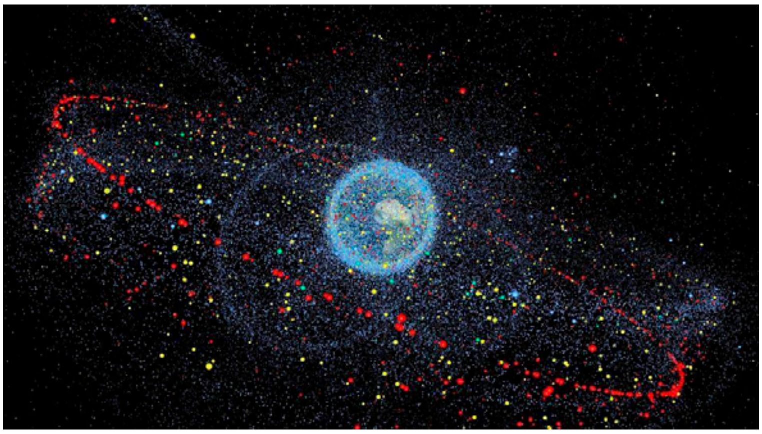
A09

Modeling the Space Debris Environment - Latest Improvements and Updates

○Carsten Wiedemann, A. Horstmann (TU Braunschweig), S. Hesselbach (DLR),
V. Braun, H. Krag (ESA), S. Flegel (unaffiliated),
M. Oswald (Airbus Defence & Space), E. Stoll (TU Braunschweig)

The latest improvements and updates in the current European reference model for describing the space debris environment are presented. The model with the abbreviation MASTER was completed with a reference epoch from November 2016. It replaces the previous version MASTER-2009. The new model has the internal version number "8". MASTER is made available by ESA via the Space Debris User Portal, including all updates. The model takes into account all known sources of space debris. This includes contributions that can be traced back to individual events, such as fragmentation, as well as continuous sources in the small particle size-range, such as surface degradation products or ejecta. The model consideres all objects that are larger than 1 µm. The new population is shown as an example for objects larger than 10 cm in comparison to the previous model. Spatial density is chosen as the form of representation. The current modeling results have shown that the spatial density has increased significantly at an altitude of 800 km compared to the previous version. This is mainly due to a reevaluation of historical fragmentation events. The main events that led to the significant increase in fragments are shown. The high-resolution particle flux analysis capability of the model is discussed using the example of two selected orbits.



Biography

Carsten Wiedemann

Dr.-Ing. Carsten Wiedemann is a permanently employed senior scientist at the Institute of Space Systems at the Technische Universität Braunschweig (Germany). His tasks include the following positions: quality manager of the institute, team head of the space debris group, organization and presentation of lectures, supervision of student research projects, and scientific project work. He is member of the DLR delegation at the Inter-Agency Space Debris Coordination Committee (IADC). His field of research is the modeling of the space debris environment. One important research project was the development and upgrading of the ESA MASTER model.

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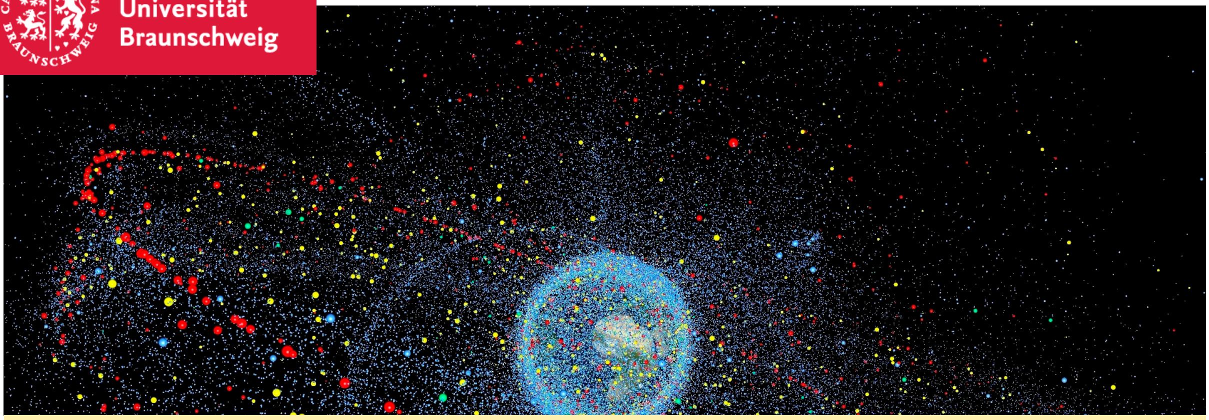


Modeling the space debris environment - latest improvements and updates

C. Wiedemann[1], A. Horstmann[1], S. Hesselbach[2], V. Braun[3], H. Krag[4], S. Flegel[5], M. Oswald[6], E. Stoll[1]

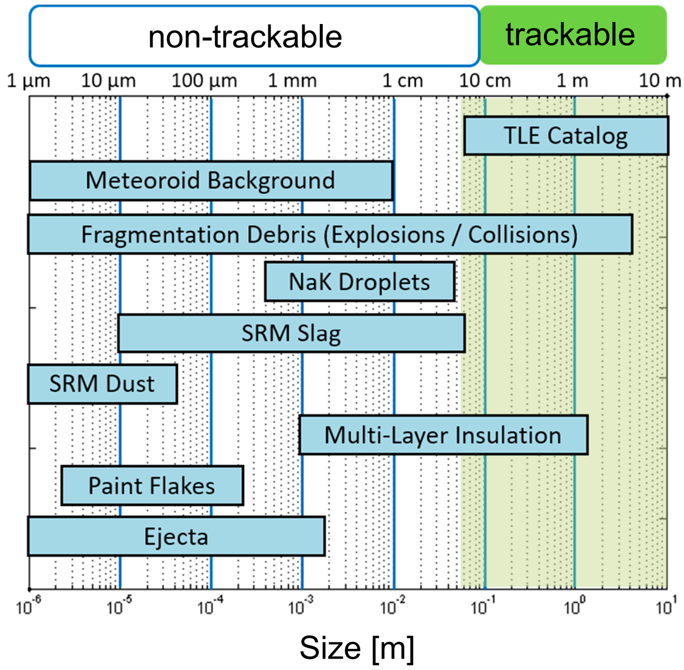
[1]Institut für Raumfahrtsysteme (IRAS), Technische Universität Braunschweig, Hermann-Blenk-Str. 23, 38108 Braunschweig
[2]Deutsches Zentrum für Luft- und Raumfahrt, Weltraumlagezentrum, 47589 Uedem
[3]Space Debris Office, ESA/ESOC, Robert-Bosch-Str. 5, 64293 Darmstadt
[4]ESA Space Safety Programme Office, Robert-Bosch-Str. 5, 64293 Darmstadt
[5]unaffiliated
[6]Airbus Defence & Space GmbH, 88039 Friedrichshafen

Introduction

- The latest improvements and updates in the current European reference model for describing the space debris environment are presented.
- The model with the abbreviation MASTER was completed with a reference epoch from November 2016.
- It replaces the previous version MASTER-2009. The new model has the internal version number "8".
- MASTER is made available by ESA via the Space Debris User Portal, including all updates [1].
- The model takes into account all known sources of space debris.
- This includes contributions that can be traced back to individual events, such as fragmentation, as well as continuous sources in the small particle size-range, such as surface degradation products or ejecta.
- The model considers all objects that are larger than 1 µm.

[2] ESA/ESOC, Space Debris User Portal, https://sdup.esoc.esa.int

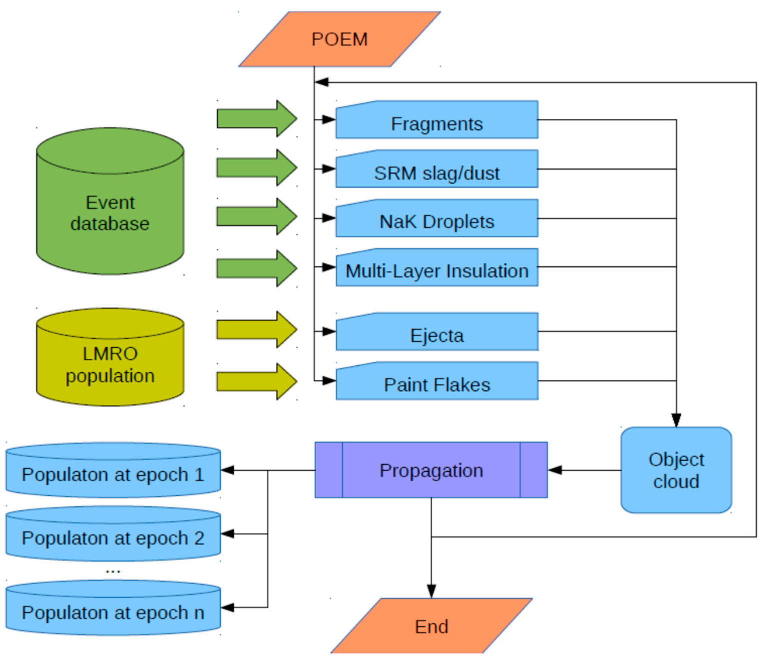
Sources of Debris and Meteoroids



The contribution of the explosion and collision fragments covers the entire size range considered. In practice, however, the fragments only make a dominant contribution to space debris above 1 cm particle diameter.

The small-size regime is dominated by two different particle groups, ejecta and paint flakes, which occur in extremely high numbers.

Schematic View of the Data Flux in POEM

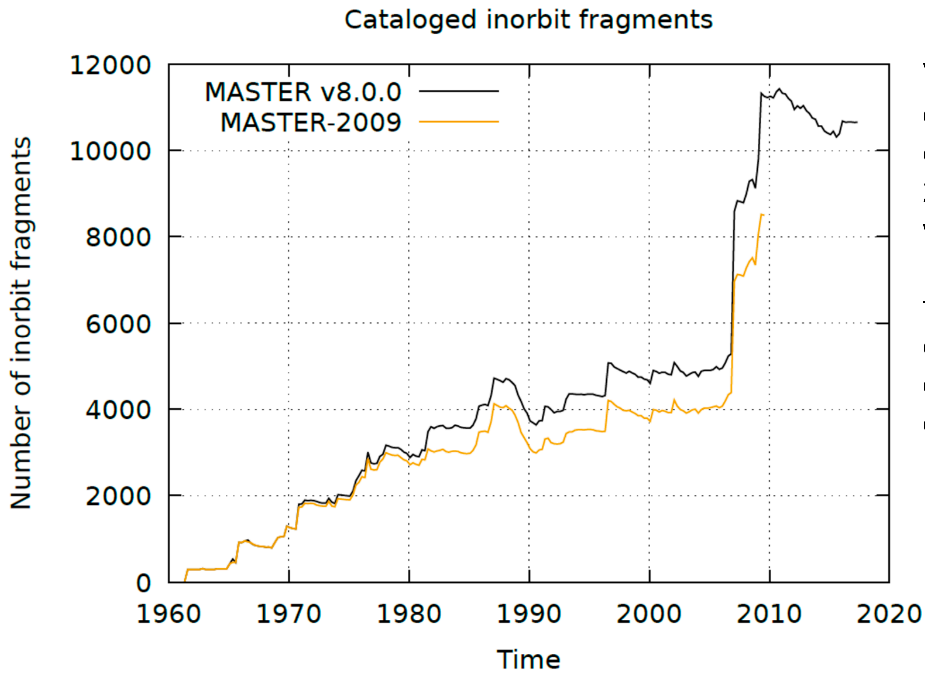


One input file is the list of all events in which space debris objects were released.

The second input file is the population of Launch and Mission Related Objects. The LMRO themselves are included in the model as a population.

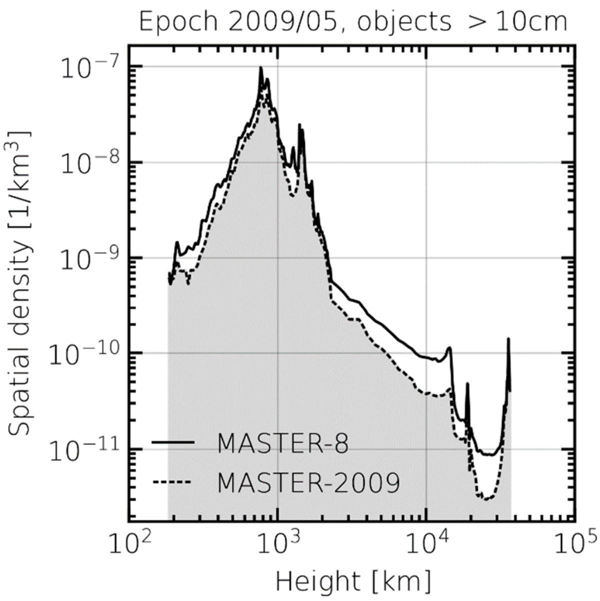
In addition, LMRO are the source for further contributions to space debris. These are the ejecta and the paint flakes which are permanently released from these objects.

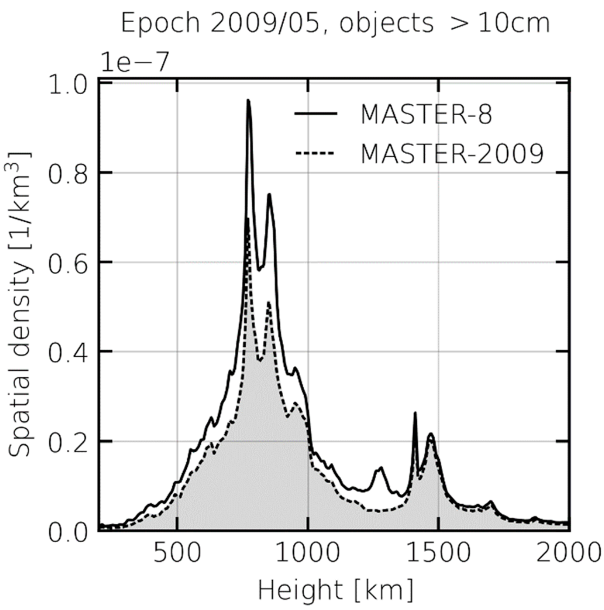
Comparison of Fragments: MASTER-2009 and MASTER-8



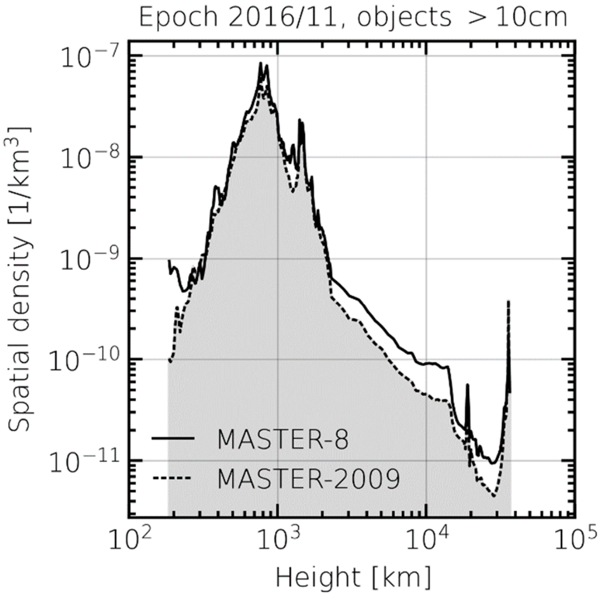
Various new TLE objects have been cataloged between 2009 and 2016, which can be traced back to fragmentation events that occurred in the early 1980s or even before.

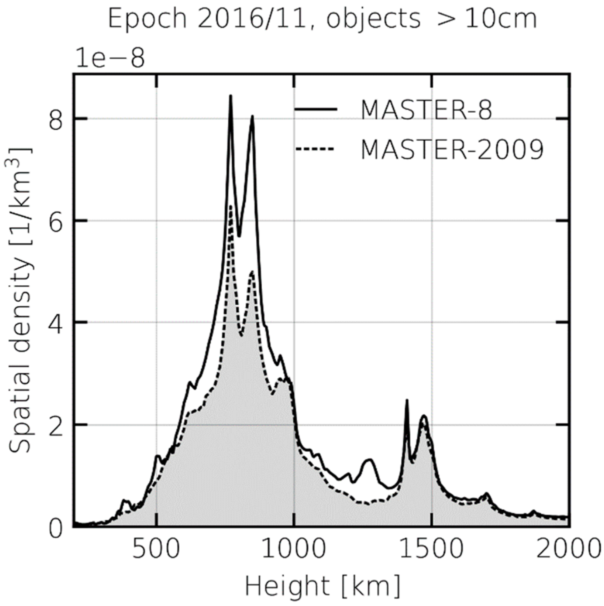
Comparison of 10 cm Populations (2009)



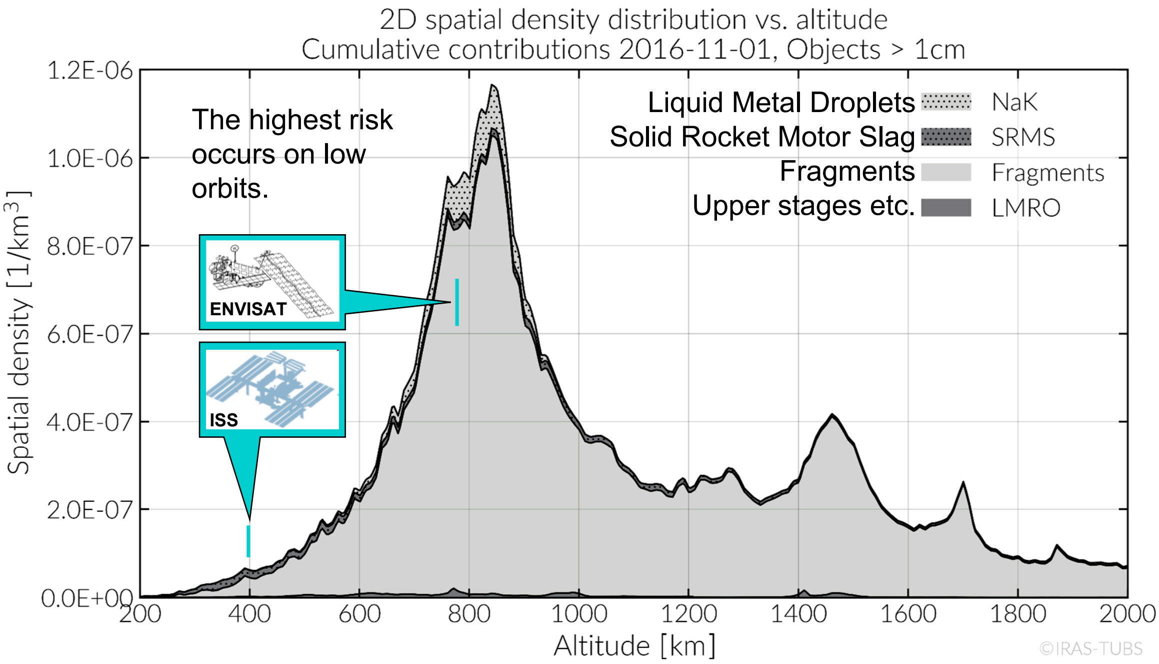


Comparison of 10 cm Populations (2016)



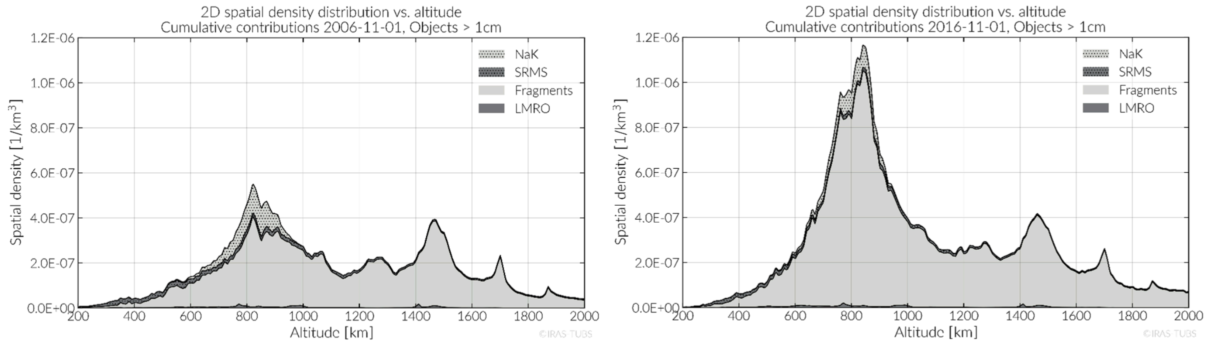


Distribution of space debris (2016)



Increase of space debris

Significant increase in fragments due to two events:
- FengYun-1C (2007)
- Cosmos/Iridium (2009)



2006 2016

Spatial density of objects greater than one centimeter according to MASTER

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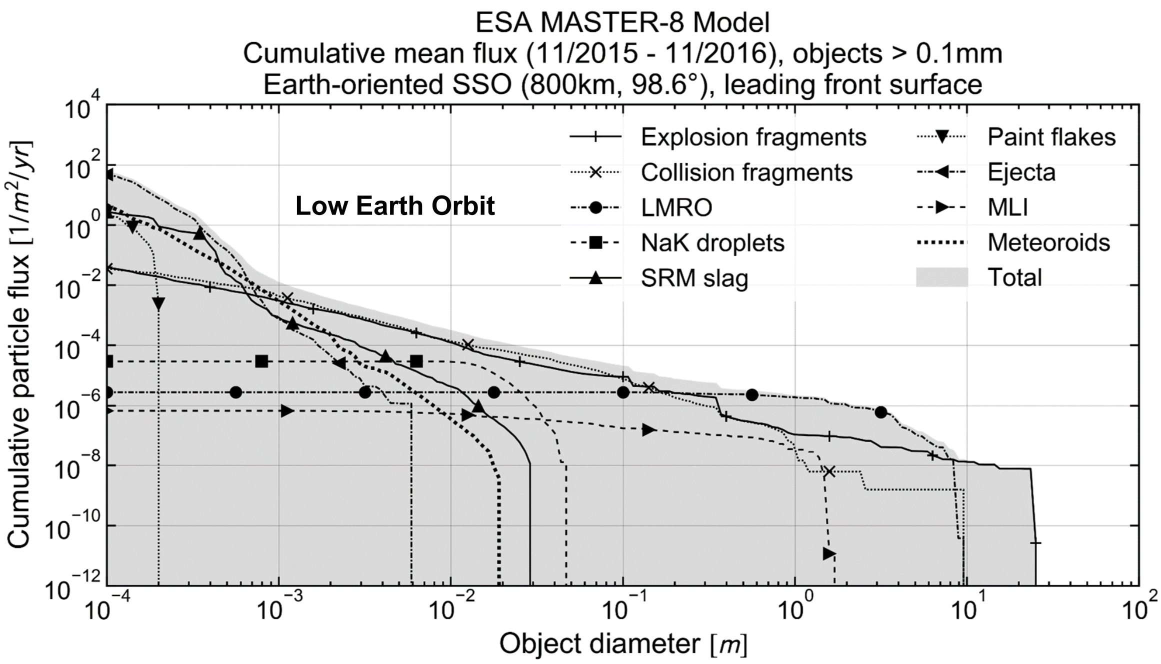
Size Distribution LEO



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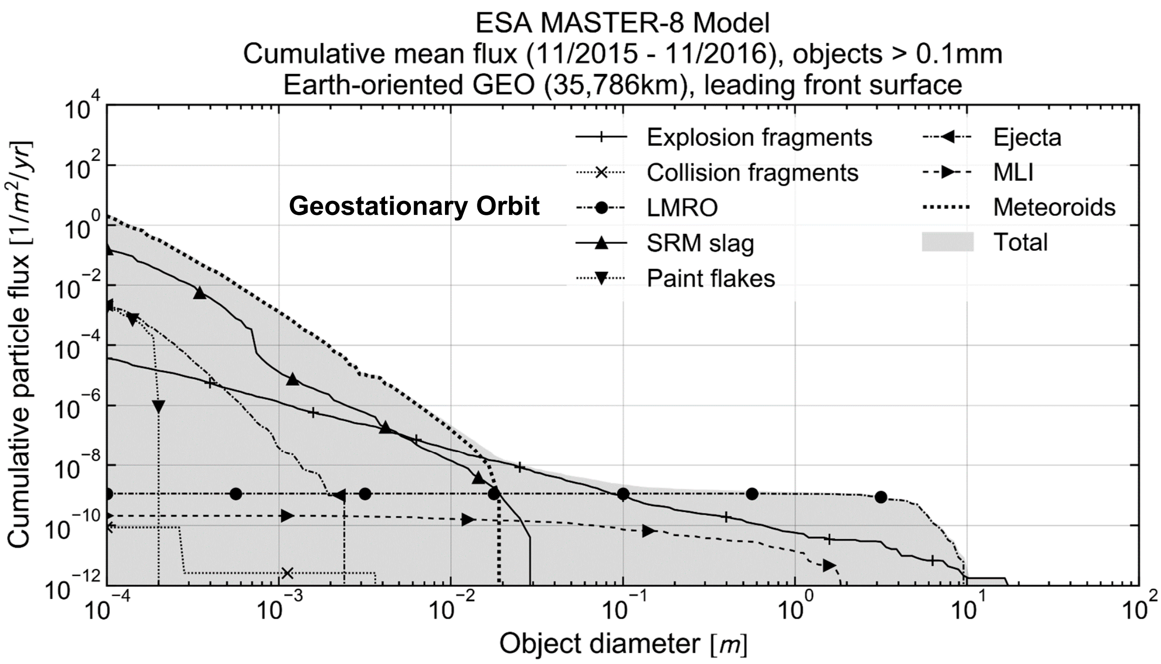
Size Distribution GEO



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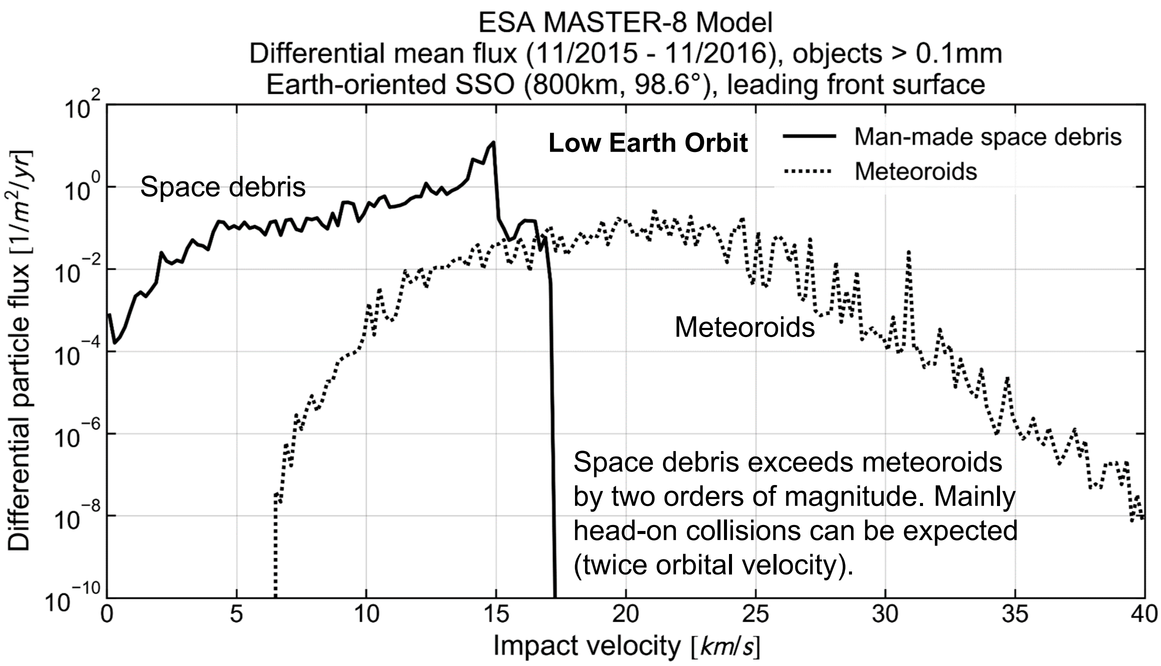
Impact Velocity Distribution on LEO



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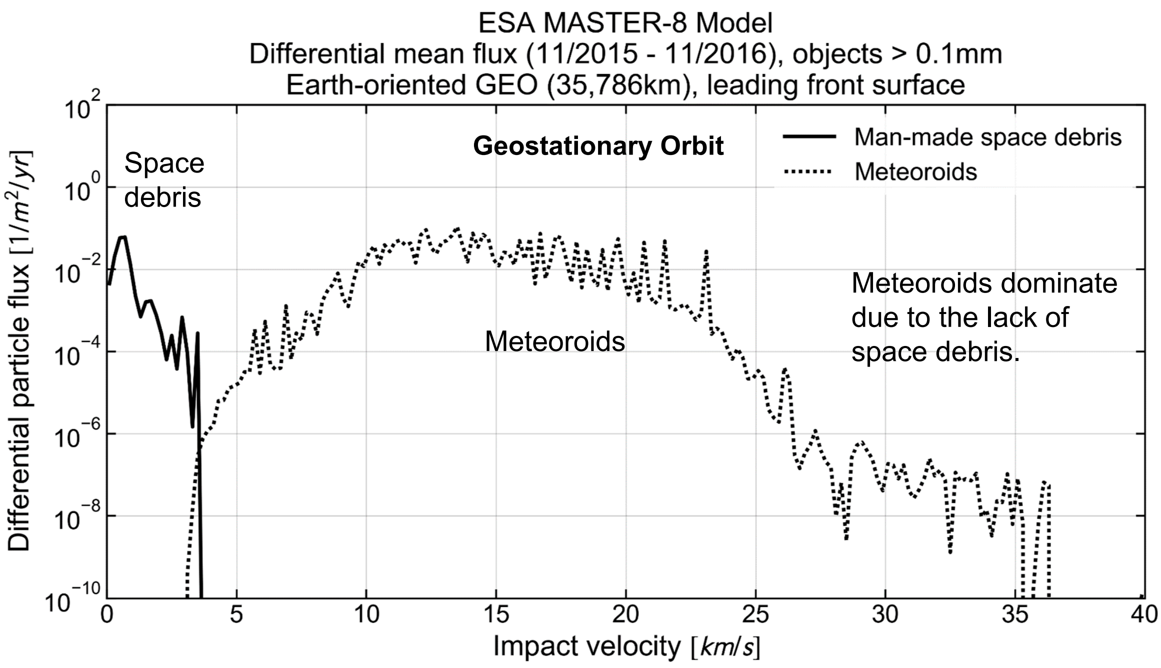
Impact Velocity Distribution on GEO



Summary

- The new population is shown as an example for objects larger than 10 cm in comparison to the previous model.
- Spatial density is chosen as the form of representation.
- The high-resolution particle flux analysis capability of the model is discussed using the example of two selected orbits.
- The current modeling results have shown that the spatial density has increased significantly at an altitude of 800 km compared to the previous version.
- This is mainly due to a reevaluation of historical fragmentation events.
- The main events that led to the significant increase in fragments are explained.

Acknowledgement

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