Research on laminar fins system

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Abstract

The laminar flow vertical tail fins is designed and evaluated to develop practical technology for natural laminar flow wings in future subsonic aircraft. By analysing the effects of surface roughness on the flow field, we aim to define criteria for surface roughness that preserve laminar flow characteristics.

Ref. URL: https://www.aero.jaxa.jp/eng/research/ecat/igreen/

Reasons and benefits of using JAXA Supercomputer System

The design of laminar airfoils to reduce aircraft fuel consumption requires rapid develpment processes and extensive high-precision fluid flow analyses to examine fine details of boundary layer flows. Surface roughness analysis demands even more detailed investigation than standard design requirements. To accomplish these tasks, the use of supercomputer is essential.

Achievements of the Year

To summarize the achievements of this research project, the developed laminar flow wing design technology was applied to the entire aircraft design. At the Aeronautical Technology Directorate of JAXA, a target pressure distribution that sustains the boundary layer in a laminar state was predefined, and an inverse design method was used to develop a wing shape that achieves this distribution. As a result, this approach successfully attained a laminar flow surface coverage of 46.2% while preserving control effectiveness comparable to that of a conventional (non-laminar) wing. Even when accounting for the effects of surface roughness, which is being investigated separately, fuel consumption is estimated to be reduced by approximately 0.8%.

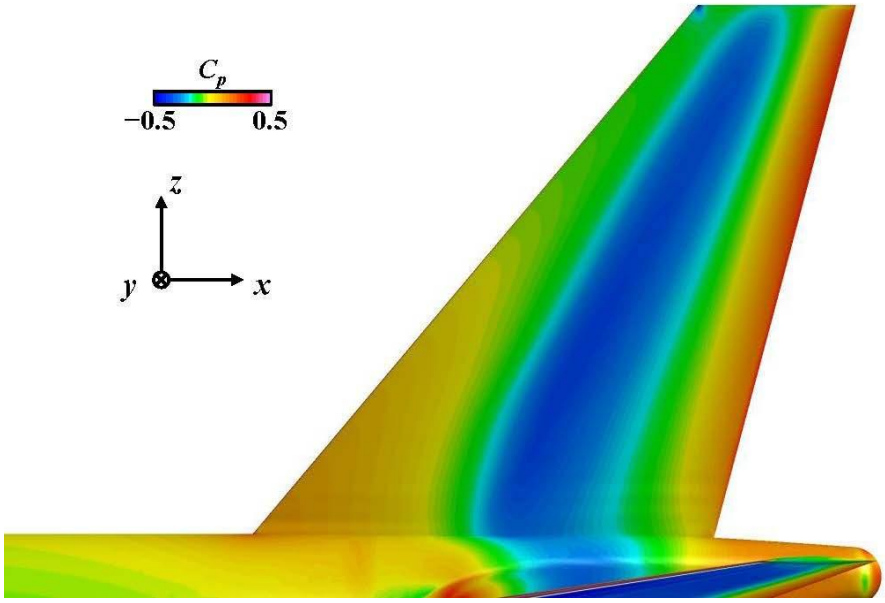

Fig. 1: Pressure distribution on the laminar flow vertical tail under the assumed flight conditions of the entire aircraft (M = 0.78, altitude 35,000 ft).

Publications

- Peer-reviewed papers

N. Tokugawa, T. Ishida, K. Ueshima, K. Ohira, "Demonstration of Natural Laminar Vertical Tail at Flight Reynolds Number in ETW", submitted to Proc. of Tenth IUTAM Symposium on Laminar-Turbulent Transition (IUTAM LTT 2024)

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	48 - 10008
Elapsed Time per Case	55 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 4.62

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	120,676,785.17	5.52
TOKI-ST	106,641.68	0.11
TOKI-GP	118,399.89	1.82
TOKI-XM	52,472.88	25.54
TOKI-LM	79,402.19	5.73
TOKI-TST	223.79	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	1,276.39	0.86
/data and /data2	235,373.41	1.13
/ssd	14,958.00	0.80

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	28.13	0.09

[*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)	3,444.38	2.35

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