Observed Infrasonic Signals of Auroral Electro Arcs Detections at I37NO Station in 2020

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Abstract

In the polar latitudes regions, both the Northern and Southern Hemispheres of the Earth, one of the natural phenomena observed periodically is the occurrence of auroral displays in the sky. Low frequency signals *are* generated with the production of the auroral electrojet arcs in the atmosphere which are sensitive to microbarometer sensors of the infrasound array network when the wind direction favours their propagation for detection. Such event detection though non-treaty relevant, is vital for assessing the capability of the array network for the verification regime. In 2020, the observed infrasound signal detection from the auroral occurrences in the atmosphere over Northern Norway was studied for their propagation parameters. The frequency content of the infrasound signals associated with these auroral electrojet arcs was <0.1 Hz, typical of this source. They showed pulsating infrasound signals with trace velocities <1 km/s. The signals observed generally showed azimuths indicative of a direct line of source overhead in the atmosphere.

Introduction

Frequencies <20 Hz is inaudible and refered to as infrasound. The infrasound signals from various sources are characteristic of the sources. A few signals have one constant main frequency (e.g. microbaroms: 0.2 Hz), while most infrasound signals have frequencies of varying range [1]. In the upper atmosphere in the polar latitudes (both Northern and Southern) regions, auroral arcs display natural-coloured light *as a result of electrojet arcs interactions in the atmosphere* (fig. 1). During the auroral electrojet arcs display, infrasound signals are generated in the process, due to sound pressure fluctuations in the atmosphere [2]. These signals are propagated and recorded by micobarometer sensors of the IMS stations periodically.

Fig. 1 Auroral arcs display in the sky

2. IMS Infrasound Monitoring Station I37NO

The IMS infrasound network has 53-stations currently certified and operating out of the planned 60-station network distributed across the world. I37NO station is part of the network. These network of infrasound sensors monitors low frequency acoustic signals from explosion triggered sources either natural or man-made [3]. It is located at Bardufoss in northern Norway (table 1 and fig. 2). It consists of 10-element array (fig. 2) with main array enclosing a centered triangular sub-array. The pentagonal main array has average spacing of 1km surrounding a triangular sub array with average spacing of 360 m [4]. In real time recorded data is transmitted to IDC in Vienna.

Table 1 General description of the certified I37NO infrasound station

Station	Location	Date of Certification	No. of Elements	Array Element Layout	General Site Description
IS37	Bardufoss, Norway	19-12-2013	10-element	Centered irregular triangle array	Forest, flat area

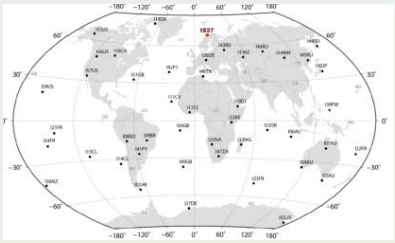

Fig. 2 Location of I37NO infrasound station in the IMS network

3. Infrasound Signals from Auroral Electrojet Arcs

Infrasound signals associated with auroras have been explained using two hypothesized of generating mechanisms. Infrasound signals from aurora are often impulsive, generated the by supersonic motion of auroral arcs that contain strong electrojet currents; it is this motion that sets up a shock wave large enough to be observed on the ground [5]. Secondly, a newer hypothesis is that pulsating aurora infrasound waves are generated by the heating of the atmosphere (by the precipitation of auroral electrons) within pulsating auroral patches in thin layers of the lower ionosphere. Observed to exhibit quasi-continuous signals, often with the durations of hours, have amplitudes of 50–200 mPa, and with high trace velocities [5].

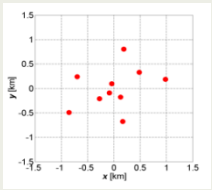

Fig. 3 I37NO station geometry

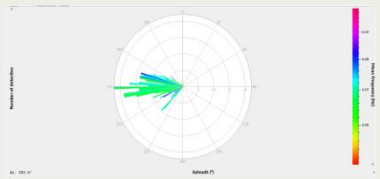

Fig. 4b Infrasound detection of auroral arcs at the I37NO station

4. Detection of Infrasound Signals of the Aurora Event

Pulsating infrasound signals related to the auroral arcs *were* observed over places in the Northern Norway in 2020 by processing using DTK DIVA and GPMCC algorithm software. Processed at very low frequency range of 0.01 – 0.1 Hz characteristics detections of acoustic signals related to be auroral electrojet arcs [3, 5] displayed overhead in the atmosphere were detected at I37NO (fig. 5).

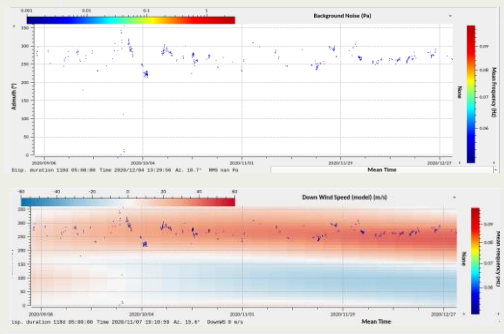

Fig. 4a Infrasound detection of auroral arcs at the I37NO station in 2020

5. Conclusion

At very low frequencies <0.1 Hz, infrasound signals were observed to be associated with auroral electrojet arcs displays overhead in the sky in Northern Norway. With observed azimuth descriptive of a direct line of source overhead in the atmosphere.

References

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