URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Pajala Fireball

J. Vierinen[(1)(5)], T. Aslaksen[(2)], J. Chau[(3)], M. Gritsevich[(9)], B. Gustavsson[(1)], D. Kastinen[(4)], J. Kero[(4)], A. Kozlovsky[(5)], T. Kværna[(8)], D. McKay[(7)], S. Midskogen[(6)], T. Ulich[(5)], and K. Vegum[(2)(6)]
(1) University of Tromsø, Norway
(2) Tromsø Astronomy Union, Norway
(3) Institute of Atmospheric Physics, Germany
(4) Swedish Institute of Space Physics, Sweden
(5) Sodankyla Geophysical Observatory, Finland
(6) Norwegian Meteor Network, Norway
(7) University of Turku, Finland
(8) NORSAR, Norway
(9) University of Helsinki, Finland

Observations of the atmospheric effects of larger fireball and bolide class meteors are relatively sparse, mainly due to their seldom occurrence. Larger meteor events are known to be associated with metallic ion chemistry, ionospheric irregularities, ion-neutral coupling, intense fragmentation, and dusty plasma phenomena. This study presents optical, multi-wavelength radar, and infrasound measurements of a large ≈ -13 apparent magnitude daylight fireball that occurred on December 4th 2020 at 13:30:37 UTC. The fireball was recorded with two geographically separated meteor cameras, allowing an accurate trajectory to be determined. The orbital parameters indicate that the object has a Comet Encke-like orbit, with the velocity and radiant consistent with the Northern Taurid meteor shower. The dynamic mass estimate based on velocity and deceleration was found to be between 15 and 170 kg. Two VHF specular meteor radars observed a six minute long non-specular range spread trail echo as well as a head echo. Bi-static interferometric range-Doppler analysis of the meteor trail echoes allowed estimation of the horizontal wind altitude profile as well as tracking of the gradual deformation of the trail over time due to neutral wind shear. The meteor trail plasma was also observed with a bi-static ionosonde system as a sporadic E type ionogram trace that lasted for an hour. The estimated zonal wind shear was found to be favorable to formation of a sporadic E layer, and it is also likely that the vertical convergence of the metallic ions also contributed to the longevity of the trail observed with meteor radars, as the part of the trail that was observed longest occurred at the altitude of the zero-crossing of the zonal wind shear. Infrasound observations showed a relatively weak infrasound emission created by the atmospheric entry of the meteoroid, indicating that the object burned up completely at a relatively high altitude. Our results show that interferometric radar measurements of long lived non-specular meteor trails produced by larger meteoroids can be a good measurement of the path of the meteor, and can therefore be used for radiant determination. Interferometric range-Doppler measurements of these types of long lived range-spread meteor trails can also be useful for observing the neutral wind. A dedicated multi-static meteor radar campaign conducted during a meteor shower time period is proposed to further study the role of horizontal wind shear for meteor trail duration, and to study neutral dynamics of the mesosphere with a high temporal and spatial resolution.