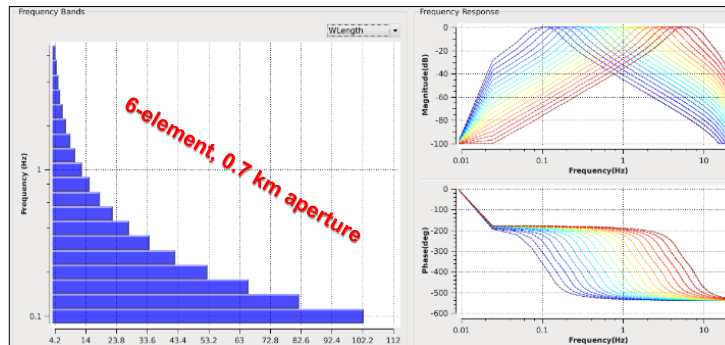
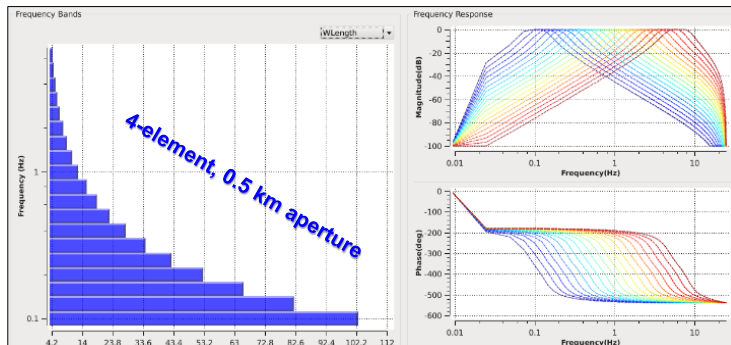
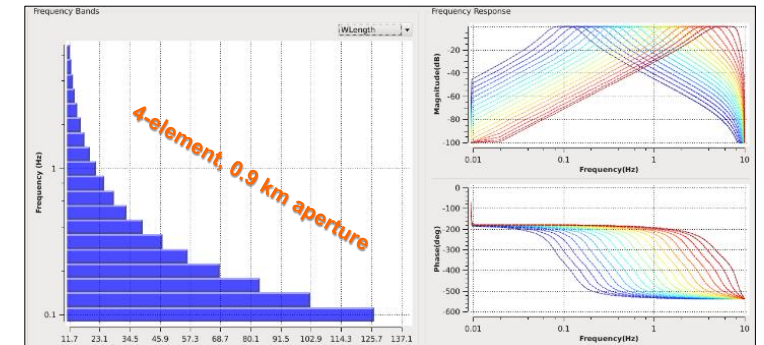
IPLOR array



BURARI array

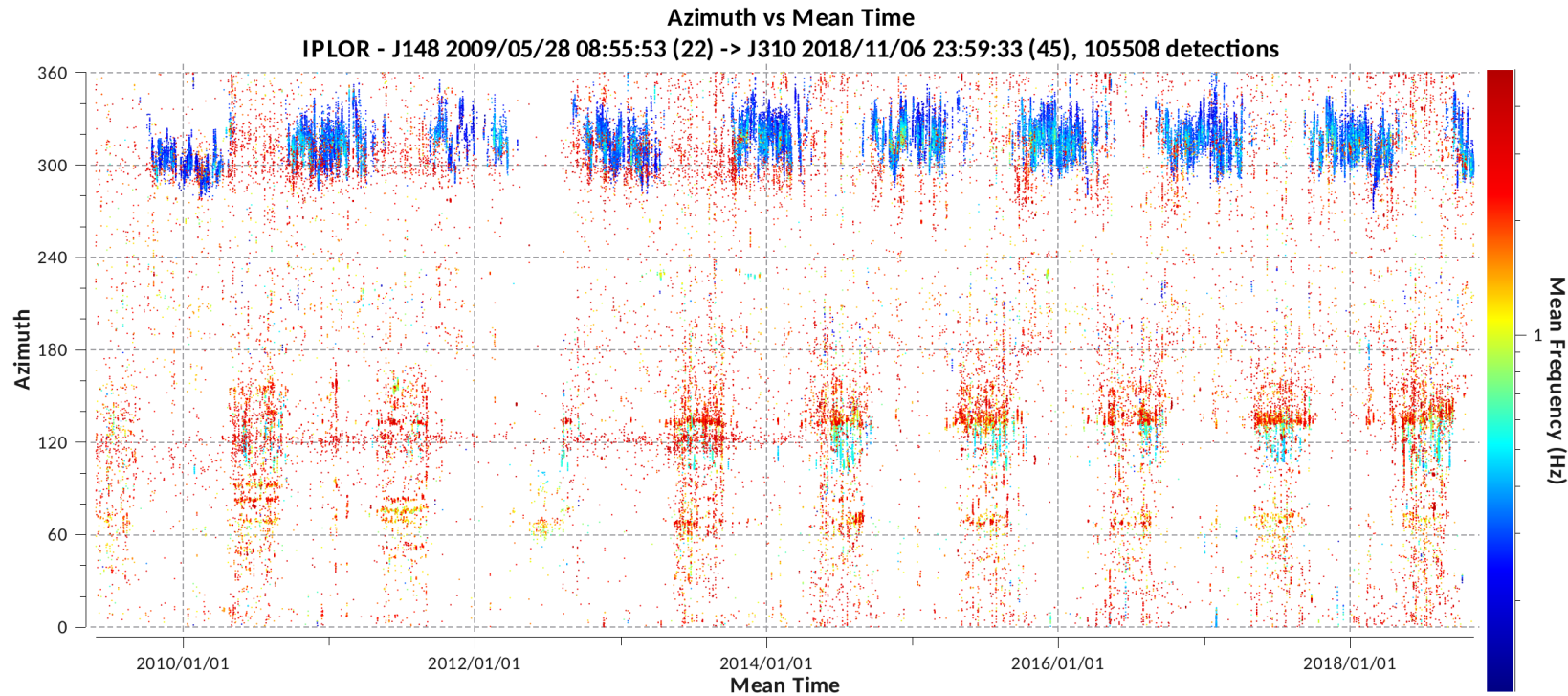


I67RO array

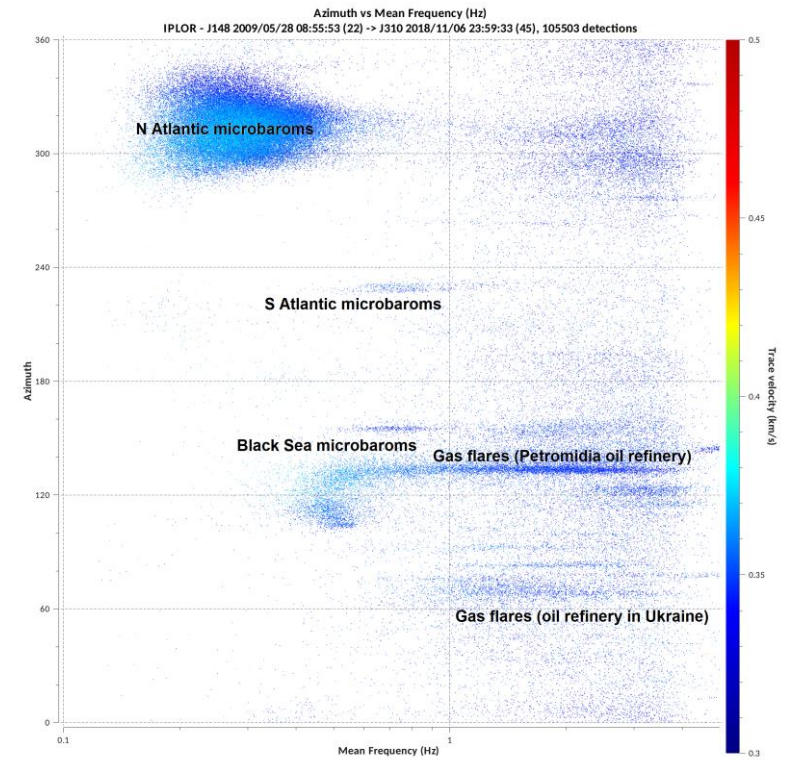


Infrasound detections analysis

IPLOR 6-element array, 2.5 km aperture



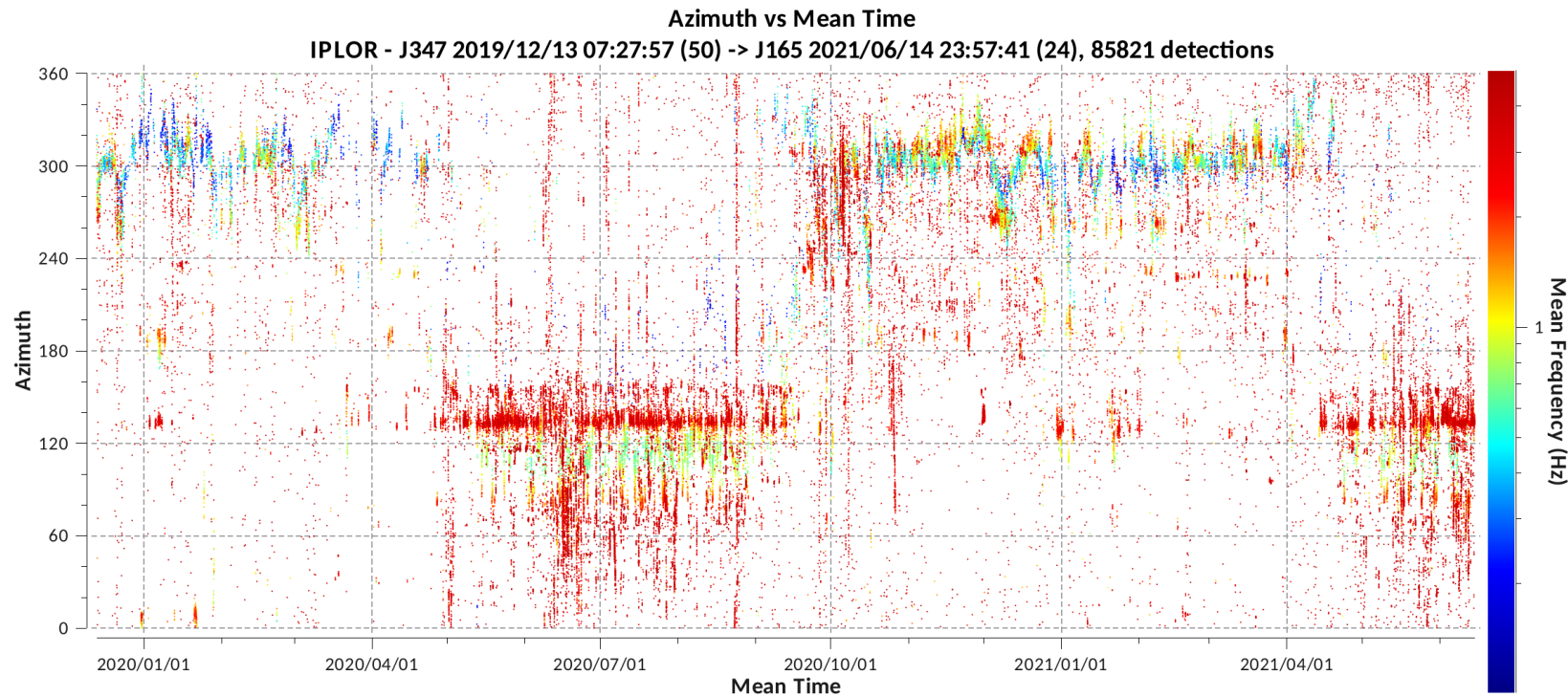
PMCC detection results



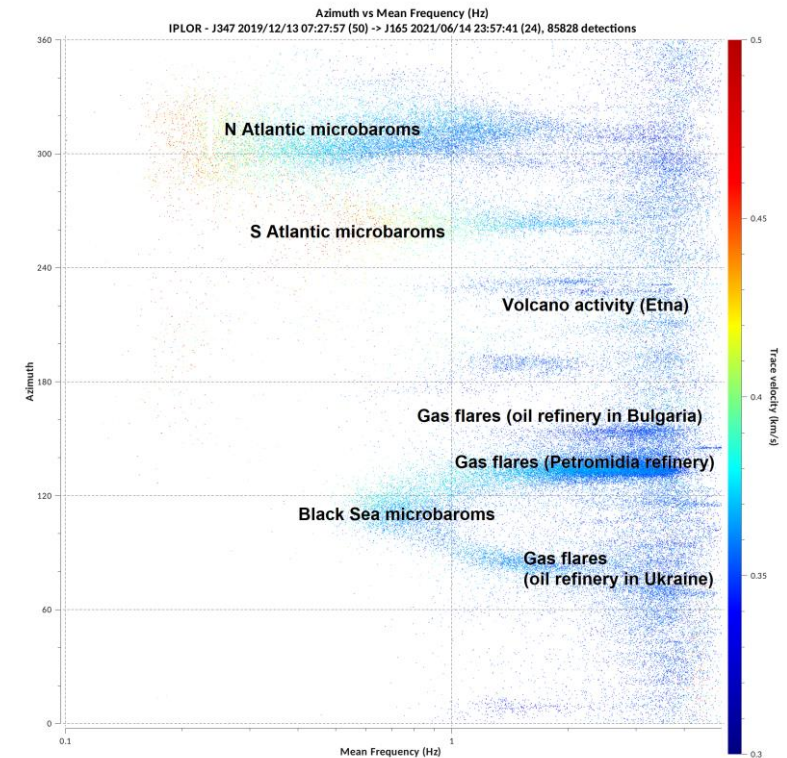
Main sources of coherent noise

Infrasound detections analysis

IPLOR 4-element array, 0.5 km aperture



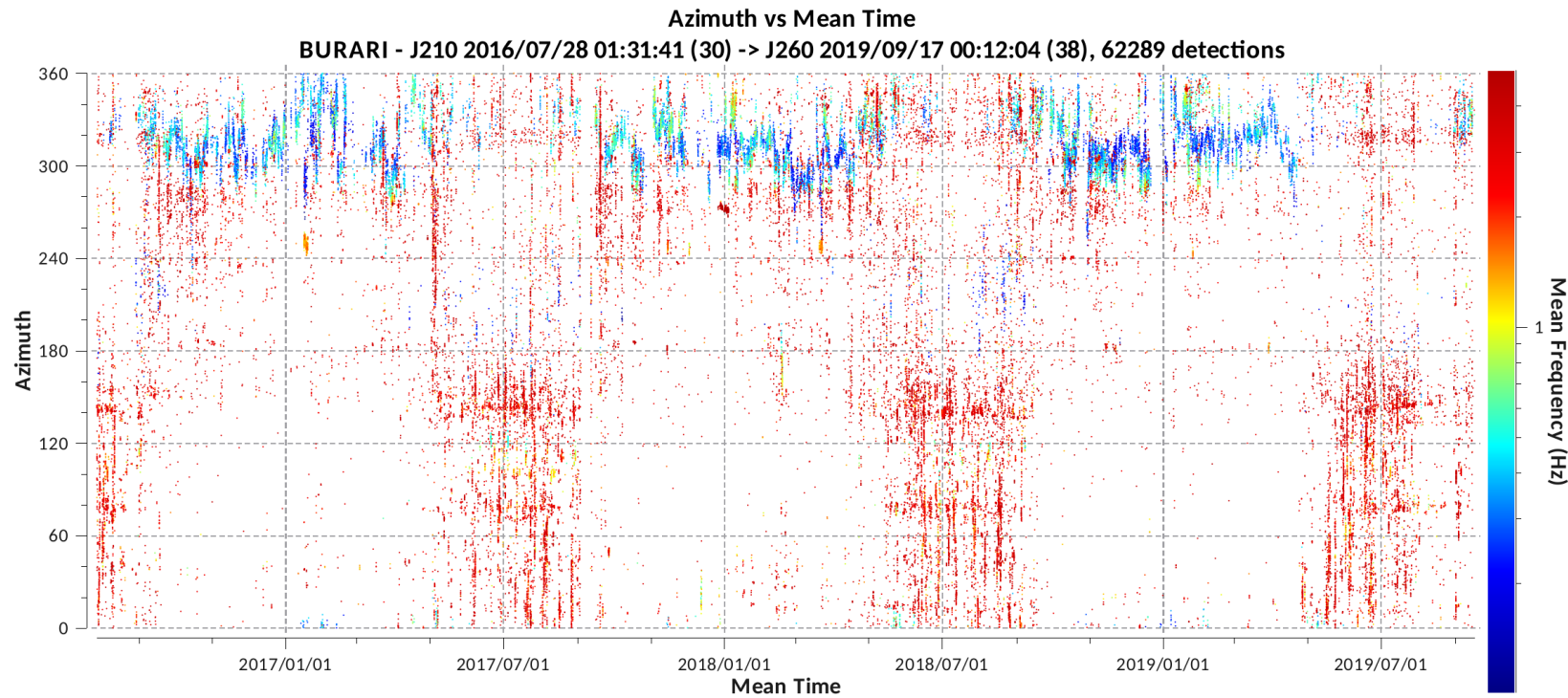
PMCC detection results



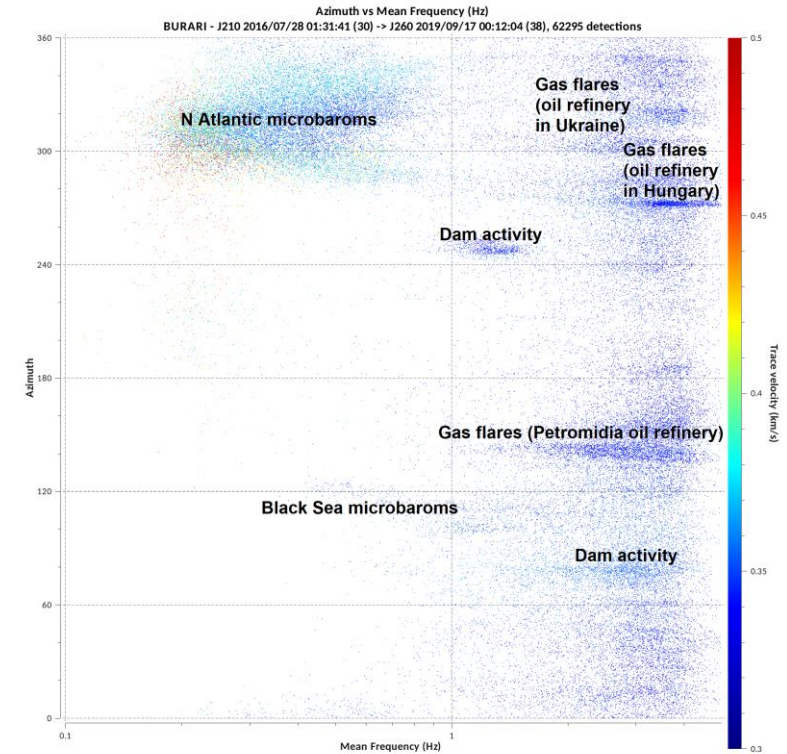
Main sources of coherent noise

Infrasound detections analysis

BURARI 4-element array, 1.2 km aperture



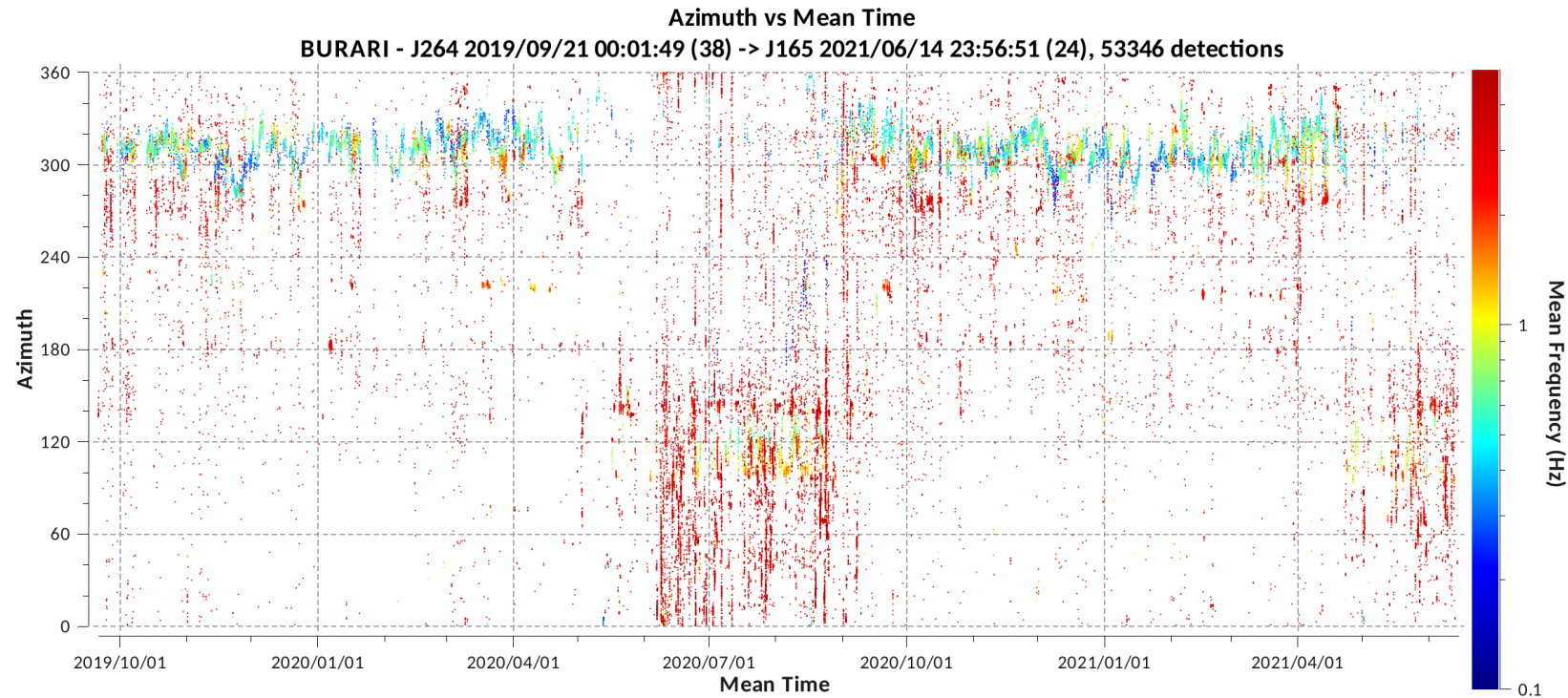
PMCC detection results



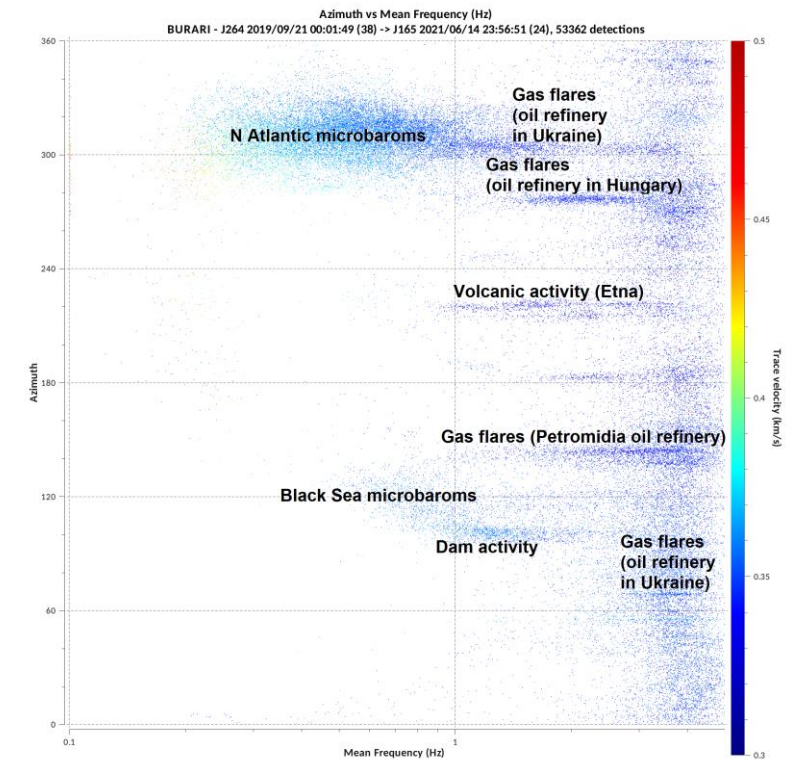
Main sources of coherent noise

Infrasound detections analysis

BURARI 6-element array, 0.7 km aperture



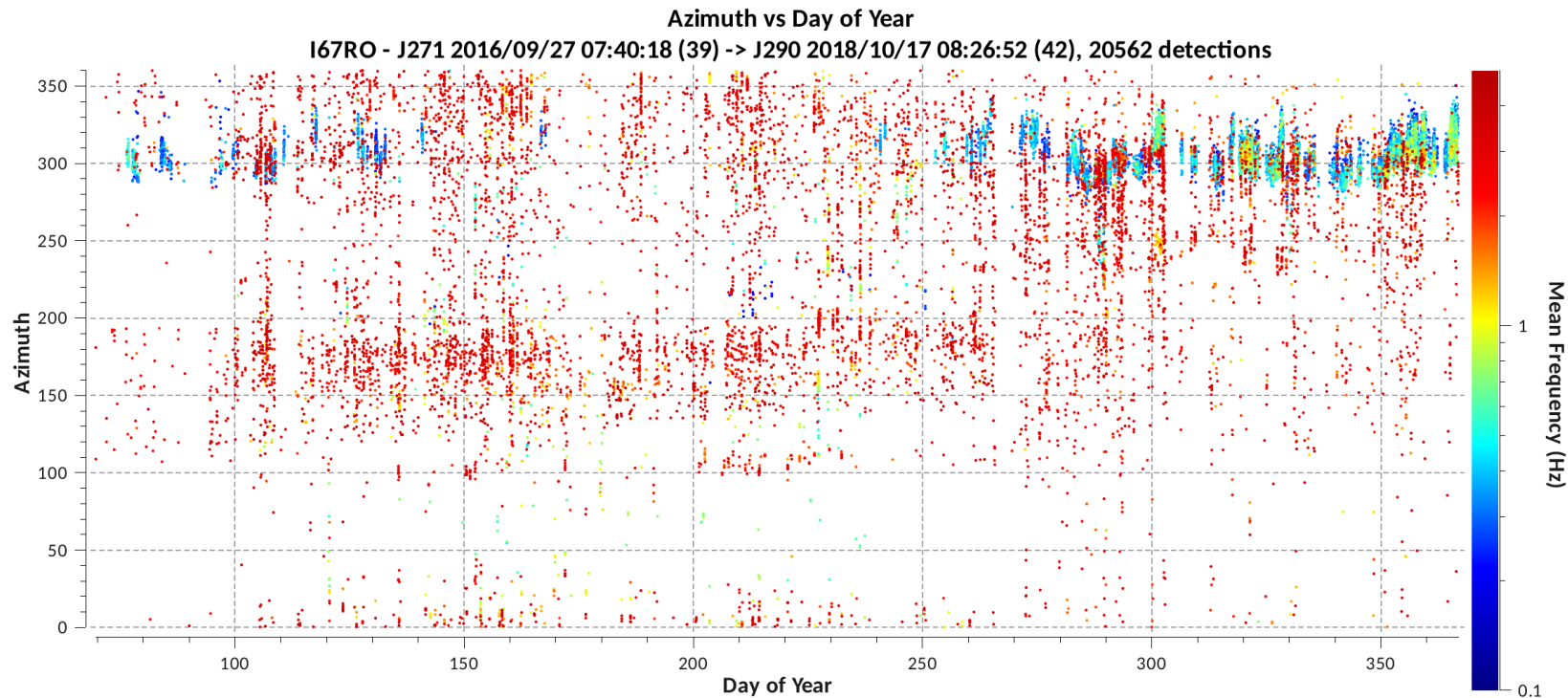
PMCC detection results



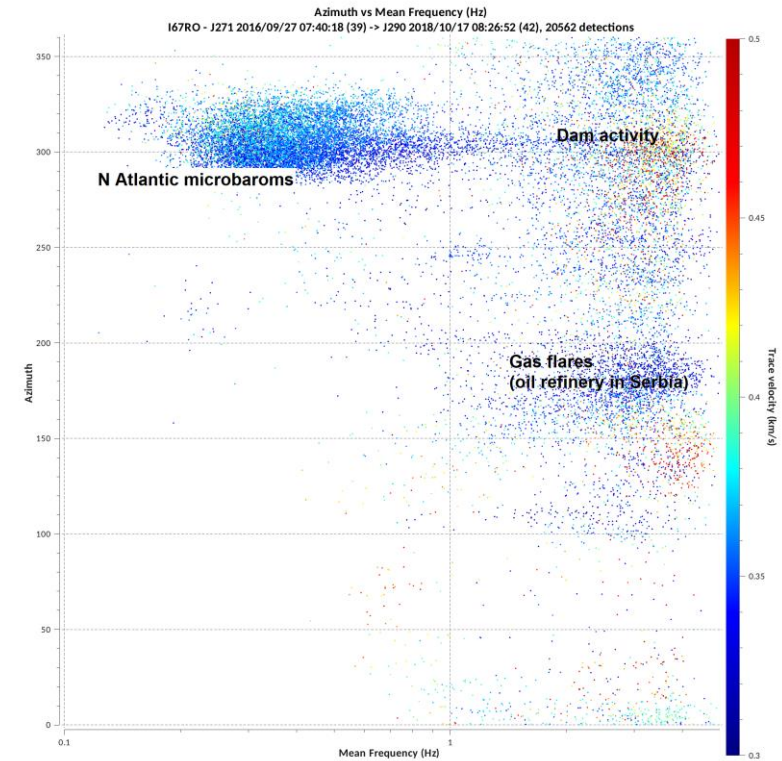
Main sources of coherent noise

Infrasound detections analysis

I64RO 4-element array, 0.9 km aperture

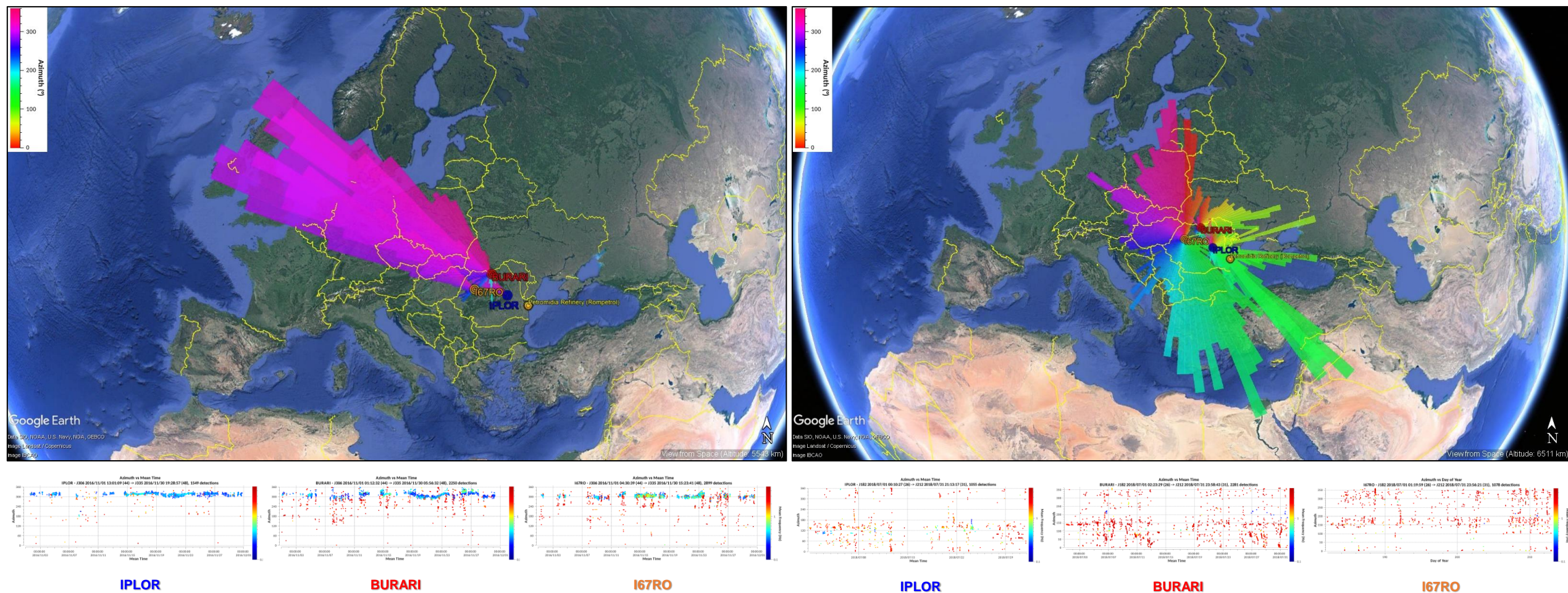


PMCC detection results



Main sources of coherent noise

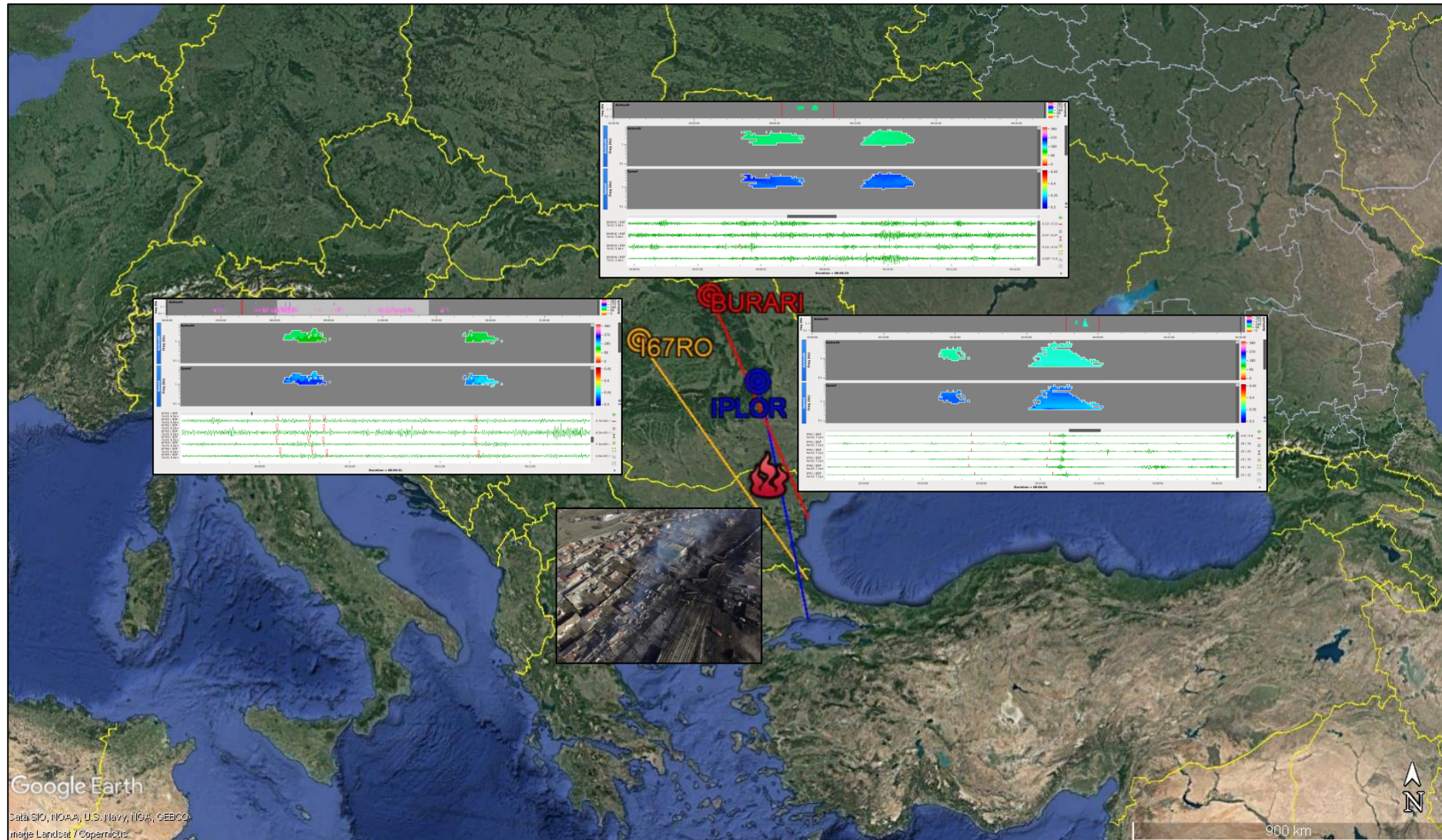
Infrasound detections analysis



Two examples of the PMCC detections visualized with Google Earth tool is presented for all the three stations (November 2016 – left side and July 2018 – right side); DTK-DIVA detection panels are showed as well

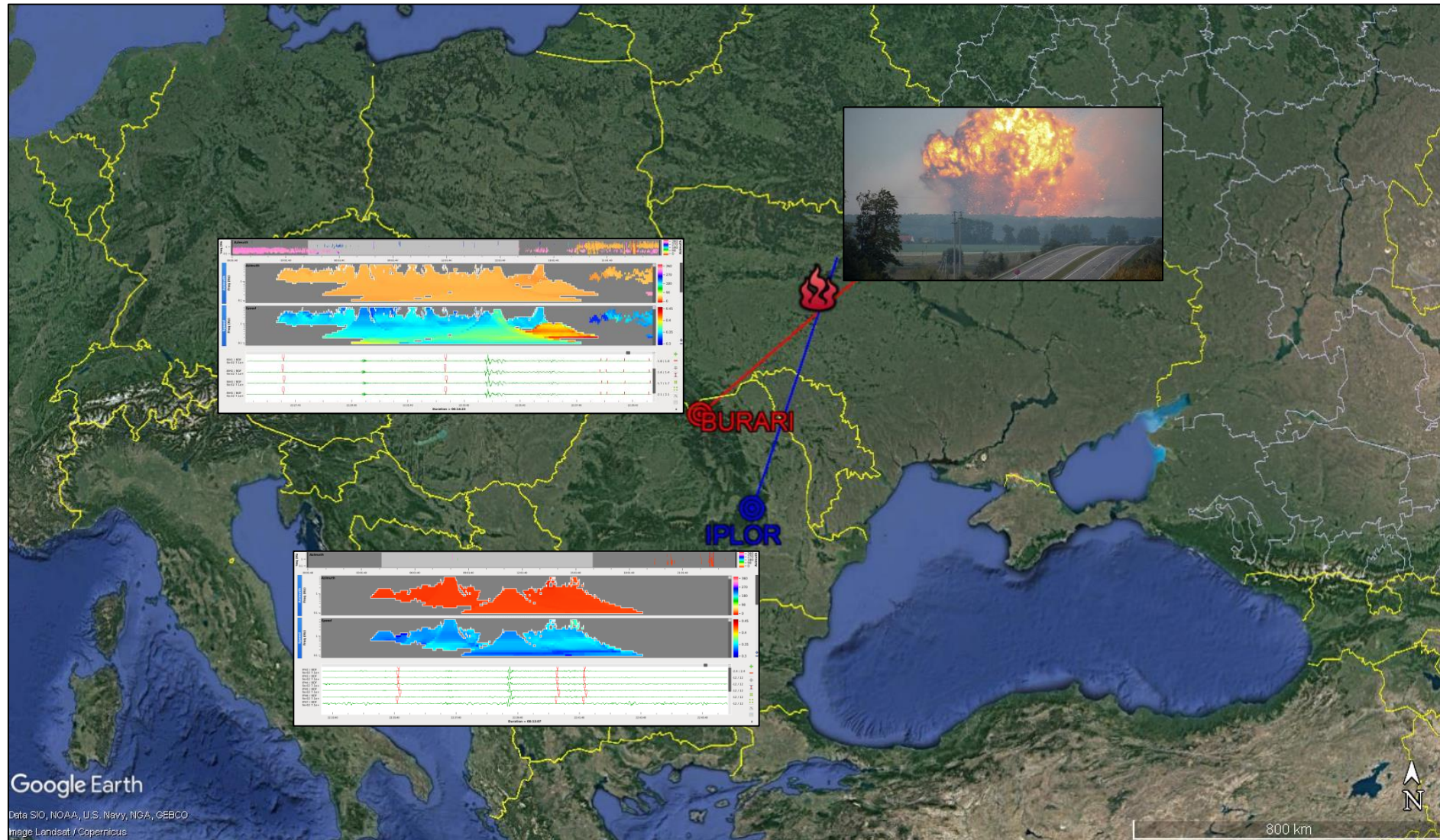
Infrasound sources detected

Explosion of gas tank transporter train at Hitrino (Bulgaria) / 10.12.2016



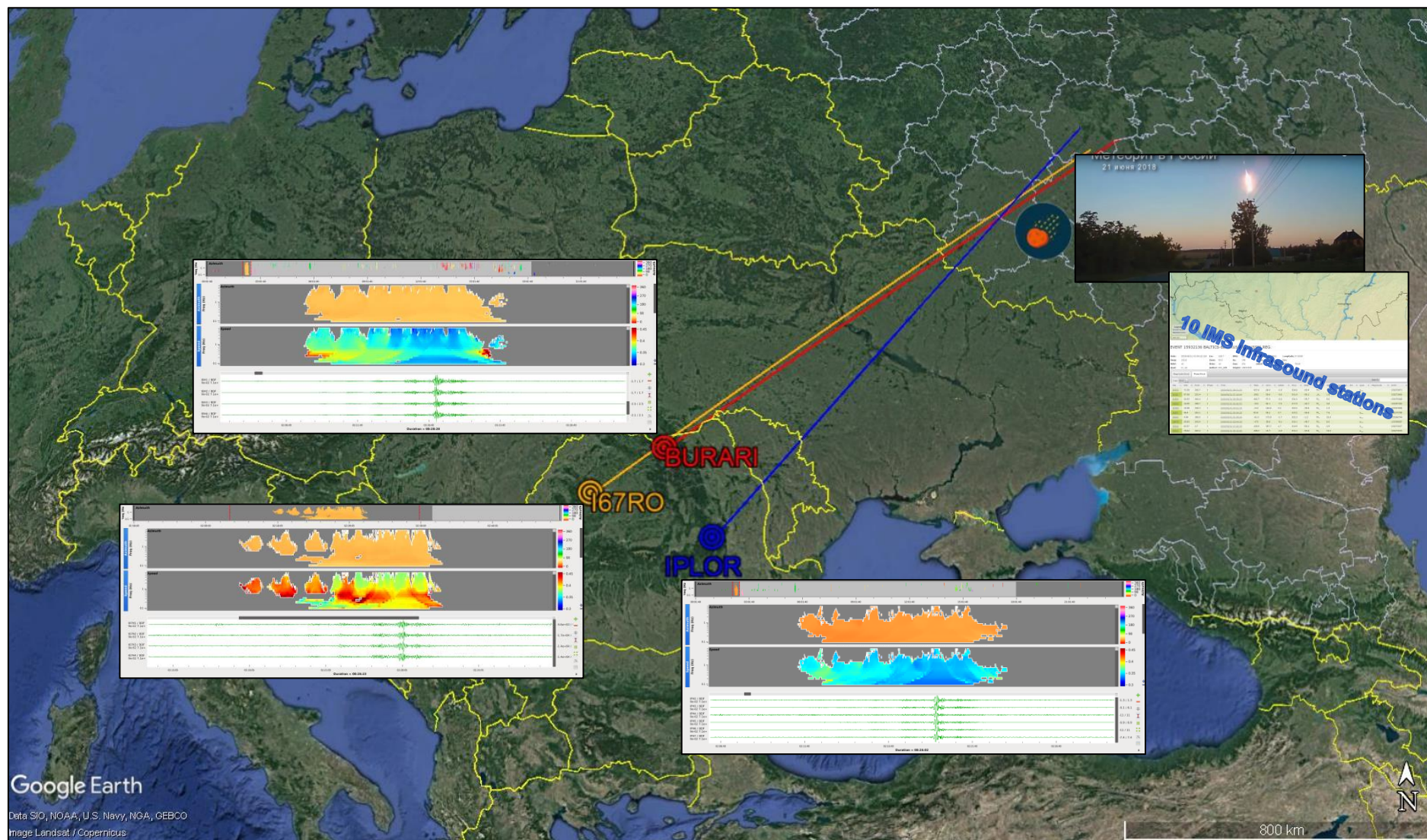
Infrasound sources detected

Explosion of ammunition depot in Kalynivka, Ukraine / 26.09.2017



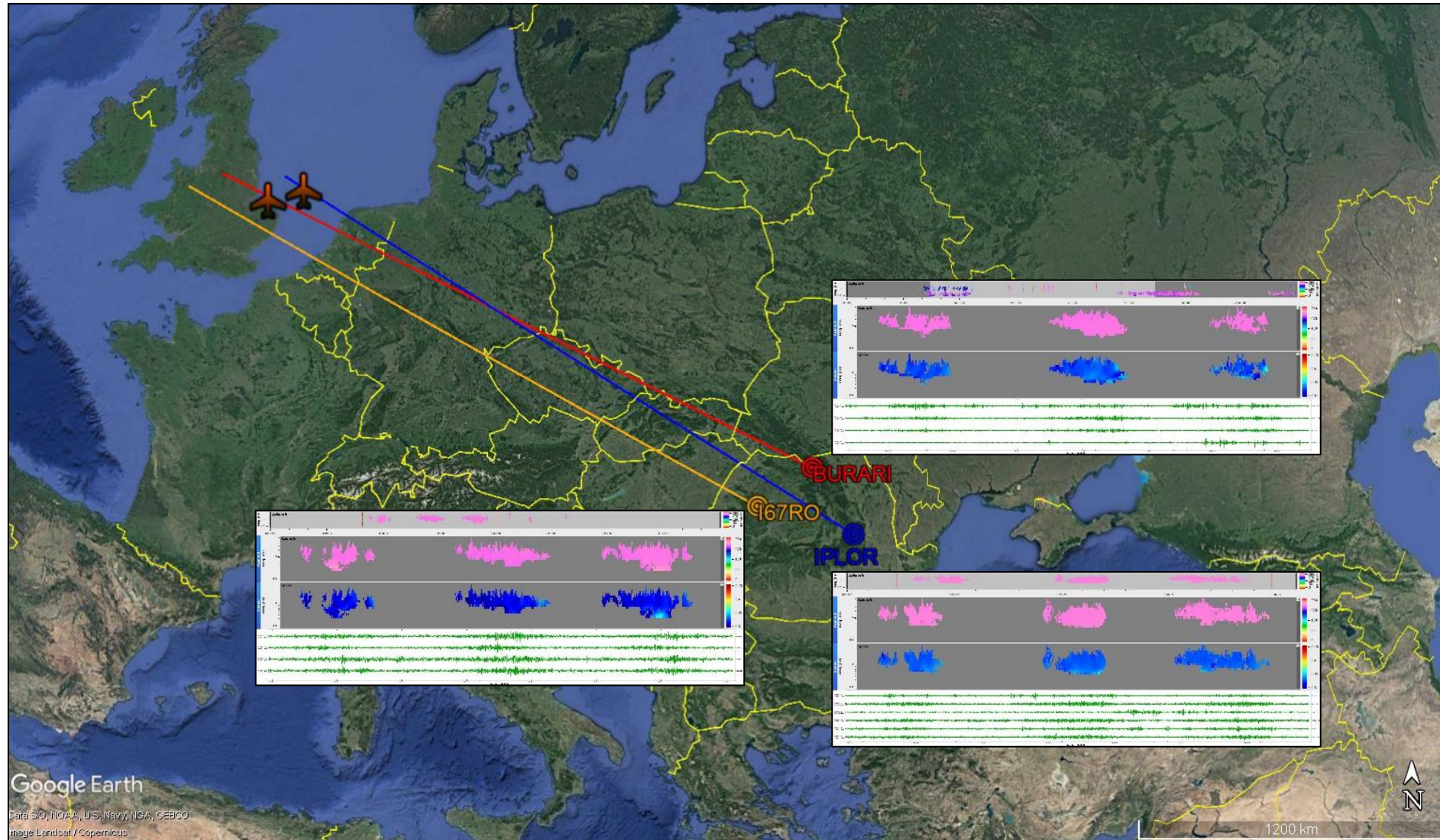
Infrasound sources detected

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



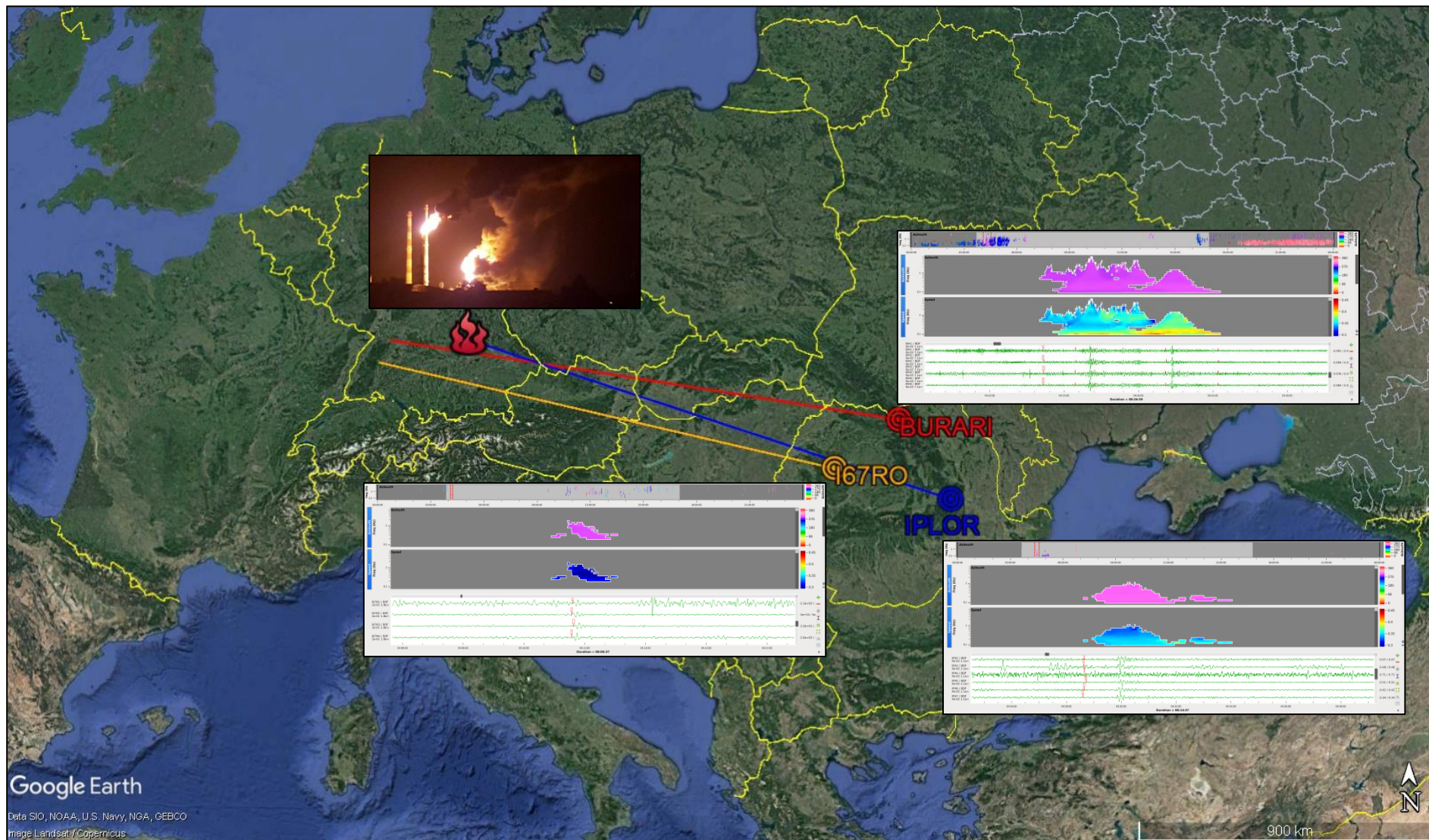
Infrasound sources detected

Supersonic flights over the North Sea region / 21.03.2018



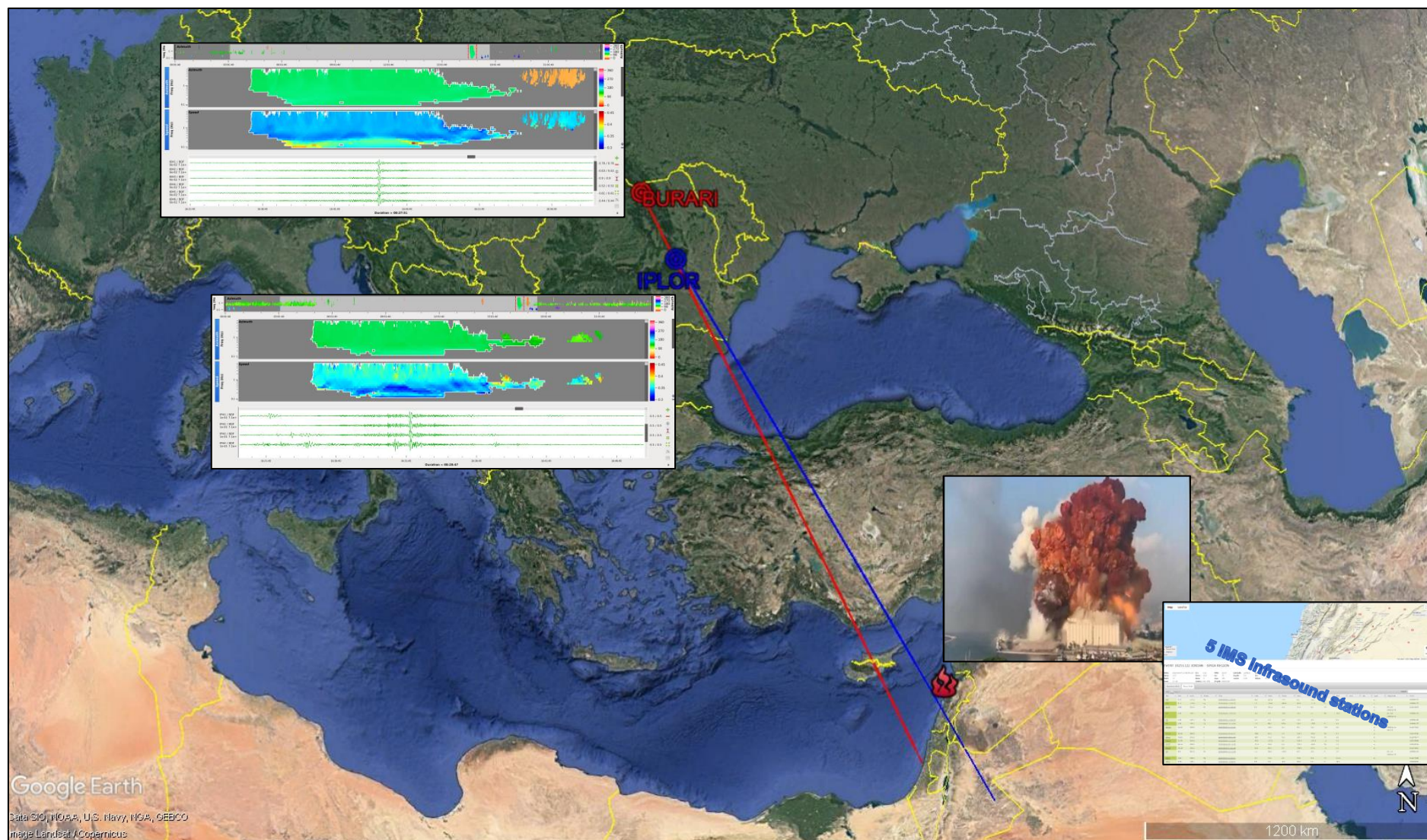
Infrasound sources detected

Explosion at oil refinery in Ingolstadt, Germany / 01.09.2018



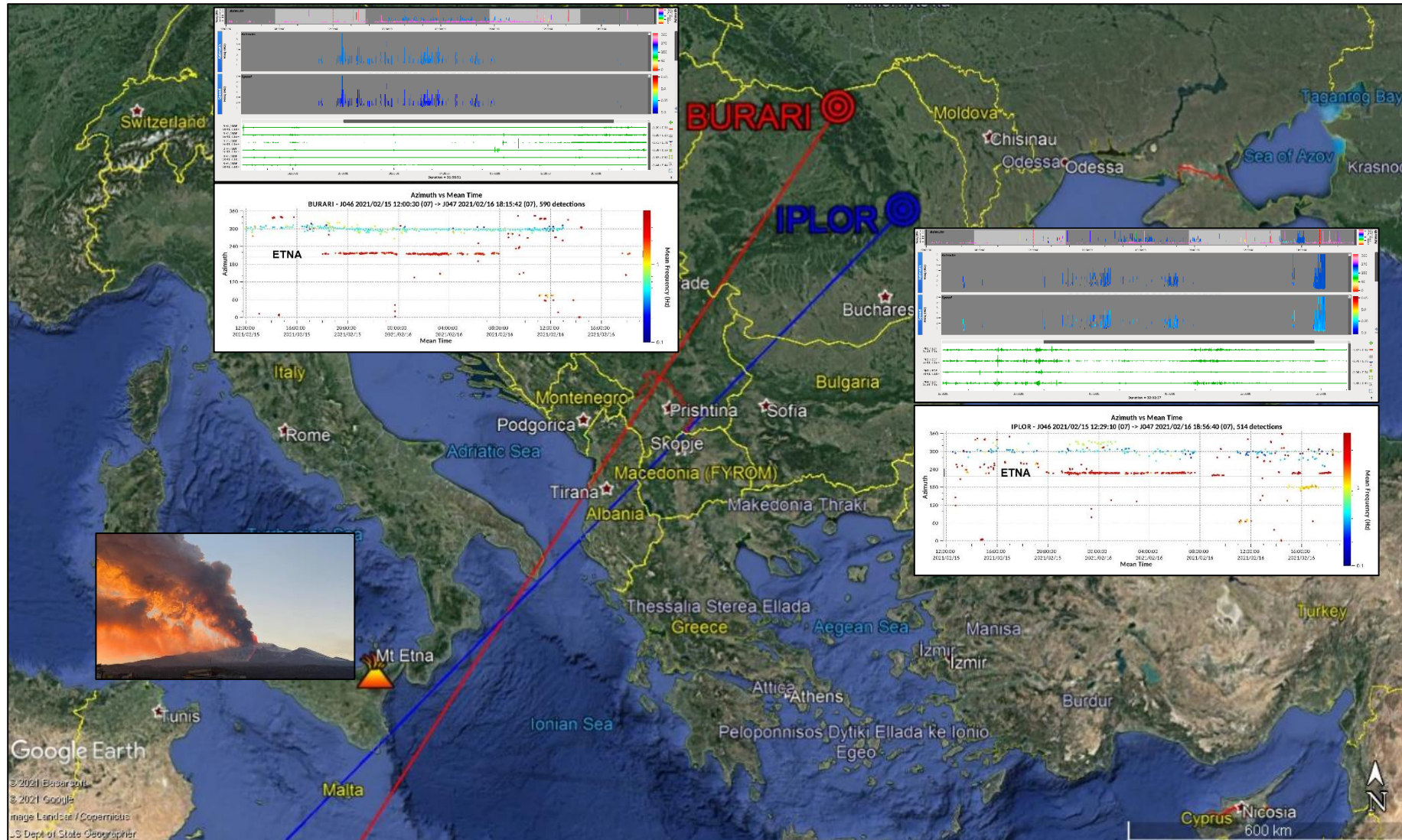
Infrasound sources detected

Beirut accidental explosion / 04.08.2020



Infrasound sources detected

Etna eruption / 15-16.02.2021



Summary

- The monitoring performance of the infrasound stations deployed on the Romania's territory is presented
- Infrasound data are processed and analyzed on routinely basis at NIEP by using a duo of infrasound detection-oriented software – DTK-GPMCC and DTK-DIVA – packaged into CTBTO NDC-in-a-Box
- Detection capability assessment, main sources of coherent noise, as well the capacity of fusing the detections into support of understanding various infragenic sources are shown
- A good characterization of the detected signals in the frequency-azimuth space or frequency-trace velocity space is clearly observed
- Infrasonic signals generated by several relevant sources detected with the three arrays deployed on the Romanian territory are presented