A Virtual Observatory (VO) Event model for the optical detection of meteors and transient luminous events

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Abstract

Optical counterparts of atmospheric transient events are subject of observation and investigation of a growing community. Professional as well as amateur observation networks are established in Europe and abroad to collect data important not only for the scientific investigation of some physical processes but also to assess their possible impacts on Earth's environment. We propose here an implementation of the Virtual Observatory Event standard to the domain of meteors and Transient Luminous Events (TLEs). A well established standard for real-time alert on those domains will facilitate coordination between networks and simplify the extraction of critical information. This will result in improved collaboration between the amateur community and agencies (e.g. the ESA Fireball Database, or the CNES TARANIS mission).

1. Introduction

Atmospheric optical transient events are observed and analyzed for space weather forecasting or for scientific research in an increasingly systematic way. This abstract focuses on meteors and Transient Luminous Events (TLEs): the first ones are linked to sky surveillance activities because of damages produced by possible collisions as for artificial space debris, the second are classified as ionospheric disturbances then belonging to the domain of space weather. They have often been subject of paired optical observation campaigns, as their monitoring benefits from continuous sky surveillance and similar hardware installations. Data provided by professional and amateur observers need to be compared, merged and archived. A well defined standard describing observation metadata is then necessary in order to efficiently process those data and enable real-time updates.

2. VOEvents for atmospheric surveillance

VOEvent[1,2] is a standardized protocol developed to report observations of astronomical events. It has been officially adopted by the International Virtual Observatory Alliance (IVOA) in 2006. A VOEvent alert has a generic structure defined by the standard tags:`<who>`, `<how>`, `<what>`, `<why>`, `<wherewhen>`. The VOEvent system is already used by several large-scale projects such as the Gamma-Ray Coordinate System (GCN), the Large Synoptic Survey Telescope (LSST), the European Low Frequency Array (LOFAR), or the Solar Dynamic Observatory (SDO). In the framework of the Planetary Space Weather Service (PSWS) of the Europlanet-H2020 Research Insfrastructure (EPN2020RI) project [3], we propose to use VOEvent for atmospheric observations like meteors and TLEs.

2.1. Meteors

Several camera networks already exist in Europe and around the world, aiming to detect and triangulate shooting stars, compute the trajectory of the possible meteorite and constrain the orbital properties of the meteoroid. Professional and amateur networks (see among others [9], [4], [5], [8]) working together will allow Europe to be completely independent in obtaining awareness about Earth space environnment and existing risks connected to atmospheric reentries. European Space Situational Awareness national programs would benefit from having a common and standard framework for sharing information on meteor and fireball detections, and their contribution to the ESA Fire-

[1] http://www.ivoa.net/documents/VOEventTransport/20170320/REC-VTP-2.0-20170320.html

[2] http://www.ivoa.net/documents/VOEvent/20110711/REC-VOEvent-2.0.pdf

ball Information System[3] would become more efficient. A Virtual Meteor Observatory initiative has already come alive in a European context [7] [2], ending up in the adoption of an XML-based communication format. Its connection to VOEvent standard will guarantee its sustainability in a larger and well documented context.

2.2. TLEs

Transient Luminous Events (TLEs) are large-scale optical events occurring in the upper-atmosphere from the top of thunderclouds up to the ionosphere. TLEs may have important effects in local, regional, and global scales of the atmosphere, but many features of TLEs are not fully understood yet. TARANIS (Tool for the Analysis of RAdiations from lightNIngs and Sprites) is a CNES satellite project dedicated to the study of impulsive transfers of energy between the Earth atmosphere and the space environment[4]. The TARANIS microsatellite will fly over thousands of TLEs for at least two years. Its scientific instruments will be capable of detecting these events and recording their luminous and radiative signatures, as well as the electromagnetic perturbations they set off in Earth's upper atmosphere. Coupling TLEs observation to the already existent meteor detection networks, will allow the observation of TLEs over unprecedented space and time scales [6], strongly increasing the probability of joint detection and hence the scientific return of space missions such as TARANIS and ASIM (ESA).

3. Summary and Perspectives

In the framework of the Europlanet-H2020 Research Insfrastructure (EPN2020RI) project, we propose to use the VOEvent standard for the surveillance of transient atmospheric events like meteors and TLEs. We have validated the proposed syntax[5,6] in the EPN2020 PSWS infrastructure.

The VOEvent syntax will be implemented in the meteor and TLE detection software FreeTure [1], and we will provide support for amateur and professional networks willing to adopt the VOEvent scheme.

[3] http://neo.ssa.esa.int/search-for-fireballs
[4] https://taranis.cnes.fr/en
[5] https://gist.github.com/cmarmo/de5c0d5332444385ac0d4afc9a5dd92e
[6]

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