THE 22 SEPTEMBER 2020 FIREBALL: INFRASONIC DETECTION OF A RARE EARTHGRAZER. E. A. Silber¹, M. Ronac Giannone¹ and D. C. Bowman¹, ¹Sandia National Labs, Albuquerque, NM, USA (esilbe@sandia.gov).

Introduction: Very bright meteors, or fireballs, are generally produced by objects larger than ~10 cm in diameter [1,2]. Fireballs are capable of generating shockwaves that can decay to very low frequency acoustic waves, also known as infrasound [2,3]. Meteoroids entering the atmosphere at such shallow angles that they ‘graze’ the upper regions of the Earth’s atmosphere are known as earthgrazers. There are very few well-documented observations of earthgrazers recorded in literature [4]. It is uncommon for high-altitude (≥100 km) fireballs to produce infrasound detectable at ground-based stations, although a few instances had been documented in literature [3]. Here we report infrasound observations of a rare earthgrazing fireball.

The 2020 Earthgrazer: A rare horizon-to-horizon earthgrazer entered at ~34 km/s over northern Europe on 22 September 2020 at 03:53:40 UTC. It captured attention of many eyewitnesses and was recorded by numerous ground-based all-sky cameras (Fig. 1) [5]. As per the initial analyses provided by the Global Meteor Network [6], the luminous path of the earthgrazing fireball commenced over Germany and terminated over the UK (Fig. 2), at an altitude of 101 km and 107 km, respectively. The deepest point of entry was ~90 km [6].

![Fig. 1: All-sky camera image of the earthgrazer. Image credit: Cees Bassa](image1)

Fig. 1: All-sky camera image of the earthgrazer. Image credit: Cees Bassa [5].

![Fig. 2: Ground track of the earthgrazing fireball. Infrasound stations that detected the event are also shown.](image2)

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Infrasonic Detection: Despite its high-altitude and apparently silent (to humans) passage, the earthgrazer was detected by infrasound stations EXL, DBN, and CIA of the Royal Netherlands Meteorological Institute (KNMI) network [7] several minutes after it had entered the atmosphere. Fig. 3 shows the detection at the EXL array. The peak-to-peak amplitude was 0.26 Pa.

The infrasound signatures at all three arrays exhibited an N-wave appearance, diagnostic of a ballistic shock. At EXL, which was in the close proximity to the fireball trail, the apparent signal arrival was nearly vertical, consistent with our hypothesis that the signal was ballistically generated. The average dominant signal period across the three stations was 1.43±0.20 seconds. Using the AFTAC energy relations adapted to bolides [8], the energy release was estimated at 18±8 tons of TNT equivalent across the three stations. Our preliminary estimate places the meteoroid diameter at ~1 m.


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