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# MeteorNews

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*A bright fireball photographed by four stations of the Danish Meteor network on December 25 at 2:11 UT.*

# Contents



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*Front cover picture*: A bright fireball photographed by four stations of the Danish Meteor network on December 25 at 2:11 UT photographed by Jesper Grønne, Silkeborg, Denmark (http://groenne.eu/).



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# Spectra of slow bolides

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The results for two atypical spectra of bolides are described together with their atmospheric trajectory and orbit. The first bolide is a member of the group "Na-free" meteoroids, the second bolide is characterized by a relatively low proportion of magnesium triplet emission lines (MgI).

## 1 Introduction

In the period from late December to mid-April there is no activity of a significant meteor showers, with the exception of January Quadrantids. The total activity of the meteor showers is therefore very low and also sporadic background is at a minimum of its activity during the year. In that period are mainly meteor showers active belonging to the Antihelion source. Activity of the Virginid-Leonids complex prevails from January to March, this is transferred in April into the Scorpio-Sagittarids complex. The common characteristic of the meteors belonging to the Antihelion source is the relatively low geocentric speed which lies for most meteors from this source between 20 and 30 km/s. During this period, at the turn of 2015 and 2016, two spectra of very slow fireballs belonging to the sporadic background were recorded by the spectrographs at the Valasske Mezirici Observatory. For these slow meteors the observed spectrum is very extensive, often including more than 20 frames taken during the flight of a meteor. In this case it was the same, the spectrum of the bolide 20151230_222303 comprises a total of 21 frames with recorded spectrum, in the case of the bolide 20160326_222333 it were 19 frames. Both spectra were recorded on a spectrograph with the designation VM_SW (southwest camera) installed at the Valasske Mezirici Observatory.

## 2 Equipment and data analysis

Spectrographs VM_NW (northwest camera) and VM_SW (southwest camera) were put into operation during October 2015. The QHY5LII-M camera is equiped with a 1/3" CMOS chip Aptina MT9M034 with an effective resolution of 1280 × 960 px (Koukal et al., 2016). The field of view is 80° × 60° (spectrograph VM_SW) and 89° × 67° (spectrograph VM_NW), the systems use fast Tamron megapixel lenses (F/1.0) with a variable focal length (3–8 mm). FOV and resolution of the CMOS chip enables the use of holographic diffraction grating with a density of 1000 lines/mm. In this configuration the spectrograph reaches a stellar limiting magnitude +4.5m, the faintest recorded meteors then have a relative magnitude up to +2.0m. The magnitude for meteors with a measurable spectrum has to be at least -2.0m. Detection of meteors is done by UFOCapture software[1], and for astrometric and photometric processing UFOAnalyzer software[2] (SonotaCo, 2009) is used. The resulting video is divided into individual images (frames), every image is subsequently a dark frame and flat field corrected with frames captured by the cameras QHY5LII-M. Orbits of meteoroids in the solar system are calculated using the software UFOOrbit[3] (SonotaCo, 2009). The deceleration is derived from this software as an exponential fit of the actual speed of the meteor for each frame. Spectrograph calibration in the x-axis (wavelength) was performed using a calibration neon lamp. Calibration was performed as non-linear, using 6 multiplets of neon emission lines at wavelengths between 5852 and 7032 Å. The resulting basic spectrograph resolution was determined from 5 independent measurements at 9.7 Å/px (spectrograph VM_SW) and 10.8 Å/px (spectrograph VM_NW).

## 3 Bolide 20151230_222303 (SPO)

The bright bolide (assignment 20151230_222303 SPO) was observed on December 30, 2015 at $22^h23^m03^s$ UT. The network CEMENT (Central European Meteor Network) captured this phenomenon on two cameras, one was located in central Moravia (Valasske Mezirici Observatory – spectrograph SW) and one was in southern Slovakia (Senec). To calculate the atmospheric path of the bolide and the orbit of the meteoroid in the Solar system were used recordings from the stations Senec and Valasske Mezirici Observatory (spectrograph SW). The projection of the beginning of the atmospheric path was located at the coordinates N49.294° E16.632° near the village of Utechov (Czech Republic), the height of the bolide at this time was 77.0 kilometers above the Earth surface. The end of the projection of the atmospheric path was located at the coordinates N49.606° E16.648° near the village of Skocova Lhota (Czech Republic), the height of the bolide at this time was 41.4 kilometers above the Earth surface.

[1] "UFOCapture V2 Users Manual". http://sonotaco.com/soft/UFO2/help/english/index.html.
[2] "UFOAnalyzer V2 Users Manual". http://sonotaco.com/soft/download/UA2Manual_EN.pdf.
[3] "UFOOrbit V2 Users Manual". http://sonotaco.com/soft/UO2/UO21Manual_EN.pdf.

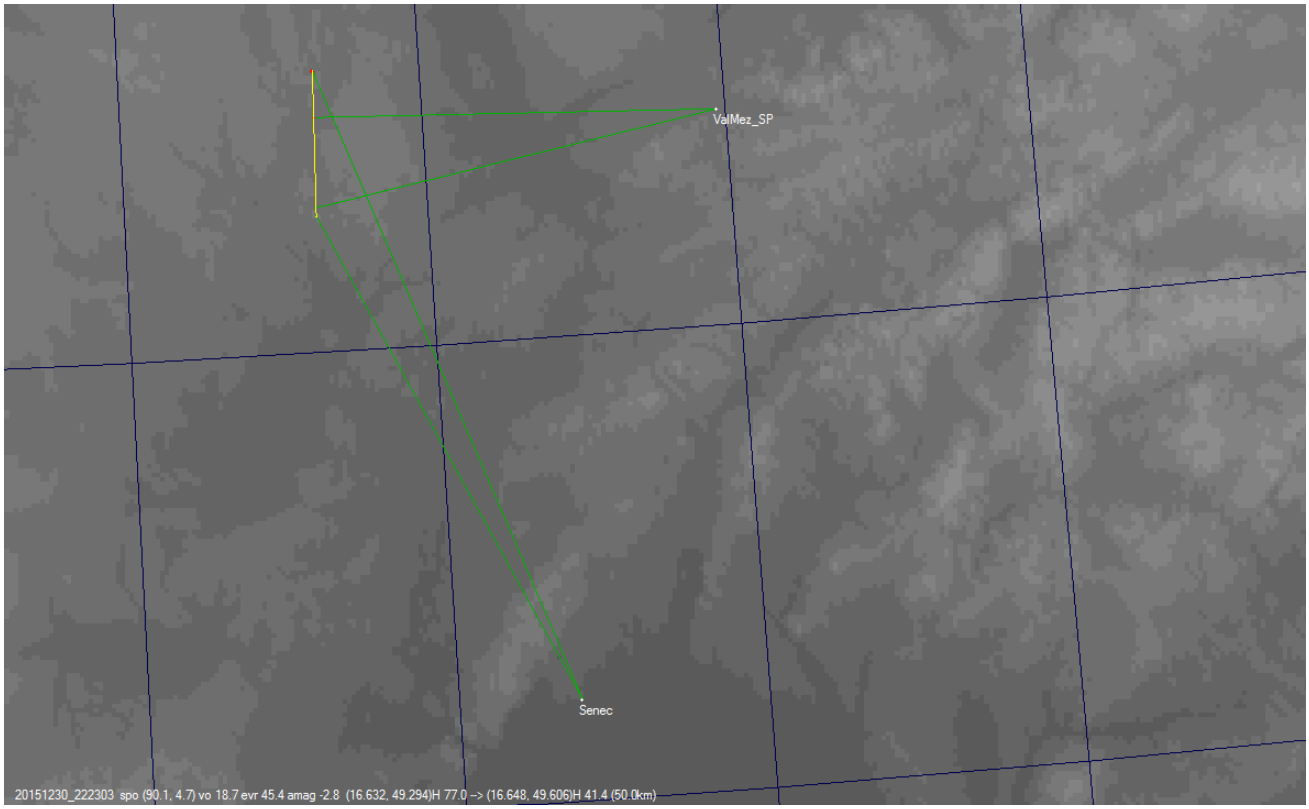
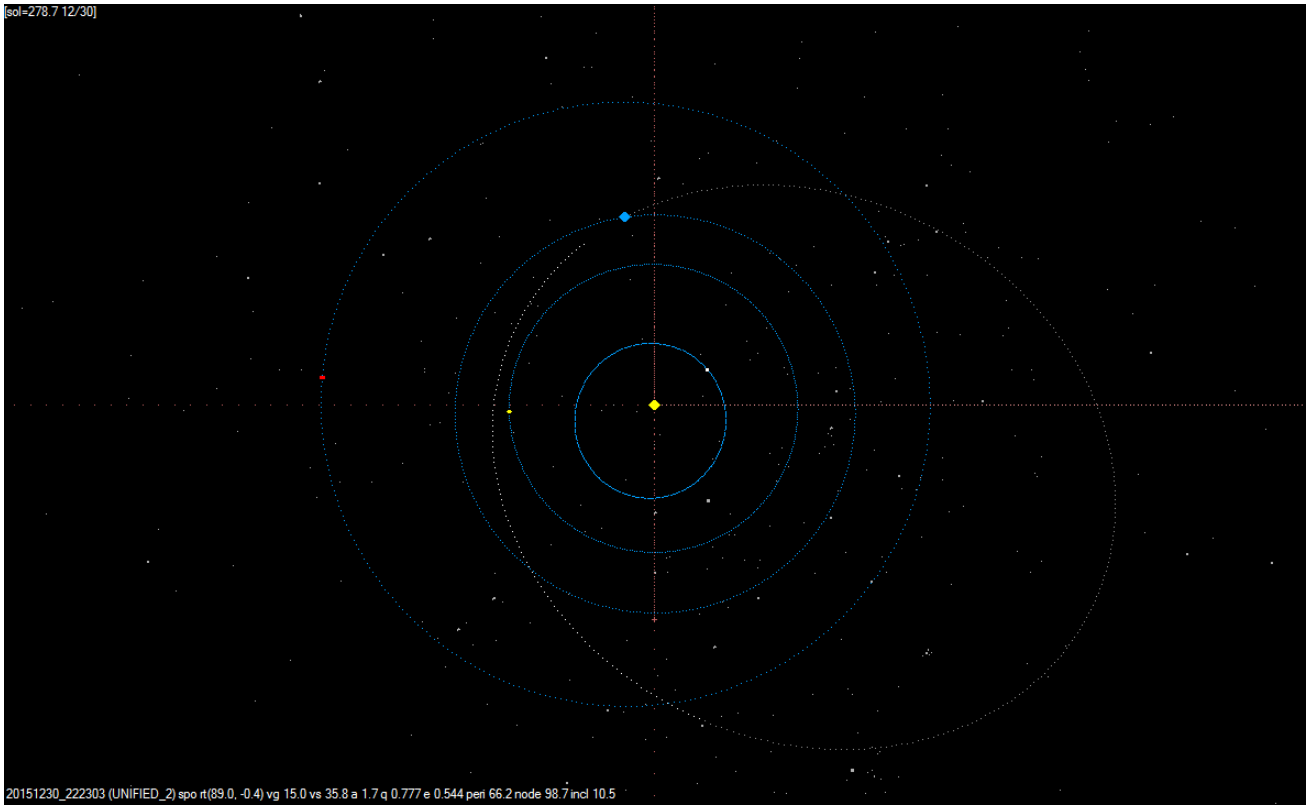



*Figure 1* – 2D projection of atmospheric path of the bolide 20151230_222303 to the Earth´s surface. (Author: Jakub Koukal).



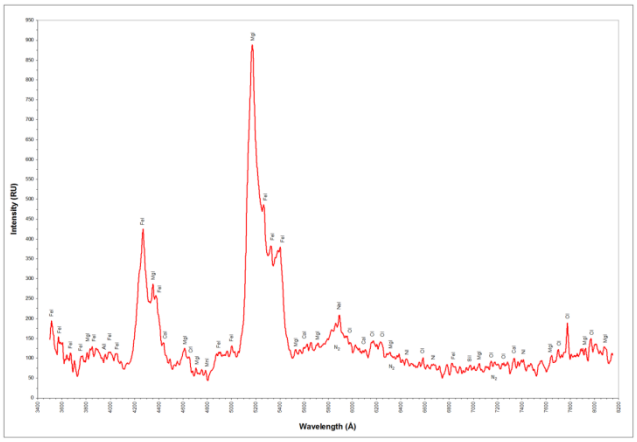

It was a very slow meteor, its geocentric velocity before entering the Earth's gravitational field was 15.00±0.03 km/s (including the effect of the deceleration). The orbital elements of the meteoroid´s orbit were as follows: a = 1.703 AU (semi-major axis), q = 0.777±0.001 AU (perihelion distance), e = 0.544±0.001 (eccentricity), i = 10.54±0.01° (inclination), ω = 66.21±0.02° (argument of the perihelion), Ω = 98.677° (longitude of the ascending node). The bolide was a sporadic meteor with as geocentric radiant RA = 88.9±0.1° (right ascension),

DEC = –0.4±0.1° (declination). The projection of the meteoroid orbit in the Solar system is shown above (*Figure 2*).

Emission lines of elements were identified in the calibrated summary spectrum of the bolide in the following representation – iron (FeI), magnesium (MgI), sodium (NaI), manganese (MnI), chromium (CrI), silicon (SiI) and a relatively weak line of calcium (CaI). The ratio of the emissions of elements belonging to the Earth´s ionized atmosphere against magnesium (N2/MgI, NI/MgI a OI/MgI) is low because this does not depend on the mass of the body, but on its speed. The ratio of the relative intensities of multiplets OI-1/MgI-2 is only 0.212. For meteor showers with a high geocentric velocity (eg. for Leonids and Perseids) this ratio usually exceeds 3 and often reaches values close to 6. The overall ratio of relative intensities MgI-2:NaI-1:FeI-15 is 0.389:0.082:0.528. The body can be characterized as a member of the group "Na-free", thus the group of bodies with very low or practically missing contents of sodium (NaI). The calibrated aggregated spectrum of the bolide 20151230_222303 is given below (*Figure 4*).

*Figure 3* – Combined spectrum image of the bolide 20151230_222303. (Author: Valasske Mezirici Observatory).




The emission lines of FeI multiplets are strongly represented, most to the maximum at a wavelength of 4271 Å with a relative intensity of 422.8 RU (observed wavelength), which corresponds to the emission lines FeI-42 (4272 Å – laboratory wavelength), as well as within multiplet FeI-15 with maxima at wavelengths of 5267 Å – 486.1 RU (5270 Å), 5327 Å – 382.7 RU (5328 Å) and 5404 Å – 379.8 RU (5406 Å). The highest relative intensity of the emission lines in the summary calibrated spectrum of the bolide has triplet MgI-2 with a peak at a wavelength of 5172 Å – 888.6 RU (5174 Å) followed by the emission lines of FeI-42 and FeI-15. Doublet of NaI-1 observed at a wavelength of 5892 Å – 208.9 RU (5893 Å) thus achieves a quite low relative emission intensity, comparable with a maximum of OI-1 observed at a wavelength of 7775 Å – 188.8 RU (7774 Å). An uncalibrated evolution of the bolide spectrum in selected frames is given below (*Figure 5*).

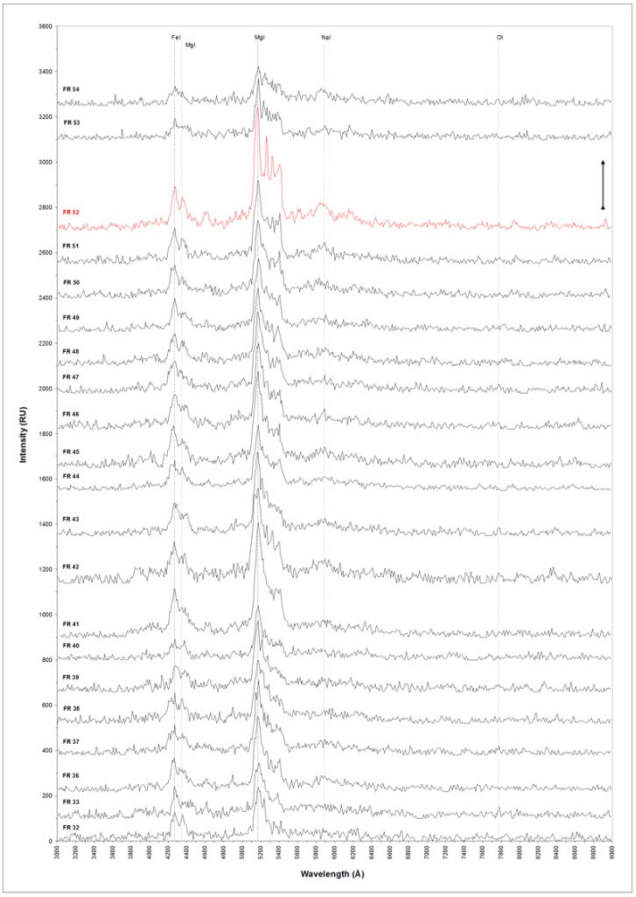



*Figure 5* – Uncalibrated evolution of the bolide 20151230_222303 spectrum in selected frames (range 3000-9000 Å). (Author: Jakub Koukal).

## 4 Bolide 20160326_222333 (SPO)

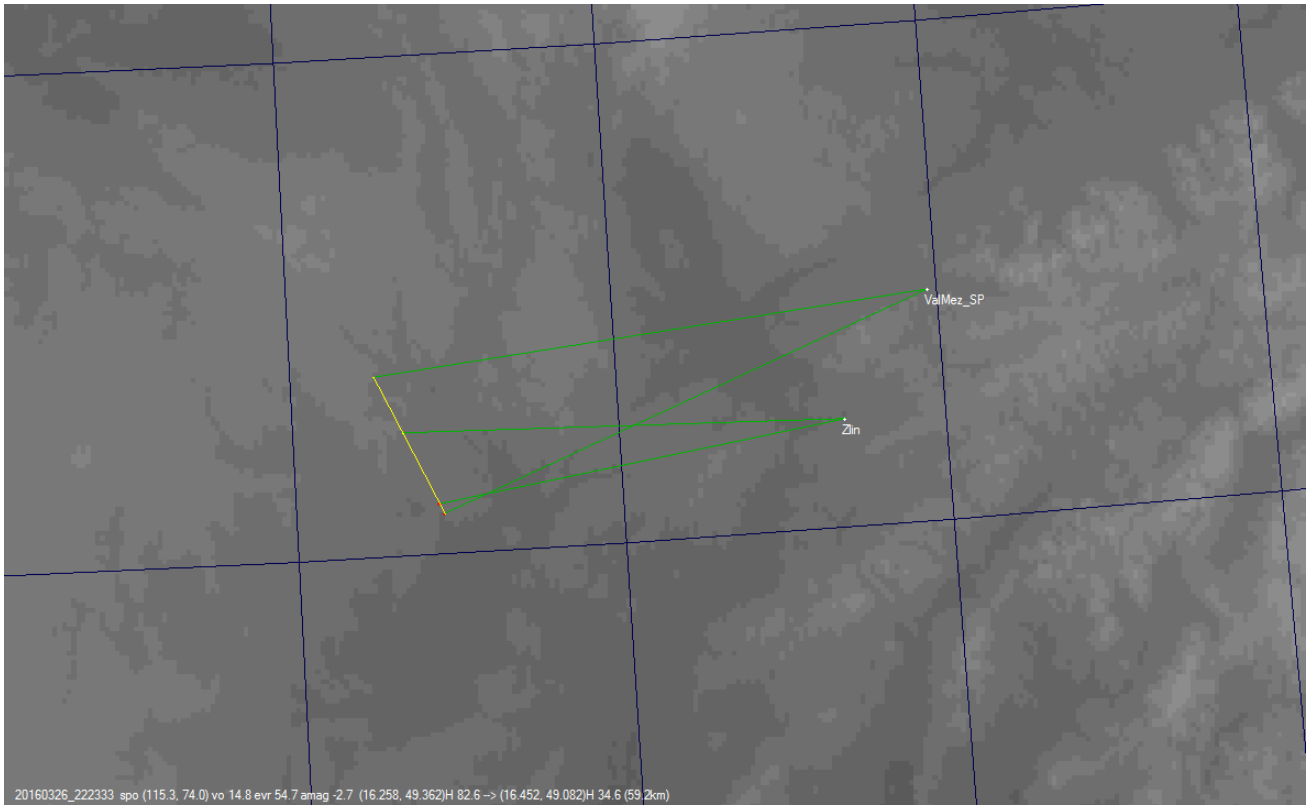



*Figure 6* – 2D projection of atmospheric path of the bolide 20160326_222333 to the Earth´s surface. (Author: Jakub Koukal).

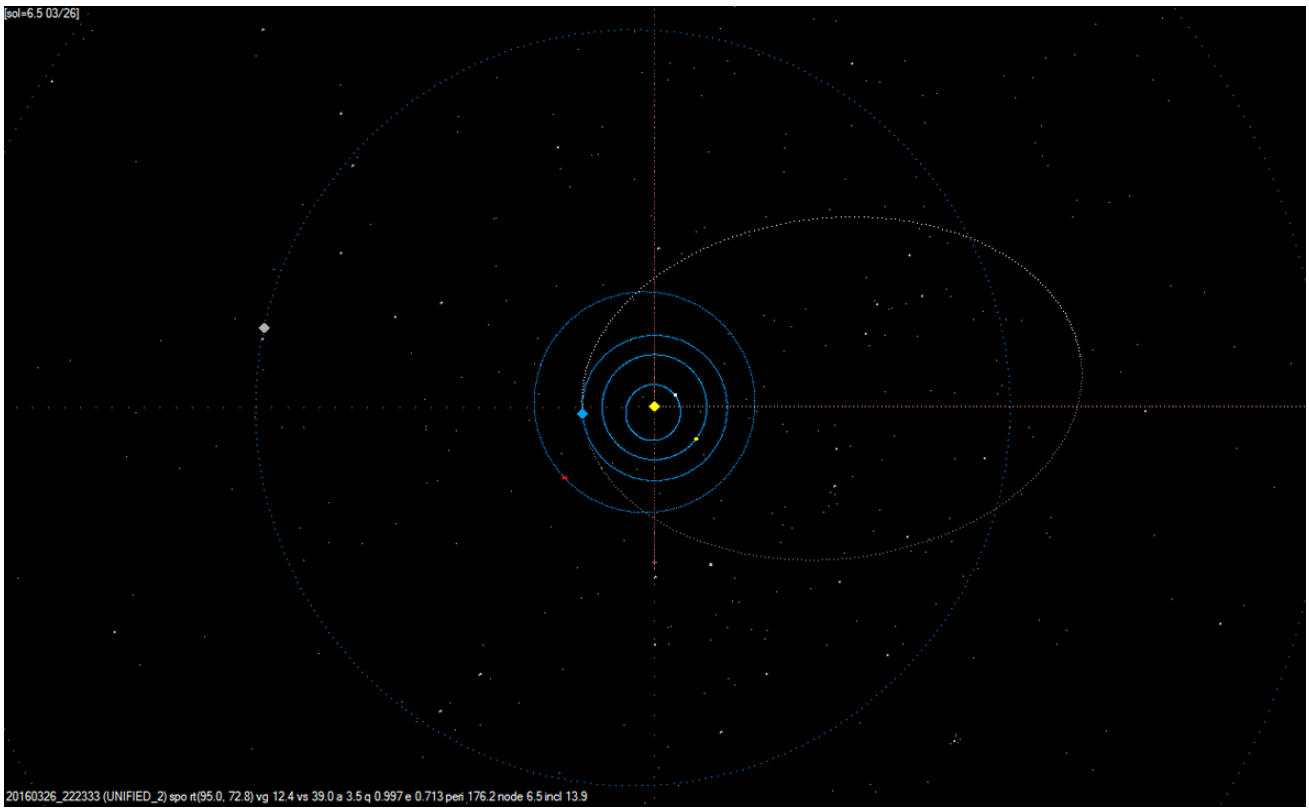



*Figure 7* – Orbit of the meteoroid in the Solar system, including the effect of deceleration. (Author: Jakub Koukal).

height of the bolide at this time was 82.6 kilometers above the Earth's surface. The end of the projection of the atmospheric path was located at coordinates N49.082° E16.452° near the city of Dolni Kounice (Czech Republic), the height of the bolide at this time was 34.6 kilometers above the Earth's surface. The bolide reached an absolute brightness -3.28m, an estimate of the input mass of the particle is 273.6 ± 39.7 g. The 2D projection of the bolide trajectory in the atmosphere is shown above (*Figure 6*).

a = 3.471 AU (semi-major axis), q = 0.997±0.001 AU (perihelion distance), e = 0.713±0.001 (eccentricity), i = 13.92±0.02° (inclination), ω = 176.16±0.03° (argument of the perihelion), Ω = 6.477° (longitude of the ascending node). The bolide was a sporadic meteor with as geocentric radiant RA = 95.0±0.2° (right ascension), DEC = 72.8±0.1° (declination). The projection of the meteoroid orbit in the Solar system is shown above (*Figure 7*).

Emission lines of elements were identified in the following representation in the calibrated summary spectrum of the bolide: iron (FeI), magnesium (MgI), sodium (NaI), manganese (MnI), chromium (CrI), silicon (SiI) and a relatively weak line of calcium (CaI) and titanium (TiI). The ratio of the emissions of elements belonging to the Earth´s ionized atmosphere against magnesium (N2/MgI, NI/MgI a OI/MgI) is low, the ratio of the relative intensities of multiplets OI-1/MgI-2 is 0.765, which in this case is also caused by low intensity of the multiplet MgI-2 emissions. The overall ratio of relative intensities MgI-2:NaI-1:FeI-15 is 0.150:0.375:0.475. Interesting is the high intensity of emission lines of the multiplet FeI-15. The calibrated aggregated spectrum of the bolide 20160326_222333 is given below (*Figure 9*).

*Figure 8* – Combined spectrum image of the bolide 20160326_222333. (Author: Valasske Mezirici Observatory).

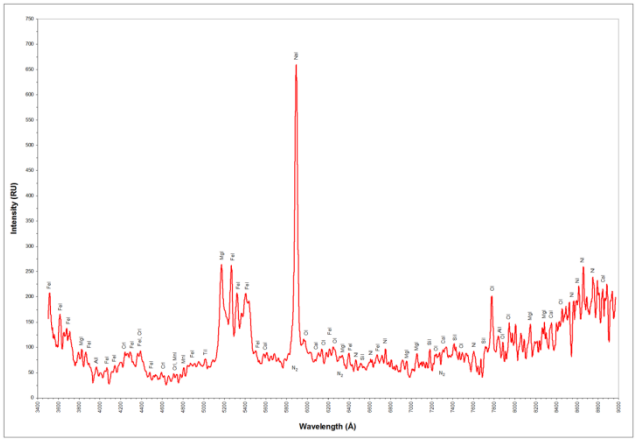
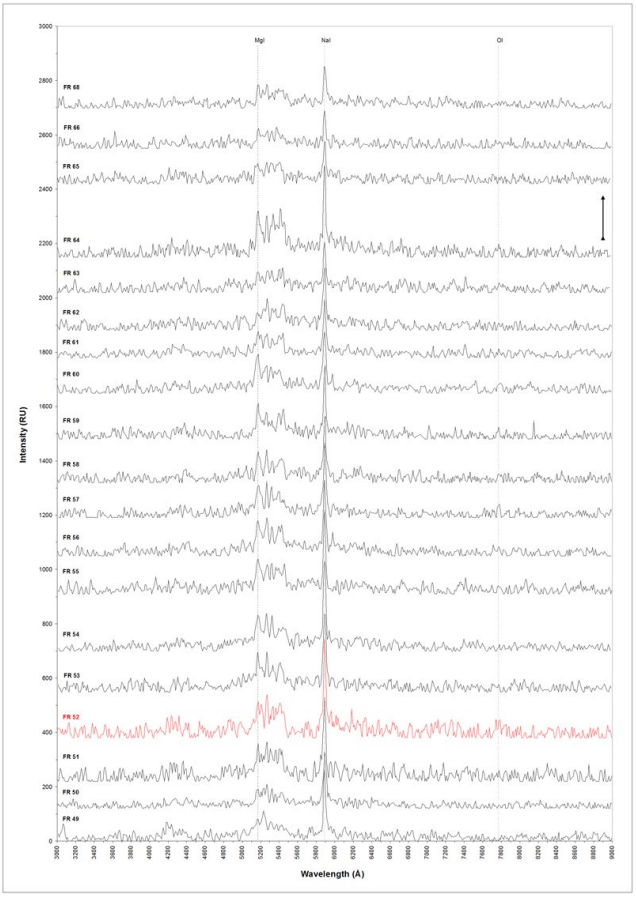



*Figure 9* – Calibrated spectrum of the bolide 20160326_222333 (range 3500-9000 Å). (Author: Jakub Koukal).




## 5 Conclusions

Both these spectra of bolides are quite untypical, the first one is characterized by low intensity of the emission line of sodium doublet (NaI) – so it is a member of the group "Na-free" meteoroids. The spectrum of the second bolide is characterized by a relatively low proportion of magnesium triplet emission lines (MgI), these emission lines reach an intensity comparable with the intensity of individual emission lines of the multiplet FeI-15. The

location of both spectra in the ternary diagram MgI-NaI-FeI is shown below (*Figure 11*).

## References

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

Koukal J., Srba J., Gorkova S., Lenza L., Ferus M., Civis S., Knizek A., Kubelik P., Kaiserova T., Vana P. (2016). "Meteors and meteorites spectra". In Roggemans P. and Roggemans A., editors, *Proceedings of the International Meteor Conference*, Egmond, Netherlands, June 2-5, 2016. IMO, pages 137–142.

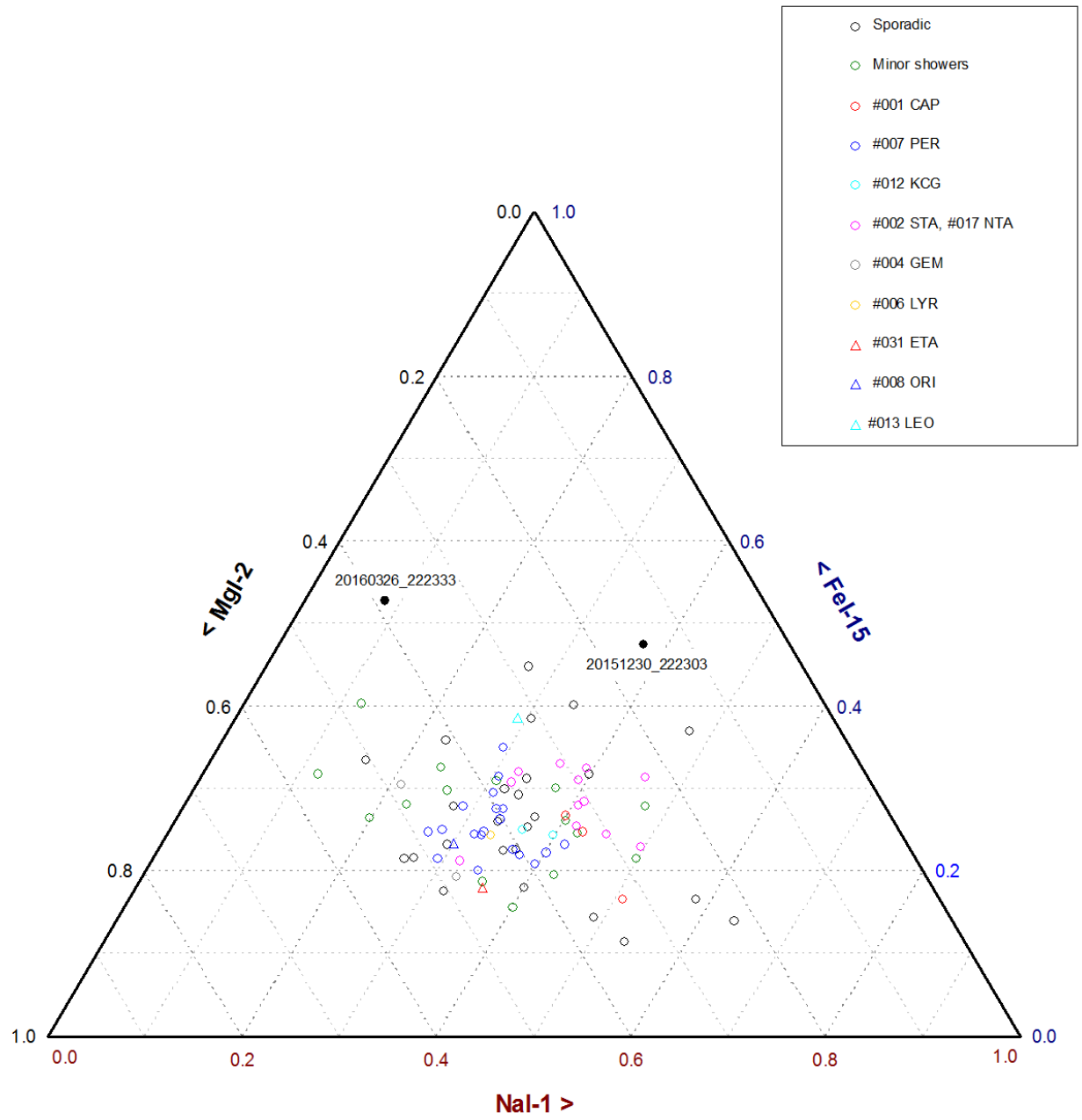



*Figure 11* – Ternary diagram MgI-NaI-FeI of all spectra recorded at the Valasske Mezirici Observatory shows the position of both bolides. (Author: Jakub Koukal).

# Visual observing reports

**Paul Jones**

A summary of observing reports from autumn.2016 has been compiled.

## 1 Oct 22/23 2016 Orionid observations from North Florida

I'll piggyback on Brenda Branchett's report on our rare opportunity to observe the 2016 Orionids side by side at hers and Dave's lovely home in Deltona, Florida on Oct., 22/23 morning. Although we battled a 43% sunlit waning crescent moon high in the eastern sky, the Orionids did not disappoint us whatsoever! It was great to have some observing company again, too.

In addition to Brenda's 90 minutes of observing time summarized below, I managed 2 full hours and logged a total of 45 meteors altogether in that time – 28 Orionids, 2 South Taurids, 1 epsilon Geminid, 1 possible Andromedid and 13 sporadics. The cool, crisp and clear air reduced the atmospheric scattering of the moonlight and made sky conditions remarkably good for meteors.

As Brenda mentioned, the overall highlight of our watch was a splendid, deep yellow, -4 Orionid fireball that raced north across Auriga leaving a nice train behind it. Orionid fireballs are somewhat rare, so seeing a beauty like that made the watch, but it wasn't the only highlight. I also bagged a –2 Orionid low in the southern sky during the second hour and we both saw the possible Andromedid meteor low in the western sky cutting a slow path southward. It wasn't very bright, only about +3 magnitude, but its slow speed and radiant line up made me pretty darned sure it was one.

With all the hubbub over Hurricane Matthew and resultant clean up, I am hopelessly behind on reporting our meteor observations. Both Brenda and I have been out quite a bit in October, despite the obstacles as both the Orionids and Taurids have been active and producing nice activity all month.

## 2 Post maximum 2016 Orionid observations from North Florida – splendid!

I was able to get out again yesterday morning (Oct., 23/24, 2016) for two more very productive pre-dawn hours, checking out the post maximum activity of the Orionids. This time, I was back on the trusty "meteor roof" of my home on Crazy Horse Trail in St. Augustine, Florida. I figured with the moon still depressing the morning skies, there was no real reason to travel to a darker sky spot and I was pleasantly surprised at how well I was able to do from the roof, a mere thirty feet from my bedroom!

All told in the two hours (4:00 – 6:00 a.m.), I had a total of 64 meteors, with hourly Orionid counts of 14 and 26. I was lucky to catch a "mini-spurt" of Orionids in the second hour that almost doubled the count! The Orionids are great at having these mini-spurts in their activity levels and I've seen it several times from them in recent years. No other meteor shower does it quite like the Orionids do!

Here's my data:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- LMI: Leonis Minorids
- SPO: sporadics

Date: October 23/24, 2016 Observer: Paul Jones, Location: 5 miles southwest of St. Augustine, Florida, Lat: 29.84 N, Long:81.32W, LM: 5.8, sky conditions: 25% moonlight degradation, Facing: south.

0400 – 0500 EDT (0800 – 0900 UT), $T_{eff}$: 1.0 hour, no breaks

- 14 ORI: +1, +2(2), +3(6), +4(5)
- 1 STA: +3
- 1 EGE: +1
- 7 SPO: +1 +2, +3(3), +4(2)
- 23 total meteors

6 of the 14 ORIs left visible trains, most common colors were bluish white and yellow in the brighter ones.

0500 – 0600 EDT (0900 – 1000 UT), $T_{eff}$: 1.0 hour, no breaks

- 26 ORI: -1, +1, +2(4), +3(11), +4(7), +5(2)
- 2 STA: +2, +3
- 2 EGE: +2, +4
- 1 LMI: +3
- 10 SPO: 0, +1, +2(2), +3(4), +5(2)
- 41 total meteors

11 of the 26 Orionids left visible trains and once again the most observed colors were bluish white and yellow.

For several reasons, the Orionids are my favorite of the annual major meteor shower to observe and have been since the 1970s. First of all, they are pieces of arguably the most famous comet in the history of astronomy – Halley's Comet! Second, they are by far the most challenging of the major showers to observe successfully due to the

faintness of their meteors and the wee hours in which they finally "switch on" their activity level.

But mostly, it is because they usually occur right about the time when we get that first cool snap of the fall season that brings in chilly, crisp and very clear nights with the winter constellations blazing away in all their glory in the pre-dawn and a sky full of faint and short Orionids glittering like sparkling little diamonds against the jet black skies. I look forward to the Orionids all year, and in 2017 they hit at New Moon – YAY!!

## 3 Tuesday morning's (Oct., 24/25 2016) Orionid observations from North Florida

I'm still trying to play catch up on reporting all the meteor observations Brenda and I made this week for the post maximum of the 2016 Orionid Meteor Shower. This report is for our watches on Tuesday morning, Oct.,24/25, 2016. Once again that morning, sky conditions were excellent despite the waning moon still affecting the sky somewhat.

Brenda got in one hour and I managed two hours from up on the home "meteor roof" and we both had Orionid rates in the double digits before morning twilight, plus a host of other contributors also!

Here's my results:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- LMI: Leonis Minorids
- SPO: sporadics

Date: Oct., 24/25, 2016. Observer: Paul Jones, Location: 5 miles southwest of St. Augustine, Florida, Lat: 29.84 N, Long:81.32W, LM: 5.8, sky conditions: 20% moonlight degradation, Facing: south.

0410 – 0510 EDT (0810 – 0910 UT), $T_{eff}$: 1.0 hour, no breaks

- 12 ORI: 0, +2(2), +3(4), +4(4), +5
- 1 STA: +1
- 1 EGE: +2
- 10 SPO: +2(2), +3(6), +4(2)
- 24 total meteors

3 of the 12 ORIs left visible trains, most common colors were bluish white and yellow in the brighter ones.

0510 – 0610 EDT (0910 – 1010 UT), $T_{eff}$: 1.0 hour, no breaks

- 15 ORI: -1, +1, +2(3), +3(4), +4(5), +5
- 2 STA: +2, +4
- 1 EGE: +1, +
- 2 LMI: -1, 0
- 8 SPO: 0, +1, +2(2), +3(4), +5(2)
- 28 total meteors

4 of the 15 Orionids left visible trains, as did both LMIs, the EGE and 1 STA, once again the most observed colors were bluish white and yellow.

There were many bright and beautiful meteors of all types flying around in the second hour this morning! It was great to catch two bright members of the Leonis Minorid Meteor Shower as well. This minor stream is active for a week only during the Orionids, but produces some nice, bright and long-pathed meteors in the last hour before dawn hits. I recall seeing a couple during last year's Orionids as well.

Here's Brenda's results from Deltona, Florida:

Sky conditions were not the best but got out anyway to check on activity.

Date:

October 25, 2016

Time: 4:45-5:45 a.m.

Sky Conditions: 4.0 magnitude visible. Some cirrus cloud and haze. 60 percent of sky visible.

- Orionids — 10
- Sporadics — 7
- S. Taurid — 1
- Total — 18

## 4 Oct. 25/26, 2016 (Wednesday morning) Orionid observations from the "meteor roof"

I managed to get in 1.25 more hours Orionid observing in the pre-dawn on Wednesday morning from up on the meteor roof of my home in St. Augustine, Florida before low flying clouds rolled in quickly off the ocean and shut me down.

Although it was evident that the Orionids are ramping down a bit, they still were in the double digit range and I had yet another busy and enjoyable albeit abbreviated watch. Here's my data:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- LMI: Leonis Minorids
- SPO: sporadics

Date: Oct., 25/26, 2016. Observer: Paul Jones, Location: 5 miles southwest of St. Augustine, Florida, Lat: 29.84 N,

Long: 81.32W, LM: 5.8, sky conditions: 20% moonlight and cloud degradation, Facing: south.

0430 – 0545 EDT (0830 – 0945 UT), $T_{eff}$: 1.25 hour, no breaks

- 12 ORI: +1, +2(2), +3(4), +4(4), +5
- 1 STA: +1
- 2 LMI: 0, +1
- 12 SPO: +2, +3(5), +4(6)
- 27 total meteors

4 of the 12 ORIs and 1 of the LMIs left visible trains, most common colors were bluish white and yellow in the brighter ones.

Once more I had two lovely bright members of the Leonis Minorids grace the latter part of the watch and the ORIs just refuse to quit! Back at it again in the morning!

## 5 Oct. 26/27, 2016 (Thursday morning) Orionid observations from the "meteor roof"

Once again Mother Nature allowed Brenda and I one more good look at the descending branch of the 2016 Orionids in the pre-dawn, me from St. Augustine, Florida and Brenda from Deltona, Florida.. Our continued good luck in the weather department is amazing and much appreciated!

We each managed just one hour's time on this morning, but the Orionids continue to break double digits on their hourly rate! They simply will not quit it seems. Here's my data:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- LMI: Leonis Minorids
- SPO: sporadics

Date: Oct., 26/27, 2016. Observer: Paul Jones, Location: 5 miles southwest of St. Augustine, Florida, Lat: 29.84 N, Long: 81.32W, LM: 5.8, sky conditions: 20% moonlight and cloud degradation, Facing: south.

0515 – 0615 EDT (1015 – 1115 UT), $T_{eff}$: 1.25 hour, no breaks

- 11 ORI: +1, +2(3), +3(3), +4(3), +5
- 1 STA: +2
- 1 EGE: +3
- 2 LMI: -1, +1
- 9 SPO: 0, +1, +2, +3(3), +4(2), +5
- 24 total meteors

4 of the 11 ORIs and 1 of the LMIs left visible trains, most common colors were bluish white and yellow in the brighter ones.

This hour started dead slow, but kicked in well during the last few minutes. I had almost all the brighter meteors of all types hit in about the last ten minutes of the watch. It was a great mini-show at the end, I'm just glad I was awake enough not to miss it…;o).!

Here's Brenda's report for her hour down in Deltona:

A little later than usual, but got my hour in this morning.

Date: October 27, 2016

Time: 4:45-5:45 a.m.

Sky conditions: 4.0-4.5 magnitude. 75 per cent sky visible.

- Orionids – 9
- E. Gem –1
- Taurids –2
- Sporadics — 4
- Total — 16

Friday morning was clouded out, we'll try once again in the morning. So far for the entire year-to-date in 2016, I (Paul) have totaled 85 hours of meteor watching and recorded 2,804 meteors in all. I'm shooting for over 100 hours of observing for the entire year and hoping to top 3,000 meteors! The 2,804 I've recorded already in 2016 beats my previous personal best by a long shot. Hopefully, the weather and my stamina can hold out…;o).

## 6 Amazing Oct. 28/29 2016 Orionid observations from Matanzas Inlet, Florida

Finally, a day I did not have to commute or work and since the moon was out of the pre-dawn sky, I figured it was time to revisit trusty Matanzas Inlet, Florida (MI) for a true dark sky meteor watch. And I was not disappointed!

I got there just before 0430 EDT and was greeted by a pitch black sky blazing with the stars of the winter constellations and a lovely sea breeze on top of it. Before I get to the data, here are a few general observations from this memorable morning:

- it was sad and tragic to travel south on the "beach road" (A1A) below Crescent Beach as the almost entire 4.2 miles of highway down to Matanzas Inlet was piled high on either side of the road with folks furniture, mattresses, dressers, sofas, cabinets and tons of drywall – all ruined by the storm surge from Hurricane Matthew.
- our trusty parking lot observing site at the inlet was devoid of cars because Hurricane Matthew destroyed the boardwalk down to the inlet itself. No more flounder fishermen to share the morning with…:o(.

- despite a brisk easterly sea breeze, the post Matthew flock of mosquitoes found me and quickly distracted me from an otherwise perfect observing morning.
- Almost from the time I arrived, there was a sensational display of Zodiacal Light rising up from the eastern horizon through Leo and into Cancer, with a yellow diamond stud embedded in the middle of it (Jupiter)! It was an amazing sight that grew steadily brighter and by the time I wrapped up the two hour session, had actually begun to light up the sea spray around it in a ghostly glow that had me thinking I was actually in The Twilight Zone…;o). I mean, who ever heard of the Zodiacal Light virtually casting shadows!!?

The meteor activity was amazing as well as I counted a total of 65 meteors of all types in two hours under the razor sharp skies. The first hour (0420 – 0520 EDT) had an insane number of 36 meteors flash by, many of them too faint for me to ever have been able to see from the "meteor roof" back home. That kind of activity is why I risk the mosquitoes and the "no-see-um" gnats down at MI.

The second hour (0520-0620 EDT) saw slightly fewer numbers of meteors (29), but they got much brighter: I had a stunning -3 blue-white sporadic near-fireball light up and split the zenith, then later a lovely yellow, -2 late Orionid zipped through Cancer heading northeast. What a meteor morning it was!!

Here's the data:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- LMI: Leonis Minorids
- SPO: sporadics

Date: Oct., 28/29, 2016. Observer: Paul Jones, Location: north bank of Matanzas Inlet, Florida, 18 miles south of St. Augustine, Florida, Lat: 29.75 N, Long:81.24W, LM: 6.5, sky conditions: clear, Facing: west.

0420 – 0520 EDT (0820 – 0920 UT), $T_{eff}$: 1 hour, no breaks

- 13 ORI: +1, +2(3), +3(4), +4(3), +5(2)
- 4 STA: +3(3), +4
- 1 EGE: +3
- 2 LMI: 0, +2
- 16 SPO: +1(3), +2, +3(6), +4(5), +5
- 36 total meteors

2 of the 13 ORIs, 1 of the LMIs and 2 SPOs left visible trains, most common colors were bluish white and yellow in the brighter ones.

0520 – 0620 EDT (0920 – 1020 UT), $T_{eff}$: 1 hour, no breaks

- 10 ORI: -2, +2, +3(3), +4(2), +5(3)
- 2 STA: +1, +2
- 1 LMI: +1
- 16 SPO: -3, +1(2), +2(5), +3(2), +4(5), +5
- 29 total meteors

1 of the 10 ORIs, 1 of the LMIs and 2 SPOs left visible trains, most common colors were bluish white and yellow in the brighter ones.

The post maximum Orionids show no signs of quitting yet, they're like the Energizer Bunny of the meteor showers…;o). It never ceases to amaze me the difference a truly dark sky makes on seeing faint meteors. Even the tiny little fourth and fifth magnitude meteors are easy to spot and the bright ones are even more showy than they otherwise would be. As I write this, the skies are deep crystal blue and that can only mean one thing: I'll be out there in the morning once again, come 0430 EDT!!

## 7 Oct 30/31 2016 meteor observations from Matanzas Inlet, Florida

After a solid overcast night before last, this morning was the opposite – not a cloud in sight. Unless you count fog as being a cloud, because there were clouds of fog everywhere! Everywhere that is, except down at trusty Matanzas Inlet, Florida (MI)…;o).

I managed two more hours of beautiful dark sky meteor viewing this morning as the walls of fog piled up around the horizons in all directions, but hardly touched the skies above trusty MI! Seems like the inlets are the last places to be affected by the frequent fog this time of year (as long as it is not sea fog, that is…;o).

Looks like the Orionids are finally beginning to "power down" somewhat, as their rates fell below double digits per hour this morning, but were still quite evident indeed. I also had a couple of superb South Taurids and a spurt of sporadics in the second hour that included a gorgeous, –1 earthgrazer that shot slowly through 40 degrees of sky from Auriga, all the way over to northern Cassiopeia – what a stunner it was!

Here's what I saw:

Observed for radiants:

- ORI: Orionids
- AND: Andromedids
- STA: Southern Taurids
- EGE: epsilon Geminids
- SPO: sporadics

Date: Oct., 30/31, 2016. Observer: Paul Jones, Location: 5 miles southwest of St. Augustine, Florida, Lat: 29.84 N, Long: 81.32W, LM: 5.8, sky conditions: 20% moonlight degradation, Facing: west.

0415 – 0515 EDT (0815 – 0915 UT), $T_{eff}$: 1.0 hour, no breaks

- 7 ORI: 0, +1, +2(2), +3, +5(2)
- 4 STA: +2, +3(2), +4
- 1 EGE: +3
- 11 SPO: +2, +3(4), +4(4), +5(2)
- 23 total meteors

1 of the 7 ORIs and 2 of the 4 STAs left visible trains, most common colors were bluish white and yellow in the brighter ones.

0515 – 0615 EDT (0915 – 1015 UT), $T_{eff}$: 1.0 hour, no breaks

- 8 ORI: +2, +3(4), +4(2), +5
- 3 STA: +3, +4(2)
- 17 SPO: -1, 0, +1(2), +2(3), +3(4), +4(4), +5(2)
- 28 total meteors

None of the 8 Orionids left visible trains, but 3 of the SPOs did (especially the –1 earthgrazer that was visible on the sky for about five seconds (an amazingly long time for most meteors), the most observed colors were bluish white and yellow.

I've decided to face west these last few mornings to keep a better eye on the STAs as that radiant drops well into the west by the pre-dawn timeframe. Also, I'm watching to catch any additional ANDs that may show up as that radiant also is way over in the NW sky in the pre-dawn. So far however, no more of them have shown up after that one that Brenda and I saw on Sunday morning. More on the ANDs later – they are indeed a story waiting to be told!

The stunning -1 earthgrazer SPO was the "star of the watch" by far! An "earthgrazer" is caused by a meteoroid particle whose atmospheric entry point is on or very near the observer's visible horizon. The resultant meteor seems to skip along the atmosphere at a very shallow angle, much like a rock thrown low and flat to skip across water. The meteor is seen to last much longer in its trajectory, seems much slower in its velocity and it may often actually even skip in and out of the atmosphere. They are somewhat rare, but do occur every so often.

This particular one I saw this morning, just happened by chance to visually line up well with the Orionid radiant although it was decidedly NOT an Orionid because of that radiant's position high above the horizon. Radiants located high above the horizon rarely produce earthgrazers of the type I saw this morning. We call it a chance sporadic line up. Nonetheless, it was a very memorable meteor for sure! Please pardon my digression into "Meteors 101″…;o). Meteor watching is such as great way to learn overall visual observing techniques and concepts, not to the least of which: constellation recognition and basic positional astronomy.

The weather seems like it will cooperate for many mornings into the immediate future, so I anticipate many more opportunities to monitor the Taurids and the Andromedids going forward. Much more later…

## 8 Nov 21/22 2016 meteor observations from Matanzas Inlet, Florida – FIREBALL!!!

It truly amazes me how fast a normal, mundane meteor watch can turn into a memory for a lifetime, but it sure did for a very lucky yours truly last night/this morning from the glittering skies of trusty Matanzas Inlet (MI)! I was there to check out an obscure and little known minor shower called the Alpha Monocerotids (AMO). I didn't see even one AMO in the two hours I was out there, but what I did see kept me far, far away from the Complaint Department…;o).

I got there a bit before 11:00 p.m. to take advantage of the final two hours of dark skies before the waning crescent moon rose a bit before 1:00 a.m. I had been there about 20 minutes when at 11:18 p.m. EST, suddenly all of MI was lit up by a flash of intense orange light! I caught the source of the flash out of the corner of my eye and turned my head just in time to see the terminal burst of a stunning North Taurid (NTA) fireball fall into the southwest horizon in a shower of sparks! I estimate it was at least -8 in magnitude, perhaps even brighter! The initial flash was the brightest and it was slightly brighter than the terminal burst, but both flashes were magnificent and deep tangerine orange in color.

The awesome 360 degree, wide horizons at MI helped me greatly in seeing this beauty. The entire fireball played out less than ten degrees above the southwest horizon and was visible for maybe two seconds max. Virtually anywhere without almost perfect horizons would not have allowed this gem to have been seen directly. One might have caught the flash only, but the meteor itself would most likely have been hidden behind trees, buildings, etc. It reminded me of our recent Perseid group watch when we all saw the flashes of a Perseid fireball, but not the meteor itself. This time, I was lucky and the meteor hit just above my horizon. Beyond this stunner, I did catch a few other nice NTAs, here's my overall results:

Observed for radiants:

- AND: Andromedids
- NTA: North Taurids
- NOO: November Orionids
- AMO: Alpha Monocerotids
- SPO: sporadics

Date: Nov. 21/22, 2016, Observer: Paul Jones, Location: North Bank of Matanzas Inlet, Florida (about 15 miles south of St. Augustine, Florida), Lat: 29.75 N, Long: 81.24 W, LM: 6.8, Clear, Facing SE.

1100 – 1200 p.m. EST (0400 – 0500 UT), $T_{eff}$: 1.0 hour, no breaks

- 2 NTA: –8, +1
- 1 NOO: +2
- 8 SPO: +2(3), +3(3), +4, +5
- total meteors

The –8 NTA fireball left a short train and had an intense orange color in both of its two bright flashes.

1200 -1:00 a.m. EST (0500 – 0600 UT), $T_{eff}$: 1.0 hour, no breaks

- 5 NTA: –1, 0, +2, +3, +4
- 1 NOO: +2
- 9 SPO: +1, +2, +3(2), +4(4), +5
- 15 total meteors

The two brightest NTAs both left short trains and were bluish white in color.

Needless to say, the NTAs completely stole the show this morning! They had a good showing even above and beyond the stunning fireball. The November Orionids (NOO) are another minor shower of interest I plan to be out for in the nights ahead. They reach maximum on Nov., 28th near New Moon. The NOOs are medium in speed and look just like Geminid meteors which will also be kicking in here in a couple of weeks! This is an awesome time for meteor watching to be sure.

I had no gnats or mosquitoes bother me at all during this watch, just the gentle sounds of the waters of the inlet lapping at the bank and the waves breaking on the beach. I have a feeling that the NTAs might have another jewel or two like the one last night up their sleeve in the nights ahead. Would anyone like to join me out there? Company is quite welcomed…;o).

P. S. – This two hour watch officially put me over 100 hours of meteor observing for 2016 – 101 to be exact! My total number of meteors seen during that time has surpassed 3,100! It has been an incredible meteor observing year to be sure.

## 9 Nov 26/27 2016 meteor observations from Matanzas Inlet, Florida

Catching up on two recent pre-dawn meteor observing sessions: one yesterday morning with fellow ACACer Brenda Branchett at the Branchett home in Deltona, Florida and the other this morning from a windy Matanzas Inlet.

Brenda and I managed a brief watch from her and Dave's back yard yesterday morning (Nov 25/26, 2016) seeing some nice late Leonids and a few others in between patches of cirrus cutting across our field of view. I got in 1 1/2 hours observing time and totaled 12 meteors that featured three nice Leonids and Brenda got in one hour with 2 Leonids, 2 Taurids and 3 sporadics. It's always great to get a chance to co-observe with another "meteorphile" from time to time.

This morning, I was out once again at trusty Matanzas Inlet under less than perfect conditions with an 18 mile per hour NE wind blowing, but lovely dark and clear skies as always. I had 36 meteors total in a very busy 1 3/4 hours before the winds drove me away…;o). I found myself tracking seven different radiant sources scattered out all over the sky from horizon to horizon! Here's my data from this morning's session:

Observed for radiant:

- LEO: Leonids
- NTA: North Taurids
- NOO: November Orionids
- PSC: psi Cassiopeids
- HYD: sigma Hydrids
- PUP: Puppids-Velids
- PSU: psi Ursa Majorids
- SPO: sporadics

Date: Nov. 26/27, 2016, Observer: Paul Jones, Location: North Bank of Matanzas Inlet, Florida (about 15 miles south of St. Augustine, Florida), Lat: 29.75 N, Long: 81.24 W, LM: 6.8, Clear, Facing: west.

0400 – 0500 EST (0900 – 1000 UT), $T_{eff}$: 1.0 hour, no breaks

- 4 LEO: +1(2), +2(2)
- 2 PUP: +2(2)
- 2 PSU: +2, +3
- 1 NTA: +2
- 1 DPC:+2
- 1 HYD: +3
- 13 SPO: -1, 0, +1, +2(2), +3(4), +4(3), +5
- 24 total meteors

Two LEOs, 2 SPO and the DPC left a short train, yellow and blue tints were seen in the bright meteors.

0500 -0545 EST (1000 – 1045 UT), $T_{eff}$: 0.75 hour, no breaks

- 2 LEO: +2, +3,
- 1 NOO: +3
- 1 PSU: +2
- 8 SPO: 0, +2, +3(3), +4(2), +5
- 12 total meteors

One of the LEOs and one SPO left short trains and were bluish white in color.

It was a bit challenging trying to keep track of seven different radiant sources (plus sporadics) all in the sky at the same time, but it sure did keep me on my toes. As you can see from the data, all of them were producing as well. The LEOs continue to be active well past their Nov. 17 maximum. I have been seeing them all month long pretty

much! All told, I have recorded 51 LEOs in the 18 hours of observing I've done in the month of November and that is with the maximum pretty much mooned out this year. Not a bad showing from them at all!

Several of the minor radiants I'm currently tracking will reach maximum in early December and with the Geminids kicking in also, it promises to be a very busy couple of weeks coming up in the meteor department.

## 10 Dec. 10/11, 2016 meteor observations from Deep Creek, Florida – TOUCHDOWN

You know, I'm sure glad I have 60+ years' experience trying to figure out Florida weather. Most times I need every minute of it… especially during the Geminids! This morning was a case in point. When I awoke at 0230, it was perfectly clear. Ten minutes later, it was solid overcast. The clouds were coming in off the ocean, so I reasoned that if I went inland instead of to the coastal area, I might be able to get beyond them.

So, I decided to eschew trusty Matanzas Inlet, Florida and opted for the "potato fields" of the Hastings, Florida area instead – ending up at the Deep Creek Conservation Area. When I got there, it was mostly cloudy with the moon still up in the western sky. I hung out and in fifteen minutes most of the clouds melted away just in time for me to start my hour at 0400 a. m. And for the next two hours, I had one heck of a show put on for me in the meteor department!! Soon after, Brenda Branchett joined me down in Deltona, Florida and we stayed in touch via cell phone.

All told under the lovely dark skies in two hours, between 0400 – 0600 a.m., I totaled 80 meteors, with 48 of them being Geminids! I had a gorgeous -4 Anthelion/Taurid fireball and four negative magnitude Geminids during the watch and, Brenda and I caught a strange "double satellite" during the second hour. More on that later. Here's my data:

Observed for radiants:

- ANT: Anthelions
- GEM: Geminids
- EHY: eta Hydrids
- HYD: sigma Hydrids
- MON: Monocertoids
- PSU: psi Ursa Majorids
- XVI: Dec. chi Virginids
- DSV: Dec. sigma Virginids
- DLM: Dec., Leonis Minorids
- DAD: Dec. alpha Draconids
- SPO: sporadics

Date: Dec. 10/11, 2016, Observer: Paul Jones, Location: Deep Creek Conservations Area, Hastings, Florida (about 15 miles southwest of St. Augustine, Florida), Lat: 29.69 N, Long: 81.44 W, LM: 6.8, Clear, Facing: west.

0400 – 0500 EST (0900 – 1000 UT), $T_{eff}$: 1.0 hour, no breaks

- 28 GEM: -3, -2, +1(2), +2(8), +3(10), +4(4), +5(2)
- 2 HYD: +2, +4
- 2 ANT: -4, 0
- 1 DSV: +2
- 10 SPO: +1, +3(4), +4(4), +5
- 43 total meteors

The -4 ANT left an eight second long train through Hydra, both negative magnitude GEMs left short trains as did one SPO and the +2 DSV.

0500 – 0600 EST (1000 – 1100 UT), $T_{eff}$: 1.0 hour, no breaks

- 20 GEM: -1(2), 0, +1(2), +2(4), +3(7), +4(4),
- 2 HYD: +2, +3
- 1 EHY: +2
- 1 DSV: 4
- 1 ANT: 3
- 12 SPO: -1, +2(2), +3(2), +4(5), +5(2)
- 37 total meteors

Both negative magnitudes GEMs left short trains as did the -1 SPO., yellow and blue colors were seen in the brighter ones.

Brenda recoded 20 GEMs and 7 sporadics between 4:15 and 5:45 a.m. under hazy skies from Deltona, with a -4 Geminid fireball she caught low in the south. Great job under sub-par conditions, Brenda!

As if the GEMs and all the meteors didn't do enough to make this watch memorable, even the satellites kicked in with a rare sighting by Brenda and I of a strange formation of two satellites travelling across the sky in tandem about two degrees apart. I asked Brenda to check with Dave who knows some websites to check on satellite Passovers. Here is what he found out:

"So just to clarify what Brenda and yourself observed this morning was a spy satellite designated USA 229 the first one is listed as USA 228 DEB which turns out to be debris from the launch that apparently is caught in the same orbit and the second one was the actual satellite. Launched 04/17/2015 from air force western test range and listed under NORAD. You can go online and Google USA 229 and find out more, amazingly my search lead me to a website that allows you to track the satellite!"

All in all, was an amazing meteor watch and one that I really didn't think we were going to be able get in. Next up is a chance to see the "night after max" of the Geminids coming up on Thursday evening, when Geminid fireballs are frequently seen in the evening sky. If clear, I'll be out somewhere to check them out, even with the Full Moon shining away!

# Fireball events

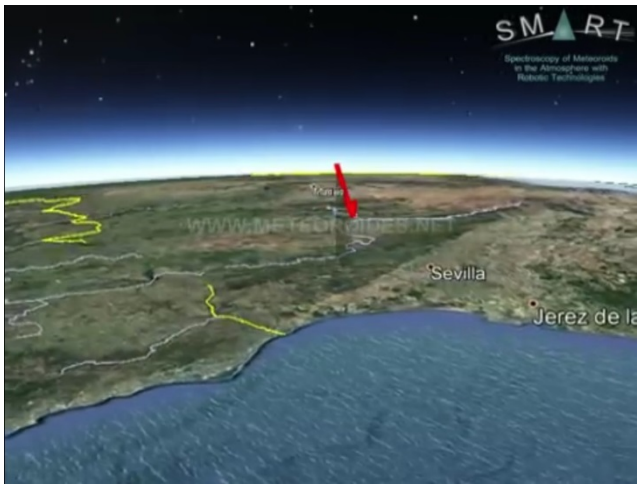
**Compiled by Paul Roggemans**

paul.roggemans@gmail.com

An overview is presented of exceptional fireball events which got covered in Meteor News during the period October – December 2016.

## 1 Large fireball after sunset, 29 September 2016

On September 29, a few minutes after sunset (at 18:47 UT), a very bright fireball was witnessed over the South of Spain. The preliminary analysis of this sporadic event reveals that it was produced by a rock that hit the atmosphere at about 90.000 km/h. The bolide began at a height of about 85 km and ended at an altitude of around 51 km[1].




## 2 Fireball over Espirito Santo-Brazil

On 20 October, two cameras of Exoss project – Vix1 and Vix3 station – registered a fireball crossing over the middle north of Espirito Santo State, in Brazil. It happened at 05:56:18 UTC, just one day before the Orionids shower peak.

https://youtu.be/2wfJ65EIIRM

## 3 Slow cometary fireball on Oct. 26 (at 23:57 UT)


This fireball was observed over the South of Spain on Oct. 26, at 23:57 UT (1:57 local time on Oct. 27). The event was produced by a sporadic cometary meteoroid that hit the atmosphere at about 94000 km/h. The fireball began at a height of 90 km over the province of Cordoba and ended at a height of 40 km over the Mediterranean Sea.

https://youtu.be/ryhUd9krCqg

Reported by Jose Maria Madiedo.

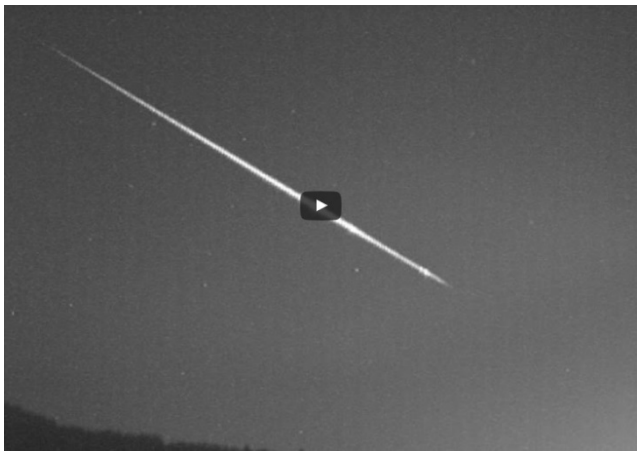
This video shows several fireballs recorded on 20-21 October 2016, during the peak of the Orionid meteor shower. These events are produced by fragments (meteoroids) from Comet Halley that hit the Earth's atmosphere. The images were obtained by several meteor

[1] https://youtu.be/PLjgiiJ6dJ0

stations of the Spanish Meteor Network that operate in the framework of the SMART Project.

https://youtu.be/ewi5FFvmXZk



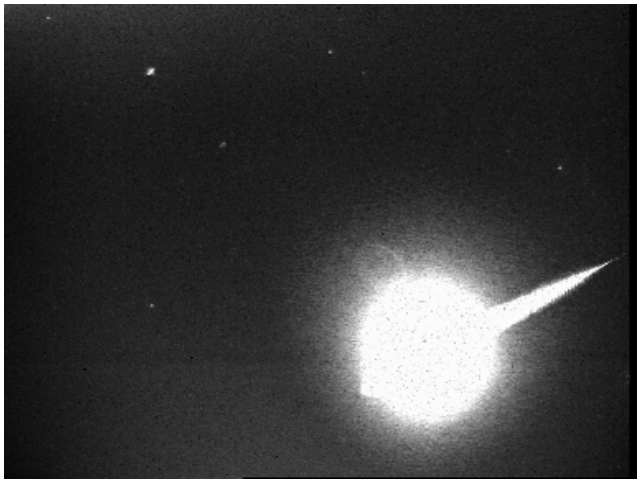
Reported by Jose Maria Madiedo.

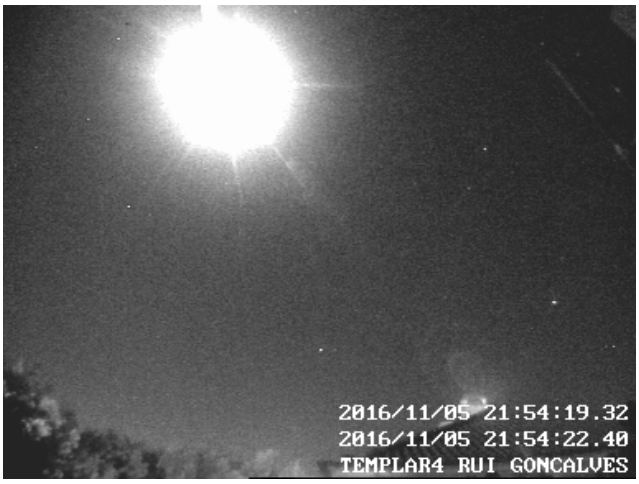
## 5 Giant fireball over Japan 31 October 2016

https://youtu.be/8JBVKOBvj8s

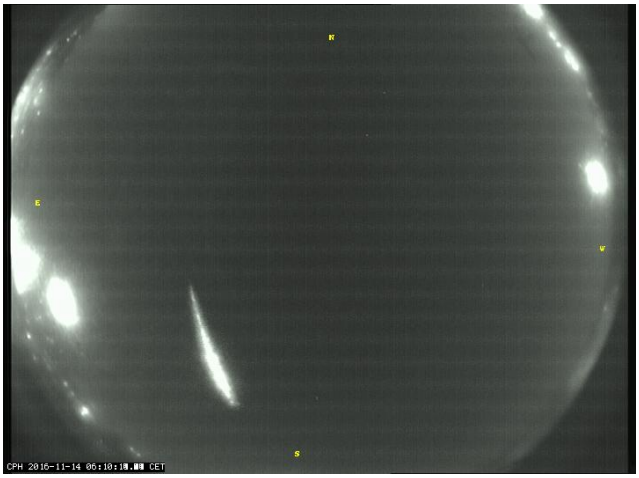
## 6 Huge Southern Taurid Fireball Over Portugal

An huge Southern Taurid with a magnitude estimated at –11, near full moon magnitude, entered the Iberian Peninsula atmosphere last 5th November. It was registered from Lisbon and Tomar PMN-Portuguese Meteor Network systems. Unfortunately J. Madiedo's system pointed to the Calculating its trajectory and velocity, Rui Gonçalves estimated a descending trajectory from 108 to 59 km with an initial velocity of 28 +/- 0.5 km/s, with is one of the STA characteristics. West and Lisbon was obstructed from dense clouds.




Reported by Carlos Saraiva.



A bright fireball has been photographed by the Danish camera network. The fireball started at about 89 km and ended at 42 km elevation, with a velocity of 34 km/s. The calculated radiant was R.A. = 230.5° and decl. = +51.4°. For more details see:

http://www.stjerneskud.info/fireball/event2016-11-14-06-10-13/.

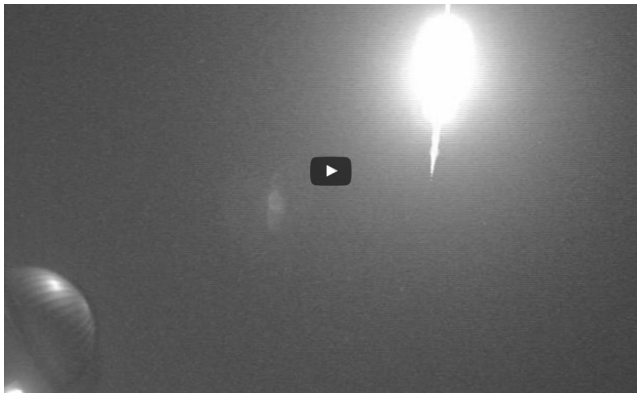
Camera in Copenhague, Denmark (video fragment).

The Fireball has been photographed from Brandenburg (Germany) too. See at the top of the image.

## 8 Fireball during the Super Moon on 15 Nov (at 2:55 UT)

Very bright fireball appeared over the South of Spain on 15 Nov. at 2:55 UT (3:55 local time). It belongs to the Southern Taurids meteor shower. The event took place during the Super Moon and was produced by a fragment from Comet 2P/Encke that hit the atmosphere at about 110.000 km/h. The bolide began at a height of about 108 km over the province of Granada and ended at an altitude of 60 km over the south of the province of Jaen.

https://youtu.be/qFjJ73ye68U



Reported by Jose Maria Madiedo.

## 9 Daytime fireball on 19 Nov. 2016 (at 6:33 UT)

https://youtu.be/q08t2lxGkUQ

Reported by Jose Maria Madiedo.

## 10 Stunning fireball on 18 Nov. 2016 (at 22:31 UT)

This amazing fireball overflew the Mediterranean Sea on 18 Nov. 2016 at 22:31 UT (23:31 local time). The event was produced by a meteoroid that hit the atmosphere at about 72000 km/h. The bolide began at an altitude of about 80 km above the sea level and ended at a height of around 60 km above the sea. The fireball was recorded in the framework of the SMART Project from the astronomical observatories of Calar Alto (Almería, Spain) and La Sagra (Granada, Spain).

https://youtu.be/nnIJFedRxgg

Reported by Jose Maria Madiedo.

## 11 Spectacular Fireball 28 November 2016

The Danish Camera Network captured a spectacular fireball over Southern Sweden on 2016 November 28 at 18h25m26s UT. It started as low as 64 km and ended at 32 km with a very low speed of 15 km/s. The radiant was located at R.A. 290.5° and decl. -26.8°.

For more information see:

http://stjerneskud.info/fb/event2016-11-28-18-25-26/

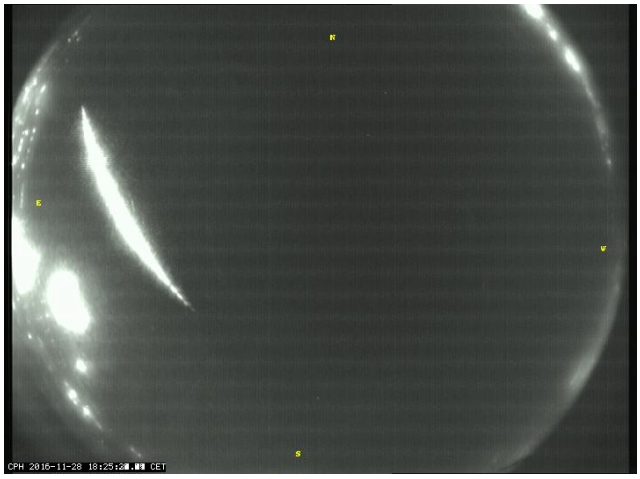
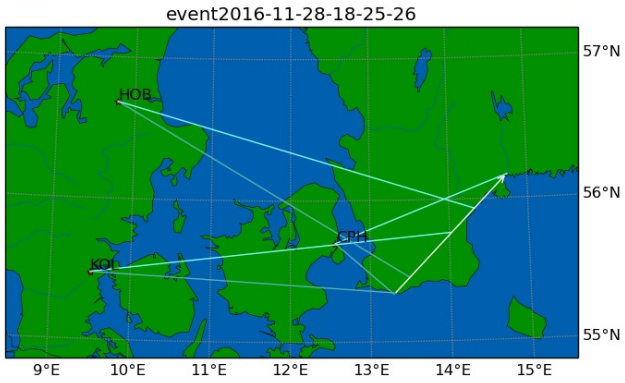
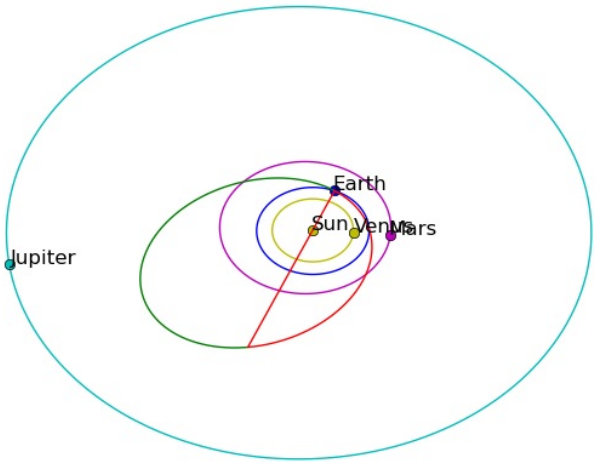


*Figure 1* – fireball on 18 Nov. 2016.



## 12 Fireball 6 December ~11h37m UT in Khakassia near Sayanogorsk (Russia)

A bright fireball and likely meteorite dropping is being reported from Siberia, in the Republic of Khakassia on 2016 December 6, at 18h37m local time (= 11h37m UT).

Eyewitnesses saw a flash followed two minutes later by vibrations and a rumbling noise was heard. This was strong enough to trigger car alarms to go off.

The following video compiles a few of the first released images: https://youtu.be/cO3WNzSejGY

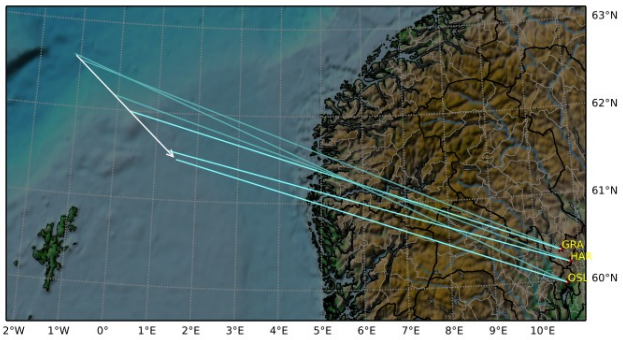
No fragments of any meteorites have been found so far: http://www.astrowatch.net/2016/12/siberian-meteorite-could-be-up-to-15.html

Reported by Galina Ryabova.

## 13 Norwegian fireball 2016 December 6

On the morning of 2016 December 6, at 4h15m (UT) a fireball lit up the sky over southern Norway. A ~ –17 magnitude fireball appeared over the Norwegian Sea. It was visible for 12 seconds and showed several explosions. Witnesses saw the fireball splitting into different parts.

The fireball was captured by three cameras of the Norwegian meteor network (Norsk meteornettverks) and the trajectory could be calculated as well as the orbit. The fireball started at 95.3 km and ended at 36.9 km at an entry velocity of 20 km/s. It is a sporadic with a radiant position at R.A. = 14.2° and decl. = +26.3°.




https://youtu.be/QUlUM7GNMg8

More information can be found:

http://norskmeteornettverk.no/meteor/20161206/041504/

## 14 Andalusia, December 11, at 21:25 UT

Awesome ball of fire from the night of December 11, at 22:25 local time. Flew Over Andalusia, specifically the provinces of Granada and Jaen.

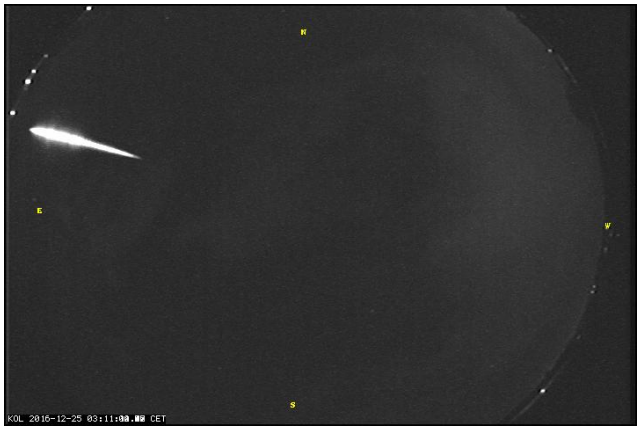
The event was recorded by the cameras that operate within the framework of the project smart from the observatories of the hita (Toledo), Calar Alto (Almeria), Sierra Nevada (Granada), La Sagra (Granada), Seville and Huelva. What caused the entry into the Earth's atmosphere of a rock from an asteroid at a speed of about 72 thousand km / h.

https://youtu.be/XXTEAXyXAb4

Reported by Jose Maria Madiedo.

## 15 December 25 Fireball over Denmark

A bright fireball has been photographed by four stations of the Danish Meteor network. It started at 83 km and ended at 31 km, moving at 20 km/s from a radiant at R.A. 81.2° and Decl. +23.6°.



http://stjerneskud.info/fb/event2016-12-25-03-11-10/

# CAMS BeNeLux September results

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A summary of the CAMS BeNeLux results for the month September 2016 is presented. A relevant number of orbits could be collected for a series of minor showers listed in the IAU Meteor Shower Database.

## 1 Introduction

The weather in September was very favorable for CAMS. Most stations could collect data with their systems for at least 29 nights. As a result, a total of 3982 orbits could be collected, among these several streams from the IAU meteor database (*Table 1*).

## 2 Some results

The shower (479) SOO (September Omicron Orionids) appears to be a by-product of comet P/Halley. The shower (81) SLY (September Lyncids) is listed in the IAU database with a peak at solar longitude 168° and 186°. From the September data it appears we got some shower members around the first peak.

On September 24th at 19:19 UT the 50000th orbit since the start of our network in March 2012, was confirmed.

Last year CAMS detected activity from Cygnus. We looked at the data whether this stream, (757) CCY, showed activity again. *Figure 1* shows all radiant positions in the period of (757) CCY – activity last year from a broad region around the theoretical CCY-radiant with orbital elements corresponding to the theoretical elements of this CCY-stream. It seems that activity from this stream was not substantial this year.

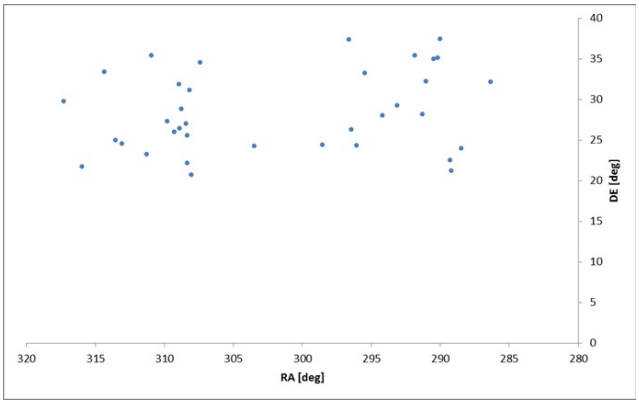


*Figure 1* – Radiant positions registered by CAMS Benelux for the period 1–23 September 2016.

| | | CAMS Benelux | | | | IAU database | | |
|---|---|---|---|---|---|---|---|---|
| | | # | $V_g$ | i | ω | $V_g$ | i | ω |
| 206 | AUR | 11 | 67,1 | 150,2 | 113,5 | | | |
| 208 | SPE | 77 | 64 | 139,2 | 245,3 | 64,5 | 138,9 | 241,9 |
| 210 | BAU | 11 | 65,2 | 142,8 | 197,7 | 66,5 | | |
| 216 | SPI | 34 | 28,2 | 6,8 | 132,3 | 27 | 6,9 | 127,3 |
| 219 | SAR | 20 | 36,2 | 16,4 | 321,2 | 36,5 | 18,9 | 324,9 |
| 416 | SIC | 10 | 52,1 | 94,8 | 215,2 | 50 | | |
| 424 | SOL | 5 | | | | | | |
| 430 | POR | 10 | 67,8 | 153,4 | 47,6 | 68 | 154,1 | 46,3 |
| 479 | SOO | 8 | 66,4 | 157,4 | 57,9 | 67,6 | 159,9 | 57,6 |
| 76 | KAQ | 5 | | | | | | |
| 81 | SLY | 11 | 60,3 | 117,4 | 120,3 | 61 | | |

 

# October Camelopardalis outburst model comparisons in the years 2005, 2016, 2017

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The predicted activity due to the one revolution dust trail is compared to the observed activity in 2016.

## 1 Introduction

This year is of special interest for the short lived OCT-shower, because according to the medium long period model, the calculated 1-revolution trail would pass quite close to the same place (relative to the Earth orbit) as in 2005. Unfortunately for us, here in Finland, the expected maximum time was before darkness. However, we paid attention with our Finnish Fireball Network to our fireball camera meteors and we had widely clear skies then. We captured about twenty probable OCT meteors, three of which were multi-station meteors. One of these, in absolute brightness around the fireball magnitude limit was captured by five stations. This yields a first class solar system orbit:

a= 347 A.U.
e = 0.9971 ± 0.0125
i = 78.7°
Ω = 192.66°
ω = 171.40°
q = 0.99436
P = 6459 Y

## 2 Long period model

The situation is very interesting for the long period model, because the modeled rD (trail solar distance in the descending node) happens to increase very little progressively in between the years 2005, 2016, 2017 by about (barely) 0.0002 AU in between 2005 and 2016 and with about a similar value (0.0002) in between 2016 and 2017. This situation is a favorable change, because in between these years the trail is far from this situation. The calculated course relative to the Earth orbit is shown in the graph (*Figure 1*). This calculation is based on an assumed ejection in the year 1255, but the result is only very weakly dependent on the assumed year, if the applied period is more than about 300 years.

## 3 The 2016 OCT outburst

And there really was an outburst, as seen for example in the Japanese radio results:

http://meteornews.org/2016-october-camelopardalids-radio-results/

And the last graph of 10 minute recordings in this link is of special interest:

http://www5f.biglobe.ne.jp/~hro/Flash/2016/OCT/index.html

Read also:

http://www.cbat.eps.harvard.edu/iau/cbet/004300/CBET004329.txt.

A maximum peak with the duration of well less than half an hour appears to have been observed about exactly at the predicted time.

I expect this to be the encounter of the actual core of the 1-revolution trail. Otherwise it is not very clear to me in what degree the more wide peak in this and earlier years has been of the 1-r trail as compared to the filament expected to have formed by a few other trails of previous revolutions.

The exact location of the 1-r core is still not exactly known. In the graph, this was adjusted to fit exactly in this year. But we do not yet know what will happen next year. It could be possible that we encounter an even more strong very short maximum peak or otherwise about the same as in this year or maybe practically none of this. By comparing these three encounters (2005, 2016 and 2017) it is expected that the position of the actual 1r-trail will get more precisely pinpointed. Hence, this repeating situation in these years is very interesting and favorable to study.

## 4 Next year and beyond

Next year, the timing is suitable in the evening of Oct. 5, but the Moon will be almost full. In the graph and in the values for the calculated miss-distance, the Earth orbit radius from the Sun ($r_E$ = radii at the encounter position) has been assumed to be the same as in this year. Further checks on this can be made and applied, probably at least with the final analysis of the 2017 results that we hope to obtain.

I also note that in years with no favorable encounter of the actual dense 1-r trail, the filament is also expected to "move" roughly according to the graph and so the best

solar longitude for each year can be taken from this graph.
The total change in this is quite small.

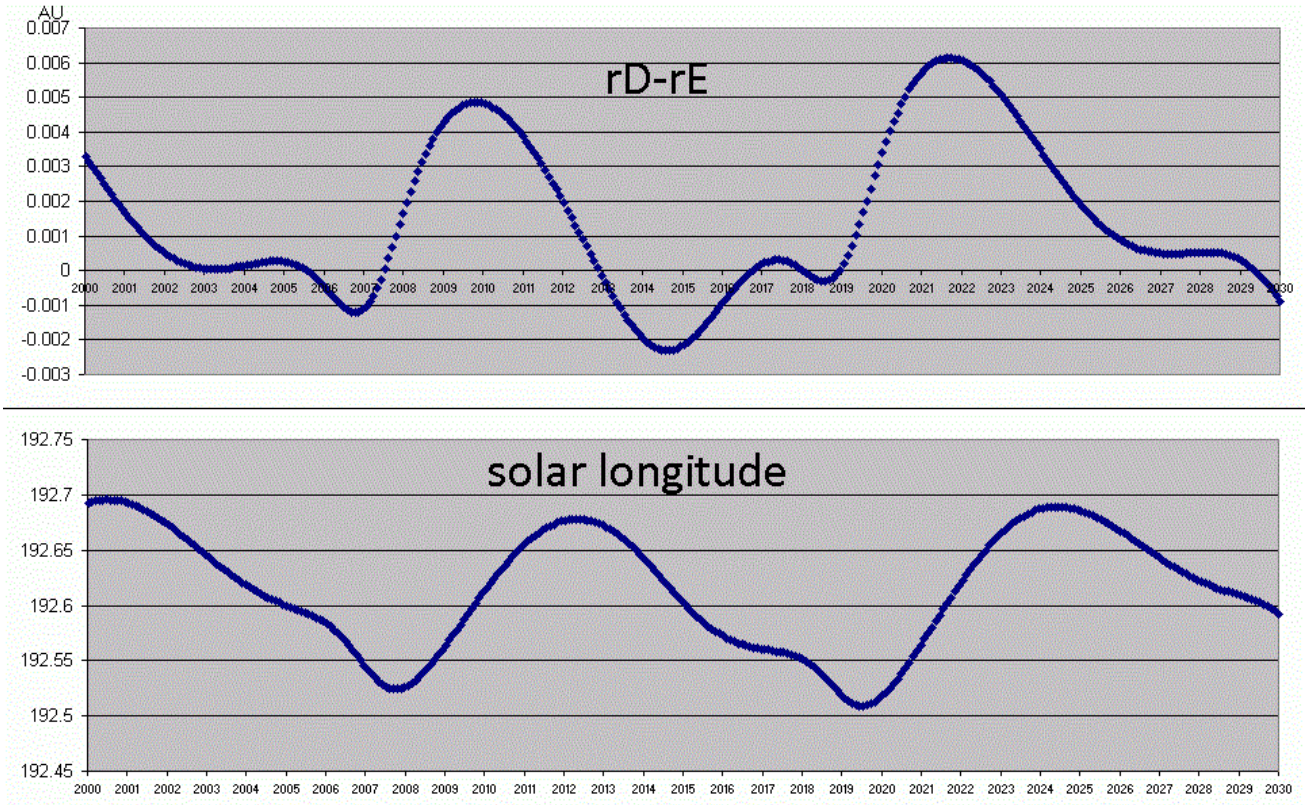


*Figure 1* – The calculated course relative to the Earth orbit.

 

# CAMS Benelux contributed 4 OCT orbits

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A summary of the CAMS Benelux observations of the October Camelopardalids (281 OCT) is presented.

## 1 Introduction

In good agreement with a prediction by E. Lyytinen, several video- and radio networks all over the world detected activity of the October Camelopardalid meteor shower ((281 ) OCT) on the 5th of October 2016, centered at ~ 14:45 UT.

## 2 The observations

CAMS BeNeLux captured four members of this stream in the early evening. Stations in the most eastern parts of the BeNeLux captured the first OCT at 17:48:57 UT (*Figure 1*, Martin Breukers / Hengelo and Carl Johannink / Gronau).

*Figure 1* – CAMS 321 Hengelo 2016 Oct 05 17h48m57.49s UT (Martin breukers).


*Figure 2* – CAMS 391 Mechelen 2016 Oct. 05 18h55m18.59s UT (Luc Gobin).


*Figure 3* – CAMS 365 Alphen a/d Rijn, 2016 Oct. 05 22h01m02.78s UT (Robert Haas).


*Figure 4* – CAMS 389 Mechelen 2016 Oct. 05 22h01m02.78s UT (Paul Roggemans).

The last OCT was captured at 22:01:03 UT by Robert Haas, Martin Breukers, Klaas Jobse and Paul Roggemans (*Figure 4*).

Median geocentric radiant position and mean orbital elements of these four OCT meteors are in good agreement with values given by P. Jenniskens in CBET 4329.

This is another example that even in areas with only moderate climate conditions over the year, CAMS can provide valuable results.

 

# CAMS Benelux Orionids results

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A summary of the CAMS Benelux observations of the 2016 Orionids is presented.

## 1 One successful night!

Nearly all participants in the CAMS BeNeLux network had clear skies during the night October 22/23. More than 300 meteors were captured simultaneously that night.

Apart from the well-known Taurids, Orionids and Leo Minorids, we observed some other minor showers (see *Figure 1*).

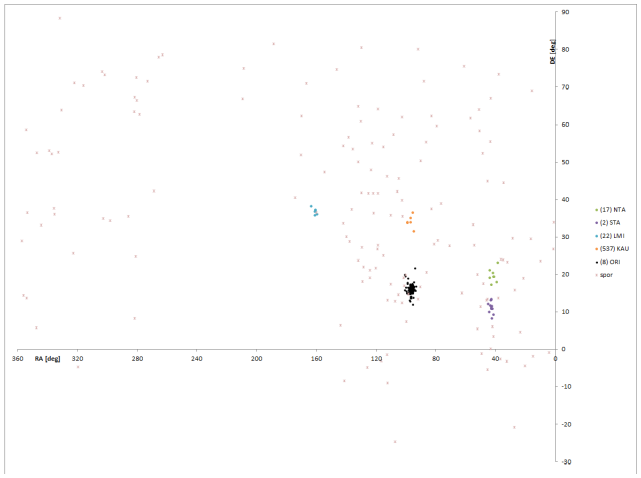


*Figure 1* – Plot with all the radiants of the double station meteors of 22-23 October 2016.

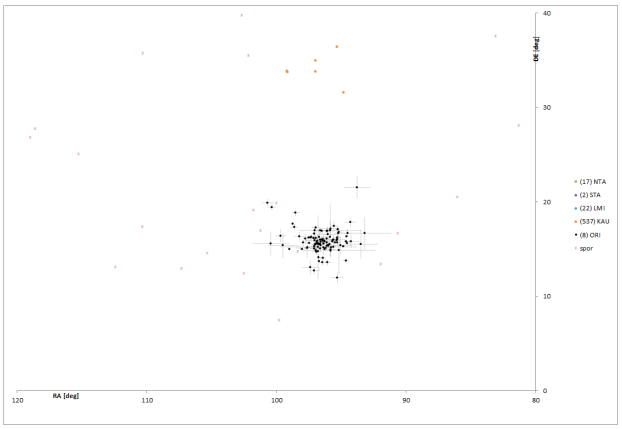


*Figure 2* – Close up of the Orionid radiants obtained on 22-23 October 2016.

Not all of them are shown in *Figure 1*, e.g. one epsilon Geminid ((23) EGE) and one October Ursae Minorid ((241) OUI) were captured by two or more of our stations.

Outstanding of course were the Orionids, as can be seen in *Figure 1* and in detail in *Figure 2* (with errors in radiant position shown).

 

# CAMS New Zealand survived earthquake!

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## 1 Earthquake in New Zealand

A strong earthquake occurred in New Zealand, but the two CAMS stations are functioning normal without any damage. The earthquake caused most damage north from the CAMS stations. Another, but very good news from CAMS@New Zealand is that a technical improvement had a significant gain in the number of orbits captured since April this year (see *Figure 1*).

## 2 More CAMS news

The CAMS project started in 2010 with the first stations in California. The professional CAMS stations got soon coverage from Californian amateur volunteers. In 2012 CAMS@benelux got started, covering meteor activity during Californian daylight hours. More CAMS coverage followed in 2014 with CAMS@Florida and CAMS@Mid Atlantic, but managed by the enthusiasm of amateurs, while CAMS@New Zealand started as a professional project. Meanwhile CAMS projects have been successfully set up in Arizona and in the United Arab Emirates. With an annual yield of over 100.000 accurate meteor orbits per year, collected at the northern and southern atmosphere on an almost 24h on 24h basis, CAMS will rewrite meteor astronomy in the years to come.

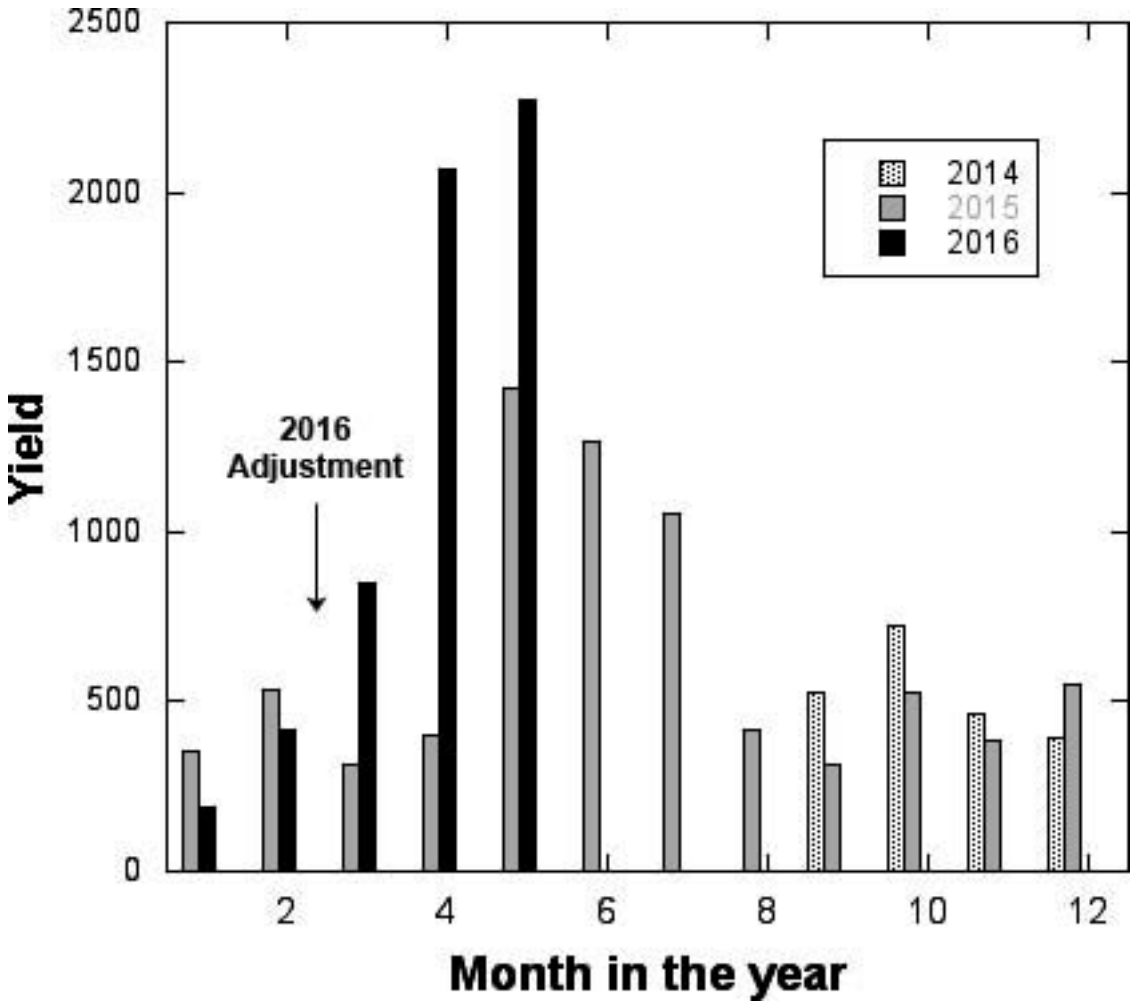


*Figure 1* – Monthly yield in number of orbits for CAMS @ New Zealand.

# Meteor activity from 2001XQ on 2-3 December 2016?

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## 1 Call for observations

The minor shower 66 Draconid (541 SDD) which was discovered by the Croatian Meteor Network (Šegon et al., 2014) has a mean orbit based on 43 meteors, similar to the orbit of 2001 XD. The asteroid 2001 XD has an orbit typical for Jupiter family comets and therefore may be a dormant comet. The shower activity ranges from November 23 until December 21.

*Table 1* – The orbital data

| Source: | 541 SDD | 2001 XQ |
|---|---|---|
| S.L. | 255.2 | |
| RA | 302 | |
| Decl. | 62 | |
| $V_g$ | 18.2 km/s | |
| q | 0.981 | 1.035 |
| e | 0.657 | 0.716 |
| ω | 184.8 | 190.1 |
| Ω | 255.2 | 251.4 |
| I | 27.2 | 29 |

According to Jérémie Vaubaillon there is a reasonable good encounter factor (0.67, see for more information the recent paper Vaubaillon, 2016) indicating a possible enhanced activity on December 2 (~21h30m UT) and December 3 (~7h UT), from a radiant at RA = 310° and decl. = +64°. These meteors are very slow moving with an entrance velocity of 21 km/s.

All meteor observers are encouraged to pay attention to any possible meteors from this source, although no outburst or any anything spectacular has to be expected.

## References

Šegon D., Gural P., Andreić Ž., Skokić I., Korlević K., Vida D. and Novoselnik F. (2014). "New showers from parent body search across several video meteor databases". *WGN*, **42**, 57–-64.

Vaubaillon J. (2016). "A (revised) confidence index for the forecasting of meteor showers". In Roggemans A. and Roggemans P., editors, *Proceedings of the International Meteor Conference*, Egmond, the Netherlands, 2-5 June 2016. Pages 302–303.

 

# Stabbing the Dragon with some enhanced activity

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The attempt to confirm the predicted activity for the minor shower 66 Draconid (541 SDD) was negative but instead a remarkable enhanced activity was observed from the same constellation: (336) DKD December kappa Draconids.

## 1 Introduction

The night December 2/3 was clear in the BeNeLux. This was a good opportunity to check whether CAMS BeNeLux could confirm the forecast for enhanced activity of the 66-Draconids meteor shower (Antier, 2016). According to dynamical modeling results for 2016 by Jérémie Vaubaillon, the 66-Draconids meteor shower might show some enhanced activity on December 2nd (around 21h30m UT) and December 3rd (around 07h00m UT). The theoretical radiant would be located at RA = 310°, Dec. = +64° position, which is between Draco and Cepheus. So the radiant would be circumpolar for our latitudes.

## 2 The observational data

In the morning the data for this night from Klaas Jobse (Oostkapelle), Jos Nijland (Benningbroek) and Carl Johannink (Gronau) were the first available, so we checked whether the radiant positions for simultaneously captured meteors agreed with the theoretical radiant. Unfortunately, this was not the case. However some meteors appeared to have a radiant at another position in Draco, but the number of simultaneous meteors (at that moment 3) was too low for a definite conclusion.

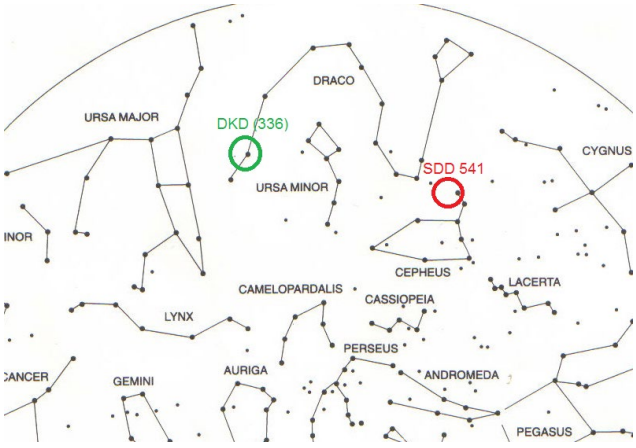


*Figure 1* – The radiant positions in Draco.

In the afternoon data from other stations became available: Paul Roggemans (Mechelen), Koen Miskotte (Ermelo), Martin Breukers (Hengelo), Erwin van Ballegoij (Heesch), Cees Bassa (Dwingeloo), Robert Haas (Alphen aan de Rijn), Tim Polfliet (Gent), Hans Betlem (Leiden), Jean-Marie Biets (Wilderen) en Bart Dessoy (Mostheuvel). Now it was obvious: there was enhanced activity from another region in Draco, located at RA=186°, DE =70°, that night: the established shower (336) DKD December kappa Draconids (Jenniskens et al., 2011, 2016). The first meteor of this stream was captured trimultaneously at 19:39 UT from Benningbroek, Hengelo and Gronau. The last meteor was captured at 05:08:48 UT from Hengelo, Dwingeloo and Gronau.

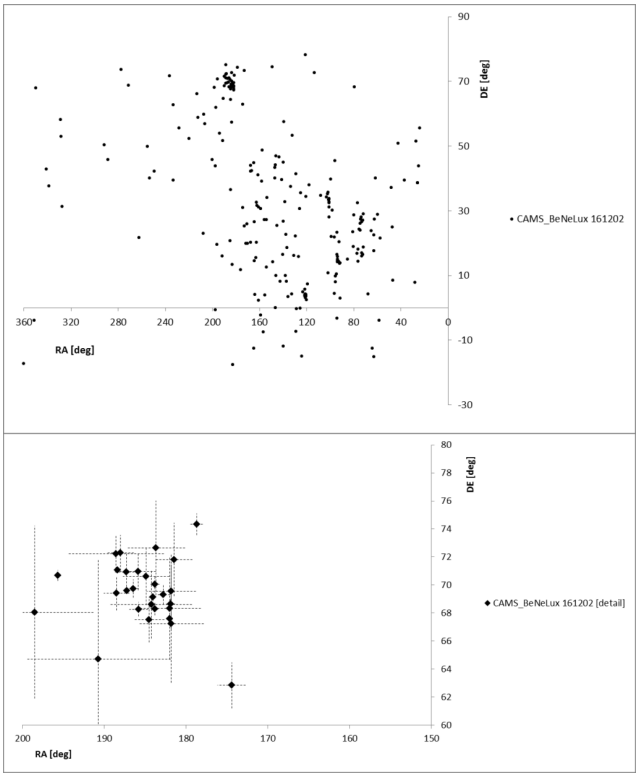


*Figure 2* – all radiants for Dec. 2/3 (top), and detail (bottom).

## References

Antier K. (2016). "Possible 66-Draconids activity on Dec 2-3 2016". On www.imo.net.

Jenniskens P., Gural P. S., Grigsby B., Dynneson L. , Koop M. and Holman D. (2011). "CAMS: Cameras for Allsky Meteor Surveillance to validate minor meteor showers". *Icarus*, **216**, 40–61.

Jenniskens P., Nénon Q., Albers J., Gural P. S., Haberman B., Holman D., Morales R., Grigsby B. J., Samuels D. and Johannink C. (2016). "The established meteor showers as observed by CAMS". *Icarus*, **266**, 331–354.

# Worldwide radio results autumn 2016

**Hiroshi Ogawa**

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## 1 2016 October Camelopardalids

October Camelopardalid activity was caught by using worldwide radio meteor observation (35 observing stations in the world). You can see this result at the following web-site edited by Mr. Hirofumi Sugimoto (Japan): http://www5f.biglobe.ne.jp/~hro/Flash/2016/OCT/index.html (*Figure 1*).

This result shows a clear peak around 14:00 – 15:00 (UT) on 5 October with $ZHR_r$ = 40. The more detail peak time was around 14:45 (UT) on 5 October 5 by 10 minutes result (only observing stations in Japan).

## 2 Orionids 2016

The latest information of Orionids 2016 has been updated. This result was provided using worldwide radio meteor observation.

In addition, the annual variations of the Orionids 2004-2016 using radio meteor observation were provided as follows see: Annual Variations of Orionids.

This page also provides the latest information of the Orionids 2016 using the Activity Level Index (*Figure 2*). As preliminary result, the peak time was estimated around 19$^h$ (UT) on 21$^{st}$ October (as solar longitude: 208°.601). Since this result is a preliminary result, this analysis may change.

## 3 Ursids 2016 strong activity confirmed

Mr. Hirofumi Sugimoto (Japan) reported a possible strong activity of the Ursids 2016. After I received this news, I calculated the Ursids 2016 activity using worldwide radio meteor observed data from RMOB. As a result, a strong activity was observed. The peak time was around 10:00-11:00 (UT) on 22nd Dec. The FWHM had -2.0hr / +4.0hr. The activity graph is Shown in Figure 3.

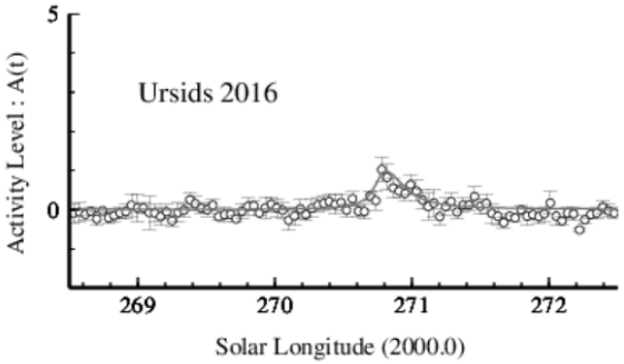


*Figure 3* – using 20 observing stations in 10 countries. (The International Project for Radio Meteor Observations – Hiroshi Ogawa).

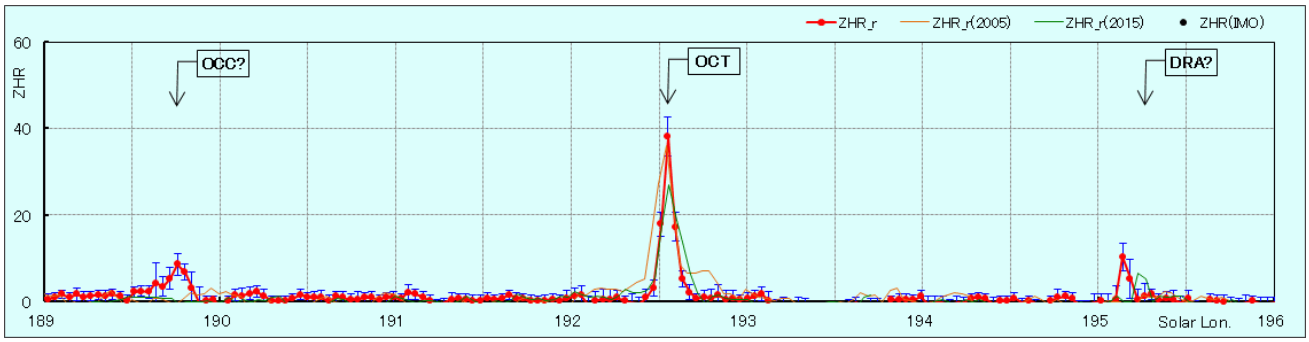


*Figure 1* – 2016 OCC and OCT radio observations.

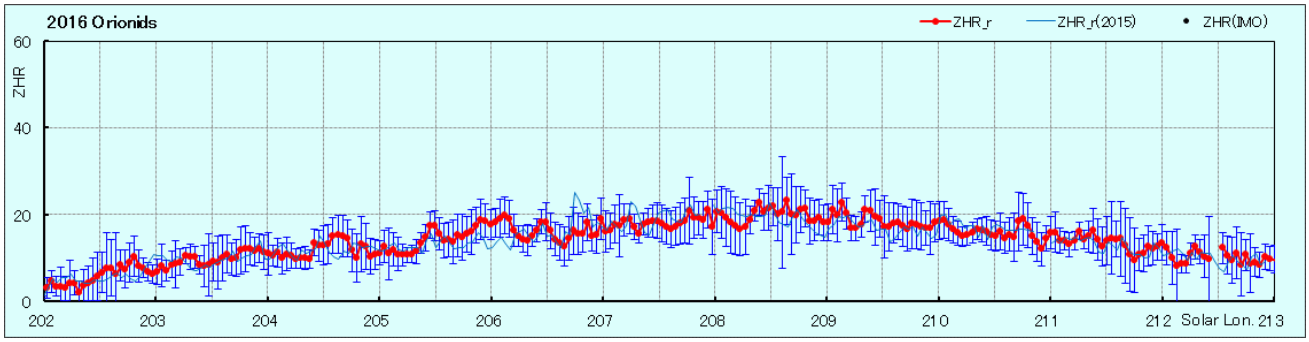


*Figure 2* – 2016 Orionid radio observations.

 

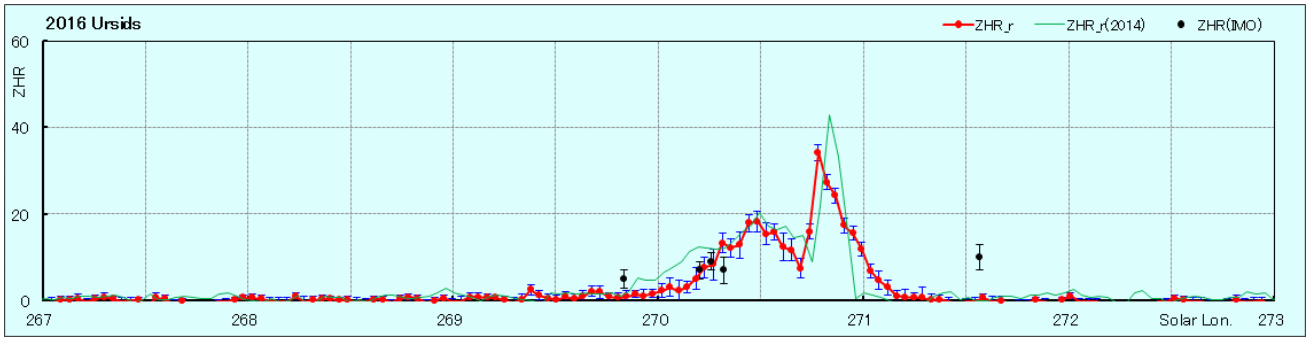


*Figure 4* – Estimated ZHR graph from radio data.

(URL: http://www5f.biglobe.ne.jp/~hro/Flash/2016/URS/index.html – Hirofumi Sugimoto)

# Double camera configuration
# Assistant program for meteor stations

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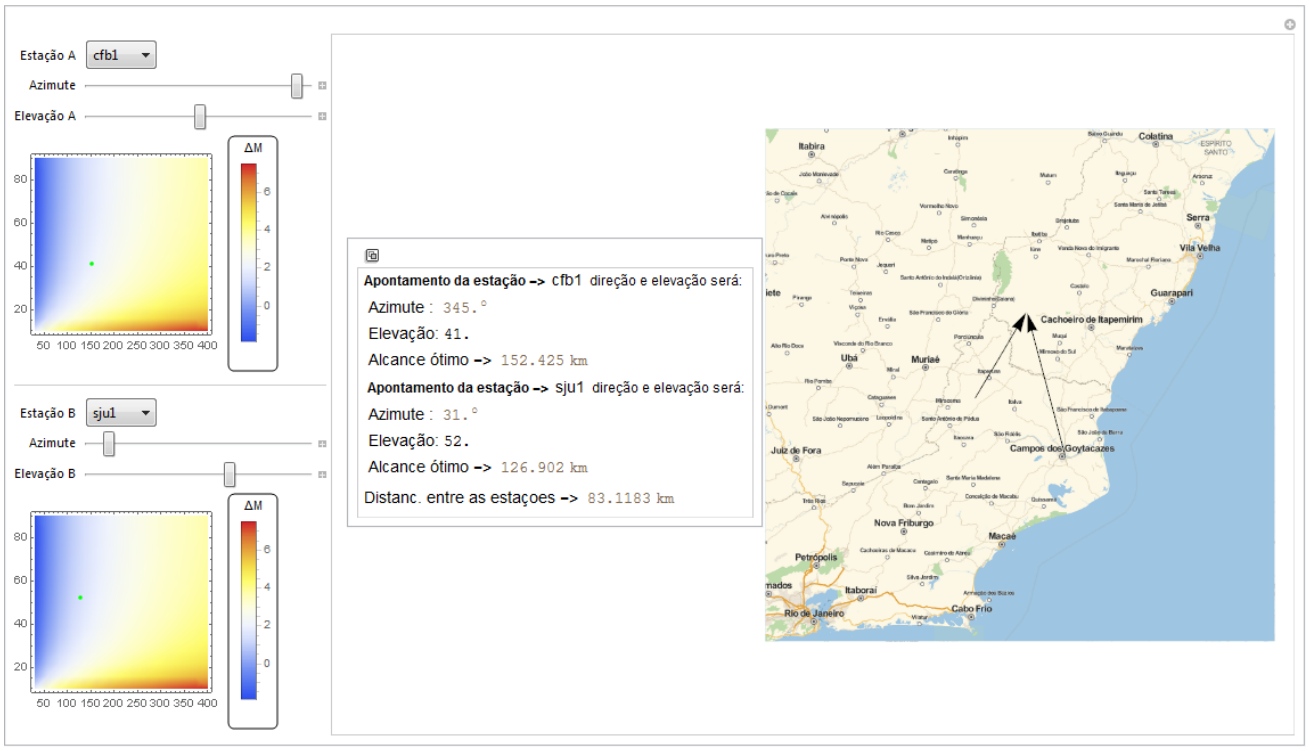
Recently we build a program to assist double cameras coverage configuration. The DOCCA (double camera configuration assistant) software is in its first version, and is based on mathematic language, but yet helps the network to improve double detections meteors. It takes in account the distance stations, the high of an ideal meteor brightness, and an average 'r' factor for a typical shower.



# The PRO-AM Lunar Impact project Exoss

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In order to attain its goals, the Exoss project is now launching the lunar impact project – monitoring meteoroids impacts, using telescope observations of the non-illuminated side of the moon, looking for flashes that could be meteoroids striking the lunar surface, through a remote observatory.

The remote observatory: O ROCG – Remote Observatory of Campos dos Goytacazes, was built during this year and is located in the Brazilian city, Campos dos Goytacazes, Rio de Janeiro State, by amateur astronomer Carlos Henrique Barreto, under the scientific and technical supervision of the Exoss coordinator, Marcelo De Cicco.

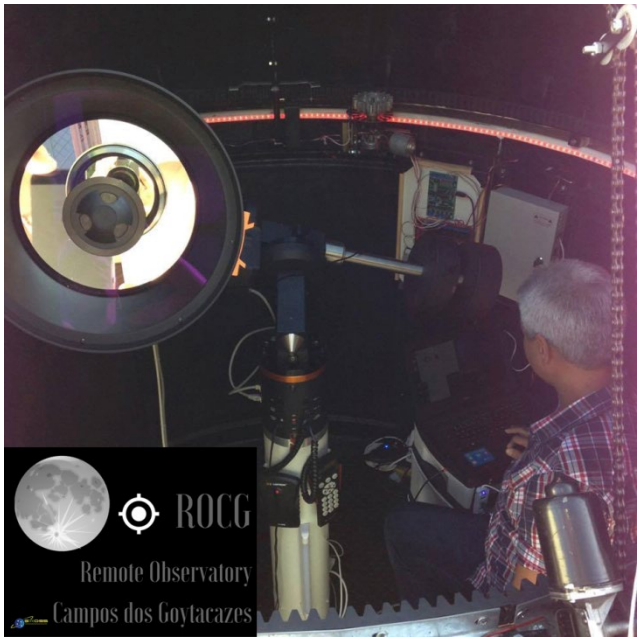



*Figure 1* – In the picture, the amateur astronomer Carlos Henrique is setting adjustments for the polar alignment.

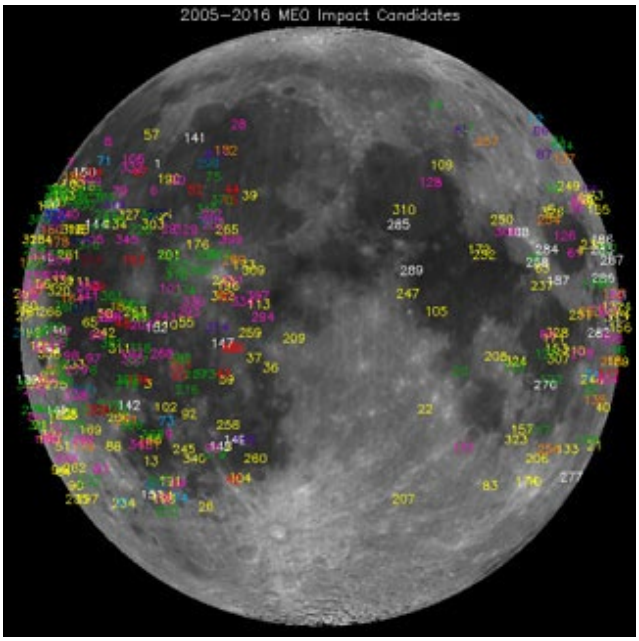
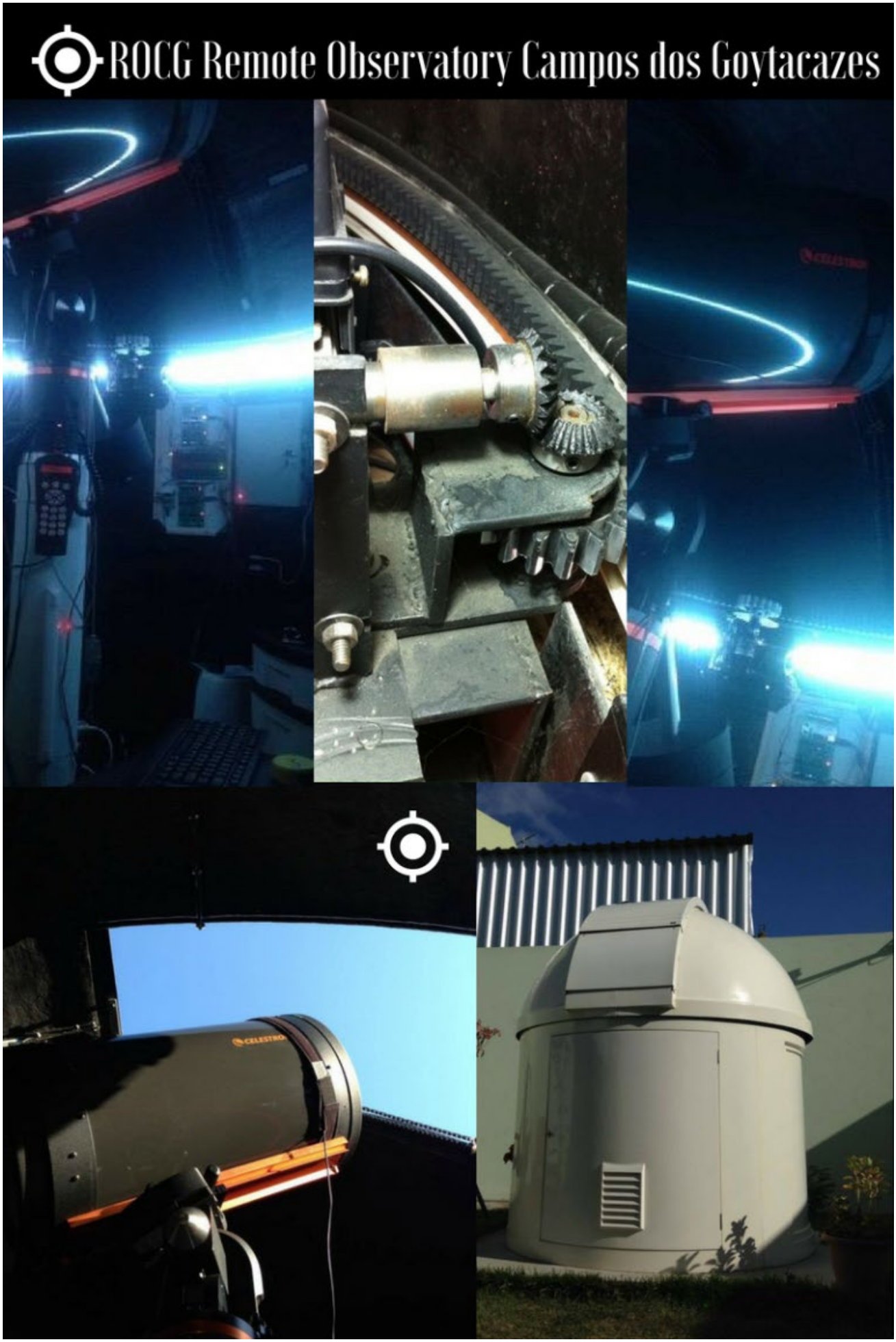



*Figure 2* – Impact candidates 2005-20016. Credits: Marshall Space Center/NASA Meteoroid Environment Office (MEO).

To aim the lunar impact observation goals, a Celestron C–14, f/3.3 and a Stellacam Ex camera attached to the telescope are in use for video monitoring the dark side of the moon. Another camera, Watec 902 H is also available.



# Long grazing and slow trail fireball over Portugal

**Carlos Saraiva**

A long and slow trail meteor with an absolute magnitude estimated over -5 (fireball), has been captured on 25th October under high clouds condition by five PMN (Portuguese Meteor Network) systems; TEMPLAR1, TEMPLAR2 and TEMPLAR4, RO2 and RO3.

Rui Gonçalves calculated its trajectory, velocity and an estimate of the initial mass. It was detected from 69.0 km to 54.0 km with an initial velocity of 14.0 km/s, remaining almost constant. The estimated photometric mass is over 250 g.


*Figure 1* – Fireball atmospheric trajectory over Portugal.

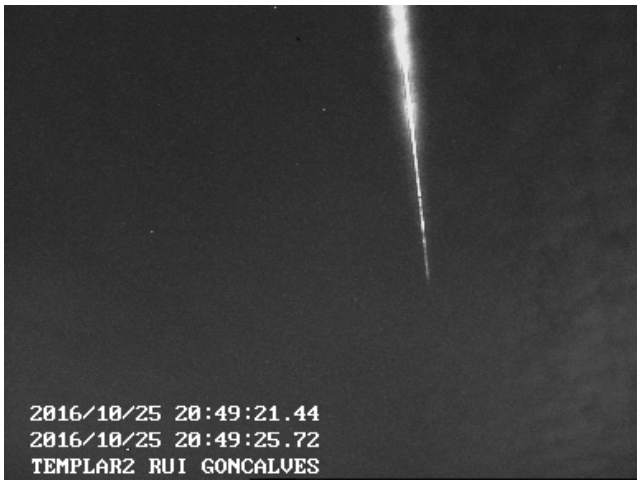



*Figure 2* – TEMPLAR2 summed image (near Tomar).

*Figure 3* – RO3 summed image (near Lisbon).

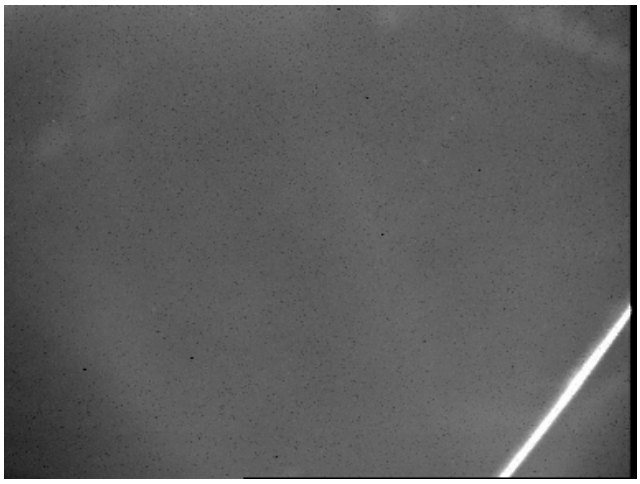


*Figure 4* – RO2 summed image (near Lisbon).

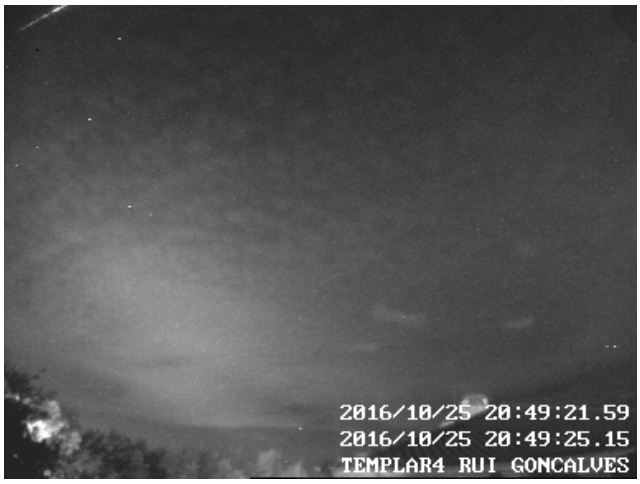



*Figure 5* – TEMPLAR4 summed image (near Tomar).

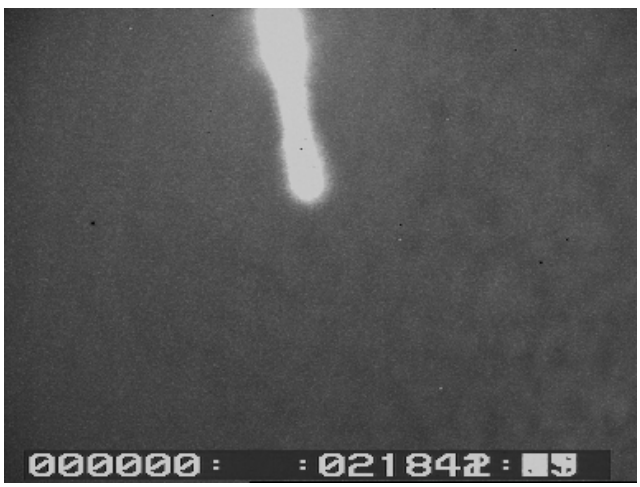


*Figure 6* – TEMPLAR1 (incomplete) summed image (near Tomar) with meteor leaving the field.

# RAMBo radio observations

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An overview of the radio observations by RAMBo Meteor Group for the months October and December 2016 is presented.

## 1 Two meteors shower on 31 oct

RAMBo has registered two showers on 31/10/2016. In the graphs you can see the 283 OPL pi Leonids and the 525 ICY iota Cygnids.

Both with low HR, but the mass index rise is well observable (See *Figure 1*).

## 2 Geminids 2016

We can see two days of activity: the 13 and the 14 December. What is relevant is a twenty minute of "heavy bombing" at 262,950 of solar longitude, in which the HR remains low but the mass index increased a lot. This was just before the expected forecast of the 68 Geminids shower (610 SGM), (See *Figures 2-3*).

## 3 Strong Ursids activity in 2016

This year RAMBo has recorded a strong Ursid activity. In *Figure 3* you can see that the maximum started at 270,800 of solar longitude. The first graph shows the mass behavior, the second one (red) shows the Hourly Rate.

More information on our web site www.ramboms.com.

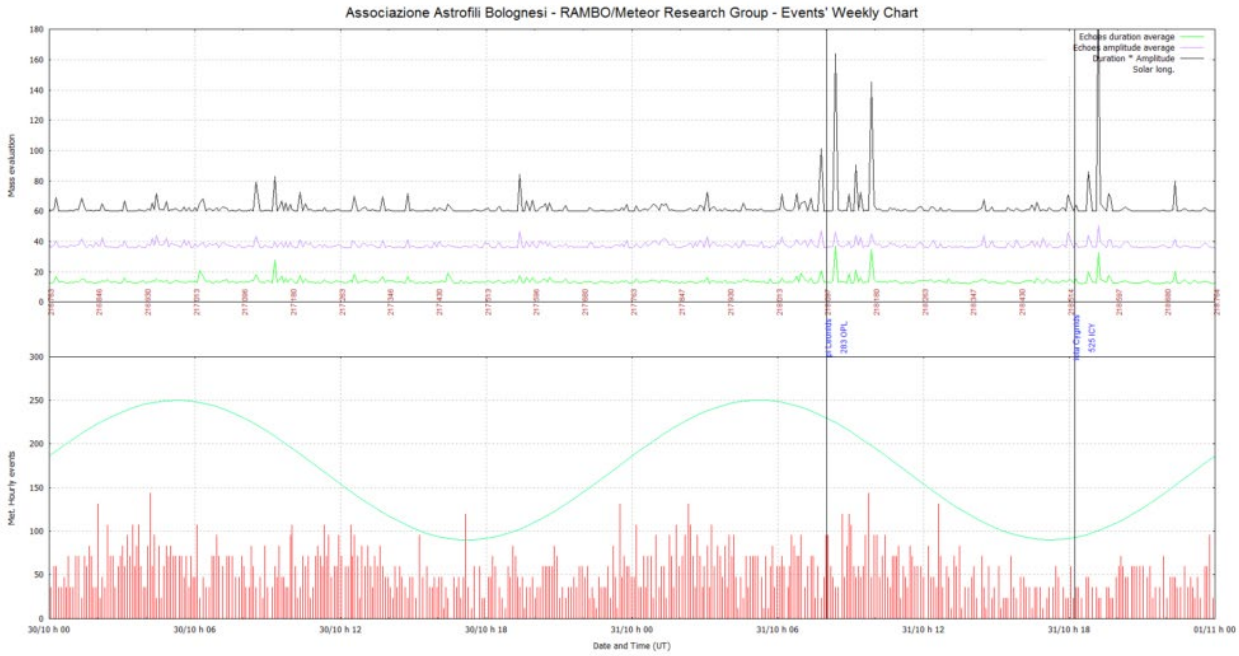


*Figure 1* – Two meteors shower on 31 oct.

 

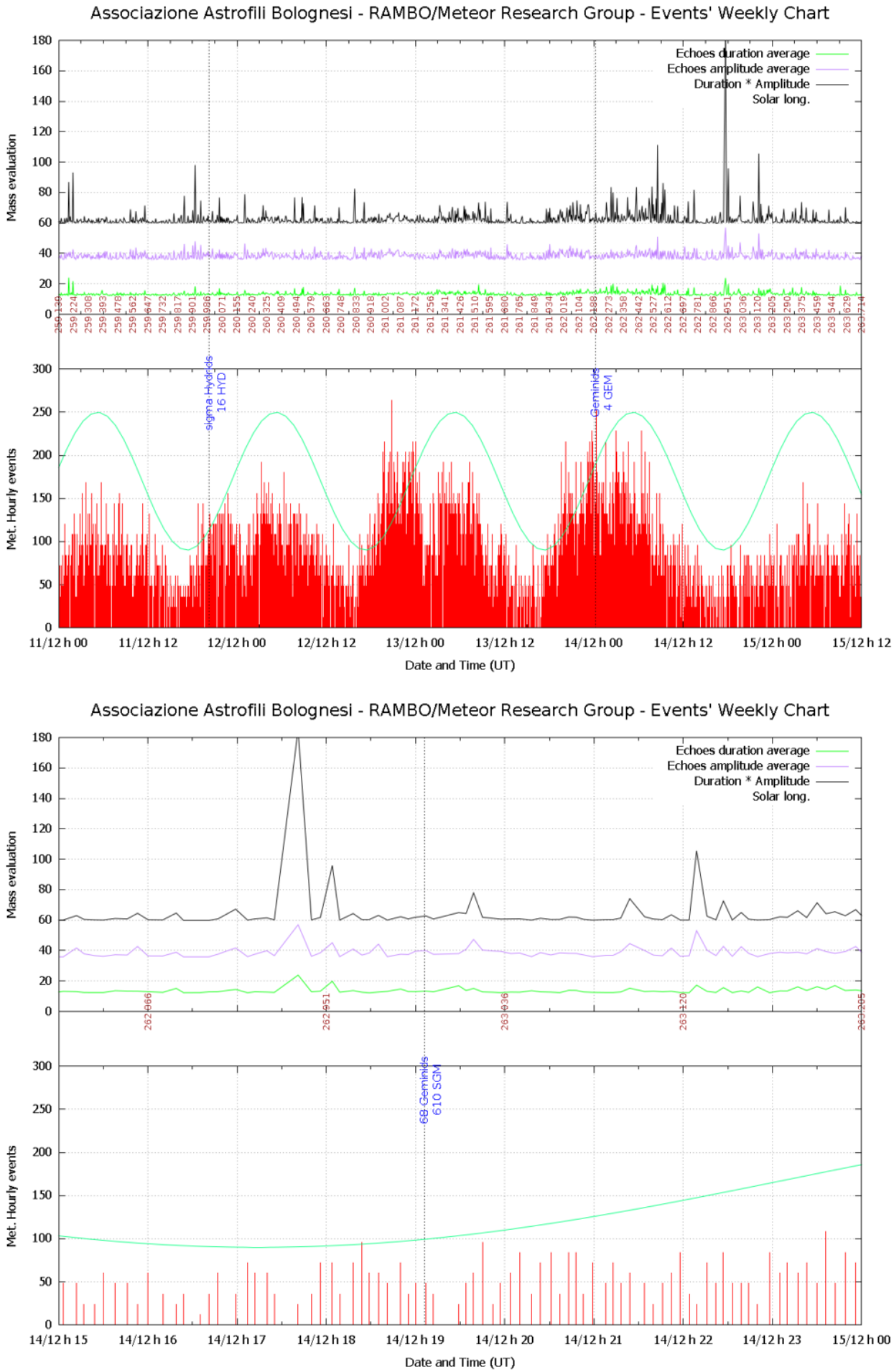


*Figure 2* – Geminids 2016.

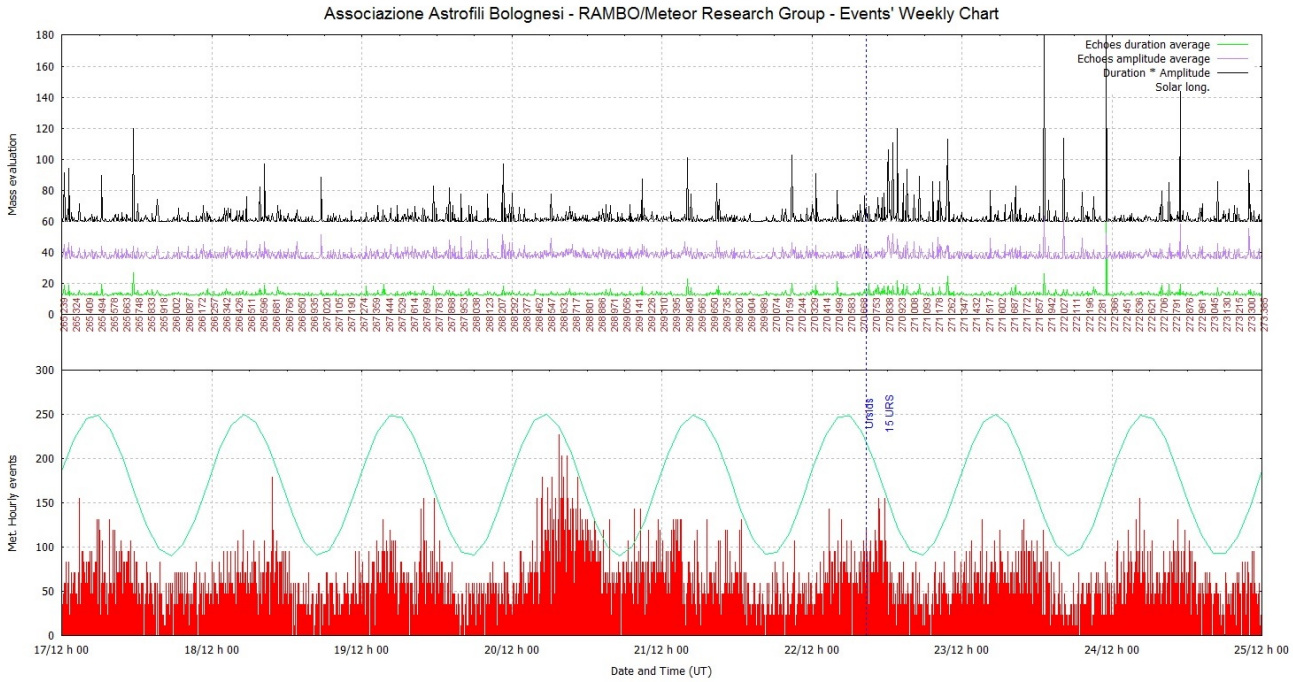


*Figure 3* – Ursids 2016.

 

# Radio meteor observations in the world: Monthly report for October 2016

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This report was provided by The International Project for Radio Meteor Observation. In October 2016, three topics were presented.

## 1 October Camelopardalids

The possible activity of the October Camelopardalids was predicted by some researchers. One of them, Mikiya Sato, predicted this activity at 14:49 (UT) on 5th October ($\lambda_o$ 192°.564). As a result, worldwide radio meteor observers caught a small distinct activity. This activity was a very narrow profile with FWHM = 1.5 hours. The activity graph shows the following features. The peak time was 14:00-15:00(UT) on 5th October ($\lambda_o$=192°.551). The peak activity level was 0.72 ± 0.38.

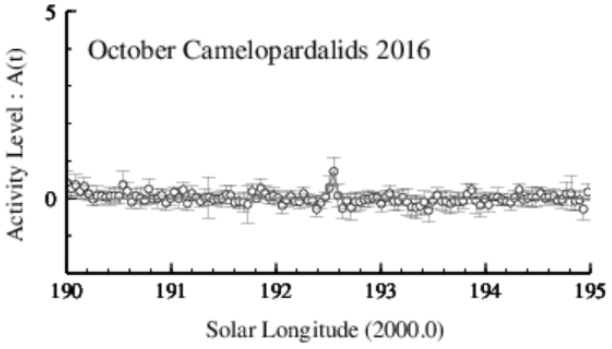


*Figure 1* – using 22 observing staions in nine countries.

The estimated activity profile using the Lorentz Profile had a 0.7 activity level peak at 14:30 (UT) on 5 October ($\lambda_o$ 192°.551). The FWHM was -1.0 / + 0.5 (hours). This increased activity was observed at almost all observing stations. Mr. Hirofumi Sugimoto in Japan has calculated the estimated visual ZHR using this activity level. It is possible to check this on his website: http://www5f.biglobe.ne.jp/~hro/Flash/2016/OCT/index.html.

## 2 October Draconids

The next topic were the October Draconids. This shower displayed high activity in 2011 and 2012. After that, there was no unusual activity in 2013–2015. No outburst was predicted for 2016.

As a result, worldwide radio meteor observers confirmed that there was no unusual activity. The activity graph is shown in *Figure 2*. The detailed result has also been presented at October Draconids 2016.

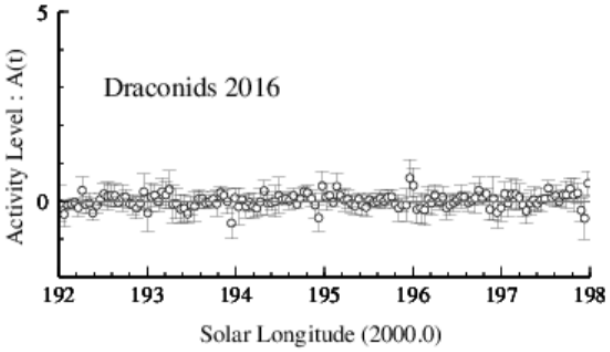


*Figure 2* – using 22 observing stations in nine countries.

## 3 Orionids

The last topic were the Orionids. In 2006 and 2007, higher Orionid activity was observed worldwide. In recent years, however, there was no distinct higher activity.

As a result in 2016, worldwide radio meteor observers confirmed that there was no unusual activity although a small increase was observed. The activity graph is shown in *Figure 3*. The detailed results have also been shown at the Orionids 2016 page. The estimated activity profile had 0.3 activity level peak at around 0h (UT) on 22 October ($\lambda_o$ 208°.81). An activity level of 0.3 means the usual activity level comparable to the non-meteor shower activity.

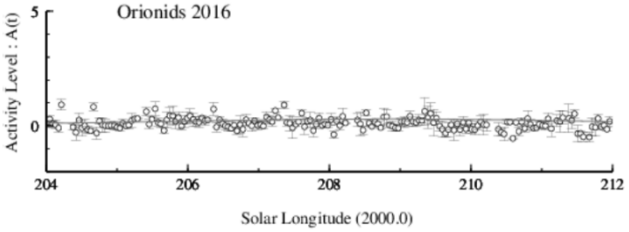


*Figure 3* – using 21 observing stations in nine countries.

With radio meteor observing it is difficult to register the detailed Orionid activity structure because of the geocentric velocity of the Orionids being too fast. It is therefore difficult to obtain a clear activity profile in the case of a visual ZHR less than 30 (like in the case of the Orionids).

Mr.Hirofumi Sugimoto in Japan has calculated the estimated visual ZHR using this activity level. It is possible to check on his website:

http://www5f.biglobe.ne.jp/~hro/Flash/2016/ORI/index.html.

## 4 General meteor activity in October

Beside these topics, *Figure 4* displays the monitored result (using ONLY Japanese stations) in October 2016.

Around the 17th – 18th, the activity levels showed a high activity. This result was also shown across the world. It was uncertain, although there is a possibility of an unpredicted activity. There is, of course, also a possibility for some observing error.

## Acknowledgment


- Radio Meteor Observing Bulletin (RMOB)
- Radio Meteor Observation in Japan (RMOJ)
- All radio meteor observers


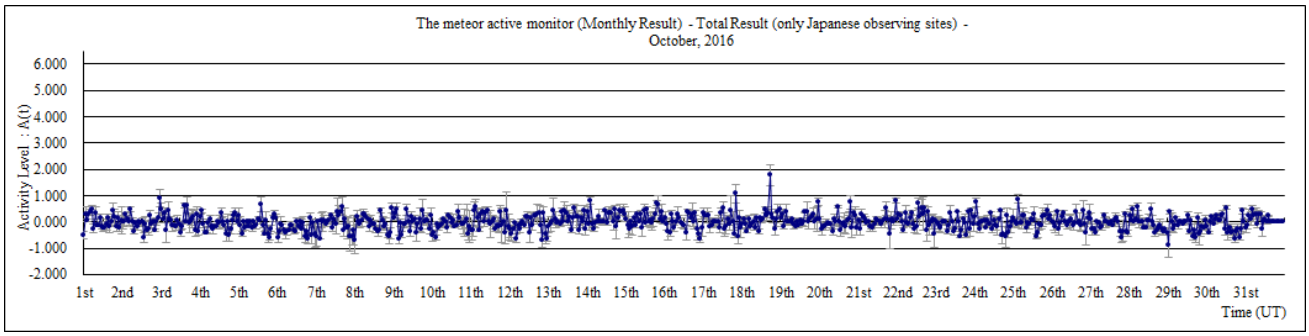


*Figure 4* – Monitored result for October (only Japan).

 

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