frontiers | Frontiers in Space Technologies

TYPE Editorial
PUBLISHED 24 February 2023
DOI 10.3389/frspt.2023.1159825

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Space Debris, a section of the journal Frontiers in Space Technologies

RECEIVED 06 February 2023
ACCEPTED 16 February 2023
PUBLISHED 24 February 2023

CITATION
Bauer W, Braun V, Kitazawa Y and Telichev I (2023), Editorial: Space environment characterization. *Front. Space Technol.* 4:1159825. doi: 10.3389/frspt.2023.1159825

Editorial: Space environment characterization

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KEYWORDS

space debris, meteoroids, space environment, in-situ debris measurement, modelling

Editorial on the Research Topic
Space environment characterization

The space environment poses many challenges to spacecraft operations in Earth's orbits. The environment is composed of various factors that must be taken into account, such as micrometeoroids and orbital debris (MMOD), space weather events, and harsh thermal and radiation conditions. Therefore, a thorough understanding of these factors and the ability to effectively address them is essential for the design, operation, and performance of spacecraft in Earth's orbits. Space-based sensors and detectors are a growing trend that enables real-time measurements and observations of the space environment.

The article by Dignam et al. discussed in this Research Topic presents a new design for a passive space dust detector intended for deployment in Low Earth Orbit (LEO) for roughly 1 year. Upon its return to Earth, the detector will be analyzed for impact features generated by dust particles. The detector design includes using multiple Kapton foils, which have been demonstrated to effectively preserve details of the impacting particles' size and chemistry. The residue chemistry can be used to determine their origin (whether it is from human-made debris or naturally occurring micrometeoroids). The study also found that a thin coating of 10 nm of palladium effectively reduces the loss of mass on Kapton foils when exposed to atomic oxygen.

A novel method of *in-situ* space debris detection was proposed in the article by Fexer that uses a combination of conductance and characteristic impedance measurements, enabling the detection of multiple small impacts along one line. In addition, this proposed system can be used in conjunction with existing detection methods, providing an additional level of redundancy.

The use of CubeSats satellites as cost-efficient platforms for MMOD characterization is a new and promising approach. The article by Oikonomidou et al. describes the current progress of the MOVE-III CubeSat project at the Technical University of Munich, which focuses on obtaining *in-situ* measurements of sub-millimetre space debris and meteoroids in the Low Earth Orbit. The data collected on flux, particle mass, and velocity will be used to verify and enhance existing models for space debris.

The article by Hanada et al. examines the potential of improving orbital debris (OD) models and presents analysis techniques for OD datasets. It has proposed a new approach to estimate the direction of angular momentum of a broken-up object at a specific time from *in-situ* debris measurements.

The article by Klein et al. discusses another aspect of the space environment, providing an in-depth analysis of proton radiation spectra. This research can potentially be beneficial for a wide range of space-related applications, including mission analysis and material and component development.

An accurate atmospheric density model and an atmospheric composition model are crucial for predicting orbits and controlling debris in LEO. The article by Kimoto et al. examines the data on atomic oxygen in super-low Earth orbit at an altitude of 300 km or less, obtained from the sensors installed onboard the SLATS satellite. The analysis of this data is expected to provide valuable insights into the material degradation caused by atomic oxygen on satellites operating in the super low Earth orbits.

We anticipate that this Research Topic will serve as a valuable resource for readers, providing an overview of the current state of the art in the rapidly developing field of space environment characterization.

Author contributions

IT wrote the initial draft of the editorial, reviews by WB, VB, and YK.

Conflict of interest

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