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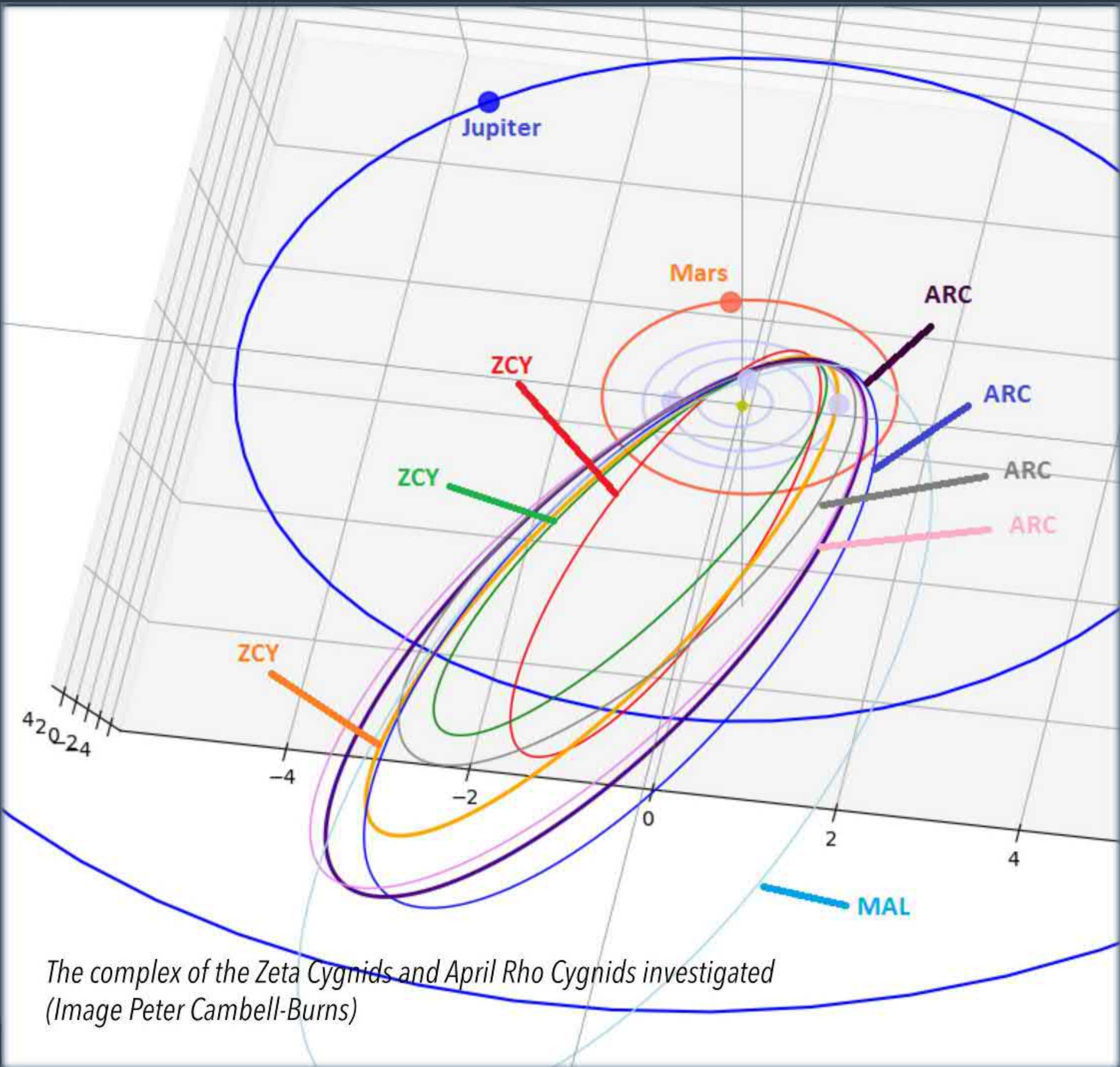

The complex of the Zeta Cygnids and April Rho Cygnids investigated (Image Peter Cambell-Burns)

- Minor shower case studies
- 2017 Report BOAM
- Lyrids 2018
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- Radio observations
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Contents

Zeta Cygnids (ZCY) and April rho Cygnids (ARC) two filaments of a single meteor stream?

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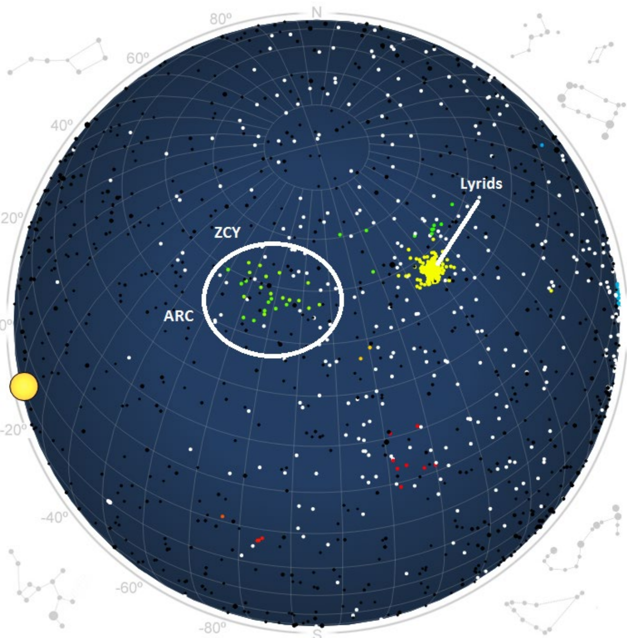
An independent search among 685362 public available orbits showed the presence of a concentration of similar orbits for both the Zeta Cygnids (ZCY) and April Rho Cygnids (ARC). The resulting orbital elements for the two showers confirm a small difference in inclination and argument of perihelion but this does not exclude a common origin. There is no sign of any periodicity and the ARC filament was not in outburst in 2012. The Nu-Cygnids (NCY-409) entry in the IAU working list of meteor showers is identical to the April Rho-Cygnids (ARC–348). The radiant drift corrected positions have a large overlap. The shower characteristics are identical. The activity profiles display several sub-maxima and suggest a layered structure of superimposed streamlets left over from a single parent body, either a Halley type comet or Jupiter family comet.

1 Introduction

Looking for the ζ-Cygnids on the CAMS website we find the radiants of these orbits spread over a large region of the sky, almost the entire constellation of Cygnus (*Figure 1*). A widely scattered radiant area is typical for an old diffuse meteor stream. Checking the individual radiant points, we see that some radiants are identified as April ρ-Cygnids (ARC–348) although the geocentric velocity is about the same as for the ζ-Cygnids (ZCY–040). To make the picture complete, the IAU working list of meteor showers also mentions a third unconfirmed shower, the ν-Cygnids (NCY–409) in the same time lapse in the same radiant area but without any orbital elements. The naming of a meteor shower according to the star near the center of the shower radiant can be misleading in the sense that this creates a false impression of accuracy. Most shower radiant sizes are poorly known and the median value for the radiant position differs by several degrees for different datasets. Meteor showers have a complex and dynamic nature while the observational accuracy in orbit determination tend to be overestimated, leading to too optimistic interpretations.

Although the initial idea for this paper was a case study on the ζ-Cygnids, the preliminary verifications of the available orbit data indicated a more complex picture. The presence of at least one established meteor shower at about the same radiant position in the same time span with almost identical velocity and characteristics required a wider scope to review these showers. Although two showers of different origin may share the same radiant area with an overlap in activity period, it looks more appropriate to consider the April–May Cygnid radiants as a single complex with different streamlets that were detected and listed as separate showers. The small differences in orbital elements for the different filaments could be explained as the result of planetary perturbations by nearby planet Jupiter, something that remains to be proven by stream modelers. *Figure 1* also shows the Lyrid radiant, a much more compact radiant.



2 ZCY (040) and ARC (348) history

Attempts to find similar orbits in the photographic meteor orbit catalogue with 4873 accurate photographic orbits obtained between 1936 and 2008 were negative. The Harvard radar orbit catalogues 1961–1965 and 1968–1969 (Hawkins, 1963) contain several orbits with a low threshold of $D_D < 0.105$ for both reference orbits. The first mention in literature of the ζ-Cygnids appeared in a stream search on radio orbits (Sekanina, 1976).

A radiant search on single station video meteors (Molau and Rendtel, 2009) listed 402 meteors identified as ζ-Cygnids but with an activity period and maximum well ahead of the period determined in later shower searches based on video orbits. This detection might be spurious as it is based on backwards projection of single station meteor paths and not on orbital data. This radiant search also revealed the ν-Cygnids (NCY–409) based on 508 single station meteor trails, included in the IAU working list of meteor showers although no reference orbit is available for this type of data. The proximity of the very active Lyrids (LYR–006) near its maximum activity combined with the natural sporadic background activity may seriously distort any attempts to derive minor shower radiants from single station video data. The activity period and time of best activity correspond to the shower component for the ζ-Cygnids obtained from our analyses.

The April ρ-Cygnids (ARC–348) were discovered by CMOR from orbit data collected 2002–2009 (Brown et al., 2010) while the ζ-Cygnids (ZCY–040) shower was not detected in this search. The analysis by Brown et al. (2010) also suggests a possible association between the ARC–348 shower and the May Lacertids (MAL–350).

Phillips et al. (2011) confirmed the activity of the ARC shower with 29 CAMS orbits obtained between April 27 and May 7 with low activity peaks on April 28 and May 1. Clear weather in 2012 between April 15 and 23 allowed CAMS to collect 1362 orbits (Jenniskens and Halberman, 2013). Based on this dataset evidence was found for the ν-Cygnids (NCY–409) for which IMO claimed discovery in 2009. The authors concluded that the NCY was not another manifestation of the nearby April ρ-Cygnids as the radiant position in the 2012 CAMS dataset was separated in time and position. Because the shower did not appear in the meteor stream search of SonotaCo the question arose whether this shower was in "outburst" in 2012 although only very small numbers of similar orbits were collected.

In a later study Jenniskens et al. (2016) concluded that the NCY–409 discovery was identical to the ζ-Cygnids (ZCY–040) and should be removed from the working list. However, at the time of writing this paper the NCY–409 entry remains the list. All the reference orbits listed in the IAU working list of meteor showers are listed in *Table 4*.

3 The available orbit data

We have the following data, status as of June 2018, available for our search:

- EDMOND EU+world with 317830 orbits (until 2016). EDMOND collects data from different European networks which altogether operate 311 cameras (Kornos et al., 2014).
- SonotaCo with 257010 orbits (2007–2017). SonotaCo is an amateur video network with over 100 cameras in Japan (SonotaCo, 2009).
- CAMS with 110521 orbits (October 2010 – March 2013), (Jenniskens et al., 2011). For clarity, the CAMS BeNeLux orbits April 2013 – May 2018 are not included in this dataset because this data is still under embargo.

Altogether we can search among 685362 video meteor orbits.

4 Orbit selection

Although we have reference orbits from previous research, we want to check if we can find any evidence for the existence of this shower. If some concentration of similar orbits can be found, we can try to calculate our own reference orbit.

In a previous series of shower analyses (Roggemans and Johannink, 2018; Roggemans, 2018; Roggemans and Campbell-Burns, 2018a, 2018b, 2018c, 2018d) we selected a time span in solar longitude around the time of maximum. Without any idea about the activity period, this required some steps to extend the time span until no more similar orbits were found. To have a better idea of the activity period and spread of the radiant positions, we compiled a single list of the 685362 orbits to make a preliminary selection using the reference orbit from literature and the D-criteria of Southworth and Hawkins (1963), Drummond (1981) and Jopek (1993). We considered four different threshold levels of similarity:

- Low: $D_{SH} < 0.25$ & $D_D < 0.105$ & $D_H < 0.25$;
- Medium low: $D_{SH} < 0.2$ & $D_D < 0.08$ & $D_H < 0.2$;
- Medium high: $D_{SH} < 0.15$ & $D_D < 0.06$ & $D_H < 0.15$;
- High: $D_{SH} < 0.1$ & $D_D < 0.04$ & $D_H < 0.1$.

Next, we derived the minima and maxima for the solar longitude, right ascension, declination and geocentric velocity for the orbits that fulfill the low threshold D-criteria. These limits were used to extract the selection of orbits used for this analysis. We applied this procedure to make two selections, one for the ζ-Cygnids (ZCY–040) and one for the April ρ-Cygnids (ARC–348).

For the case of the ζ-Cygnids this procedure resulted in the following selection with 969 orbits:

- Time interval: $17° < \lambda_{\odot} < 46°$;
- Radiant area: $294° < \alpha < 325°$ & $+33° < \delta < +52°$;
- Velocity: 36 km/s < v_g < 49 km/s.

For the case of the April ρ-Cygnids this procedure resulted in the following selection with 618 orbits:

- Time interval: $25° < \lambda_{\odot} < 52°$;
- Radiant area: $307° < \alpha < 338°$ & $+38° < \delta < +56°$;
- Velocity: 35 km/s < v_g < 47 km/s.

The individual radiant positions for both showers appeared mixed in the large radiant region with the eastern part of the large radiant mainly populated by ARC-radiants while the ZCY-radiants dominated in the western part. In total we got 1143 different orbits for both ARC and ZCY selections together of which 444 orbits appear in common in both selections.

5 Shower case study

The median values of each selection were used as parent orbit to calculate D-criteria in a first approach to find the orbits with a similarity which indicates a dust concentration. The median values obtained for the orbits which fulfill the high threshold level are taken as a new parent orbit to recalculate the D-criteria to obtain the final median values for the different threshold levels. The final results for the above-mentioned threshold levels are listed in *Table 1* for the ζ-Cygnids selection and in *Table 2* for the April ρ-Cygnids.

Table 1 – The median values for the final selected orbits with four different threshold levels on the D-criteria, compared to the reference orbit from literature for the ζ-Cygnids (Jenniskens et al., 2016).

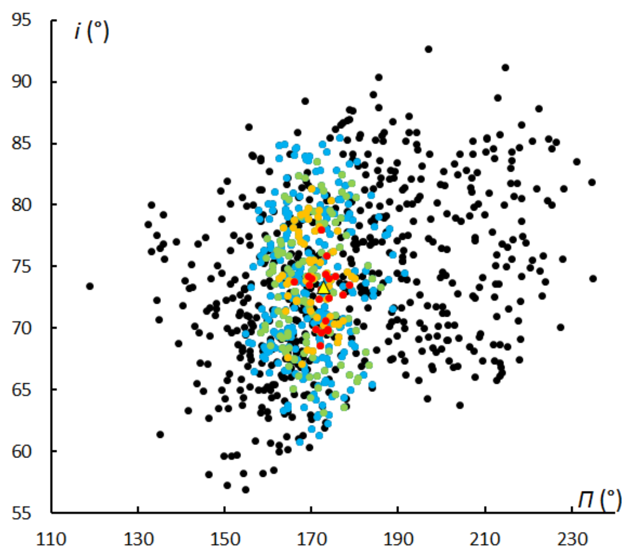
	Low	Medium low	Medium high	High	Reference (2016)
$\lambda_\odot$	31.4°	31.9°	31.9°	33.2°	32.0°
α_g	310.3°	311.4°	311.3°	311.7°	309.5°
δ_g	+43.5°	+43.7°	+43.5°	+44.4°	+42.5°
v_g	42.6	42.7	44.4	44.1	43.0
a	5.2	5.1	5.1	5.2	3.93
q	0.892	0.888	0.892	0.898	0.900
e	0.830	0.827	0.821	0.826	0.780
ω	138.7°	138.1°	138.5°	139.5°	140.5°
Ω	31.4°	31.9°	31.9°	33.2°	31.5°
i	73.5°	73.7°	74.0°	73.3°	74.9°
N	405	185	77	20	64
S	*58%*	*81%*	*92%*	*98%*	

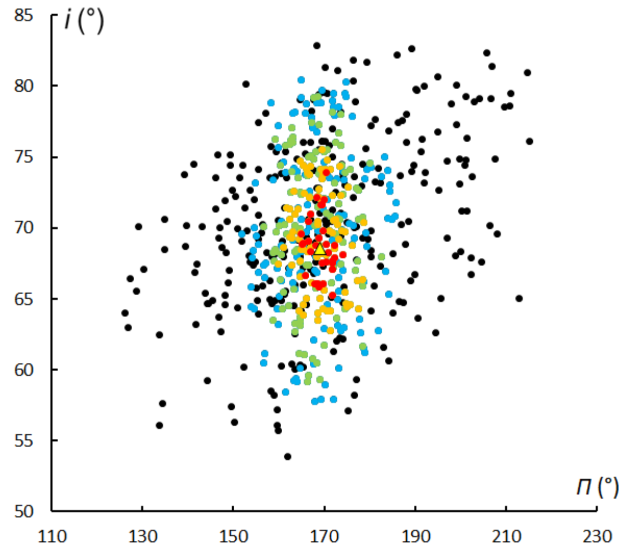
The differences between both showers are very small; The April ρ-Cygnids have a reference orbit about 6° in solar longitude later than the ζ-Cygnids, a slight lower velocity and lower inclination. Particles of both showers share to a large extend the same space in the solar system, with many orbits that fulfil the D-criteria for both parent orbits. The question arises on which criteria these two showers were identified as two physically separated meteor streams? The similarity between the two datasets with orbits suggests that both are dust trails within a single diffuse meteor stream complex.

Table 2 – The median values for the selected orbits with four different threshold levels on the D-criteria, compared to the reference orbit from literature for the April ρ-Cygnids (Jenniskens et al., 2016).

	Low	Medium low	Medium high	High	Reference (2016)
$\lambda_\odot$	35.8°	37.2°	38.5°	40.3°	38.0°
α_g	320.0°	321.4°	322.4°	324.7°	322.1°
δ_g	+46.6°	+46.6°	+47.4°	+48.4°	+46.6°
v_g	41.4	41.3	41.0	40.9	40.9
a	6.0	6.1	5.9	6.4	6.14
q	0.852	0.847	0.842	0.833	0.842
e	0.860	0.858	0.856	0.870	0.864
ω	132.0°	131.2°	130.3°	128.8°	130.3°
Ω	35.8°	37.2°	38.5°	40.3°	39.4°
i	69.6°	69.6°	68.9°	68.6°	69.7°
N	346	210	111	32	42
S	*44%*	*66%*	*82%*	*95%*	

Figure 2 shows the plot of the inclination versus length of perihelion for both 'showers'. There is a diffuse but distinct concentration of similar orbits. The large overlap in space for the orbits of the two components becomes obvious in this plot, with a slight difference of 3° in length of perihelion and about 5° in inclination. It is impossible to distinguish the orbit association properly for many orbits





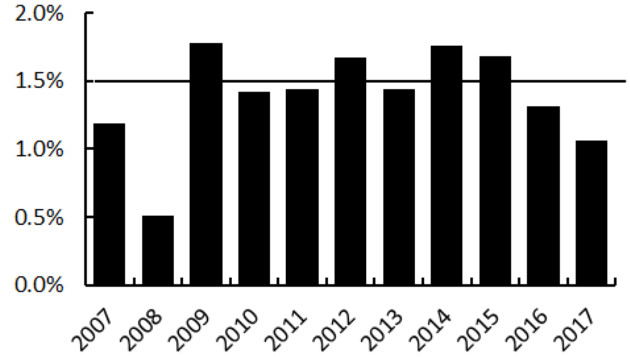


Figure 3 – The percentage of ZCY orbits per year ($D_D < 0.105$) relative to the total number of orbits obtained that year during the ZCY activity period.

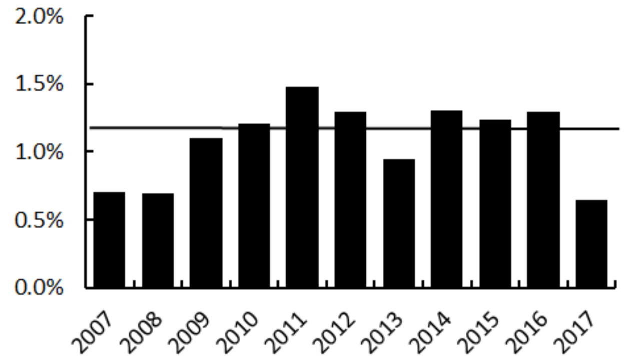


Figure 4 – The percentage of ARC orbits per year ($D_D < 0.105$) relative to the total number of orbits obtained that year during the ARC activity period.

There is no indication for any periodicity in the annual activity. Orbits for both shower components are registered during each year. The variation from year to year can be perfectly explained as statistical fluctuations. The question if the NCY–409, later considered as another instance of the ARC–348 shower, were in outburst in 2012 can be answered by this study. There was annual activity and no sign of any outburst. The fact that the shower did not occur in the meteor stream search of SonotaCo orbits 2007–2011, does not prove that SonotaCo did not contain orbits of the ARC shower. Our analyzes include 26 possible ARC orbits for SonotaCo for 2007–2011.

The activity of minor showers such as the ZCY and ARC showers remains far below the statistical limits required to obtain any zenithal hourly rates or flux rates. Instead, we can make a simple estimate of the activity profile by counting the number of orbits accumulated per degree of solar longitude during a significant time span, e.g. 10 years or more, compensating years with unfavorable circumstances. This approach ignores all influences that may affect hourly rates and therefore it is not the ideal way to proceed, but given the long period of time and the large global scale to collect orbits, this approach will give a good idea of the number of shower orbits encountered by the Earth per solar longitude.

Figure 5 shows the number of orbits per degree of solar longitude for both showers for the different threshold levels of the D-criteria. For the low threshold level, the two showers together count 529 orbits of which 223 orbits fulfil the criteria for both parent orbits. These 223 orbits appear in both activity profiles what explains the common parts in the profile. The first peak in *Figure 5* (left) at $\lambda_\odot = 31.5°$ and a second peak at $\lambda_\odot = 33.5°$ are due to the ζ-Cygnids. A third peak at $\lambda_\odot = 38.5°$ in the ζ-Cygnids profile is due to April ρ-Cygnids that fulfil the D criteria for the parent orbit of the ζ-Cygnids. The first two peaks in *Figure 5* (right) with the activity profile for the April ρ-Cygnids is due to ZCY-orbits that fulfil the D-criteria for the parent orbit of the April ρ-Cygnids. The peak at $\lambda_\odot = 38.5°$ (~April 29) corresponds to the time of maximum activity given in *Table 2* (Jenniskens et al., 2016). *Figure 5* seems to show a secondary peak two days later at $\lambda_\odot = 40.5°$ (May 1), which may correspond to the second of two peaks reported in 2011 by Phillips et al. (2011). Considered as one single stream the ZCY and ARC activity looks like a layered structured with successive filaments of dust concentrations comparable to the structure of the Orionid shower in October but at a much lower activity level. The first peaks on the profile in *Figure 5* may be associated with the earlier instances of ZCY activity reported by Sekanina (1976) and Jenniskens et al. (2018). The last peak in the ARC profile may be due to the May Lacertids (MAL–350) activity associated with the ARC shower by Brown et al. (2010) (*Table 4*).

Table 3 – Radiant drift with ± σ for the two shower components obtained from the orbits for each threshold level of the D-criteria.

Threshold level	ZCY – 040		ARC – 348	
	$\Delta\alpha / \lambda_\odot$	$\Delta\delta / \lambda_\odot$	$\Delta\alpha / \lambda_\odot$	$\Delta\delta / \lambda_\odot$
Low	0.93±0.03	0.28±0.03	0.93±0.05	0.32±0.03
Medium low	0.86±0.05	0.29±0.05	0.98±0.06	0.33±0.04
Medium high	0.82±0.09	0.20±0.09	1.07±0.07	0.31±0.05
High	1.02±0.21	0.32±0.21	0.93±0.15	0.22±0.14

Both shower components allow deriving a radiant drift in Right Ascension and declination with a reasonable result for all four threshold levels (*Figures 6 and 7, Table 3*). The resulting radiant drift suggests that we have two components of the same meteor shower seen few days apart. The ZCY radiant drift starting from $\lambda_\odot = 31.5°$ gets the ZCY radiant close to the ARC radiant position at $\lambda_\odot = 38.5°$. *Figure 8* shows how scattered and diffuse the uncorrected radiant positions for both the ZCY and ARC components appear. Applying the radiant drift valid for the medium low threshold we see two changes in the plot: the scatter on the remaining sporadic radiants (black dots) increases while the radiants with possible shower

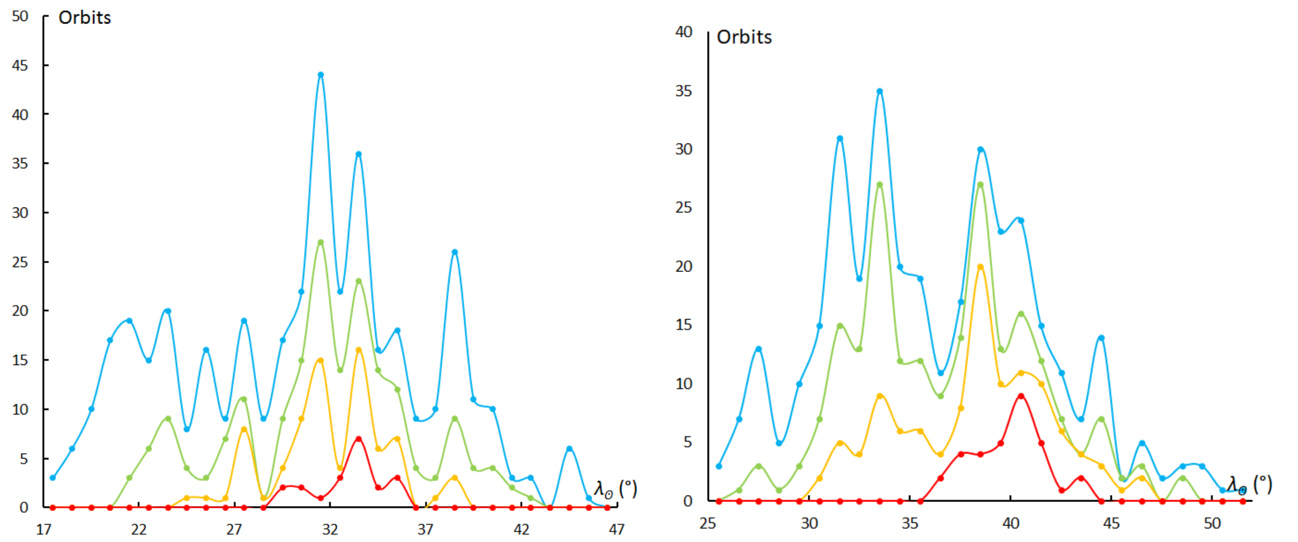


Figure 5 – The number of ζ-Cygnids orbits (left) and April ρ-Cygnids orbits (right), collected per degree of solar longitude $\lambda_{ʘ}$ during the period 2007–2017 with blue for $D_D < 0.105$, green for $D_D < 0.08$, orange for $D_D < 0.06$ and red for $D_D < 0.04$.

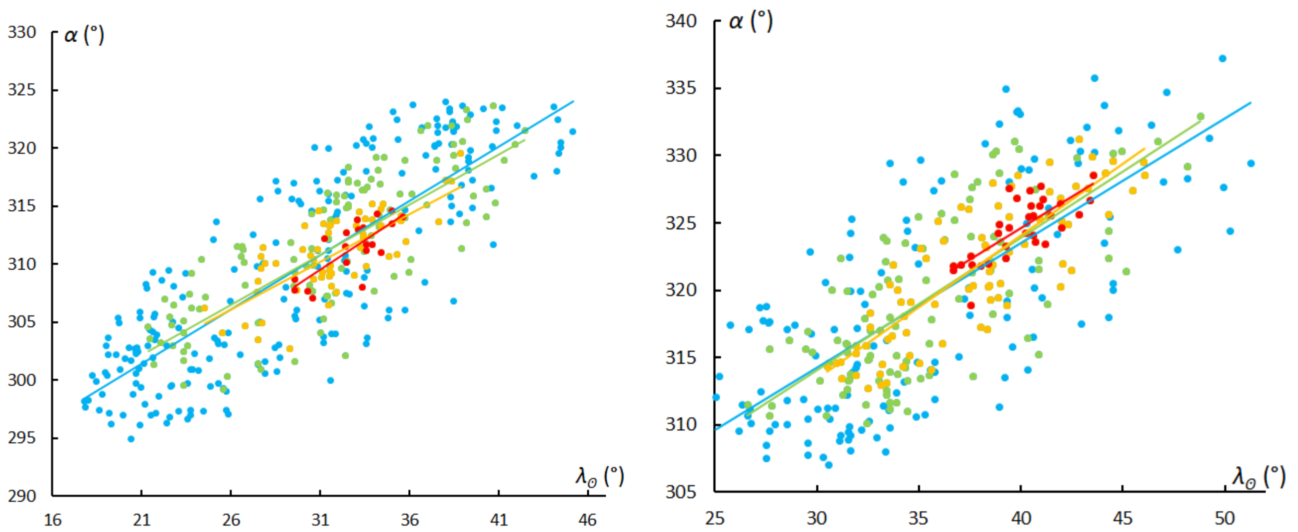


Figure 6 – Radiant drift in Right Ascension α against solar longitude $\lambda_{ʘ}$, for ζ-Cygnids orbits (left) and April ρ-Cygnids orbits (right). The different colors represent the 4 different levels of similarity.

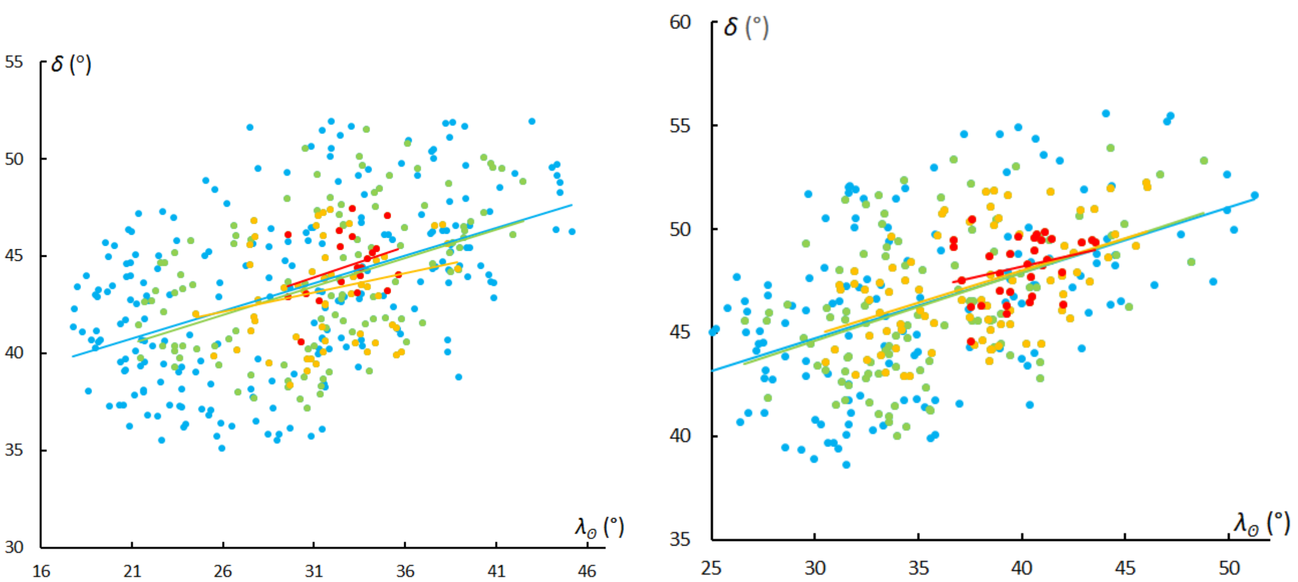


Figure 7 – Radiant drift in declination δ against solar longitude $\lambda_{ʘ}$, for ζ-Cygnids orbits (left) and April ρ-Cygnids orbits (right). The different colors represent the 4 different levels of similarity.

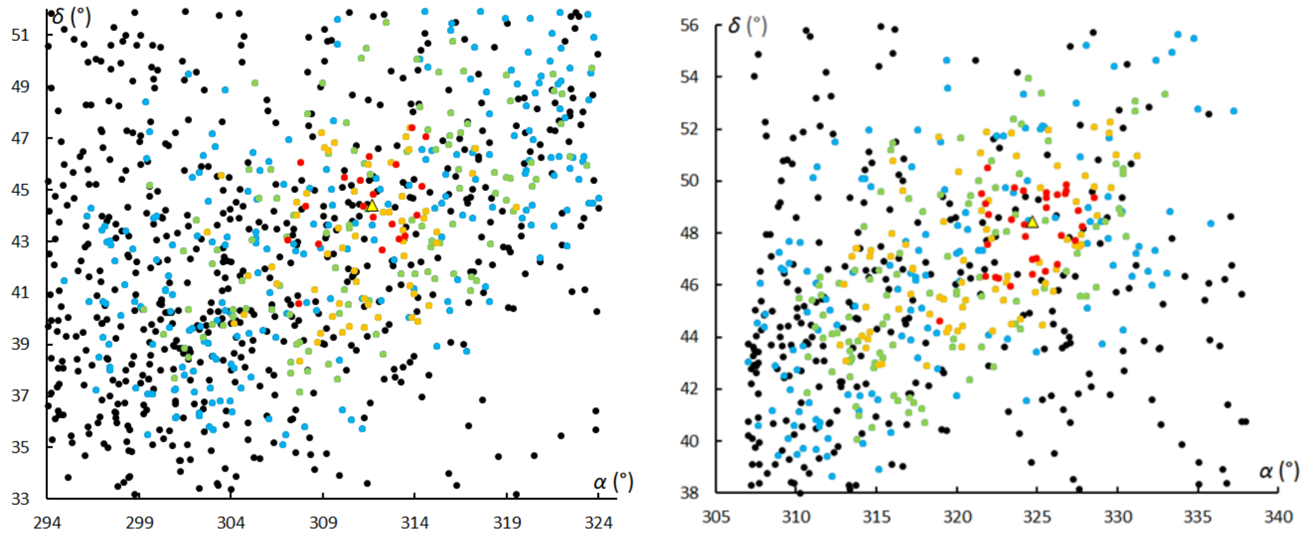


Figure 8 – Plot of the radiant positions as selected, for 969 ζ-Cygnids orbits (left) and 618 April ρ-Cygnids orbits (right). The different colors represent the 4 different levels of similarity according to different threshold levels in the D-criteria. The yellow triangles mark the final reference orbits.

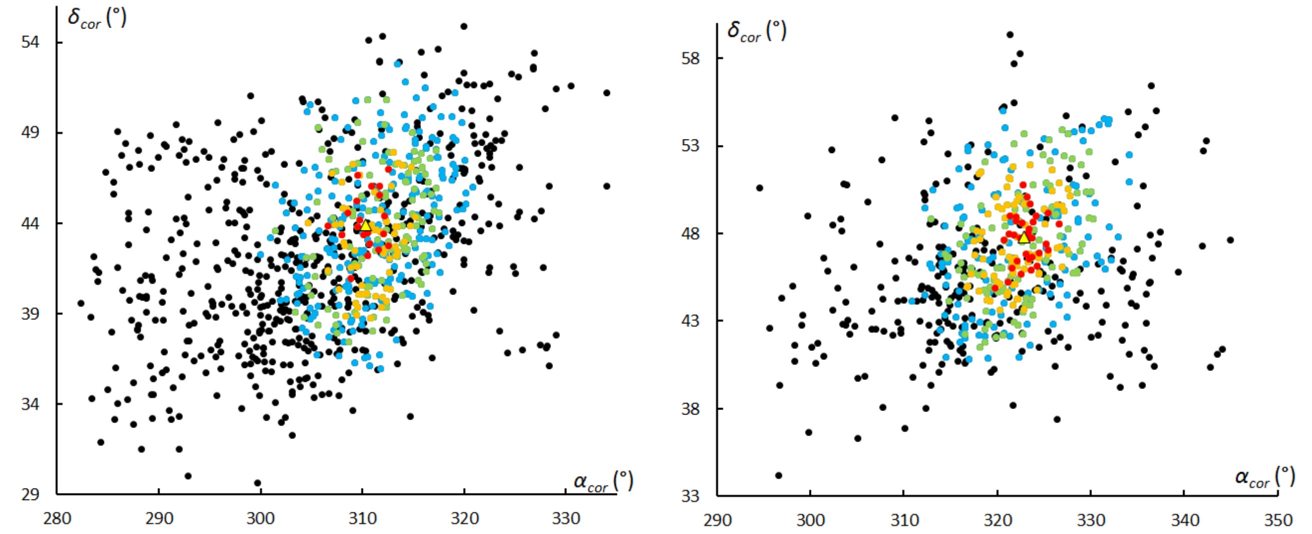


Figure 9 – Plot of the radiant drift corrected radiant positions, for ζ-Cygnids orbits (left) and April ρ-Cygnids orbits (right). The different colors represent the 4 different levels of similarity. The yellow triangles mark the final reference orbits.

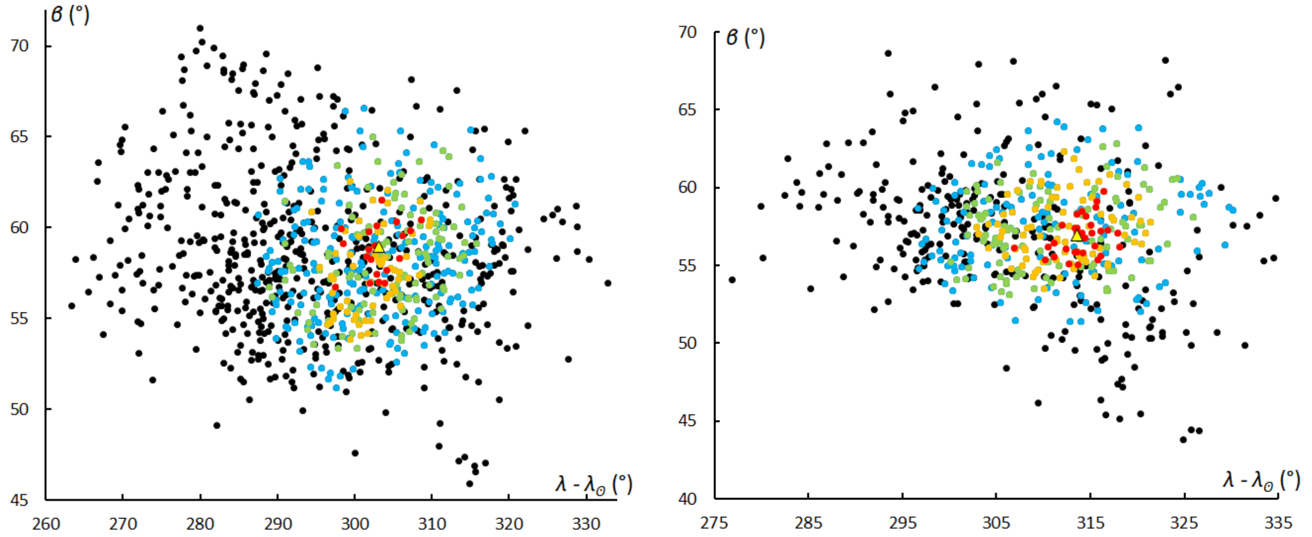


Figure 10 – Plot of the ecliptic latitude β against the Sun centered longitude $\lambda - \lambda_{\odot}$, for ζ-Cygnids orbits (left) and April ρ-Cygnids orbits (right). The different colors represent the 4 different levels of similarity. The yellow triangles mark the final reference orbits.

Table – 4 The orbital data for the ZCY–040, ARC–348, NCY–409 and MAL–350 all J2000.

$\lambda_\odot$ (°)	α_g (°)	δ_g (°)	$\Delta\alpha$ (°)	$\Delta\delta$ (°)	v_g km/s	*a* AU	*q* AU	*e*	ω (°)	Ω (°)	*i* (°)	*N*	Source
16	299.0	+40.2	0.5	0.3	43.6							402	ZCY Molau & Rendtel (2009)
20	303.8	+44.8			39	3.86	0.898		139.8	19.2	66.4	30	ZCY Sekanina (1976)
21.8	301.4	+40.4			42.5	3.84	0.909	0.765	142.2	21.8	74.3	87	ZCY Jenniskens et al. (2018)
30.0	305.2	+39.4	1.8	0.7	40.4							508	NCY (IMO)
31.6	309.9	+41.3			43.3	3.7	0.893		137.3	31.6	74.6	37	NCY Jenniskens (2013)
31.9	*311.4°*	*+43.7*	*0.86*	*0.29*	*42.7*	*5.1*	*0.888*	*0.827*	*138.1*	*31.9*	*73.7*	*185*	*ZCY This study D_D<0.08*
32.0	309.5	+42.5	0.64	0.26	43.0	3.93	0.900	0.780	140.5	31.5	74.9	64	ZCY Jenniskens et al. (2016)
37.0	324.5	+45.9	0.61	0.36	41.8	6.51	0.810	0.875	125.6	37.0	69.9	1006	ARC Brown et al (2010)
37.2	*321.4*	*+46.6*	*0.98*	*0.33*	*41.3*	*6.1*	*0.847*	*0.858*	*131.2*	*37.2*	*69.6*	*210*	*ARC This study D_D<0.08*
38.0	322.1	+46.6	0.66	0.32	40.9	6.14	0.842	0.864	130.3	39.4	69.7	42	ARC Jenniskens et al. (2016)
38.9	320.9	+46.5	-	-	41.1	4.58	0.848	0.815	131.4	38.9	70.1	252	ARC Jenniskens et al. (2018)
39.9	324.5	+45.9			41.8	5.56	0.844		130.4	39.9	69.7	29	ARC Phillips et al. (2011)
42.0	335.6	+45.3	0.61	0.5	43	11.14	0.725	0.935	114.8	42.0	70.6	881	MAL Brown et al. (2010)

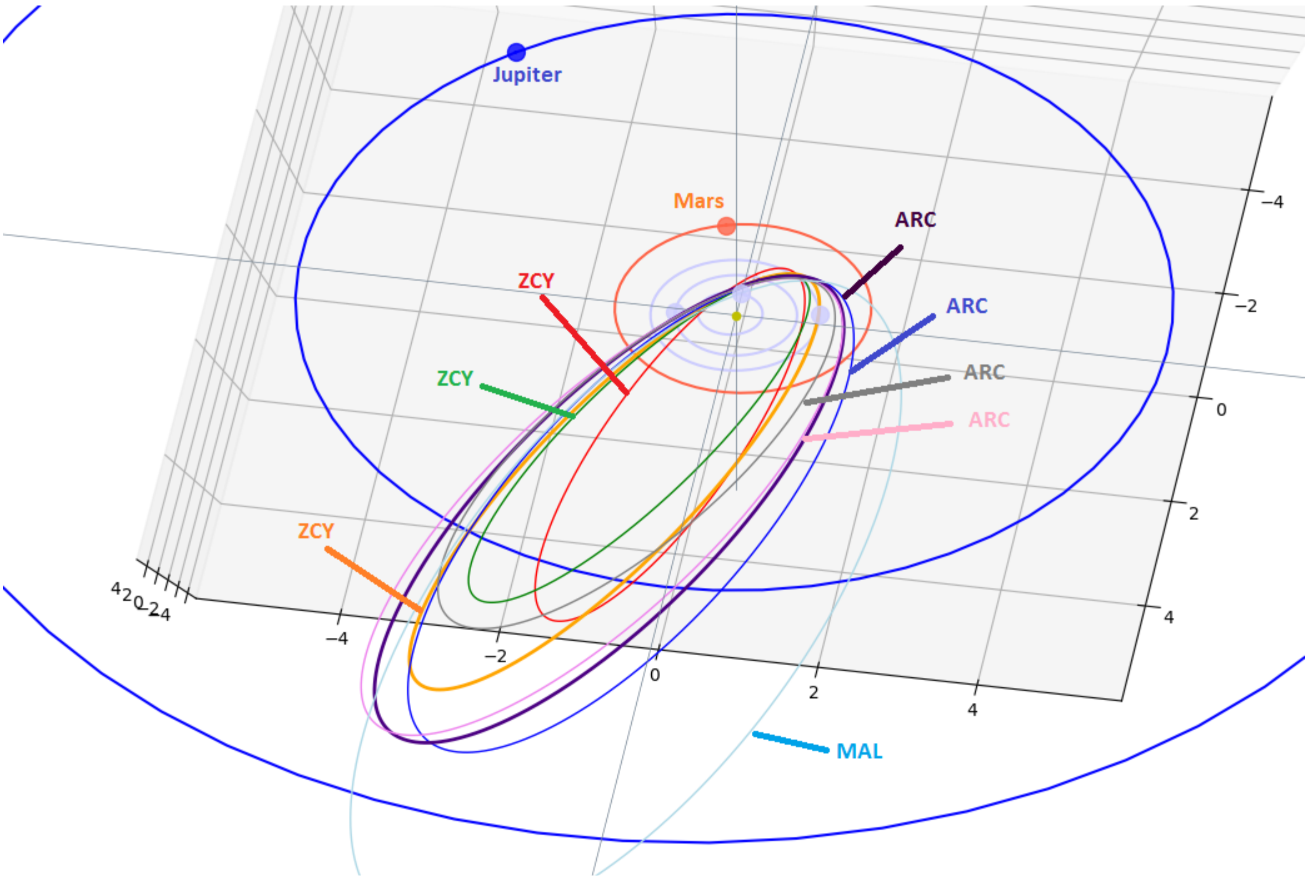


Figure 11 – Some of the reference orbits listed in Table 4, colors correspond to the following references: ZCY (orange) this study D_D<0.08, ZCY (red) Jenniskens et al. (2018), ZCY (green) Jenniskens et al. (2016), ARC (blue) Brown et al. (2010), ARC (purple) this study, ARC (pink) Jenniskens et al. (2016), ARC (grey) Jenniskens et al. (2018), MAL (blue) Brown et al. (2010).

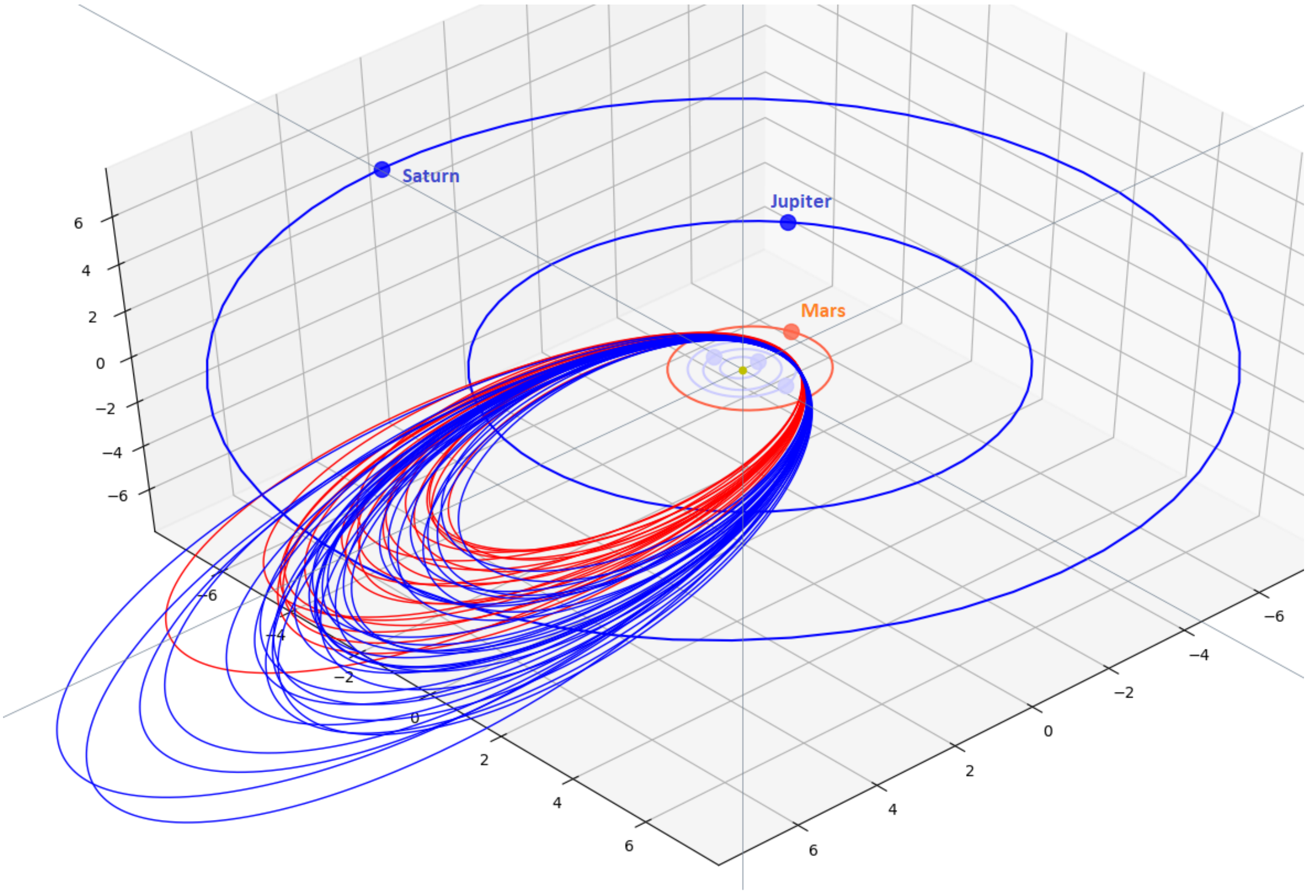


Figure 12 – The 20 ZCY–040 orbits that fulfill the high threshold value (red), the 32 ARC–348 orbits that fulfill the high threshold values (blue).

association contracts into a more compact radiant area (*Figure 9*). This proves that the radiant drift is valid. Both plots also show that the two corrected radiant areas have a lot of overlap when corrected for radiant drift for the 5° in solar longitude difference in time for which the plots are valid.

Another way to have an idea about the size and shape of the radiant area is a plot of the solar centered ecliptic coordinates shown in *Figure 10*. We can see a rather large sized radiant area. The April ρ-Cygnids picture appears slightly more diffuse than that for the ζ-Cygnids.

The median values for the beginning and ending heights of the ζ-Cygnids are 102.8 ± 4.0 and 91.8 ± 4.1, for the April ρ-Cygnids these values are almost identical with 102.0 ± 4.2 and 91.6 ± 4.5. These ablation heights are well above the average values for a geocentric velocity of ~42 km/s which is an indication for a very volatile composition, typical for meteoroids of a cometary origin.

Both ZCY and ARC components are rich in bright meteors and deficient in faint meteors. The median values that were found for the brightness of the ζ-Cygnids was m_{abs} = –0.6 [–4.8 to +2.5], for the April ρ-Cygnids we got m_{abs} = –0.6 [–5.5 to +2.7]. These characteristics are typical for an older shower which lost its smaller particles with time.

6 Comparing orbits

In *Table 4* we list the different orbits as listed in the IAU Working list. The interpretation of this data requires some reflections.

Certain entrees concern shower discoveries for which no orbit is known or for which the orbital elements are incomplete. Defining meteor showers based on single meteor station tracks is based on the 19th century methodology of the visual era which led to a lot of controversy. It makes very little sense to apply this 19th century methodology to the more accurate single station video data when orbit data is available. A minimum criterion for any shower discovery should be a statistical relevant sample of accurate orbits.

Observational errors have still a significant effect on the resulting orbits, also for those reference orbits with 'accurate' orbits. Video records allow collecting statistical significant number of orbits, but all these orbits have uncertainty margins caused by observational limitations, also the triangulation solution is a best fit but not exact. Most sensitive is the velocity measurement which seriously affects the semi-major axis *a* resulting in a huge scatter at the aphelia. The difference between the different reference orbits for both ζ-Cygnids and April ρ-Cygnids is well visible in *Figure 11*.

Old dispersed meteor streams intersect the Earth orbit over a considerable long period of time which means mainly large differences in both the descending node Ω and the argument of perihelion ω. The D criteria are unsuitable to associate physical related obits that are dispersed greatly. The grouping we see in *Figure 12* which corresponds to the ζ-Cygnids (red) and April ρ-Cygnids (blue) may be the result of the preliminary selection of orbits in two different time intervals. *Figures 12 and 13* show how the orbits with the highest similarity for each component are weaved in between each other.

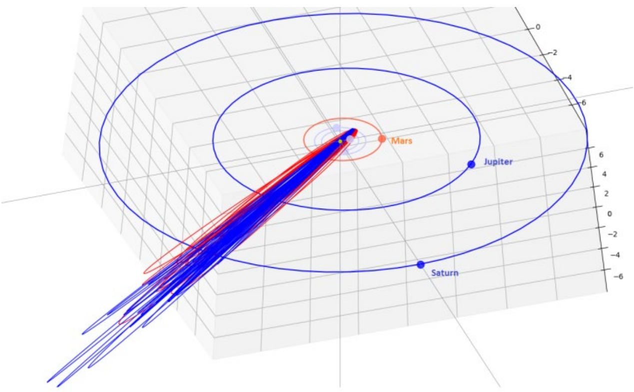


Figure 13 – The 20 ZCY–040 orbits that filfill the high threshold value (red), the 32 ARC–348 orbits that fulfill the high threshold values (blue), seen in the orbital plane of the stream.

Peter Jenniskens et al. (2016) classified the April ρ-Cygnids as a Halley Type Comet shower in the toroidal source, while the ζ-Cygnids are considered as a Jupiter Family Comet shower in the toroidal source, because of a slight lower inclination of the April ρ-Cygnids. The ZCY–040 and ARC–348 are listed as possibly paired showers in the toroidal ring.

The very first mention of this stream appeared in the stream search on radio meteor orbits by Sekanina (1976) and the naming in the original paper was "April Cygnids", more appropriate than ζ-Cygnids for such scattered radiant. If the shower naming would be reconsidered April-May Cygnids would be a more appropriate naming.

7 Conclusion

The attempt to document the ζ-Cygnids (ZCY–040) shower required to take the probably related April ρ-Cygnids (ARC–348) into account. An independent search among 685362 public available orbits proved evidence for the presence of a concentration of similar orbits for the two selections on (λ_O, α_g, δ_g, v_g), for both showers, ZCY and ARC. The resulting orbital elements for the two showers are very similar with the references in literature and differ only within the error margins.

Both sources have orbits every year since 2007, there is no indication for any periodicity. The ARC filament was not in outburst in 2012 as we have plenty of orbits each previous year. The ν-Cygnids (NCY–409) entry in the IAU working list of meteor showers is definitely another entry identical to the April ρ-Cygnids (ARC–348). The radiant drift obtained in this analyzes shows the drift corrected ZCY radiant overlapping to a large extend with the ARC radiant, with median values only few degrees apart within a rather large scattered radiant area. The ablation heights and brightness for both ZCY and ARC meteors are identical, indicating a similar origin. The activity profile shows multiple sub-maxima that may be an indication for a layered structure of superimposed streamlets left over from a single parent body, either a Halley Type comet or Jupiter Family comet. Our results confirm the difference in inclination between the ARC and ZCY components. The activity profile with different sub-maxima can explain the differences in time of maximum activity, radiant position and orbital elements between the different literature sources listed in *Table 4*. The different sub-maxima caused by different streamlets are likely the remnants of an old diffuse meteor shower of cometary origin.

Acknowledgment

The authors are very grateful to Jakub Koukal for updating the dataset of EDMOND with the most recent data, to SonotaCo Network (Simultaneously Observed Meteor Data Sets SNM2007–SNM2017), to CAMS (2010–2013) and to all camera operators involved in these camera networks.

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2017 Report BOAM June to September 2017

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A summary of the Perseid shower and the most interesting meteor events recorded by the French network BOAM during the period of June until September is presented.

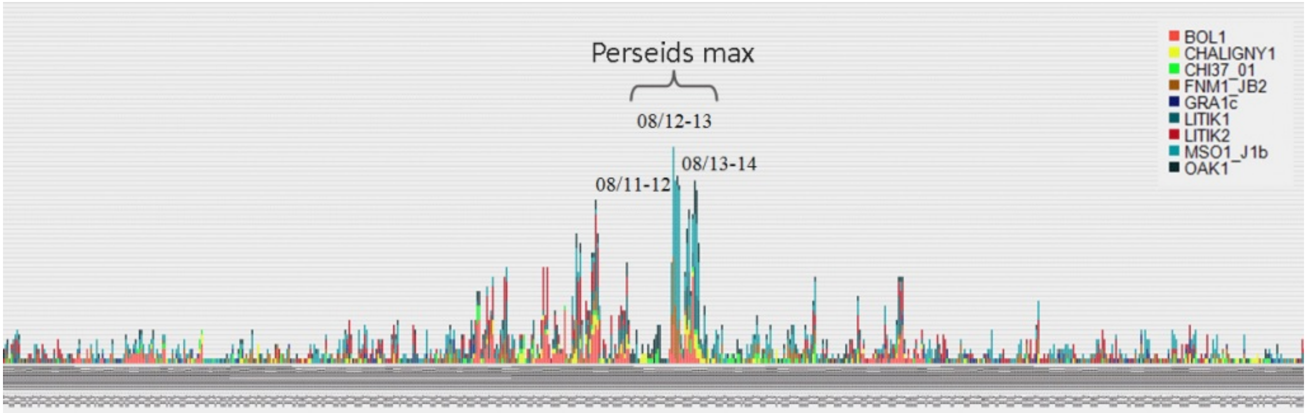

Figure 1 – Overview of the number of captures for the period June to September 2017 – GraphBoam.

1 Introduction

The beginning of the second half of the year is made up of the Perseid stream with its fast and bright meteors. This year, the weather was not good during the peak of this major shower but the summertime allowed us to collect some nice shots.

2 July 17 – August 24: Perseids

The Perseid shower is associated with the dust trail released by the comet 109P / Swift-Tuttle each time when it passes close to the Sun (about every 130 years). The maximum activity happens during the night of 12 to 13 August when the Zenithal Hourly Rates increase up to 60 – 120 meteors per hour according to the year.

Table 1 – The Perseid meteor stream characteristics.

Period of activity	July 17 – August 24
Maximum	August 12–13
Radiant position (max)	$\alpha = 57.6°$ and $\delta = +48°$
Zenithal Hourly Rate (max)	100 meteors per hour
Velocity	59 km/s
Population index *r*	2.6
Parent body	109P/Swift-Tuttle

Last year the moon was full on August 7th and its luminosity was still 80% during the maximum of the Perseids. Therefore the observing conditions were not very good, between a moonless period with a low radiant elevation at the beginning of the night and a high radiant position with the bright moon present at the sky towards the end. Anyway, the cloud cover prevented us from enjoying anything of these mediocre conditions.

Figure 2 – Stacked picture of 59 Perseids from the MSO1_J1 station (Normandie) during the night of August 12th to 13th.

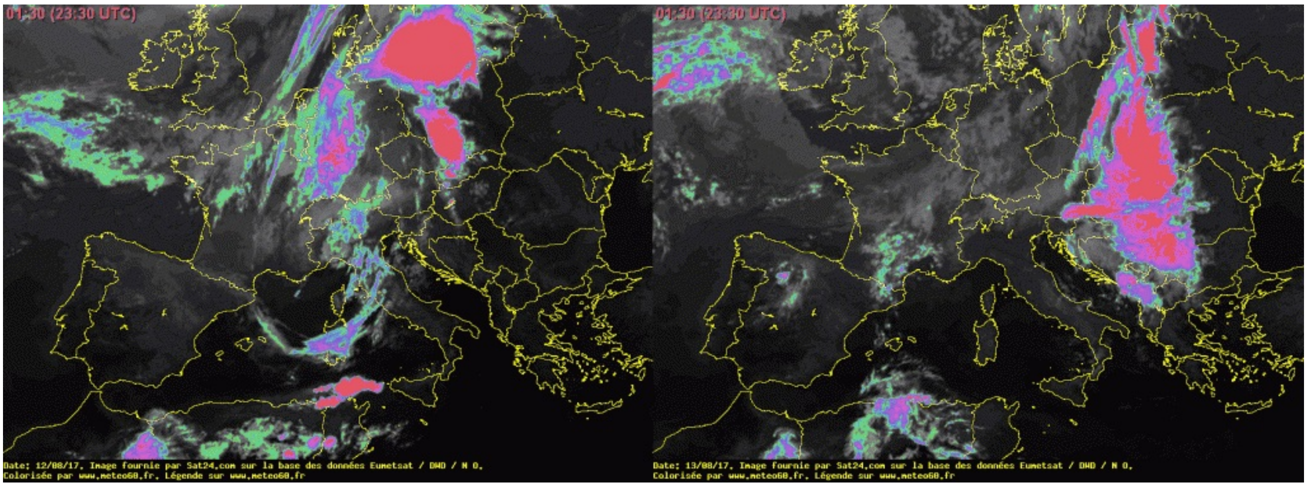

Figure 3 – IR satellite images on August 12th and 13th at 23h30m UTC ©Sat24.com / meteo60.fr.

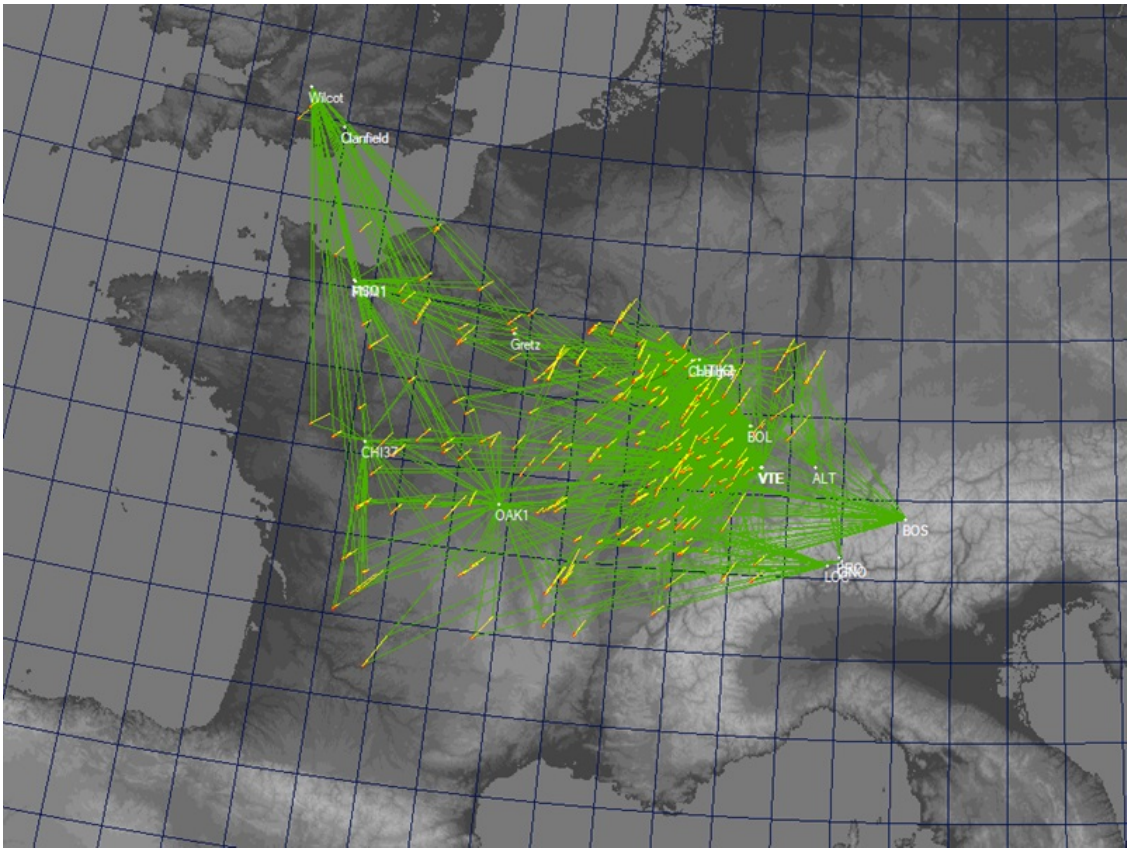

Figure 4 – 198 Perseid trajectories on the ground map – UFOorbit.

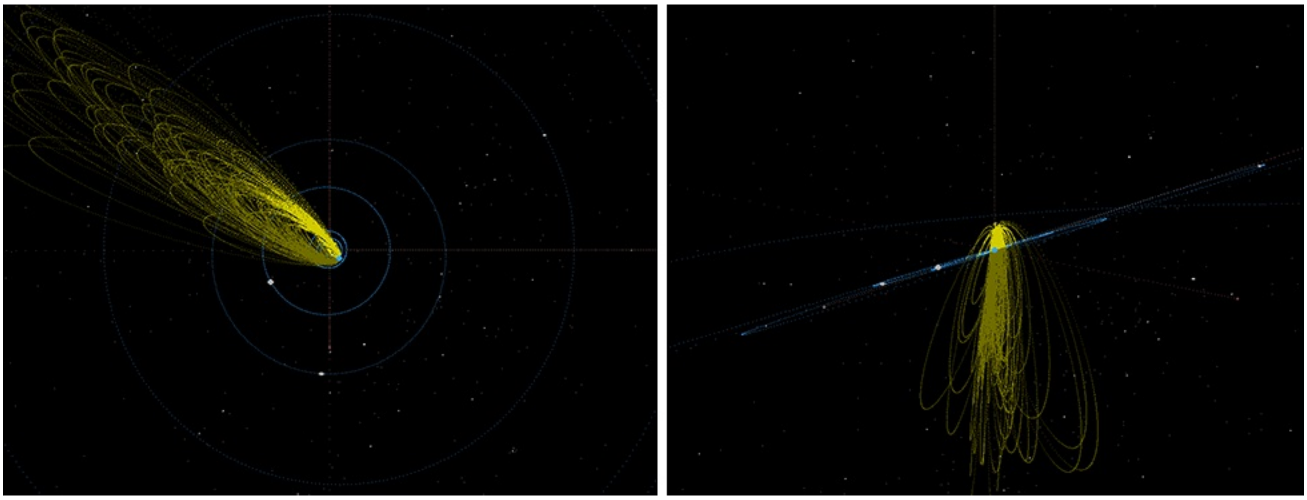

Figure 5 – 198 Perseid orbits in the solar system map: top view side view – UFOorbit. Rq: The semi-major axis of the orbit calculated depends a lot on the velocity of the meteor, the accuracy is rather poor for this element.

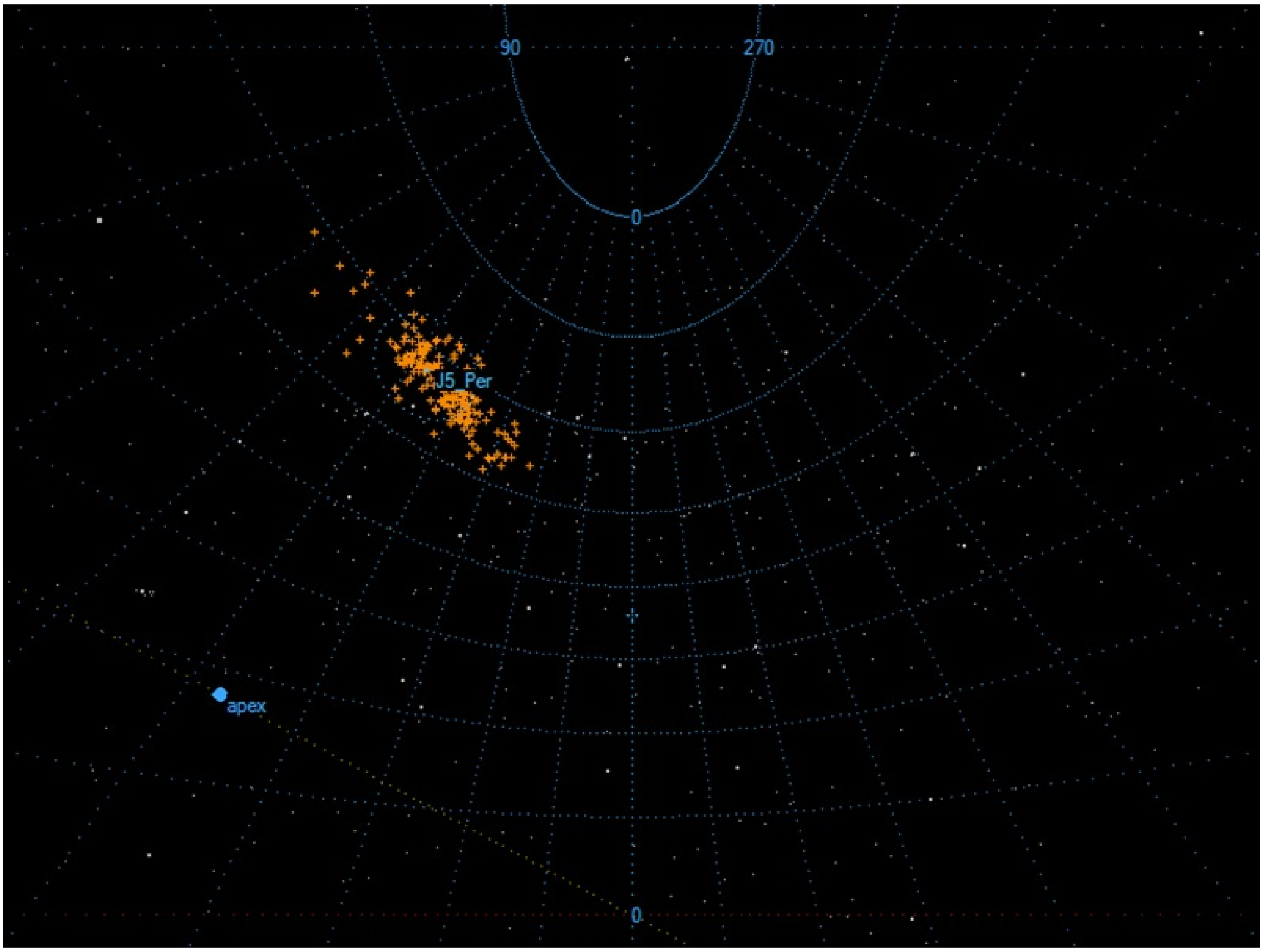

Figure 6 – 198 Perseid radiants on the gnomonic projection sky map – UFOorbit.

In total we recorded only 853 Perseids, which is 4 times less than the result in 2016 (3275 detections). Normandie's cameras FNM1_JB2 and MSO1_J1 saved us, thanks to the better weather in this region.

Thanks to the data sharing between BOAM, UKMON and FMA, 198 orbits, radiant positions and trajectories could be calculated over the period of the Perseids activity, 07/21-09/02.

3 Peculiar meteor events

2017/06/19 – 00:46:06 UT: Fast and long meteor M20170619_004606

Figure 7 – M20170619_004606 – Bollwiller (France) – C.Demeautis.

Figure 8 – M20170619_004606 – Chaligny (France) – Marco.

Figure 9 – M20170619_004606 – Val Terbi (Switzerland) – R.Spinner.

A –3.3 magnitude, fast (65 km/s) sporadic meteor crossed the East of France over a distance of 238 km. It entered in the atmosphere with a low inclination of 4°. Sporadic, Absolute magnitude: –3.3, Duration time: 3.64 s, Velocity: 65 km/s, altitude at start: 114 km, altitude at end: 96 km, trajectory length: 238 km, inclination: 4°. Radiant position: $\alpha = 342°$ and $\delta = –21°$.

Figure 10 – M20170619_004606 – Val Terbi (Switzerland) – R.Spinner.

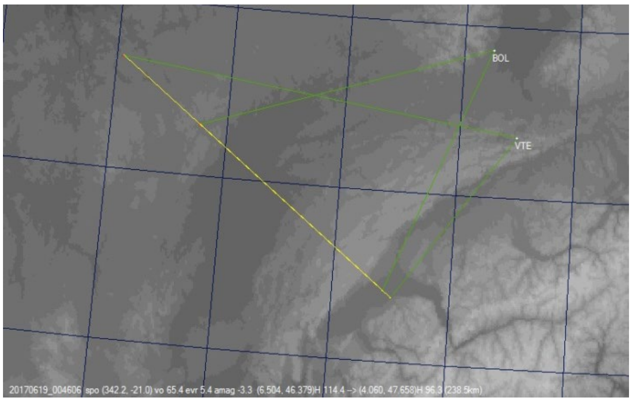

Figure 11 – M20170619_004606 trajectory on the ground map.

2017/06/20 – 01:07:25 UT: M20170620_010725

A –4.9 magnitude sporadic fireball caught by Astrochinon's station during 4.00 seconds.

Figure 12 – M20170620_010725 – Chinon (France) – Astrochinon.

2017/06/29 – 21:49:19 UT: Multiple exploding fireball M20170629_214919

This object lighted up during 1.86 seconds entering into the atmosphere with multiple explosions (magnitude –6) and left a persistent trail like a pearl necklace.

Figure 13 – M20170629_214919 – May-sur-Orne (France) – S.Jouin[1].

2017/07/29 – 02:51:24 UT : Bright Capricornid M20170729_025124

Figure 14 – M20170729_025124 – Cerilly (France) – T.Gulon.

Figure 15 – M20170729_025124 – Val Terbi (Switzerland) – R.Spinner.

[1] http://video.boam.free.fr/detection/video/M20170629_234919_MSO1_J1b.flv

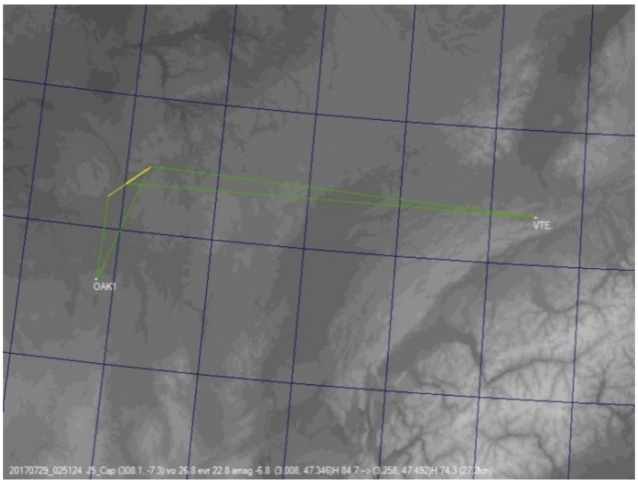

Figure 16 – M20170729_025124 trajectory on the ground map.

Capricornid, absolute magnitude: –6.8, duration time: 2.06 s, velocity: 27 km/s, altitude at start: 85 km, altitude at end: 74 km, trajectory length: 27 km, inclination: 24°. Radiant position: $\alpha = 308°$ and $\delta = -7°$.

2017/08/06 – 00:43:46 UT: Perseid M20170806_004346

A fast Perseid fireball ending with a flare of magnitude –5.6 and caught by 2 cameras, but with a too close baseline to calculate the orbit.

Figure 17 – M20170806_004346 – Fleville (France) – T.Gulon[2].

Figure 18 – M20170806_004346 -Chaligny (France) – Marco.

2017/08/12 – 23:44:22 UT: Perseid M20170812_234422

A Perseid ending by a flare of magnitude –5.5 and producing nice persistent trail.

Figure 19 – M20170824_033751 – May-sur-Orne (France) – S.Jouin[3].

2017/08/21 – 01:27:59 UT: M20170821_012759

Figure 20 – M20170821_012759 – Cerilly (France) – T.Gulon.

Figure 21 – M20170821_012759 – Val Terbi (Switzerland) – R.Spinner.

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[2] http://video.boam.free.fr/detection/video/M20170806_004346_LITIK1_.flv

[3] http://video.boam.free.fr/detection/video/M20170813_014424_MSO1_J1b.flv

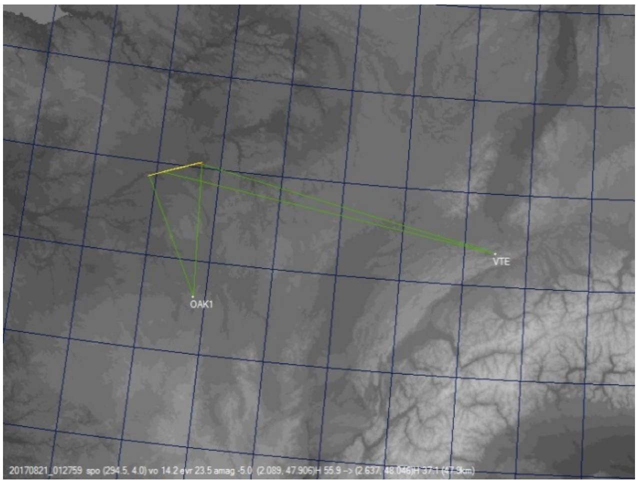

Figure 22 – M20170821_012759 trajectory on the ground map.

Capricornid, absolute magnitude: –5.0, duration time: 3.38 s, velocity: 14 km/s, altitude at start: 56 km, altitude at end: 37 km, trajectory length: 48 km, inclination: 23°. Radiant position: α = 294° and δ = +4°.

2017/09/10 – 19:28:50 UT: Very bright fireball over South-East of France M20170910_192850

This object appeared after sunset and was widely observed from half East of France. According to the 90 witnesses reported on the IMO fireball page, the fireball reached a magnitude of –13 and the meteor fragmented into multiple pieces at the end of its trajectory.

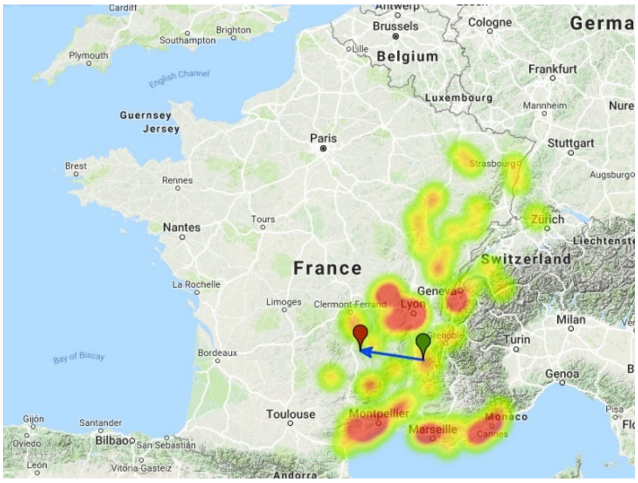

Figure 23 – 90 visual reports – IMO[4].

Figure 24 – M20170910_192850 – Fleville (France) – T.Gulon.

[4] http://fireballs.imo.net/members/imo_view/event/2017/3138

It was recorded by the camera LITIK2 from Fléville located 480 km north of the event and by the station VTE in Val Terbi, a camera from the Swiss meteor network FMA. Calculations on the data of those cameras result in a low inclination of the trajectory, 12° and a length of 178 km during 5.76 seconds. The accuracy is rather poor considering the great distances in these observations.

Sporadic, absolute magnitude: –3.5, duration time: 5.76 s, velocity: 31 km/s, altitude at start: 88 km, altitude at end: 49 km, trajectory length: 178 km, inclination: 12°. Radiant position: α = 3.7° and δ = +4.6°.

It was also caught by all-sky cameras of the FRIPON network and by two independent all-sky cameras.

Figure 25 – M20170910_192850 – Val Terbi (Switzerland) – R.Spinner.

Figure 26 – M20170910_192850 – Val Terbi (Switzerland) – R.Spinner.

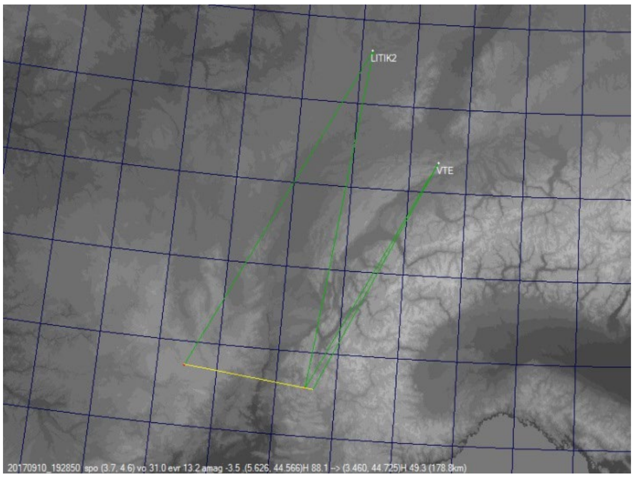

Figure 27 – M20170910_192850 trajectory on the ground map.

Figure 28 – Video from Minervois (France) © Jean Marie Jacquart[5].

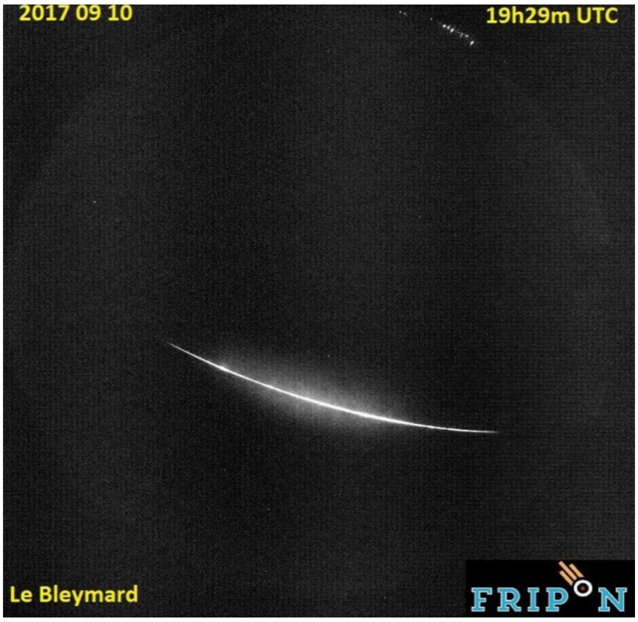

Figure 29 – Record from Le Bleymard © Fripon.

Figure 30 – Capture at Dauban (France) © F.Kügel / C.Rinner.

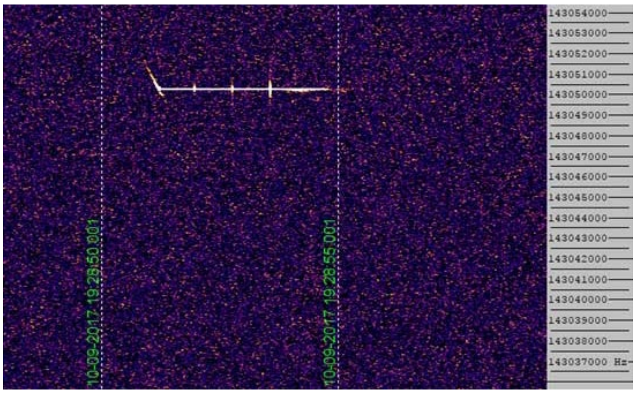

Figure 31 – GRAVE radar reflection from Marseille © Fripon.

2017/09/14 – 19:04:39 UT: M20170914_190439

Sporadic, absolute magnitude: –4.1, duration time: 2.55 s, velocity: 41 km/s, altitude at start: 114 km, altitude at end: 70 km, trajectory length: 103 km, inclination: 19°. Radiant position: α = 5° and δ = +20°.

Figure 32 – M20170914_190439 – May-sur-Orne (France) – S.Jouin.

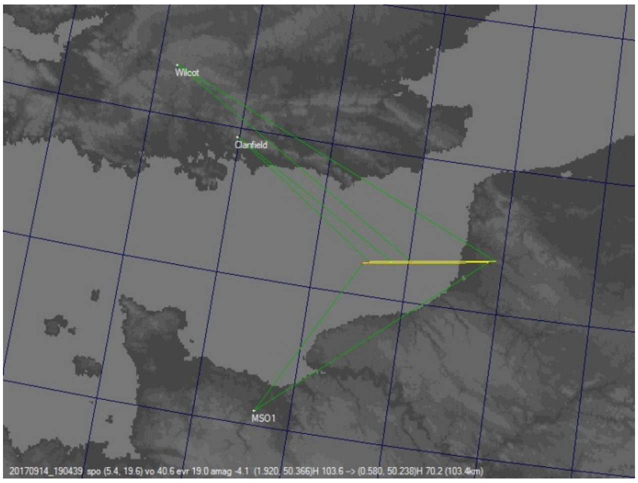

Figure 33 – M20170914_190439 trajectory on the ground map.

[5] https://youtu.be/0iPeCFvCu98

CAMS BeNeLux: results April 2018

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Weather provided very good observing conditions around the traditional Lyrid maximum. 1929 orbits were collected in 27 (partly) clear nights, of which 203 could be identified as members of the Lyrid stream. The radiant drift in R.A. was +0.87 ± 0.08 degrees per day. De radiant drift in declination was -0.10 ± 0.11 degrees per day, based upon the 106 Lyrids obtained in the period between April 17/18 and April 23/24 fulfilling the D-criterion < 0.04.

1 Introduction

The month of April was characterized by an abrupt transition of rather cold to mainly very warm weather. The change occurred about the 10th of April. It was the start of an overall sunny period which persisted until almost the end of the month. The timing was perfect with mostly clear nights around the traditional Lyrid maximum.

2 The data

The month of April counted only three nights without any double station meteors. Beyond April 14–15, also the two last nights of the month had zero coincidences. Especially the nights in the period of 16 until 23 April had very clear nights. Hence, it is no surprise that most double station meteors were obtained during the nights near the Lyrid maximum.

In total 1929 orbits were registered by our network, a new record for this month in spring. *Figure 2* displays the radiant positions of all registered orbits. The strong concentration around α = 270° and δ = +30° is indeed due to the Lyrids.

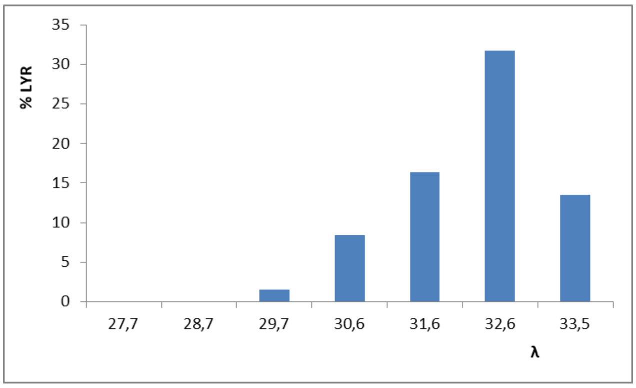

Figure 1 – Percentage of Lyrids relative to the other meteors during the nights 17–18 until 23–24 April 2018. (Source: CAMS BeNeLux data).

To distinguish the Lyrid orbits from the other meteors, the D- criterion of Drummond has been applied (Drummond, 1981). A total of 106 orbits were found which fulfilled this Drummond criterion D_D < 0.04. *Figure 1* shows for each of the nights of 17–18 April until 23–24 April the percentage of Lyrids of the dataset relative to the number of other meteors in the same night. We see a nice activity profile which is in good agreement with the known profile with a maximum activity around solar longitude 32°.

The number of Lyrids is large enough to derive the radiant drift around the maximum for the period of 17 until 23 April (λ_O ~ 29.5° – 33.6°). In *Figure 3* we see a radiant drift in Right Ascension of 0.87 ± 0.08°/λ_O. *Figure 4* shows the radiant drift in declination with –0.10 ±0.11°/λ_O.

The standard deviation with these values has been derived using a matrix in Excel which does not only calculate the best linear fit, but also provides the standard deviation on the slope[6] (Bouma and Doom, 2018).

Jenniskens et al. (2016) gives a drift for the Right Ascension and declination of respectively +0.66° and +0.02°. Our results are still within the error margin compared to the reference for the drift in declination. This is not the case for the drift in Right Ascension as our value is a bit larger than the value given by Jenniskens et al. (2016).

In order to check our data, we compared with some other public available datasets. We used the datasets of Edmond and SonotaCo. We selected the following data from these datasets:

- Solar longitude between 19° and 44°;
- Right Ascension of the radiant between 257° and 287°;
- Declination of the radiant between +23° and +44°;
- Geocentric velocity between 41.7 and 51.7 km/s.

[6] http://pages.mtu.edu/~fmorriso/cm3215/UncertaintySlopeInterceptOfLeastSquaresFit.pdf

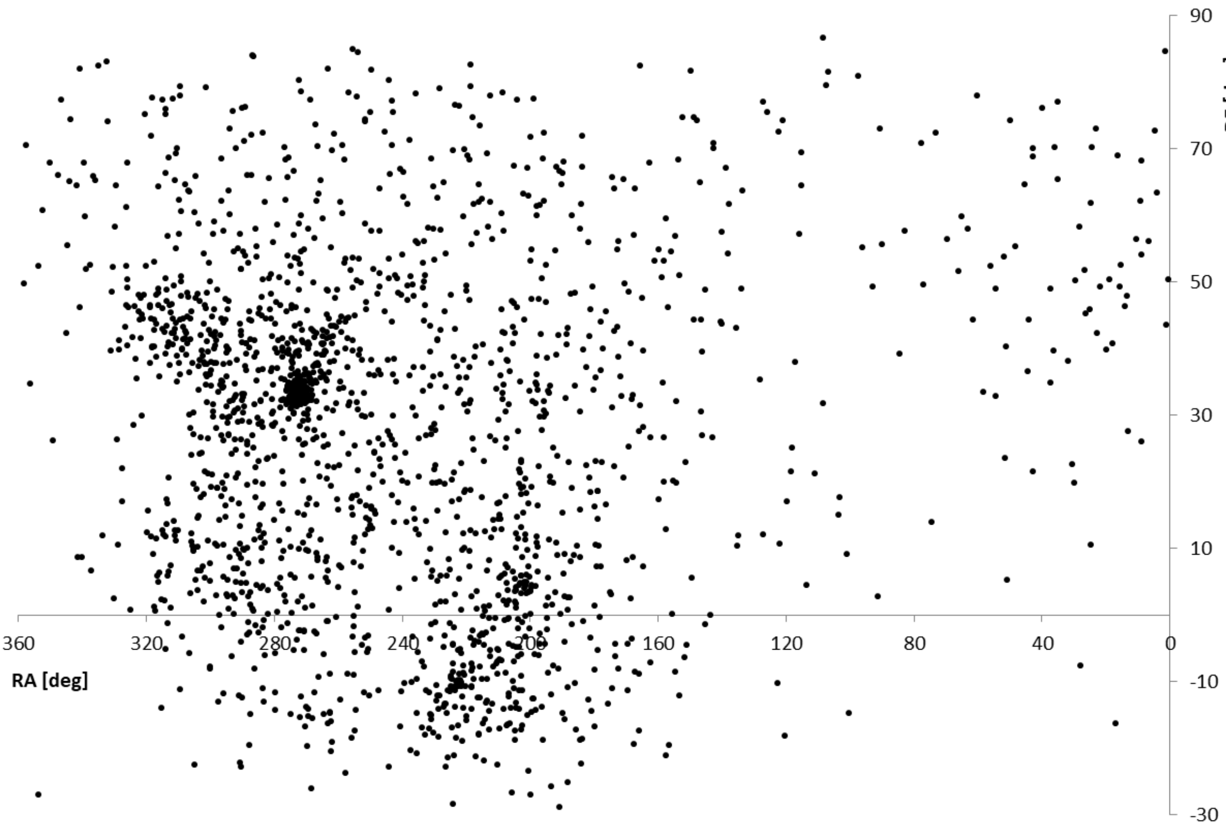

Figure 2 – Radiant positions of the 1929 orbits collected by CAMS BeNeLux in April 2018.

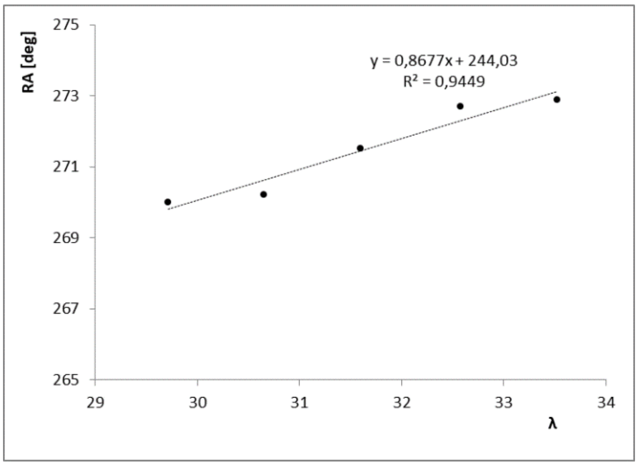

Figure 3 – Radiant drift in Right Ascension for the Lyrids 2018. (Source: CAMS BeNeLux data).

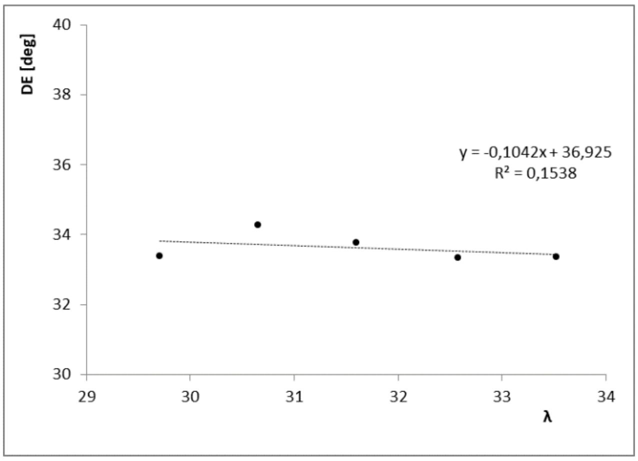

Figure 4 – Radiant drift in declination for the Lyrids 2018. (Source: CAMS BeNeLux data).

Table 1 – Median values for the radiant positions, v_g and orbital elements of the Lyrids obtained from data of CAMS BeNeLux (2018), Edmond/SonotaCo and Jenniskens (2016).

	BeNeLux (2018)	EDMONd / SonotaCo	Jenniskens (2016)
λ_O	32.5°	32.3°	31.7°
α_g	272.3°	272.1°	272.1°
$\Delta\alpha$	+0.87±0.08°	+1.04±0.03°	+0.66°
δ_g	+33.4°	+33.4°	+33.6°
$\Delta\delta$	–0.10±0.11°	–0.21±0.02°	+0.02°
vg	46.8 km/s	46.5 km/s	46.7 km/s
a	29.9 AU	14.9 AU	25.6 AU
q	0.9208 AU	0.919 AU	0.923 AU
e	0.969	0.943	0.964
ω	213.9°	214.5°	213.6°
Ω	32.5°	32.3°	31.7°
i	79.7°	79.3°	79.3°
N	106	1750	1249

3533 orbits fulfilled the above-mentioned criteria. The median values for the orbital elements q, e, i, ω and Ω of this selection are representative for the Lyrids and have been used as parent orbit to compute the D-criteria. The median values of the orbits with $D_D < 0.04$ were used as final reference orbit for the Lyrids to re-compute the D-criteria. For the 1750 Lyrid orbits with a value of $D_D < 0.04$ the median values for the solar longitude, geocentric radiant position, geocentric velocity and orbital elements were computed. The results are listed in *Table 1*.

Using only orbits $D_D < 0.04$ in the time lapse of 28.2° until 35.9° in solar longitude for the Edmond and SonotaCo data we find a drift of +1.04±0.03° in Right Ascension and –0.21±0.02° in declination. These values differ a lot from those given in literature (Jenniskens et al., 2016).

3 Conclusion

The Lyrids could be very well observed this year. The radiant drift could be derived from the available data. For the declination our value is still within the margin of the literature value. For data from Edmond and SonotaCo we find a slight but clearly negative drift for the declination.

For the Right Ascension we find a drift of +0.87±0.08° from our data, a slightly larger value than the value in literature. For the Edmond/SonotaCo data the resulting drift in Right Ascension is even larger with 1 degree per day.

Acknowledgment

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Lyrid 2018 observations from Ermelo, the Netherlands

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A report is presented for the Lyrid observing campaign. The favorable weather in the Netherlands allowed to make visual observations during most of the nights of the Lyrid activity.

1 Introduction

In 2018 the Lyrids would not be very favorable. A New Moon on April 14 means in the pre-nights after April 20 some moonlight. The nights 21–22 and 22–23 April would still be more than respectively 2 hours and 1 hour of moonless dark skies in the Netherlands. Fortunately, the weather cooperated very well in that period and I could observe the Lyrids during many nights. I made the following observing report.

2 April 16–17

The night of Monday on Tuesday was almost entirely clear. As the weather was expected clear all week, I decided to keep a bit of a steady rhythm so that I could keep observing in a normal way because I had a regular working week. That meant getting to bed early at 17^h UT in the evening and setting the alarm at 23^h UT.

When I arrived at the Groevenbeek Heide (a heath) there were some fog banks, but these dissolved soon. The observations started at 23^h33^m UT. The sky was nice and dark and very transparent. The Milky Way was visible from Cassiopeia to the Sagittarius. There was surprisingly little air traffic and also little road traffic. Only the last half hour more traffic was audible.

The meteor activity was somewhat disappointing, given the beautiful starry sky. In total, 29 meteors were seen during 3 hours and 19 minutes with a lm of 6.4. SQM (Sky Quality Meter) values rose to 20.42 maximum. Amongst those 29 meteors there were 2 Anti-helions and 6 Lyrids. The most beautiful was a magnitude +2 Lyrid with a flare near the radiant in Hercules. A +2 ANT a few minutes later in Cassiopeia was also worth the watch. The Lyrid hourly counts were resp. 2.2, and 2. At 2^h10^m UT I saw, somewhat surprised, thick plucks of cirrus hanging in the west, which gradually shifted eastwards. From 2^h35^m UT the cirrus moved into my field of view. At 2^h52^m UT I ended the observations. The twilight had already made its appearance. I still enjoyed the view: Jupiter in the southwest, Antares in the south and in the east the planets Saturn and Mars in the constellation of Sagittarius. The temperature had dropped to –2 degrees Celsius.

Table 1 – Meteor counts April 16–17 2018[7].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
23:57	0:45	0,35	0,80	6,34	20,30	2	0	6	9
0:45	1:30	1,13	0,75	6,40	20,43	2	1	7	10
1:30	2:30	2,00	1,00	6,37	20,36	3	1	6	8
2:35	2:52	2,73	0,28	6,18	20,20	0	0	2	2

3 April 17–18

During the evenings heavy cirrus clouds were moving over the Netherlands, but they were dissolved when I started the observations at 23^h57^m UT. Because of my job during the day I took this time a shorter session. The Groevenbeek Heath was again used as location. In the first hour there were some very thin remnants of the cirrus clouds, the sky looked a little light and the transparency was a bit less. After half an hour this was all past and the weather was nice and clear. The lm improved to 6.4, the SQM rose to 20.43. The temperature dropped from +3 to +1 degree Celsius. Furthermore, it was striking that there was a lot of (air) traffic this night.

During these 2.55 hours I counted 27 meteors of which 7 were Lyrids. There was also some more beautiful stuff. A +2 ANT in Hercules, as well as a +1 sporadic meteor both in Hercules were beautiful. At 1^h53^m UT a +1 Lyrid appeared in Cassiopeia and while I reported the data on my Dictaphone, I saw something “bright” moving low in the northeast. I also saw a persistent train that was visible for 5 seconds. It was a beautiful –2 sporadic meteor.

Table 2 – Meteor counts April 17–18 2018[8].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
23:57	0:45	0,35	0,80	6,34	20,30	2	0	5	7
0:45	1:30	1,13	0,75	6,40	20,43	2	1	6	9
1:30	2:30	2,00	1,00	6,37	20,36	3	1	7	11

4 April 18–19

This night I observed again from the Groevenbeek Heide between 23^h52^m and 02^h30^m UT. The conditions were now clearly less. The sky background was lighter and here and

[7] http://www.imo.net/members/imo_vmdb/view?session_id=76365

[8] http://www.imo.net/members/imo_vmdb/view?session_id=76366

there some patches of very thin cirrus were visible. Low in the southeast below 5 degrees thicker cirrus was visible, Antares was barely visible. The planets Saturn and Mars were also barely visible at first. Later it did improve somewhat when the cirrus had disappeared in the southeast. However, new cirrus was emerging from the southwest, but this only reached my FOV (field of view) after the end of the observations. The limiting magnitude was 6.3. The SQM meter did not go beyond 20.35. The temperature rose from 11 to 13 degrees during the night. This was due to an increasing southeastern wind.

The moderate sky affected the number of meteors I observed, I counted 22 meteors including 7 Lyrids and 2 Antihelions. A +2 Lyrid and especially the magnitude 0 Antihelion were the highlights of this session. The bluish Antihelion was nice to see with some fragmentation. The time was 01^h34^m UT.

Furthermore, it was worth noting that I could once again observe a NOSS duo. The wax was visible around 23^h59^m UT and moved from Boötes to Draco, each magnitude +4, roughly 1 degree apart.

Table 3 – Meteor counts April 18–19 2018[9].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
23:52	0:44	0,30	0,867	6,32	20,26	1	0	5	6
0:45	1:30	1,13	0,750	6,30	20,34	4	1	3	8
1:30	2:30	2,00	1,000	6,30	20,33	2	1	5	8

5 April 19–20

Because I had to start a bit earlier this day at my job, I went again for a shorter session. Location: Groevenbeek Heide. I could observe between 23^h46^m and 02^h00^m UT. The sky had deteriorated a bit compared to the previous night. The lm initially was +6.3 but gradually declined to 6.2. The SQM meter gave values from 20.34 decreasing to 20.26. Nevertheless, 24 meteors were still seen. A nice blue +1 APEX meteor rose from the south-eastern horizon with a persistent train of 3 seconds.

Tabel 4 – Meteor counts April 19–20 2018[10].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
23:46	0:30	0,13	0,73	6,32	20,32	2	1	4	7
0:30	1:15	0,88	0,75	6,27	20,32	2	1	5	8
1:15	2:00	1,63	0,75	6,22	20,26	4	0	5	9

6 April 20–21

This night was clear in the evening, but it was very hazy. And a weather check just after 23^h UT taught me that it was still very hazy: lm 5.8. When I left for work more than two hours later, it was mostly cloudy. So no observations were done from Ermelo that night.

7 April 21–22

Since the Lyrid maximum was expected on 22 April 2018 around 20^h UT, this and the next nights were the important ones. The weather forecasts were not good for this night. For several days, the Dutch weather institute KNMI indicated that the cloud cover would increase during the course of the night. However, on Saturday the 21st, clearings were predicted. During the day plenty of cirrus was present, but in the evening, it seemed to dissolve. I did a short 2-hour-long nap in the evening. In that period the all sky camera recorded a long Lyrid of magnitude –4 with final flare. When I was awake the sky was clear. When I biked to the heath, the Moon was low in the west and there were some small patches of cirrus visible here and there. Only low in the west there was thicker cirrus visible.

I started at 23^h34^m UT with a lm of 5.8 obtained in area 11 (Boötes). After 00^h26^m UT the Moon was no longer visible, it was already low in the west behind the thicker cirrus clouds. Sky conditions had lm 6.2 at that time. The lm improved even further to 6.4 and then decreased again due to the upcoming dusk. After 2^h10^m UT the sky deteriorated: a kind of haze moved in from the southwest, causing the lm to drop to 6.2, while thicker cirrus was approaching from the same direction.

After 02^h30^m UT, the lm continued to drop as a result of the advancing twilight.

Figure 1 – Magnitude –3 Lyrid on 23 April 2018 at 2^h20^m UT. Camera: Canon 6D with Canon EF 8-15 mm zoom fish eye lens set at 8 mm.

The activity of the Lyrids was rather flat this night. Half-hour counts of 3 to 4 were the norm. Most Lyrids were faint. A pair of +1 that appeared right behind each other were the most beautiful ones. In total I observed 45 meteors between 23^h34^m and 02^h50^m UT, with 23 Lyrids and 2 Antihelions. Despite the slightly lesser observing circumstances, it was a good result. It was more than I expected based on the weather forecast.

[9] http://www.imo.net/members/imo_vmdb/view?session_id=76367

[10] http://www.imo.net/members/imo_vmdb/view?session_id=76369

Table 5 – Meteor counts April 21–22 2018[11].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
23:34	0:04	23,82	0,500	5,92	20,20	4	0	3	7
0:04	0:35	0,33	0,500	6,22	20,28	3	0	2	5
0:35	1:05	0,83	0,500	6,32	20,34	4	1	3	8
1:05	1:36	1,34	0,500	6,36	20,39	3	0	3	6
1:36	2:06	1,85	0,500	6,35	20,36	5	1	5	11
2:06	2:37	2,36	0,500	6,15	20,22	3	0	3	6
2:37	2:50	2,73	0,217	6,00	20,03	1	0	1	2

8 April 22–23

In the evening we got a bright clear sky but this was soon followed by increasing cirrus and a passage of high clouds, then came middle level clouds and finally it was clearing up again and clear from 1^h34^m to 2^h35^m. In that last period I did a short session, but the sky was very hazy with lm variable between 5.9 and 6.1. Because of the weather I decided this time to observe on the flat roof of my dormer.

I was not disappointed: the first meteor I observed was a –2 Lyrid in Cepheus which was also nicely recorded with CAMS 353 (*Figure 2*). During a break because of some passing clouds, I saw another magn. 0 Lyrid between the clouds and at 2^h20^m UT a very beautiful –3 Lyrid in Draco with a persistent train of 5 seconds (*Figure 1*). In addition, a number of +1 Lyrids were seen. During this short period of 0.933 hour I counted 11 Lyrids, 1 Antihelion and 5 sporadic meteors. In total I had 17 meteors. This was visually the final observing night for the Lyrids 2018. For me this Lyrid year was very successful.

Table 6 – Meteor counts April 22–23 2018[12].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot
Start	End	[h]	[h]		mean	LYR	ANT		
1:34	2:37	2,09	0,933	6,02	19,93	11	1	5	17

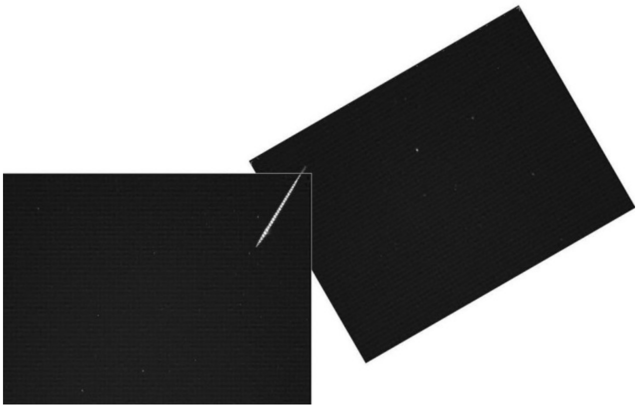

Figure 2 –A –2 Lyrid in Cepheus captured by CAMS.

[11] http://www.imo.net/members/imo_vmdb/view?session_id=76371

[12] http://www.imo.net/members/imo_vmdb/view?session_id=76372

On the hunt for the Eta Aquariids in 2018

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A report is presented for the Eta Aquariid observing campaign. The favorable weather in the Netherlands allowed to make visual observations during several of the nights of the Eta Aquariid activity.

1 Introduction

Gosh! I wrote in the Orionids report of 2017 about the enormous lack of Scandinavian high pressure areas in recent years. These weather systems often cause an offshore wind with many clear nights in the Netherlands as a result. Since April 2018 it is a coming and going of these high pressure areas in those parts, a situation that already lasts until the moment of writing this report (end of July). After the successful Lyrid campaign, I was eagerly awaiting the next moonless period. But even during the moonlight period, observations were made to see some eta Aquariids (ETA's).

Observing the ETAs in the Netherlands is a "sport". A serious analysis of Dutch ETA observations is not possible because the radiant level in the Netherlands remains low to 10–12 degrees. The twilight begins at the same time as the radiant rises (around 01^h10^m UT). For the Dutch meteor-observer there is a short time frame of 1.0 or 1.5 hours in which you could see one, two or sometimes three ETAs during dusk. But often nothing is seen. The emerging radiant is always acting versus the increasing twilight. Here is my report.

2 3–4 May 2018

This night the diminishing half-full moon would still disturb during the period when the ETAs are visible. But because the transparency was very good, visual observations were made. I observed from the flat roof of my dormer, looking in northern direction. The observations started at 00^h45^m and ended at 02^h00^m UT. In that period I counted 10 meteors. Two minutes after the start I immediately saw the most beautiful meteor from this session: a beautiful earth grazer moving from Cygnus to Draco with all ETA characteristics: bluish in color, the right speed and a 3 second persistent train. However, the ETA radiant is still under the horizon at that moment. Several CAMS stations have recorded this meteor and it was as expected not an ETA.

At 01^h32^m UT I saw a +1 ETA, but it was just too low for CAMS 353. The meteor appeared just below the 'w' of Cassiopeia.

Table 1 – Meteor counts May 3–4 2018[13].

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
0:45	2:00	1,38	1,25	5,6	19,55	1	1	1	7	10	1,00	C

3 4–5 May 2018

Again a very clear night but there was still a lot of moonlight during the ETA observations. I could observe from 00^h25^m and 01^h55^m UT, the limiting magnitude dropped from 6.0 to 5.4 in this period. I counted 9 meteors including a +3 ANT and a +2 ETA. This was also in Cassiopeia again, just like the ETA from the previous night. Unfortunately, just outside the field of view of my CAMS 354 camera. However, despite the meteor as seen from Ermelo having the right ETA characteristics (speed, radiant), CAMS data from Texel and Terschelling showed that it was not an ETA. So no ETAs were seen this night.

Table 2 – Meteor counts May 4–5 2018[14].

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
0:25	1:10	0,79	0,75	6,0	19,82	0	1		2	3	1,00	C
1:10	1:55	1,54	0,75	5,6	19,64	0	0	0	7	7	1,00	C

4 5–6 May 2018

It was weekend and a clear night on the way! Also a quite night, there were hardly any cars or planes to hear. Between 23^h25^m and 02^h43^m UT I could observe. Moonrise was around 00^h15^m UT, but only after 00^h43^m UT the Moon appeared above the edge of the trees. What an incredibly clear night this was with the highest SQM (Sky Quality Meter) ever achieved on the Groevenbeek Heide: 20.60. Normally, under well-clear conditions, 20.40-20.45 is the norm. The Lm dropped from 6.4 to 4.9 during this session.

It was also an atmospheric night, first there was the planet Jupiter, the constellation of Scorpio and later in the night the trio: Moon, Saturn and Mars close together. At 23^h30^m UT I saw a bright magnitude –6 Iridium flare from the Iridium 10 satellite under Boötes. A few times I was accompanied by an owl and a few times a cuckoo was heard.

[13] http://www.imo.net/members/imo_vmdb/view?session_id=76480
[14] http://www.imo.net/members/imo_vmdb/view?session_id=76481

Many satellites were seen. At 00h31m UT, two satellites close together, forming an inverted trapezium with the stars delta and epsilon OPH and moving from north to south. Both +3 of which the right one lit up to +1 and then extinguished to +4. Further at 2h14m UT a very fast fluctuating satellite (maximum magn. +1) was seen moving from Polaris to the south.

During this session I observed two ETAs. Damn: I actually wanted to continue observing until 2h50m UT, but decided to stop at 02h34m UT. What do you think? A beautiful –1 ETA was caught with CAMS 354 one minute after I stopped, right in my field of view… (*Figure 1*). In total I counted 27 meteors of which 2 ETA and 5 ANT.

Tabel 3 – Meteor counts May 5–6 2018[15].

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
23:25	0:15	23,83	0,82	6,41	20,53	0	1	0	4	5	1,00	C
0:15	1:02	0,64	0,77	6,36	20,34	0	1	0	7	8	1,00	C
1:04	2:00	1,53	0,92	6,08	20,07	0	3	0	6	9	1,00	C
2:00	2:40	2,33	0,67	5,29	19,50	0	0	2	3	5	1,00	C

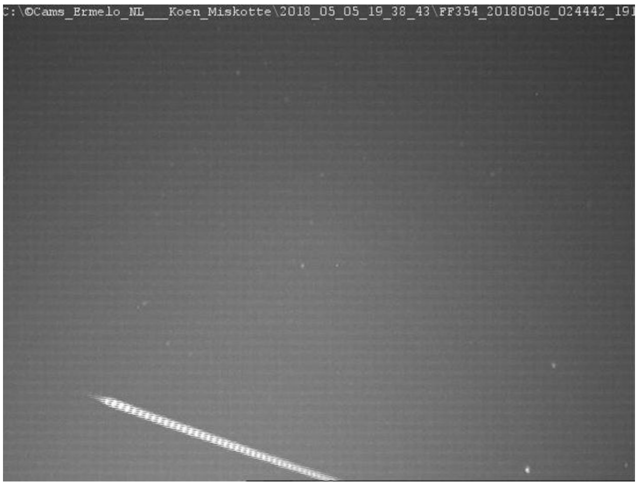

Figure 1 – Bright eta Aquariid captured with CAMS 354, May 6 2018 at 02h44m UT.

5 6–7 May 2018

A long three hours session was held on the heath during this night and again with very good observing conditions, SQM 20,45-20,49 until moonrise. Despite the fact that the meteor activity was very mediocre, it was still very enjoying. The sounds of a cuckoo from the forest, an owl or a fox in combination with the beautiful starry sky, the Milky Way, Mars, Saturn, Jupiter and moonlight was amazing. The rapidly increasing chirping of the skylarks at the end of the session completed this symphony of nature.

In total I counted 28 meteors between 23h35m and 02h50m UT, including 6 possible ELY (eta Lyrids), 5 ANT and 1 ETA. This night I observed a little longer than yesterday with the –1 ETA I missed in the back of my head. That was rewarded, because at about the same time a beautiful white magnitude 0 ETA was seen with a persistent train in Cepheus. It turned out that this meteor was also captured by CAMS 354 (*Figure 2*)! An ETA of +4 around 2h26m UT in Cepheus was not seen, as well as a +3 in Pegasus at 2h45m57s UT. The sky might have been already too bright to make these meteors visible to the naked eye, but CAMS captured it without problems.

Table 4 – Meteor counts May 6–7 2018[16].

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
23:35	0:21	23,97	0,75	6,42	20,47	3	1	0	4	8	1,00	C
0:21	1:07	0,73	0,75	6,39	20,39	0	1	0	4	5	1,00	C
1:09	1:55	1,53	0,75	6,12	20,17	1	2	0	6	9	1,00	C
1:55	2:50	2,38	0,90	5,40	18,96	2	0	1	3	6	1,00	C

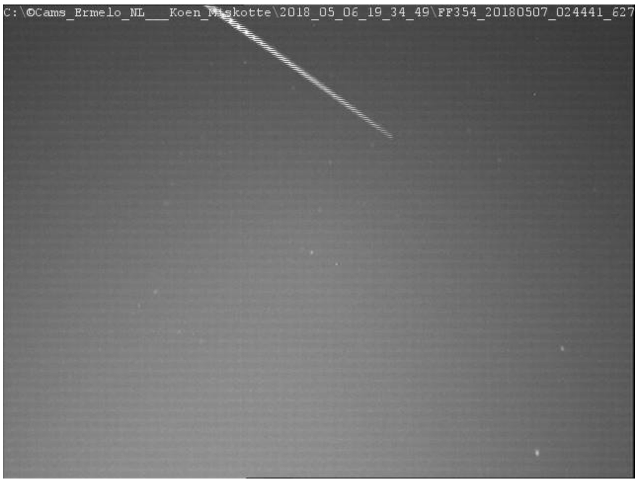

Figure 2 – Bright magnitude 0 eta Aquariid captured with CAMS 354, May 7 2018 at 2h44m UT. This one I observed visually.

6 7–8 May 2018

This night I observed from the flat roof of my dormer. Again a transparent sky (Lm 6.28), but the SQM measurements were far behind of what you would expect with a maximum of just 20.23. This session I have been observing between 00h00m and 02h30m UT. In total I counted 18 meteors of which 3 ANT, 3 ELY and 1 ETA. The latter was also recorded by several CAMS systems. At 1h47m UT a +1 SPO was seen, also recorded with CAMS 352.

Table 5 – Meteor counts May 7–8 2018[17].

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
0:00	0:45	0,38	0,75	6,28	20,22	0	2	0	2	4	1,00	C
0:45	1:30	1,13	0,75	6,28	20,15	2	1	0	3	6	1,00	C
1:30	2:31	2,01	1,01	5,88	19,25	1	0	1	6	8	1,00	C

7 10–11 May 2018

Again a clear night with good transparency (Lm 6.3) but again the SQM measurements (20.27 and decreasing) were slightly disappointing. I observed between 23h45m and 01h17m UT. At 01h17m UT the sky became cloudy, so no ETAs were seen during this session. A total of 14 meteors were observed, 3 of which were ELY and 2 ANT.

[15] http://www.imo.net/members/imo_vmdb/view?session_id=76496

[16] http://www.imo.net/members/imo_vmdb/view?session_id=76501

[17] http://www.imo.net/members/imo_vmdb/view?session_id=76515

Table 6 – Meteor counts May 10–11 2018.

Period UT		Tm	T.eff	Lm	SQM	Stream			Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ELY	ANT	ETA				
23:45	0:30	0,13	0,75	6,28	20,25	2	0	0	4	6	1,00	C
0:30	1:17	0,89	0,78	6,28	20,23	1	2	0	5	8	1,00	C

8 20–21 May 2018

One of the last moonless nights in this period was 20–21 May. With a setting Moon at 0h25m UT (40%) there was one hour of darkness. This session I was observing from the Groevenbeek Heide between 23^h00^m and 01^h34^m UT. It was again a very nice clear night! The SQM increased from 20.32 (with moonlight!) to 20.47 and then descending again. The limiting magnitude was 6.3.

A beautiful +1 SPO in Serpens and a yellow magnitude 0 in Delphinus were the most beautiful meteors. In total I counted 24 meteors, amongst them 5 ANT. No ETAs were seen during this session.

Many satellites were also visible, at 00^h03^m UT a –6 Iridium flare caused by Iridium 98, a passage of ISS at 00^h27^m UT and at 00^h17^m UT the bright NOSS duo appeared in the southern part of Ophiuchus. According to Marco Langbroek, this was the NOSS 3–8 duo (*Figure 3*).

Table 7 – Meteor counts May 20–21 2018.

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ANT	ETA				
23:00	23:46	23,38	0,75	6,35	20,39	1		5	6	1,00	C
23:46	0:32	0,15	0,75	6,37	20,46	2		6	8	1,00	C
0:32	1:18	0,92	0,75	6,21	20,35	1		8	9	1,00	C
1:18	1:34	1,43	0,25	5,90	19,83	1	0	0	1	1,00	C

Figure 3 – Star trails image with the satellites NOSS 3–8 duo captured with my all sky camera. (Canon 6D with Canon EF 8-15 mm zoom fish eye lens).

A big thank you for Paul Roggemans for checking my English!

Midsummer nights 2018. Meteor observations at Any Martin Rieux, Northern France

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From June 2 until June 16 visual observations were made from AnyMartin Rieux, France. A report is presented about the observations made in this period of June 2018.

Figure 1 – Crop of all sky image of the fireball of June 13, 2018.

1 Introduction

In the period from 2018 June 2 to 16 I rented a house from Bel Any. This is a small resort in Any Martin Rieux, a tiny French village near the Belgian border (*Figure 2*). I already stayed here during the Orionids 2017. In spite of the bad weather, we enjoyed it so much that we planned a longer vacation now. An additional advantage for the author was that the village is located in a dark area. Observing was not a must in itself, because meteor activity is always low in June. Still, I was curious about the night conditions in June, compared to October 2017 and with the circumstances in Ermelo in June (the so called gray nights).

In October 2017 I reached a limiting magnitude of 6.7, I easily saw the Gegenschein and a SQM of 21.22 with the exception of the fact that in my opinion the circumstances were not optimal.

Unfortunately, the weather this year was again a problem. Not during the day, we had very good weather with little rain and nice temperatures. The night-time observing activities did suffer from the fact that there were frequent remnants (cirrus) of thunderstorms. Eventually I could observe visually during three nights. The all sky camera was used on 7 nights.

Figure 2 – Our rented gite on the large property of Bel Any. The stool served as a tripod for the all sky camera.

2 2–3 June 2018

Because of the 50% moon I could not observe the whole period this night. The all sky camera started at 21^h00^m UT. In the Netherlands I can start visually around 22^h30^m UT at the beginning of June. This is much earlier at Any Martin Rieux, I could start at 21^h40^m UT. The Lm was already 6.0 and the SQM reached 20.25. This quickly increased to Lm 6.4 and SQM 21.20 around 22^h30^m UT, but then steadily declined due to the rising moon. The session ended at 23^h15^m UT. In the meantime, it had become somewhat foggy in the meadow next to me. The starry sky was beautiful with Jupiter in the south, to the left the constellation Scorpion, which is noticeably higher in the sky here than in the Netherlands. The Milky Way popped out, looked flabby and was clearly visible far below Scutum. Man, this is so enjoying….

In total I counted 15 meteors during this period, all faint ones. The brightest meteor was a +2 SPO. Attention was paid to ANT and possible activity of the tau Herculids. The problem with the latter is that different radiant positions can be active. I chose not to learn this from my head but to properly describe the very slow meteors radiating from a large area including Hercules and Boötes. A striking moment was that within a few minutes I observed two very slow (20 km – s) meteors radiating from an area just to the right of the triplet eta, tau and upsilon Boötes (RA 202, Dec +18), respectively magnitude +4 and +5. I do not know whether these were tau Hercules, they were the only very slow meteors that night.

Around 22^h36^m UT a double satellite formation became visible in the south. Both satellites were magn. –3 but soon extinguished to +4. I could follow them for a long time thanks to the clear sky. And in the evening twilight I saw two ISS passages.

Table 1 – Meteor counts June 2–3 2018[18].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot	F	M
Start	End	[h]	[h]		mean	tHER	ANT				
21:40	22:30	22,08	0,82	6,31	20,80	0	2	7	9	1,00	C
22:30	23:16	22,88	0,75	6,26	21,03	0	1	5	6	1,00	C

3 3–4 June 2018

In the evening the sky above Any Martin Rieux is full of thin cirrus clouds. Despite the cirrus, I took a short nap to get some rest before the observations started. When I started a large part of the cirrus was dissolved, only low in the southwest, west and north there was still a lot of cirrus, but the viewing direction was south-south-east. This situation remained so throughout the session. I also wanted to observe a half hour longer than yesterday's session, but unfortunately due to a nasty hay fever attack I was forced to stop earlier.

I could observe between 21^h40^m and 23^h15^m UT. It resulted in $t_{eff.}$ 1.47 hours, lm 6.4 and a maximum SQM of 21.28! This is more than in October 2017 despite the gray nights! Again it shows how beautiful dark it is there. In total I counted 14 meteors, of which 3 were ANT meteors. No slow meteors from Hercules or Boötes. Best meteor was a white sporadic magnitude +1 with a short persistent train in the southern part of Ophiuchus.

Table 2 – Meteor counts June 3–4 2018[19].

Period UT		Tm	T.eff	Lm	SQM	Stream		Spo	Ntot	F	M
Start	End	[h]	[h]		mean	tHER	ANT				
21:40	22:30	22,08	0,82	6,32	20,80	0	1	5	6	1,00	C
22:30	23:15	22,88	0,65	6,40	21,22	0	2	6	8	1,00	C

[18] https://www.imo.net/members/imo_vmdb/view?session_id=76607
[19] https://www.imo.net/members/imo_vmdb/view?session_id=76608

4 13–14 June 2018

At first, I had little hope for a good result. There was cirrus everywhere in the sky, but thanks to the darkness I did not have that much trouble with it. Eventually the amount of cirrus became less and it became completely clear. I was able to observe between 21^h49^m and 00^h51^m UT, which effectively yielded 3.00 hours of observation time. The lm rose again to 6.4, the SQM went even higher than in the previous nights: 21.31 maximum. Thanks to the dark conditions I got more meteors now, a total of 41 meteors were counted, of which 7 radiated from the Antihelion region.

This night I witnessed a very beautiful fireball. At 22^h50^m UT I noticed a slow meteor of magn. +2 near the star theta Aquila, which moved to the northeast and then disappeared behind a tree when the meteor was brightening to magnitude –2. It flashed through my head: "I hope she goes on long enough that she becomes visible again!". Through the tree I saw the thing moving and indeed it became visible again as a bright yellow meteor of –3 with a few short flares up to –4. The wake also became long, about 1 degree. After the two short flares, a lot of fragmentation was visible in the form of sparks that "fly along". I estimated that a maximum of 7 or 8 pieces were moving along with the meteor, which became weaker. Eventually the fireball went out as three red meteors of magnitude +2 near the star gamma Andromeda. WOW and again wow! I estimate that the entire meteor has lasted 8 seconds with this extremely long path! Later on I noticed the fireball was captured by many all sky stations in Germany, Belgium and the Netherlands (*Figures 1 and 3*).

Furthermore, many weak meteors were seen this night. But around 23^h28^m UT (~ a few minutes) a beautiful earth grazer was seen, moving from Cepheus to Arcturus (alpha Boötes), magn. +2 with an afterglowing track. The meteor resembled a lot like the ETAs of early May.

From 00^h45^m UT, thicker cirrus began to appear from the west again. Too bad, because I wanted to continue until dusk to see a possible Ariëtid. At 00^h51^m UT I had to stop without seeing anything of this meteor shower. But I was satisfied, this was a nice session.

Table 3 – Meteor counts June 13–14 2018.

Period UT		Tm	T.eff	Lm	SQM	Stream	Spo	Ntot	F	M
Start	End	[h]	[h]		mean	ANT				
21:49	22:50	22,33	1,00	6,14	20,85	1	6	7	1,00	C
22:50	23:50	23,33	1,00	6,36	21,26	4	12	16	1,00	C
23:50	0:51	0,34	1,00	6,23	21,21	2	16	18	1,00	C

It also turned out to be the last clear night at Any Martin Rieux. On the evening of the 15^{th} I made another attempt, but just before I wanted to start, lower clouds appeared in the south suddenly, marking black against the starry skies and slowly moving northward.

On Saturday the 16^{th} we returned home to Ermelo.

Figure 3 – Startrails image of the fireball of 13 June 2018 22^h50^m UT.

Lyrids 2018: an analysis

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An analysis of the Lyrids 2018 based on visual meteor observations is presented. A ZHR profile has been computed based on observations reported to the website of the International Meteor Organization and data from observers that were sent directly to the author. 588 of the 949 Lyrids reported to IMO and the author could be used for ZHR calculations. A peak in activity has been found around solar longitude 32.61°.

1 Introduction

The Lyrids in the BeNeLux were very successful. CAMS achieved some nice results and even the all sky cameras recorded a few Lyrids. The author could observe six nights during the period 15–23 April. Unfortunately, he was one of the few in the BeNeLux.

I looked on the IMO site at the amount of data submitted. It turned out that 36 observers submitted data from the Lyrids period, this yielded 918 Lyrids in 15 intervals (situation on 2 July 2018), see also *Figure 1*. The author then downloaded data according to the known selection criteria and made some calculations. The results are presented in this article.

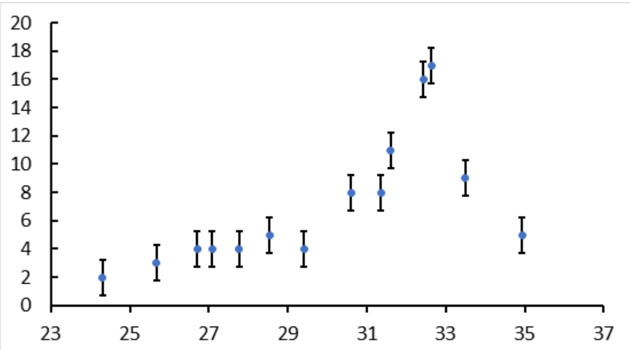

Figure 1 – ZHR on the fly curve Lyrids 2018, IMO[20].

2 Workflow

First of all, I looked at data from observers for which a recent C_p was already known. If data was available, it was downloaded, with a minimum limiting magnitude of 5.9. Observations with limiting magnitudes below 5.9 were not used. Hourly counts were used for the ZHR analysis. Data based on shorter periods were aggregated into periods of about 1 hour. Incidentally, this time the author also used data from two observers who do not report to IMO.

It is also striking how little data comes from America and Asia which is really a pity if you want to do a real global analysis. The r value calculations could only be made on the basis of European data, most of the ZHR values came from Europe and a small part from America.

3 Population index r

Of the 949 Lyrids that were reported to IMO and the author, only 335 could be used for a r value determination. This concerned data from the period 18–23 April. What often appears is that the gradient or ratio in the magnitude distributions is often the same, but that one observer has more +4 meteors than other magnitudes, while another observer has a peak at +2 or +1. There are observers who do not see meteors of magnitude +5 or +6 at conditions where the limiting magnitude is well above 6.5. The cause is difficult to indicate. Sometimes it is a matter of estimating meteors too bright, but perhaps that there are also other factors involved (e.g. with the eye?).

Table 1 – Results of population index r calculations.

	r[-2;5]	r[-1;5]	r[-1;4]	r[0;4]	r[0;5]	r[1;5]	n
17/18-4-2018	~	~	~	~	~	4,43	24
18/19-4-2018	~	~	~	~	~	3,87	30
19/20-4-2018	~	~	~	3,49	3,85	4,48	39
20/21-4-2018	~	2,73	2,31	2,85	3,31	4,03	42
21/22-4-2018	3,07	2,99	2,58	2,41	2,99	3,55	119
22/23-4-2018	2,31	2,34	2,48	3,27	2,75	2,35	70

Table 1 gives the r values. This clearly shows that in fact only for the nights 21–22 and 22–23 April a good population index r could be determined on the European continent. The results are also what you would expect from the Lyrids. In the night of April 21 to 22 the faint Lyrids dominate, the night April 22 to April 23 the bright Lyrids are the strongest. The maximum was expected in the evening of April 22 at 18^h UT (λ_O = 32.32 degrees). However, in (Rendtel, 2017) something is mentioned about a maximum that varies a little between 22 April from 10^h to 21^h UT (λ_O = 32.0–32.45 degrees).

For the ZHR calculations, a population index of 2.73 was used for the night of 20–21 April, 2.99 for April 21–22 and 2.34 for the night of April 22–23 (all European data). All calculations were based on the magnitude range [–1; +5]. In the nights before 20 April a population index of 3.00 was assumed, for the nights 23–24 and 24–25 April the r value was assumed as 2.50. These values have been adopted on the basis that only weak Lyrids have actually been seen in the period before 20 April and in the period after 23 April, less evident than 22–23, but more like the nights before.

[20] http://www.imo.net/members/imo_live_shower?shower=LYR&year=2018

4 Zenital Hourly Rate (ZHR)

As indicated before, only data from observers with a good C_p have been used. The C_p could also be calculated for a number of "new" observers.

The data was further examined for the radiant heights (observations done with radiant heights lower than 25 degrees were not used). A check was done for outliers in the ZHR but for the latter nothing was found. In total, of the 949 Lyrids reported to IMO and the author, 588 Lyrids were used. That are 143 Lyrids more than in the analysis from 2015, which was based on 445 Lyrids. The results are shown in *Table 2* and *Figures 2, 3 and 4*.

Table 2 – ZHR Lyrids 2018. Date, time, number of periods (P), number of Lyrids (N), *r*-value used and number of Observers (Obs.).

Y	M	D	UT t–m	λ⊙ 2000.0	P	N	ZHR	±	r	Obs
2018	4	14	4.17	23.923	2	6	2.7	1.1	3.00	1
2018	4	16	8.96	26.077	1	3	5.1	2.9	3.00	1
2018	4	17	3.05	26.815	4	12	4.0	1.2	3.00	2
2018	4	18	1.26	27.839	9	29	5.8	1.1	3.00	4
2018	4	19	0.88	28.682	8	30	6.2	1.1	3.00	4
2018	4	20	1.32	29.677	13	43	5.1	0.8	3.00	5
2018	4	21	1.04	30.642	17	86	7.5	0.8	2.73	7
2018	4	21	6.07	30.847	2	16	12.0	3.0	2.73	1
2018	4	22	1.00	31.616	32	177	11.6	0.9	2.99	9
2018	4	22	8.42	31.918	2	28	18.3	3.5	2.99	1
2018	4	23	0.24	32.561	19	140	14.1	1.2	2.34	5
2018	4	24	1.65	33.593	3	13	6.7	1.9	2.50	2
2018	4	25	1.89	34.577	2	5	4.6	2.0	2.50	1

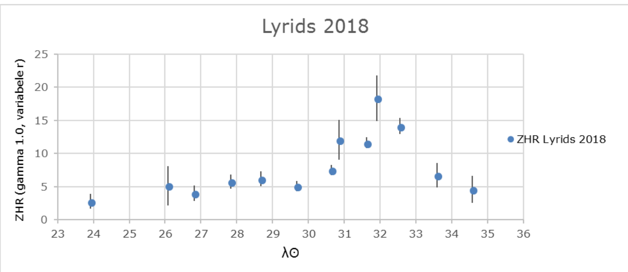

Figure 2 – Lyrids 2018 ZHR. The solar longitude corresponds with the period from April 14 to April 25, 2018.

It is clearly visible that the ZHR remains a bit stable with a ZHR of 5 in the period from $\lambda_\odot$ 26° to 30° (roughly 16 to 20 April), only after that a somewhat faster increase appears. This fact could also have something to do with the low numbers of Lyrids and on top of that, the "pollution" with look-alike sporadic meteors. The ZHR points just before $\lambda_\odot$ 31° and 32° are data from respectively 1 and 2 American observer (s).

5 April 21–22 and 22–23 2018

Here we zoom in on the maximum of the Lyrids to see if we can determine a shape in the ZHR profile and possibly pin the maximum sharper. This resulted in *Figure 3* and *Table 3*.

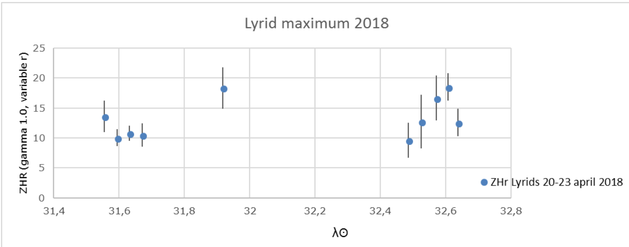

Figure 3 – ZHR Lyrids on April 21–22 and April 22–23, 2018.

Table 3 – ZHR Lyrids 2018, 21–22 and 22–23 April 2018. Date, time, number of periods (P), number of Lyrids (N), *r*-value used and number of Observers (Obs.).

Y	M	D	UT t–m	λ⊙ 2000.0	P	N	ZHR	±	r	Obs
2018	4	21	23.46	31.554	5	27	13.6	2.6	2.99	4
2018	4	22	0.44	31.594	9	49	10.0	1.4	2.99	6
2018	4	22	1.39	31.632	12	71	10.8	1.3	2.99	9
2018	4	22	2.33	31.670	6	30	10.5	1.9	2.99	5
2018	4	22	8.42	31.918	2	28	18.3	3.5	2.99	1
2018	4	22	22.39	32.486	5	11	9.6	2.9	2.34	3
2018	4	22	23.35	32.525	2	8	12.7	4.5	2.34	1
2018	4	23	0.49	32.571	2	20	16.6	3.7	2.34	2
2018	4	23	1.36	32.607	5	67	18.5	2.3	2.34	3
2018	4	23	2.11	32.637	4	30	12.6	2.3	2.34	4

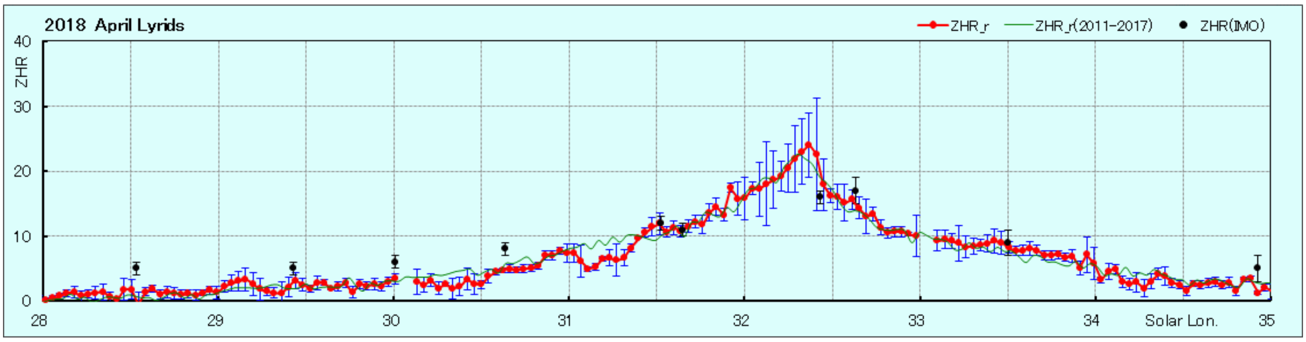

Figure 4 – Radio data of the Lyrids 2018 based on radio data (RMOB).

If we look at the ZHR profile in *Figure 3*, we see a reasonably flat pattern for 21–22 April. The course of 22–23 April looks beautiful. It shows an increasing ZHR and a maximum around λ_Θ 32.61°. This is well above the period given in (Rendtel, 2017) which runs from λ_Θ 32.0°–32.45°. Unfortunately, there is no data available from the period of 22 April 2018 between 18^h and 21^h UT. It is therefore difficult to indicate whether the peak at λ_Θ 32.61° is the real maximum peak of the Lyrids. The author therefore also looked at the well-known radio chart based on RMOB radio data. See *Figure 4*.

A peak is clearly visible on the radio graph around λ_Θ 32.3° which matches nicely with the expected value λ_Θ 32.32° from (Rendtel, 2017). However, at the time of the maximum ZHR as found in this analysis. there is also a small sub-peak in the radio data. That was also the moment that the author could observe and observed many bright Lyrids (Miskotte, 2018). So, the only conclusion we can draw from this is that the maximum of the Lyrids has not been visually observed and that the peak found from this analysis may be a sub-peak. The IMO also found the maximum activity around that of the radio chart (black graph points). Logical, there is simply no data available from around λ_Θ 32.32°.

6 Conclusions and recommendations

The Lyrids could reasonably be observed. Unfortunately, most data comes from Europe. We certainly cannot speak of a global analysis. A peak in activity has been found around solar longitude λ_Θ 32.61°, this is probably a sub peak in the activity of the Lyrids which has also been observed with radio.

Finally, the author continues to insist that a good C_p provision for observers is necessary. For this purpose, as much as possible sporadic observing data is used from the period 25 July to 31 August on the basis of hourly counts between 0 and 4 am local time.

Acknowledgment

First, a big thank you for all observers who observed the Lyrids and sent data to the author and – or IMO. These are:

Alexandre Amorim, Pierre Bader, Sarvesh Bhogaokar, Steve Brown, David Buzgo, Tibor Csorgei, Michel Deconinck, Jaroslav Dygos, Frank Enzlein, Kai Frode Gaarder, Gristoph Gerber, George Gliba, Robin Hegenbarth, Glenn Hughes, Karoly Jonas, Javor Kac, Sara Knežević, Zdenek Komarek, Sneha Kulkarni, Michael Linnolt, Adam Marsh, Peter Miklos, Koen Miskotte, Sirko Molau, Ana Nikolić, Vladimir Nikolić, Ina Rendtel, Juergen Rendtel, Terrence Ross, Branislav Savic, Stefan Schmeissner, Kai Schultze, Snežana Todorović, Michel Vandeputte, Roland Winkler, Oliver Wusk and *Sabine Wächter.*

Finally. a word of thanks to *Carl Johannink*, *Paul Roggemans* and *Michel Vandeputte* for critically reviewing and commenting on this article.

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Rendtel J. (2017). 2018 Meteor Shower Calendar. IMO.

Radio meteors – May 2018

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An overview of the radio observations during May 2018 is given.

1 Introduction

The graphs show both the daily totals (*Figures 1 and 2*) and the hourly numbers (*Figures 3 and 4*) of "all" reflections counted automatically. and of manually counted "overdense" reflections, overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.

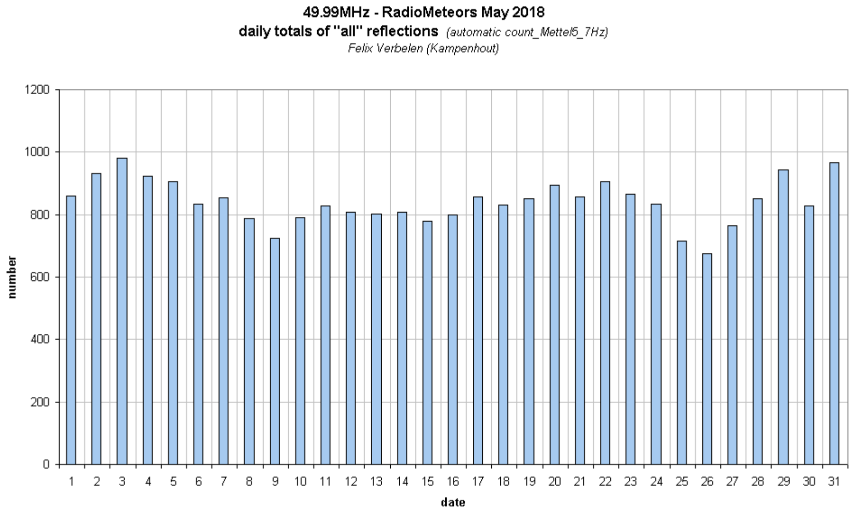
The automatic counts were sometimes difficult due to (local) interference and of thunderstorm (10 days with sometimes strong lightning activity), but most of the counting errors were corrected manually.

The eye-catchers of the month were the *eta-Aquariids* that showed a nice activity around 5 May, but were rather moderate overall, certainly in comparison with the activity in 2012–2013. See attached graph with the hourly totals of all "overdense" reflections around the eta-Aquariids' maximum activity of the period 2012–2018 (weighted averages) (*Figure 5*).

The hourly numbers, for echoes shorter than 1 minute, are weighted averages derived from:

N(h) = n(h-1)/4 + n(h)/2 + n(h+1)/4

If you are interested in the actual figures, please send me an e-mail: felix.verbelen at skynet.be.



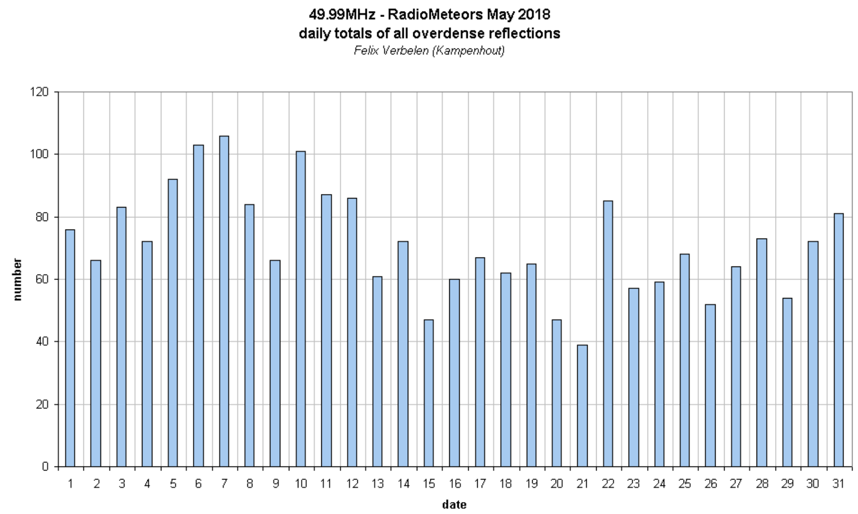
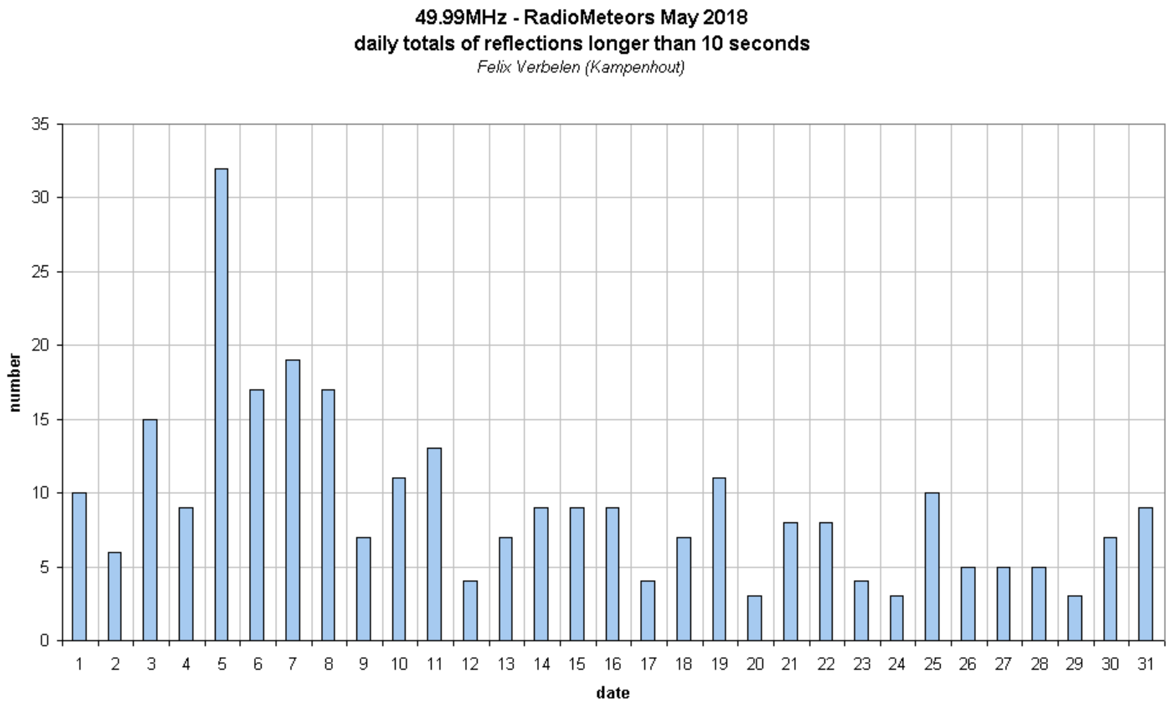


Figure 1 – The daily totals of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.



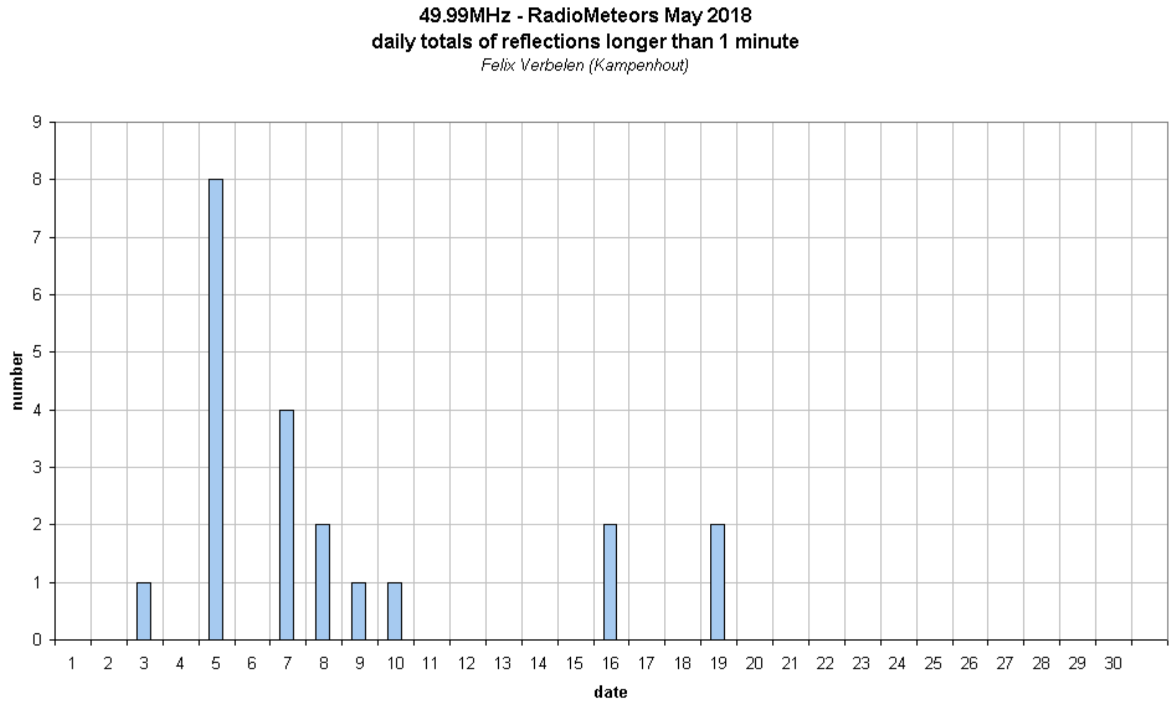
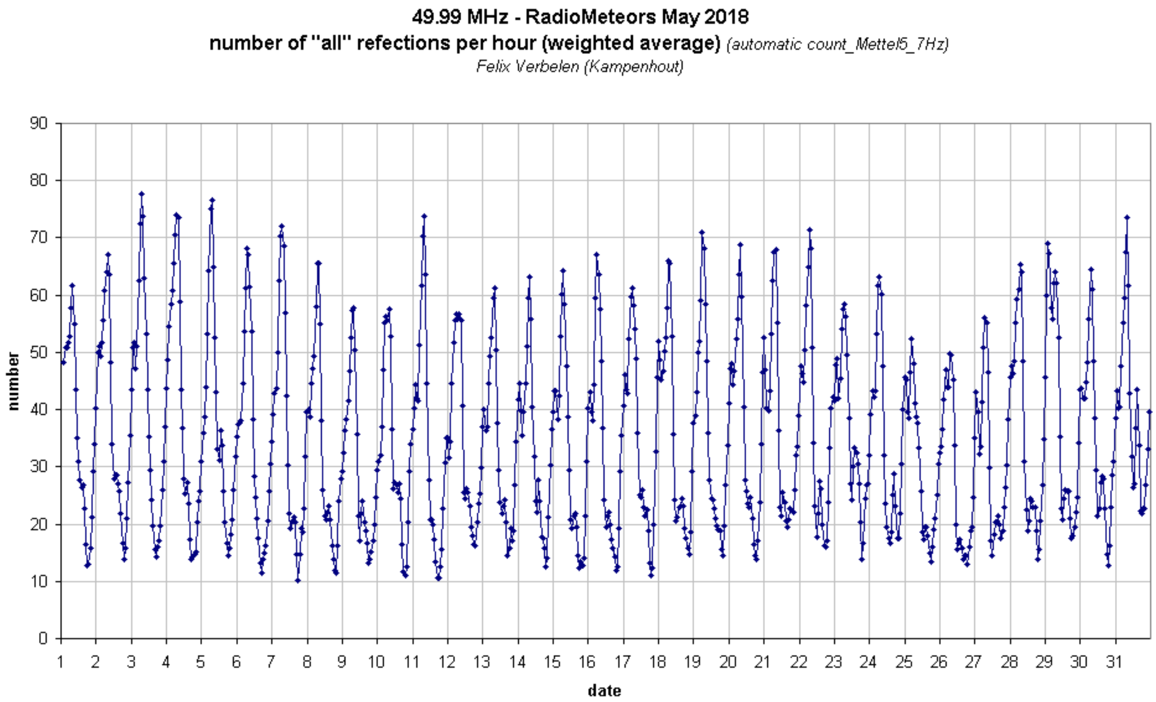


Figure 2 – The daily totals of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.



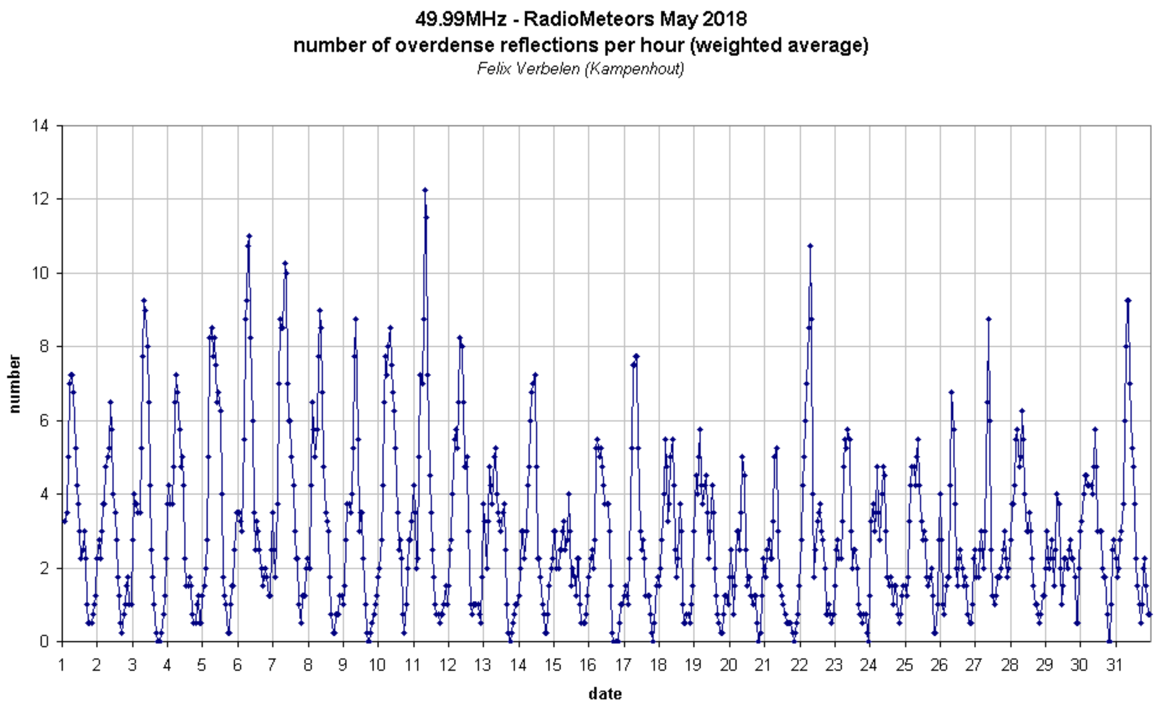
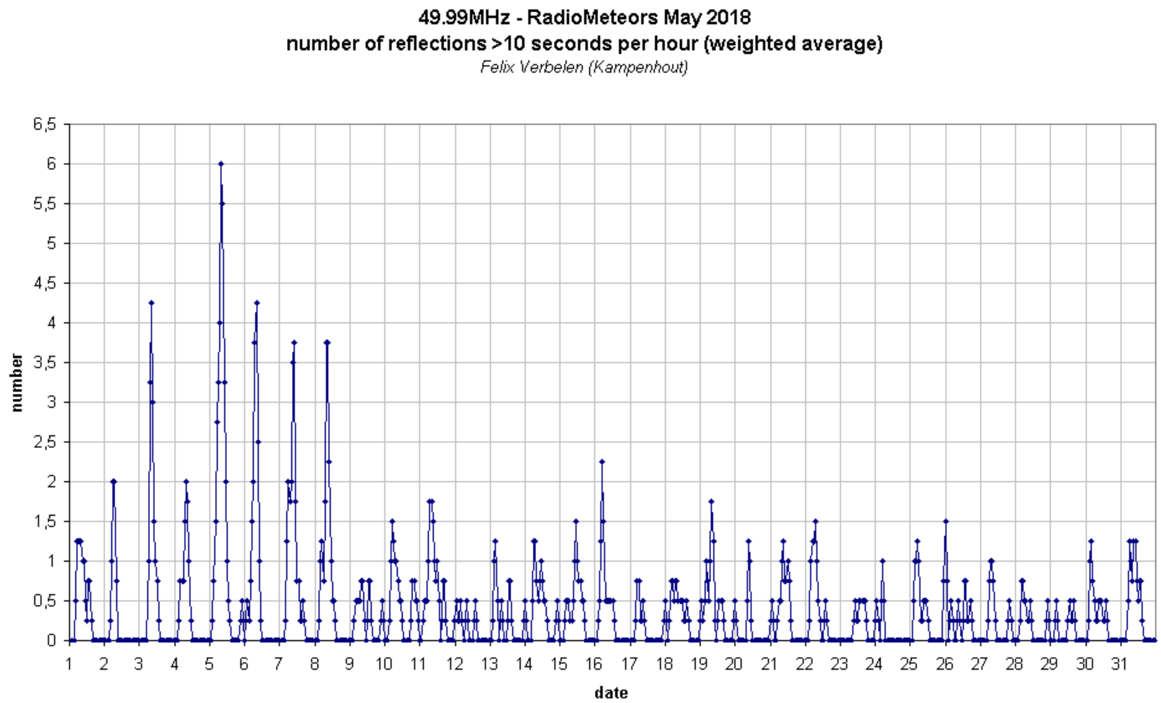


Figure 3 – The hourly numbers of "all" reflections counted automatically, and of manually counted "overdense" reflections. as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.



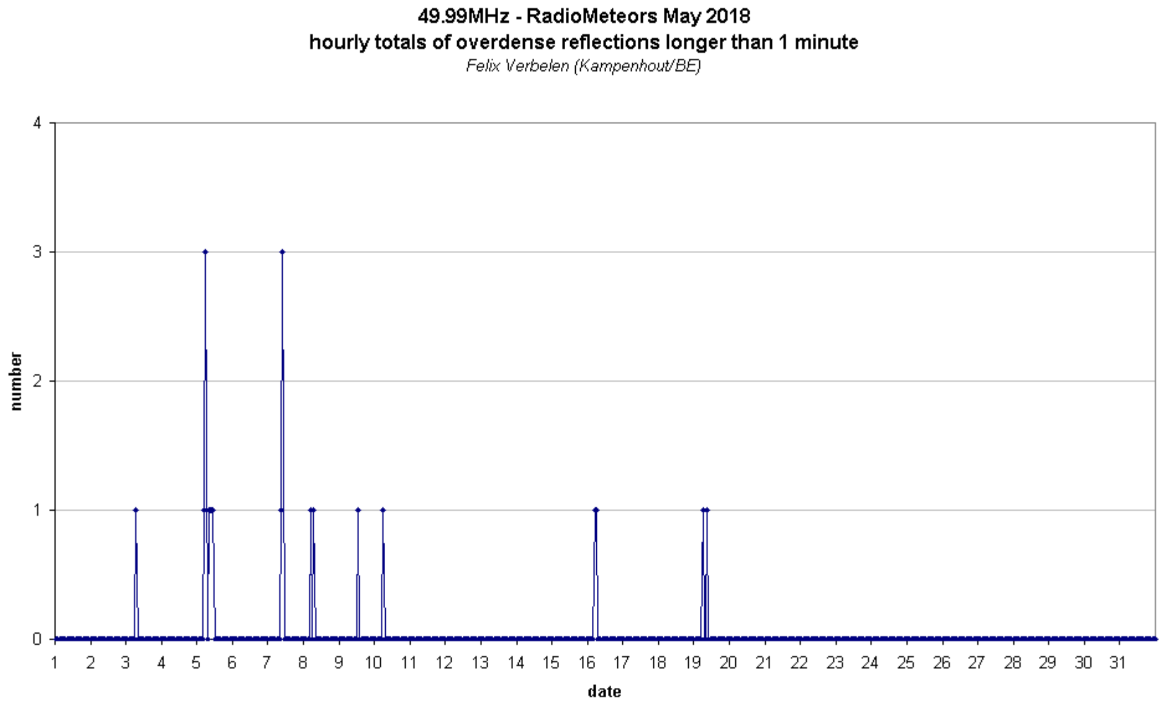
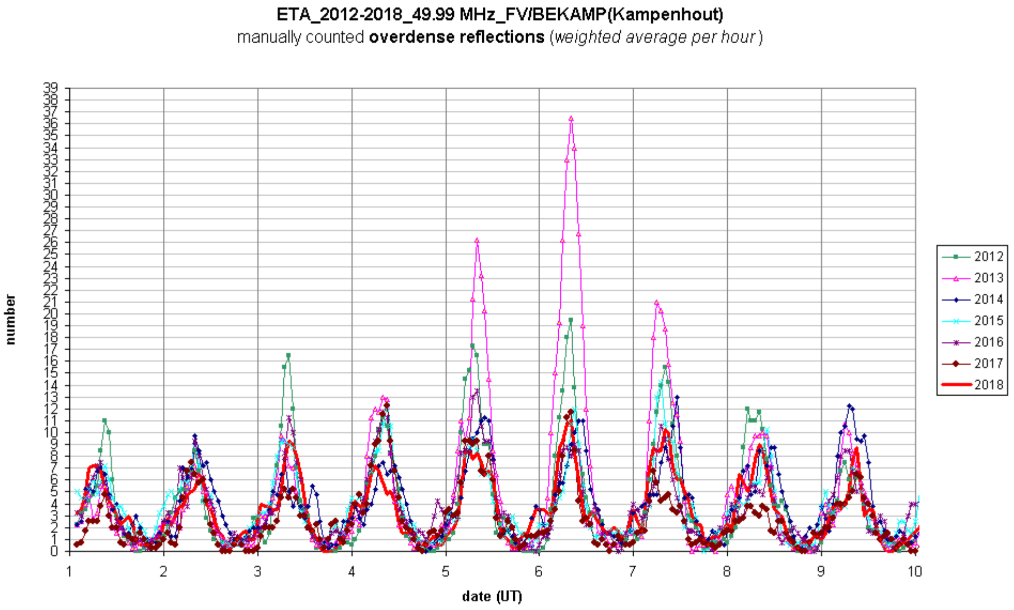
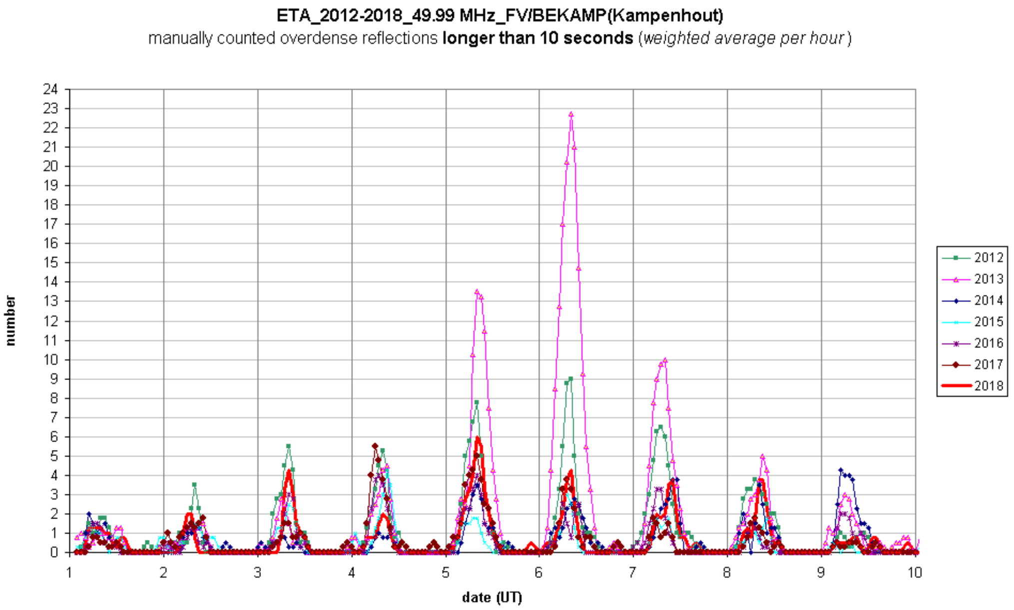


Figure 4 – The hourly numbers of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.





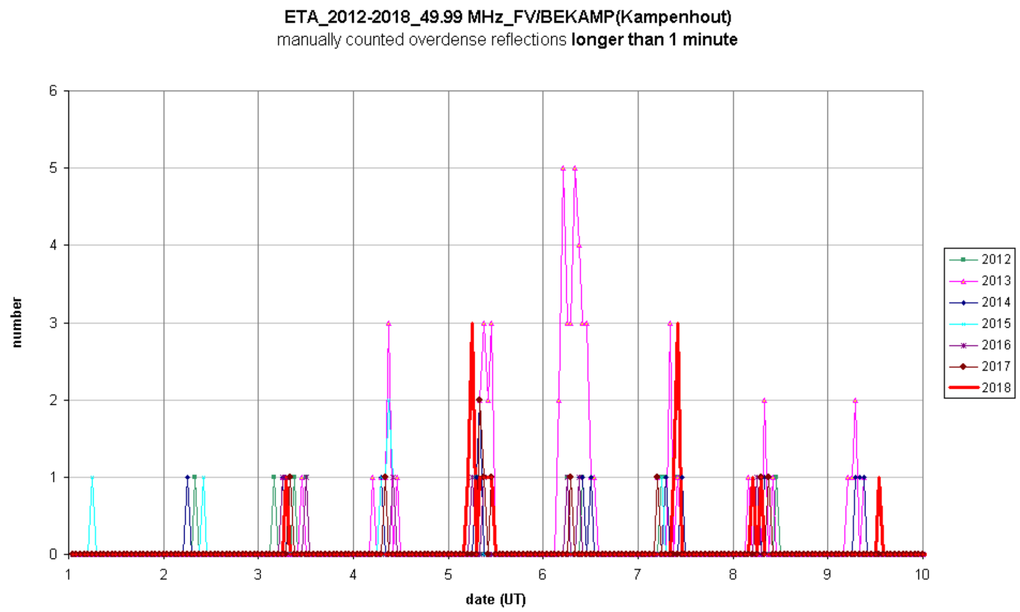


Figure 5 – The hourly totals of all "overdense" reflections around the eta-Aquariids' maximum activity of the period 2012–2018 (weighted averages), as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during May 2018.

Radio meteors – June 2018

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An overview of the radio observations during June 2018 is given.

1 Introduction

The graphs show both the daily totals (*Figures 1 and 2*) and the hourly numbers (*Figure 3 and 4*) of "all" reflections counted automatically, and of manually counted "overdense" reflections, overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during June 2018.

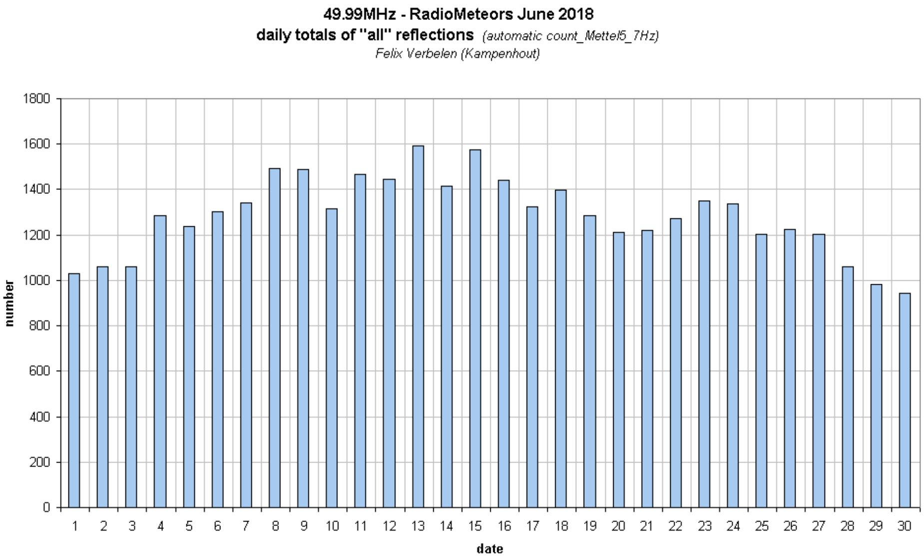
The automatic counts were sometimes very difficult due to strong (local) interference, thunderstorms (especially on 7.6.2018) and on 17 days by sometimes strong sporadic E.

Most automatic counting errors were corrected manually, sometimes by comparing with observations on 49.97 MHz (BRAMS beacon at Dourbes) or, in a few selected cases, by interpolation.

The hourly numbers, for echoes shorter than 1 minute, are weighted averages derived from:

N(h) = n(h-1)/4 + n(h)/2 + n(h+1)/4

If you are interested in the actual figures, please send me an e-mail: felix.verbelen at skynet.be



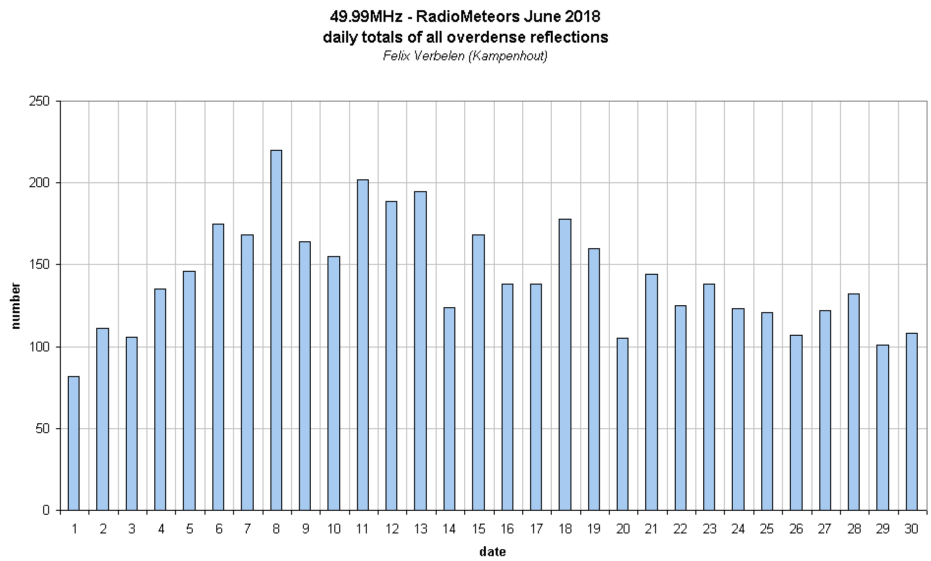
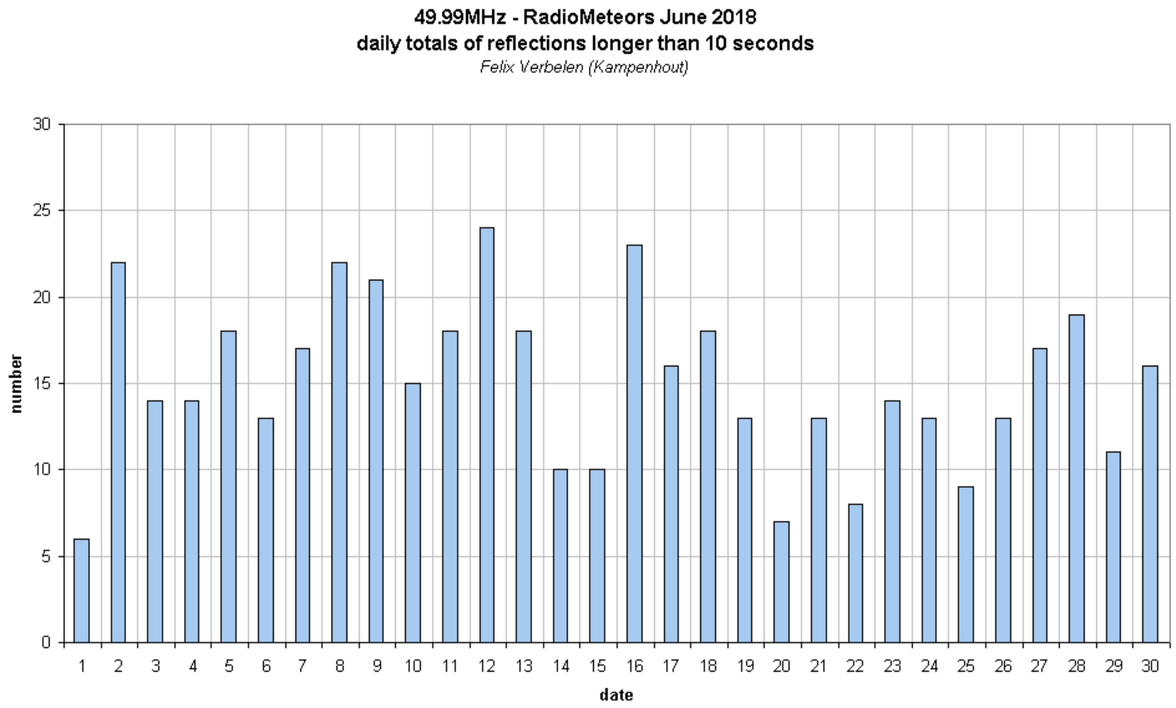


Figure 1 – The daily totals of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during June 2018.



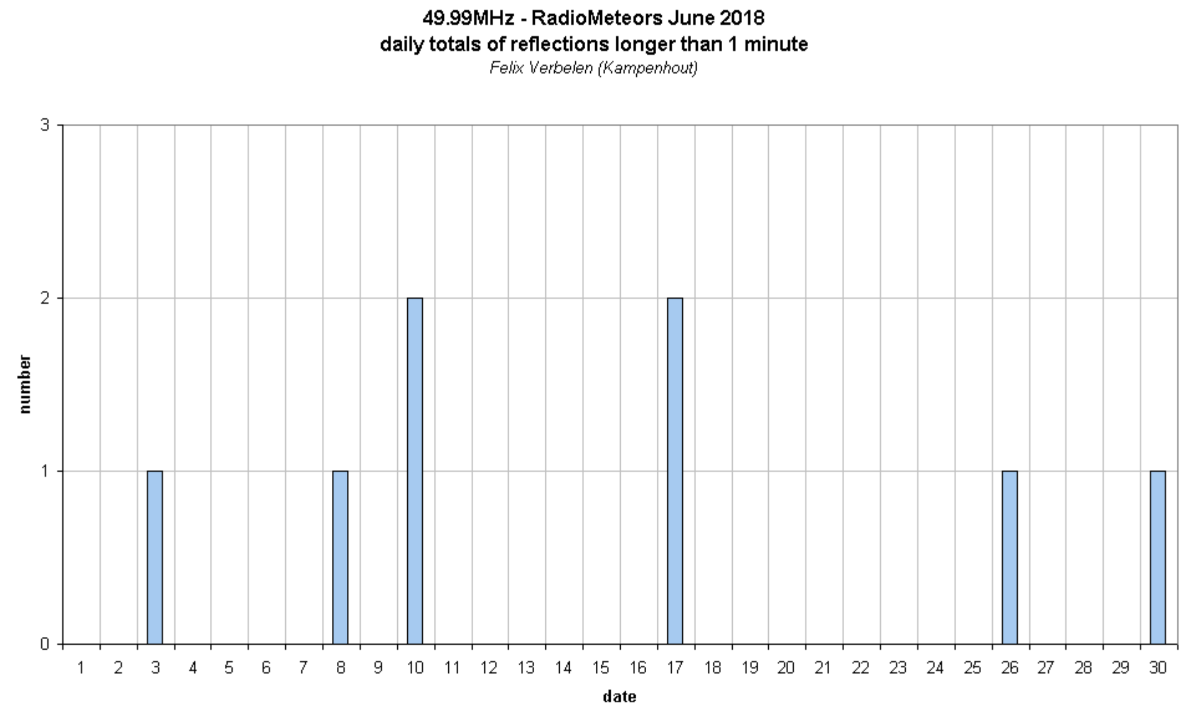
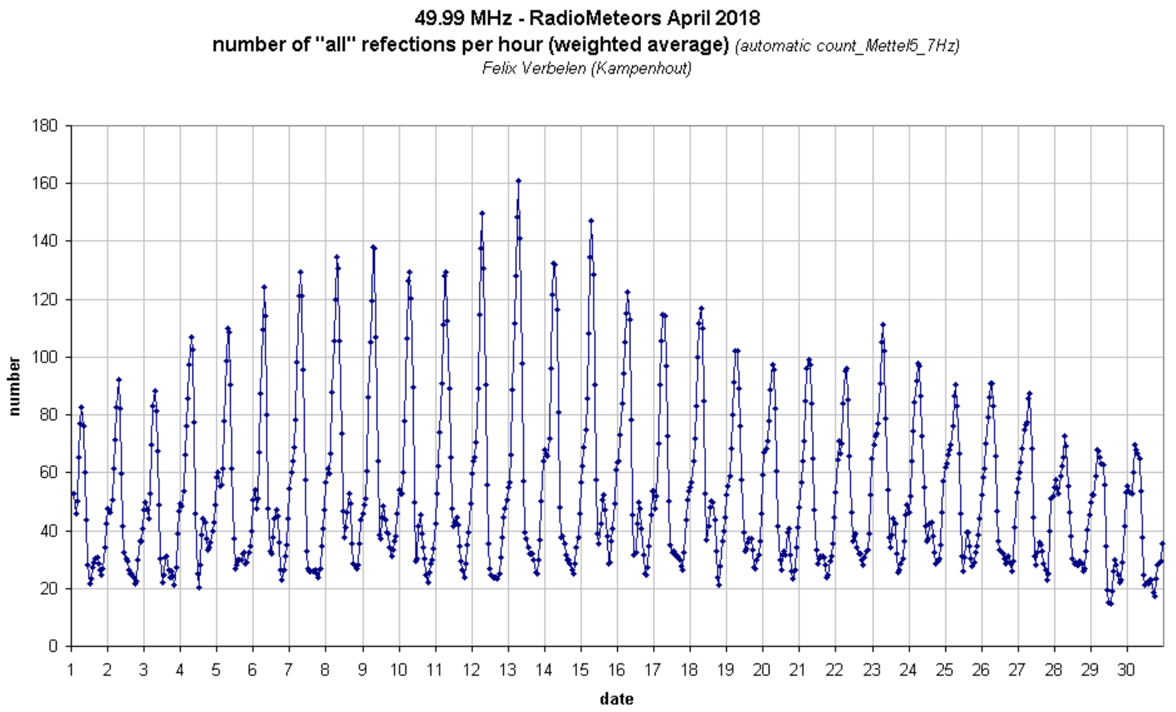


Figure 2 – The daily totals of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during June 2018.



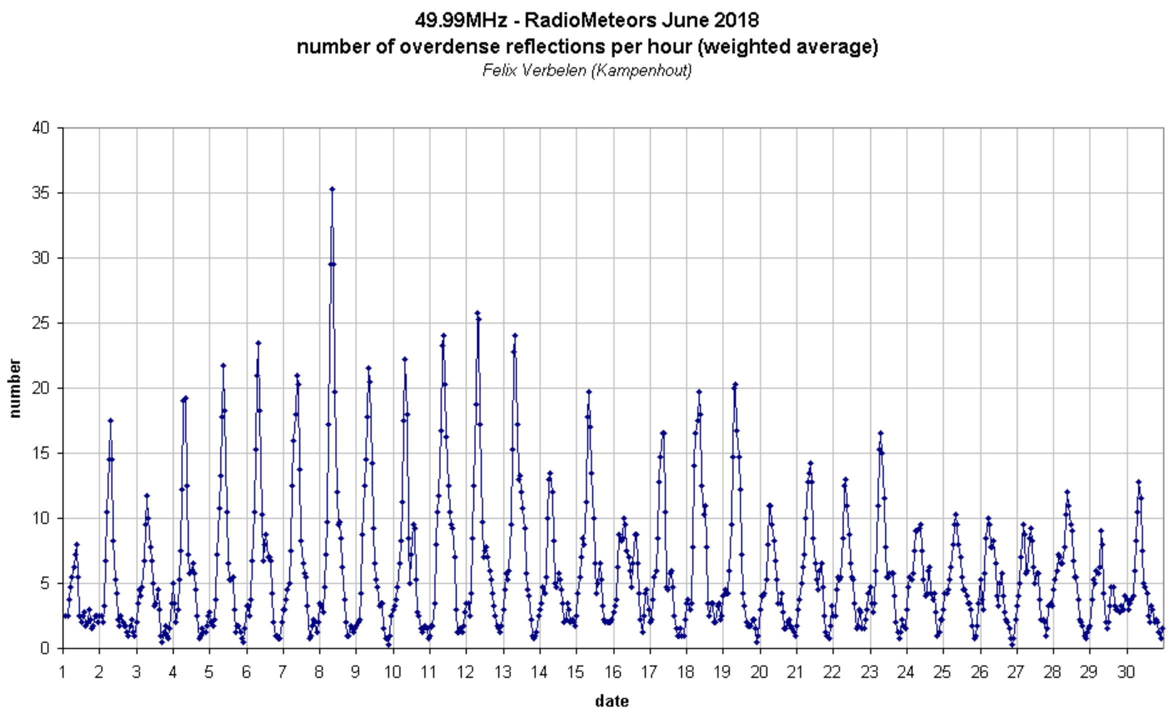
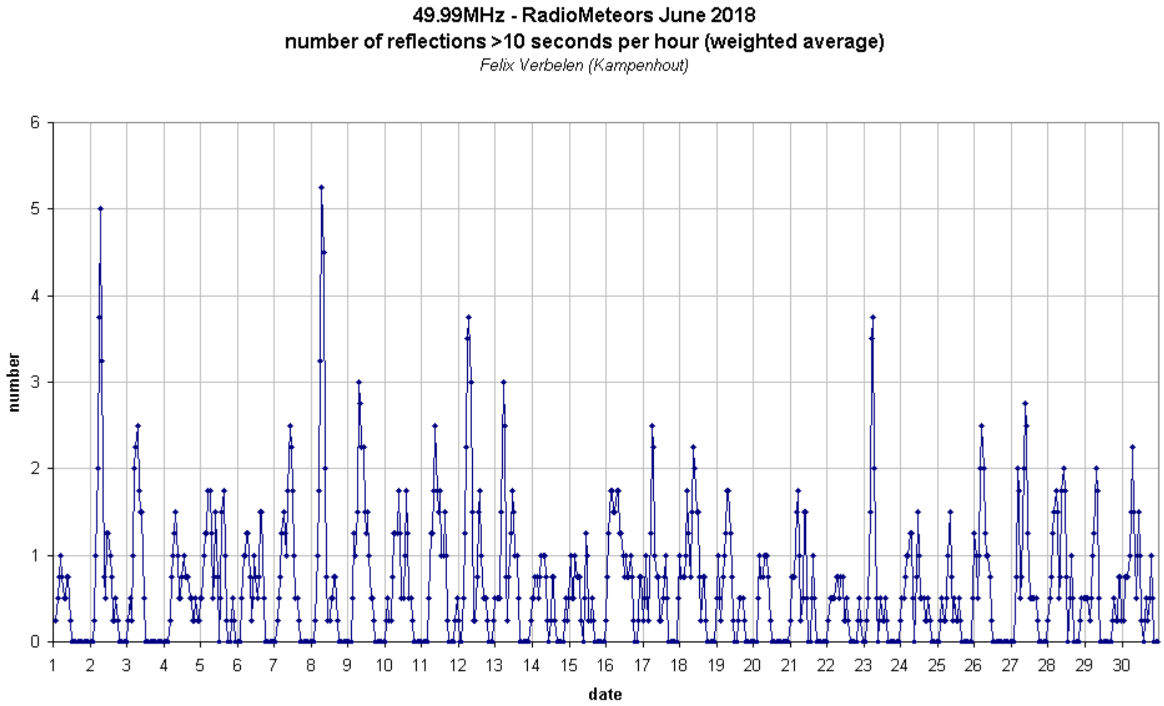


Figure 3 – The hourly numbers of "all" reflections counted automatically, and of manually counted "overdense" reflections, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during June 2018.



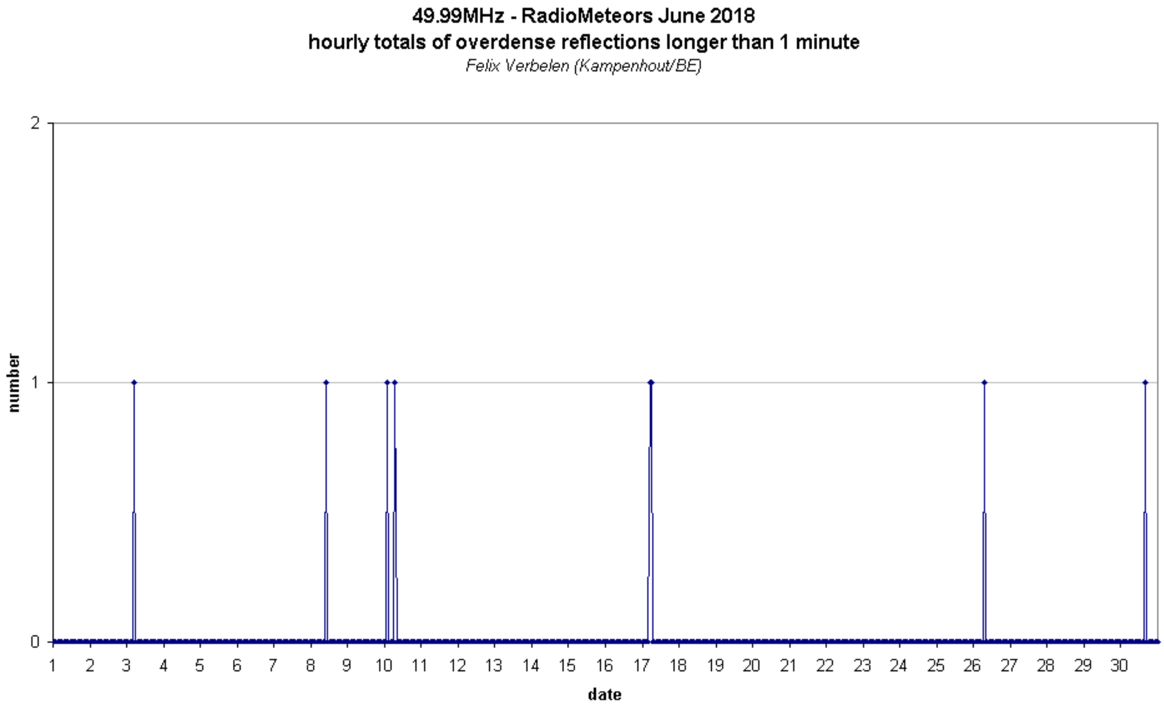


Figure 4 – The hourly numbers of overdense reflections longer than 10 seconds and longer than 1 minute, as observed here at Kampenhout (BE) on the frequency of our VVS-beacon (49.99 MHz) during June 2018.

Suspected small outburst of the June Bootids #170–JBO

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The meteorological radar RAMBo detected a sudden increase in meteor activity on June 27, 2018. It was possibly caused by a small outburst of the June Bootids stream.

1 Introduction

On June 27th, around 16^h00^m UT our meteor radar RAMBo recorded a peak in meteor activity, associated with an increase in the measured meteor masses.

Day light measurements obviously do not allow visual feedback and therefore these make it difficult to identify which stream is responsible for the recorded outburst.

2 June Bootids?

However, a clue comes from the fact that the timetable perfectly coincides with the International Astronomical Union (IAU) meteor showers forecast, which provides a maximum activity for the June Bootids at 15^h49^m on 27 June 2018. At that time the radiant height of the stream for Bologna was 50° above the horizon.

The June Bootids (#170–JBO) are usually a very weak stream, with a radiant in the constellation of Bootes at Right Ascension 220° and declination +48°; these are very slow, (14 km/sec) and therefore very spectacular. Their velocity is at the lower limit in the range of meteor velocities. The parent body is the comet 7P/ Pons-Winnecke which orbits the Sun in 6.37 years on an orbit confined within the orbit of Jupiter. Its last passage to perihelion was in January 2015. The meteor stream generated by its activity, the June Bootids, is considered by astronomers to be completely unpredictable, having generated outbursts in the years: 1916, 1921, 1927, 1998 and 2004. In 1998 the outburst was very intense and lasted seven hours.

The lower part of *Figure 1* (in red) represents the HR (Hourly Rate). You can see that the event lasted about 20 minutes (the measure represented in each column lasts 5 minutes). You can also note that it was preceded (upper part of the graph) for at least three hours in which both the duration and the amplitude of the detected meteor echoes show a more massive than usual bombardment of meteors (black line). This could suggest that we are seeing a shower in which a more rarefied but more massive component proceeds the most numerous but less massive component of 16^h UT. The solar longitude of the event is 95.700°. Furthermore, we can see in the same graph that even the Beta Taurids shower, another daylight shower, although much lower on the horizon (10°), exactly 24 hours later, seems to have left a small trace on our recordings.

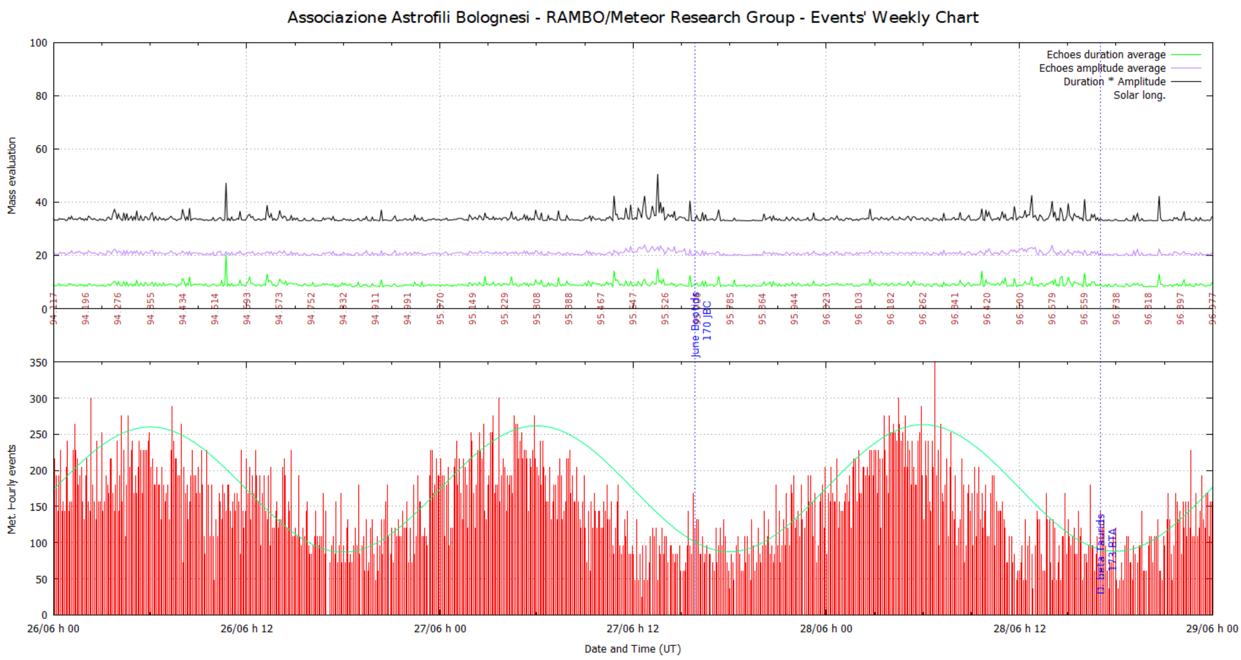

Figure 1 – RAMBo (www.rambom s.com) radio echo recording 26 until 29 June 2018.

Fireball events

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An overview is presented of exceptional fireball events by the meteor observing stations operated by the SMART Project (University of Huelva) from Sevilla and Huelva during the period June – July 2018.

1 Bright sporadic meteor over Spain on 16 June 2018

This bright and sporadic meteor was recorded over the south of Spain on 16 June at 2^h31^m local time (0^h31^m universal time)[21]. The event was produced by a fragment from an asteroid that hit the atmosphere at about 66000 km/h. The fireball began at an altitude of around 93 km over the province of Huelva, and ended at a height of about 43 km over the Gulf of Cadiz (Atlantic Ocean). The event was recorded by the meteor observing stations operating in the framework of the SMART Project (University of Huelva) from the astronomical observatories of Calar Alto, La Sagra (Granada), La Hita (Toledo) and Sevilla (*Figure 1*).

Figure 1 – Fireball 2018 June 16, 00^h31^m UT.

2 Meteorite fall on July 9

This meteor event was recorded over Andalusia and the Mediterranean Sea on 9 July 2018 at ^{5}h13^m local time (3^h13^m universal time)[22]. The sporadic event was produced by a fragment from an asteroid that hit the atmosphere at about 65000 km/h. The mag. –12 ±1 fireball began at an altitude of around 89 km over the province of Almería, and ended at a height of about 31 km over the Sea. The analysis of its atmospheric path and the terminal point of the trajectory show that this was a potential meteorite-producing event. The meteorite would have fallen into the sea, but with a small mass of just a few grams. The event was recorded by the meteor observing stations operated by the SMART Project (University of Huelva) from the astronomical observatories of Calar Alto (Almería), La Sagra (Granada), La Hita (Toledo) and Sevilla (*Figure 2*).

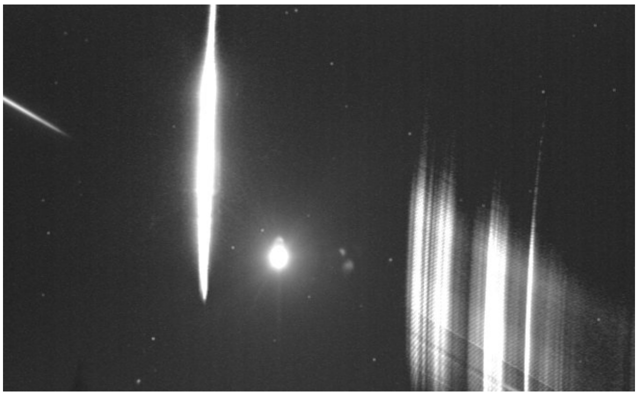

Figure 2 – Fireball 2018 July 9, 03^h13^m UT.

3 Bright meteor over the Mediterranean on 17 July at 2^h20^m UT

This mag. –9 sporadic meteor event was recorded over the Mediterranean Sea on 17 July 2018 at 4^h20^m local time (2^h20^m universal time)[23]. The event was produced by a meteoroid following an asteroid-like orbit that hit the atmosphere at about 54000 km/h. The fireball began at an altitude of around 91 km over the sea, and ended at a height of about 31 km. The fireball was recorded by the meteor observing stations operating in the framework of the SMART Project (University of Huelva) from the astronomical observatories of Calar Alto (Almería), Sierra Nevada (Granada) and Sevilla (*Figure 3*).

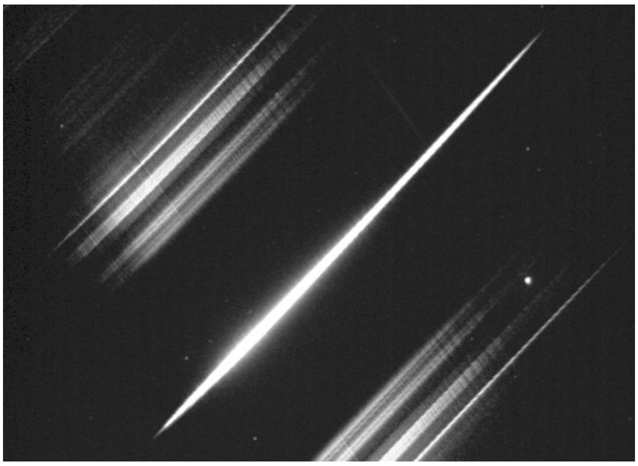

Figure 3 – Fireball 2018 July 17, 02^h20^m UT.

[21] https://youtu.be/Ywj_pW7VPOg
[22] https://youtu.be/5qPf1PIbyGE
[23] https://youtu.be/in3LswAGzBQ

4 Alpha-Capricornid fireball over Andalusia on 19 July

This mag. –8 fireball event was recorded over Andalusia on 19 July 2018 at 5^h28^m local time (3^h28^m universal time)[24]. The event was produced by a meteoroid from Comet 169P/NEAT that hit the atmosphere at about 80000 km/h. The alpha-Capricornid fireball began at an altitude of around 95 km over the province of Granada, and ended at a height of about 43 km over the province of Almería. It was recorded from the meteor-observing stations operating in the framework of the SMART Project (University of Huelva) from the astronomical observatories of Calar Alto (Almería), La Sagra (Granada), La Hita (Toledo), Huelva and Sevilla (*Figure 4*).

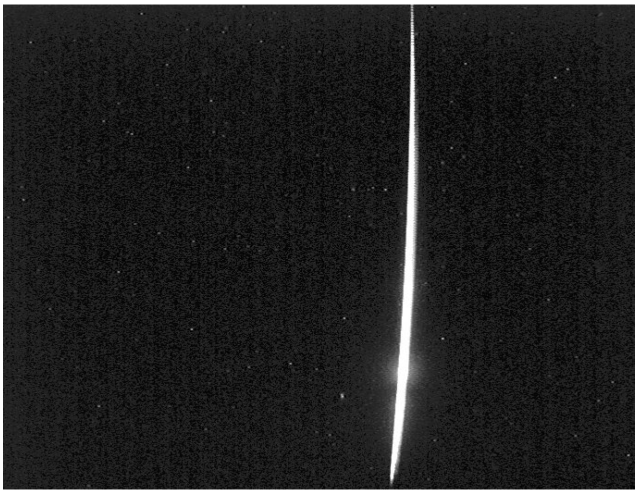

Figure 4 – Fireball 2018 July 19, 03^h28^m UT.

5 Fireball as bright as the Moon over Spain

This stunning meteor event, which was as bright as the Full Moon, was recorded over the Mediterranean Sea on 23 July at 22^h22^m local time (20^h22^m universal time)[25]. The event was produced by a fragment from an asteroid that hit the atmosphere at about 61000 km/h. The fireball began at an altitude of around 89 km over the sea, and ended at a height of about 37 km. It was recorded by the meteor observing stations operating in the framework of the SMART Project from the astronomical observatories of Calar Alto, La Sagra (Granada), Sierra Nevada (Granada) and Sevilla (*Figure 5*).

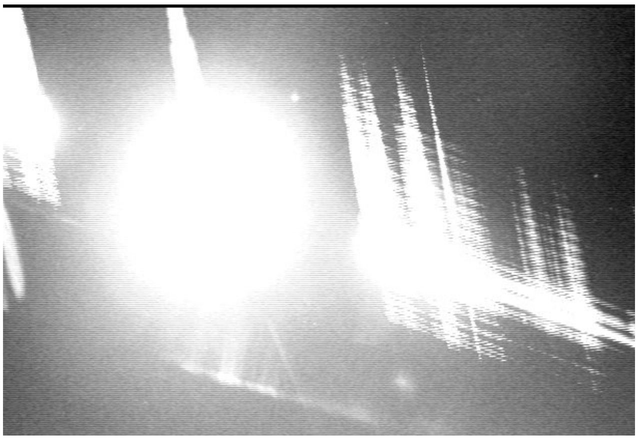

Figure 5 – Fireball 2018 July 23, 20^h22^m UT.

[24] https://youtu.be/1s_seJQJRzc
[25] https://youtu.be/anpBpYmAAAY

Suspected asteroid 2018 LA impact

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Asteroid 2018 LA was discovered about 8 hours before it entered into the Earth atmosphere above South Africa and Botswana as a fireball. A summary report with the preliminary data is presented.

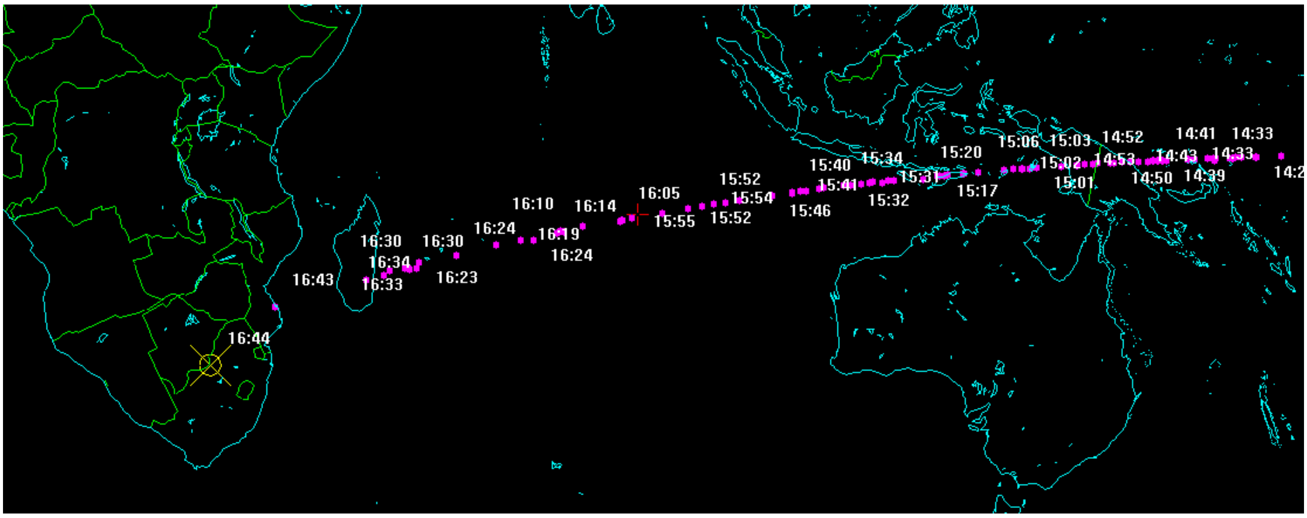

Figure 1 – Pre impact trajectory of Asteroid 2018 LA.

1 Introduction

Asteroid 2018LA was discovered by *Richard Kowalski* using a 60” telescope and it surprised astronomers with its very close to Earth approach trajectory.

According to NASA/JPL’s Center for Near Earth Object Studies (CNEOS), asteroid 2018 LA approached Earth at 27738 miles per hour (44640 km per hour).

Trajectory models suggested that a small asteroid 2018 LA should impact Earth’s atmosphere over South Africa on Saturday, June 2, 2018.

2 The impact

First reports came from Botswana and South Africa via the IMO fireball report form. This suspected meteorite fall was likely to be linked with the newly-discovered asteroid 2018 LA. Video recording of the event confirms a large fireball event (magnitude –28) with a subsequent impact explosion. The event happened on 2nd of June 2018 at 18^h49^m local time and was first reported from Ottosdal, North West, South Africa. A video registration can be found online[26].

Public reports about a bright flash of light, sonic booms and some shaking of the ground could be associated with a giant dust cloud registered on a Doppler radar image, indicating an explosion of a bolide about 20 miles off the coast followed by an impact in the ocean.

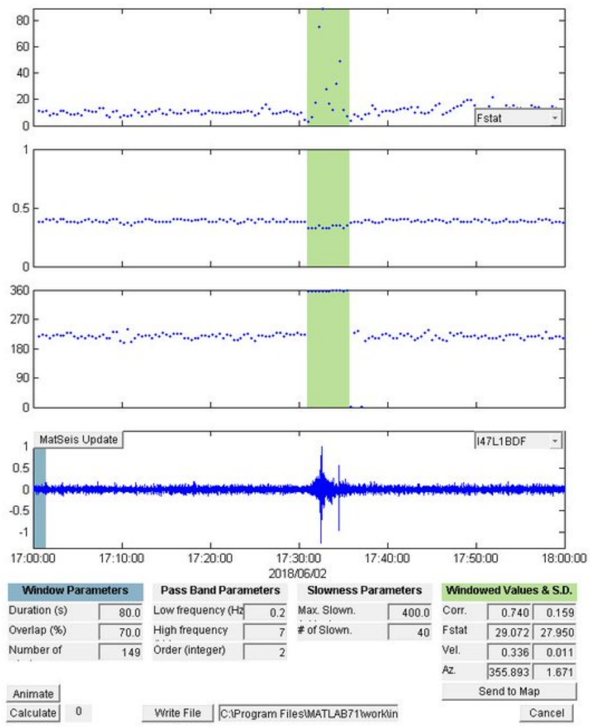

Figure 2 – Strong infrasound detection of a bolide at station I47 in South Africa at 1730 UT. Origin time between 1645-17 UT over Botswana. Yield 0.3-0.5 kT, corresponding to 2m diameter asteroid (Source Peter Brown).

[26] https://youtu.be/rnBvSNYy-EY

3 Preliminary results

The orbit has been determined as (de la Fuente Marcos, 2018):

$a = 1.374 \pm 0.002$ AU;
$e = 0.4303 \pm 0.0009$,
$i = 4.284° \pm 0.004$ °;
$\Omega = 71.8795° \pm 0.0013°$,
$\omega = 256.04° \pm 0.03°$;

Meanwhile an expedition by Dr. Peter Jenniskens to Botswana successfully recovered some debris from asteroid 2018 LA (*Figure 4*).

Figure 4 – Dr. Peter Jenniskens with a fresh looking 18 g meteorite found in the Central Kalahari Game Reserve.

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de la Fuente Marcos C. and de la Fuente Marcos R. (2018). "On the Pre-impact Orbital Evolution of 2018 LA, Parent Body of the Bright Fireball Observed over Botswana on 2018 June 2". *Research Notes of the American Astronomical Society,* (arXiv:1806.05164).

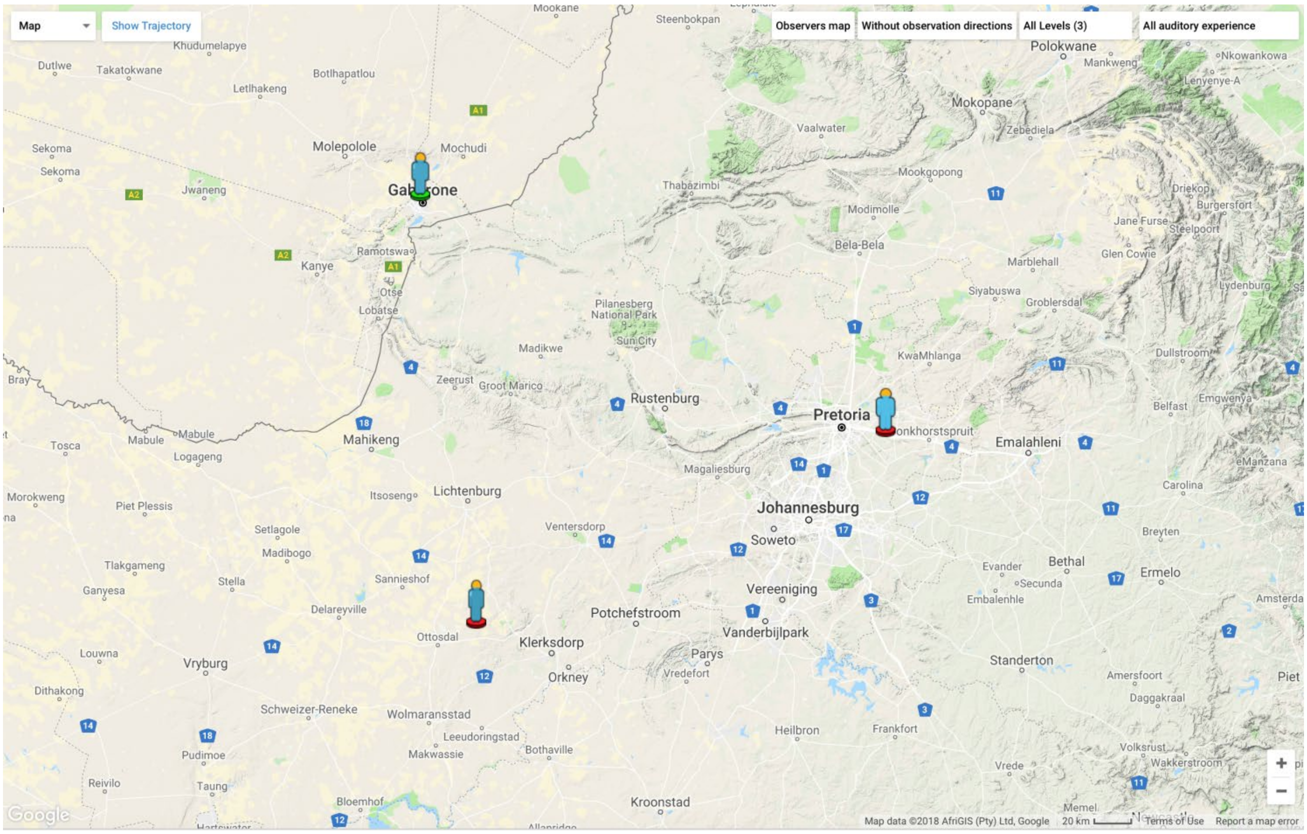

Figure 5 – Witness reports of the fireball event on 2018 June 2 in Botswana and South Africa.

February 2018 report CAMS BeNeLux

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A summary of the activity of the CAMS BeNeLux network during the month February 2018 is presented. This month offered many clear nights, 11 nights with more than 200 orbits, 3 nights had over 300 orbits. In total 23439 meteors were recorded, 12931 of which proved multiple station, or 55%. In total 4147 orbits were collected during this month, more than during all previous months of February together.

1 Introduction

After two disappointing months, December 2017 and January 2018 with the most unfavorable weather possible for meteor video work, the poor weather continued the first few nights of February 2018 until a major improvement changed the situation from 5–6 February onwards. The month of February is a winter month with long nights in the BeNeLux while meteor activity is still fairly high. The weather used to be favorable during the years 2014, 2015 and 2016 when the network counted much less cameras than today. February 2017 was characterized by very bad weather circumstances with as many as 12 nights without any single orbit. What did February 2018 bring?

2 February 2018 statistics

The night 5–6 February was the first of a long series of clear nights with every now and then a night that remained overcast. As many as 11 nights resulted in more than 200 orbits, 3 nights of these had over 300 orbits. These numbers show how rich meteor activity is this time of the year although no major showers are active.

Table 1 – February 2018 compared to previous months of February.

Year	Nights	Orbits	Stations	Max. Cams	Min. Cams	Mean Cams
2013	9	38	6	5		2.3
2014	21	601	12	29		20.3
2015	21	777	14	39		27.4
2016	24	1075	17	51	13	36.9
2017	16	717	18	53	20	38.6
2018	26	4147	22	91	48	81.7

CAMS BeNeLux managed to collect 23439 meteors with 91 cameras capturing at 22 participating stations during the best nights. 12931 or 55% of these meteors were multi-station meteors, good for 4147 orbits. With the 2018 results the total number of orbits for February obtained by CAMS BeNeLux was more than doubled. With other words, February 2018 had more orbits than all previous months of February together. The statistics for February 2018 are compared in *Table 1* with all previous February months since the start of the CAMS BeNeLux network. It is obvious that the numbers for 2018 are outstanding. It is very unlikely that we will have such exceptional favorable month of February ever again.

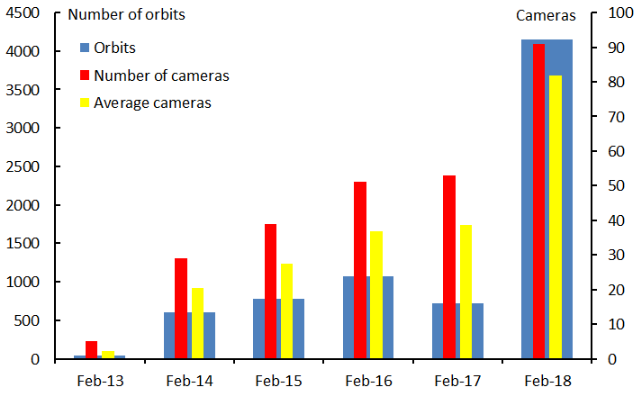

Figure 1 – Comparing February 2018 to previous months of February in the CAMS BeNeLux history. The blue bars represent the number of orbits, the red bars the maximum number of cameras running in a single night and the yellow bars the average number of cameras running per night.

On average 81.7 of the available 91 cameras were capturing per night. This high average corresponds to ~90% (89.8%) of the maximum number of cameras available which is the highest value for a month since the CAMS BeNeLux network started. Especially in the first years, before AutoCams was available in the BeNeLux, many cameras remained switched off when the weather was not good. This way the chances to obtain double station meteors for those cameras that remained active were rather small.

Only 2 nights did not yield any orbit, but even during these nights some meteors were recorded. AutoCAMS kept a minimum of 48 cameras active on all nights, even on completely overcast nights. On as many as 26 nights orbits have been collected. *Figure 1* shows the important increase in camera capacity. This combined with exceptional good weather explains the great success obtained in February 2018.

On 2018 February 14, the CAMS BeNeLux network recorded a few similar orbits which were identified with a new minor shower listed as the February Hydrids (FHY-1032) in the IAU working list of meteor showers (Jenniskens et al., 2018). Meanwhile further searches for more orbits of this stream in public available meteor orbit listings resulted in a more detailed case study on this new shower (Roggemans and Cambell-Burns, 2018).

3 Conclusion

The efforts of the entire team of the CAMS BeNeLux network were rewarded with a record number of orbits for the month of February. The many exceptional clear nights during these long winter nights, combined with the large number of cameras and the fact that the majority of the CAMS stations switched successfully to AutoCams resulted in the best month of February ever. The many orbits obtained this month provide a lot of valuable information about the rather poorly known meteor streams active during this month. The discovery of the February Hydrids (FHY-1032) is a nice achievement for the network.

Acknowledgment

Many thanks to all participants in the CAMS BeNeLux network for their dedicated efforts. Thanks to *Carl Johannink* for providing all the data on which this report is based. The CAMS BeNeLux team is operated by the following volunteers:

Hans Betlem (Leiden, CAMS 371, 372 and 373), *Felix Bettonvil* (Utrecht, CAMS 376 and 377) , *Jean-Marie Biets* (Wilderen, CAMS 380, 381 and 382), *Martin Breukers* (Hengelo, CAMS 320, 321, 322, 323, 324, 325, 326 and 327), *Bart Dessoy* (Zoersel, CAMS 397, 398, 804, 805 and 806), *Franky Dubois* (Langemark, CAMS 386), *Luc Gobin* (Mechelen, CAMS 390, 391, 807 and 808), *Robert Haas* (Alphen aan de Rijn, CAMS 3360, 3361, 3362, 3363, 3364, 3365, 3366 and 3367), *Robert Haas / Edwin van Dijk* (Burlage, CAMS 801, 802, 821 and 822), *Klaas Jobse* (Oostkapelle, CAMS 330, 331, 332, 333, 334, 337, 338 and 339) , *Carl Johannink* (Gronau, CAMS 311, 312, 313, 314, 315, 316, 317 and 318), *Hervé Lamy* (Dourbes / Ukkel, CAMS 394 and 395/ 393), *Koen Miskotte* (Ermelo, CAMS 351, 352, 353 and 354), *Piet Neels* (Ooltgensplaat, CAMS 340, 341, 342, 343, 344, 345, 349 and 840), *Tim Polfliet* (Gent, CAMS 396), *Steve Rau* (Zillebeke, CAMS 3850 and 3852), *Paul Roggemans* (Mechelen, CAMS 383, 384, 388, 389, 399 and 809), *Hans Schremmer* (Niederkruechten, CAMS 803) and *Erwin van Ballegoij* (CAMS 347 and 348).

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March 2018 report CAMS BeNeLux

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A summary of the activity of the CAMS BeNeLux network during the month of March 2018 is presented. The weather was neither exceptional good nor bad, but a bit less favorable than March in previous years. 9324 meteors were recorded, 3391 of which proved multiple station, or 36%. In total 1280 orbits were collected during this month.

1 Introduction

After an exceptional successful month of February the weather returned to a more normal situation for the low lands of the BeNeLux. March 2018 became an average month with rather less good circumstances than what March brought previous few years. Nights are getting shorter and meteor activity declines.

2 March 2018 statistics

CAMS BeNeLux managed to collect 9324 meteors of which 3391 or 36% were multi-station meteors good for 1280 orbits. This is the best number of orbits for the month of March ever. The statistics of March 2018 are compared in *Figure 1* and *Table 1* with the same month in previous years since the start of CAMS BeNeLux in 2012.

As many as 91 cameras were active during one of the best nights of March 2018. On average 73.5 cameras were capturing per night. 6 nights did not yield any orbit, but even during these nights some meteors were registered. Thanks to AutoCAMS the surveillance of the BeNeLux sky was guaranteed with a minimum of 53 active cameras on all nights. On as many as 25 nights orbits have been collected. *Figure 1* shows the enormous increase in camera capacity. Using many more cameras than previous years helped to collect more orbits than during any previous month of March, compensating the less favorable weather in March 2018.

Some technical problems at some CAMS stations prevented the identification of simultaneous meteors. A problem occurred with the time synchronization in the CAMS network. The software used to keep the CAMS PC's clocks synchronized; Dimension4 caused some very large errors on the time registration which depended on the settings of this software at some stations. By the time the problem was noticed, a lot of double station meteors had been lost due to invalid timing.

One of the basic CAMS Stations of the network, Oostkapelle, with 8 cameras, was temporarily shut down for renovation works which will take several months. This and the time synchronization problems at some CAMS stations meant that the network didn't run at full capacity during this month.

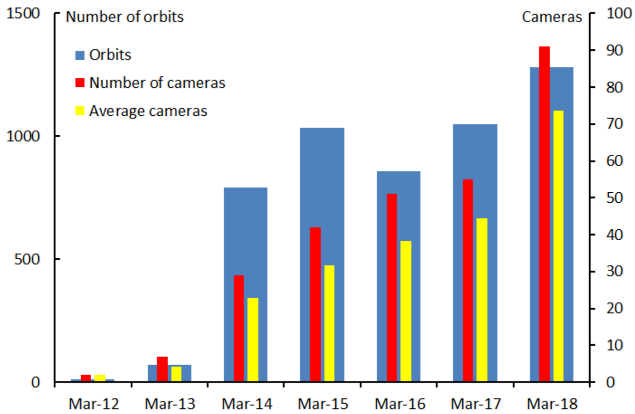

Figure 1 – Comparing March 2018 to previous months of March in the CAMS BeNeLux history. The blue bars represent the number of orbits, the red bars the maximum number of cameras running in a single night and the yellow bar the average number of cameras running per night.

Table 1 – March 2018 compared to previous months of March.

Year	Nights	Orbits	Stations	Max. Cams	Min Camas	Mean Cams
2012	2	12	2	2		2.0
2013	10	69	6	7		4.2
2014	24	793	12	29		22.8
2015	23	1033	14	42		31.7
2016	23	856	16	51	12	38.2
2017	26	1048	19	55	20	44.4
2018	25	1280	22	91	53	73.5

In the night of 11–12 March a number of orbits caught attention and an analyses was made to find more information about the associated minor shower, the X Herculids (346-XHE) (Roggemans and Campell-Burns, 2018).

The best memory of March 2018 remains beyond doubt the annual CAMS-meeting in Bussloo, the Netherlands which took place on 11 March (Roggemans, 2018).

3 Conclusion

March 2018 brought back the usual weather for the BeNeLux with mainly overcast sky and only few clear nights. Thanks to the many extra cameras compared to previous years more orbits were collected than any previous month of March.

Acknowledgment

Many thanks to all participants in the CAMS BeNeLux network for their dedicated efforts. Thanks to *Carl Johannink* for providing all the data on which this report is based. The CAMS BeNeLux team is operated by the following volunteers:

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