High-Resolution, Efficient CFD Methods by Second Slope Limiter for Transonic Speeds

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Abstract

A high-resolution, Delayed DES has been conducted around whole the aircraft under the low-speed buffet condition. This numerical case is known as a tough problem, since it is difficult to obtain good numerical solutions that agree well with the corresponding experimental data. In this study, we introduced a new, unsteady-preconditioning function which controls the numerical dissipation to control grid-dependent, unsteady numerical oscillations. Its effect has been confirmed by the numerical test.

Reasons and benefits of using JAXA Supercomputer System

1) Expensive, unsteady CFD around whole the aircraft; 2) Many numerical cases (aerodynamic problems) in which our proposed schemes are verified.

Achievements of the Year

In the calculation case that we had done until last year, there was a problem that numerical oscillation occurred in the HR-SLAU2 with high resolution. To solve this problem, we were able to suppress the numerical oscillation by verifying the time interval and the time average interval. It was also confirmed that the calculated aerodynamic coefficients were close to the experimental values by using the optimum time increments and time average intervals. Furthermore, the effects of turbulence model and numerical flux function were investigated, and it was found that the aerodynamic coefficients obtained by combining the high-resolution HR-DDES and HR-SLAU2 were closer to the experimental values than the conventional ones.

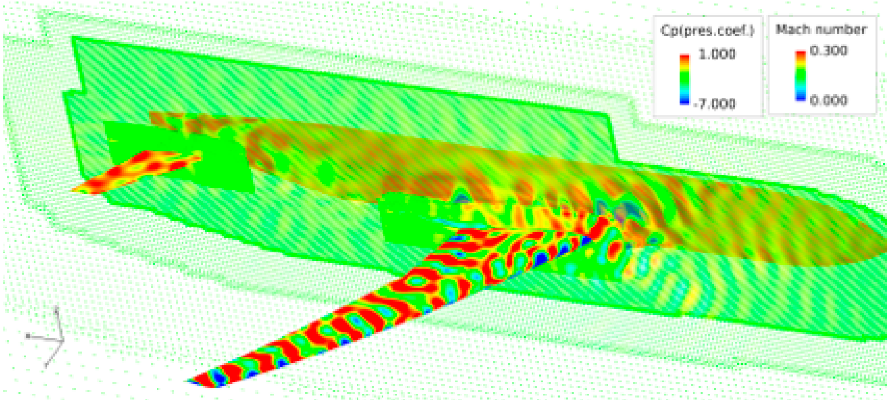

Fig. 1: Before verification of time increment and time average (numerical oscillation occurred)

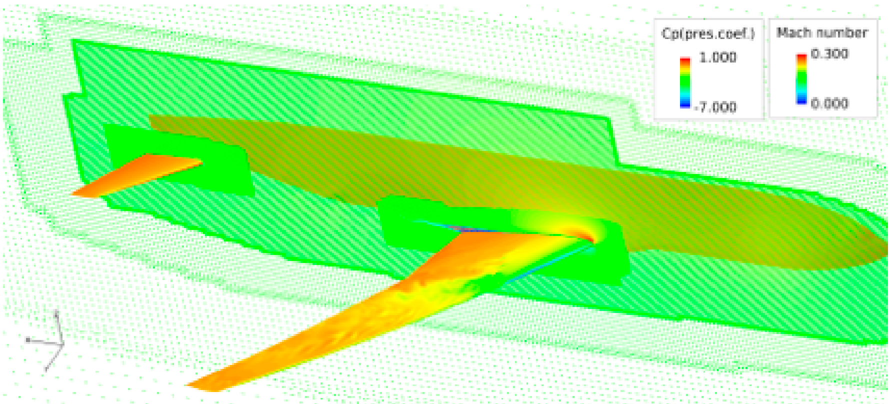

Fig. 2: After verification of time increment and time average (numerical oscillation suppressed)

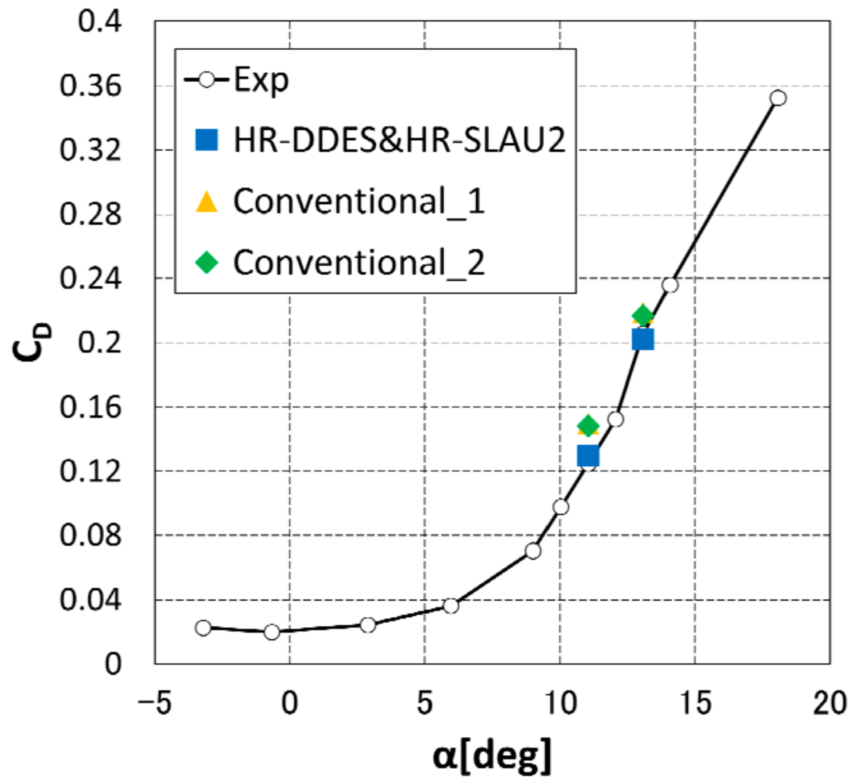

Fig. 3: Comparison of conventional and proposed methods in CD

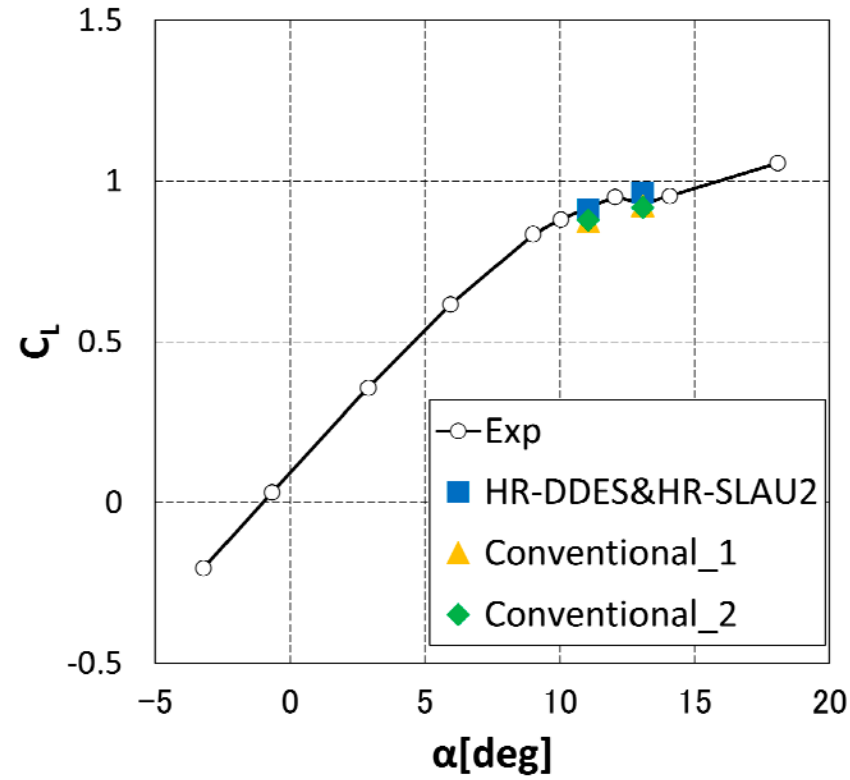

Fig. 4: Comparison of conventional and proposed methods in CL

Publications

- Oral Presentations

K. Kitamura, Y. Yasumura, M. Kanamori, A. Hashimoto : Effects of Selected Numerical Method on Unsteady NASA CRM Low-Speed Buffet Simulations, Fluid Dynamics Conference / Aerospace Numerical Simulation Symposium 2020 online, 1A11, 28 September 2020.

Usage of JSS

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	512
Elapsed Time per Case	50 Hour(s)

- **Resources Used(JSS2)**

Fraction of Usage in Total Resources[*1](%): 0.74

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	2,650,599.28	0.50
SORA-PP	137,994.14	1.08
SORA-LM	926.36	0.54
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	3,503.59	3.21
/data	149,276.44	2.88
/ltmp	38,813.73	3.31

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	55.54	1.84

[*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](%): 0.27

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	690,950.83	0.15
TOKI-RURI	56,967.09	0.33
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	2,393.76	1.64
/data	129,386.72	2.17
/ssd	5,969.85	3.12

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	55.54	1.84

[*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.