

Study of high speed fluid

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● Abstract

We conduct fundamental research on aerodynamics such as aerodynamic design of Mars aircrafts.

● Reasons and benefits of using JAXA Supercomputer System

Large eddy simulation is required for accurate evaluation of aerodynamic characteristics of Mars airplane. Aerodynamic design of Mars airplane requires several hundred cases of CFD computation. Therefore, a supercomputer is necessary.

● Achievements of the Year

Aerodynamics of Mars airplane has been studied in this fiscal year. In the high-altitude flight of Mars airplane planned in 2020 (MABE2), the flight can be high subsonic during its pull-up phase. Thus, we study Mach number effect in low Reynolds number condition using CFD (FIG.1). The results show that the lift coefficient increases and the pitching moment coefficient decreases during the pull-up phase. We also evaluate aerodynamic characteristics of the airfoil, which is obtained by an aerodynamic optimization using evolutionary algorithm and two-dimensional laminar flow simulation. Large eddy simulations of the flow around the optimized airfoil show the optimized airfoil has high lift-to-drag ratio at different angles of attack(FIG.2)(FIG.3). In addition, effects of vortex structures and laminar separation bubble on aerodynamic coefficients are revealed.

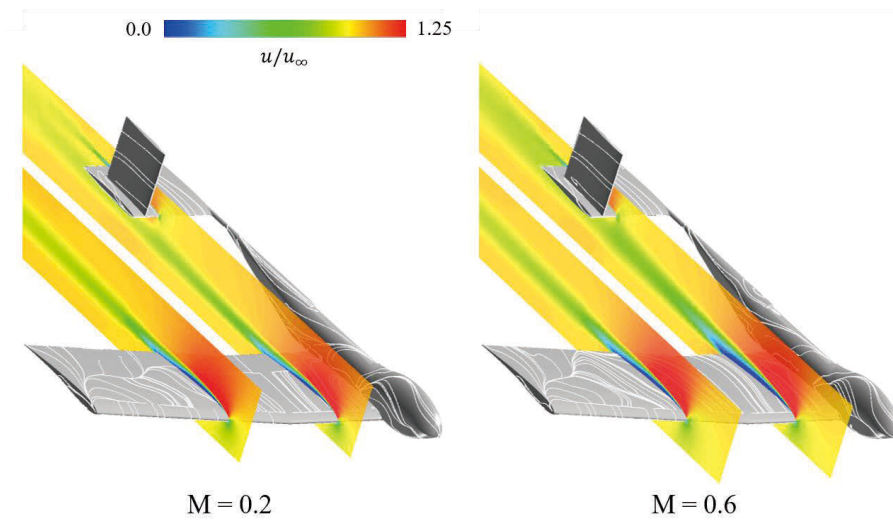


Fig. 1: Flowfield of a Mars airplane at angle of attack of 6 degrees.

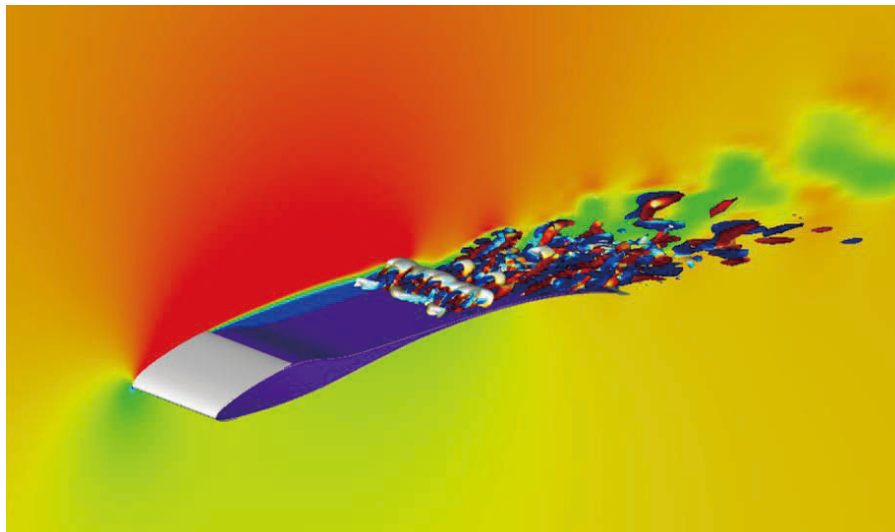


Fig. 2: Flow field around the optimized airfoil at 3 degrees of angle of attack

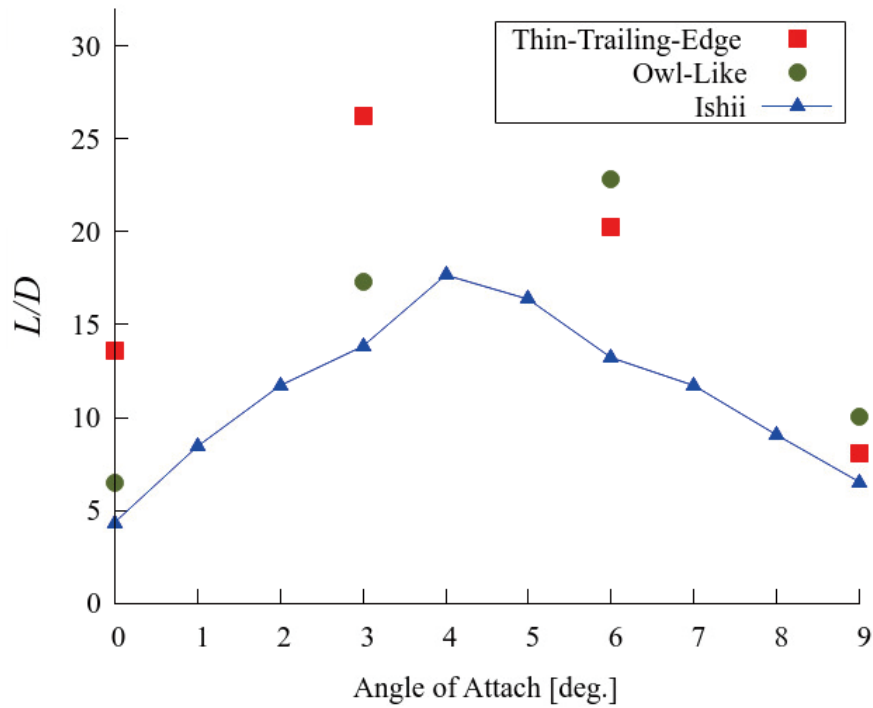


Fig. 3: Lift-to-drag ratio of the optimized airfoil

Publications

- Oral Presentations

Shota Taniguchi, Akira Oyama, Masato Okamoto, Masayuki Anyoji, Koji Fujita, and Hiroki Nagai, "Experimental and RANS analysis of full Mars airplane configurations," AIAA SCITECH FORUM 2020, Orlando, Florida, January 1-6, 2020.

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	64 - 1536
Elapsed Time per Case	450 Hour(s)

● Resources Used

Fraction of Usage in Total Resources*1(%): 0.98

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
SORA-MA	8,714,893.56	1.06
SORA-PP	989.87	0.01
SORA-LM	284.45	0.12
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2(%)
/home	2,175.30	1.81
/data	56,400.28	0.97
/ltmp	17,796.76	1.51

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	12.19	0.31

*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.