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Colas, François ; Zanda, Brigitte ; Vernazza, Pierre ; Malgoyre, Adrien ; bouley, sylvain ; Maquet, Lucie ; Steinhausser, Asma ; Egal, Auriane ; de Vet, S.J.; More Authors

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François Colas[1], Brigitte Zanda[2], Pierre Vernazza[3], Adrien Malgoyre[3], sylvain bouley[4], lucie maquet[1], Asma Steinhausser[2], Auriane Egal[5,1], Jérome Gattacceca[6], mirel Birlan[1], Karl Antier[7], Sebastien Bouquillon[8], Daniele gardio[9], Björn Poppe[10], Jim Rowe[11], Ashley King[12], Hervé Lamy[13], Salma Sylla[14], Sebastiaan De Vet[15], and zouhair Benkhaldoun[16]

[1]Observatoire de Paris, IMCCE, Paris, France (francois.colas@obspm.fr)
[2]Muséum national d'Histoire naturelle (MNHN), Paris France
[3]Laboratoire d'Astrophysique de Marseille, 38 rue Frédéric Joliot-Curie, 13388 Marseille, France
[4]Université Paris-Saclay, Orsay, France
[5]Planétarium de Montréal, Espace pour la Vie, 4801 av. Pierre-de Coubertin, Montréal, H1V 3V4, Québec, Canada
[6]CEREGE UM34, Aix-en-Provence, France
[7]FRIPON/Vigie-Ciel teams, associated with Observatoire de Paris and MNHN – Paris, France.
[8]SYRTE, Observatoire de Paris, Universite PSL, CNRS, Paris, France
[9]INAF – Osservatorio Astrofisico di Torino – Via Osservatorio 20, 10025 Pino Torinese, TO, Italy
[10]Division for Medical Radiation Physics and Space Environment, University of Oldenburg, Oldenburg, Germany
[11]SCAMP (System for Capture of Asteroid and Meteorite Paths), FRIPON, UK
[12]Natural History Museum,Cromwell Road, London, UK
[13]FRIPON-Belgium, Royal observatory of Belgium, Uccle, Belgium
[14]Universitè Cheikh Anta Diop Dakar-Fann, Senegal
[15]Delf University of Technology, Delf, The Netherlands
[16]Oukaimeden Observatory, High Energy Physics and Astrophysics Laboratory, Cadi Ayyad University, Marrakech, Morocco

FRIPON project

The FRIPON fireball project was initially conceived and founded in France in 2014 with a grant from the ANR (Agence Nationale de la Recherche), the objective was to cover the country with a dense network of all-sky cameras (~ a hundred with 80 km spacing). We built (Colas at al 2020) [1] a centralized network, a data storage architecture and a real-time data processing (astrometry of each camera, triangulation of each event to calculate the trajectory of the bright flight and finally determination of the scientific parameters: orbit, incoming mass, final mass, etc.). A catalog of orbits is produced each year and is available on the fireball.fripon.org website. The FRIPON project is designed as a real-time network, the aim of which is to trigger a search in the field within 24 hours of the fall in order to recover fresh meteorites.

Extension and results

The architecture developed for the network allows for easy expansion, and from 2016, scientists from neighboring countries were interested in joining the project using the same hardware, software and infrastructure. The main extensions involved Italy (PRISMA), Germany (FRIPON-Germany), Romania (MOROI), the United Kingdom (SCAMP), Canada (DOME), the Netherlands (DOERAK), Spain (SPMN), Belgium (FRIPON-Belgium), Switzerland (FRIPON-Switzerland), South America (FRIPON-Andino), Morocco (MOFID) and Senegal (ASAMAAN). FRIPON (www.fripon.org) is now an international project and the French network is now FRIPON-VigieCiel (www.vigie-ciel.org) a merger of the camera network and of the Vigie-Ciel citizen science project supported by Muséum national d'Histoire naturelle with the aim of involving the general public in finding meteorites by learning how to identify them and thus take part in research. Ten years after the start of the network, we now have 250 active cameras, we have obtained more than 10,000 orbits and our data has been used in the recovery of 7 meteorites (Cavezzo 2020, Winchcombe 2020, Kindberg 2021, Saint-Pierre-le-Viger 2023, Matera 2023, Menetréol 2023, Ribbeck 2024). It is important to note that over these 10 years, more than 20 searches have been organized without positive results, as the recovery efficiency is often far from 100% due to vegetation, private land, etc.

Recovery statistics

Roughly 600 detections per year included at least one French camera, as described in (Colas et al 2020) [1] this corresponds to objects larger than 1 cm and is compatible with the surface area of the national territory (10^6 km²) according to the previous estimate (Brown et al 2002) [2]. As it also predicts the fall of around 10 meteorites per year for France, we hoped at the start of the project to recover about one meteorite per year, which seems realistic: 50% of meteorites fall during the day, cloud cover is around 50% and ground searches are difficult one time out of two. Another clue is that in the 19th century, one meteorite was recovered every two years in France (Colas, 2020) [1]. Unfortunately, after 10 years of operation, we have only recovered 2 meteorites in France, which is a little disappointing but still better than the 20th century efficiency of one meteorite every 10 years. In the end, the realistic recovery rate seems close to one meteorite per year, but for all of Europe! Since the start of the program in 2015, we found 40 events with a final mass greater than 100g and 10 for 500g and more. These data are compatible with our initial estimate, but the recovery success is low due partly to agricultural changes from small farms where owners could easily identify "strange" stones to big intensive farms.

The case of 2023 CX1

Asteroid 2023 CX1 was discovered by Krisztián Sárneczky of the Konkoly Observatory on 12 February 2023, just 7 hours before it was due to hit the Earth, which made it possible to track it and calculate its orbit very precisely. Most of the telescopic data was obtained by amateurs. It is important to point out that we had to use data from different networks (FRIPON, GMN, AllSky 7, UKMON) and security cameras to calculate the atmospheric entry parameters. The potential strewnfield was then determined in parallel by several groups. The FRIPON/Vigie-ciel collaboration quickly mobilized its network and set up a field search. 4 stones were thus found by children, 4 others by amateurs and finally only 4 others by scientists who were not even meteorite specialists! In the end, amateurs played a fundamental role in the recovery success at all stages of the event: telescopic and fireball data as well as field searches.

Conclusion

The 7 meteorites found in Europe in the last 5 years would not have been found without the presence of fireball networks to give the alert and calculate the strewnfields. In Europe, we are fortunate to have a number of networks (FRIPON, GMN, AllSky7, DFN, etc.) that enable us to detect these events exhaustively. The success of our research is also largely due to citizen science programs such as Vigie-Ciel, which make it possible to organize effective field searches.

References: [1] Colas et al. (2020) *Astronomy and Astrophysics* 644, A53; *[2] Brown et al (2002) Nature, Volume 420, Issue 6913*