

Short-duration infrasound signals observed at the array PVCI

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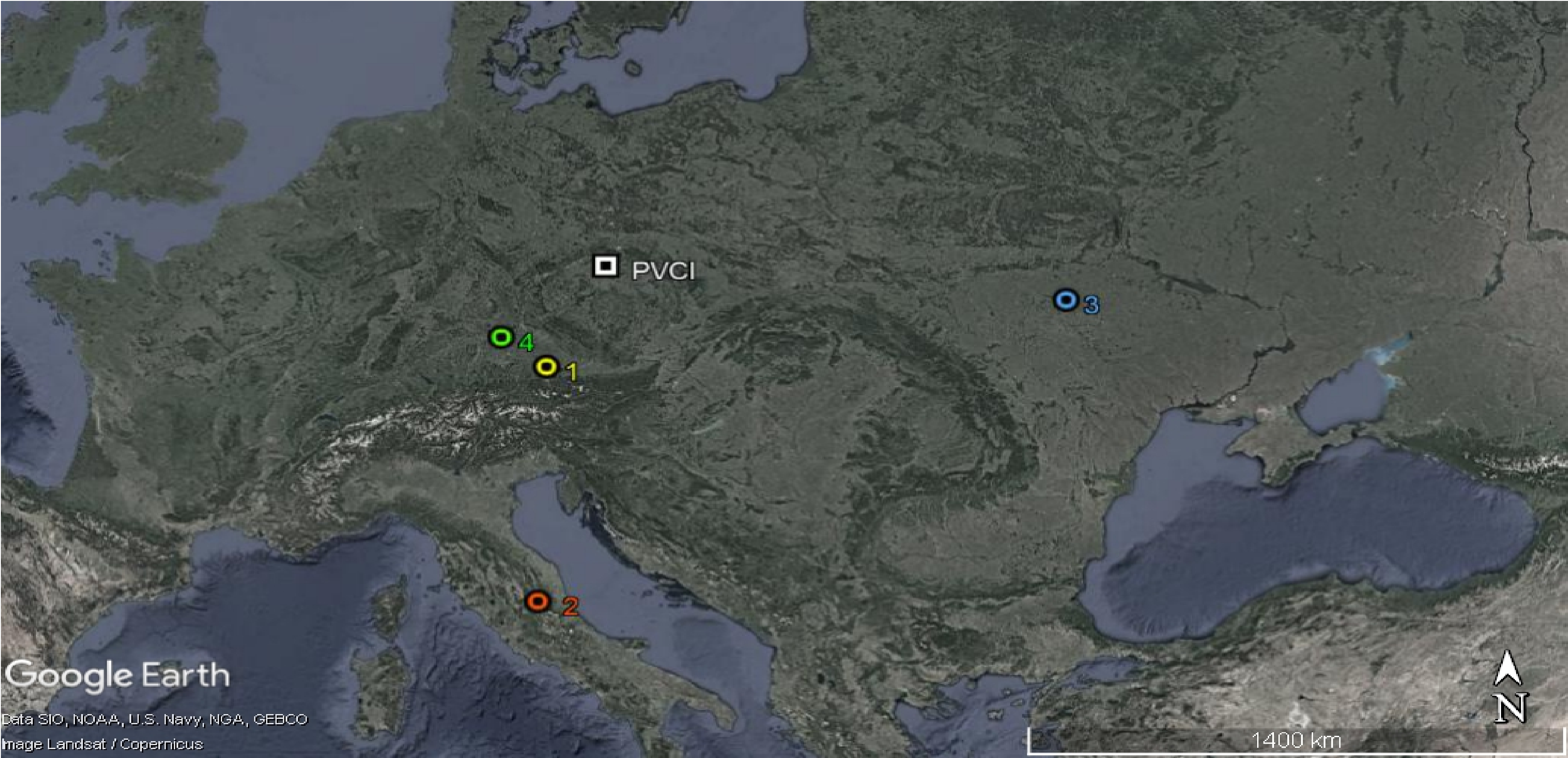


Fig.1. The array PVCI and the sources of the analysed infrasound events

1. 6 March 2016 fireball Stubenberg (EN060316)

The fireball entered Earth's atmosphere at 21:36:51 UTC. Its luminous trajectory lasted for 5.5 s. It started at the altitude of 86 km, the fireball ceased to radiate at the altitude of 17 km (CAS, Astronomical Institute). The signal arrived at PVCI at 21:51:12 UTC and at 21:52:19 UTC (Fig.1.1). GeoAc raytracing (Blom, 2014) predicts travel time of the signal between 15-20 min, i.e. expected signal arrival at 21:51-21:56 UTC. We assume we observed mainly signals from the lower part of the trajectory of the fireball (Fig.1.2-1.3)

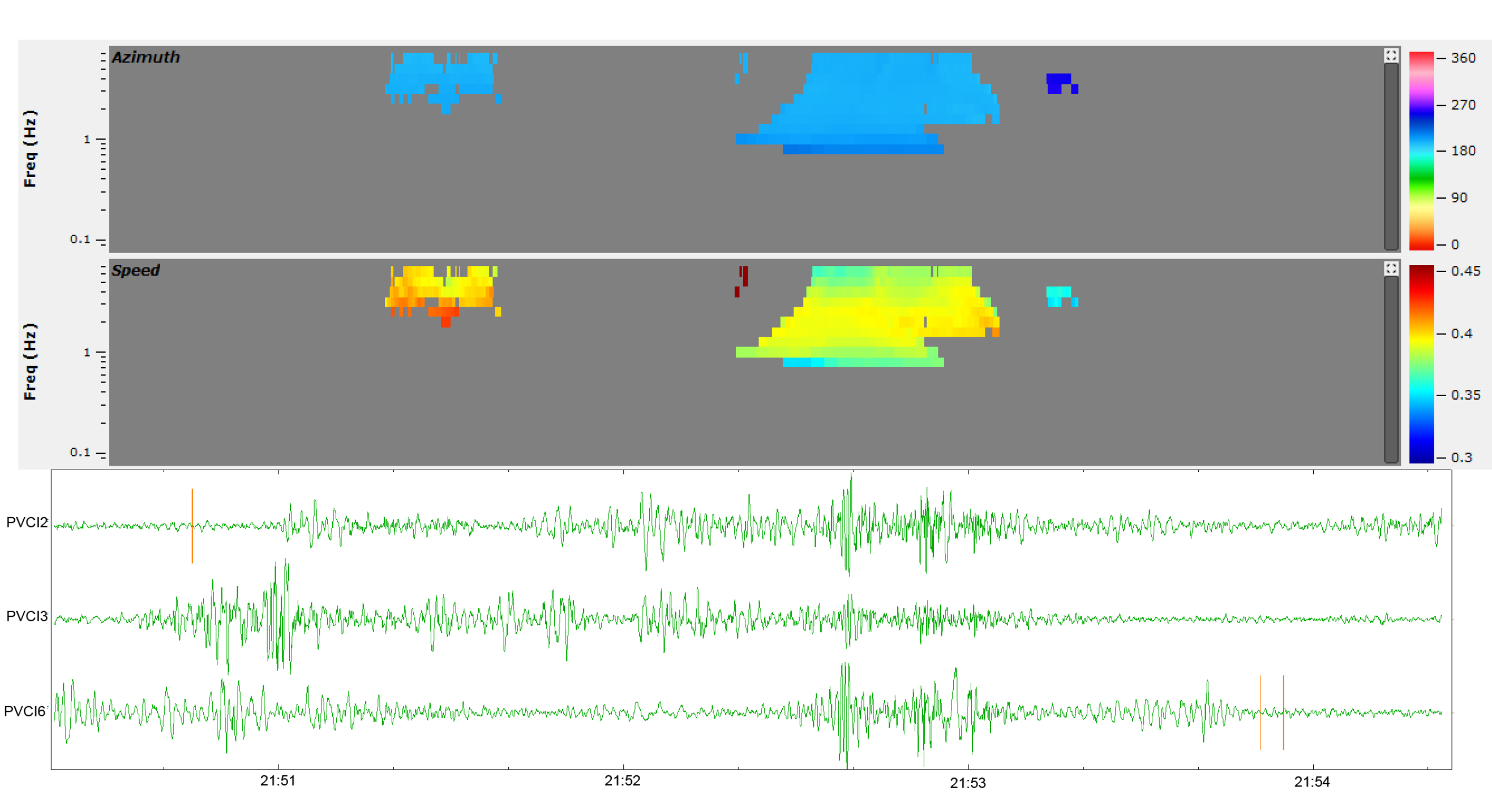


Fig.1.1. Infrasound detections on 6 March 2016 at 21:50-21:54 UTC. Top: azimuth of signal arrival. Middle: apparent velocity. Bottom: filtered signals, f=0.5-7 Hz

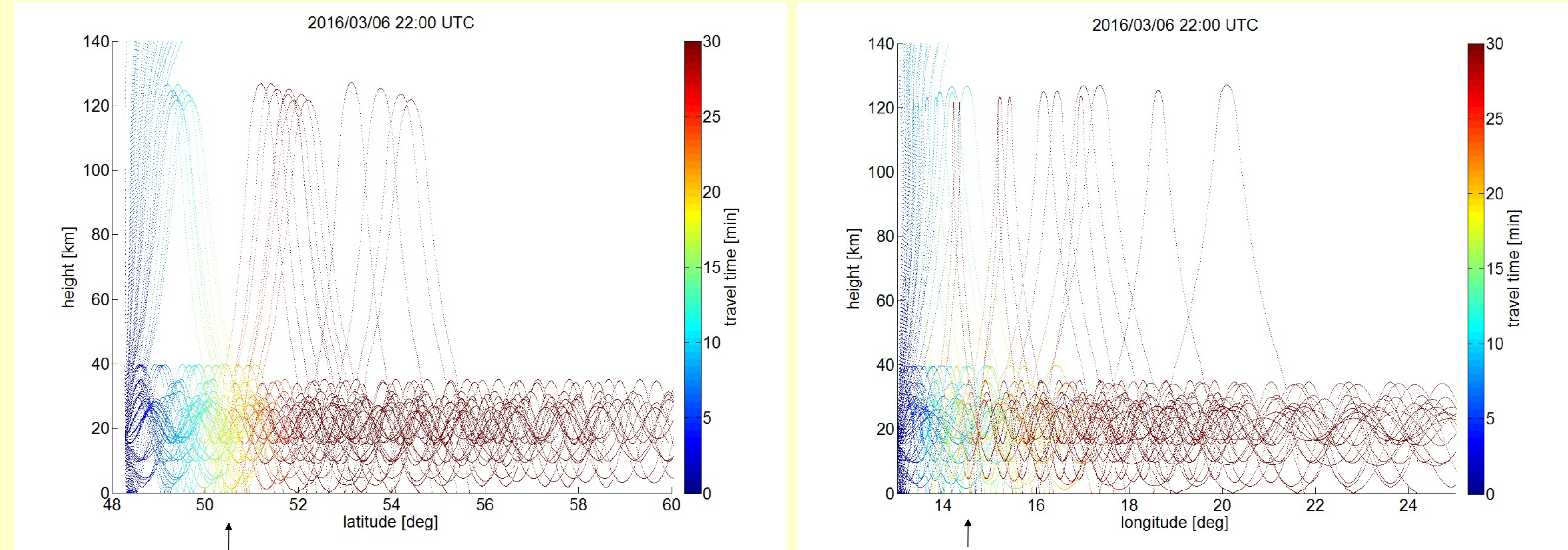


Fig.1.2 – 1.3 Simulation of infrasound propagation from an elevated source at the altitude of 17 km, signal frequency = 2 Hz. The arrows show the coordinates of the station PVCI. The raytracing was obtained from the GeoAc tool (Blom, 2014).

Introduction

- We present observations of short-duration infrasound signals at the station PVCI (50.53°N 14.57°E). The array is a member of the Central and Eastern European Infrasound Network since 2018. The array is equipped with three differential sensors of the type ISGM03. The detections were processed using the DTK-GPMCC software (Cansi, 1995; Le Pichon and Cansi, 2003) with the 1/3 octave settings.
- GeoAc tool (Blom, 2014) was used to model the propagation of infrasound. Input vertical atmospheric profiles were estimated using NRL-MSISE-00 (Picone et al., 2002) and HWM93 (Hedin et al., 1996) models and from the reanalyses ERA5 and MERRA2.
- Stratospheric data (overview maps of temperature, zonal winds and meridional winds) were obtained from ERA5, 1 hourly dataset for each incident.
- Analysis of the fireball Stubenberg (EN060316) was published by the Czech Academy of Sciences, Astronomical Institute

2. 24 August 2016 earthquake in central Italy

The earthquake of the magnitude 6.2 occurred at 01:36:33 UTC. PVCI detected infrasound arriving from the epicentre at 02:23:31-02:40:22 UTC. From the estimated celerity of 0.308 km/s, we inferred that the signal propagated in the stratospheric waveguide. The expected back-azimuth was 187°. The median of the observed back-azimuths was 196°, within the accuracy of the array.

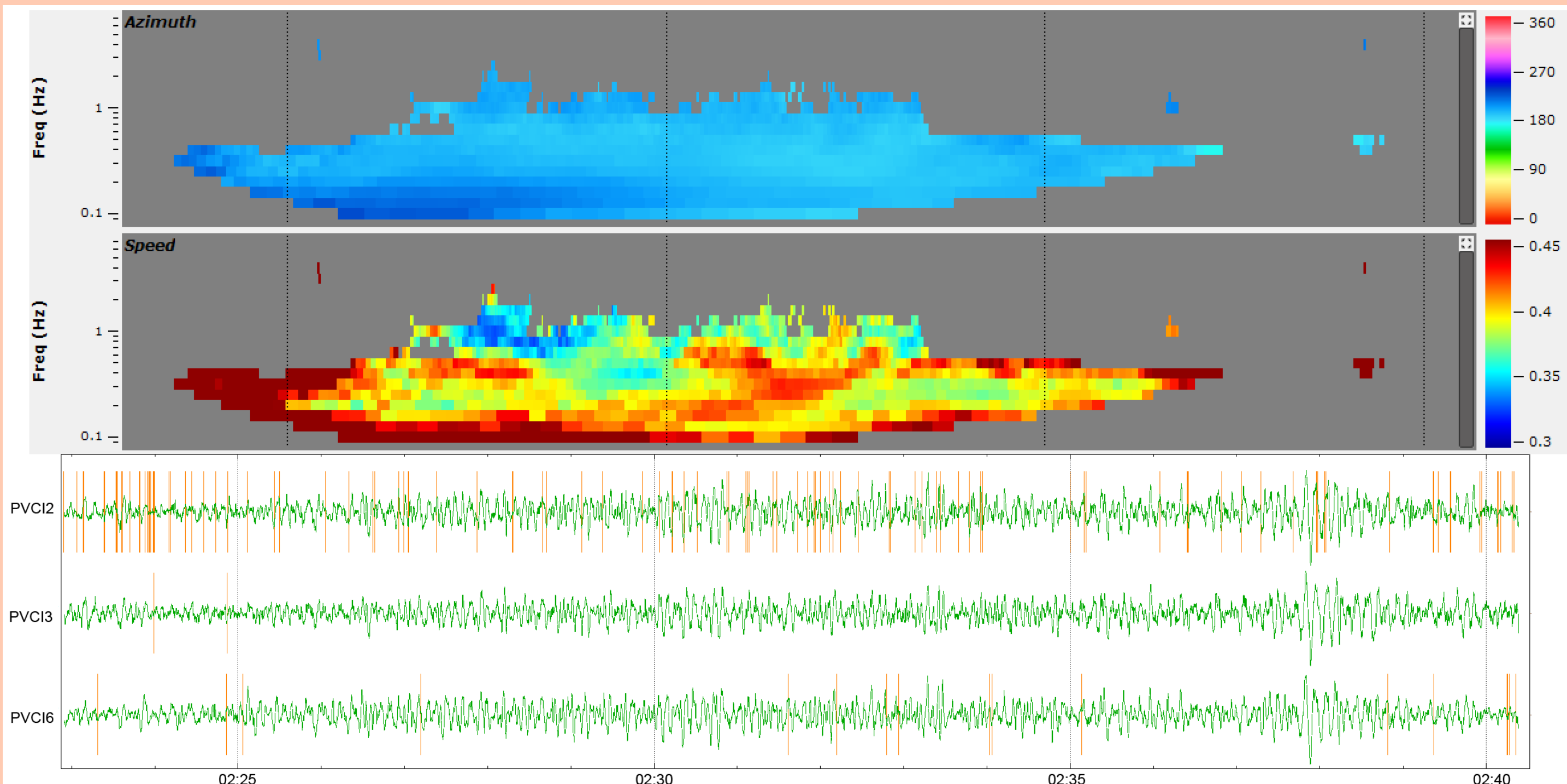


Fig.2.1. Detections of infrasound from the epicentre, 24 August 2016 at 02:23-02:40 UTC. Top: azimuth of signal arrival. Middle: apparent velocity. Bottom: filtered signals, f=0.1-2 Hz.

3. 26 September 2017 ammunition depot explosions in Kalynivka

A series of accidental explosions occurred in the ammunition depot in Kalynivka. Signals of the explosion at 19:59:27 UTC and of the explosion at 22:14:42 UTC were registered at PVCI at 21:02:26 UTC and at 23:16:35 UTC. PVCI distance from the sources was ~1000 km. The expected azimuths of signals arrivals were ~90°.

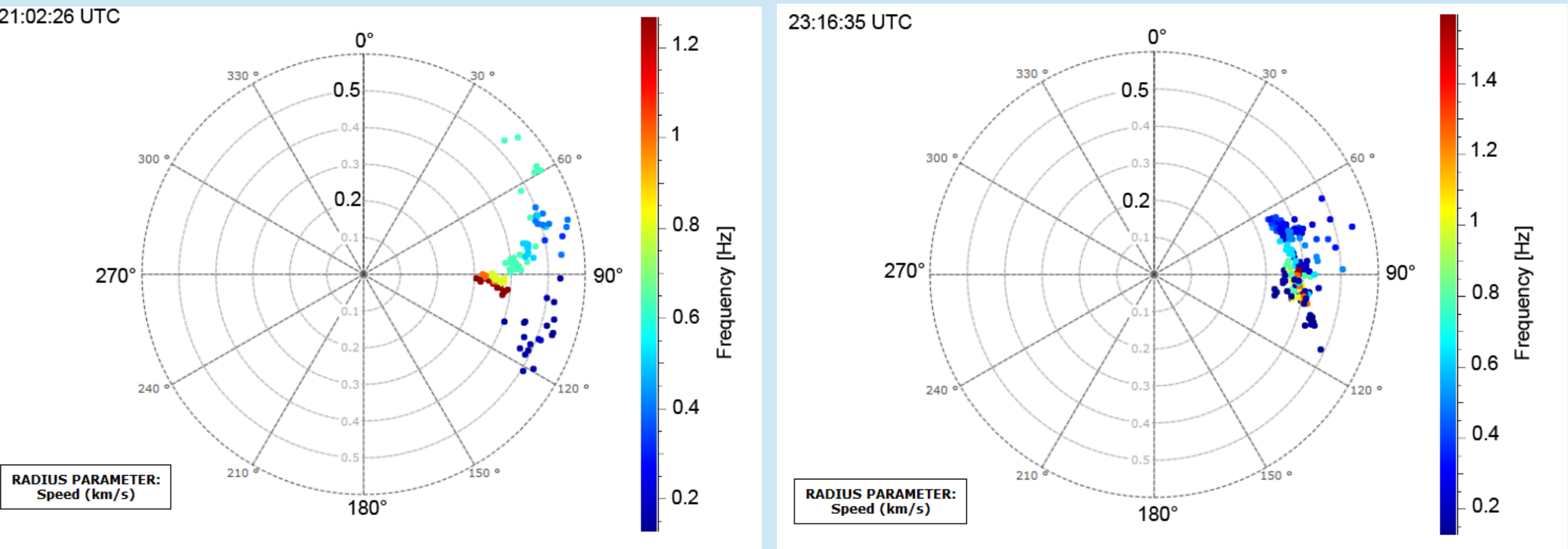


Fig.3.1-3.2 Infrasound detections on 26 September 2017 at 21:02:26-21:05:57 UTC (left) and at 23:16:35-23:21:46 UTC (right). The dots represent the detection pixels.

References

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4. 1 September 2018 explosion in the refinery near Ingolstadt

The explosion occurred at 03:11:45 UTC. The signal was detected at PVCI at 03:26:12 UTC (Fig.4.1) from the mean azimuth of 240°. The distance from the source to PVCI is 292 km. Signal celerity of 0.337 km/s indicates that it was refracted in the troposphere. Signal propagation to the north-east can be supported by strong north-eastward wind at altitudes around 8-9 km (Fig.4.2).

The event was recorded also by the other CEEIN stations PSZI, BURARI, and IPLOR. The long range propagation of the signals to the east can be supported by conditions in the middle stratosphere; westerly winds were blowing over Europe at altitudes ~25-30 km (30-10 hPa, Fig.4.3.)

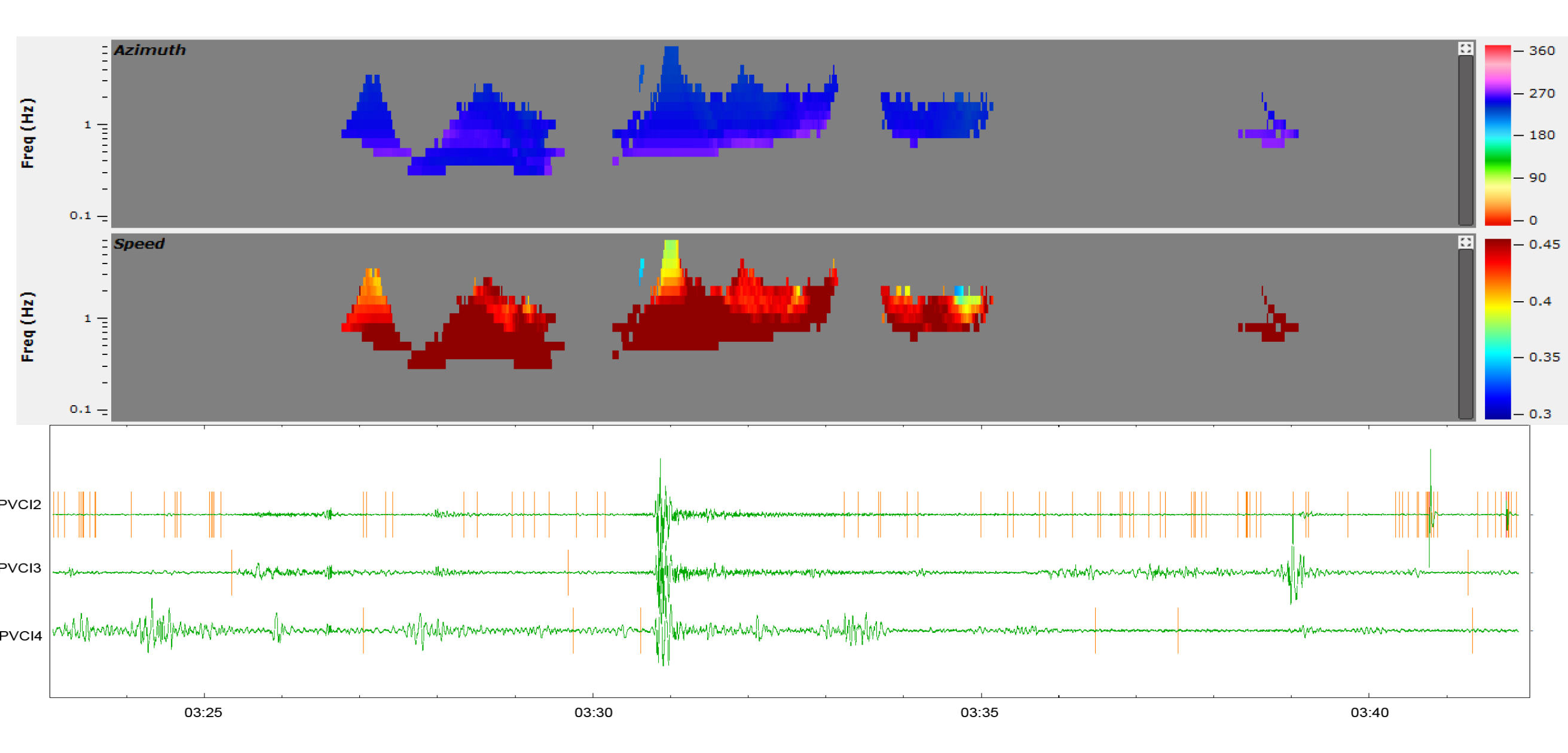


Fig.4.1. Infrasound detections on 1 September 2018 at 03:23-03:42 UTC. Top: azimuth of signal arrival. Middle: apparent velocity. Bottom: filtered signals, f=0.2-7 Hz

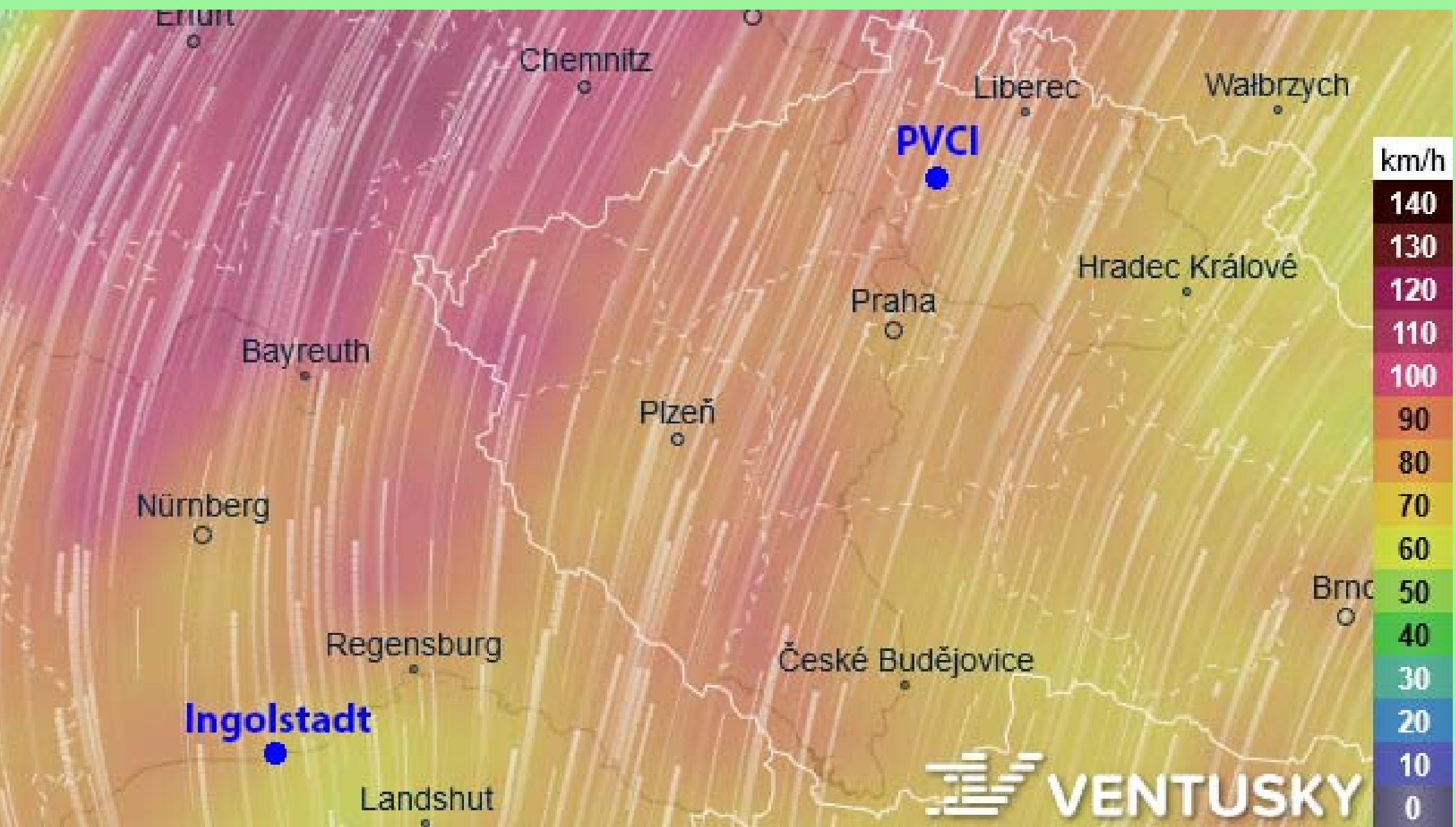


Fig.4.2. Wind speed at the pressure level 300 hPa (~9000 m) on 1 September 2018 at 03:00 UTC. Source www.ventusky.com

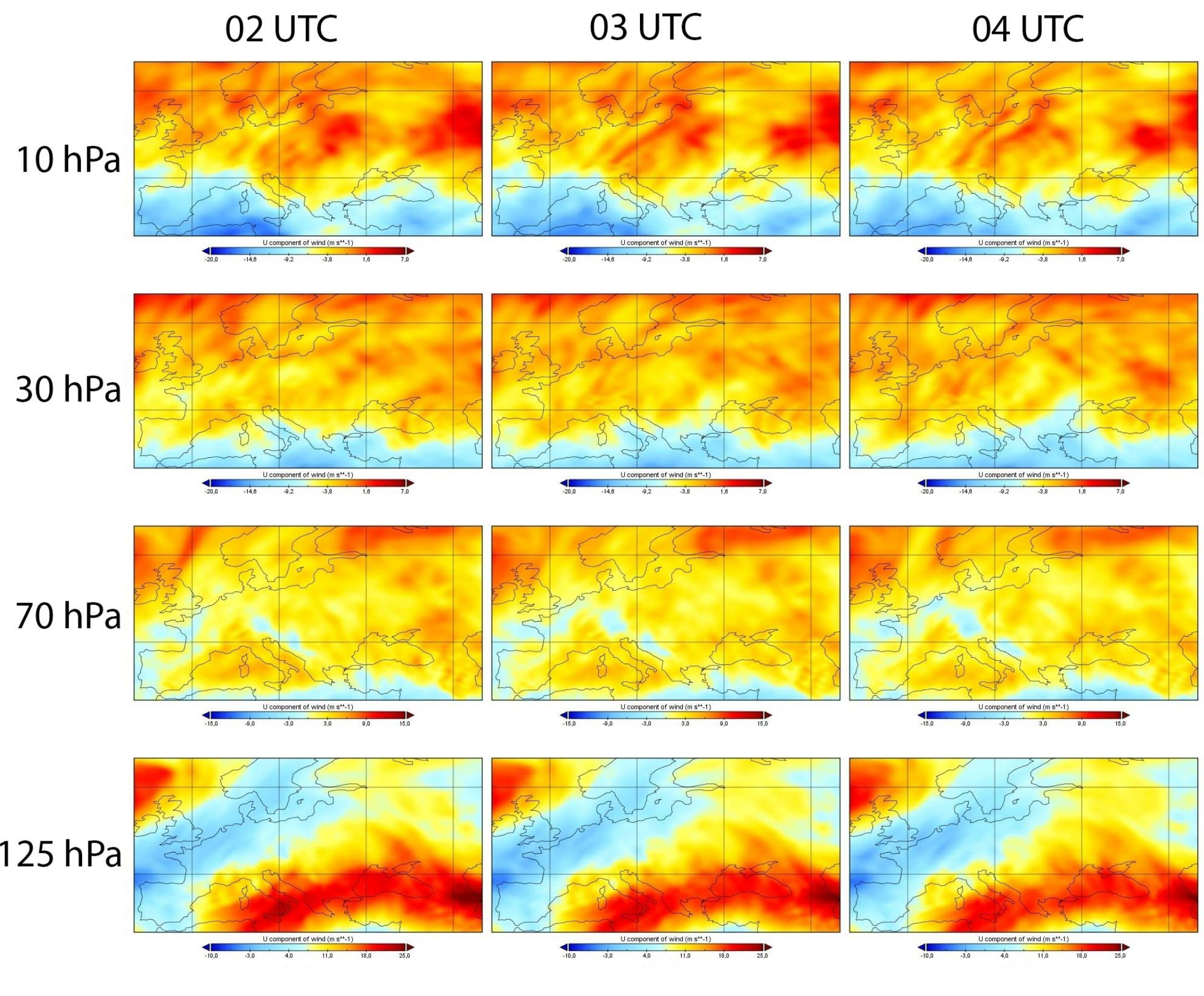


Fig.4.3. Zonal winds at altitudes of ~15-30 km on 1 September 2018 at 02-04 UTC. Yellow and reddish colours indicate westerly winds, white and bluish colours indicate easterly winds. Data were obtained from ERA5 reanalysis.