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Infrasound Signals Detected of Auroral Electrojet Arcs in 2020 by Infrasound Stations along the Arctic Circle Region

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INTRODUCTION AND MAIN RESULTS

This presentation looks at auroral arcs displays overhead in the sky as a natural phenomenon in the Arctic Circle region, periodically observed and detected by the IMS infrasound stations I18DK, I37NO and I3US. The infrasound signals associated with these auroral arcs displays in 2020 were detected at very low frequencies <0.1 Hz by these stations. They showed a wide range of azimuths of detection for the source(s), indicative of a randomly moving source(s) in the atmosphere in the preliminary study.

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Introduction

At low frequencies (<20 Hz),each infrasound source has its own characteristic frequency range. While only a few of these infrasound signals have one constant main frequency (e.g. microbaroms: 0.2 Hz), mostly they have frequencies of varying range [1]**.** At certain periods in the year, in the upper atmosphere ~~in~~ *of* the polar latitudes regions, auroral arcs are characterized by a display of natural-coloured lights. This colourful display of lights in the sky is mostly seen in the high altitudes regions such as in the Arctic and Antarctic [2]. Infrasound due to its low frequency can propagate with relatively minimum energy loss and therefore can be applied to detect and study sources at long distances [3]. Low frequency acoustic signals are generated in the atmosphere when auroral electrojet arcs occur, that results in sound pressures fluctuations in the sky. The infrasound signals are propagated and can be recorded by micobarometer sensors of the IMS stations periodically.

IMS Infrasound Monitoring Network

The IMS network of infrasound sensors monitors low frequency acoustic signals from explosion triggered sources either natural or man-made [4]. With a planned network of 60-station, currently 54-stations are certified and operating, distributed globally. They are array stations with apertures in the range from 1 to 3 km. The three Arctic Circle region IMS stations are I18DK, I37NO and I53US, located at Qaanaaq in Greenland, Denmark; Bardufoss in Norway; and Fairbanks, Alaska, United States of America respectively (fig. 1). The I18DK station comprises 8-element array, triangular with a component at the centre and a quadrangular sub-array; I37NO station is 10-element array with main array enclosing a centered triangular sub-array; and I53US is 8-element array, pentagon with a centered triangular sub-array.

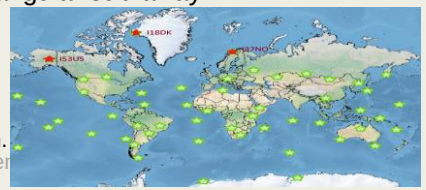

Fig 1. Map showing the location of IMS infrasound stations in the Arctic Circle region.

Methods/Data

Aurora and Infrasound Signals Generation

During the occurrence of aurora the infrasound signals generated have been explained using two generating mechanisms hypothesized. Aurora generated infrasound signals are often impulsive, generated 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 signals 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].

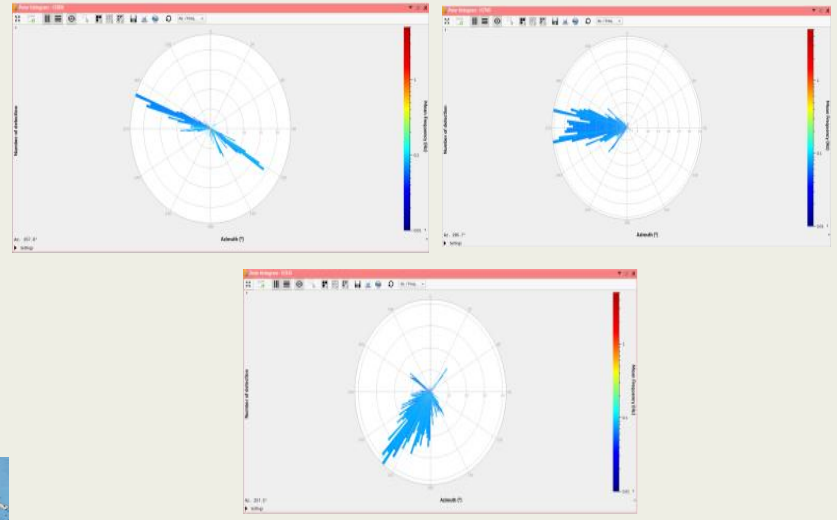

Fig. 2 Polar histogram of azimuths aurora detections at I18DK, I37NO and I53US stations.

Results

Detection of Infrasound Signals of the Aurora Event

The infrasound signals associated with the auroral arcs generated in the atmosphere over places in the Arctic Circle region in 2020 were processed using DTK DIVA and GPMCC algorithm software. The infrasound detection signals at I18DK, I37NO and I53US stations retrieved using the CTBTO external database link were processed at very low frequency range of 0.01 – 0.1 Hz, characteristic of detections of the acoustic signals associated to auroral electrojet arcs [3, 5] displayed overhead in the respective skies. They are propagated with trace velocities <1 km/s. The detection analysis preliminary, showed a wide range azimuths of detection for the source(s) (fig. 2, 3), indicative of a randomly moving source(s) in the atmosphere.

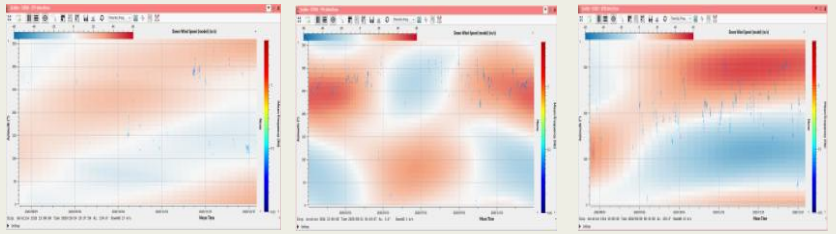

Fig. 3 Downwind direction of signal detections at I18DK, I37NO and I53US stations.

Conclusions

Auroral arcs displays overhead in the sky as a natural phenomenon in the Arctic Circle region is periodically observed and detected by the IMS infrasound stations I18DK, I37NO and I3US. The infrasound signals associated with these auroral arcs displays in 2020 were detected at very low frequencies <0.1 Hz by these stations. They *showed a* wide range of azimuths of detection for the source(s), indicative of a randomly moving source(s) in the atmosphere in the preliminary study.

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