

multi-station infrasound detections for characterization of high-altitude fireballs

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A rare class of meteoroids known as earthgrazers enter the atmosphere at shallow angles, with some returning to space after a brief hypersonic flight through the upper atmosphere. We present the detection and analysis of infrasound from a rare horizon-to-horizon earthgrazer event observed over northern Europe on September 22, 2020. The fireball generated ballistic shockwaves which were detected by three stations of the Royal Netherlands Meteorological Institute (KNMI) network. Despite the high-altitude trajectory, the pressure wave reached the ground at low frequencies detectable by infrasonic instruments. The infrasound signal exhibited a high trace velocity, indicative of near-vertical arrival angles, with most energy concentrated <4 Hz. The modeled and observational data revealed that infrasound emanated from three distinct parts of the fireball trail. This finding marks a significant milestone, representing the first documented evidence of capturing ballistic shocks from multiple distinct parts of the trail of a high-altitude fireball using infrasound. Another notable aspect of this fireball was that it was detected despite its very high altitude (>90 km). This event reinforces the potential of infrasound as a tool for monitoring and detecting unconventional high-altitude sources, such as fireballs.

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E-mail

esilbe@sandia.gov

Primary authors: Dr SILBER, Elizabeth (Sandia National Laboratories (SNL)); RONAC GIANNONE, Miro (Sandia National Laboratories); BOWMAN, Daniel (Sandia National Laboratories); Ms ALBERT, Sarah (Sandia National Laboratories (SNL))

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