

NEMO

A Global Near Real-time Fireball Monitoring System

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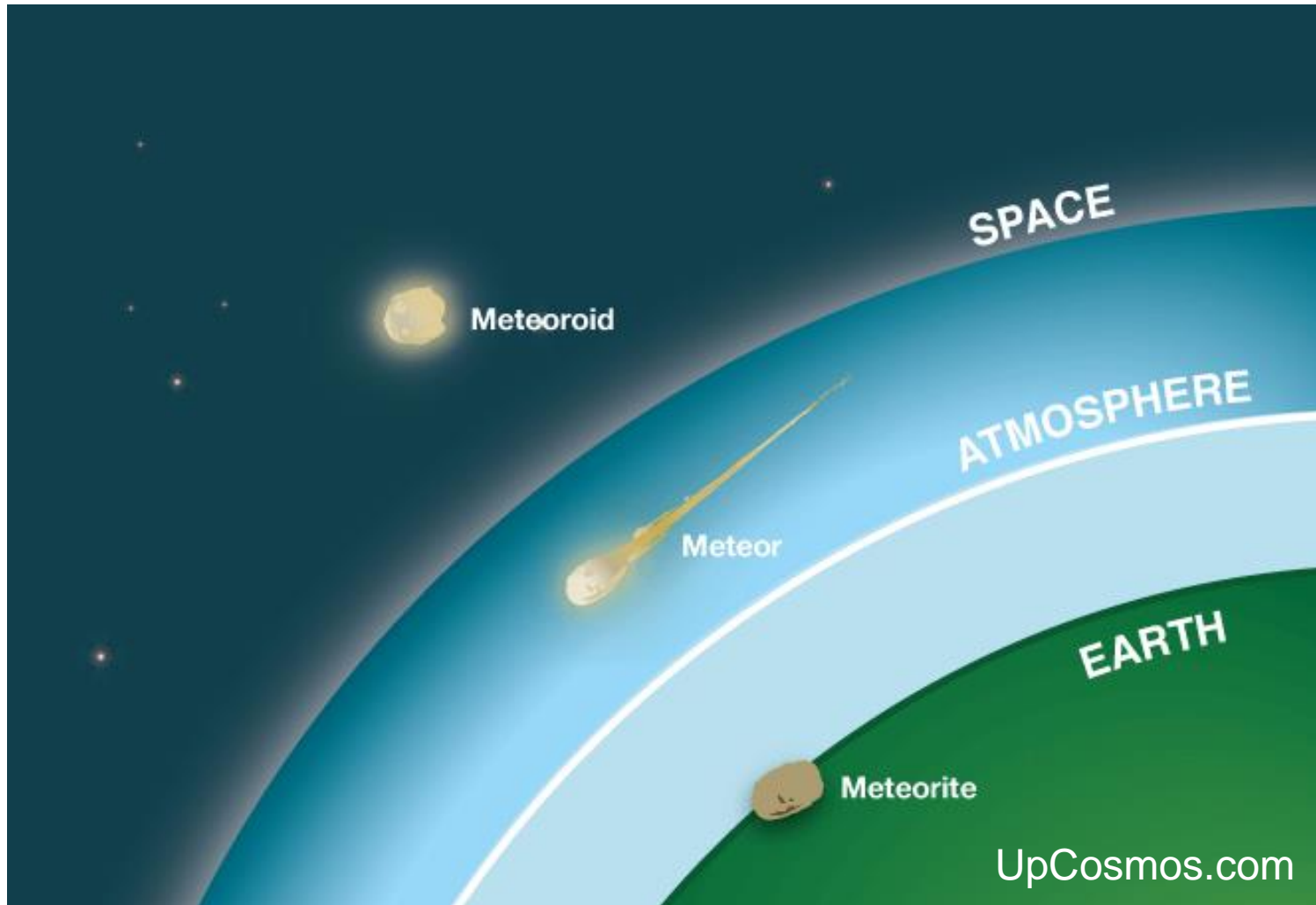
Shooting Stars

Schlegels Stausee - Zillertaler Alpen - Blick nach Süden
11.01.18 03:45 -4.0°C (f/3.5 30s iso3200)

Verbund



Meteor Research



Meteor Research

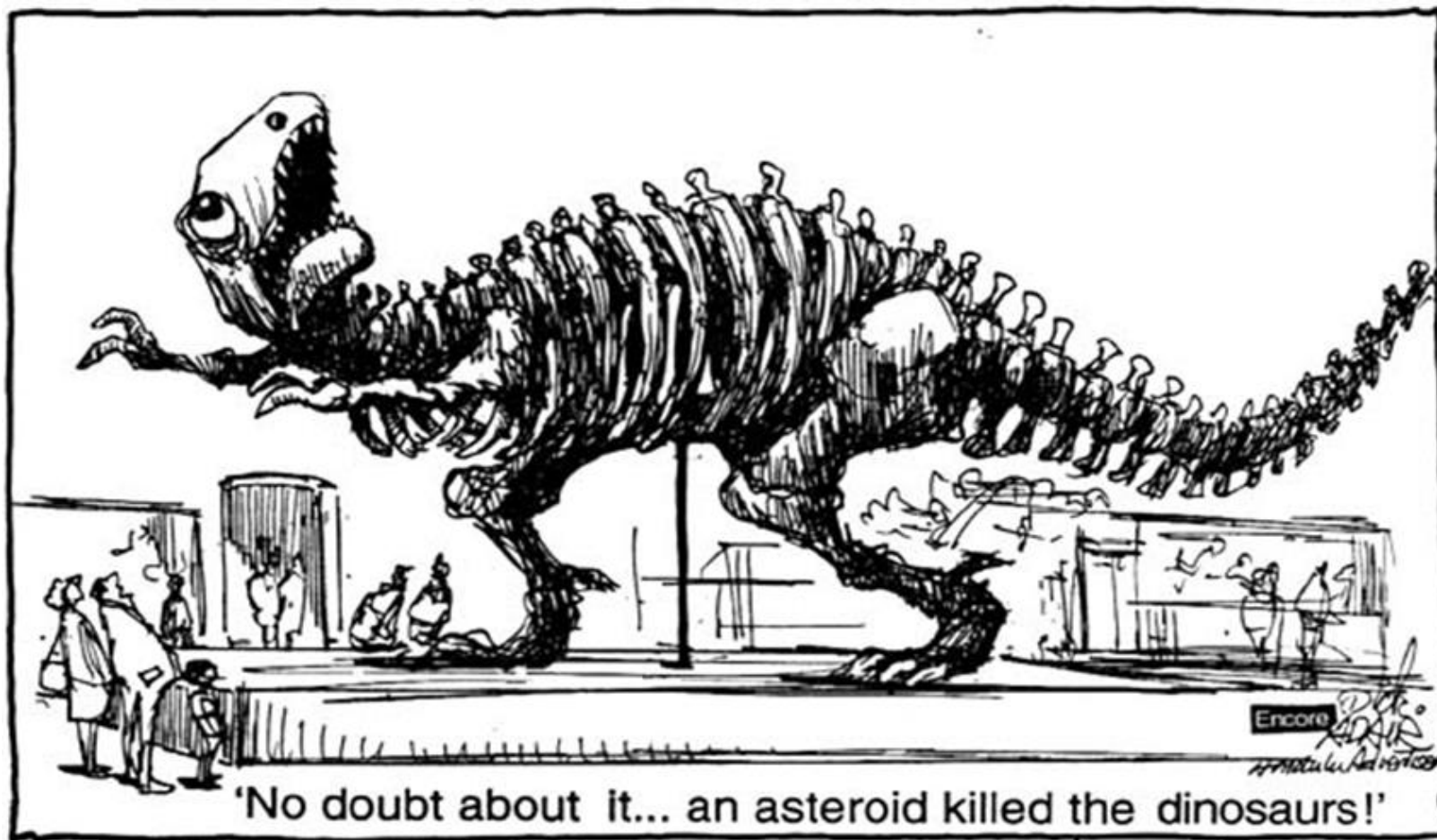
Chelyabinsk ≈ 20 m



Meteor Research Chelyabinsk ≈ 20 m



So...
why should we care?



Near real-time MOnitoring system

Interested in objects that

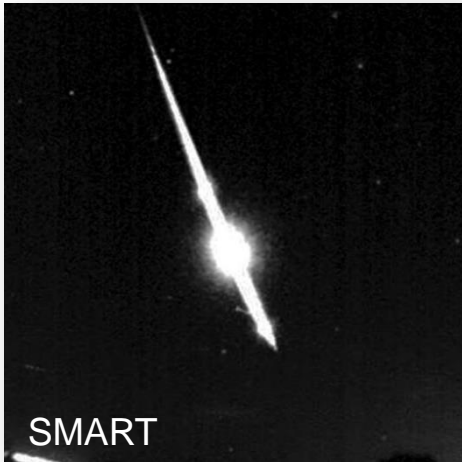
- regularly impact the Earth atmosphere
 - are too small to be detected by NEO surveys
 - cause bright fireballs
- Validate models of meteoroid fluxes and the near-Earth asteroid population
- Close the gap between large meteoroids and small asteroids



Chelyabinsk fireball
15. Feb. 2013

Coordination with FIS

Events brighter –10 mag



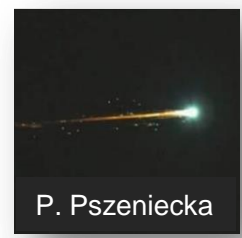
Fireball Information System
from Space Situational
Awareness
– near-Earth object (NEO)

Who is interested in the data?

- Planetary Defence Office (ESA)
- Planetary Defense Coordination Office (NASA)
- IAWN (International Asteroid Warning Network)
- BGR (Federal Institute for Geosciences and Natural Resources)
- The Public i.e. IMO (International Meteor Organisation)

Main Objective

Fireball Sighting



Brighter
-10 mag

Current Situation



NEMO

Data sources

- Data from infrasound stations of the CTBTO –Comprehensive Nuclear-Test-Ban Treaty Organisation using vDEC
- Publicly available data from US Government sensors
- Re-entry predictions of satellites and space debris
- Internet and social media
- Meteor networks



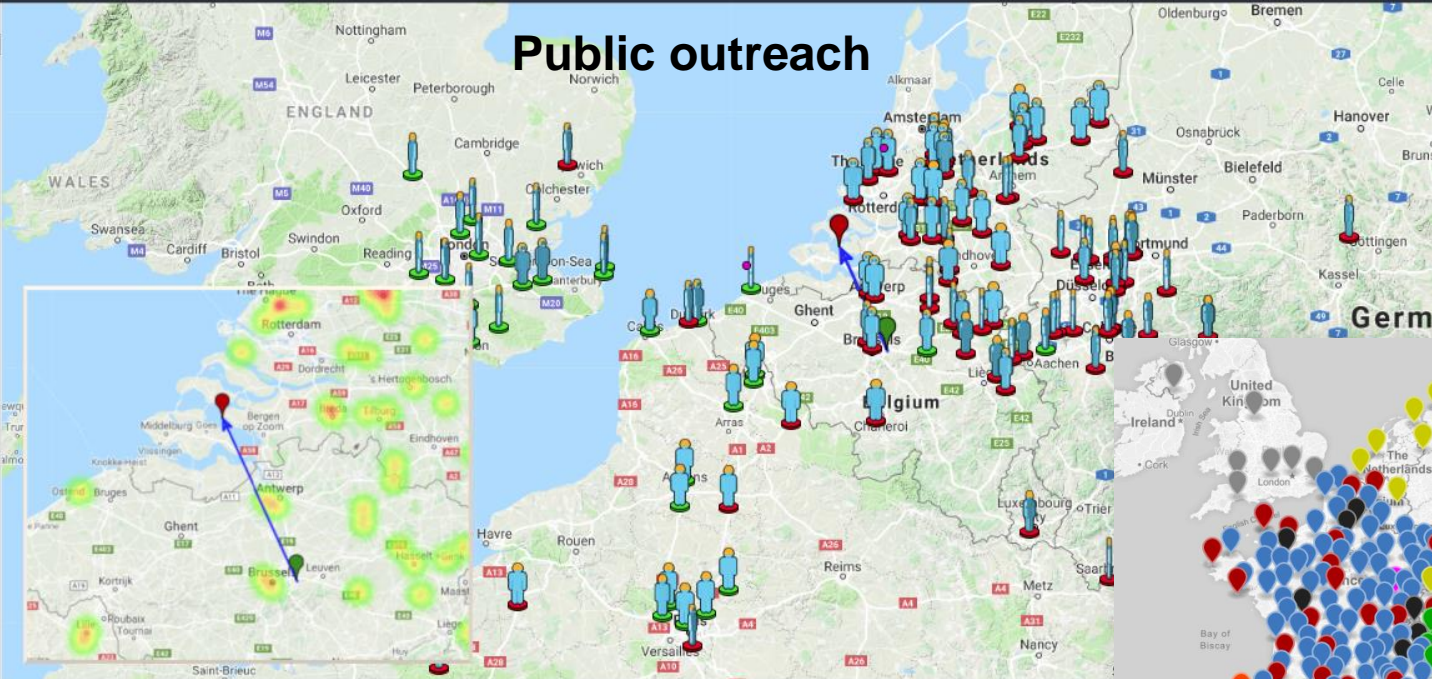
Some specific goals

Europe: Objects > 10 cm



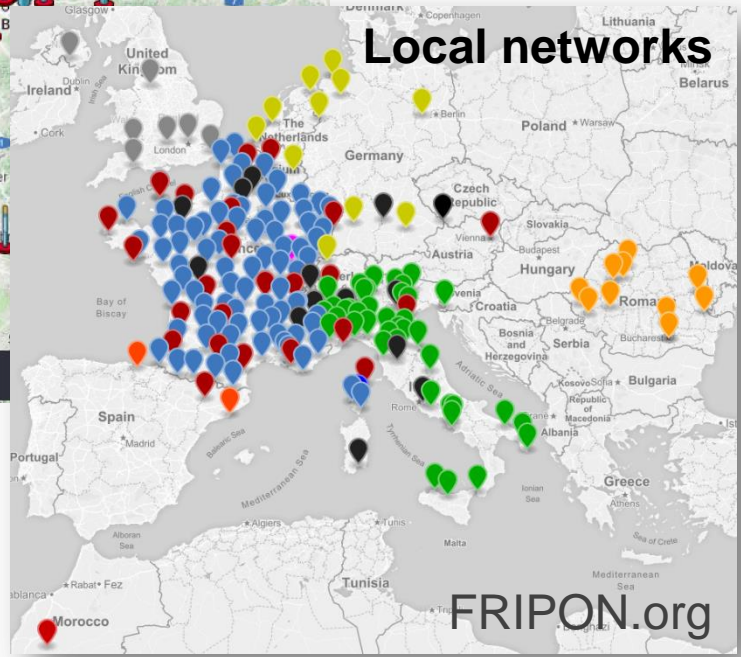
Local Meteor Detectors

IMO International Meteor Organization Event#741-2019 Witness Locations and Est. ground trajectory



www.imo.net

15 February 2019 – the Netherlands



Some specific goals

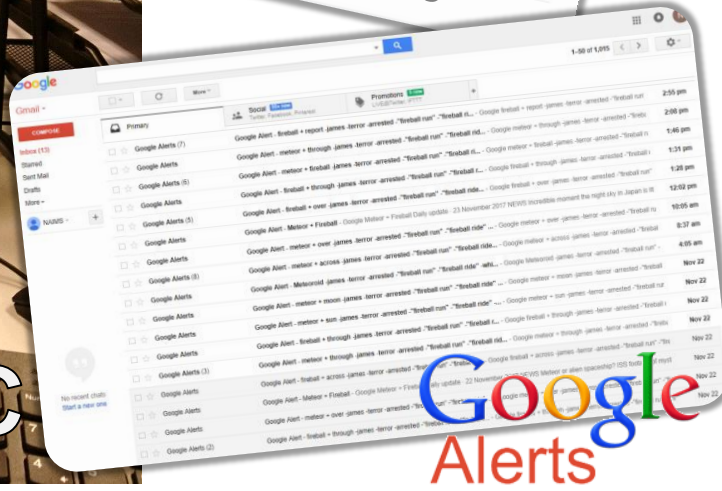
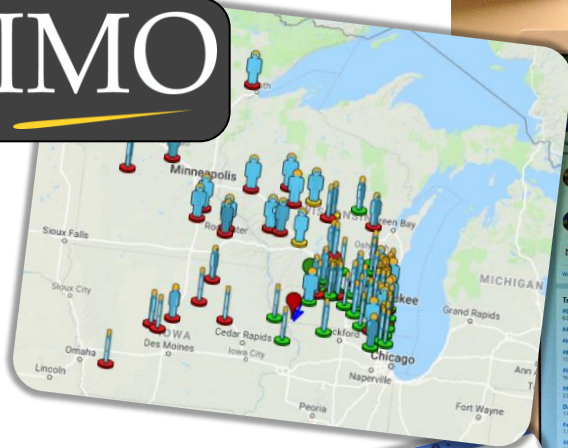
Global: Objects > ca 1 m



Social Media



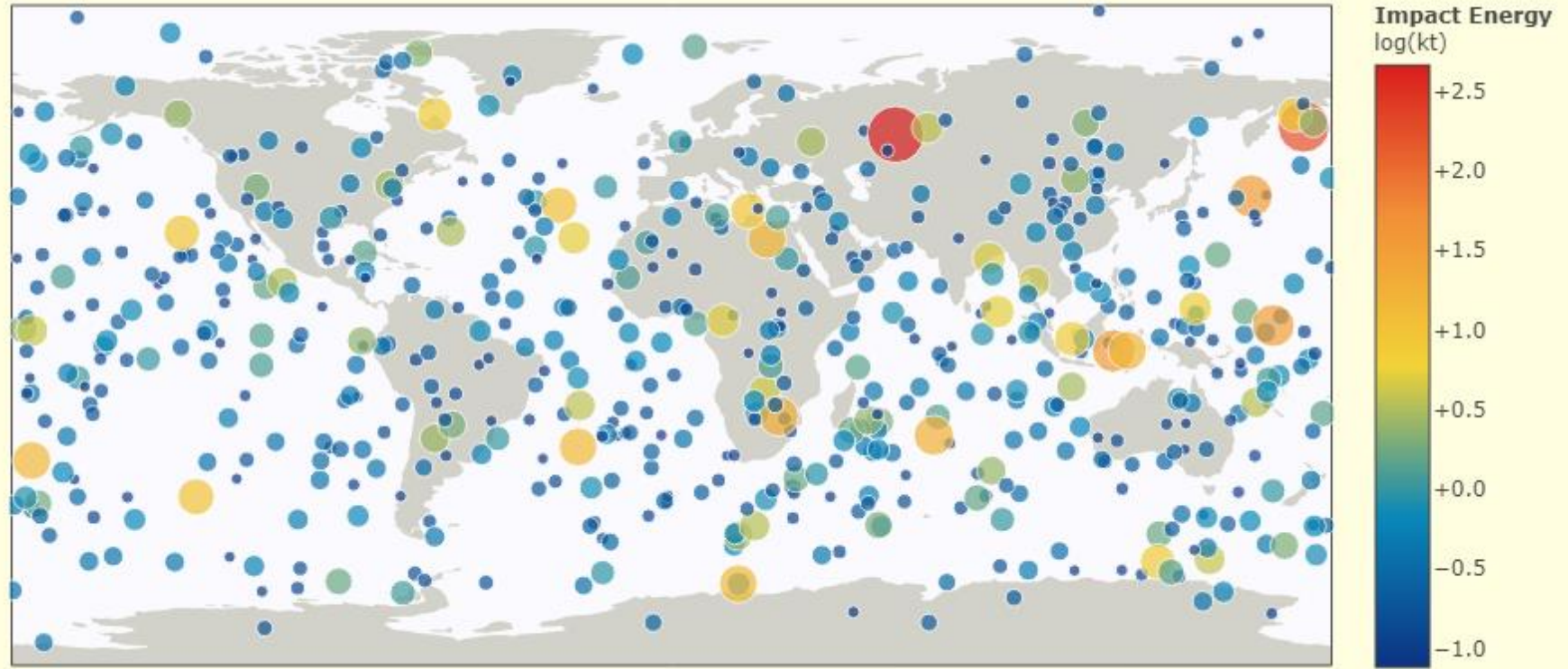
IMO



The NEMO-PC

Google Alerts

NASA US Govt. Satellite Data



<https://cneos.jpl.nasa.gov/fireballs/>

Alan B. Chamberlin (JPL/Caltech)

From CNEOS (Center for NEO Studies) at JPL (Jet Propulsion Laboratory)

CTBTO

IMS (International Monitoring System) - Infrasound

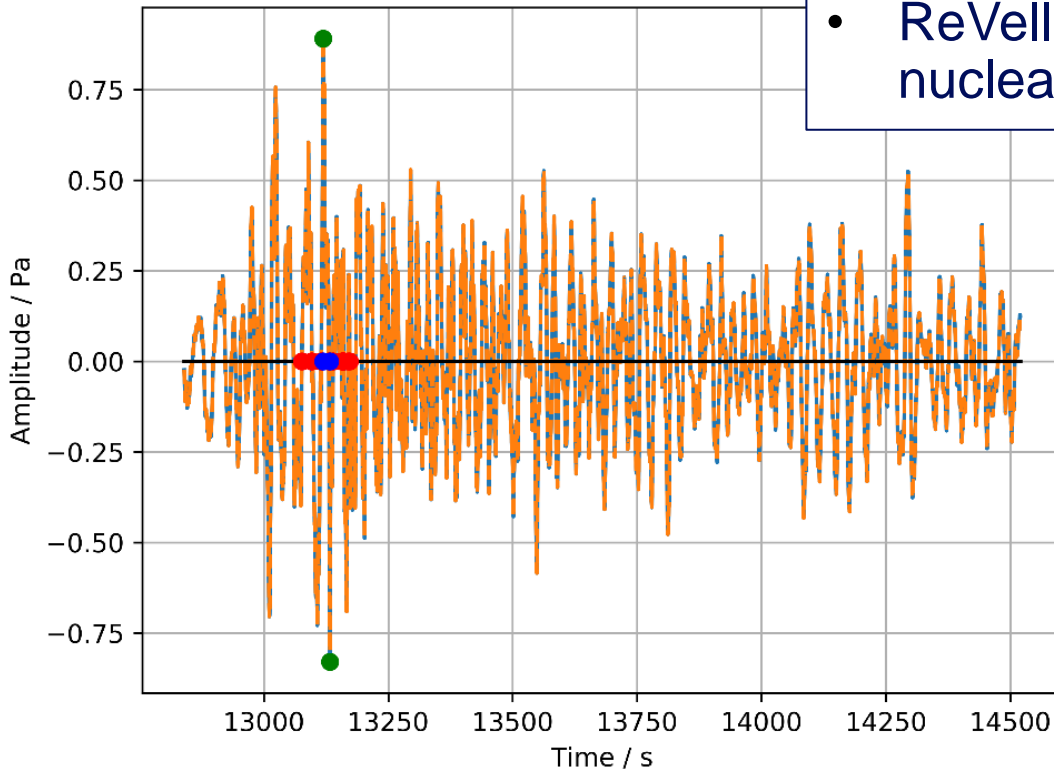


Bright fireball reported
➔ Infrasound data is
requested from BGR

CTBTO

IMS (International Monitoring System) - Infrasound

- Meteor signal in waveform
- Energy determination
- Using period at maximum amplitude
- ReVelle (1997) formula based on nuclear explosions



NEMO Event



NEMO

NEMO Event



Residents of the European part of Russia have reported a bright fireball lighting up the sky, which was emitting a blinding light. Theories on social media varied from a simple meteor to aliens arriving for World Cup 2018.

NEMO Event



Apostol875/Youtube

Daytime fireball over Russia 21 June 2018 - 01:15 UT (04:15 LT)



Very bright daylight
#Russia, #meteorit



Very bright daylight fireball expl
A very bright daylight fireball explo
21, 2018. The event lasted several
watchers.news

04:52 - 21. Juni 2018

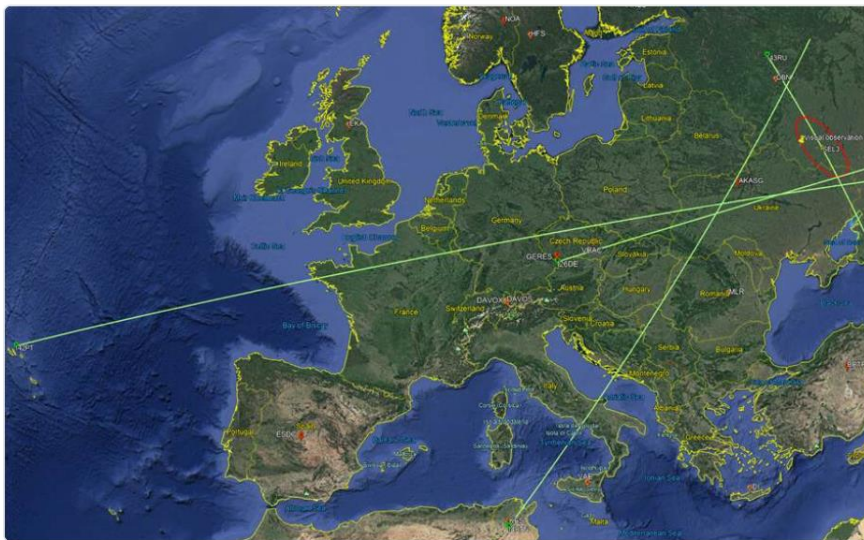
0:09 1.734 Au



Lassina Zerbo
@SinaZerbo

Folgen

#CTBT #IMS detection of a #Bolide above western #Russia 🇷🇺 The automatic process used 4 IMS infrasound stations; IS43 (#Russia - Dubna), IS26 (#Germany) IS48 (#Tunisia) IS42 (#Portugal – Azores Island). Analyst review expected to add about 7 additional #infrasound stations.



Folgen

all spotted over
k, Lipetsk, Voronezh,

26. Juni 2018

ackson873 #Bright #Fireball #Streaks

reaks through the sky over Russia,...
ek that NASA publicly revealed its plans
cking and detection systems for smaller
s, and now a video from Russia sh...

Folgen

des over Russia,

plodes over Russia, Meteorites possible
t fireball exploded over western Russia during
urs of June 21, 2018. The event lasted
ore the object disintegrated in a bright flas...

Daytime fireball over Russia

21 June 2018 - 01:15 UT (04:15 LT)



NEMO

Daytime fireball over Russia

21 June 2018 - 01:15 UT (04:15 LT)

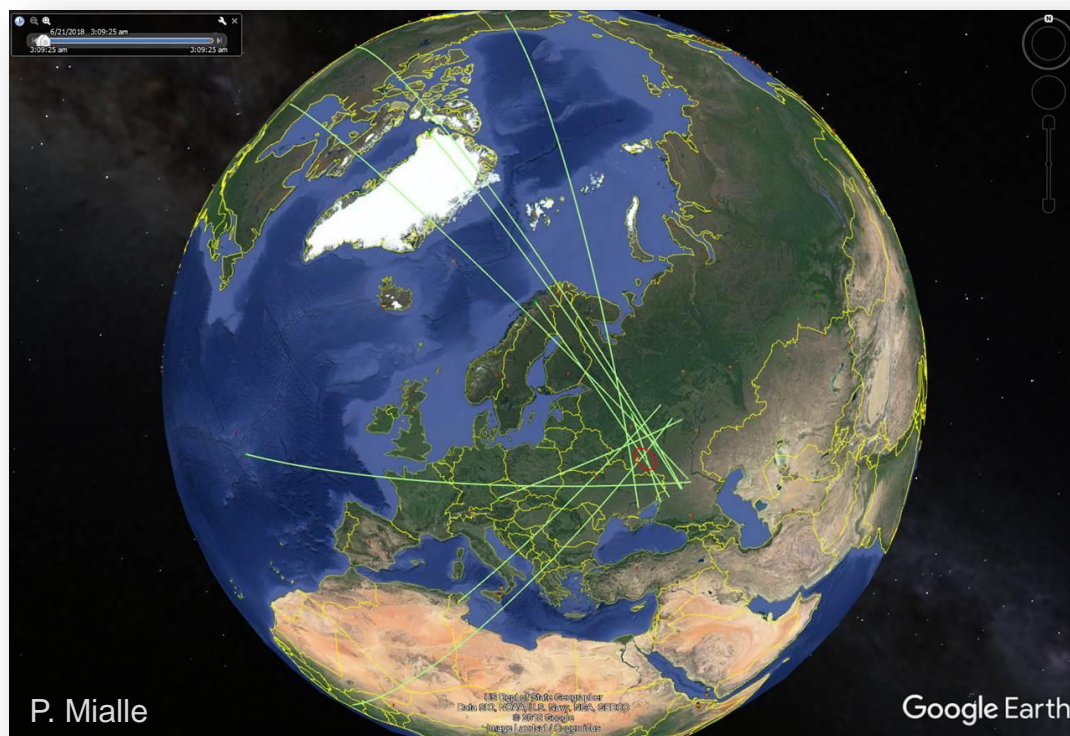
Infrasound

10 Infrasound stations

- a source energy of **2.4 kt TNT.**
- a size of about **4 m**

CNEOS/JPL found

- a source energy of **2.8 kt TNT.**



Daytime fireball over Russia

21 June 2018 - 01:15 UT (04:15 LT)



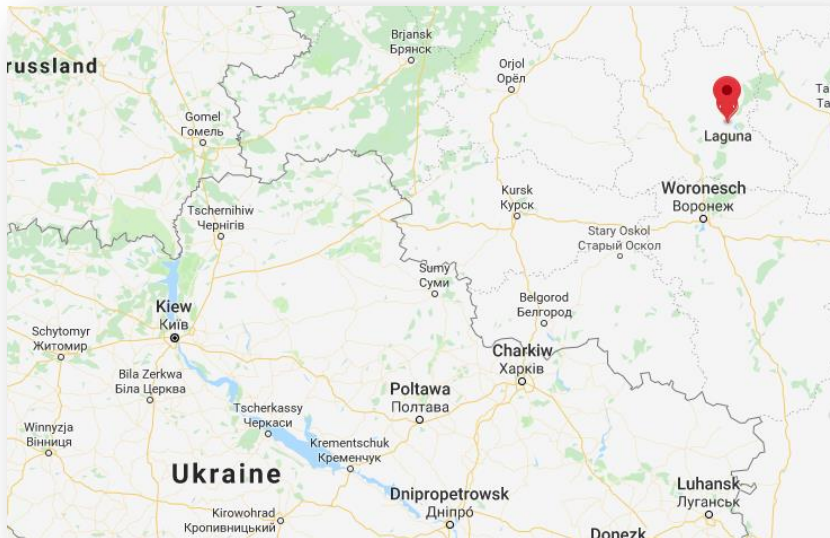
NEMO

Daytime fireball over Russia

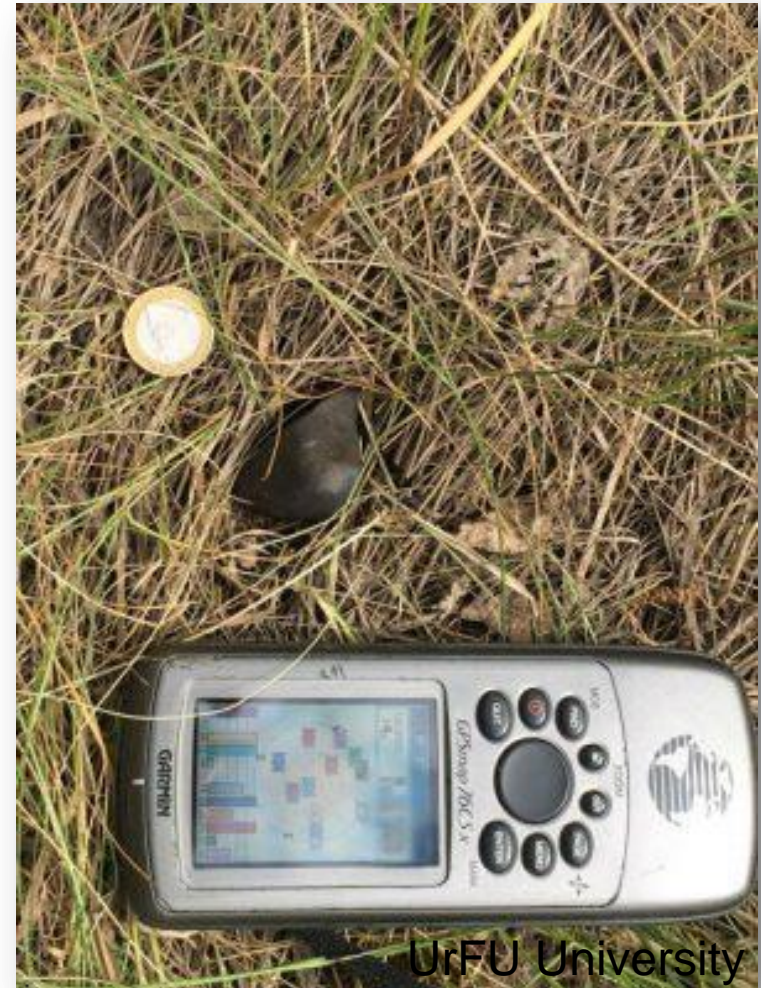
21 June 2018 - 01:15 UT (04:15 LT)

Scientists from the Ural Federal University

- Found over **5 kg of meteorites**
- Largest: **0.55 kg**

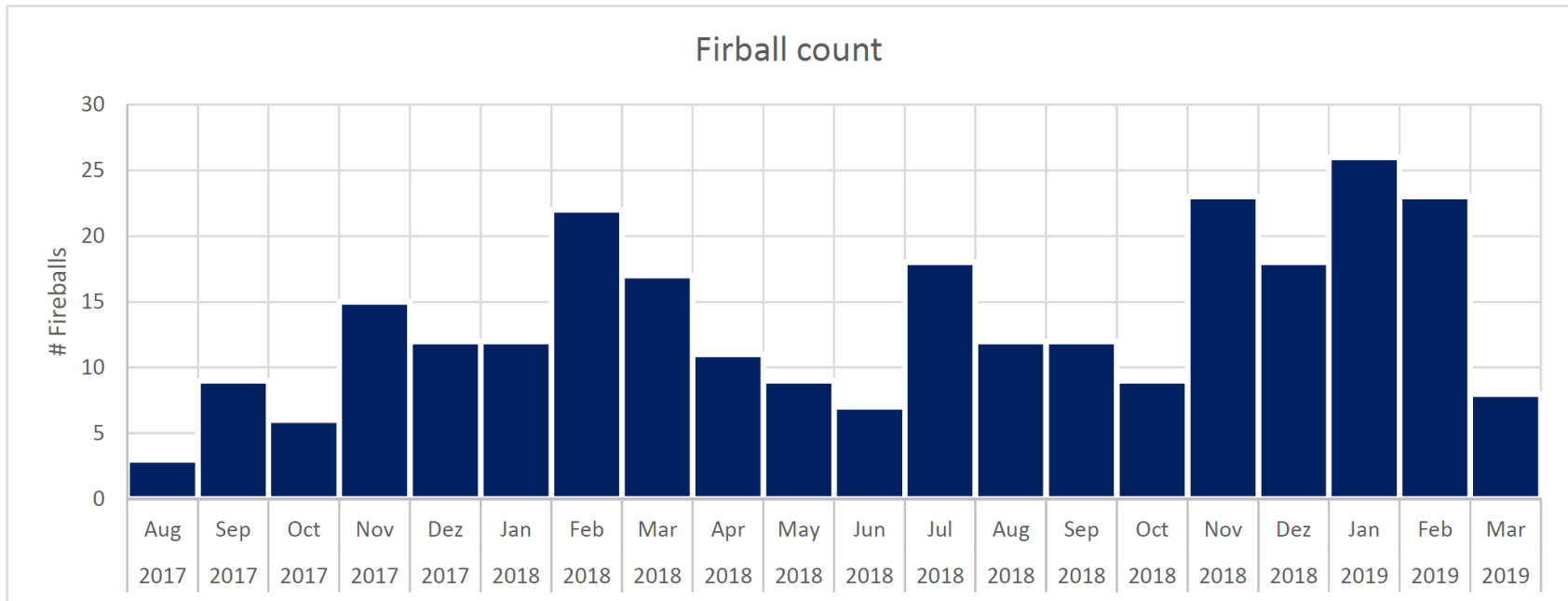


→ Prove no aliens!

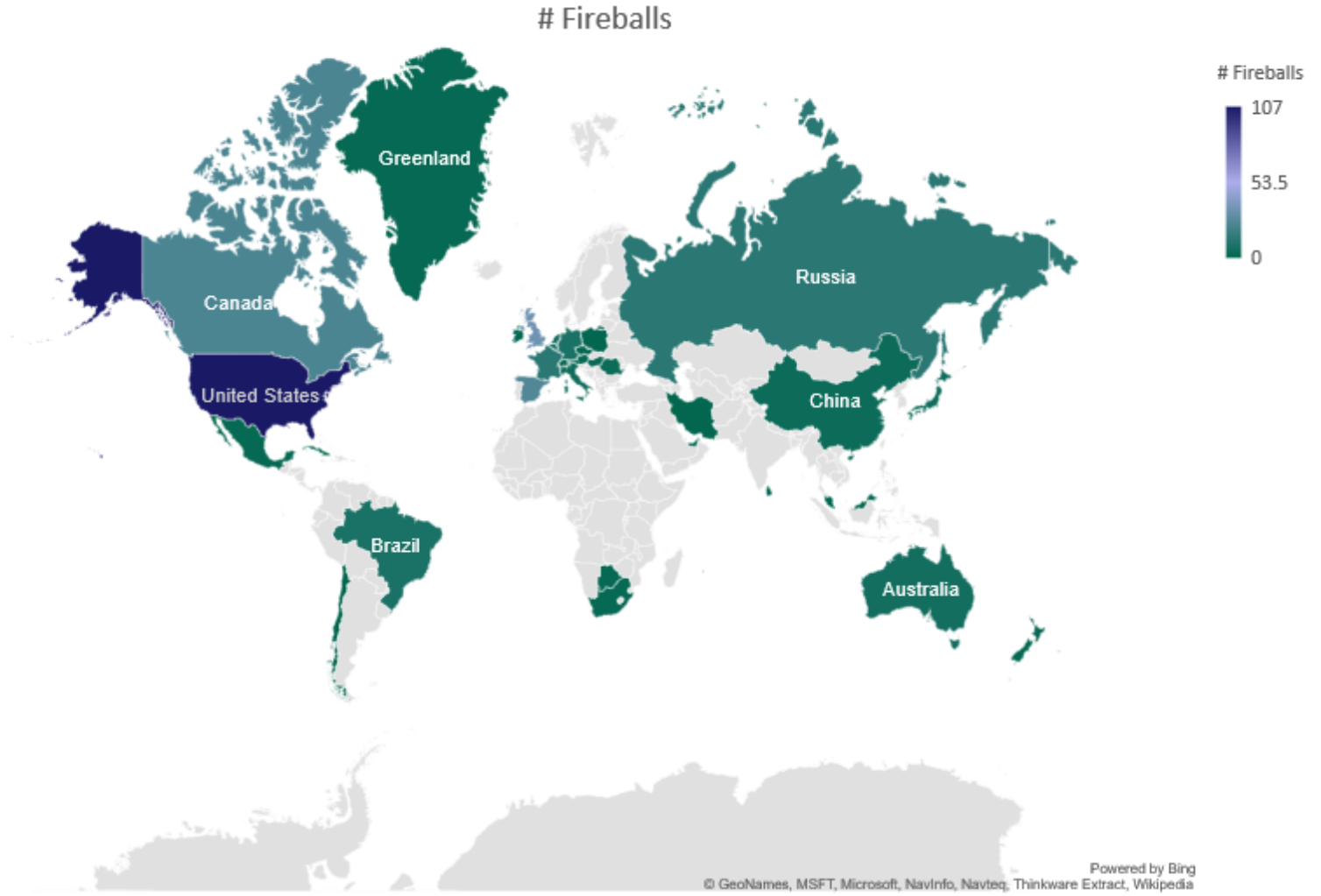


NEMO Events

- First NEMO Event was in August 2017
- About 20 months of test-operation
- Since Aug 2017: ~ 300 total



World Map Event



- Adding social media services
- Reliable infrasound energy determination and semi-automation
- Data from existing fireball networks and other sources
 - ➔ Access, analyze, and combine
- Accurate fireball flux determination

References

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- S. Drolshagen, J. Kretschmer, D. Koschny, G. Drolshagen, and B. Poppe, "Mass Accumulation of Earth from Interplanetary Dust, Meteoroids, Asteroids and Comets", Proceedings of the International Meteor Conference, Mistelbach, Austria (2015)
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- Edwards et al. (2006) Estimates of meteoroid kinetic energies from observations of infrasonic airwaves
- Clauter, D.A., Bladford, R.R., 1998, Capability modelling of the proposed International Monitoring System 60-Station Infrasonic Network, LAUR-98- 56, Los Alamos National Labs Report, Los Alamos, NM.
- S26: Credit Elias Nemeh, Credit D. Brown, Credit L. Lozano, Credit John Hendricks, Credit J. Narancio, Credit Ian Griffin

Thank you for your interest

Meteoroid Impact NEOs (Near-Earth Objects)

NEO Diameter	Impact energy [Megatons TNT] (1g TNT \equiv 4184 J)	Interval [Years]	Effect
2 mm		1 per hour (visible from each location)	Nice meteor
3 m	0.002	0.5	Fireball, Sudan event, meteorites on ground
10 m	0.08	5	Bolide, fear, shock wave, 5-fold energy of Hiroshima bombe
40 m	5	300	Tunguska Explosion or crater
140 m	220	10,000	Regional destruction, Tsunami
500 m	10,000	200,000	Europe-wide destruction
1 km	80,000	700,000	Millions of deaths, globale Effects
10 km	80 million	100 million	End of human civilisation

Drolshagen et al. (2017)