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. In this year, we focus on the improvement of parachute simulation scheme and ablator thermal stress analysis scheme.

Reasons and benefits of using JAXA Supercomputer System

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

Achievements of the Year

A parachute for a sample return capsule was studied to simulate drag and projected area by performing FSI analysis (fluid structure interaction analysis). Following the construction of the analysis environment in the previous year, the analysis was performed (Fig. 1) and the parachute aerodynamic parameters were changed, each data was acquired. Ablators are also studied to evaluate the thermal stresses that occur during arc heating wind tunnel testing by thermal stress analysis. Based on the analysis of the previous year, analysis was conducted for several shapes to confirm the differences depending on the shape. (Fig. 2)

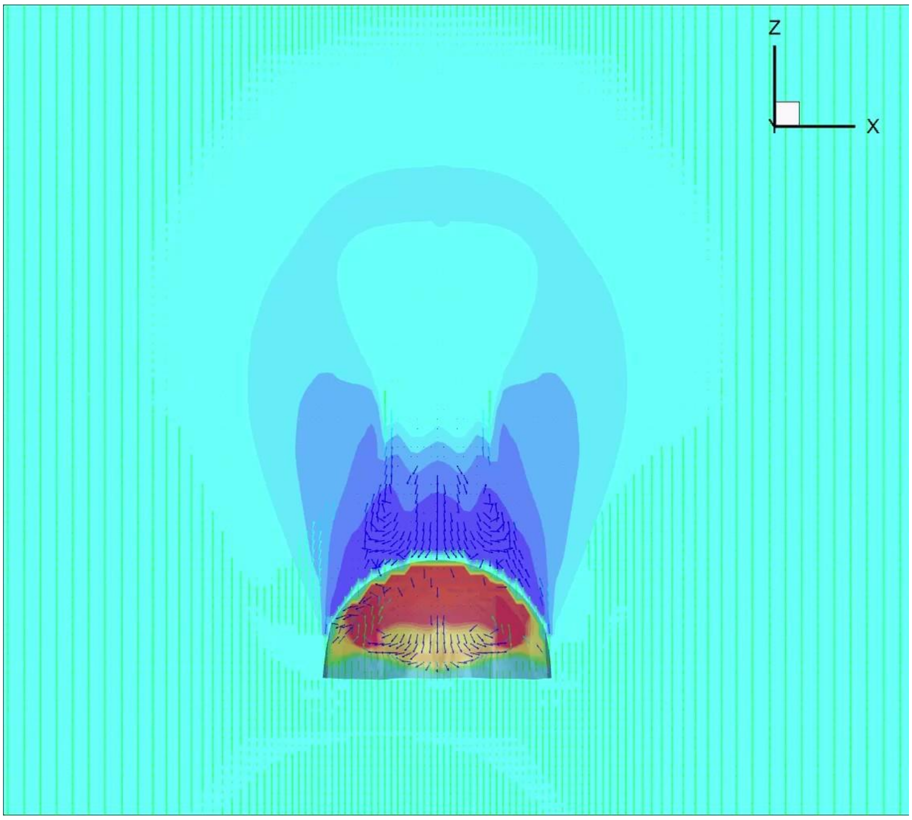

Fig. 1: Visualization results of FSI analysis (Video. Video is available on the web.)

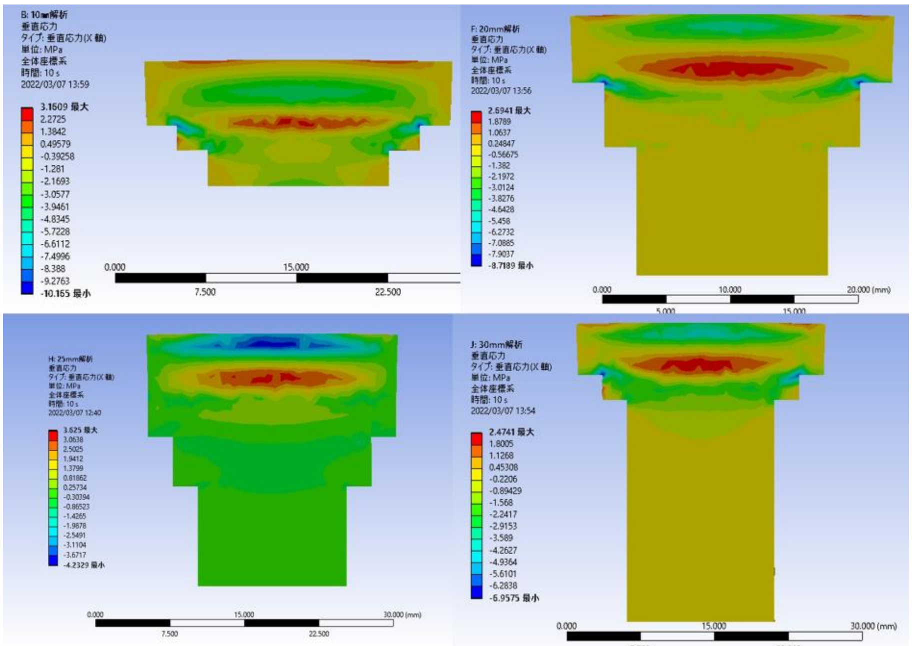

Fig. 2: Analysis results 10s after heating

Publications

- Oral Presentations

Proceedings of the Space Sciences and Technology Conference: 2021

Symposium on Flight Mechanics and Astrodynamics: 2021

33rd International Symposium on Space Technology and Science

Usage of JSS

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	8
Elapsed Time per Case	12 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 0.09

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	463,461.95	0.02
TOKI-ST	507,770.77	0.63
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	191.67	0.19
/data and /data2	3,663.33	0.04
/ssd	283.33	0.07

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.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage*2(%)
ISV Software Licenses (Total)	661.40	0.46

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