On the frequency of the superfireballs: >150 years of reports

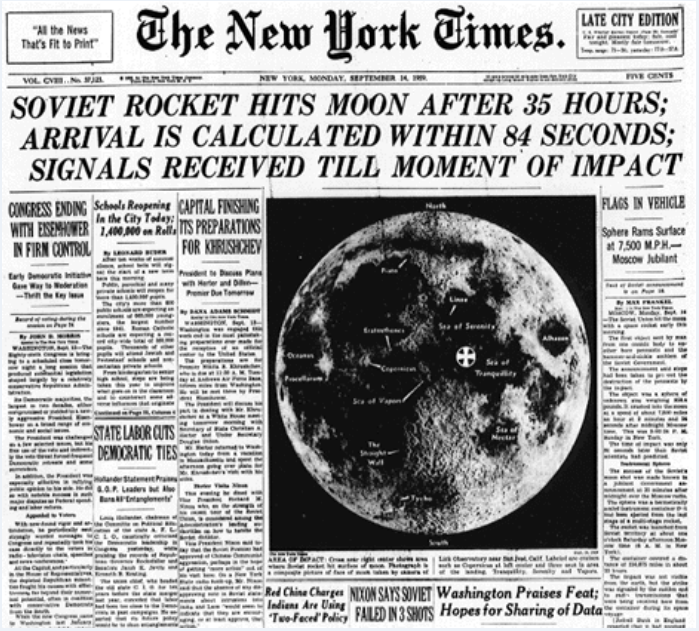
Sandra Zamora, **Francisco Ocaña**,
Alejandro Sánchez de Miguel, Maruška Mole

29th August - IMC 2015
Mistelbach, Austria

Image: Alex Alishevskikh

Introduction

- Fireballs have been repeatedly reported and documented through the years, cultures, etc.



"All the News That's Fit to Print"

The New York Times.

LATE CITY EDITION

VOL. CVIII . No. 37,125. NEW YORK, MONDAY, SEPTEMBER 14, 1959. FIVE CENTS

SOVIET ROCKET HITS MOON AFTER 35 HOURS; ARRIVAL IS CALCULATED WITHIN 84 SECONDS; SIGNALS RECEIVED TILL MOMENT OF IMPACT

CONGRESS ENDING WITH EISENHOWER IN FIRM CONTROL

Early Democratic Initiative Gave Way to Moderation —Thrift the Key Issue

Schools Reopening In the City Today; 1,400,000 on Rolls

CAPITAL FINISHING ITS PREPARATIONS FOR KHRUSHCHEV

President to Discuss Plans with Herter and Dillon— Premier Due Tomorrow

STATE LABOR CUTS DEMOCRATIC TIES

Hollander Statement Praises G.O.P. Leaders but Also Bars All 'Entanglements'

FLAGS IN VEHICLE

Sphere Rams Surface at 7,500 M.P.H.— Moscow Jubilant

Red China Charges Indians Are Using 'Two-Faced' Policy

NIXON SAYS SOVIET FAILED IN 3 SHOTS

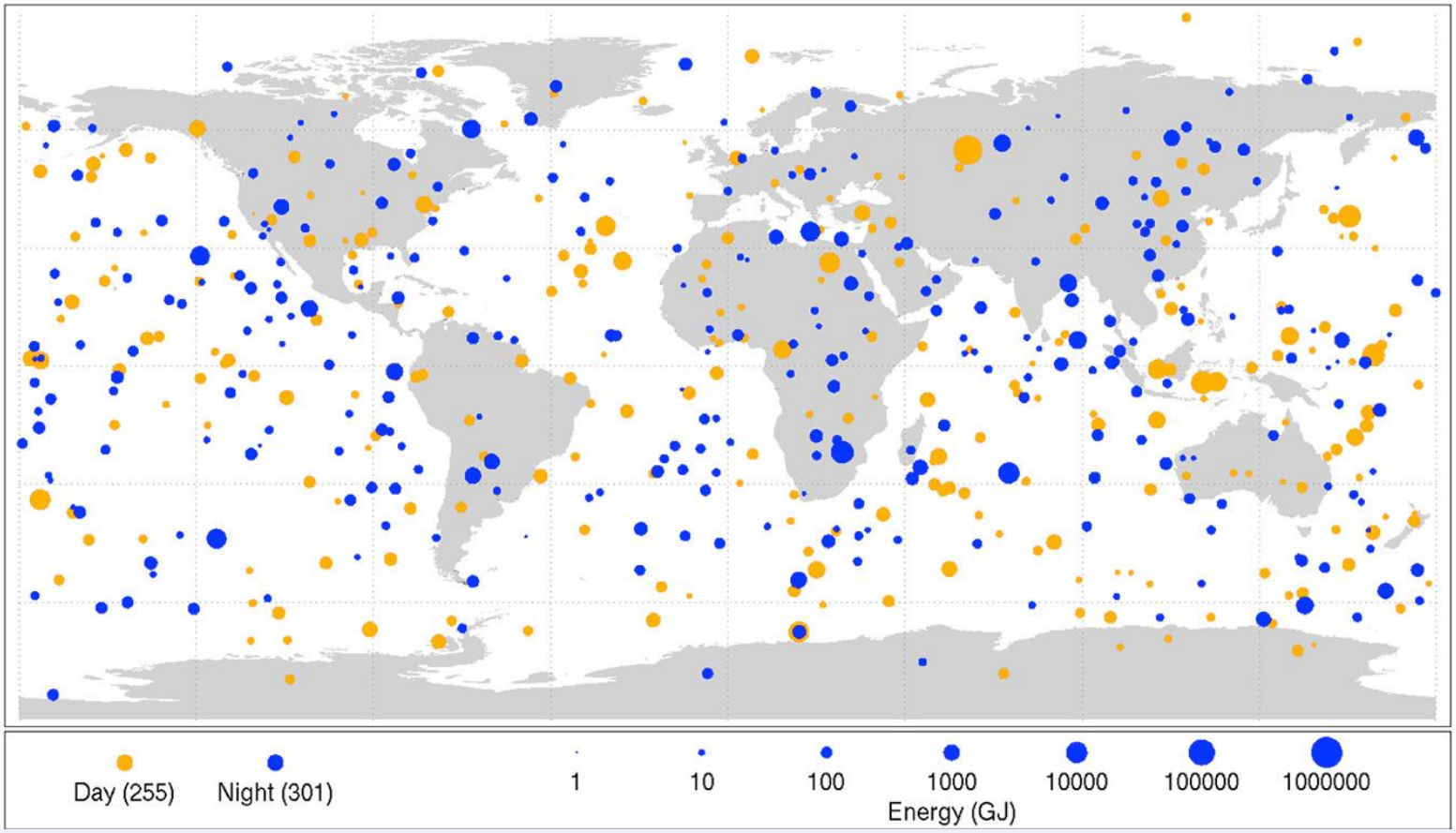
Washington Praises Feat; Hopes for Sharing of Data

- Digitalisation of sources like **newspapers** it opens vast possibilities on the meteor research

- Most of the events recorded in news papers are **'as bright as full moon'** or brighter. We call all of them **'superfireballs'** though there is no consensus on the limit for such a category (some authors brighter than -17)

Bolide Events 1994–2013

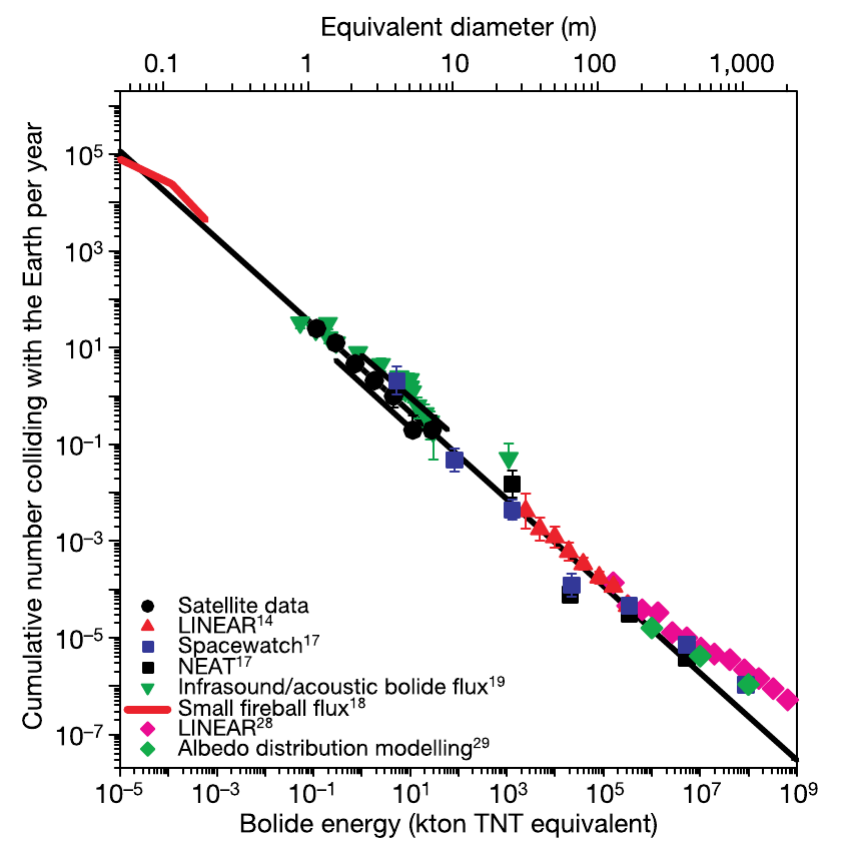
(Small Asteroids that Disintegrated in Earth's Atmosphere)



1 ton of TNT = 4 GJ ~ magnitude -13 ~ 10^4 kg ~20cm

JPL Press Release http://www.jpl.nasa.gov/news/news.php?release=2014-397

Previous works



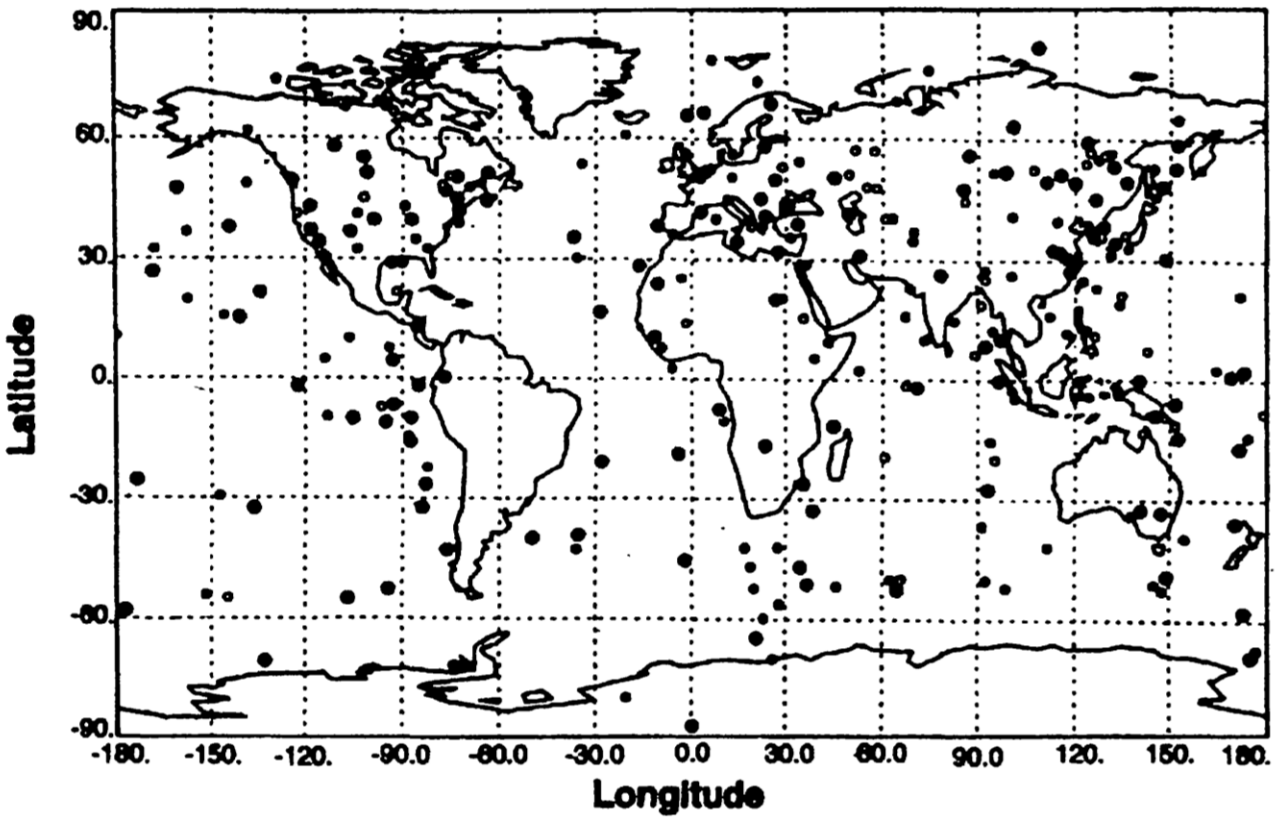
Brown et al. 2002

- Around the ‘superfireballs’ category we have a gap in the meteoroid influx
- They are too scarce for ground networks, and/or too dim for satellite detection

Previous works

- *Denning, 1912* – 429 fireballs end of XIXth and beginning XXth century
- *Astapovic & Terentjeva, 1968* – Fireballs 1-15th centuries (mainly 12th century) – 1220 fireballs
- *Terentjeva, 1989* – Fireballs streams – 554 fireball from MORP and Prairie networks 2nd half XXth century
- *Beech, 2006* – 2373 fireballs Millman Fireball Archive

Previous works



- 287 events
- 1972 to 1997
- DoD satellites (IR)

Ceplecha et al. 1999

Citizen science

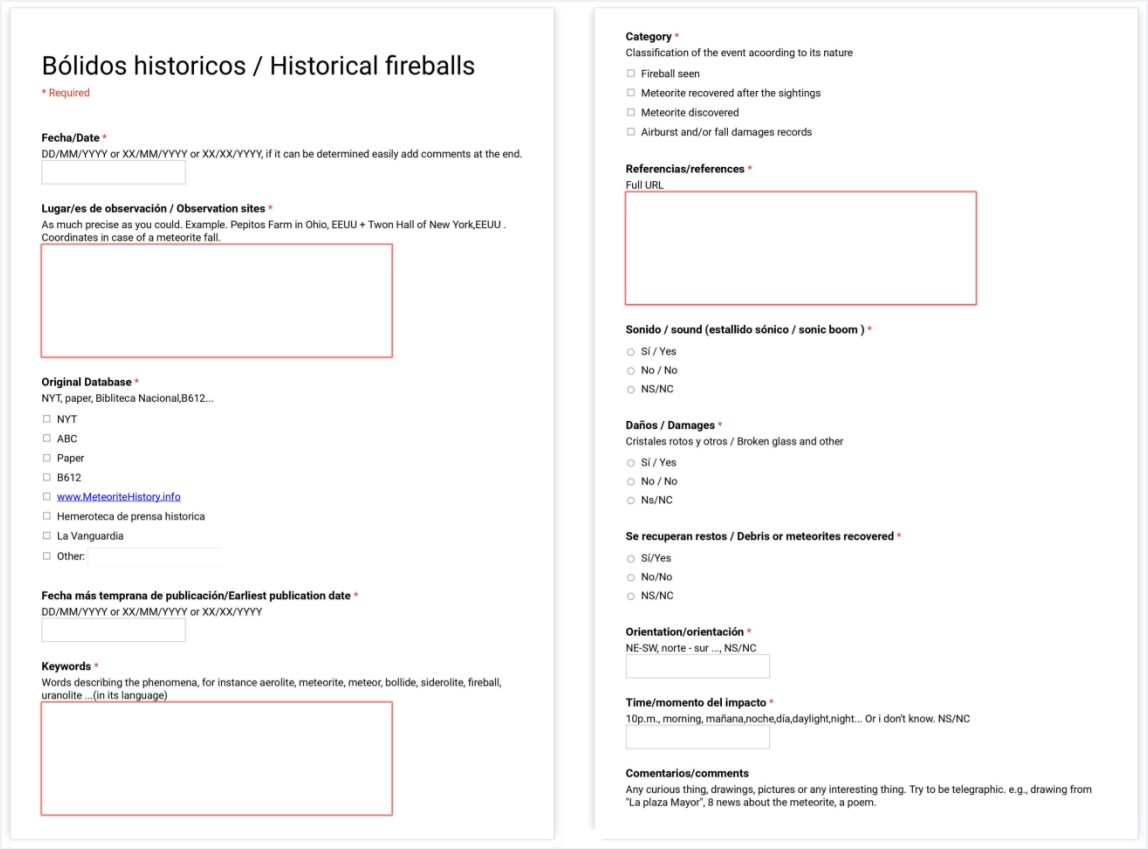
Project ‘Historical fireballs’

- Collaboration of undergraduate students of the Faculty of Physics and members of the University astronomical club of the Complutense University ASAAF-UCM
- Future crowdsourcing
- Recompilation, analysis and software
- Introduction to science world: 2 national conferences (May/Sept 2014), press release (Dec 2015), paper in outreach magazine (Jan 2015), international conference (Aug 2015)

Team: Alejandro Sánchez de Miguel (UCM), Francisco Ocaña (UCM), Sandra Zamora (ASAAF), Maruška Mole (UNG), Carlos E. Tapia (ASAAF), Alejandro Santamaría (ASAAF), Abel de Burgos (ASAAF), Clara Lorenzo (ASAAF), Marina Tsvetanova Petrova (ASAAF) y Guillermo Herráiz (ASAAF), +10 more

Method

- Elaboration of the databases – Google forms
- Source selection
- Statistical analysis
- Software development



Bólidos historicos / Historical fireballs

* Required

Fecha/Date *
DD/MM/YYYY or XX/MM/YYYY or XX/XX/YYYY, if it can be determined easily add comments at the end.

Lugar/es de observación / Observation sites *
As much precise as you could. Example. Pepitos Farm in Ohio, EEUU + Twon Hall of New York,EEUU . Coordinates in case of a meteorite fall.

Original Database *
NYT, paper, Bibliteca Nacional,B612...
- ☐ NYT
- ☐ ABC
- ☐ Paper
- ☐ B612
- ☐ www.MeteoriteHistory.info
- ☐ Hemeroteca de prensa historica
- ☐ La Vanguardia
- ☐ Other:

Fecha más temprana de publicación/Earliest publication date *
DD/MM/YYYY or XX/MM/YYYY or XX/XX/YYYY

Keywords *
Words describing the phenomena, for instance aerolite, meteorite, meteor, bollide, siderolite, fireball, uranolite ...(in its language)

Category *
Classification of the event acoording to its nature
- ☐ Fireball seen
- ☐ Meteorite recovered after the sightings
- ☐ Meteorite discovered
- ☐ Airburst and/or fall damages records

Referencias/references *
Full URL

Sonido / sound (estallido sónico / sonic boom) *
- ○ Sí / Yes
- ○ No / No
- ○ NS/NC

Daños / Damages *
Cristales rotos y otros / Broken glass and other
- ○ Sí / Yes
- ○ No / No
- ○ Ns/NC

Se recuperan restos / Debris or meteorites recovered *
- ○ Sí/Yes
- ○ No/No
- ○ NS/NC

Orientation/orientación *
NE-SW, norte - sur ..., NS/NC

Time/momento del impacto *
10p.m., morning, mañana,noche,día,daylight,night... Or i don't know. NS/NC

Comentarios/comments
Any curious thing, drawings, pictures or any interesting thing. Try to be telegraphic. e.g., drawing from "La plaza Mayor", 8 news about the meteorite, a poem.

Databases

5 databases – 2393 fireballs

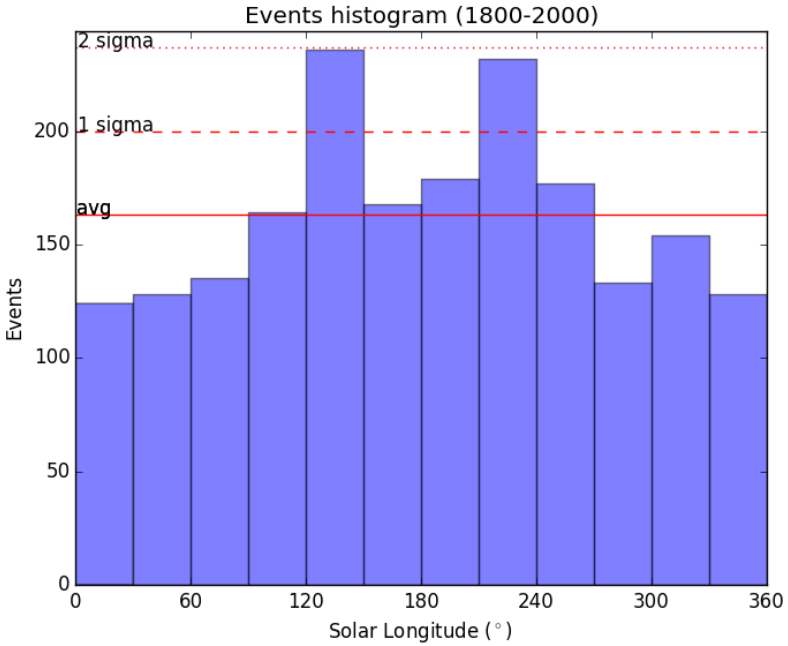
- NYT -- 377 events – 1800-2000
- Biblioteca Nacional – 70 events – 1850-1900
- ADS (papers) – 107 events – 1900-2000
- Others – 205 events – 1800-2000

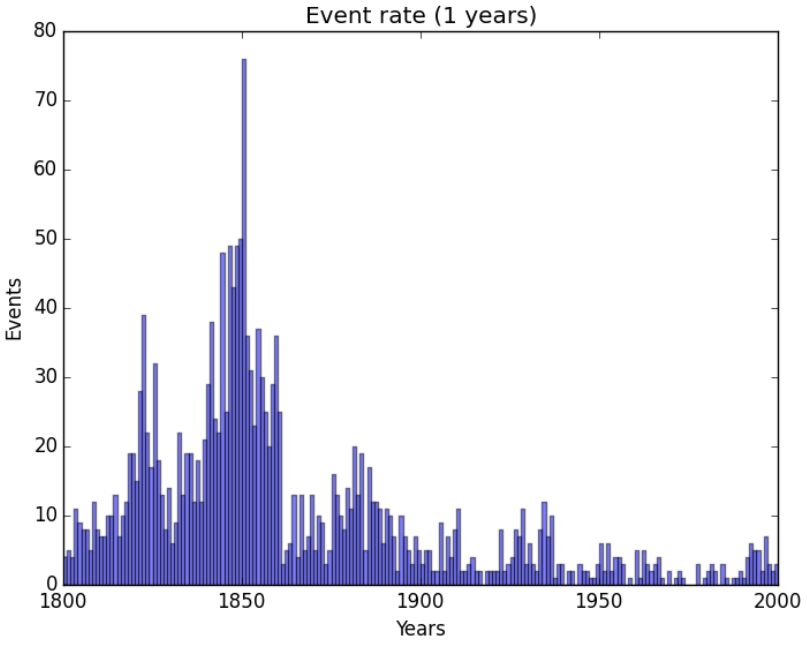
- BAAS – 1634 events – 400-2000

Time, place, reference (link to the source), other data (sonic boom?, damage?)

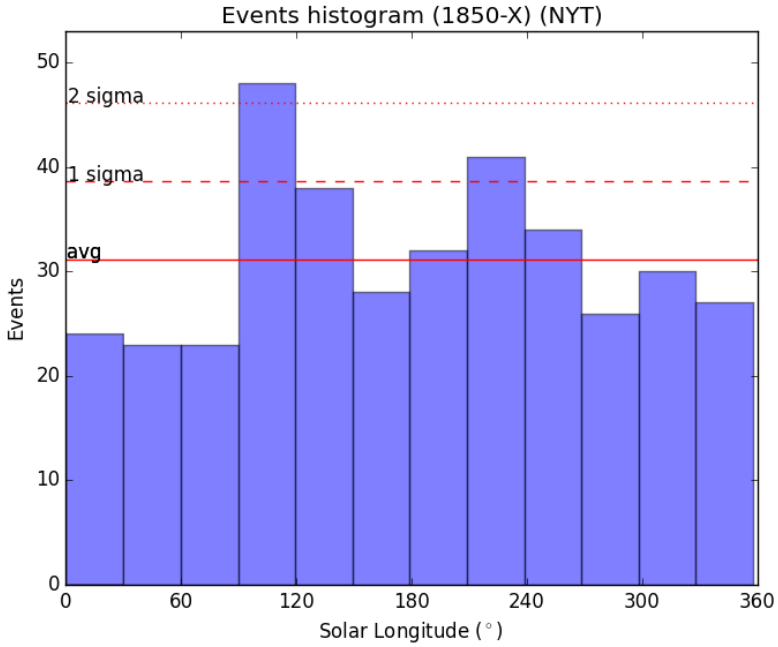
Different biases (geographical, time, duration) – all of them show similar results

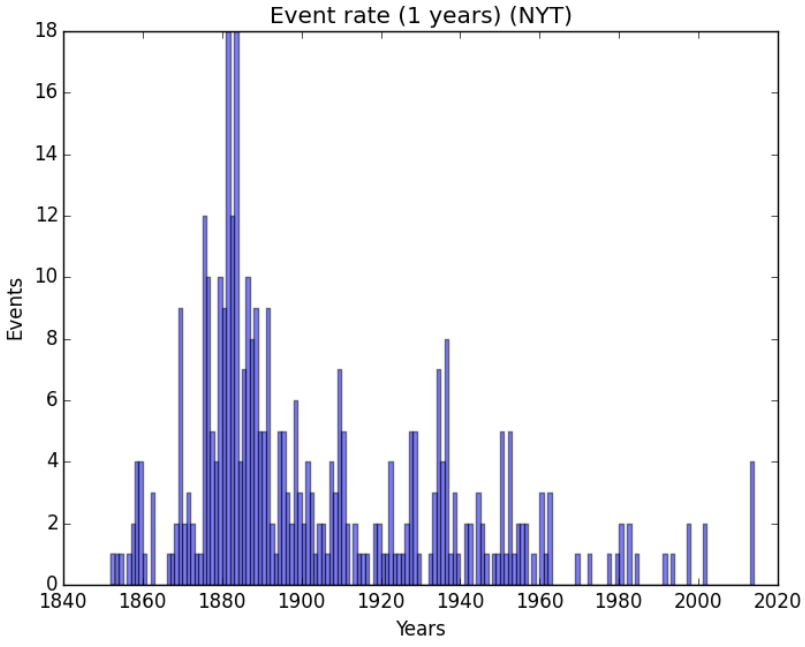
Databases - All



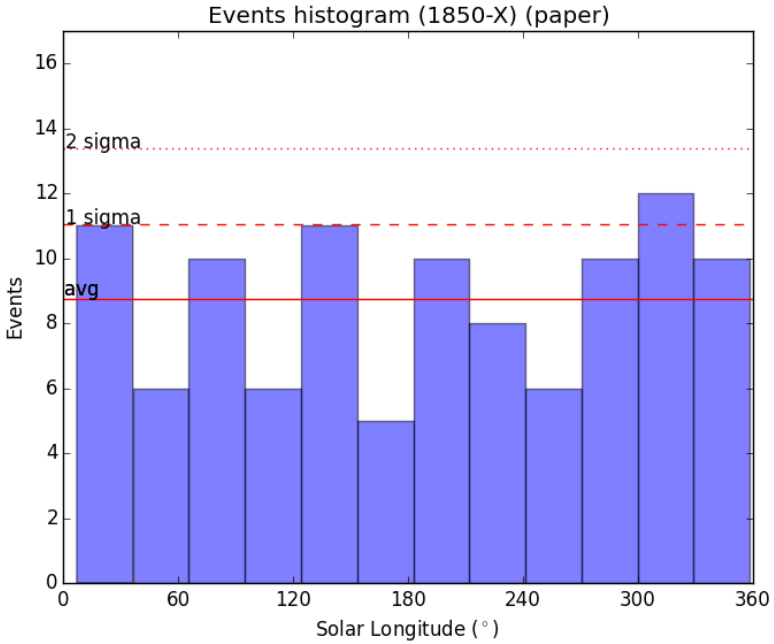


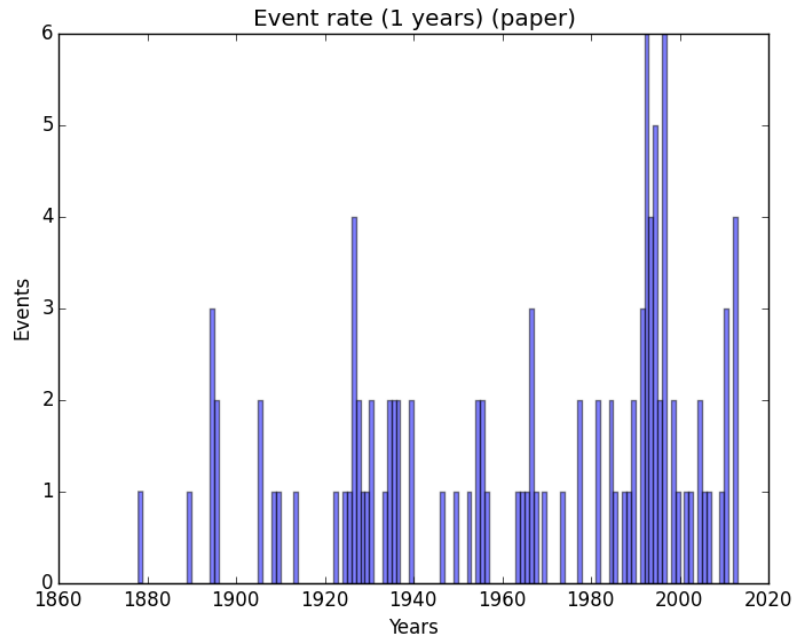
Databases - NYT





Databases - ADS

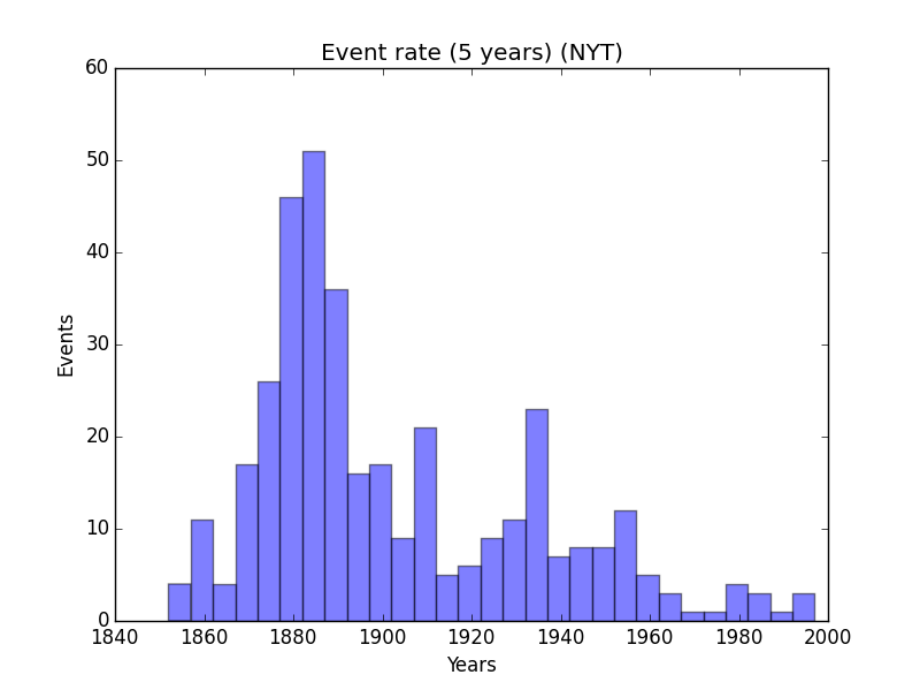


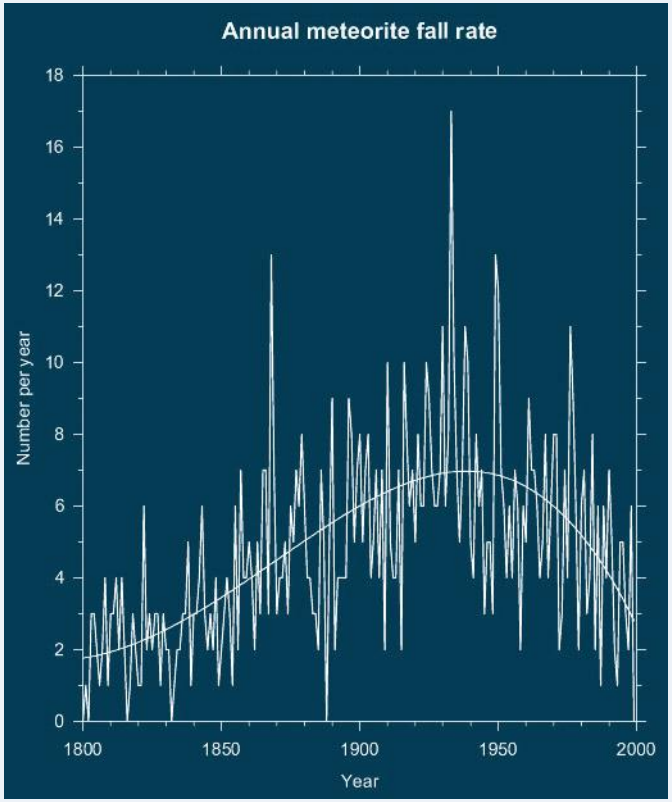


Results I

Beech M., 2002

Superfireball rate along the decades

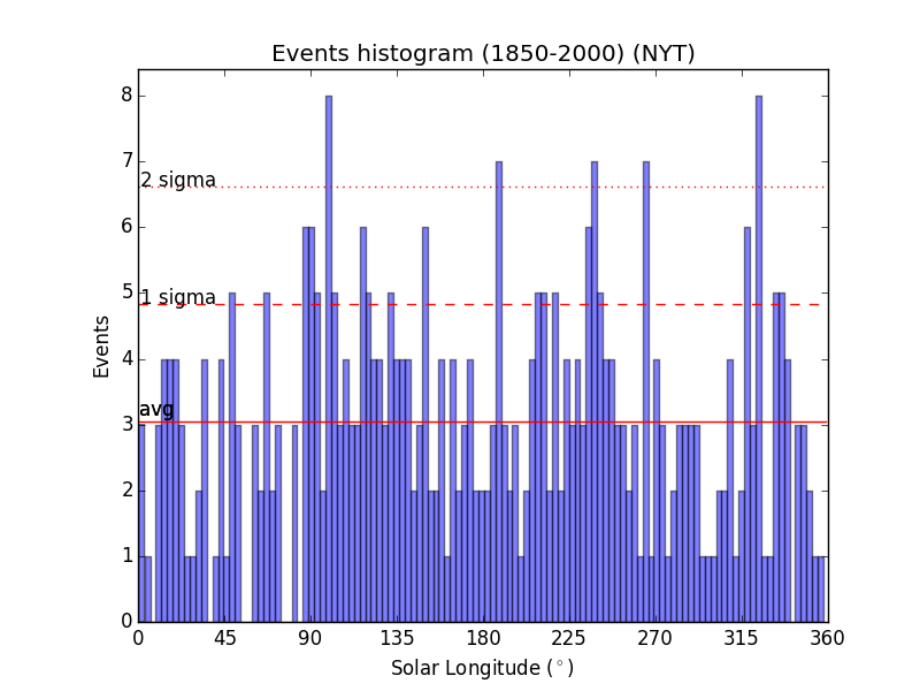




Not adequate database for absolute numbers!

Results II

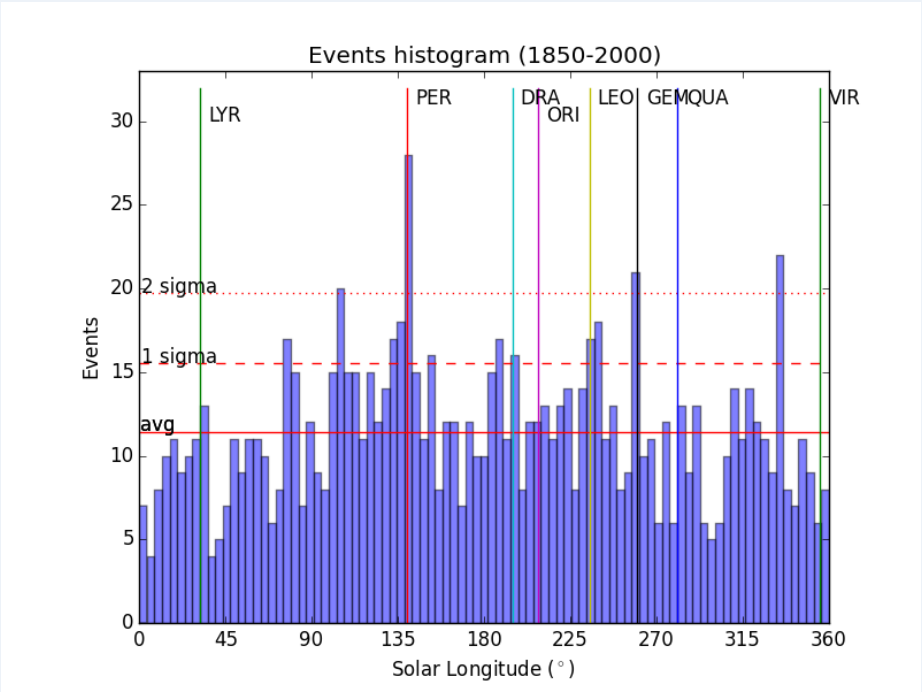
Superfireballs along the year

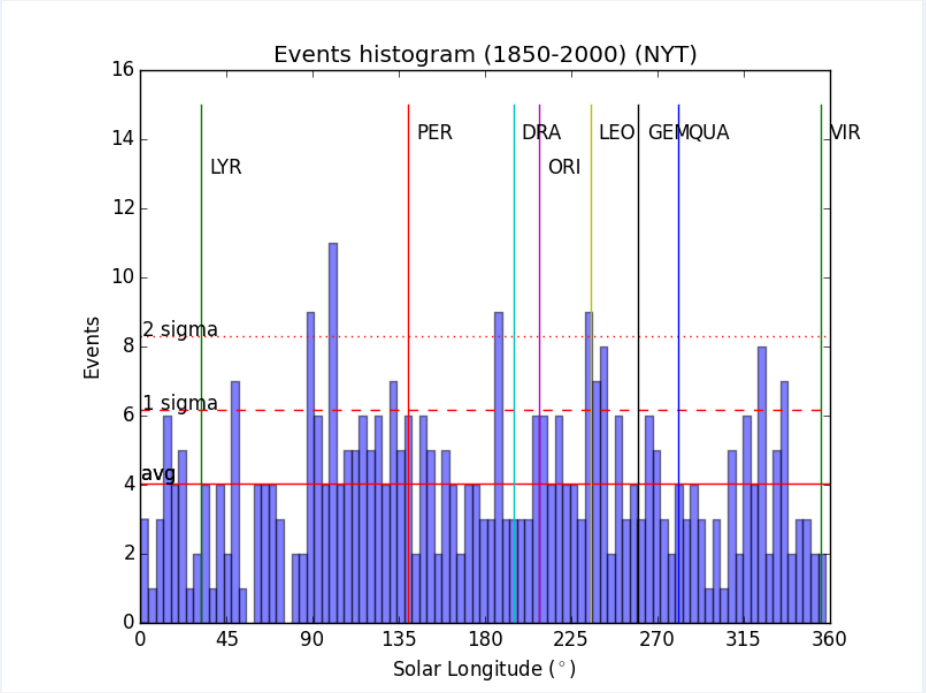


NYT database (only SF). There may be superfireball streams!

Results IIIa

Superfireballs and meteors showers

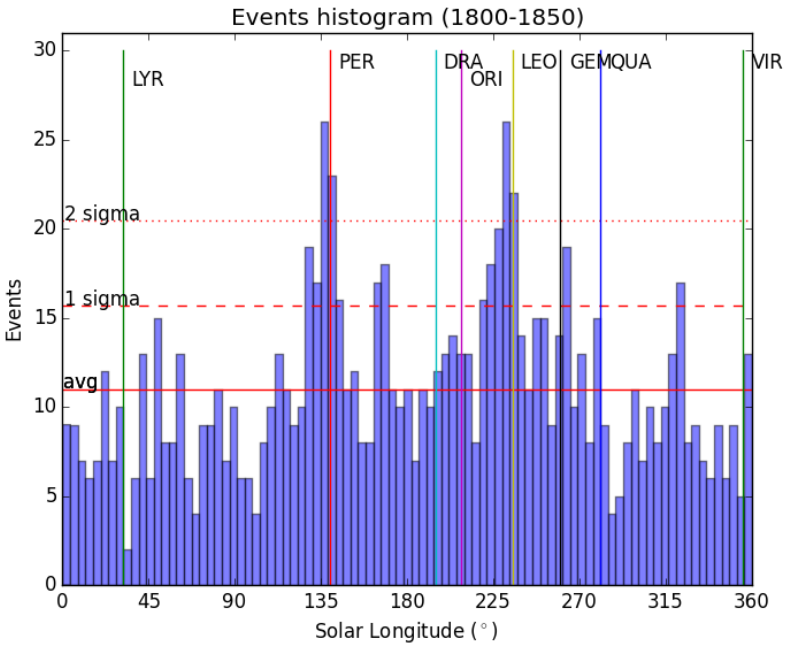


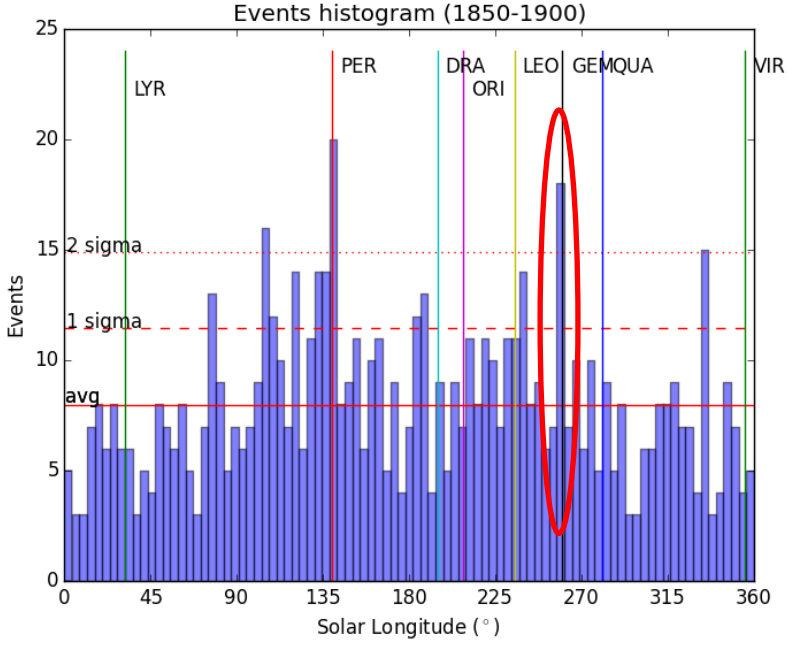


All databases (fireballs included) vs NYT (superfireballs only).

Results IIIb

Superfireballs and meteors showers





All databases (fireballs included). Geminids. Before and after 1850.

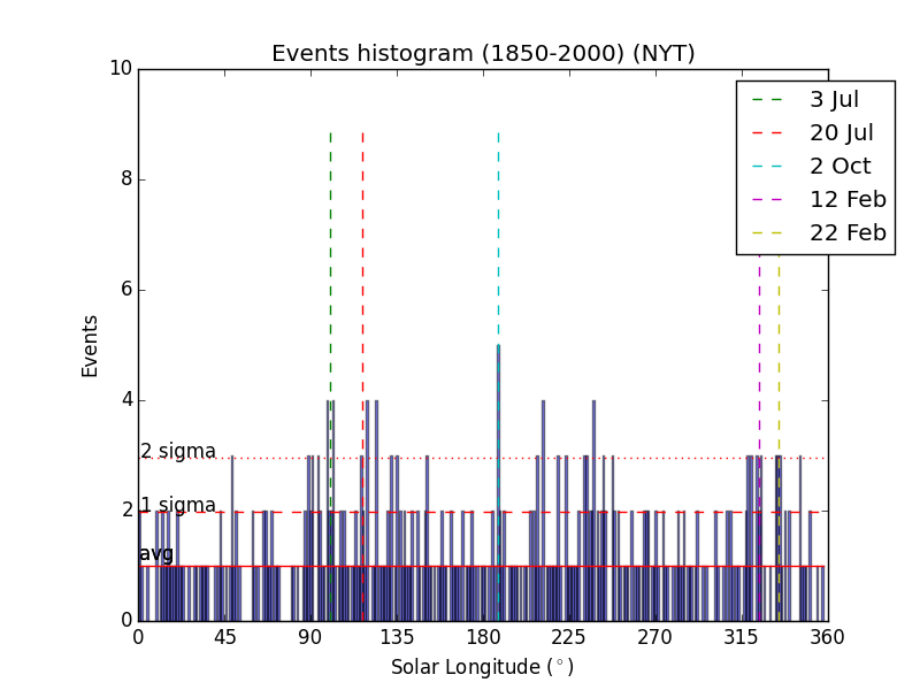
Results IVa

Possible superfireballs streams

- Feb 14
- Feb 22
- July 3
- July 20
- Oct 2

- Do such streams exists?
- How ‘wide’ are them?

  Bin size importance!
- How long do they last?

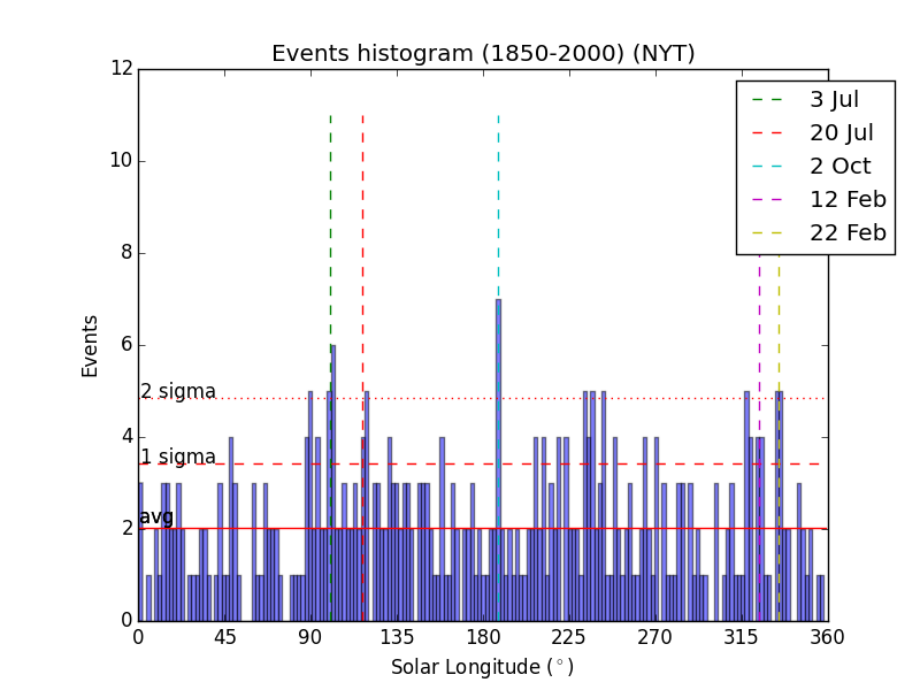


NYT db. 1-day bin (prob. undersampled)

Results IVb

Possible superfireballs streams

- Feb 14
- **Feb 22**
- **July 3**
- July 20
- **Oct 2**

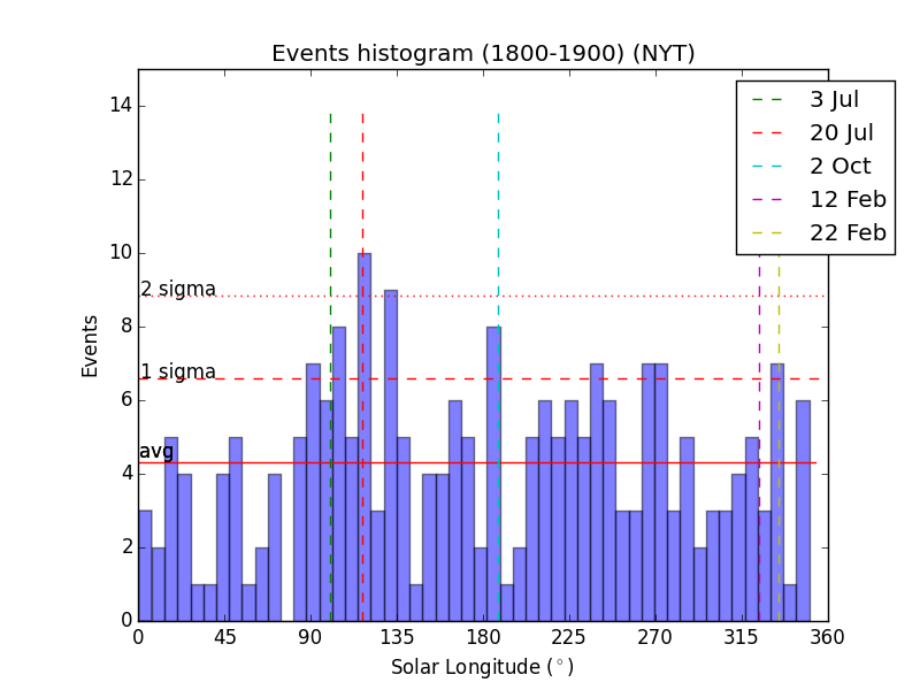


NYT db. 2-day bin. July 3 and Oct 2 streams

Results IVc

Possible superfireballs streams

- Feb 14
- Feb 22
- July 3
- **July 20**
- Oct 2



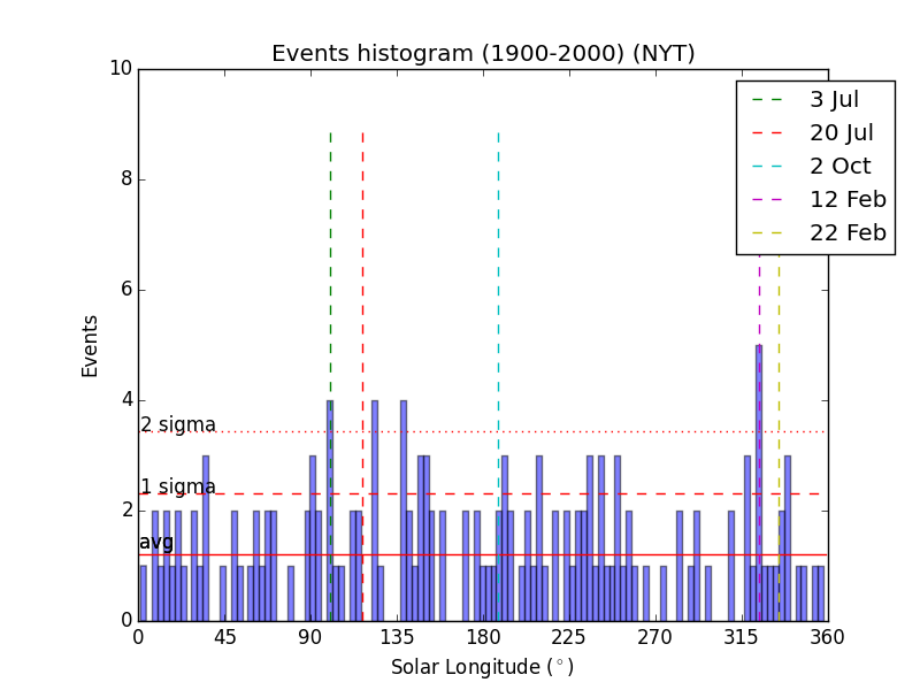
NYT db. 7-day bin. 1800-2000. July 20 stream!

The Meteor of 1860 by Frederic Church (observed the 20th July 1860)

Results IVd

Possible superfireballs streams

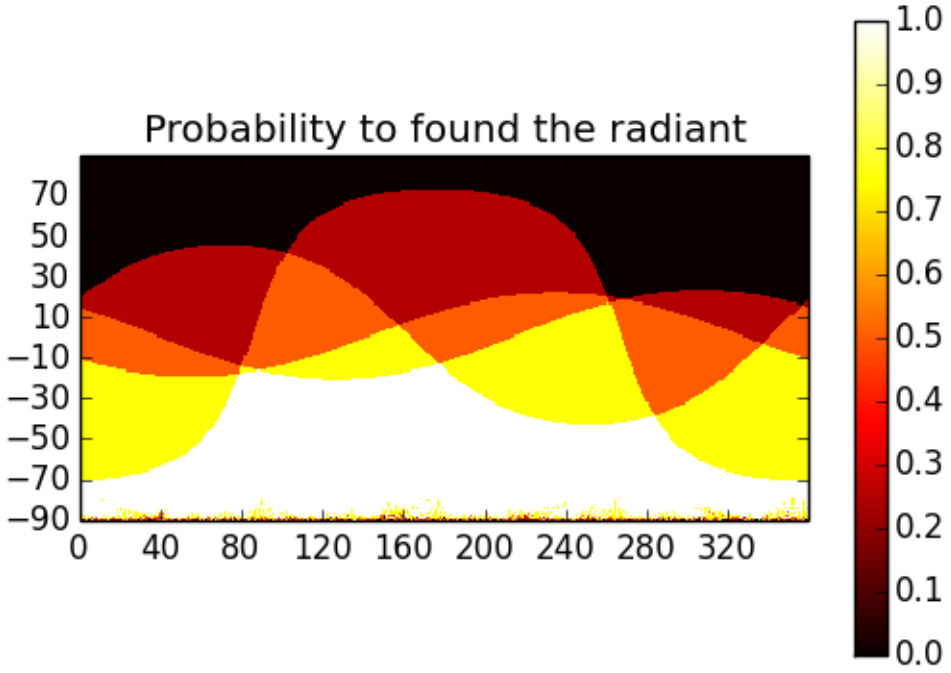
- **Feb 14**
- Feb 22
- **July 3**
- July 20
- Oct 2



NYT db. 3-day bin. **XXth century**. 14th Feb

Pinpointing radiants I

Location + local sky at the moment of observation

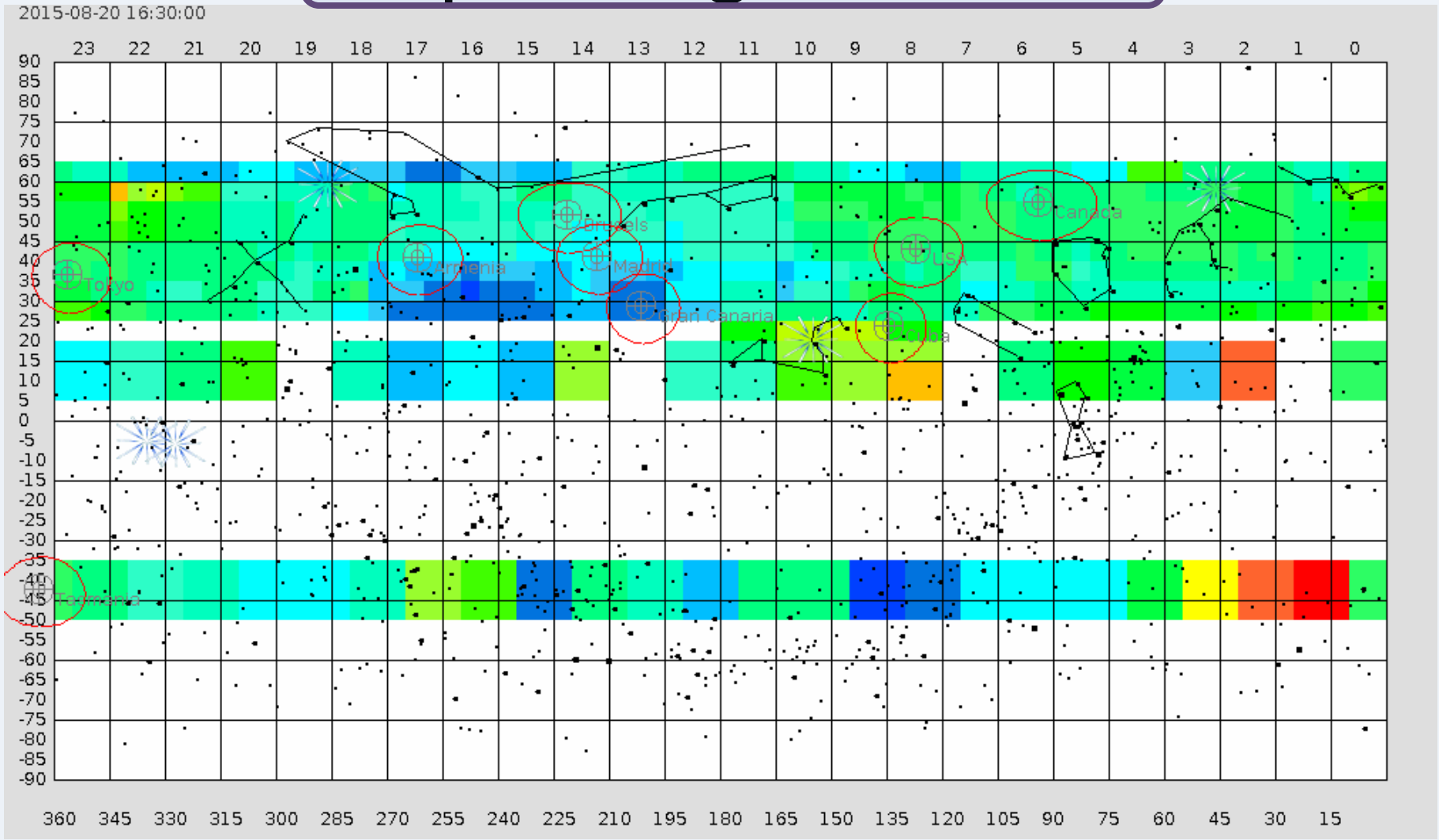


4 fireballs from JPL database observed at Southern Hemisphere

Discussion:

probability function (higher with radiant at zenith?)

Pinpointing radiants II



RaMAP (Radio Meteor Activity Projection) . Esteban Holgado N. www.rmob.org

Future work

- Complete databases
- More data gathering (different languages)
- Statistical analysis
- Maps for radiant search
- Eliminating biases
- Compare current news pieces to DoD satellites

Conclusions / Discussion

A **lot of data available**: still to be gathered and analysed!

Superfireballs streams missing faint meteors.

Is that possible? We have found five candidates:

- Jul 3
- Oct 2
- Feb 22
- Jul 20
- Feb 14

Citizen science: Let's collaborate! The **importance of the language**.

On the frequency of the superfireballs: >150 years of reports

Sandra Zamora, **Francisco Ocaña**,
Alejandro Sánchez de Miguel, Maruška Mole

29th August - IMC 2015
Mistelbach, Austria

Image: Alex Alishevskikh