2020 URSID METEOR SHOWER ACTIVITY FROM VIDEO RECORDINGS AND FORWARD-SCATTER ECHO DETECTIONS. E. Peña-Asensio[1,3], J.M. Trigo-Rodríguez[2,3], A. Rimola[1], J. Izquierdo[4], M. Chioare[5], L.G. Morillas[6], A. Pérez[6], J.A. Reyes[6], S. Pastor[6], V. Cayuelas-Mollá[6], A.J. Robles[6], A. Lasala[6], P. Pujols[6], J.C. Tejedor[6], M. Aznar[6], L. Orduña[6], J. Ribas[6], D. Rodríguez[6], A. Carbonell[6], R. Domènech[6], V. Ibáñez[6], C. Guasch[6], A. Fernández[6], C. Alcaraz[6], and A. Oliva[6]. [1]Universitat Autònoma de Barcelona (UAB), Bellaterra, Catalonia, Spain. eloy.pena@uab.cat, [2]Institute of Space Sciences (CSIC), Campus UAB, Carrer de Can Magrans s/n, 08193 Cerdanyola del Vallés, Barcelona, Catalonia, Spain, [3]Institut d'Estudis Espacials de Catalunya (IEEC), Ed. Nexus, Barcelona, Catalonia, Spain, [4]Dpto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain, [5]Observatorio Astrofísico de Javalambre (OAJ), CEFCA, Teruel, Spain, [6]Red Española de Investigación sobre Bólidos y Meteoritos (SPMN).

Introduction: Since the 19th century, it is known that meteorites come from outer space, but falls are quite rare events [1]. The smaller range of meteoroids, going from tens of microns up to cm-sized, are constantly impacting the Earth's atmosphere, and most of them are cometary in origin [2]. As a result of the systematic observation of the sky, it has been possible to establish 112 regular meteoroid streams that produce known meteor showers every year [3]. Thanks to the techniques developed, the study of meteors allows more and more precise linking of meteoric events to parent bodies by physical-chemical properties and orbit similarity [4]. Meteor recording gives information about the origin of meteoroids and the continuous decay of asteroids and comets [5].

From an astrochemical point of view, meteoroid streams allow estimating the delivery of volatile-rich materials to Earth from periodic comets [6].

Cometary bolides are produced by cm-sized meteoroids that disrupt efficiently in the atmosphere due to the porous composition of comets based mainly on ices, rocks and organic components [7]. Nevertheless, thanks to the recordings, meteors that present a catastrophic disruption at the end of their atmospheric flight allow their dynamic strengths to be computed, extracting clues about the evolution and structure of comets [8]. This is exactly what happened in the Ursid event SPMN221220C (Fig. 1). Ursid shower is related to the Jupiter family comet 8P/Tuttle and takes place at the end of December, which complicates their observation due to the bad weather. However, SPMN network was able to capture this event from multiple stations and using different instruments.

Figure 1. SPMN221220C recorded from Estepa, Sevilla (left) and from La Aparecida, Alacant (center) and La Murta, Murcia (right).

Study case: The SPMN221220C event occurred on December 22th, 2020. SPMN network facilities videotaped from three stations, see Table 1 for coordinates.

Station	Longitude	Latitude	Alt.
Estepa	4º 52´ 36" W	37º 17´ 29" N	537 m
La Aparecida	1º 00´ 14" W	38º 04´ 54" N	35 m
La Murta	1º 40´ 32" W	38º 05´ 48" N	469 m

Table 1. SPMN stations recording the 221220C event.

We have analyzed the video recording using our software *3D-FireTOC*, which allows to detect the meteor motion, perform the astrometry, calculate the atmospheric trajectory and compute the heliocentric orbit. The reduction takes into account diurnal aberration, zenith attraction, light aberration, atmospheric refraction and extinction [9]. The atmospheric trajectory is depicted on Fig. 2.

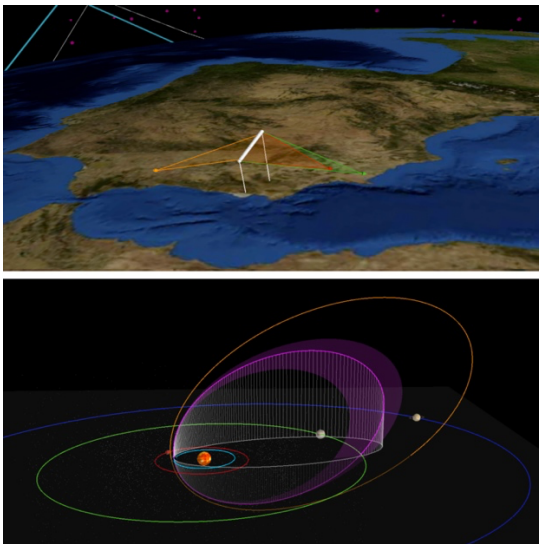

Figure 2. SPMN221220C atmospheric reconstruction (top). In purple the meteoroid heliocentric orbit, while in orange appears 8P/Tuttle parent comet orbit. The orbit of Earth appears in light blue, followed by the outer planets up to Saturn (dark blue).

The fireball started at a heigh of 110.83±0.13 km with a velocity of 34.29±0.12 km/s and suffered an explosion at 73.44±0.14 km having a velocity of 29.28±0.10 km/s (see Fig. 3). The aerodynamic strength results in 4.35±0.10 kPa. Both the speed, radiant and calculated orbital parameters point to a clear association with the Ursids, and the 8P/Tuttle parent comet (Fig. 2). The radiant, velocities and orbital parameters are shown in Table 1.

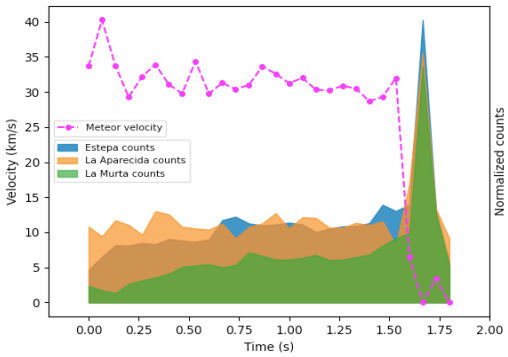

Figure 3. SPMN221220C observed velocity curve crossed with the normalized photometric counts.

We also recorded the meteor activity from Jaén and Fuenlabrada forward-scatter stations. Fig. 4 shows the data compared with that of 2019 Ursids recorded by the same stations.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	213.8±0.8	219.6±1.3	18.0±0.6
Dec. (º)	74.2±0.3	74.5±0.6	51.2±0.5
V_∞ (km/s)	34.29±0.12	32.41±0.13	39.6±0.3
Orbital parameters			
a (AU)	3.8±0.4	**ω (º)**	205.6±0.9
e	0.749±0.027	**Ω (º)**	270.425±0.006
q (AU)	0.9424±0.0028	**i (º)**	52.5±0.5

Table 2. SPMN221220C radiant data and orbital parameters.

The 2020 Ursids were not producing an outburst as predicted [1], but still provided a nice display. From the data collected (Fig. 4), an average flux of 20 echoes per hour and exhibiting a particular peak on the 21st and 22nd of overdenses echoes. The 2020 Ursids activity was even smaller than that of 2019, without any evidence of outburst.

Conclusions and future work: The 2020 Ursids have not produced a meteor outburst as predicted [1], but were composed of large meteoroids producing a nice fireball display. The maximum occurred at solar longitude 270.315º (J2000.0) with a meteoroid flux estimated from three video stations in the visual range up to magnitude +4 was 20 meteoroids/1000 km^2·h.

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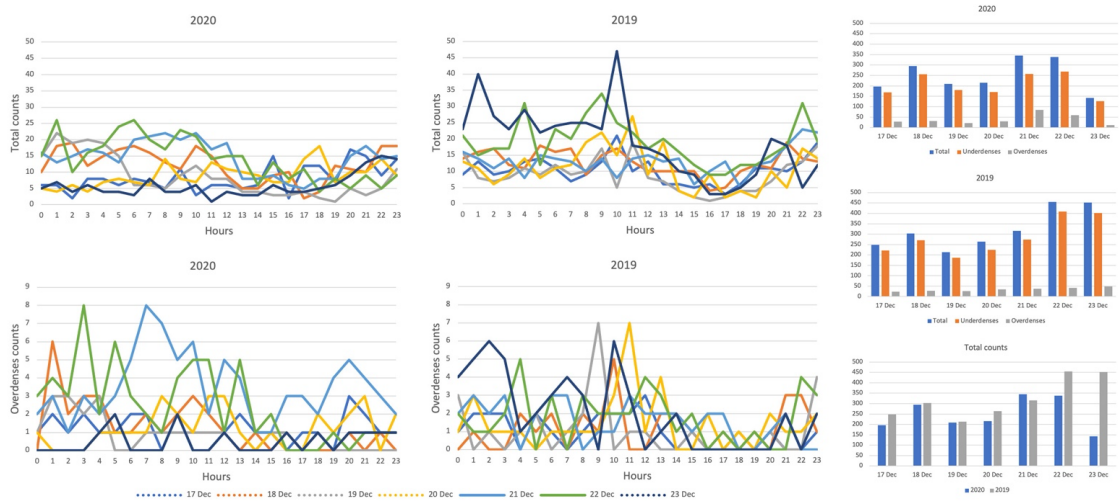

Figure 4. Forward-scatter comparison of 2020 and 2019 Ursids activity by days and hours.