Prediction of aerothermal environment around atmospheric entry vehicles with sophisticated numerical tools

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Abstract

In this study, we try to enhance physical models for high temperature gas and numerical simulation method to accurately predict heating and aerodynamic characteristics at hypersonic atmospheric entry. We aim to develop high fidelity simulation tool by demonstrating improvement of prediction accuracy by comparing experimental data and simulation results with the newly proposed model and method. We also aim to develop a damage prediction method by analyzing thermal stress distribution in heatshields under atmospheric entry heating conditions.

Reasons and benefits of using JAXA Supercomputer System

In order to evaluate uncertainties in nonequilibrium thermochemical models and freestream conditions, supercomputer has been used to perform a large number of CFD runs by changing physical models and flow conditions.

Achievements of the Year

The parachute of sample return capsules was the target of this research, and the purpose was to extend a numerical analysis code for supersonic parachute to low speed parachute. In this year, as shown in Fig. 1, the parachute size and the grid generation method were changed, and the analysis environment was constructed.

Additionaly, thermal stress analyses (see Fig. 2) were performed on ablators, which are thermal protection materials of sample return capsules, during arc heating wind tunnel tests. The dependence of interlaminar strength on delamination was evaluated.

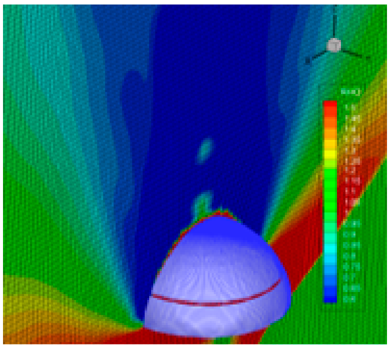

Fig. 1: Parachute fluid-structure interaction analysis integrated with geometry change

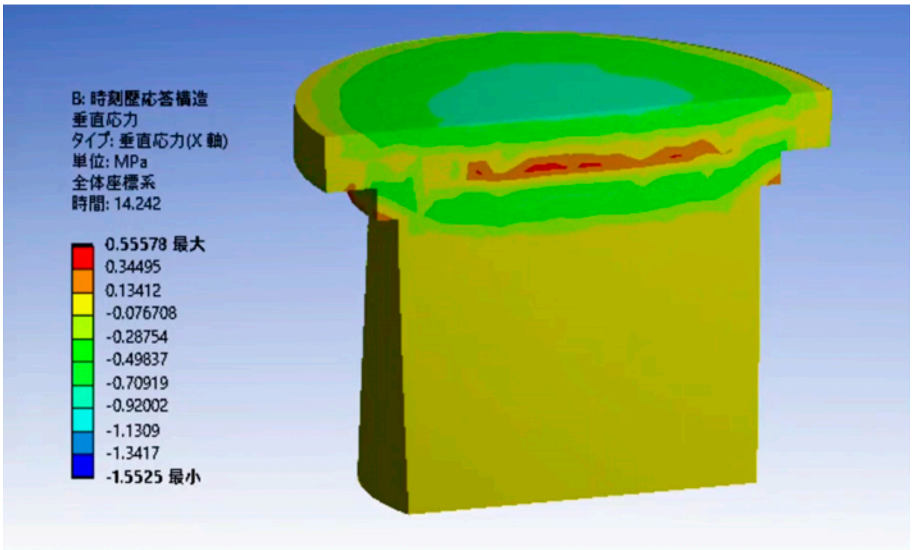

Fig. 2: Thermal stress analysis of an ablator during a arc-heated wind tunnel test (Video. Video is available on the web.)

Publications

N/A

Usage of JSS

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	3
Elapsed Time per Case	50000 Second(s)

- **Resources Used(JSS2)**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	0.00	0.00
SORA-PP	15,002.56	0.12
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	297.23	0.27
/data	5,887.35	0.11
/ltmp	5,045.58	0.43

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	0.00	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.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	45.31	0.00
TOKI-RURI	1,624.30	0.01
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	182.79	0.13
/data	3,493.63	0.06
/ssd	270.21	0.14

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	0.00	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.