Long-term orbital environment prediction by orbital debris evolutionary model

Report Number: R20EG3105
Subject Category: Research and Development
URL: https://www.jss.jaxa.jp/en/ar/e2020/14349/

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Abstract

Increase of space debris is a problem for reliability of future space activity. JAXA has researched space debris related technology for space debris mitigation and environmental remediation. The effectiveness of space debris countermeasures is evaluated based on the prediction of future orbital environment using the orbital debris evolutionary model (NEODEEM) jointly developed by JAXA and Kyushu University.

Ref. URL: http://www.kenkai.jaxa.jp/eng/research/debris/debris.html

Reasons and benefits of using JAXA Supercomputer System

NEODEEM predicts the situation of over 200 years orbital propagations of more than 20000 elements and orbital events by using Monte-Carlo method (evaluate the average of 100 runs). Therefore, JSS2 is used to reduce run time and to process a large amount of data. Only SORA_PP is used for compatibility with PC version (WINDOWS).

Achievements of the Year

As the evaluation of the future orbital environment, study of the orbit insertion capacity tolerance of the spacecraft was carried out using the orbital debris evolutionary model (NEODEEM). The impact on orbital environment with a huge number of satellites such as LC (Large Constellation) system currently being deployed in orbit and the effects of various related parameters were evaluated (evaluation of insertion altitude effect (Fig. 1), and the evaluation of the number of insertion spacecraft (Fig. 2)).

These results are used as a basis for evaluating the effectiveness of debris mitigation measures and discussing international rules.

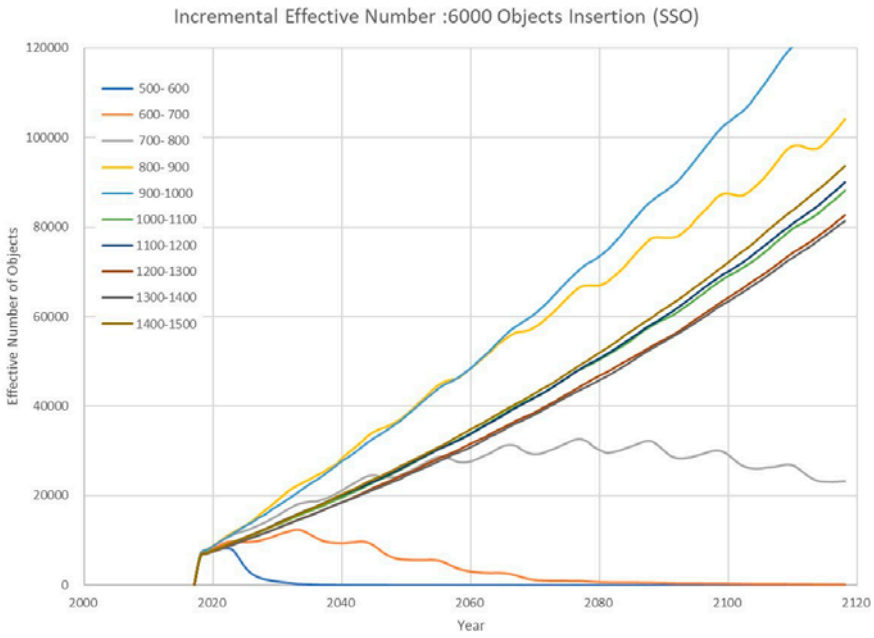

Fig. 1: Evaluation of insertion altitude effect by Effective Number

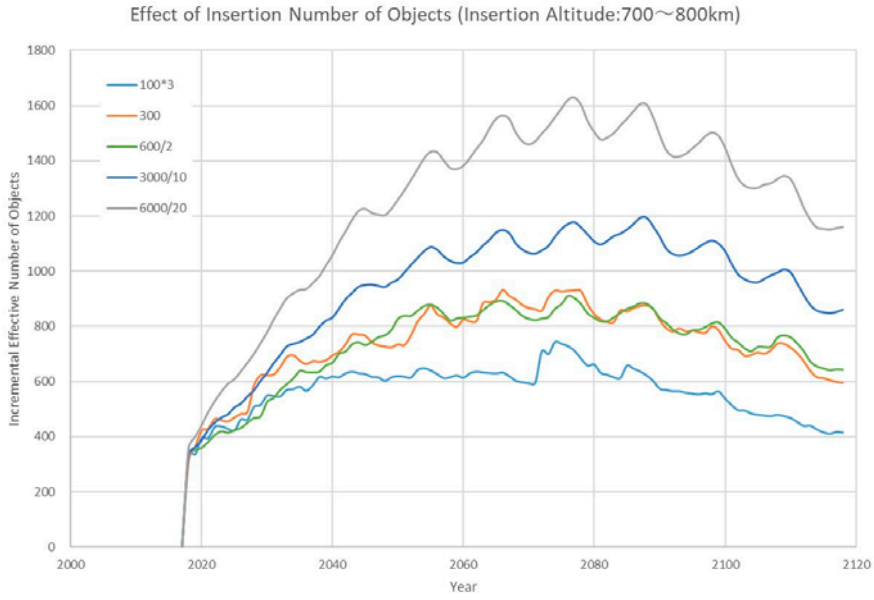

Fig. 2: Evaluation of the number of insertion spacecraft

Publications

- Peer-reviewed papers

1.Kawamoto, Nagaoka, Sato, Hanada "Impact on Collision Probability by Post Mission Disposal and Active Debris Removal" The Journal of Space Safety Engineering

2.McKnight, Witner, Letizia, Lemmens, Anselmo, Pardini, Rossi, Kunstadter, Kawamoto, Aslanov, Dolado, Ruch, Lewis, Nicolls, Jing, Dan, Baranov,Grishko "Identifying the 50 Statistically Most Concerning Derelict Objects in LEO" Acta Astronautica

- Oral Presentations

1.NAGAOKA Nobuaki, KAWAMOTO Satomi, KITAGAWA Yasuhiro (JAXA), HANADA Toshiya (Kyushu Univ.) "Study of the Orbit Insertion Capacity Tolerance of the Spacecraft Using the Orbital Debris Evolutionary Model" 9th Space Debris Workshop

2.KAWAMOTO Satomi, NAGAOKA Nobuaki, KITAGAWA Yasuhiro, YANAGISAWA Toshifumi, UENO Hiroshi (JAXA), NAKAWATASE Ryuji, UEDA O. Hiroko, HATTA Shinji (MUSCAT Space Engineering), HANADA Toshiya (Kyushu Univ.) "Development of JAXA's Original Baseline File for Debris Evolutionary Model" 9th Space Debris Workshop

Usage of JSS

Computational Information

Process Parallelization Methods	Assigning Monte-Carlo runs with same initial conditions to multiple cores
Thread Parallelization Methods	N/A
Number of Processes	10
Elapsed Time per Case	60 Hour(s)

Resources Used(JSS2)

Fraction of Usage in Total Resources[*1](%): 0.32

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	0.00	0.00
SORA-PP	563,533.76	4.42
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	19.07	0.02
/data	190.73	0.00
/ltmp	3,906.25	0.33

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	10.61	0.35

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources[*1](%): 0.07

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-RURI	113,287.54	0.65
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	14.31	0.01
/data	143.05	0.00
/ssd	143.05	0.07

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	10.61	0.35

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.