STATUS OF NEMO, THE NEAR REAL-TIME MONITORING SYSTEM

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ABSTRACT

The NEar real-time MOnitoring System (NEMO) is a project developed by University of Oldenburg, Germany, and since January 2020 is being operated by ESA [1, 2]. It collects information for bright fireballs on a global scale. This paper gives a brief description of NEMO, its aims, working principle and, in particular, the current status and the expected future developments.

Keywords: NEO; observation; fireballs.

1. NEAR REAL-TIME MONITORING SYSTEM (NEMO)

- An alert system based on social media.
- Combining information from various data sources (meteor networks, data from infrasound stations of the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO), publicly available data from US Government sensors, re-entry predictions of satellites and space debris).
- Since mid-January 2020 maintained at the European Space Agency.

2. NEMO'S WORKFLOW (EXAMPLE)

NEMO constantly crawls through Twitter looking for content of our interest, i.e. `fireballs` (but also `meteor showers`, `meteoroid streams`). After filtering out unnecessary tweets (e.g. Canadian whisky called *Fireball* or Taiwanese drama *Meteor Garden*, etc.), NEMO generates an alert-notification about a potential event of interest. This is further analysed by an operator. This includes checks with reliable resources (local fireball networks, IMO, re-entry database,...) and combine as much information about the fireball/event as possible from all of them.

The Winchcombe case [3], is a great example how much exchange between meteor networks (amateurs and professionals) can bring to the scientific (and not only) community. From NEMO side the situation unfolds in that period as shown in Figure 1.

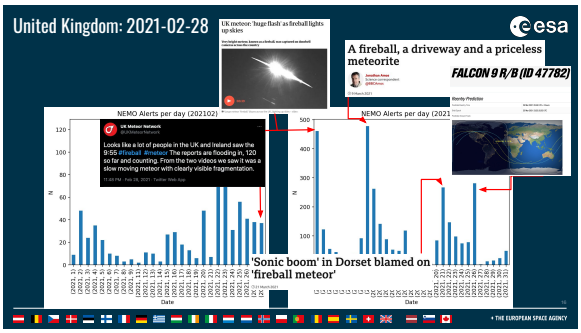

Figure 1. NEMO's workflow; the example of March 2021 events.

First NEMO alerts reached operator's inbox soon after the event on February 28$^{\text{th}}$, 2021, at 21:54 UTC occurred. These were tweets coming from early witnesses. Especially the day after, as news about the event reached main news outlets, NEMO generated the most alerts (March 1$^{\text{st}}$). In the next days the spread of the information cooled down a bit, to increase again with the news about the recovery of the meteorite on March 9$^{\text{th}}$. Such coverage catches quite often people attention and awareness. Therefore, when the next event happens people react immediately. So, when in the area of Dorset, UK, the boom was heard and the streak of light was seen in the sky on the afternoon of March 20$^{\text{th}}$, it increased NEMO's detections; together with the main outlets coverage again as well (e.g. The Guardian, BBC).

Not all of the events that NEMO detects are caused by objects of the natural origin. The same month the reentry of the SpaceX Falcon 9 upper stage was widely reported in the Pacific Northwest on March 26$^{\text{th}}$. Eyewitnesses reported to the IMO across that region, some heard booms, and the event was detected by nearby weather radars (NOAA) too.

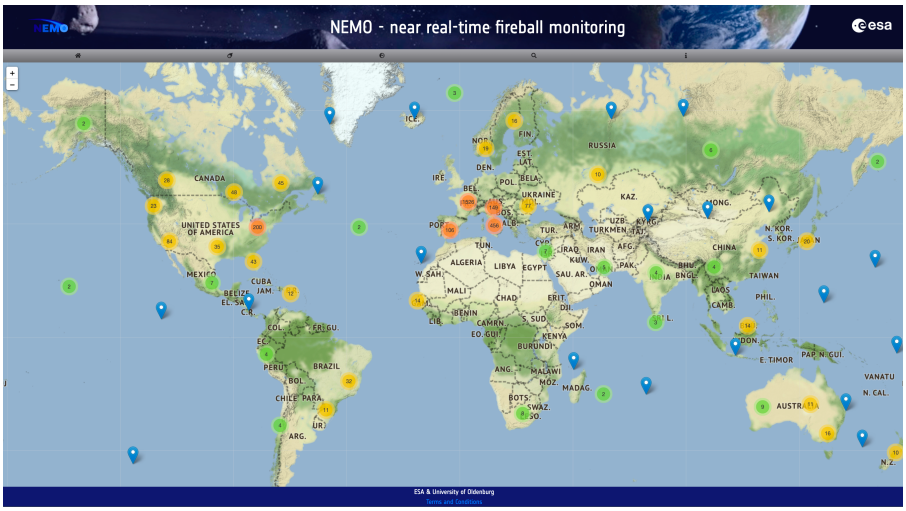

Figure 2. Map presenting all NEMO events in the database

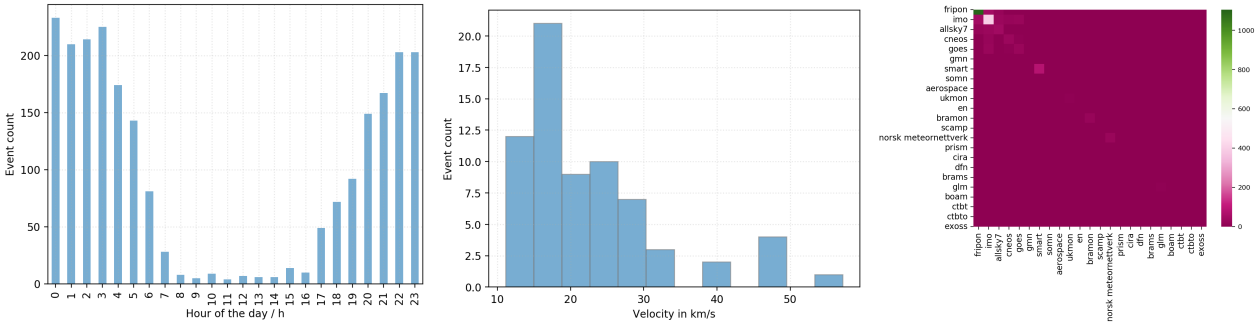

Figure 3. NEMO fireball events plotted over the hour in estimated local time (LT) at which they occurred (left). Velocity distribution of the fireballs in the NEMO database for which information about the velocity is available in 5 km/s-bins (middle). Cross-correlation between sources/networks supplying information about fireballs in NEMO DB (right).

3. SUMMARY

- There are over 3 thousand fireballs in the NEMO database (Figure 2).
- Only a few events were detected during daytime (Figure 3).
- The velocity distribution with the expected trend towards lower speeds (Figure 3).
- The smallest object in the database for which the weight is known has a mass of 1.4 kg and the largest 400 t.

4. FUTURE DEVELOPMENTS

Additional developments are ongoing and planned such us:

- These include a notification system to inform observation networks on events and a more automatic system to identify re-entering objects.
- Predictions of re-entering space debris and fireballs.

REFERENCES

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