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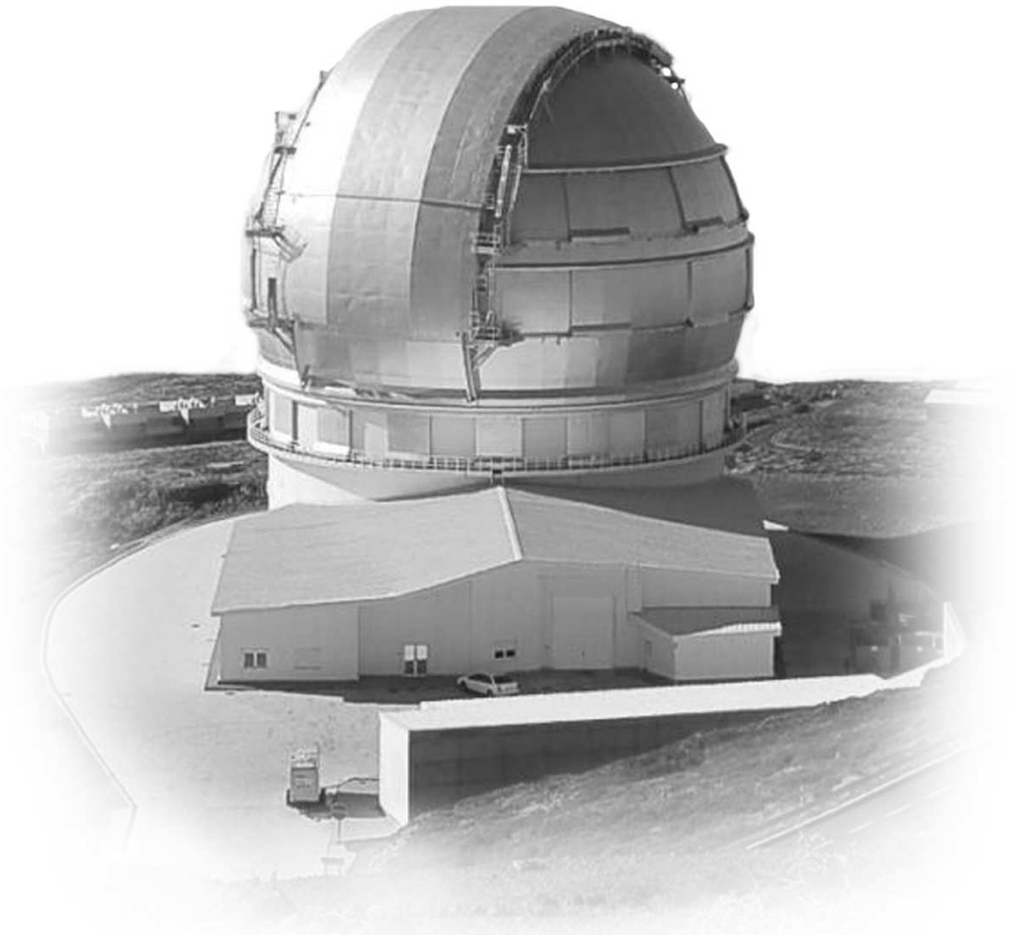

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Development of a fireball database for the NEO segment of ESA's Space Situational Awareness Programme

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A fireball database will be developed within the near-Earth objects (NEO) segment of ESA's Space Situational Awareness (SSA) Programme. It will include information on fireballs brighter than magnitude −10 observed since January 1, 2010. This paper presents background information and discusses the context and content of the fireball database.

1 Introduction

ESA's Space Situational Awareness Programme started in 2009 with a preparatory phase. It consists of three segments: Space Surveillance and Tracking (SST), Space Weather (SWE), and Near-Earth Objects (NEO). The SSA-NEO segment mainly focuses on

1. NEO observations (surveys, follow-up observations, physical characterization);
2. orbit predictions and impact risk assessments;
3. precursor services which make observations, derived data and additional information available to users; and
4. NEO mitigation issues (study of impact effects and deflection missions, international coordination).

Objects larger than 30–40 m are generally considered to have the potential of causing damage when impacting Earth. However, smaller objects exploding in the atmosphere can cause concern as well, both to the general public and to decision makers, as the energy release can be similar to those from nuclear weapons. The NEO segment will not apply any size limit for objects detected in space. Meter-sized objects will be treated and catalogued as well as larger NEOs if they are observed. Obviously the chance to detect an object in space decreases for smaller objects. For smaller objects it is foreseen to complement the NEO data by information on brighter fireballs.

Figure 1 presents an overview of the SSA-NEO segment.

2 NEO Services

NEO services will be gradually established. During the present precursor phase the NEO services provided include the following topics:

1. news releases and potential impact warnings;
2. NEO orbits, NEO impact risk (if applicable), and close approaches;
3. physical properties of NEOs;
4. Sky images and special measurements (rotation curves, spectra);
5. fireball data; and
6. educational material and supporting tools.

It should be pointed out that the NEO services mainly use data from existing facilities and databases, such as NEODyS (NEODyS-2, 2012), for orbits, close approaches and impact risks, or EARN (2012), for physical properties.

The NEO data will usually be accessible on-line. A preliminary version of the NEO websites has just been deployed (`http://neo.ssa.esa.int`). The on-line NEO site has a dedicated sub-menu for a fireball database.

3 Fireball database

3.1 Background

The fireball database will become an integrated part of the SSA-NEO Small Bodies Data Centre (SBDC). It will be a searchable on-line database. The data will complement NEO data towards smaller sizes and shall help to derive fluxes of smaller NEOs. The main interest is in the meter-sized objects. Impacts from meteoroids/NEOs in this size range are expected to occur on a weekly or monthly basis (considering the complete Earth surface). Space-based and infrasound measurements of such large fireballs were presented by Brown et al. (2002). Figure 2, taken from Brown et al. (2002) shows measured fluxes down to about 1 m diameter. The fireball database will complement such space-based data—not all of which may be publicly available—and will extend the fluxes towards smaller sizes. This will bridge the gap to standard meteoroid flux models which cover the micrometer to centimeter size range, such as, e.g., the meteoroid model by Grün et al. (1985).

In addition, the stored information on fireballs will support queries from scientists, political entities, or the interested public on observed atmospheric events.

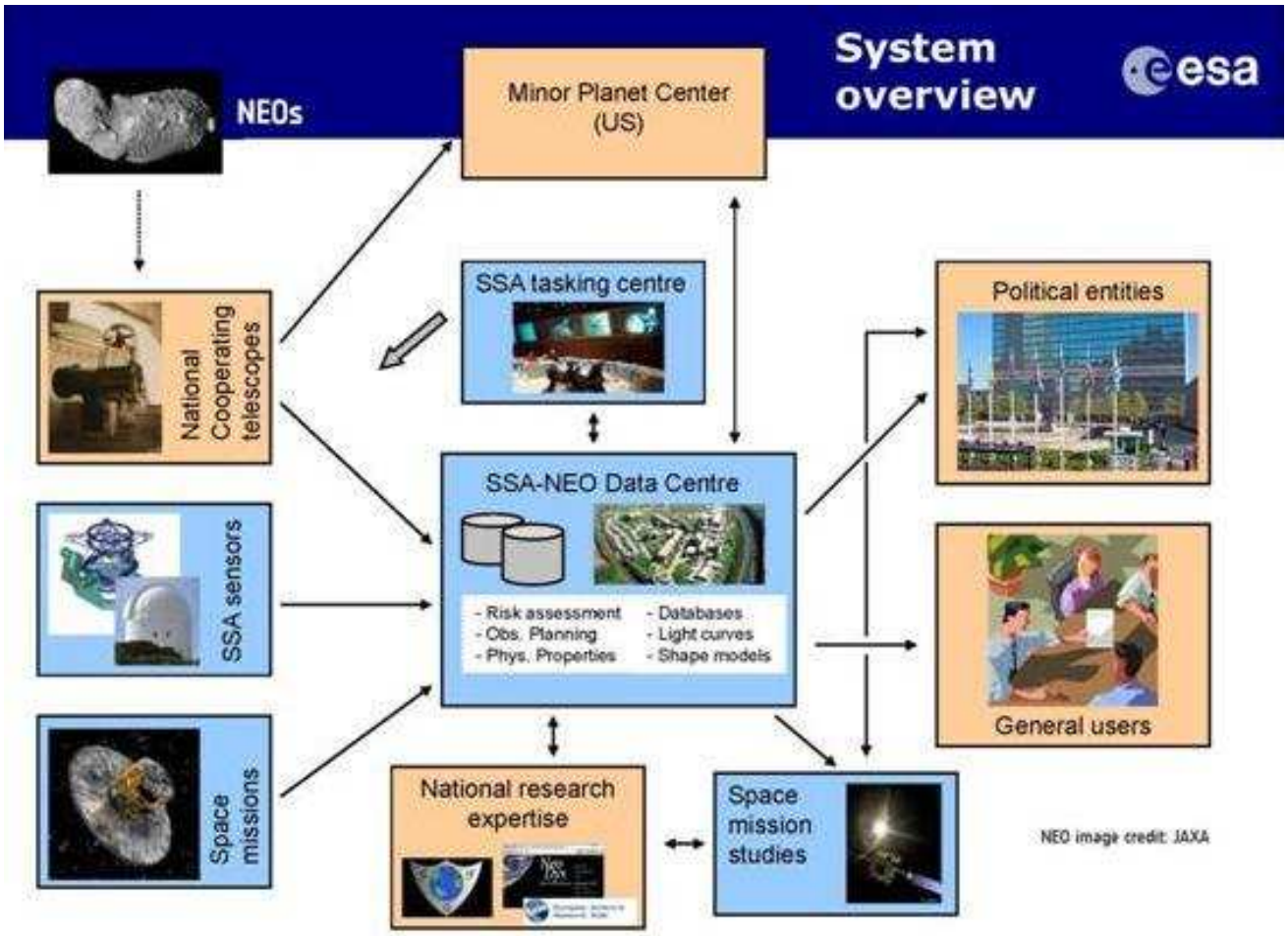

Figure 1 – Overview of the SSA-NEO system.

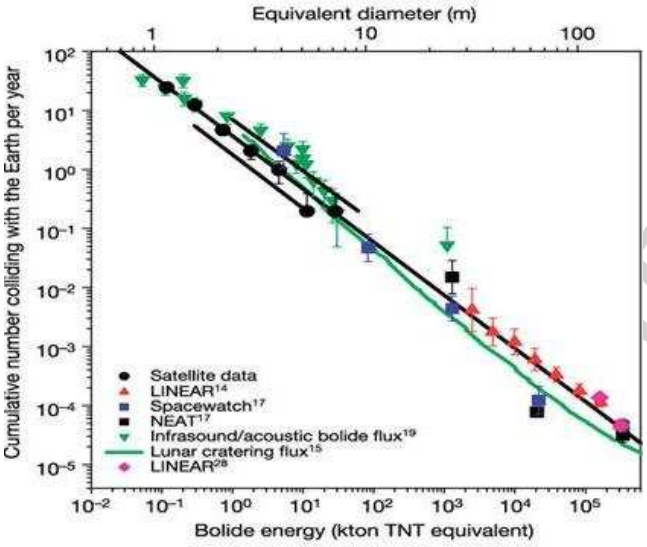

Figure 2 – The flux of small near-Earth objects colliding with Earth (Brown et al., 2002).

3.2 Content

The fireball database will include worldwide data on bright fireballs observed since January 1, 2010. The aim is to include all fireballs brighter than about magnitude −10. Information on individual fireballs will be somewhat flexible and could include the following:

1. information on date, location, brightness, etc.;
2. range of visibility, flight direction, etc.;
3. additional info, such as sound, fragmentation, explosion, meteorites found, etc.;
4. pictures, videos, articles;
5. information on public reactions;
6. derived parameters, such as velocity, trajectory, orbit, size, energy release, etc.; and
7. links to other sources and databases.

3.3 Development

The development of the fireball database has started in mid-2012 as part of a larger industrial SSA software development contract. The main activity will be the development of the fireball database itself and its implementation into the overall SSA-NEO database framework. Initially, only a limited amount of actual fireball data will be included.

The procedure to establish and maintain the scientific content of the fireball database has still to be defined and established. Several fireball databases already exist. It is intended to cooperate with existing fireball

databases and networks as well as with other interested groups and individuals who can provide relevant data. Interested contributors are encouraged to contact one of the authors.

4 Conclusion

It is planned to include a fireball database into the SSA-NEO segment to complement the information on NEOs in space. The fireball data will support scientific studies and inquiries from the general public. Cooperation is sought with existing fireball networks and interested persons to establish and maintain the fireball database.

At present only one object (2008 TC3) was first detected in space, about 20 hours before impact, and then observed as a bright fireball over Sudan. It is hoped that such overlap will become more frequent in future.

In the future, ground-based fireball observations could be complemented by a planned dedicated fireball sensor in space.

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