EDMOND Meteor Database

Leonard Kornoš[1], Jakub Koukal[2], Roman Piffl[2], and Juraj Tóth[1]

[1] **Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Mlynská dolina, 842 48 Bratislava, Slovakia**
kornos@fmph.uniba.sk

[2] **CEMeNt - Central European Meteor Network**

A next version of the video meteor orbit database EDMOND (European viDeo MeteOr Network Database) is presented. The database is a result of the cooperation and data sharing among several European video networks. The IMO VMN (Video Meteor Network) data are also included. The latest version (v. 4) of the database contains 83 369 orbits selected by conservative criteria.

1 Introduction

Thanks to a broad international cooperation of video meteor observers from several European countries, we managed to create a multi-national network EDMONd (European viDeo Meteor Observation Network) (Kornoš et al., 2013). Nowadays, the following national networks, in alphabetical order, are connected to the European viDeo Meteor Observation Network:

- BOAM (Base des Observateurs Amateurs de Météores), French amateur observers;
- CEMeNt (Central European Meteor Network), a cross-border network of Czech and Slovak amateur observers);
- HMN (Hungarian Meteor Network/Magyar Hullócsillagok Egyesület), Hungarian amateur observers;
- IMTN, Italian amateur observers in Italian Meteor and TLE Networks;
- PFN (Polish Fireball Network/Pracownia Komet i Meteorẃ, PkiM);
- SVMN (Slovak Video Meteor Network), Comenius University network;
- UKMON (UK Meteor Observation Network), a network of British amateur observers; and

several individual observers from Bosnia and Herzegovina, Serbia, and Ukraine, where an extensive network is being created.

In the last year, observers affiliated to the IMO VMN (Video Meteor Network) have started to share their data, and the data of EDMONd and IMO VMN have been merged. The IMO VMN has been created in 1999 and at present consists of observers from Germany, Slovenia, Italy, Hungary, Finland, Portugal, Netherlands, United Kingdom, Spain, Poland, and Belgium. More than 1.2 million single-station meteors of the IMO VMDB (Video Meteor Database) form a predominant contribution to the database.

One can say that nowadays EDMOND and IMO VMN is collecting data from observers from a substantial part of Europe, and, due to this international cooperation, meteor activity is monitored almost over entire Europe. By count, the database has accumulated 1 639 358 records of single-station meteors from 2000 to 2013. The statistics are presented in Table 1 and the counts of single-station meteors in particular years are plotted in Figure 1. Data reduction from some years has not yet been completed.

Two different tools are used by observers in EDMONd and IMO VMN: the MetRec software written by Sirko Molau (1999) and the UFO Tool written by SonotaCo (2009). In the last column of Table 1, the software used in particular networks (stations) is mentioned.

Table 1 – Networks, stations, single-station meteors, and software tools used

Network	Stations	Meteors	Tools
BOAM	10	26 779	UFO
CEMeNt	15	40 742	UFO
HMN	13	167 834	MetRec
IMTN	15	135 534	UFO
PFN	23	30 576	UFO and MetRec
SVMN	3	39 257	UFO
UKMON	4	3 372	UFO
Bosnia	4	1 390	UFO
Serbia	1	58	UFO
MeteorsUA	6	1 742	UFO
IMO VMN	61	1 192 092	MetRec
Total	155	1 639 358	

2 Compilation and reduction of the database

The catalogue of meteor orbits is created by using the software UFOOrbit. The application imports all data in the UFO format. This means that all data obtained and analyzed by UFO tools can be used without any change. However, data obtained by the MetRec software have to be converted into the UFO format, using the program INF2MCSV written by SonotaCo. In the

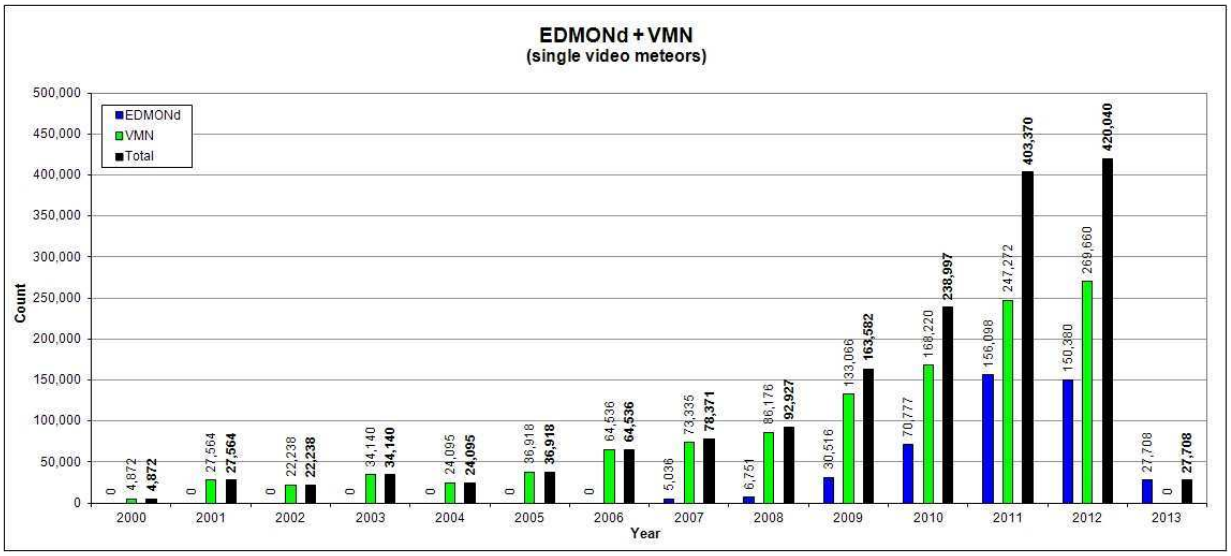

Figure 1 – Number of single-station meteors in EDMONd and IMO VMN

program UFOORBIT, all combinations of meteors in a time interval $dt = 5$ s are created. For these combinations, the level Q_0 is set and some other additional conditions also have to be set (parameters are defined in the UFO Manual[1]):

- $Gm\% > -100\%$ (overlap of a meteor sighting from two stations);
- 15 km $< H1 <$ 200 km (beginning height);
- $H2 <$ 200 km (terminal height);
- $QA > 0.15$ (empirical quality parameter within the interval [0,1]); and
- $dV <$ 7 km/s (the largest difference in velocity between stations considered to compute the orbit).

The last condition is the most important modification in comparison to the previous versions of the database. The value of 7 km/s is about 10% of the largest geocentric velocity of a bound object (unfortunately, it is not possible to set directly the value of 10%). In this way, most false meteors are eliminated.

The output from UFOORBIT is a set of orbits which contains preliminary orbits computed for each station of the considered meteor and also a mean `UNIFIED` orbit as a final solution. To reject less precise orbits and also to eliminate the rest of false orbits, another filter is applied in two ways to the set of orbits (see also Kornoš et al., 2013): (a) criteria only applied to the final solution in the line `UNIFIED`; and (b) criteria applied to each line of a meteor—if some line does not fulfill the following criteria, the meteor is rejected:

- $Q_0 > 1\overset{\circ}{.}0$ (observed trajectory angle);
- $dur > 0.1$ s (duration of the meteor);
- $Qc > 10°$ (angle of convergence);
- $dGP < 0\overset{\circ}{.}5$ (distance between two poles of the orbit); and
- $dv12\% < 7.07\%$ (difference in geocentric velocity between the unified result and one of the considered stations).

A combination of EDMOND and IMO VMDB data provided 109 445 preliminary meteor orbits. After applying stricter limiting conditions, altogether 97 665 (v. 4a) and 83 369 (v. 4b) meteor orbits remained in the database.

Table 2 – Number of orbits in the versions 4a and 4b in particular years.

Year	v. 4a	v. 4b	Year	v. 4a	v. 4b
2001	287	251	2008	2 197	1 941
2002	84	71	2009	4 731	4 193
2003	137	113	2010	13 301	11 505
2004	42	33	2011	32 443	27 562
2005	89	82	2012	39 456	33 425
2006	601	531	2013	2 93	2 519
2007	1 358	1 143	Total	97 665	83 369

3 Summary

EDMOND v. 4 is the result of a processing of more than 1.6 million meteor records obtained during the period 2000–2013 at stations in dozens countries in Europe. Several hundreds of observers have participated in collecting this enormous data set. It is one of the most complex databases of meteor orbits obtained by sensitive video technique, and contains about 71 000 double-station, almost 10 000 three-station and more than 2000 four-station orbits. There are about 49 000 sporadic and 35 000 shower meteors in the database and we could identify 249 showers by the IAU MDC list ($D' = 0.1$,

[1] `http://sonotaco.com/soft/UO2/UO21Manual_EN.pdf`.

Drummond, 1991) when at least 5 meteors in eachy shower are required. After a small inspection we can say that the EDMOND database is in size and also in quality similar to the well known Japanese database of video orbits (SonotaCo, 2009), which has started in 2007. The data about these orbits will be freely accessible[2] and at the web site of the Astronomical and Geophysical Observatory of the Comenius University in Modra[3]. Data are sorted by years of observation.

Acknowledgements

The authors are thankful to all observers and coordinators of the national meteor networks for their cooperation without which such accomplishment would not have been possible. We thank Sirko Molau and Enrico Stomeo for their help with the integration of data from the IMO Video Meteor Network into EDMOND. This work was supported by the grant APVV-0516-10.

References

Drummond J. D. (1991). "Earth-approaching asteroid streams". *Icarus*, **89**, 14–25.

Kornoš L., Koukal J., Piffl R., and Tóth J. (2013). "Database of meteoroid orbits from several European video networks". In Gyssens M. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, La Palma, Canary Islands, Spain, 20–23 September 2012. IMO, pages 21–25.

Molau S. (1999). "The meteor detection software MetRec". In Baggaley W. J. and Porubčan V., editors, *Proceedings of the International Conference Meteoroids*, Tatranská Lomnica, Slovakia, 17–21 August 1998. Astron. Inst., Slovak Acad. Sci., pages 131–134.

SonotaCo (2009). "A meteor shower catalog based on video observations in 2007–2008". *WGN, Journal of the IMO*, **37**, 55–62.

Leonard Kornoš during his Friday morning presentation. (Credit Bernd Klemt.)

[2]`http://cement.fireball.sk`.
[3]`http://www.daa.fmph.uniba.sk`.