The 2016 Gamma Draconids outburst

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The 2016 γ-Draconids outburst observed by video is yet another outburst that was independently discovered by forward scatter radio observations. Thanks to the high declination of the radiant, it was recorded by many observers in the northern hemisphere. A detailed activity profile was also obtained.

1 Introduction

During the past few years, we have reported on forward scatter observations of predicted outbursts or enhanced activity of the following known streams:

- October 2011 Draconids (Steyaert, 2013);
- May 2013 η-Aquariids (Steyaert, 2014a);
- May 2014 Camelopardalids, associated to Comet 209P/LINEAR (Steyaert, 2014b);
- February 2015 γ-Lyrids (Steyaert, 2015). This outburst was confirmed by Brown (2016). There was a weak return in 2017 (Pellens, 2017).

This contribution is an update on our previous paper (Steyaert, 2015), and discusses a new and similar outburst.

2 Discovering outbursts

Figure 1 shows the hourly counts obtained by Felix Verbelen for 2014–2016. He has been monitoring the VVS beacon since the beginning of 2005 with the same receiver and antenna setup.

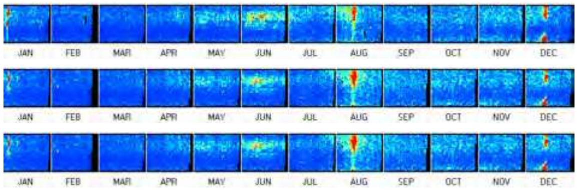

Figure 1 – Yearly overview of the counts of Verbelen obtained for the years 2014–2016.

The well-known annual streams are easily recognized: the Quadrantids on January 3–4, the Lyrids end April, the η-Aquariids early May, the long-lasting daytime streams in June, the Perseids in August, and the Geminids mid-December. The presence of the Orionids in October and the Leonids in November varies from year to year. There was also a strong return of the Ursids in 2016.

Figure 2 – Participating stations in RMOB (Radio Meteor Observatories On-line).

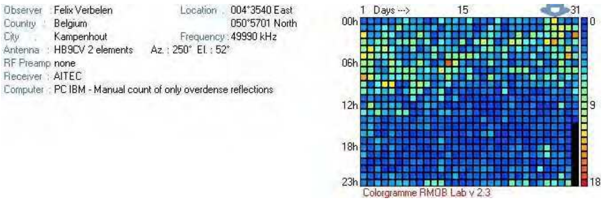
Observer : Felix Verbelen
Country : Belgium
City : Kampenhout
Antenna : HB9CV 2 elements Az. : 250° El. : 52°
RF Preamp none
Receiver : AITEC
Computer : PC IBM - Manual count of only overdense reflections
Location : 004°3540 East
050°5701 North
Frequency : 49990 kHz

Figure 3 – Typical daily radio count pattern.

During February and March there are no known major streams, and the annual sporadic activity is the lowest of the year. Hence, this is the period of the year (for the northern hemisphere) during which smaller streams can be more easily detected from the normally low counts. Along with the longer nights during these months, there is also a good chance of optically recording activity if the weather cooperates. Outside this period, the signal-to-noise ratio of a smaller stream is too low at nighttime.

For radio observers, unknown activity can also be more easily discovered when the sporadic activity is at its lowest, i.e., during local afternoon to midnight hours.

3 Observations

During July 2017, there were 57 submissions to RMOB (Radio Meteor Observatories On-Line, Figure 2).[1] Most of the observers employ automatic counting methods. Some of the stations are still in a testing phase. It should be noted that several new stations in Brazil have recently come on line, which creates the possibility of studying the southern hemisphere streams.

A typical monthly graph (Figure 3) shows the daily pattern with a maximum in the morning hours local

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[1] `http://www.rmob.org/livedata/main.php`.

time, and a minimum in the evening, with superimposed stream activity, like the daytime β-Taurids in early July.

4 Finding previously unknown activity

In checking the monthly submissions to RMOB, the following mail exchange between the authors took place:

```
Date: Tue, 02 Aug 2016 11:43:42 +0200
To: Jeffrey Brower <jbrower@meteorchaser.net>
From: Chris Steyaert <csteyaert@gmail.com>
Subject: Re: RMOB 2016 07 Brower

Hi Jeff,

Several observations recorded an outburst on
July 28, 0h - 1h UT. I'll look into that one.
```

Seventeen reflections are seen in the 5-minutes Speclab waterfall spectrum (Figure 4), which is exceptional for that time of the day. An extrapolated rate of 200 per hour occurs only for the strongest streams.

An automatic counting script found only seven reflections, shown on the lower axis of Figure 4). It clearly needs more tuning.

In total, twelve RMOB observers recorded increased activity in the interval July 27, 23^{h} UT–July 28, 2^{h} UT, indicated with blue arrows in the various panels of Figure 5.

All types of transmitters are present:

- the 50 W VVS beacon (49.99 MHz);
- the Megawatts GRAVES radar (143.05 MHz) in France; and
- TV stations in North America and Japan.

Simply adding (without any scaling) the counts of these twelve observers for the two days around the outburst (Figure 6) confirms the higher activity for July 27, 23^{h} UT, and July 28, 0^{h} UT.

5 Optical observations

Contrary to the 2015 February 5 event, there was no need to try to locate the radiant of the stream based on the radio observations. Quoting from the *Central Bureau Electronic Telegram* 4292,[2]

```
JULY GAMMA DRACONID METEOR OUTBURST

P. Jenniskens, SETI Institute and NASA Ames
Research Center, reports that stations of the
CAMS meteor video camera network in the
Netherlands detected unusually strong activity
from the July gamma Draconids shower (IAU
shower number 184) between July 27d23h56m and
28d00h23m UT. According to the data analysis by
M. Breukers (Hengelo,The Netherlands),about
half of all 126 single-station-detected meteors
in the partially clouded night (typically with
brightness around magnitude +2) radiated from
this shower's radiant, as did five out of nine
multi-station meteors.  The median geocentric
radiant position was R.A. = 279.88 +/- 0.12 deg,
Decl. = +50.12 +/- 0.46 deg (equinox J2000.0),
with geocentric velocity 27.31 +/- 0.09 km/s,
(equinox J2000.0).
```

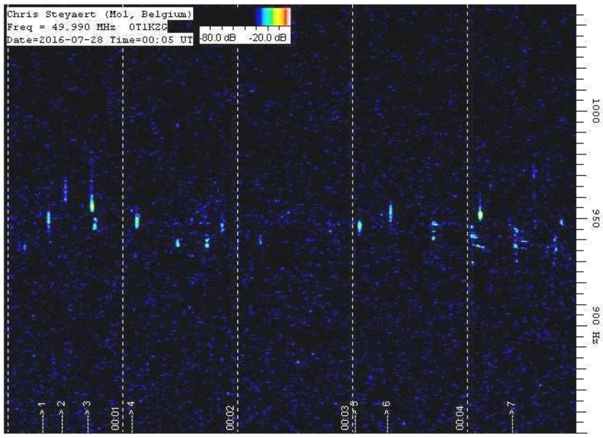

Figure 4 – Spectrum obtained by Steyaert in the interval July 28, $0^{\mathrm{h}}00^{\mathrm{m}}$–$0^{\mathrm{h}}05^{\mathrm{m}}$ UT.

Jeff records the counts in 10-minute intervals, which is a good compromise of time resolution versus number. The average number of reflections the day before and after the outburst in the interval $23^{\mathrm{h}}30^{\mathrm{m}}$–$0^{\mathrm{h}}30^{\mathrm{m}}$ UT is 4 to 7. It is significantly higher from July 27, $23^{\mathrm{h}}40^{\mathrm{m}}$, to July 28, $0^{\mathrm{h}}30^{\mathrm{m}}$ (boxed in Figure 7). This is somewhat longer than the interval given by CAMS, most probably because it includes fainter meteors.

6 Radiant position

The radiant was rather high in the sky for Europe (Figure 8). This poses a problem for explaining the high number of underdense meteors in Figure 4.

According to classical underdense specular reflection geometry, the reflections can only take place at a large distance, and consequently their number and intensity should be low. The same happens, e.g., at the Perseids culmination of the radiant, but this is from more overdense meteors at higher speed. This leads to the conclusion that the reflections in Figure 4 are short but non specular.

7 Conclusion

Beyond any doubt, moderately strong stream outburst can be identified in the heterogeneous forward scatter counts.

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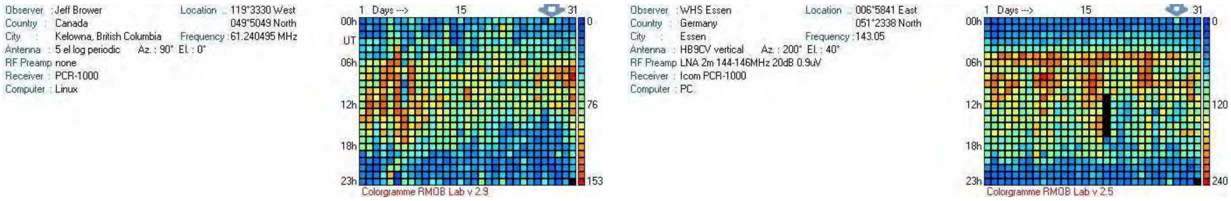
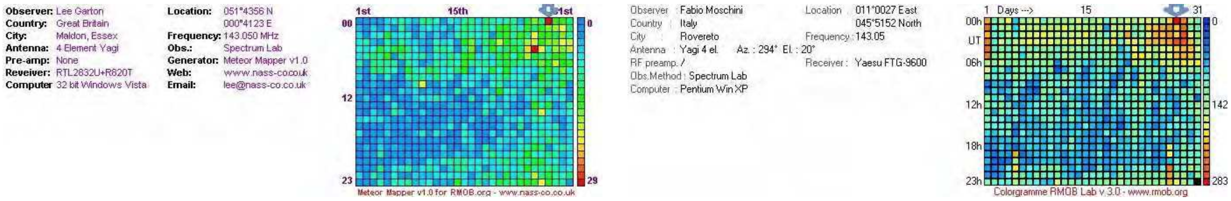
[2] `http://www.cbat.eps.harvard.edu/iau/cbet/004200/CBET004292.txt`.


Observer : Jeff Brower
Country : Canada
City : Kelowna, British Columbia
Antenna : 5 el log periodic Az. : 90° El. : 0°
RF Preamp none
Receiver : PCR-1000
Computer : Linux
Location ... 119°3330 West
049°5049 North
Frequency : 61.240495 MHz

Observer : WHS Essen
Country : Germany
City : Essen
Antenna : HB9CV vertical Az. : 200° El. : 40°
RF Preamp LNA 2m 144-146MHz 20dB 0.9uV
Receiver : Icom PCR-1000
Computer : PC
Location ... 006°5841 East
051°2338 North
Frequency : 143.05

(a) Jeff Brower, Canada

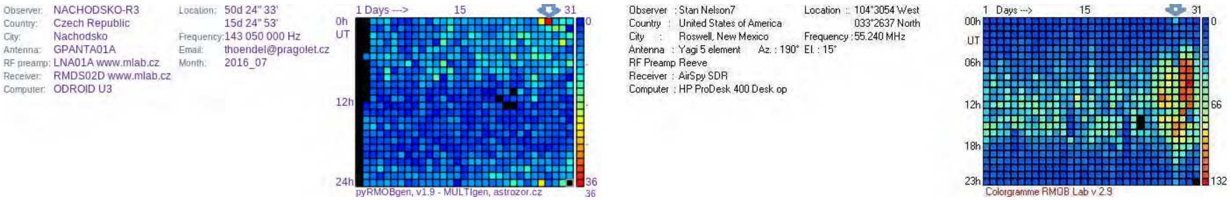
(b) Walter Hohmann Sternwarte, Germany


Observer: Lee Garton
Country: Great Britain
City: Maldon, Essex
Antenna: 4 Element Yagi
Pre-amp: None
Reveiver: RTL2832U+R820T
Computer 32 bit Windows Vista
Location: 051°4356 N
000°4123 E
Frequency: 143.050 MHz
Obs.: Spectrum Lab
Generator: Meteor Mapper v1.0
Web: www.nass-co.co.uk
Email: lee@nass-co.co.uk

Observer : Fabio Moschini
Country : Italy
City : Rovereto
Antenna : Yagi 4 el. Az. : 294° El. : 20°
RF preamp. /
Obs.Method : Spectrum Lab
Computer : Pentium Win XP
Location : 011°0027 East
045°5152 North
Frequency : 143.05
Receiver : Yaesu FTG-9600

(c) Lee Garton, UK

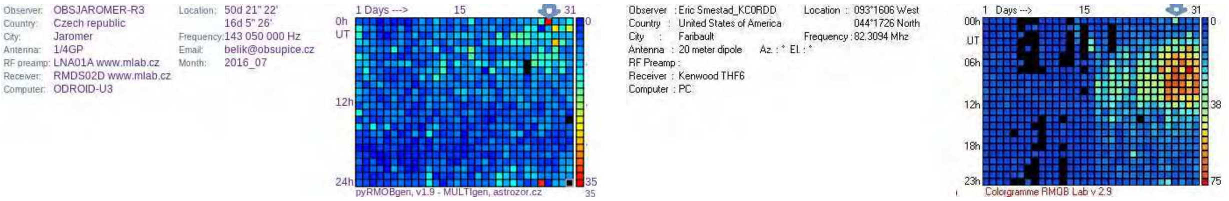
(d) Fabio Moschini, Italy


Observer: NACHODSKO-R3
Country: Czech Republic
City: Nachodsko
Antenna: GPANTA01A
RF preamp: LNA01A www.mlab.cz
Receiver: RMDS02D www.mlab.cz
Computer: ODROID U3
Location: 50d 24" 33'
15d 24" 53'
Frequency: 143 050 000 Hz
Email: thoendel@pragolet.cz
Month: 2016_07

Observer : Stan Nelson7
Country : United States of America
City : Roswell, New Mexico
Antenna : Yagi 5 element Az. : 190° El. : 15°
RF Preamp Reeve
Receiver : AirSpy SDR
Computer : HP ProDesk 400 Desk op
Location :: 104°3054 West
033°2637 North
Frequency : 55.240 MHz

(e) NACHODSKO-R3, Czech Republic

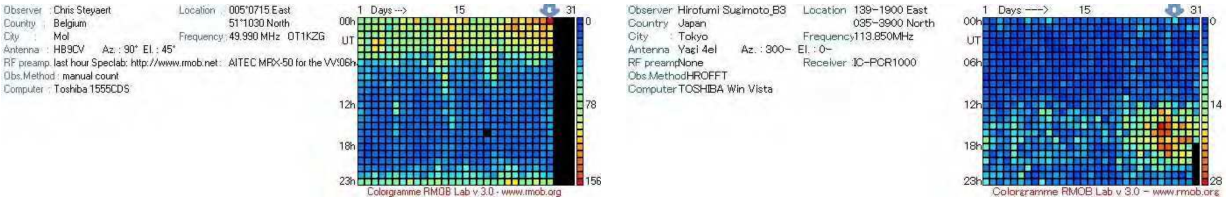
(f) Stan Nelson, USA


Observer: OBSJAROMER-R3
Country: Czech republic
City: Jaromer
Antenna: 1/4GP
RF preamp: LNA01A www.mlab.cz
Receiver: RMDS02D www.mlab.cz
Computer: ODROID-U3
Location: 50d 21" 22'
16d 5" 26'
Frequency: 143 050 000 Hz
Email: belik@obsupice.cz
Month: 2016_07

Observer : Eric Smestad_KC0RDD
Country : United States of America
City : Faribault
Antenna : 20 meter dipole Az. : ° El. : °
RF Preamp :
Receiver : Kenwood THF6
Computer : PC
Location :: 093°1606 West
044°1726 North
Frequency : 82.3094 Mhz

(g) OBSJAROMER-R3, Czech Republic

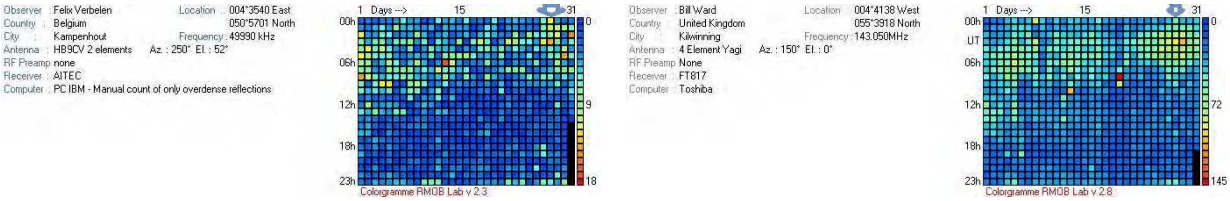
(h) Eric Smestad, USA


Observer : Chris Steyaert
Country : Belgium
City : Mol
Antenna : HB9CV Az. : 90° El. : 45°
RF preamp. last hour Speclab: http://www.rmob.net : AITEC MRX-50 for the VV
Obs.Method : manual count
Computer : Toshiba 1555CDS
Location : 005°0715 East
51°1030 North
Frequency : 49.990 MHz OT1KZG

Observer Hirofumi Sugimoto_B3
Country Japan
City : Tokyo
Antenna Yagi 4el Az. : 300– El. : 0–
RF preamp None
Obs.Method HROFFT
Computer TOSHIBA Win Vista
Location 139–1900 East
035–3900 North
Frequency 113.850MHz
Receiver IC–PCR1000

(i) Chris Steyaert, Belgium

(j) Hirofumi Sugimoto, Japan


Observer : Felix Verbelen
Country : Belgium
City : Kampenhout
Antenna : HB9CV 2 elements Az. : 250° El. : 52°
RF Preamp none
Receiver : AITEC
Computer : PC IBM - Manual count of only overdense reflections
Location ... 004°3540 East
050°5701 North
Frequency : 49990 kHz

Observer : Bill Ward
Country : United Kingdom
City : Kilwinning
Antenna : 4 Element Yagi Az. : 150° El. : 0°
RF Preamp None
Receiver : FT817
Computer : Toshiba
Location : 004°4138 West
055°3918 North
Frequency : 143.050MHz

(k) Felix Verbelen, Belgium

(l) Bill Ward, UK

Figure 5 – Twelve RMOB observations of increased activity in the interval July 27, 23$^{\mathrm{h}}$ UT–July 28, 2$^{\mathrm{h}}$ UT, indicated with blue arrows in panels (a)–(l).

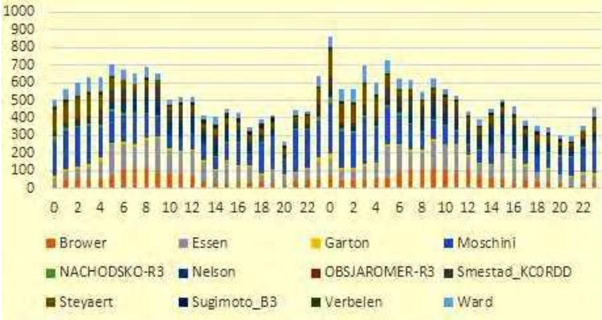


Figure 6 – Stack of all counts shown in Figure 5.

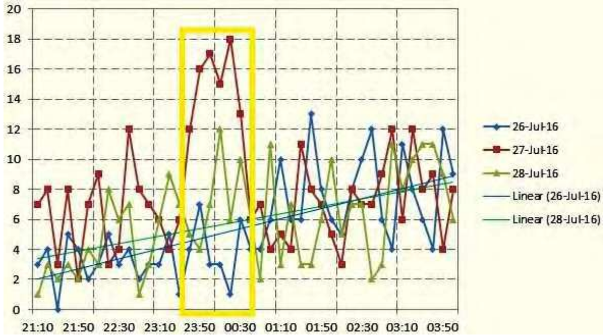


Figure 7 – Jeff Brower's 10-minute counts around the time of the outburst.

8 Analysis opportunities

Currently, basic data in the Visual RMOB Archives[3], which contains data since 2000, are not systematically scanned for unknown activity. Several more streams may await discovery in this database.

Acknowledgement

The authors wish to thank the `rmob.org` contributors, the CAMS community, the IMO, and especially Pierre Terrier, who hosts `rmob.org` since 2001.

References

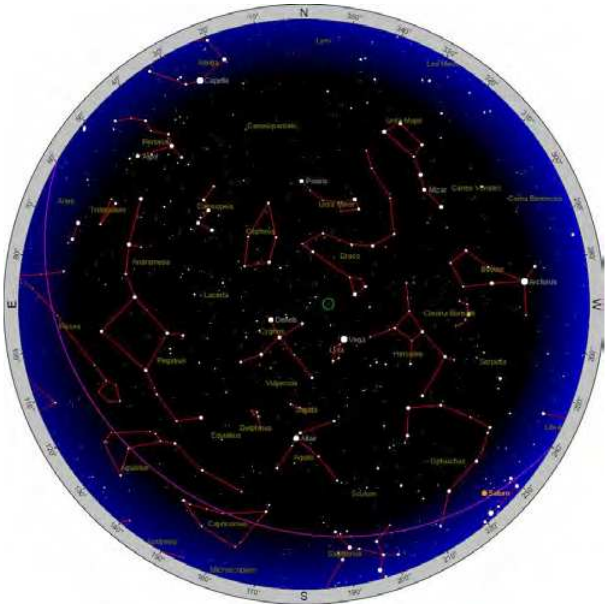


Figure 8 – Visible sky on July 28, $0^{\rm h}$ UT for $\varphi = 51\overset{\circ}{.}2$ N and $\lambda = 4\overset{\circ}{.}4$ E. The small green circle towards the center is the γ-Draconids radiant.

Brown P. (2016). "Recent shower outbursts detected by the Canadian Meteor Orbit Radar (CMOR)". In Roggemans A. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, Egmond, the Netherlands, 2–5 June 2016. IMO, pages 42–45.

Pellens L. (2017). Personal communication.

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Steyaert C. (2014b) "The global radio Camelopardalids 2014". In Rault J.-L. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, Giron, France, 18–21 September 2014. IMO, pages 190–193.

Steyaert C. (2015). "The 2015 February 5 event". In Rault J.-L. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, Mistelbach, Austria, 27–30 August 2015. IMO, pages 73–77.

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[3] `http://www.rmob.org/articles.php?lng=en&pg=28`; `http://rmob.org/visual/2017/`, and other years.