Numerical study on low-speed buffet

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Abstract

Low-speed buffet is an aerodynamic vibration phenomenon that occurs during low-speed and high-angle-of-attack conditions. In order to safely fly an aircraft, it is important to analyze low-speed, high-angle-of-attack flows where low-speed buffet can occur. Therefore, in this project, CFD analysis is performed for around aircraft. As a method, DDES using RANS near the wall and LES in other areas is performed. In this DDES, we analyze RANS / LES switching closer to the wall. We aim to find analytical solutions that are closer to experimental values than conventional calculations.

Reasons and benefits of using JAXA Supercomputer System

It is absolutely necessary to prepare a computational grid with high-resolution near the separated zone in order to predict a low-speed buffet phenomenon accurately. The number of grid point is of the order of tens of millions, which is prohibitively large from a view point of a computation with a personal computer. The processing capability of JSS2 is therefore necessary for our research.

Achievements of the Year

In this our research, NASA-CRM was analyzed under two flow conditions. In the DDES analysis method, the switching position of RANS / LES is changed using the model parameter Cdes. Cdes = 0.65 is the default value. If it is larger than this, the RANS region expands, and if it is smaller, the RANS region narrows.

The first condition of the flow is an experiment performed with the European Transonis Windtunnel(Lutz et al., AIAA 10.2514/6.2015-1094, 2015), and the experimental values are compared. It can be seen that the cross-sectional pressure distribution at the blade root, which was difficult to reproduce by CFD analysis, approaches the experimental value when Cdes is reduced to about 0.1 (Fig. 1).

Next, it compares with the experiment performed in the low-speed wind tunnel of JAXA(Uchiyama et al., AIAA 10.2514/6.2019-2190, 2019). DDES analysis with Cdes of 0.1 gave better agreement on lift coefficients (Fig. 2).

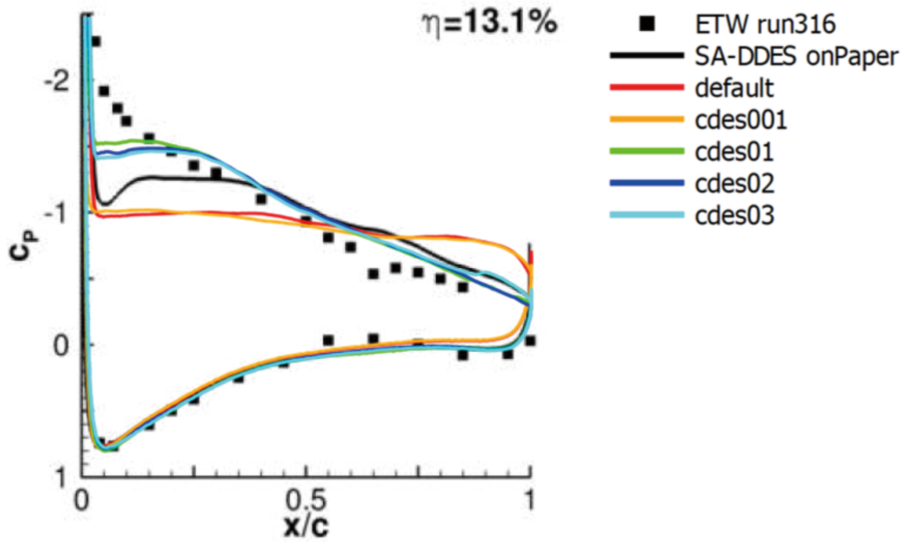

Fig. 1: pressure distribution in wing root section

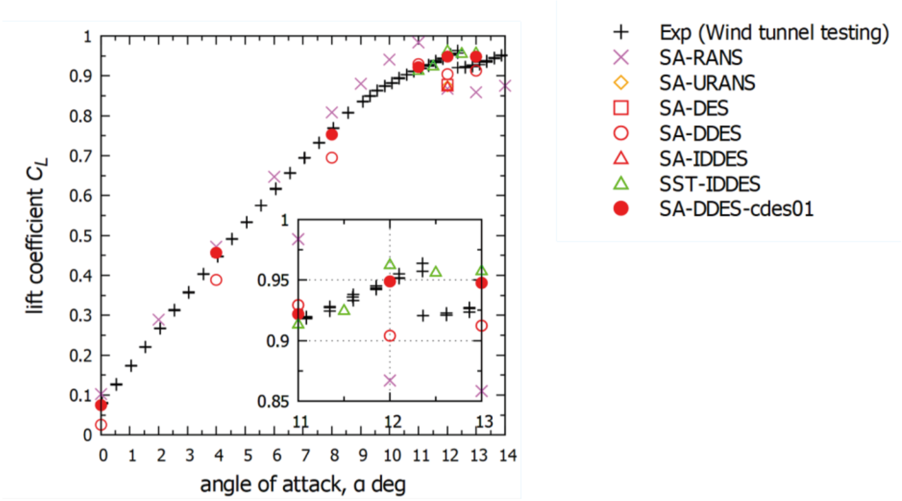

Fig. 2: variation of lift coeficient against angle of attack

Publications

N/A

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	480
Elapsed Time per Case	240 Hour(s)

- **Resources Used**

Fraction of Usage in Total Resources*1(%): 0.16

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
SORA-MA	1,430,169.20	0.17
SORA-PP	1,858.61	0.01
SORA-LM	1,293.87	0.54
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	476.84	0.40
/data	9,765.63	0.17
/ltmp	1,953.13	0.17

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.