Study on dynamic instability of a reentry capsule at transonic speed

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Abstract

It is known that atmospheric entry capsules exhibit dynamic instability during transonic to subsonic flight due to unsteadiness of wake dynamics. And, the possibility in which the fluid phenomenon of the specific frequency affects the dynamic instability is indicated. To investigate the wake dynamics, we numerically simulated flowfield around the normal flat plate, and we applied dynamic mode decomposition (DMD) to the obtained unsteady flowfield data.

Reasons and benefits of using JAXA Supercomputer System

Large calculation cost is required to simulate unsteady flow fields.

Achievements of the Year

A DMD analysis was performed on the numerical results for a normal flat plate at M=0.2. Figure 1 shows the collapse of the spanwise vortex at low frequencies obtained from the DMD. The wavelength of the spanwise unsteadiness is shown in Figure 2, and the characteristic structure of the low-frequency fluid phenomenon is extracted.

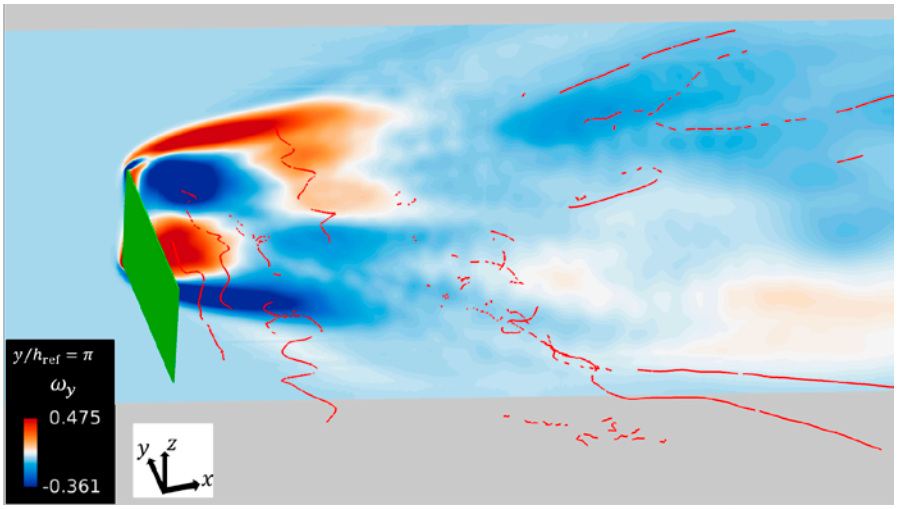

Fig. 1: Vortex core structure behind a normal flat plate

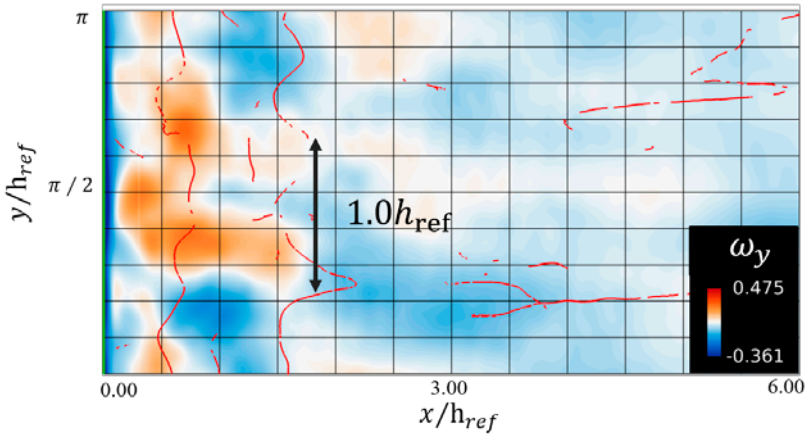

Fig. 2: Decay wavelength of vortex core

Publications

- Oral Presentations

Harafuji, M., Ohmichi, Y., Kanazaki, M., "Dynamic Mode Decomposition Analysis for Low-Frequency Phenomenon of the Wake behind a Normal Flat Plate," The 34th Computational Fluid Dynamics Symposium, Okinawa, December 2020.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	128
Elapsed Time per Case	50 Hour(s)

Resources Used(JSS2)

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

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	306,613.12	0.06
SORA-PP	17,465.44	0.14
SORA-LM	1,309.47	0.77
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	238.42	0.22
/data	42,480.49	0.82
/ltmp	976.56	0.08

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	26.79	0.89

[*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](%): 0.03

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-RURI	32.04	0.00
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	238.42	0.16
/data	42,480.49	0.71
/ssd	47.68	0.02

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	26.79	0.89

[*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.