Discharge-flow coupling simulation towards airflow control using nanosecond-pulse-driven plasma actuators

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Abstract

Dielectric barrier discharge (DBD) plasma actuators are promising devices as active airflow control. The purpose of this project is to clarify the mechanism of flow separation control around an airfoil using DBD plasma actuators driven by repetitive nanosecond pulses in terms of discharge-flow coupling simulation.

Reasons and benefits of using JAXA Supercomputer System

The use of the supercomputer is necessary to perform numerical simulation of the flow field with discharge simulation since Poisson's equation for electrical potential, which requires a large computational cost, must be solved every time step. The difference in the time scale between atmospheric pressure discharge and airflow also increases the computational cost, requiring the supercomputer.

Achievements of the Year

We performed a large eddy simulation (LES) of around an airfoil with DBD actuation as a preliminary study of the coupling simulation. A simple model that provides the spatial distribution of the heating effect by the nanosecond-pulse-driven DBD plasma actuator was employed for the LES. We confirmed that the flow separation was prevented by the nanosecond pulse discharge with a specific frequency (Fig.1). We will conduct a quantitative comparison between the simulation result and the experimental result. The three-dimensional discharge-flow coupling simulation will be conducted as future work.

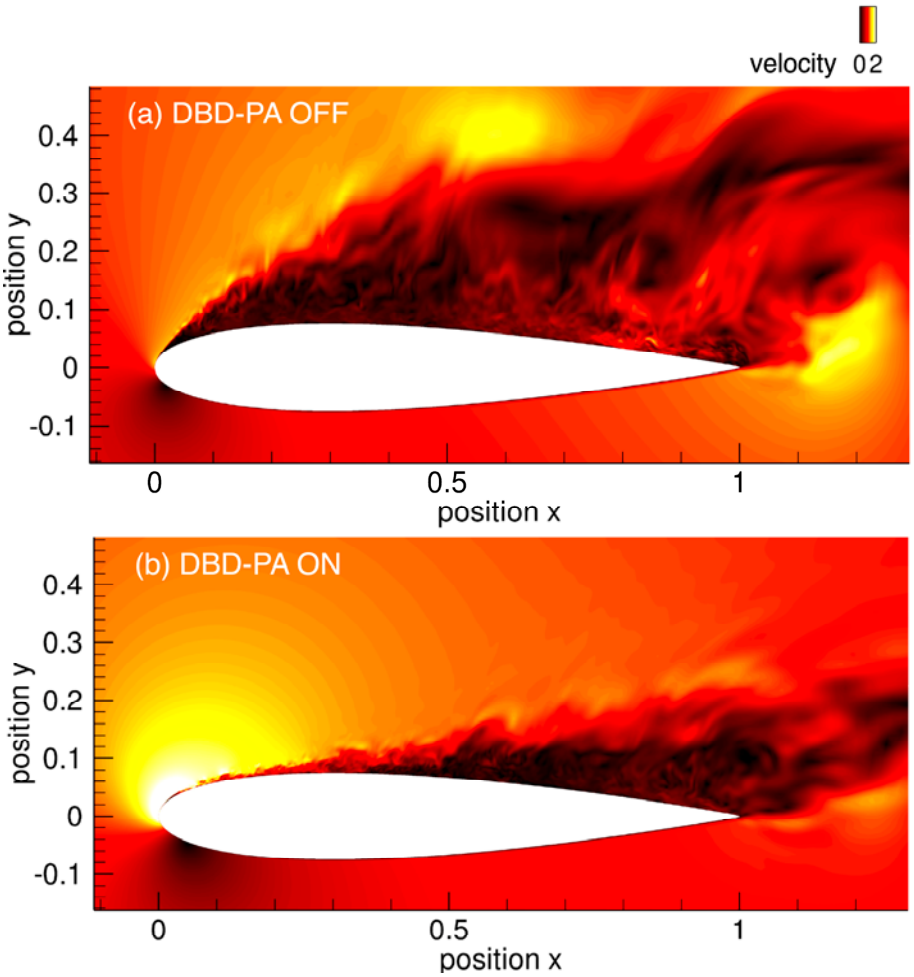

Fig. 1: Airflow separation control by repetitively pulsed discharge.

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	2 - 960
Elapsed Time per Case	72 Hour(s)

- **Resources Used(JSS2)**

Fraction of Usage in Total Resources[*1](%): 0.11

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
SORA-MA	621,425.40	0.12
SORA-PP	0.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	195.50	0.18
/data	9,813.31	0.19
/ltmp	2,929.69	0.25

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	6.46	0.21

[*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.

- **Resources Used(JSS3)**

Fraction of Usage in Total Resources[*1](%): 0.01

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-RURI	0.00	0.00
TOKI-TRURI	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2](%)
/home	190.73	0.13
/data	9,765.63	0.16
/ssd	95.37	0.05

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2](%)
J-SPACE	6.46	0.21

[*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.