

Numerical Prediction of aerodynamic characteristics over the eVTOL Configurations

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● Abstract

Various types of eVTOL (electric vertical take-off and landing aircraft) have been proposed to develop new mobility markets such as air taxis, and global competition is intensifying. However, the development history of eVTOL is relatively short, and there is little data for designing products that meet the various needs. Therefore, numerical simulations are expected to be used as a means of compensating data.

In this study, Unsteady Reynolds-averaged Navier-Stokes analysis was performed on the LA-8 geometry toward the evaluation of aerodynamic characteristics of a distributed electric propulsion vertical takeoff and landing aircraft.

Ref. URL: <https://www.aero.jaxa.jp/eng/research/basic/numerical/>

● Reasons and benefits of using JAXA Supercomputer System

JSS is necessary to complete large scale numerical simulations of unsteady phenomena and to understand it in short time span.

● Achievements of the Year

Unsteady RANS (URANS) analysis of the NASA LA-8 geometry was performed using FaSTAR-Move to evaluate the aerodynamic characteristics of a tandem tilt-wing eVTOL aircraft during transition flight (Fig. 1). The effectiveness of URANS analysis for transition flight analysis was demonstrated (Fig. 2). It was also found that the problem of the loss of longitudinal stability in the high angle of attack region was caused by the propeller slipstreams delaying the stall of the forward wing and maintaining the generation of the pitch up moment (Fig. 3).

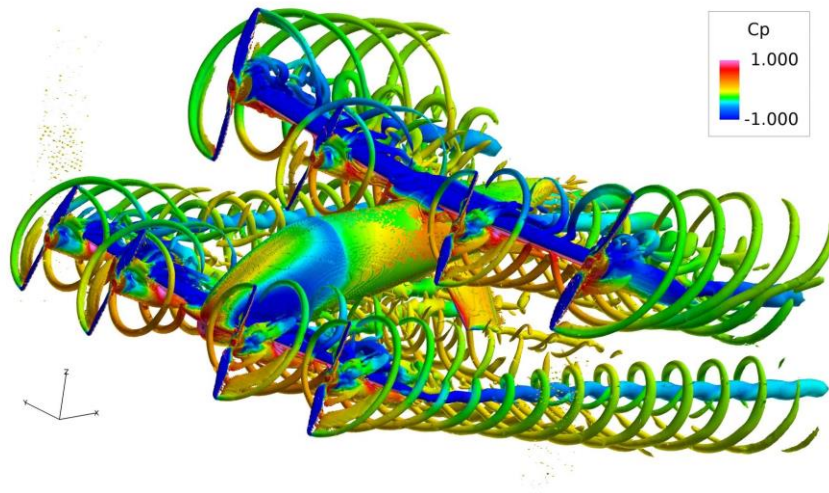


Fig. 1: Flow field during transition flight obtained from URANS analysis (tilt angle 22.5 deg, angle of attack -3.0 deg, isosurface of Qcriterion 1.0). (Video. Video is available on the web.)

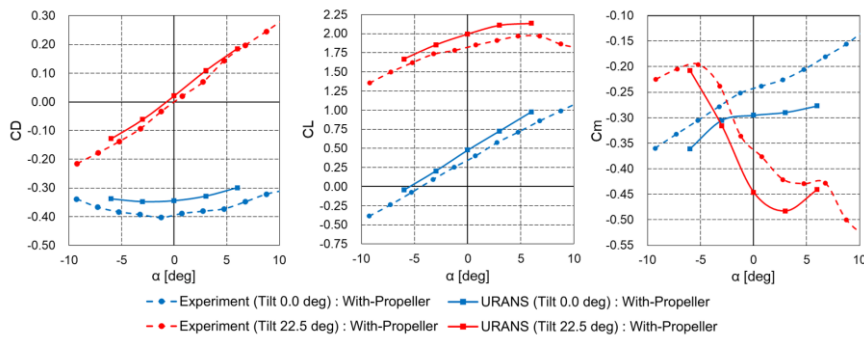
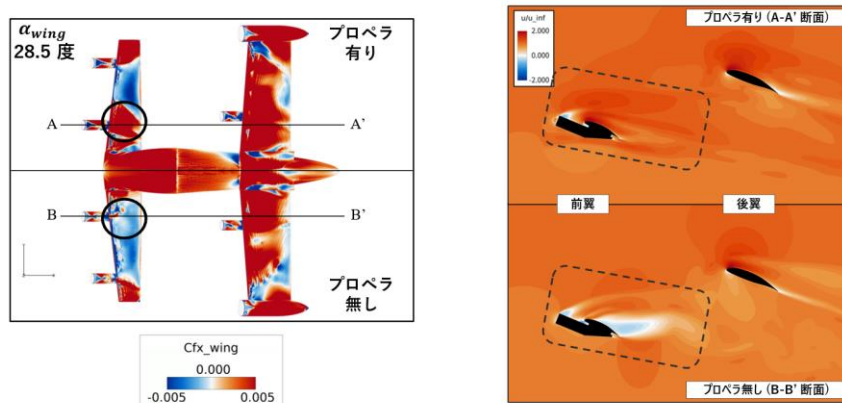


Fig. 2: Comparison of results of URANS analysis and wind tunnel experiments for cruise configuration (Tilt 0.0 deg) and transitional flight configuration (Tilt 22.5 deg).



壁面摩擦係数 ($\alpha_{body} = 6.0 \text{ deg}$, $\alpha_{wing} = 28.5 \text{ deg}$) u/u_{inf} ($\alpha_{body} = 6.0 \text{ deg}$, $\alpha_{wing} = 28.5 \text{ deg}$)

Fig. 3: Wall friction coefficient distribution and flow velocity distribution at high angles of attack (red: area of attached flow, blue: area of detached flow).

● **Publications**

- Oral Presentations

1)Atsushi Shinozuka, Shota Taniguchi, Kanako Yasue, Ryota Fukuchi and Akira Oyama, "Aerodynamic Analysis of Tandem Tilt-Wing eVTOL Aircraft in Cruise and Transition Flight," AIAA SCITECH 2024 Forum, 2024.

2)Atsushi Shinozuka, Kanako Yasue, Ryota Fukuchi and Akira Oyama, "Aerodynamic Analysis of Tandem Tilt-Wing eVTOL Aircraft in Transition Flight,"61st Aircraft Symposium, 2023.

3)Atsushi Shinozuka, Kanako Yasue, Ryota Fukuchi and Akira Oyama, "Aerodynamic Analysis of Tandem Tilt-Wing Planetary Exploration Aircraft in Transition Flight,"Dynamics of Space Navigation Symposium 2023.

4)Atsushi Shinozuka, Kanako Yasue, Ryota Fukuchi and Akira Oyama, "Aerodynamic Analysis for the Design of Tandem Tilt-Wing eVTOL Aircraft,"JSASS North Branch 2024 Meeting, 2024.

● **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	480 - 2016
Elapsed Time per Case	200 Hour(s)

● **JSS3 Resources Used**

Fraction of Usage in Total Resources*1(%): 1.12

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage*2(%)
TOKI-SORA	29,618,224.97	1.34
TOKI-ST	51,747.86	0.06
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	57,937.68	4.41
TOKI-TST	871.21	0.01
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	1,437.03	1.19
/data and /data2	144,252.04	0.89
/ssd	2,510.00	0.24

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage* ² (%)
J-SPACE	7.19	0.03

*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)	1,169.54	0.53

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