Meteor shower search for amateurs

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In this paper, the method and the results of a meteor shower search using SonotaCo and Croatian Meteor Network data are presented. The graphs used are shown and, for the animations, the web links are given.

1 Introduction

Over the course of years, the Croatian Meteor Network has outgrown its initial purpose of collecting data and obtaining orbits. It was decided to start working on searching for meteor showers. The first method used is presented and discussed, together with the results.

2 Data—what to do with it?

In the years between 2007 and 2010, CMN collected 19 372 orbits (Šegon et al., 2012; Korlević et al., 2013; Croatian Meteor Network, 2013). Combined with SonotaCo data[1] (2007–2011), these efforts resulted in more than 130 000 individual meteor orbits. The initial idea was to plot the orbits on an all-sky map with color-coded geocentric velocity.

3 CMN_solPlot software

From many years of experience in meteor science, we have come to the conclusion that all available visualization software is unsatisfactory. Most of the produced graphs are visually unattractive and non-intuitive. It was therefore decided to write new software from scratch which would satisfy modern standards of visual representation. Thus, CMN_solPlot came into existence.

The programming language used was Python[2]. It uses the Matplotlib library[3] for plotting functions, and it offers a wide selection of visual data representation methods. The software takes the orbits and the desired range of solar longitudes to be plotted as input. The output is a high-resolution PNG image in the pseudo-cylindrical equal-area sinusoidal map projection. The brighter stars are also plotted in the background.

For the purpose of this paper, images are presented in greyscale, and hence the color-coded geocentric velocity is not visible.

[1] http://sonotaco.jp/doc/SNM/.
[2] http://www.python.org/.
[3] http://matplotlib.org/.

As can be observed from Figure 1, all major meteor streams active during the year are visible. This image is very usable for presentation and awe-inducing purposes, but it has no value when it comes to meteor shower searches. Major streams are obstructing the view of the minor ones, suffocating them by sheer numbers. Taking that in consideration, it was decided to tighten the range of solar longitudes for plotting.

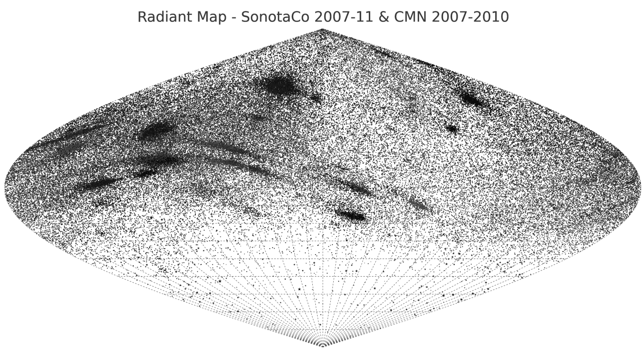

Figure 1 – SonotaCo (2007–2011) and CMN (2007–2010) data.

Thus, in Figure 2, only solar longitudes corresponding to the month of July were plotted. Compared to Figure 1, there are much fewer radiants, but as long as the major streams are prominent, it cannot be said that the optimal circumstances for new shower detection are met. A step deeper in solar longitude range reduction was taken.

Figure 3 shows the plot of only one degree in solar longitude, in this case $\lambda_{\odot} = 100°$. A complete lack of radiants is obvious, even in this very active time of year. Star-like dots on the image represent the brighter stars, not to be confused with radiant dots.

The next step was to animate all one-degree solar longitude plots. (Figure 4) The free software UnFREEz[4] was used to create GIF animations. As paper is not a suitable medium for animations, we are forced to give the readers a reference to our website where animations

[4] http://www.whitsoftdev.com/unfreez/.

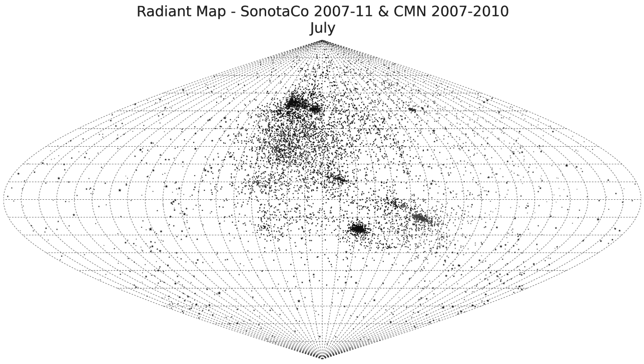

Figure 2 – SonotaCo (2007–2011) and CMN (2007–2011) data, July only.

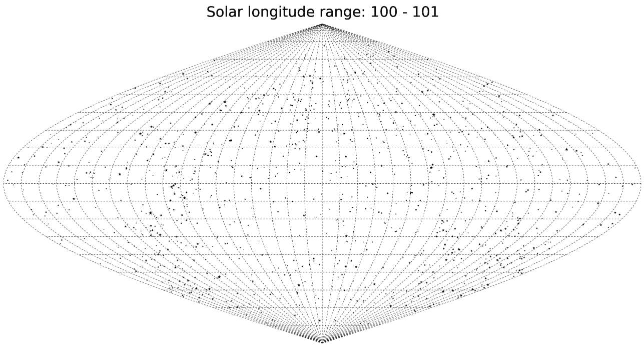

Figure 3 – SonotaCo (2007–2011) and CMN (2007–2011) data, solar longitude $\lambda_\odot = 100°$.

can be seen[5]. The authors cannot guarantee that the animations will be available online for unlimited time, so please contact one of them, if you are having difficulties loading the animations.

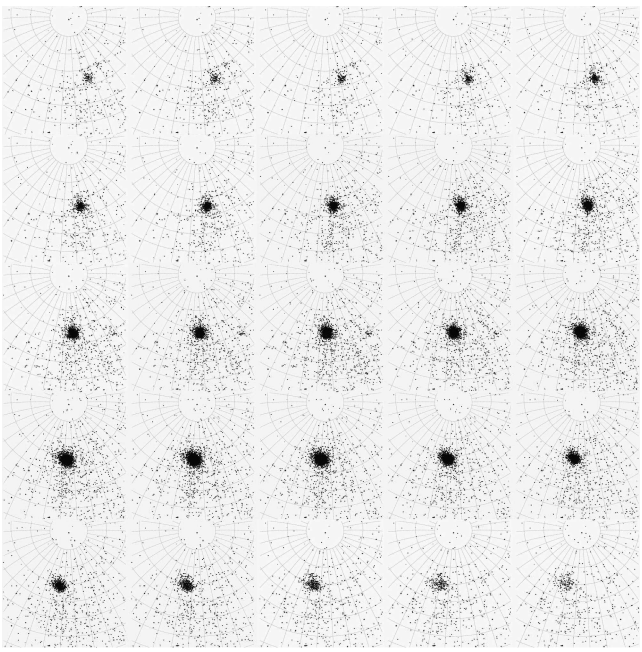

Figure 4 – Twenty five frames showing an animation of the Perseids, between $\lambda_\odot = 124°$ and $\lambda_\odot = 149°$.

[5]http://cmn.rgn.hr/downloads/cmn_animations/vida_et_al_imc_2013/vida2013.html.

4 Shower search method

The method for the search is very similar to the one described in our IMC 2012 paper (Vida et al., 2013). Animations were visually searched for groups of dots of the same color. The exact position on the sky map and the range of solar longitudes were marked. After that, the data were run through our software called SelectedRangeFilter, which extracts orbital elements of meteors within the parameter range defined. The next step was to find the correlation of each meteor to every other meteor in this reduced data set. For that purpose, pyStreamFinder was used. This software compares each meteor to all other meteors to find orbital similarities using the D-criterion. We required the value of D_{SH} to be lower than 0.15. The literature describes different versions of the D-criterion method, but we implemented the original one (Southworth and Hawkins, 1963).

5 Results

For the meteor stream search, CMN and SonotaCo data sets were used (more than 130 000 orbits). This resulted in 20 new streams that are listed at the IAU Meteor Data Center[6]. The list of the discovered streams is given in Table 1, along with the given codes and the numbers of meteors detected. Only one parent body for one of the newly discovered stream is known, namely for the λ-Ursae Majorids (Andreić et al., 2013).

6 Discussion

Advantages of this method are that radiant concentrations are clearly visible on images and that it is very simple to determine parameters such as solar longitude, right ascension and declination of the candidate shower. Some of the disadvantages are the subjective detection because the instrument used is the human eye. Therefore, it is difficult to detect radiants with higher dispersion. Also, it took a lot of time and effort to make all those plots used for searching.

7 Conclusions

After four years of data reduction, the Croatian Meteor Network database combined with SonotaCo data is large enough for a serious meteor shower search. For that purpose, new software called CMN_solPlot was developed. It uses a universal method and it is a great visualisation tool that enables us to search visually for a new streams. That resulted in 20 newly discovered meteor streams, currently listed with the IAU Meteor Data Center.

[6]http://www.ta3.sk/IAUC22DB/MDC2007/.

Table 1 – List of discovered meteor streams.

Shower name	IAU No.	Code	Meteors	Parent body
ζ-Cassiopeiids	444	ZCS	55	Unknown
κ-Virginids	509	KVI	58	Unknown
June ρ-Cygnids	510	JRC	16	Unknown
15-Lyncids	511	FLY	18	Unknown
ρ-Puppids	512	RPU	16	Unknown
ω-Capricornids	514	OMC	3	Unknown
o-Leonids	515	OLE	38	Unknown
February μ Virginids	516	FMV	21	Unknown
η-Hydrids	529	EHY	120	Unknown
August ι-Cetids	505	AIC	120	Unknown
April λ-Ophiuchids	517	ALO	20	Unknown
April 102-Herculids	518	AHE	10	Unknown
β-Aquariids	519	BAQ	20	Unknown
May β-Capricornids	520	MBC	13	Unknown
August γ-Cepheids	523	AGC	44	Unknown
λ-Ursae Majorids	524	LUM	29	C/1975 T2 Suzuki-Saigusa-Mori
ι-Cygnids	525	ICY	40	Unknown
Southern λ Draconids	526	SLD	26	Unknown
υ-Ursae Majorids	527	UUM	27	Unknown
January ζ-Draconids	528	JZD	13	Unknown

References

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