

Attitude Instability Analyses of Sample Return Capsules

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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 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 analyses of attitude instability for sample return capsules.

● 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

In this work, we have studied the dynamic instability of hayabusa(HYB)-shaped capsules in transonic flow regime by carrying out CFD computations. Since attitude instability characteristics of HYB-type capsules in transonic flow regime is not well-known in terms of size dependence and center of gravity dependence. We have studied size dependence of pitch motion with diameters of 100, 400, and 600 mm using the JONATHAN-ALE code with Large-Eddy Simulation (LES). At Mach number of 1.1, the effect of enlargement of capsules on dynamic instability characteristics as well as the sensitivity to center-of-gravity position was found. However, the discrepancy of the angle of attack range between CFD results and motion simulation results with an existing aerodynamic database was small. In our future work, we extend the computationa time and the maximum capsule diameter. Also, we investigate the dependence of flow conditions in order to improve the aerodynamic database and reliability of motion simulation results.

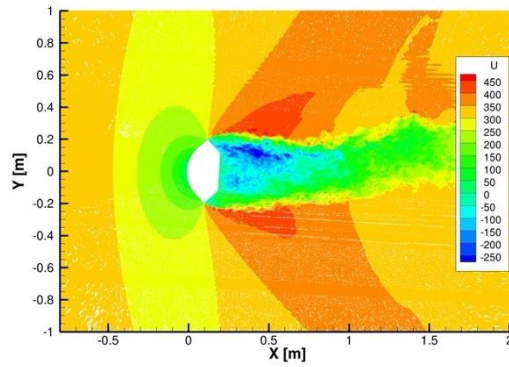


Fig. 1: Pitch motion analyses by a JONATHAN-ALE code

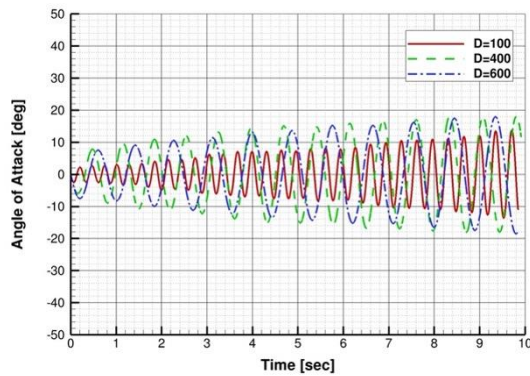


Fig. 2: Comparison of angle of attack history among D=100, 400 and 600 mm

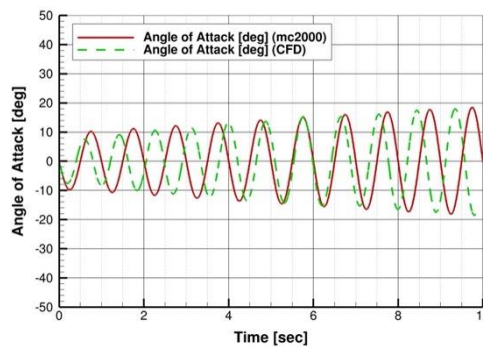


Fig. 3: Comparison of angle of attack between attitude simulation with an existing aerodynamic database and CFD results

● Publications

- Oral Presentations

Proceedings of the Space Sciences and Technology Conference: 2022

● **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	366 - 2928
Elapsed Time per Case	24 Hour(s)

● **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 2.45

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage *2(%)
TOKI-SORA	66,904,666.52	2.92
TOKI-ST	0.48	0.00
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	0.17
/data and /data2	3,663.33	0.03
/ssd	283.33	0.04

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)	0.00	0.00

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