The Fireball Monitoring System NEMO and its Relation to Imminent Impactors

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Resulting Fireball from the entry of asteroid 2022 WJ1 on 19th November 2022, photograph taken near London, Ontario, Canada (credit Robert Weryk)

14th December, 2022
EU-ESA Workshop on NEO Imminent Impactors Warning Coordination

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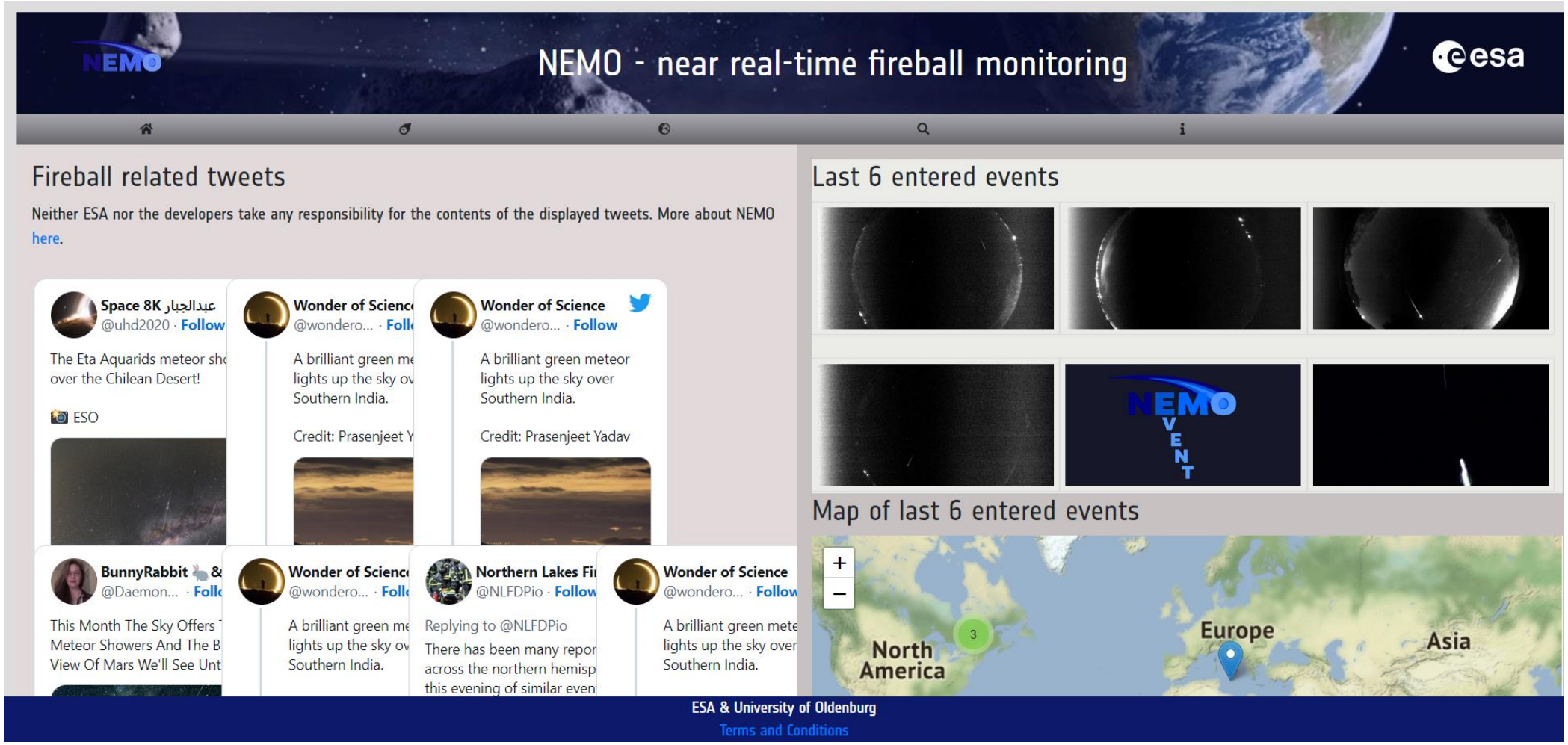
NEMO

Near real-time fireball monitoring



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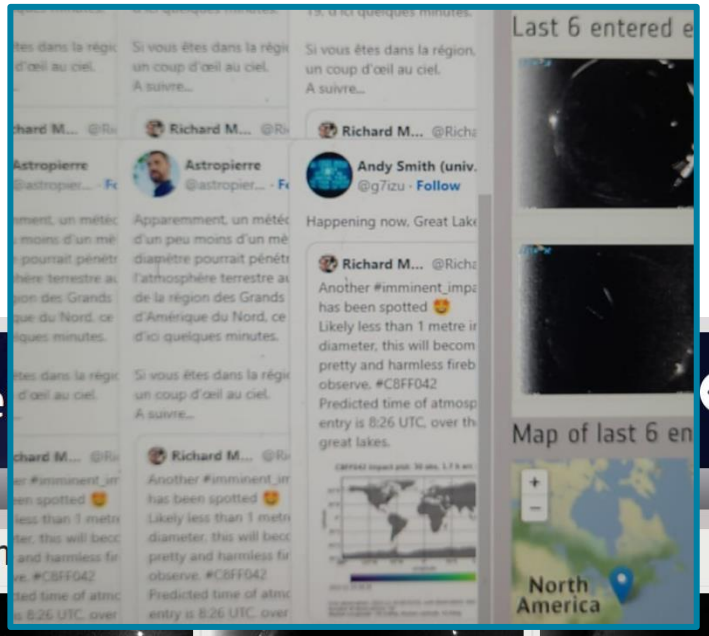

Screenshot from 19-Nov-2022

NEMO - near real-time fire

esa

Fireball related tweets

Neither ESA nor the developers take any responsibility for the contents of the displayed tweets. More about NEMO here.

Space 8K عبدالجبار @uhd2020 · Follow
The Eta Aquarids meteor sh over the Chilean Desert!
ESO

Wonder of Scienc @wondero... · Follo
A brilliant green me lights up the sky ov Southern India.
Credit: Prasenjeet Y

Wonder of Science @wondero... · Follow
A brilliant green meteor lights up the sky over Southern India.
Credit: Prasenjeet Yadav

BunnyRabbit & @Daemon... · Follo
This Month The Sky Offers Meteor Showers And The B View Of Mars We'll See Unt

Wonder of Scienc @wondero... · Follo
A brilliant green me lights up the sky ov Southern India.

Northern Lakes Fi @NLFDPio · Follow
Replying to @NLFDPio
There has been many repor across the northern hemisp this evening of similar even

Wonder of Science @wondero... · Follow
A brilliant green mete lights up the sky over Southern India.

Last 6 en

NEMO EVENT

Map of last 6 entered events

North America
Europe
Asia

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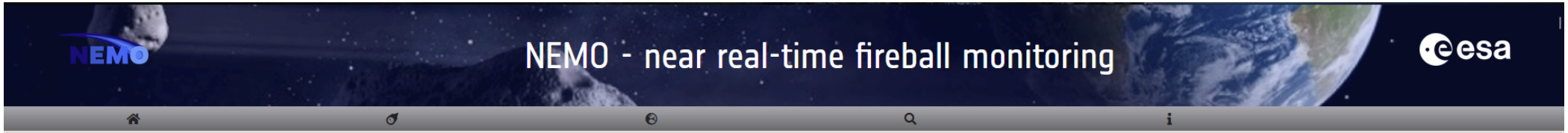

Fireball events

The content of the table is described here.

EventID	Date in UTC	Time in UTC	Region	Country	Longitude	Latitude	Velocity /km/s	Mass /kg	Size / m	Energy kt TNT	Link	Notes	Source	Image URL
2022-12-02_USA_3074	2022-12-02	00:34	West Virginia	US	*-79.506	*39.709	-	-	-	-	1	-	IMO	img
2022-12-01_CAN_3072	2022-12-01	07:31:21	Quebec	CA	*-71.798	*52.515	-	-	-	-	1	FRIPON detection (2 stations); estimated magnitude around -5.	FRIPON	img
2022-12-01_3071	2022-12-01	04:12:54	North Atlantic Ocean	-	*-17.678	*14.944	-	-	-	-	1	FRIPON detection (3 stations); estimated magnitude around -7.	FRIPON	img
2022-11-30_MLT_3070	2022-11-30	23:20:42	Comino	MT	*14.305	*36.055	-	-	-	-	1	FRIPON detection (2 stations); estimated magnitude around -5.	FRIPON	img
2022-11-30_ESP_3073	2022-11-30	15:30	Gran Canaria	ES	*-15.54	*27.992	-	-	-	-	1 2	Seismic detection as well as sound reports.	IMO	-
2022-11-30_CAN_3069	2022-11-30	06:37:44	Quebec	CA	*-71.814	*52.516	-	-	-	-	1	FRIPON detection (3 stations); estimated magnitude around -5.	FRIPON	img
2022-11-29_3068	2022-11-29	23:16:07	Mediterranean Sea	-	*3.928	*42.341	-	-	-	-	1	FRIPON detection (3 stations); estimated magnitude around -5.5.	FRIPON	img
2022-11-28_BRA_3066	2022-11-28	06:49	Rio Grande do Sul	BR	*-53.74	*-29.88	-	-	-	-	1	BRAMON: estimated magnitude around -12.	BRAMON	img
2022-11-27_CAN_3062	2022-11-27	09:59:54	Ontario	CA	*-86.022	*49.92	-	-	-	-	1	FRIPON detection (3 stations); estimated magnitude around -5.5.	FRIPON	img
2022-11-27_FRA_3061	2022-11-27	05:52:25	Nouvelle-Aquitaine	FR	*0.369	*45.456	-	-	-	-	1	FRIPON detection (2 stations); estimated magnitude around -6.	FRIPON	img
2022-11-27_USA_3065	2022-11-27	05:46	North Dakota	US	*-99.199	*47.257	-	-	-	-	1 2	-	IMO	-

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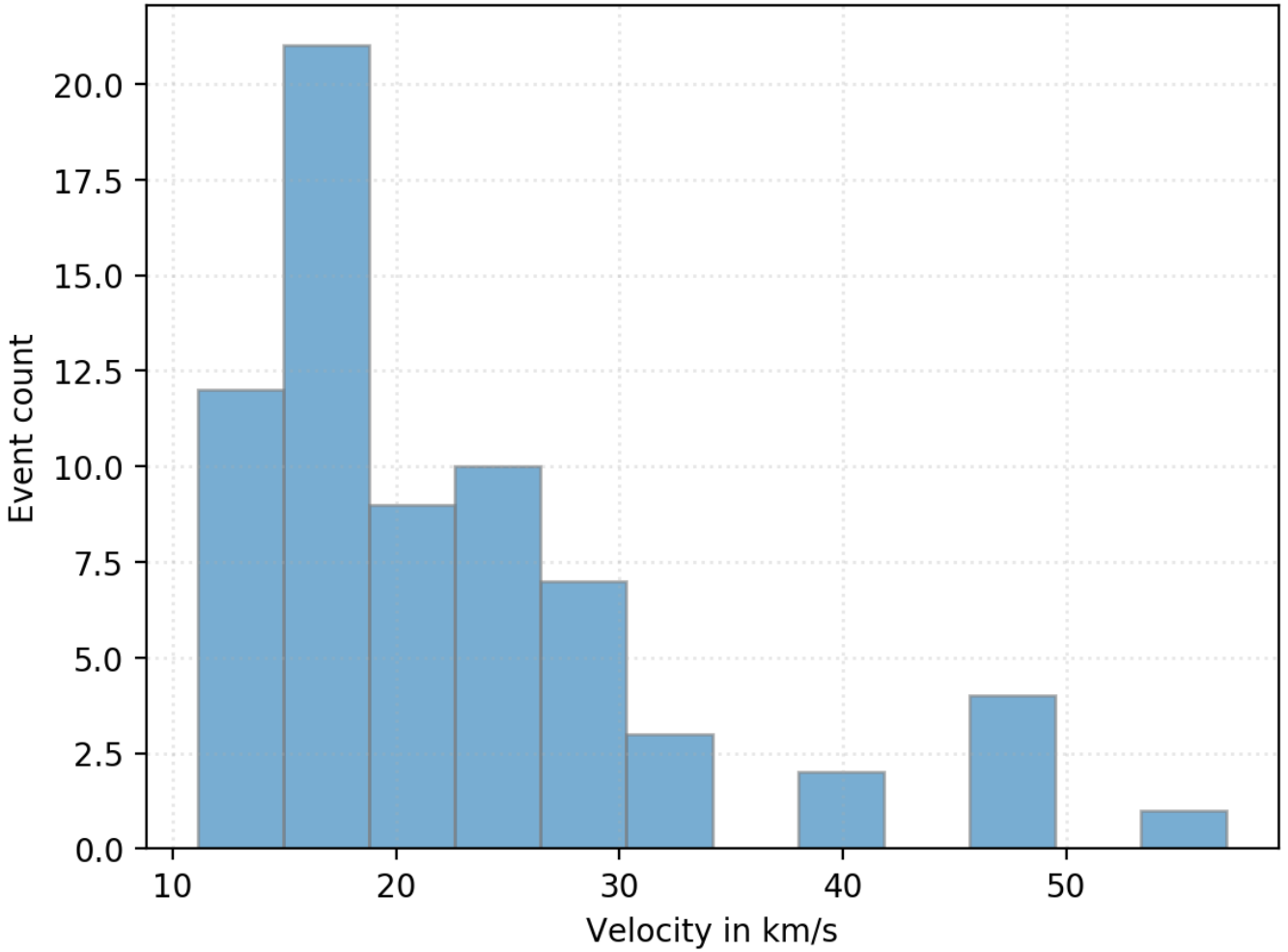

Velocity distribution of the fireballs in the NEMO database for which information about the velocity is available in certain velocity bins. Credit: Regina Rudawska, 2022.

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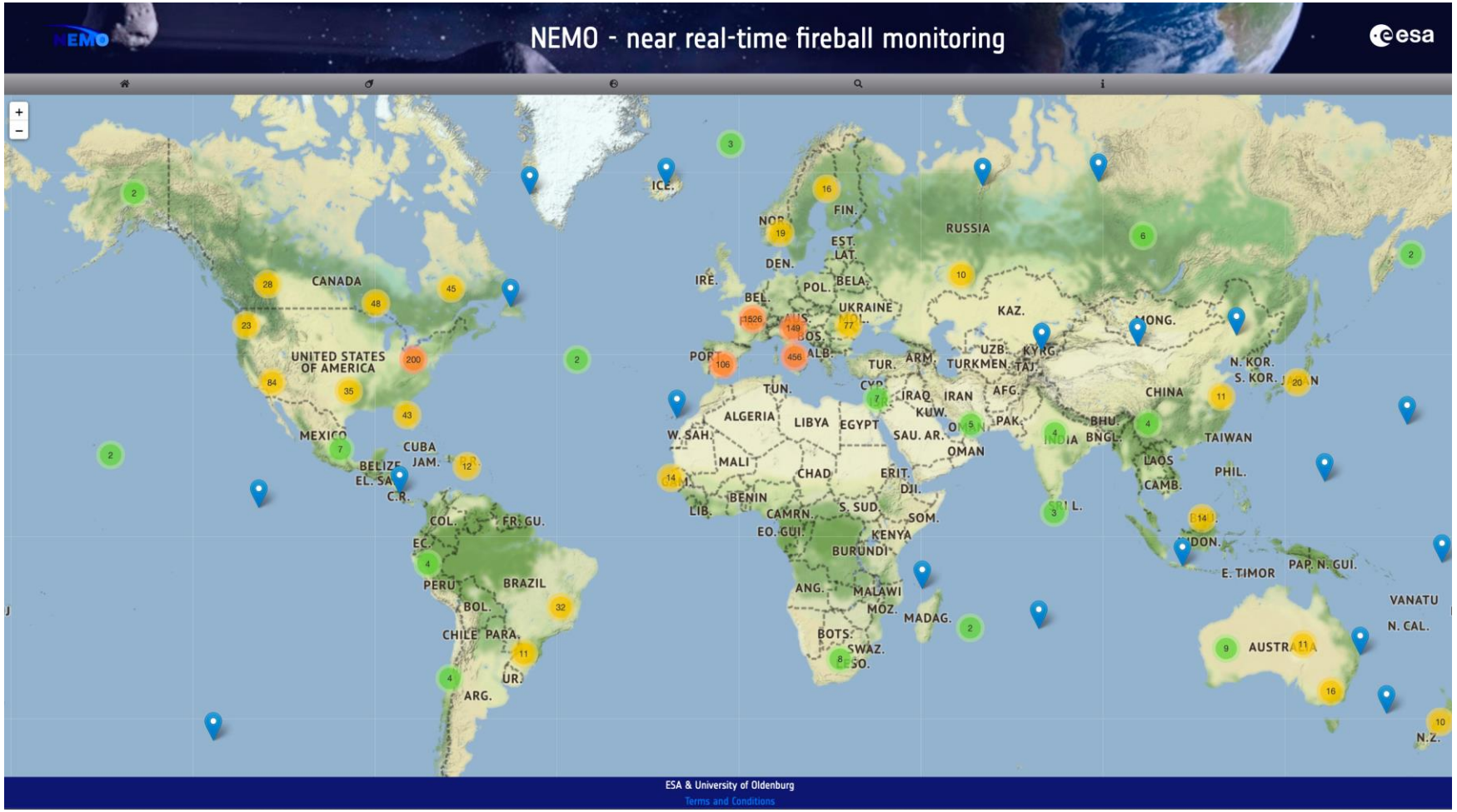

World map of NEMO events, status as of August 2022. Credit: Regina Rudawska.

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So remember this?

Fireballs like this can be described …

Richard Fleet UFOCapture Wilcot, Wiltshire

Alert / Data exchange opportunities

1. Event detection alert (ping!)
2. Single-station fireball observations
3. “State Vector” at end of Luminous Flight
4. Wind and atmospheric data
5. Strewn Field
6. Impact Alert

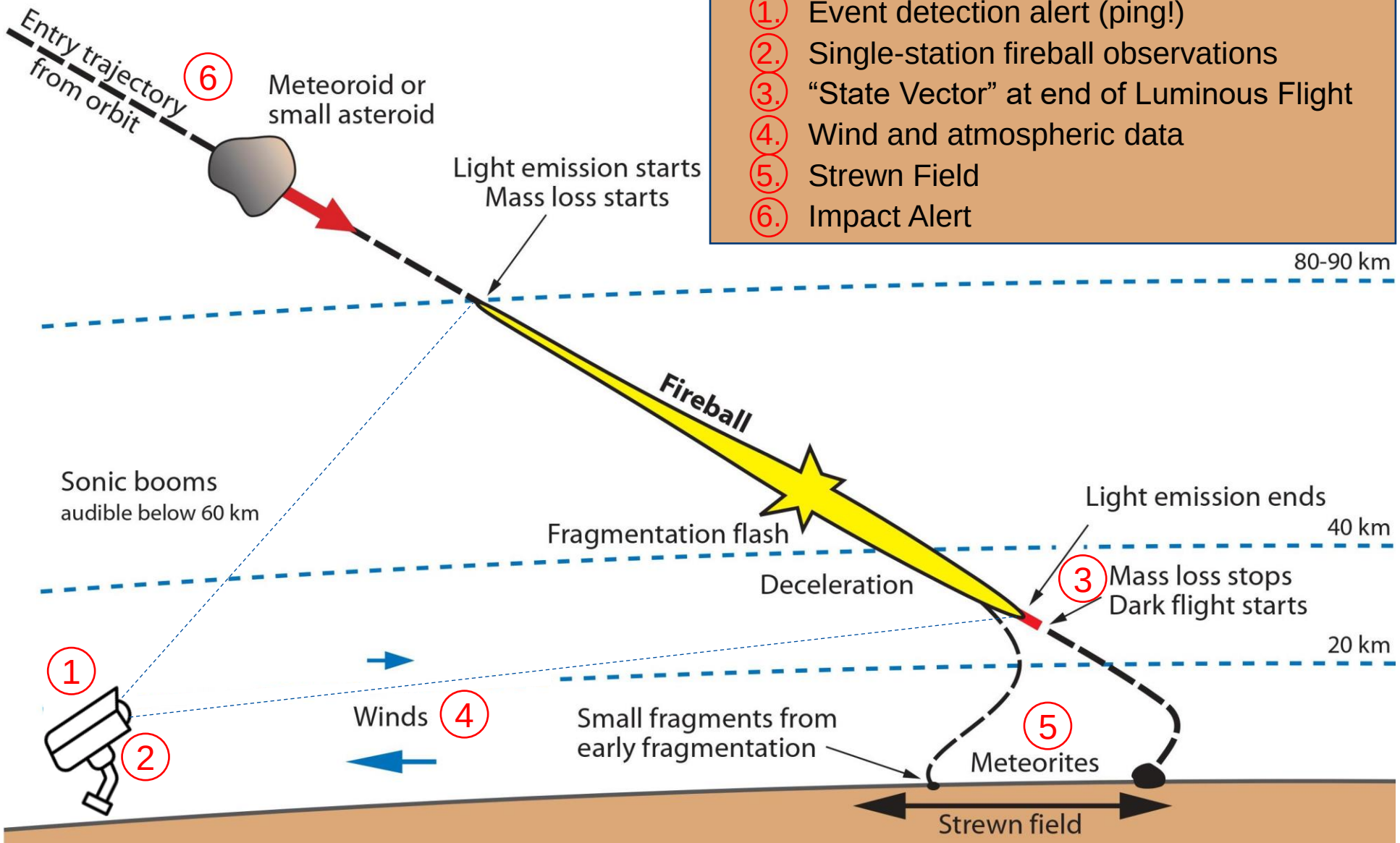
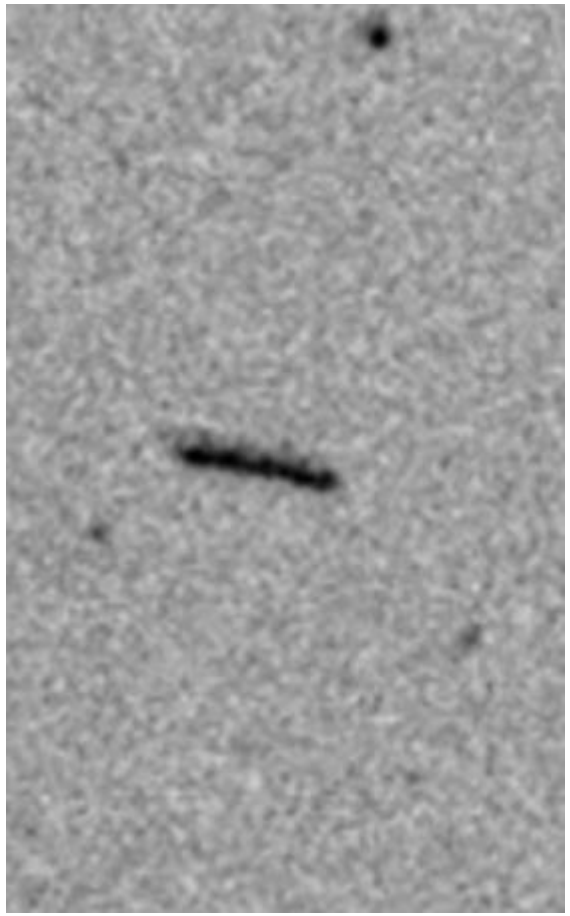


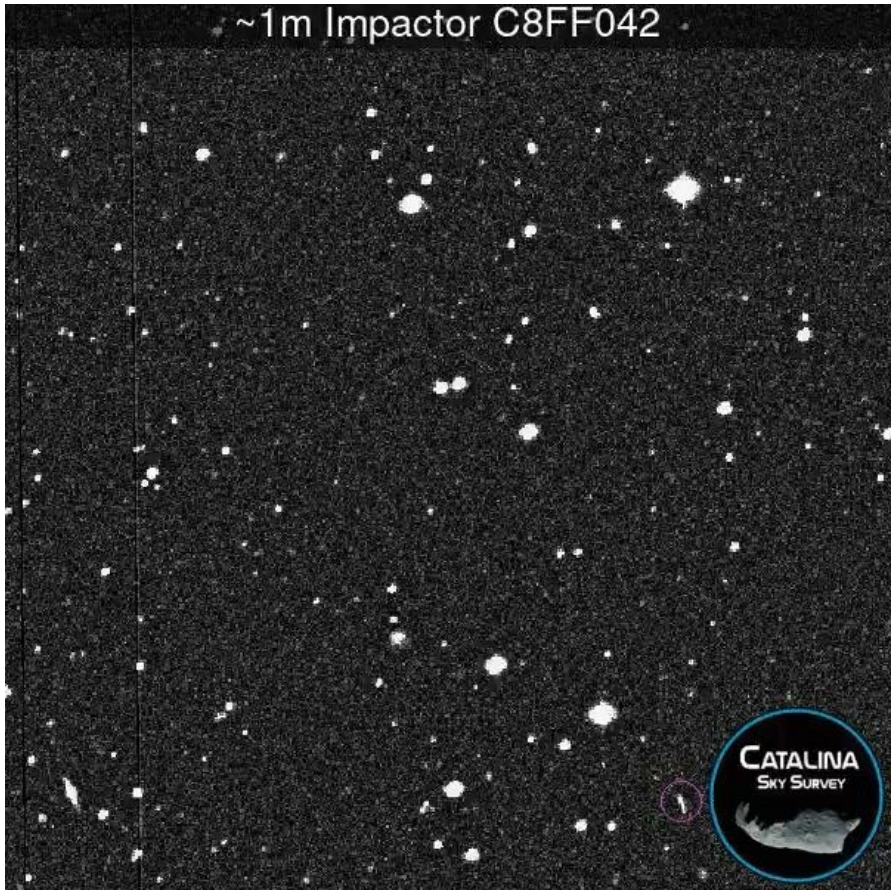
Illustration adapted from: https://doi.org/10.1093/mnras/stab586

Impactor Alert



An image of ‘Sar2593’ (2022 EB5) before impact near Iceland on 11th March 2022. Credit: Kleť Observatory.

- Asteroids have been detected prior to Earth impact **six** times
- ESA is investigating the best way to convey detailed information when such an impact is predicted.



An image sequence of 2022 WJ1 before impact near Niagara Falls, Ontario Canada on 19th November 2022. Credit: Catalina Sky Survey.

Impact Alert and NEMO

- If object was detected before impact

  → more information known prior to impact

  → fireball analysis can be more precise

  → the measured fireball brightness in combination with the determined object size in space can be used to derive the luminosity of the object in the atmosphere

Resulting Fireball from the entry of asteroid 2022 WJ1 on 19th November 2022, photograph taken near London, Ontario, Canada (Credit: Robert Weryk)

- ‘Prediction’ of potential visibility of a fireball?

  → inform general public in time or at least very quickly

Space Debris

- Integration of the re-entry information in NEMO

Re-entry of ATV-1 „Jules Verne“ on 29th September 2008 (Credit: ESA/NASA)

- **Aim:** to identify automatically fireballs from re-entering space debris for events in the NEMO database (at the presence: this is done manually).

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Information on Imminent Impactors and NEMO
Summary

- The information content and the value of NEMO could be clearly enhanced by data of imminent impactors

Find more of them!

Image of the fireball event resulting from the entry of 2022 WJ1,
Image courtesy Western Meteor Group

Thank you for your attention!

Questions?