Aerodynamic Simulations on Airframe Noise Reduction Technology (FQUROH-2)

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Abstract

Major airports are considering increasing the number of takeoffs and landings to meet the projected demand for air travel, enhance the international competitiveness of Japan's airports, and improve passenger convenience. It is essential to advance technologies that minimize airframe noise generated by high-lift devices and landing gear to reduce noise in the areas surrounding airports, even with the expected rise in takeoffs and landings. Our comprehensive approach includes developing a flight test plan using a commercial aircraft to demonstrate airframe noise reduction. Additionally, we have prepared an 8%-scale semi-span wind tunnel model of the NASA High-Lift Common Research Model (CRM-HL) for further demonstrations using a generic aircraft mode. These are part of our efforts to develop noise reduction technology practically. We used computational simulations to verify the feasibility of practical noise reduction concepts and design methods. This computational analysis evaluates noise reduction strategies applied to an aircraft by examining their aerodynamic effects on overall aircraft performance.

Ref. URL: http://www.aero.jaxa.jp/eng/research/ecat/fquroh/

Reasons and benefits of using JAXA Supercomputer System

The JSS3 allowed many high-fidelity Reynolds-averaged Navier-Stokes (RANS) simulations with aerodynamically essential details to be performed promptly in multiple flight configurations in the expected flight envelope. The aerodynamic effect of low-noise devices can be evaluated and quantified, which is difficult to achieve with wind tunnel testing alone.

Achievements of the Year

This project includes a flight demonstration of aircraft noise reduction technology developed for passenger aircraft. Additionally, the project plans to apply the same technology to a standard high-lift configuration model that represents the latest passenger aircraft geometry, known as the High-Lift Common Research Model (CRM-HL). The goal is to evaluate the noise reduction achieved with this technology on a commonly used aircraft configuration. Reynolds-averaged Navier-Stokes (RANS) simulations were performed to determine the specifications for designing and fabricating noise reduction devices for a CRM-HL wind tunnel model. RANS simulations were also conducted to validate the RANS solver and address issues compiled from a CFD workshop for predicting the aerodynamic characteristics of high-lift devices using the CRM-HL in various configurations (Fig. 1).

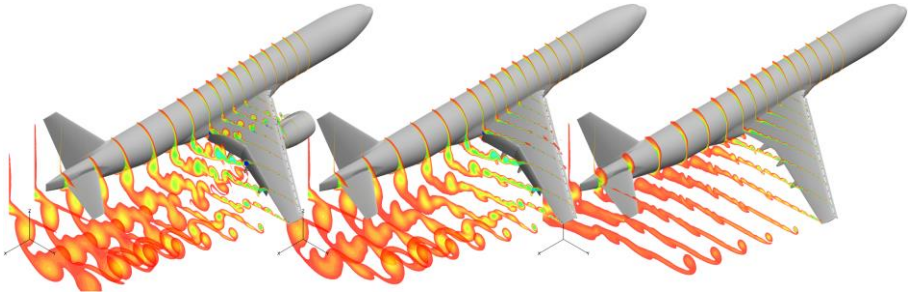

Fig. 1: Total pressure distributions around a few CRM-HL configurations at a Reynolds number of 5.9 million and an angle of attack of 10 degrees.

Publications

- Non peer-reviewed papers

1) Kojima, Y., Murayama, M., Ito, Y., and Tanaka, K., "JAXA's TAS-Code Results of Fixed Grid RANS Simulations for the Fifth High Lift Prediction Workshop," AIAA Paper 2025-0278, AIAA SCITECH 2025 Forum, Orlando, FL, January 2025, DOI: 10.2514/6.2025-0278.

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	64 - 384
Elapsed Time per Case	22.3 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.32

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	8,592,192.59	0.39
TOKI-ST	4,243.03	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	100.87	0.07
/data and /data2	22,780.77	0.11
/ssd	1,147.43	0.06

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	813.35	2.66

*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)	473.25	0.32

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