Amateur Meteor Work

Jürgen Rendtel
Leibniz-Institut für Astrophysik Potsdam (AIP)
& International Meteor Organization (IMO)

Outline

Introduction

- amateur – professional ?

Projects

- Transition visual to video
- Calibration & data mining (all methods)
- Observation: goals & results

Results

- Showers & streams
- Fireballs & meteorite falls

Conclusions

- new projects & suggestions

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Introduction

Amateur – professional

~ 30 years ago: equipment, computer resources

now: choice of goal and amount of time spent; payment

personal view, biased and probably Europe-centered

many current professionals started as amateurs

different situation to other communities (PAWG probably not „standard“)

Introduction

Amateur meteor work

Initial: visual + photographic observations

also: telescopic, radio forward scatter

IMO foundation 1989:

- commissions by observing technique (might change to topics)
- annual conferences (IMC) + proceedings
- journal WGN
- publications (handbooks, shower calendar)
- database(s)
- regular analyses, often in teams prof-am

Projects

Visual work

Standardizing procedures (observation, analysis) – late1980s

regular analyses of meteor shower rates and population index – 1990s
    PER-peaks starting 1988

extending to flux / number density

long-term series plus data mining
    (GEM >60 yrs, ORI resonant peak verification, KCG 41 yrs, etc)

outbursts (AMO 1995, AUR 2007) and peak observations (LEO series)

Projects

Video observations (1)

started 1990-s, several groups

setting standards: SonotaCo, video network in Japan

IMO Video Meteor Network (Molau et al.; ~ 80 cameras, single station)

shower association procedures, detailed analyses (2009 onwards)

new showers, activity duration (based on >2 million meteors)

outburst detection and confirmation

automated determination of meteor magnitudes

population index, *r*-profiles

minor activity features, short / weak peaks

AIP

Projects

Video observations (2)

double and multiple stations / networks

SonotaCo, CAMS (pro – am), many national networks
(see other presentations in the program)

goal: orbit determination, stream identification

additional approach: EDMOND
(European viDeo MeteOr Network Database)
combining single station data

lightcurves, spectra → atmospheric processes

includes software development

Projects

Further ideas

draft discussing possible new directions

(Arlt, Gyssens, Rendtel, 2015; reflections from Asher, Bettonvil, Gural, Koschny, Koseki, Šegon, Vaubaillon and others)

some points already in progress (presented IMC 2016)

Results

007 PER, 1988 – 2004

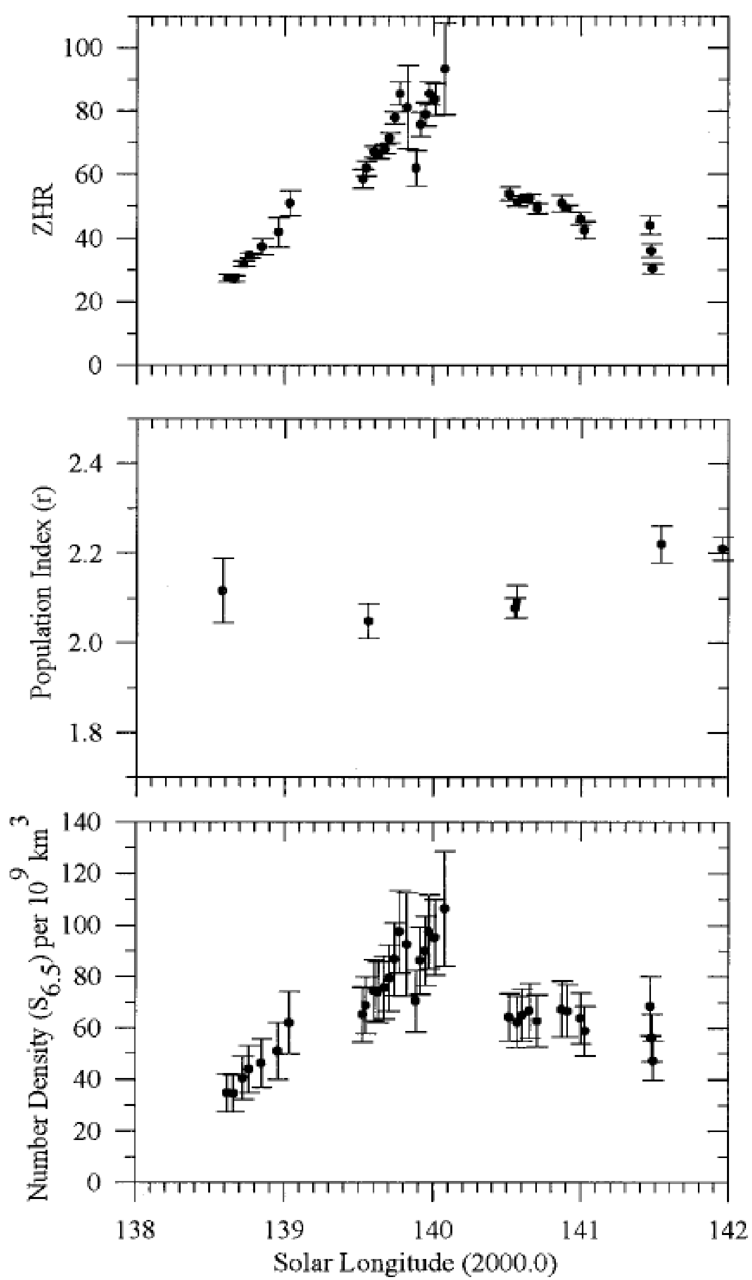
Perseid series of dust trail peaks

first global data analyses

starting from 1988

until now

expect „structured“ 2016 return



Brown & Rendtel, 1996

FIG. 1. The ZHR, r, and spatial number density ($S_{6.5}$) for the 1988 Perseid return.

Results

008 ORI, resonant maxima – back to 1914

data mining – reconstruction of rates back over decades

initiated by the strong returns 2006 – 2007

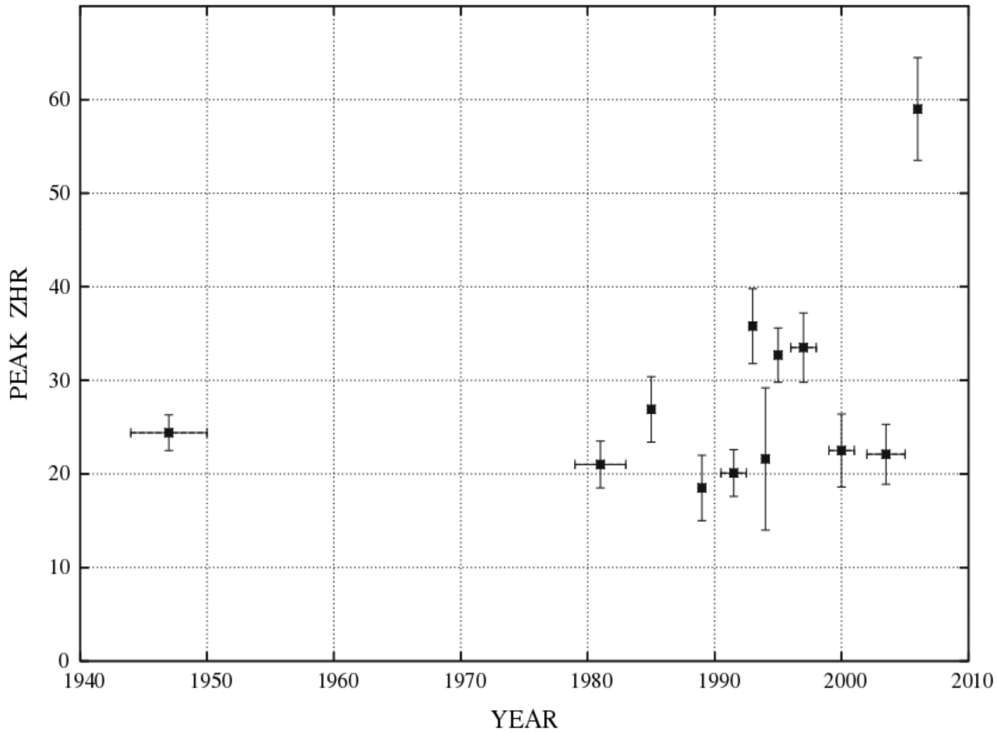
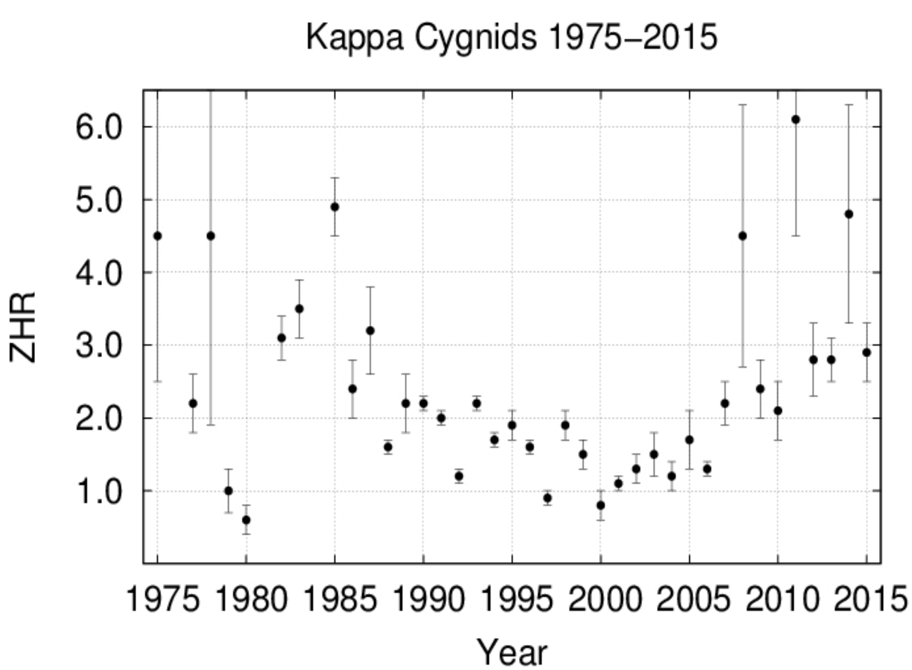


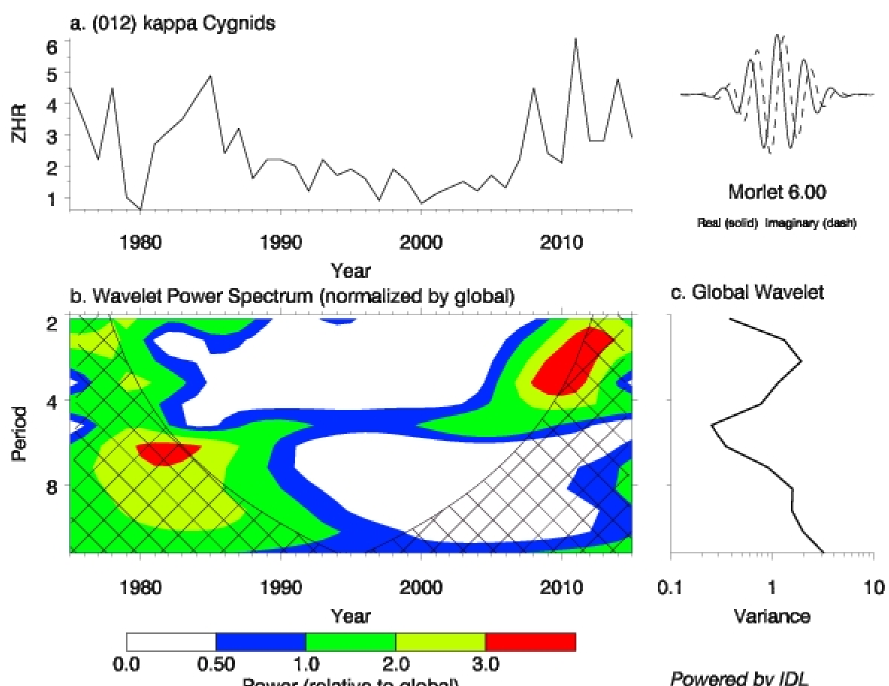
Fig. 2 Maximum ZHRs of the Orionid returns in the period 1944–2006. A horizontal error bar indicates that the value represents an average over several Orionid returns

Examples

012 KCG

- weak shower around λ=145° (Aug 17)
- periodicity of ~7 years suspected (various papers)
- visual data 1975 – 2015 (41 years, only 3 single years gap)
- wavelet analysis (also applied to Leonid short term variations 1999)





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Examples

Meteorflux.io – video data analysis

MeteorFlux.io

Use the form below to create a meteor flux profile.

Data | Binning | Stations | Advanced

Shower: PER - Perseids (8/12)

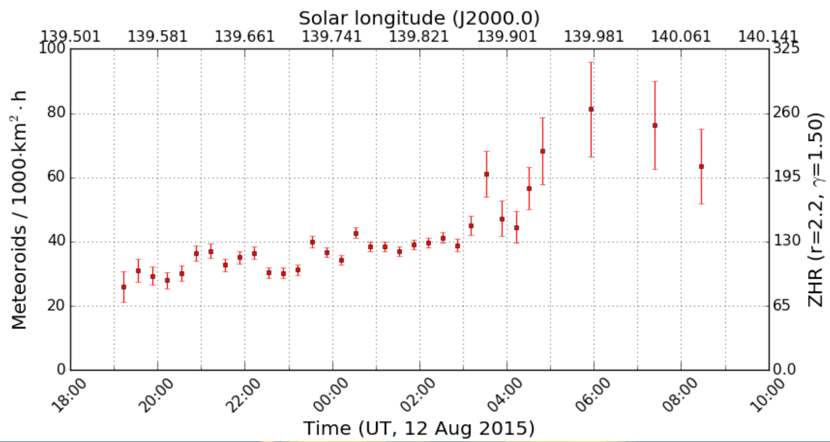
Begin: 08/12 18:00

End: 08/13 10:00

Year: 2016, 2015, 2014, 2013

Average the selected years

Create graph



Data | Binning | Stations | Advanced

Meteor counts are added together into variable-sized bins before the flux is computed for each bin. The size of the bins can be defined using the settings below.

First, specify how much data you want in each bin:

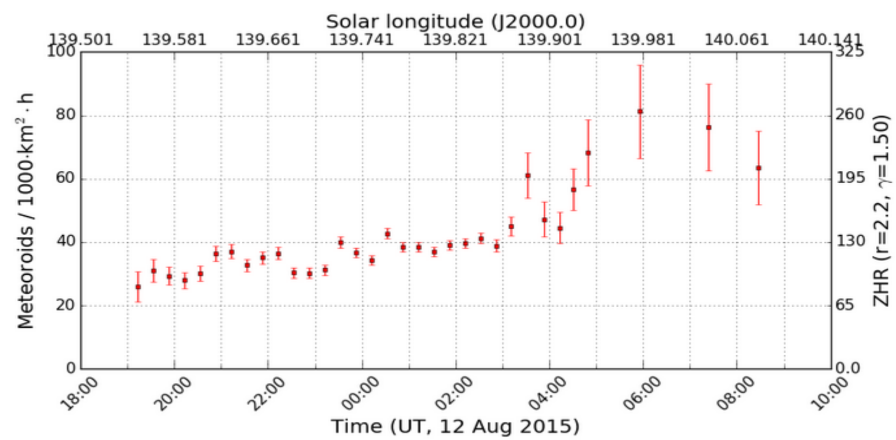
Minimum meteors per bin = 30

Minimum collection area per bin = 20000 $km^2 \cdot h$

Then specify the constraint on the time interval covered by each bin:

Bin duration (min-max) = 20 mins - 4.0 hours

Create graph

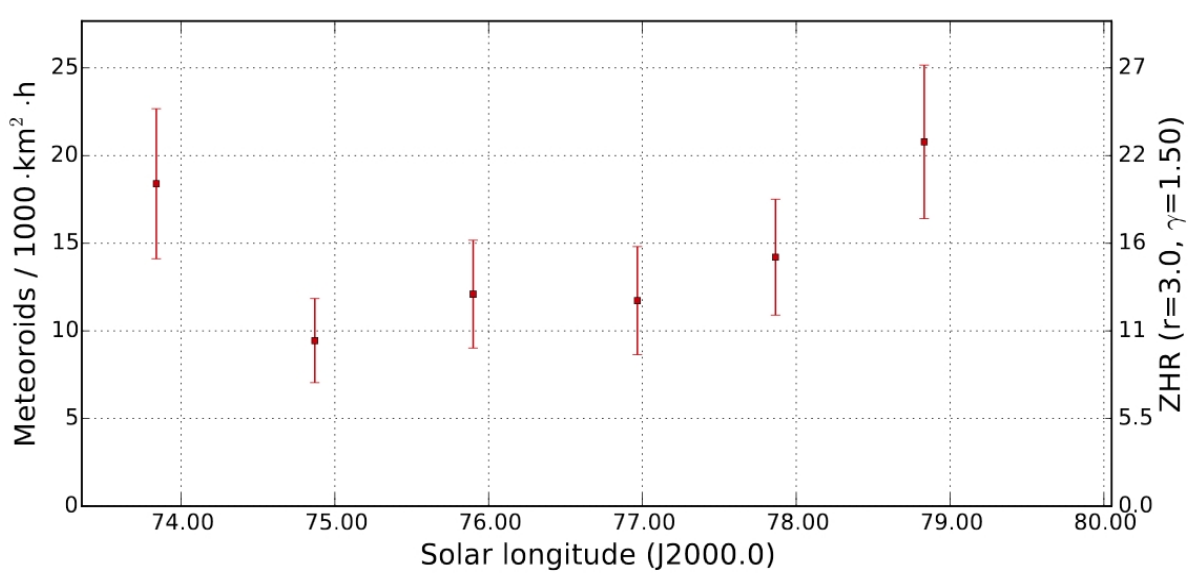


Time [UT]	Solarlon [deg]	Teff [h]	ECA [10^3 km^2 h]	nMet	Flux [10^{-3} km^{-2} h^{-1}]	ZHR
2015-08-12 19:12	139.550	11.1	1.2	30	26.0 ± 4.7	85
2015-08-12 19:33	139.564	11.9	2.6	79	31.1 ± 3.5	101
2015-08-12 19:52	139.576	15.3	3.5	103	29.4 ± 2.9	96
2015-08-12 20:12	139.590	18.3	4.3	120	28.1 ± 2.6	91
2015-08-12 20:32	139.603	21.5	5.3	159	30.3 ± 2.4	99

Examples

Daytime: 171 ARI, 221 DSX

- found in video data (rate: IMO video network, orbits: EDMOND)
- attempt to obtain further optical data
- addition to radio / radar, calibration
- currently no profile yet; flux uncertain by factor >10 (*r*, *γ*)



ARI 2011-15, video

Examples

757 CCY

- minor activity, but well detectable
- independent video data samples

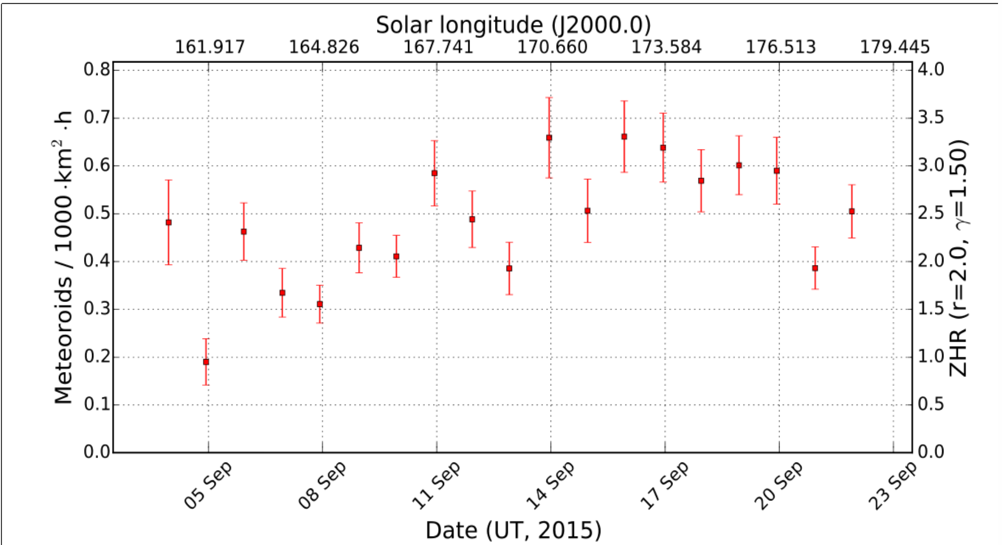


Figure 4 – Flux density profile of the χ-Cygnids 2015, derived from observations of the IMO Video Network with the new shower parameters of 2015.

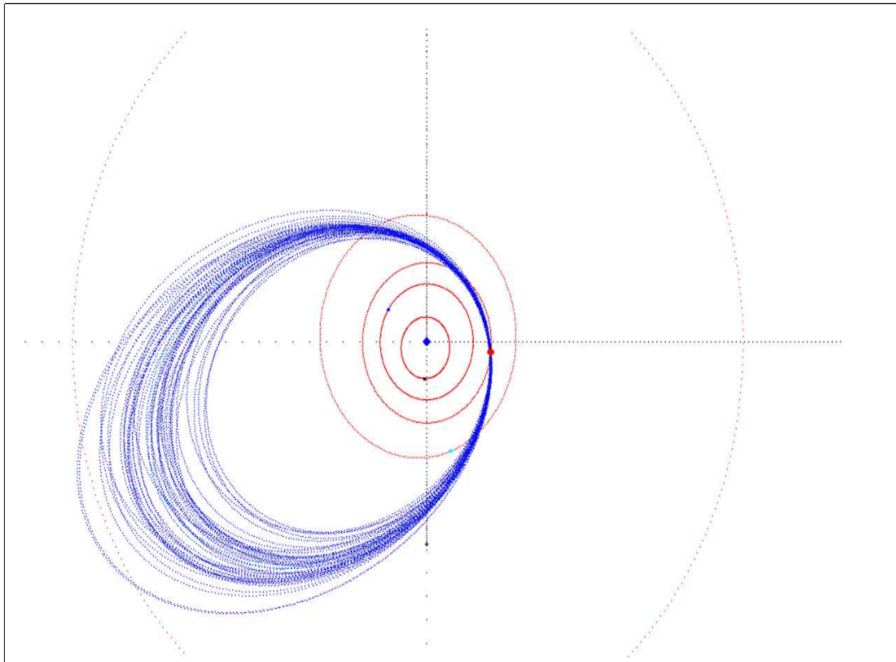


Figure 5 – View from above of the Solar system with CCY meteoroid orbits within $D_{SH} < 0.1$ derived from EDMOND multi-station observations (2007–2015).

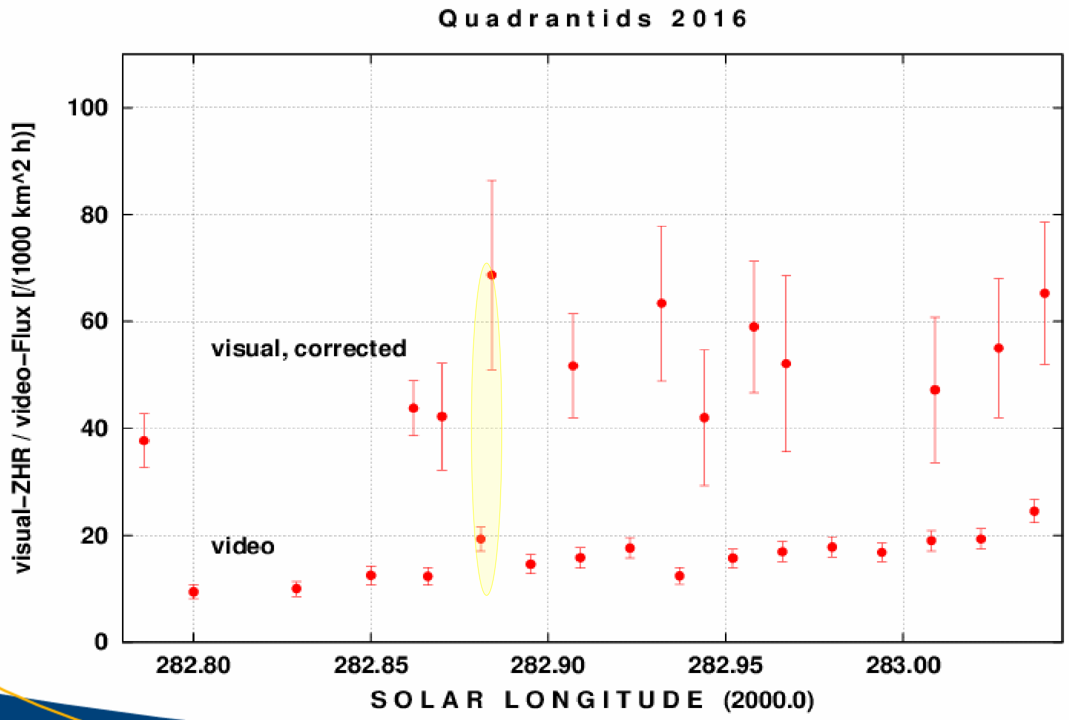
Flux: Molau et al., 2016 (IMO VMN)

Orbits: Segon et al., 2016 (EDMOND)

Examples

010 QUA, 2016

- pre-maximum sub-peak? Trust minor features?
- independent data samples: video, visual



predicted position:

3 Jan 22 UT – 4 Jan 02 UT

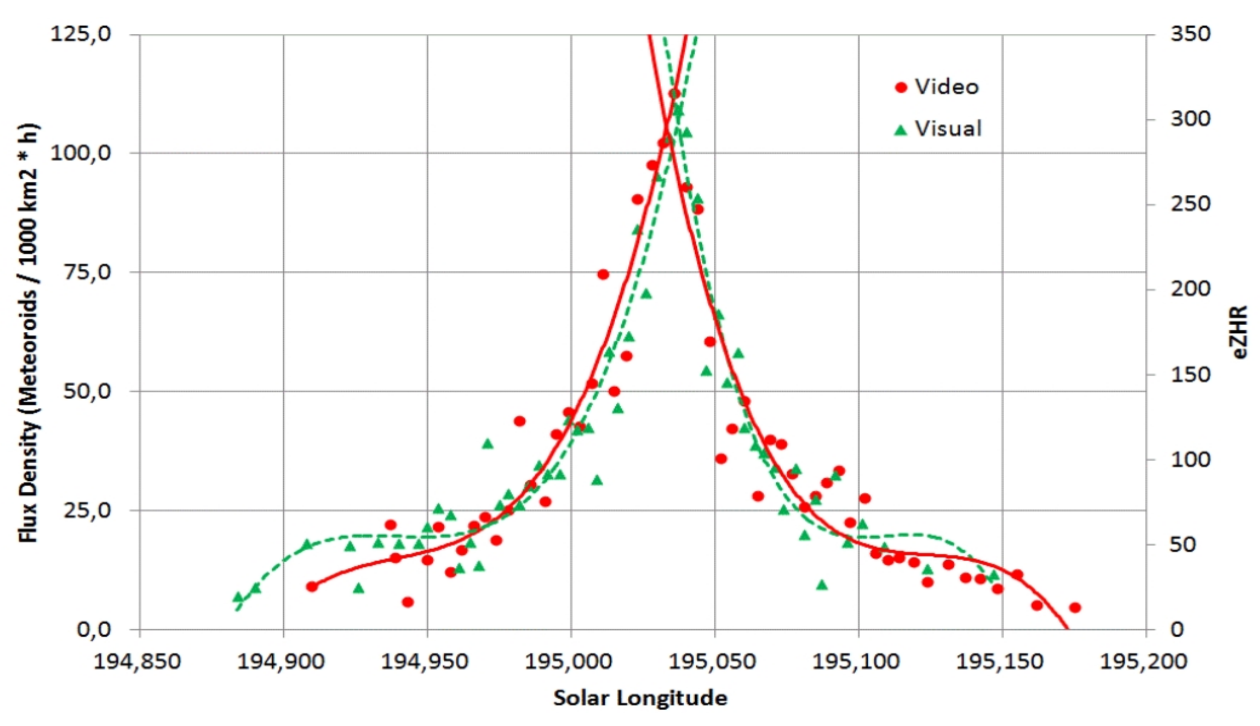
λ 282.74 – 282.91

enhancement @ 282.88

Examples

009 DRA, 2011

- real-time flux determination from video 2011 Oct 08
- independent data samples: video, visual
- 3rd order polynomial fit

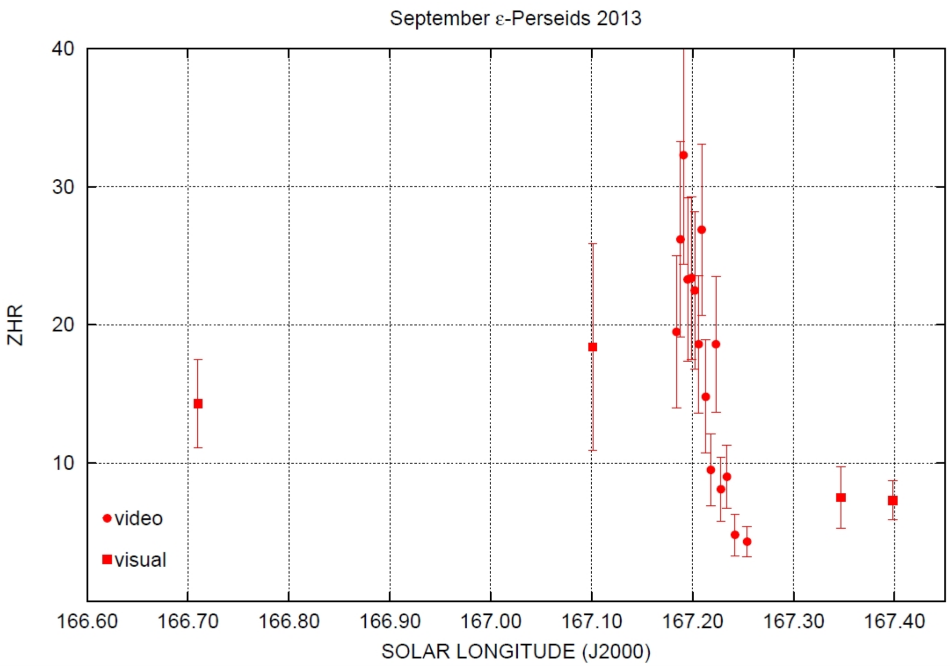


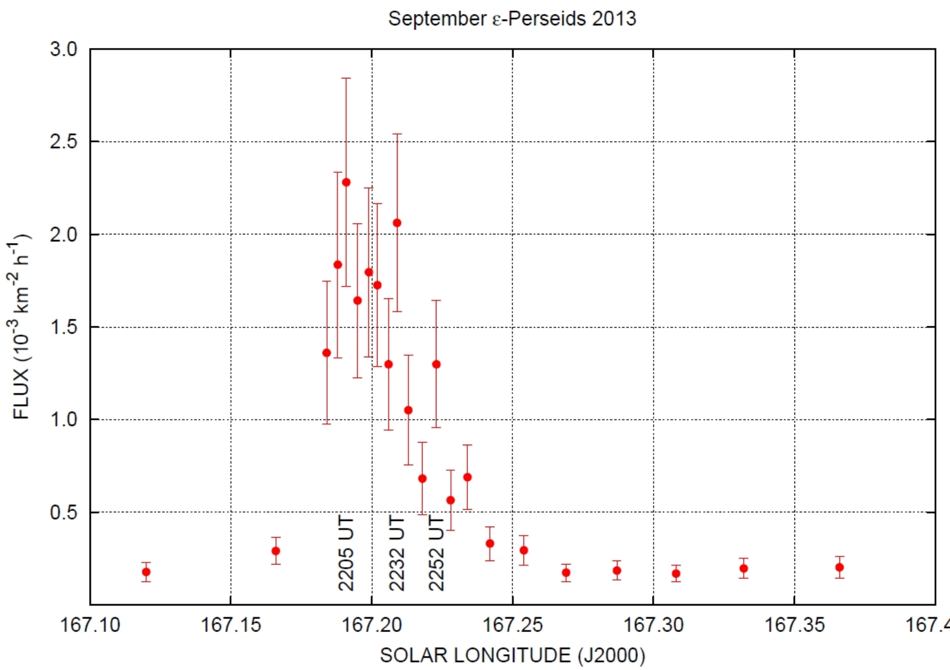
Molau et al., 2012

Examples

208 SPE, 2013

combining visual + video data, calibration + completeness





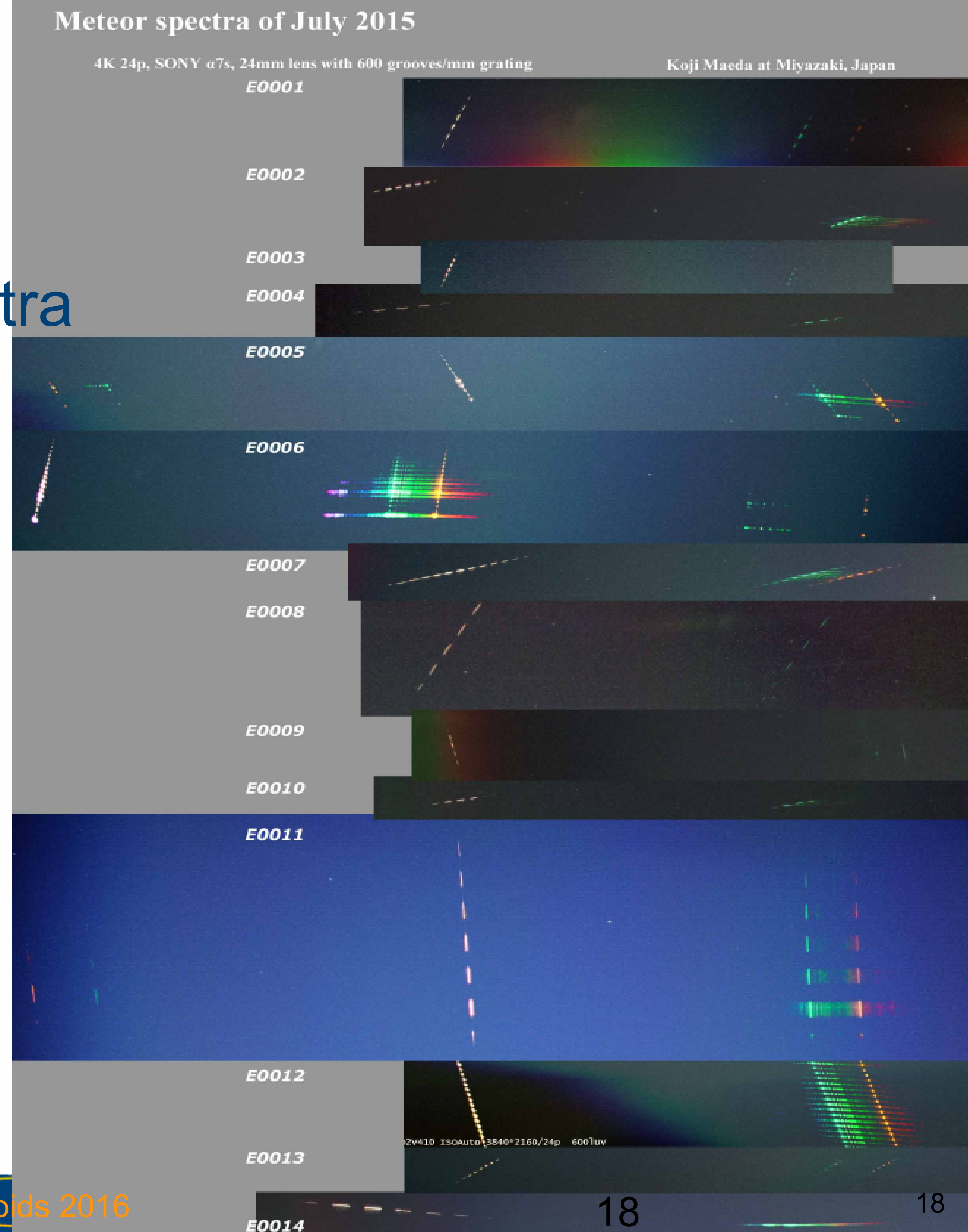
ZHR from visual (squares) and video (dots) data

Flux profile (video) with high temporal resolution, coop. Lyytinen & others

Examples

High resolution spectra

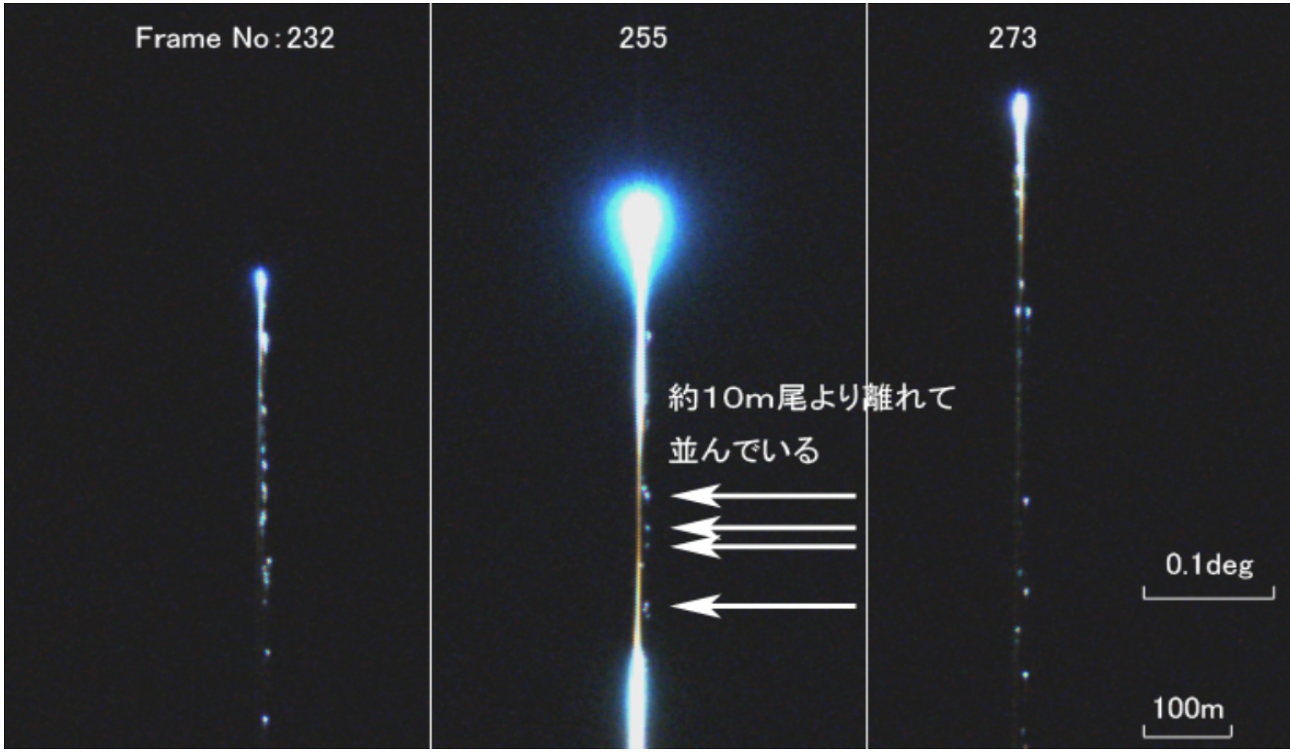
- Maeda: >300 4k video meteor spectra
- 4k video also for higher positional accuracy
- high precision shutter (Bettonvil, this conf.)



Examples

High resolution images

- Suzuki: automated fireball detection
  spatial resolution
  (cf. results from UWO trailing meteor heads)



msswg.net/CD/MSS30-2015.pdf (p. 13-18)

Examples

Fireballs worldwide

- Website, initiated by AMS (Mike Hankey, Vincent Perlerin), also via IMO

Report a Fireball: it's fun and easy!

You saw something bright and fast? Like a huge shooting star?
Report it: it may be a fireball.

We are going to ask you to fill an interactive form that is intended to be easy to fill out for anyone. Please, be as precise as you can. Your report is important, it alerts us to potentially scientifically significant events that occur, and contributes to the general database of knowledge about meteors. You will have the opportunity to give us all the details about your sighting experience at the end of the form.

- **Please, don't report sighting that lasted more than 30 seconds:** the vast majority of fireballs are only visible for few seconds.
- **Please, don't report recurring events:** seeing a fireball is extremely rare and often an once in a lifetime event.
- **Please, don't report slow blinking objects or lights crossing the sky going by 2 or 3:** a fireball looks like a big shooting star.

If you encounter technically difficulties, please click the Help links or try the simplified version of the forn

★ Start now

رأيت شيء مشرق وسريع؟ مثل نجم اطلاق النار ضخمة؟ الإبلاغ عن ذلك: قد يكون كرة من اللهب.

نحن بصدد الطلب منك ملء استمارة التفاعلي الذي يهدف إلى أن يكون من السهل ملء لأحد. من فضلك، كن دقيقا قدر المستطاع. التقرير الخاص بك هو المهم، فإنه ينبهنا إلى أحداث كبيرة محتملة علميا أن تحدث، ويسهم في قاعدة البيانات العامة للمعرفة حول الشهب. سيكون لديك الفرصة لتعطينا كل التفاصيل حول تجربة الرؤية الخاص بك في نهاية النموذج.

- **من فضلك، لا تقدم تقريرا رؤية دامت أكثر من 30 ثانية:** الغالبية العظمى من الكرات النارية ليست سوى لبضع ثوان مرئية.
- **من فضلك، لا تقرر الأحداث المتكررة:** من فضلك، لا تقرر ببطء وامض الأشياء أو أضواء عبور السماء الذهاب بنسبة 2 أو 3:
- **من فضلك، لا تقرر ببطء وامض الأشياء أو أضواء عبور السماء الذهاب بنسبة 2 أو 3:** كرة نارية تبدو وكأنها نجمة الرماية كبيرة.

If you encounter technically difficulties, please click the Help links or try the simplified version of the form.

★ نبدأ الآن

many languages

報告火流星：很有去也很簡單！

你看到什麼又亮又快的東西了嗎？像是一個
或許是一個火流星。

我們將請求您填寫一份任何人都容易明白的互動式表格。 請盡量的精確描述。你的報告是很重
知識有貢獻。 請您完成表格已提供我們您寶貴的觀測經驗。

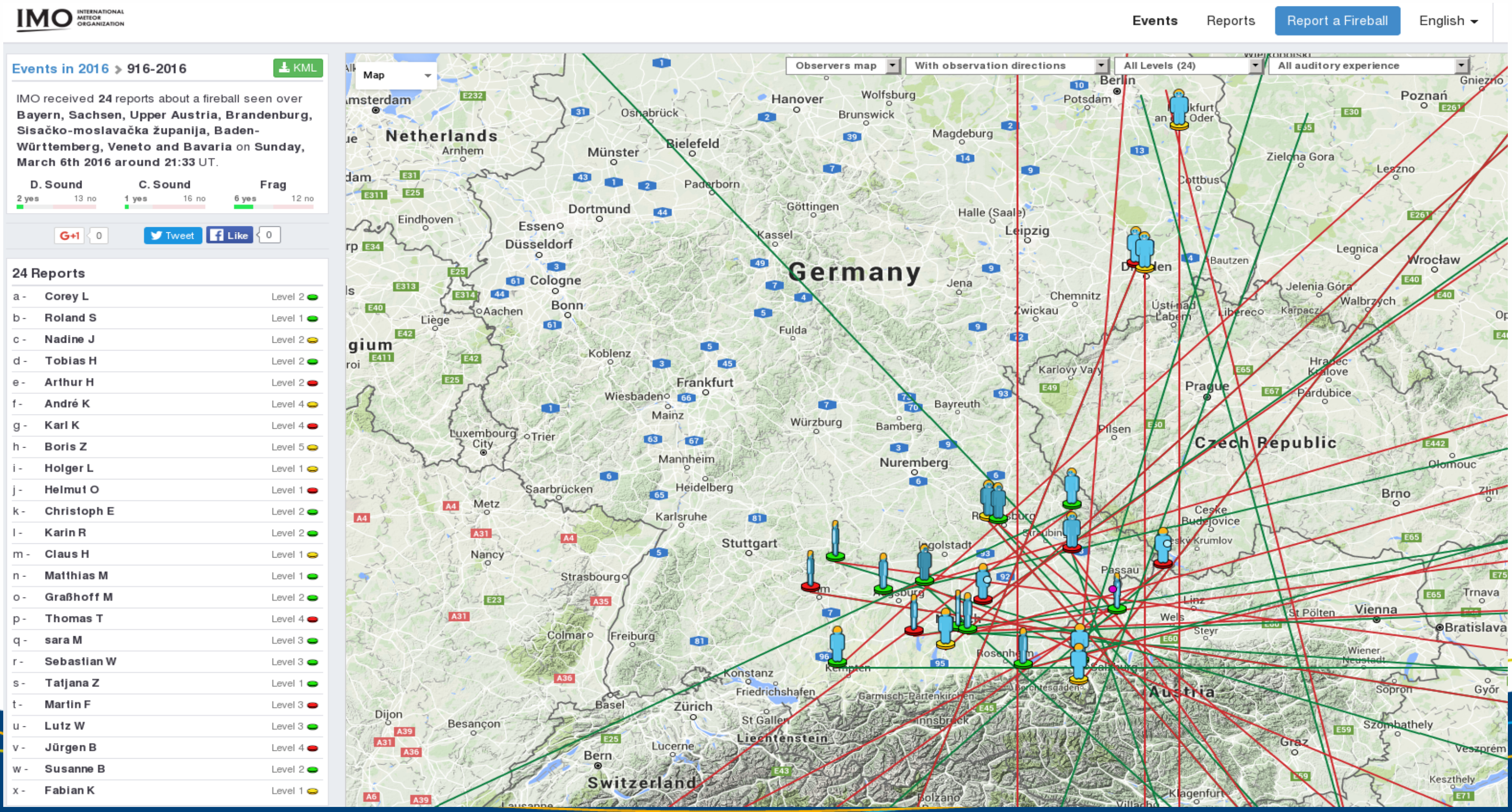
- **請不要報告超過30秒的事件：** 絕大多數的火流星只能看到幾秒鐘而已。
- **請不要重複報告同一觀測事件：** 看到火流星事很難得的，而且通常在當時只會看到一次
- **請不要報告慢速閃爍的目標，或在天空閃爍2、3次的光點。** 火流星看起來像是一個很

If you encounter technically difficulties, please click the Help links or try the simplified vers

Examples

Fireballs – meteorite falls – public outreach

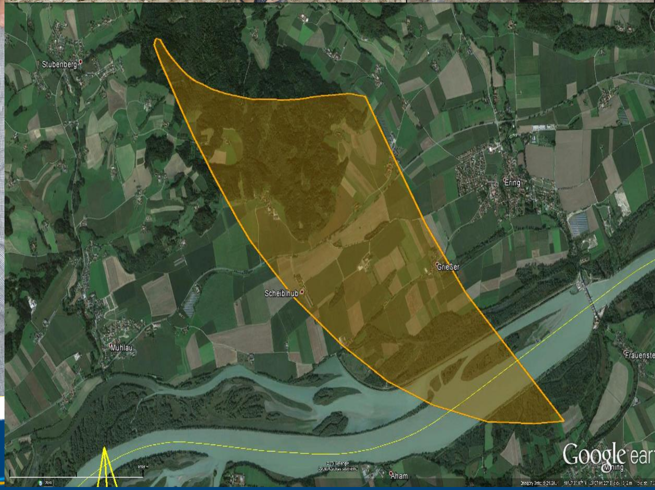
immediate feedback, low threshold to submit reports



Examples

Meteorite ground search

- combined effort (Stubenberg, Germany, 6 March 2016):
  calculation of probable impact area
  ground search (meteorite community)



Examples

Forward scatter radio observations

Yamamoto: detecting meteor echo directions analysing phase differences (software developed for interferometry)

(Yamamoto M., 2016: Exper. Astronomy, 41, 243-257)

BRAMS (Belgian network with beacon)

again: calibration with other data → fluxes

Conclusions: next steps

Confirm predictions from model calculations

observations confirming activity (time and flux)

weak activity level can be detected, flux and mass data available

opposite way: using flux (dust trail) observations to check models

and improve predictions (coop. Vaubaillon, Lyytinen, Maslov)

model streams for different mass ranges (request to model builders)

Complete stream search

positional information: radiants, orbits

physical information: mass index (for different ranges), flux

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Conclusions: next steps

Definitions of terms in meteor astronomy

(see recent paper of Borovička, WGN 2016)

meteor shower (appearance in the sky)

↔ meteoroid stream (group of orbits)

unambiguous designation of a complex phenomenon & structure

streams persist and evolve

showers may appear or not in subsequent years

(DRA; DAU, SPE, …)

Conclusions: next steps

Technical improvements, visibility of meteor work:

higher accuracy in position and time

→ improve orbit accuracy, consider effects like zenith attraction

→ deceleration, fragmentation and ablation data

extending spectral window (balloon Koukal et al. 2016, airborne, several)

conversion meteor magnitude + velocity → mass

(most relies on phot./radar studies, recent by Gritsevich, Weryk, ...)

fireballs: infrasound (Brown → amat.), but electrophonic sound detectors?

keep the PAWG and meteor shower naming groups active

public outreach and interaction with observers / reporters

see presentations IMC 2017, Meteoroids 2019


Thank you