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Seismic and infrasonic analysis of the 9 March 2014 fireball passage over South Korea

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A bright fireball was observed by many people on the evening of 9 March 2014 in South Korea, and the energy associated with the fireball event was also recorded at 19 seismic stations and 7 infrasound stations in the country. Using the impulsive seismic signals, we calculated the possible extent of the sonic source of the fireball by assuming point- and line-source models. A comparison of the observed arrival times of the seismic signals with predicted arrival times from two simplifying source models indicated that the source extent of the sounds was better explained by a line-source model than by a single-point-source model in the atmosphere. The estimated parameters of the fireball's sonic trajectory, incorporating propagation dependent on the speed of the shock wave, were estimated to be an azimuth arrival angle of 313.5° clockwise from the north and an elevation arrival angle of 44.5° above the Earth's surface, with a source time of 11:04:51 UTC at which the predicted trajectory met the Earth's surface. The estimated ground impact point was about 2 km offset from locations where meteorites associated with the fireball were found. Infrasound signals from the fireball event had different features depending on the propagation distances. For stations locating more than 300 km away, multiple ray paths made the signals appear to be dispersed and of long duration because the rays were predominantly refracted from the stratosphere. In nearby infrasound stations, the pulse N-waves indicated a direct impact from the shockwave, with little refraction in atmosphere. The kinetic local-source energy generating the sound was estimated to be about 0.8 tons TNT, based on the infrasound measurements and semi-empirical relations developed for the point- and line-source models.