# Innovation for Design, Data-acquisition, Trouble-shoot and Certification in Aircraft Development: Basic Techniques for Real Flight Prediction

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## Abstract

The Aerodynamic Prediction Technology, which is a part of the Innovation for Design, Data-acquisition, Trouble-shoot and Certification in Aircraft Development, constructs the assist technologies to accelerate domestic aircraft development sequences using basic aerodynamic technologies. The target of the Aerodynamic Prediction Technology is paradigm shift from

artisanal prediction to analytical one to accelerate domestic aircraft development sequences. This research aims to develop a computational fluid dynamics (CFD) method for simulating the effect of aerodynamic devices, such as vortex generators (VGs) and dorsal fins, to predict the aerodynamic installation effect of the aerodynamic devices on real aircraft, and the developpment of data assimilation method for turbulent transition flows.

## Reasons for using of JSS2

Computational simulations using the JSS2 reveals detailed physical phenomena of the aerodynamic devices, which is difficult only with wind tunnel tests, and development of the aerodynamic performance prediction tools.

## Achievements of the Year

For the research about aerodynamic improvement devices, computational fluid dynamics simulations using the TAS code showed that vortices generated around retrofit aerodynamic improvement devices, such as vortex generators (VGs) and dorsal fins (DFs), interact with boundary layer on the vertical

stabilizer and its rudder, and improve their performance by reducing boundary layer separation shown in Fig. 1. Wind tunnel tests were also conducted to validate computational results. VGs improved the performance of the vertical stabilizer slightly at low sideslip angles by reducing flow separation on the rudder, and DFs greatly at high sideslip angles by strong vortices generated around them.

For the research about data assimulation, sensitivity analysis of observation type was employed by using the developed data assimilation method for turbulent transition flows shown in Fig. 2. As a result, it was clarified that the leading edge temperature information has similar sensitivity to the estimation of the turbulent transition flow to the information of the velocity profile in the boundary layer.

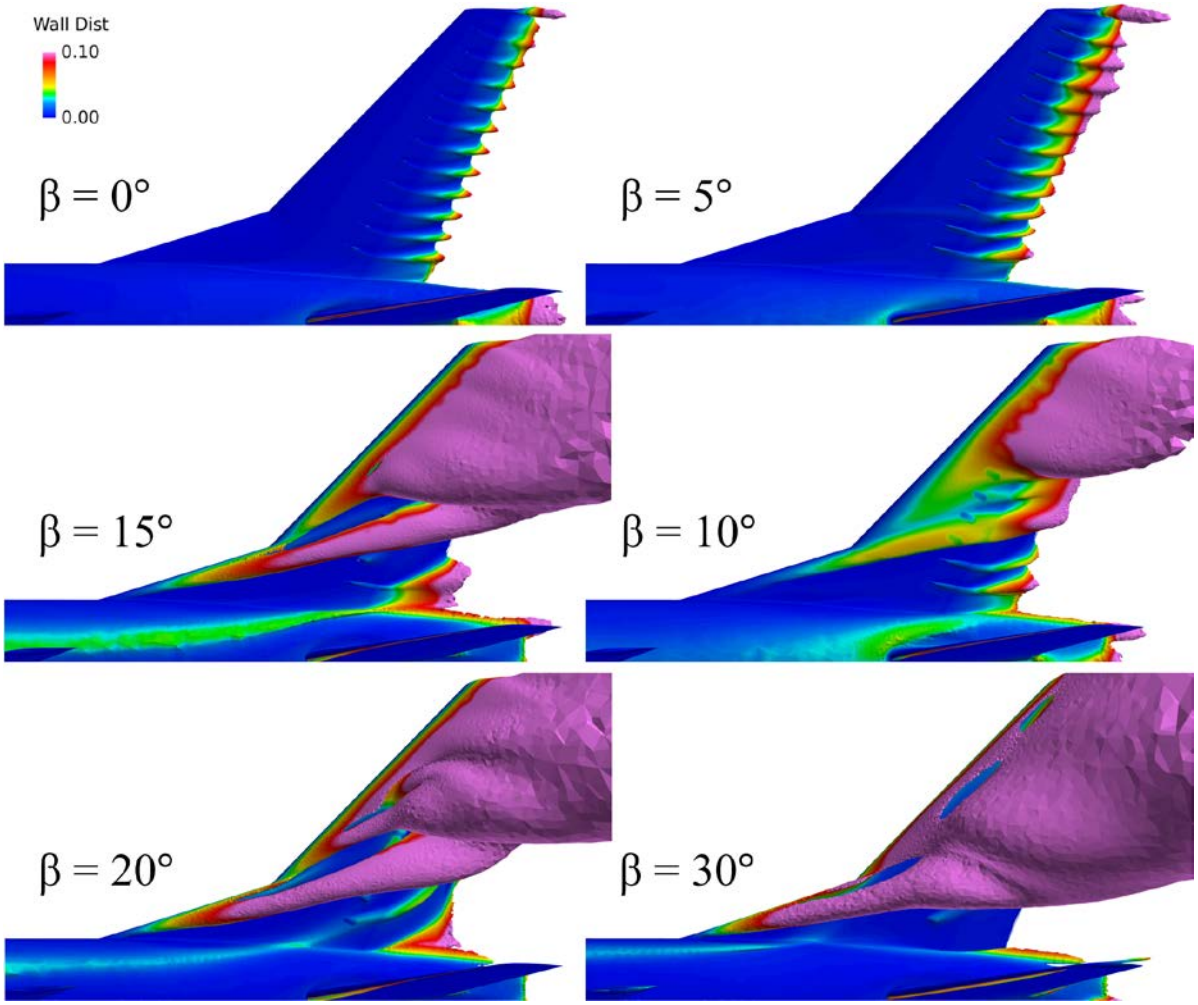


Fig.1 Total pressure isosurface colored by wall distance for the baseline dorsal fine configuration with 11 VGs at mid-chord (Reynolds number of 0.52 million and rudder deflection angle of 20degrees)

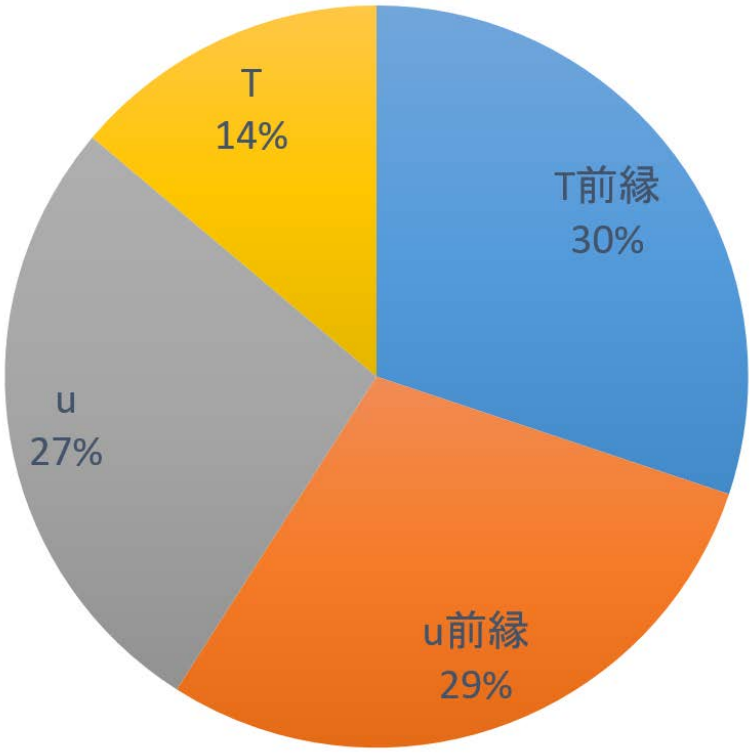


Fig.2 Sensitivity analysis result of observation type for the turbulent transition flow

## Publications

- Non peer-reviewed papers

1) Ito, Y., Murayama, M., Koike, S., Yamamoto, K., Nakakita, K. and Kusunose, K., "Computational Investigation of Vertical Stabilizer with Vortex Generators and Dorsal Fin," 36th AIAA Applied Aerodynamics Conference, Atlanta, GA, 2018, to be presented.

## Usage of JSS2

### Computational Information

| | |
|---|---|
| Parallelization Methods | MPI |
| Thread Parallelization Methods | OpenMP |
| Number of Processes | 64 - 256 |
| Elapsed Time per Case | 15.00 hours |

### Resources Used

Fraction of Usage in Total Resources*1 (%): 1.32

Details

| Computing Resources | | |
|---|---|---|
| System Name | Amount of Core Time (core x hours) | Fraction of Usage*2 (%) |
| SORA-MA | 11,119,009.13 | 1.47 |
| SORA-PP | 1,752.79 | 0.02 |
| SORA-LM | 39.62 | 0.02 |
| SORA-TPP | 0.00 | 0.00 |

| File System Resources | | |
|---|---|---|
| File System Name | Storage assigned(GiB) | Fraction of Usage*2 (%) |
| /home | 044.28 | 0.03 |
| /data | 9,015.23 | 0.17 |
| /ltmp | 5,574.70 | 0.42 |

| Archiver Resources | | |
|---|---|---|
| Archiver System Name | Storage used(TiB) | Fraction of Usage*2 (%) |
| J-SPACE | 4.57 | 0.20 |

*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