Long-term orbital environment prediction by orbital debris evolutionary model

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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 guidelines for countermeasures of space debris are researched 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. 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

Study of some indices expected to be effective in reducing future orbit debris performed using NEODEEM, to evaluate the effects of various related parameters (e.g. dependency on the altitude of active debris removal (ADR) object (Figure 1) , ADR starting time (Figure 2), and dependency on disposal altitude and speed).

The impact on the orbital environment by mega-constellation system in which a huge number of satellites are placed in orbit is also evaluated.

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

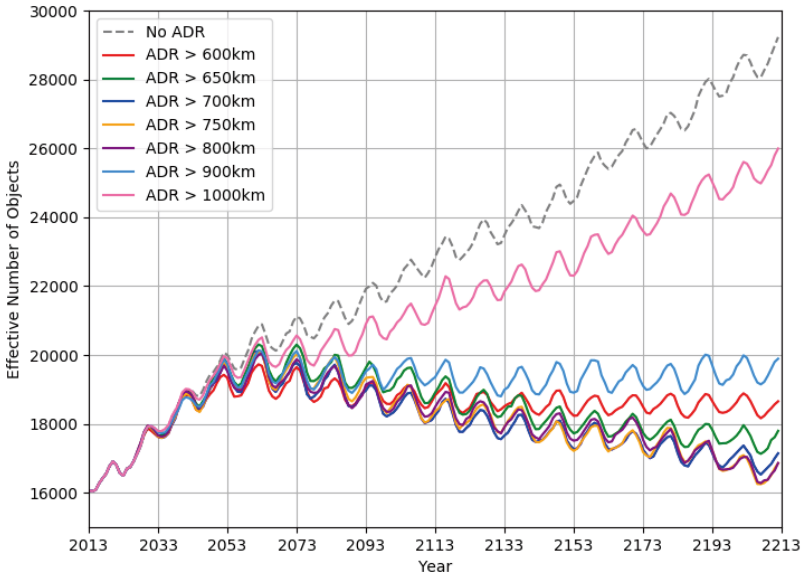

Fig. 1: Effect of ADR object altitude (five disposal objects per year)

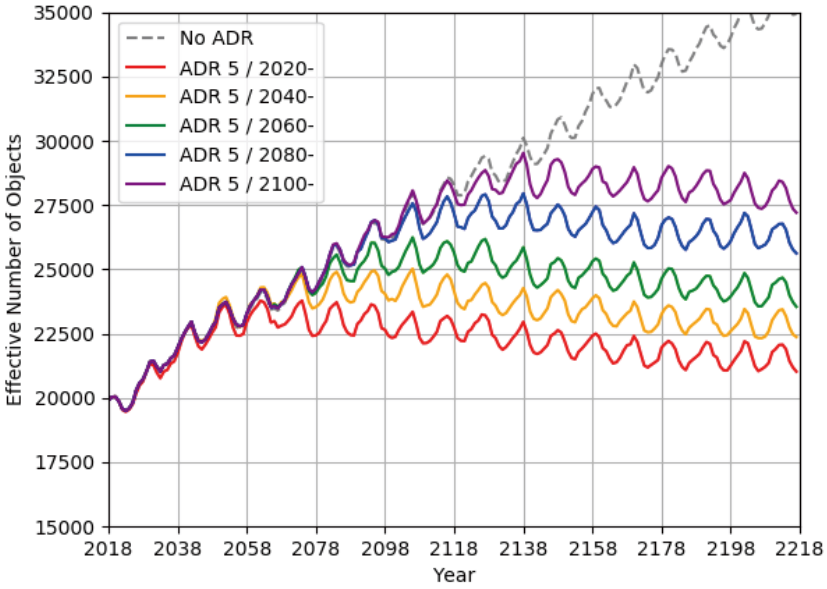

Fig. 2: Effect of ADR starting time

Publications

- Non peer-reviewed papers

1)Kawamoto, S., Nagaoka, N., Sato, T., and Hanada, T, "Impact on Collision Probability by Post Mission Disposal and Active Debris Removal", The First International Orbital Debris Conference (IOC) 2019.

2)Kawamoto, S., Nagaoka, N., Hanada, T., Abe, S. "Evaluation of Active Debris Removal Strategy Using a Debris Evolutionary Model", 70th International Astronautical Congress (IAC) 2019.

Usage of JSS2

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

Fraction of Usage in Total Resources[*1](%): 0.25

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	0.00	0.00
SORA-PP	691,812.13	4.48
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	0.01	0.00

[*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.