

The Chelyabinsk meteor:

Massive blast detected by 17 infrasound stations



The CTBTO's infrasound station IS18 in Qaanaaq, Greenland, one of the stations that detected the Chelyabinsk meteorite on 15 February 2013. Photo courtesy of Owen Kilgour.

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On 15 February 2013 at 03:22 GMT, 17 of the CTBTO's infrasound stations detected signals from an object that entered the atmosphere and disintegrated in the skies over Chelyabinsk, Russia. The furthest station to record the sub-audible sound was 15,000km away in Antarctica. How did data from these infrasound stations allow scientists to refine their estimates for the size of the meteor?

A great advantage of infrasound is that data are quickly available and energy estimates can be made relatively quickly. Given the speed

of the meteoroid, its mass could be calculated directly from the energy. There was tremendous interest in the size of the object, but the video records are very difficult to calibrate, so infrasound was the first publicly available, accurate size estimate.

Why did the meteor go undetected until it hit the atmosphere?

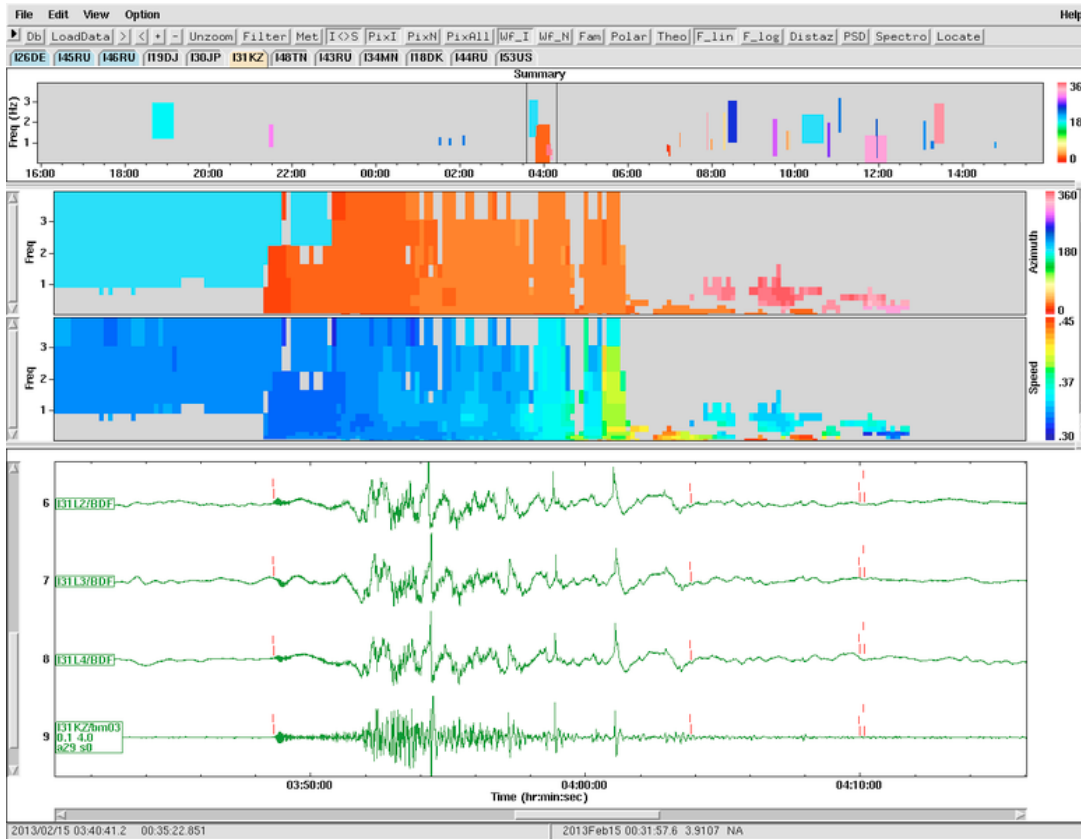
Very few objects in this size range are currently tracked. There are likely hundreds of thousands of objects this size in orbits which intersect the Earth's, but they are faint objects, and currently operating surveys cannot track a meaningful number of them (though some planned surveys may allow many of them to be discovered and monitored). An object smaller than this one was observed for about a day before it struck the Earth in 2008 (object TC3 2008, which fell in

the Sudanese desert), but that is the only time an object has been observed in space and subsequently collided with the Earth. A detection just before impact was not possible for this object, because it approached the Earth from the direction of the sun, and was obscured by the sun's glare.

How often would you expect an event of this magnitude to occur and how large was it in comparison with the bolide that exploded over Sulawesi, Indonesia, in October 2009, which was recorded by 15 of the CTBTO's infrasound stations?

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Just days earlier on 12 February 2013, the Democratic People's Republic of Korea (DPRK) claimed that it had conducted a nuclear test. A total of 94 of the CTBTO's seismic sensors registered



A visual representation of the infrasound waves and parameters by the CTBTO's International Data Centre, from the fireball recorded by the CTBTO station in Kazakhstan.

the event, which measured 4.9 in magnitude. In addition, two infrasound stations that are part of the network also detected signals. This was the first time that the CTBTO's infrasound stations had registered a nuclear test. How large would you estimate the size of the explosion over Chelyabinsk to have been in comparison with the nuclear test that the DPRK claims to have carried out?

I don't know the energy of the 12 February event, but the meteor was certainly orders of magnitude more energetic.

Since the Comprehensive Nuclear-Test-Ban Treaty (CTBT) opened for signature in 1996, infrasound technology has experienced a renaissance. While the primary purpose of CTBTO infrasound monitoring is to monitor compliance with the CTBT, the data also offer a range of potential civil and scientific applications. In addition to providing information on meteors entering the atmosphere, the data could be used to monitor aurorae, chemical explosions, volcanic ash clouds as well

as contributing to climate change research. What more do you think scientists can learn about the Russian meteor explosion on 15 February 2013 from CTBTO infrasound data?

The infrasound data provided excellent near-real-time information

on the size of the impactor. With more refined models of the atmospheric conditions at the time, the various parts of the signal may be associated with fragmentation events and points along the trail, giving a better idea of what was happening to the object as it disintegrated in the atmosphere.

BIOGRAPHICAL NOTES



MARGARET CAMPBELL-BROWN is an Associate Professor in the Department of Physics and Astronomy at the University of Western Ontario, Canada. Her research focuses on small bodies in the solar system, particularly meteoroids. Current research topics include the interaction of meteoroids with the Earth's atmosphere for large and small impactors, characterizing the sporadic meteoroid environment, and high resolution studies of meteoroid ablation to determine the composition and structure of meteoroids.