Demonstration of airborne wind turbine technology with kites for the general public

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Abstract

To reproduce the behavior of an aerial wind turbine kite on a flight simulator, we are analyzing the aerodynamic coefficient of the kite and the surrounding flow field during flight using CFD. The kite's characteristic behavior is a figure-eight flight due to self-excited oscillation, and we aim to reproduce this behavior.

Reasons and benefits of using JAXA Supercomputer System

Unlike airplane wings, kites have complex shapes, and introducing aerodynamic coefficients into the simulator requires large-scale calculations with various values for the angle of attack and angle of sideslip. Therefore, large computational resources and advanced computers are essential, so we are using the JAXA supercomputer.

Achievements of the Year

While research on power generation using kites has progressed with pumping cycles, JAXA is currently studying a method of generating power using figure-of-eight flight by self-excited oscillation. Control is essential for kite power generation, and a high-precision flight simulator is needed to verify the control system at low cost and in a short time, but it has not been possible to reproduce the figure-of-eight flight behavior of kites. Therefore, we investigated the aerodynamic coefficients of a kite using FaSTAR. As a result, we found that there is a difference between the aerodynamic coefficient used in the simulator and the FaSTAR results (Fig. 1 and 2), and we believe that this value affects the behavior during flight. This calculation contributes to the development of airborne wind-powered kites and the clarification of kite behavior.

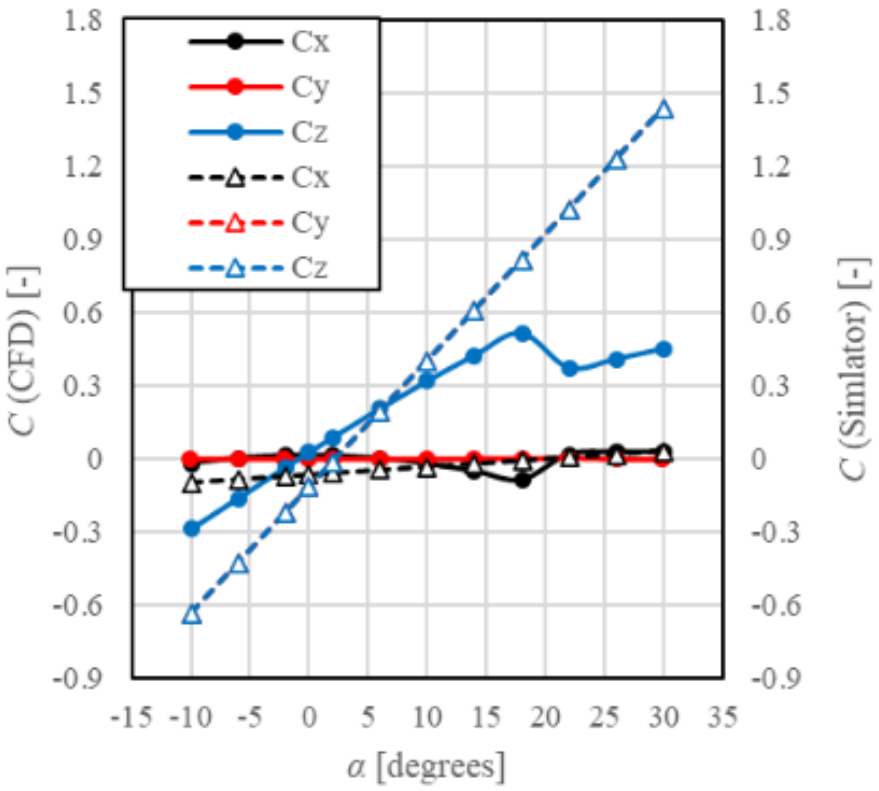

Fig. 1: Relationship between angle of attack and aerodynamic coefficient, comparison of simulator and analysis results

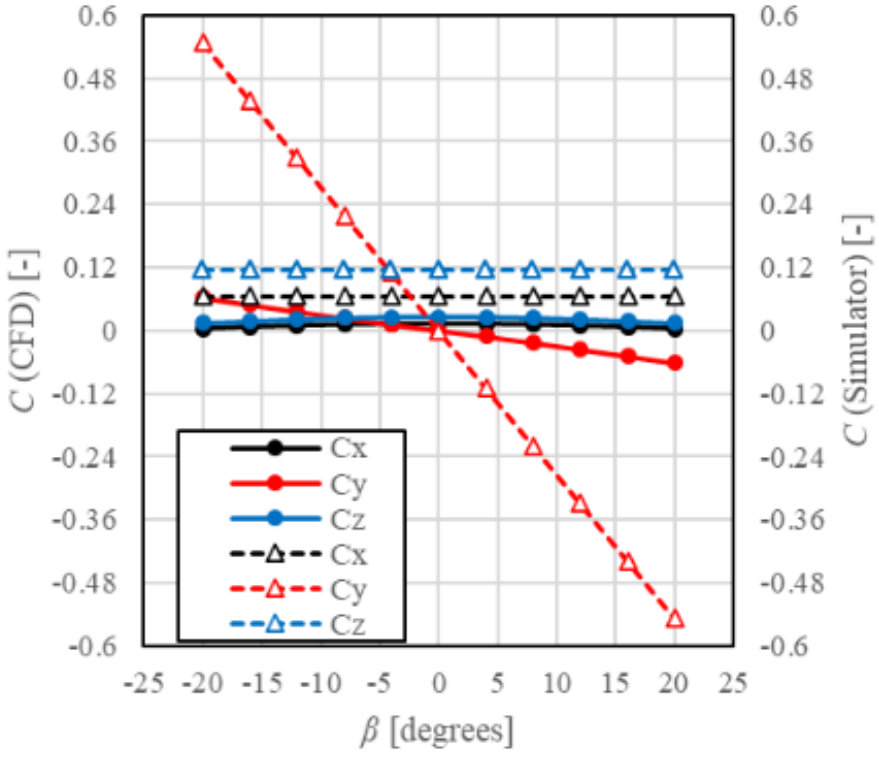

Fig. 2: Relationship between sideslip angle and aerodynamic coefficient, comparison of simulator and analysis results

- **Publications**

  N/A

- **Usage of JSS**

- **Computational Information**

Process Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	576
Elapsed Time per Case	8 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.02

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	552,219.20	0.03
TOKI-ST	2,883.97	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	0.00	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	23.33	0.02
/data and /data2	35,486.67	0.17
/ssd	239.05	0.01

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	17.59	0.06

*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)	56.71	0.04

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