

SGS Stress Transport Equation-based SGS Modeling for Comprehensive LES Model

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● Abstract

In this study, we aim to realize a comprehensive LES that does not require any tuning for model parameters to the target flow field by solving the SGS stress transport equations. The SGS stress equations are derived exactly from the spatial filtering operation, but requires modeling for the unclosed terms contained in the equations. Therefore, in this study, the unclosed terms are modeled by a priori test using a DNS database of turbulent plane jet, and we try to establish a new LES model with SGS stress transport equations.

Ref. URL: <https://kaken.nii.ac.jp/en/grant/KAKENHI-PROJECT-18K03963/>

● Reasons and benefits of using JAXA Supercomputer System

In order to model the unclosed terms in the SGS stress transport equations, a priori test using statistical data by DNS is required for high Reynolds number condition. For performing DNS under high Reynolds number condition of $Re > 10000$, a numerical mesh of the order of one billion points is required. Such large-scale simulation can be executed only on a supercomputer, and therefore, supercomputer system is indispensable for carrying out this research.

● Achievements of the Year

LES analysis was carried out for a plane turbulent jet at $Re = 10,000$ by incorporating SGS stress transport equation modeled by a priori test using DNS database into LES framework. The obtained SGS stress distribution was similar to that of the priori test, although it was a preliminary result (Fig. 1).

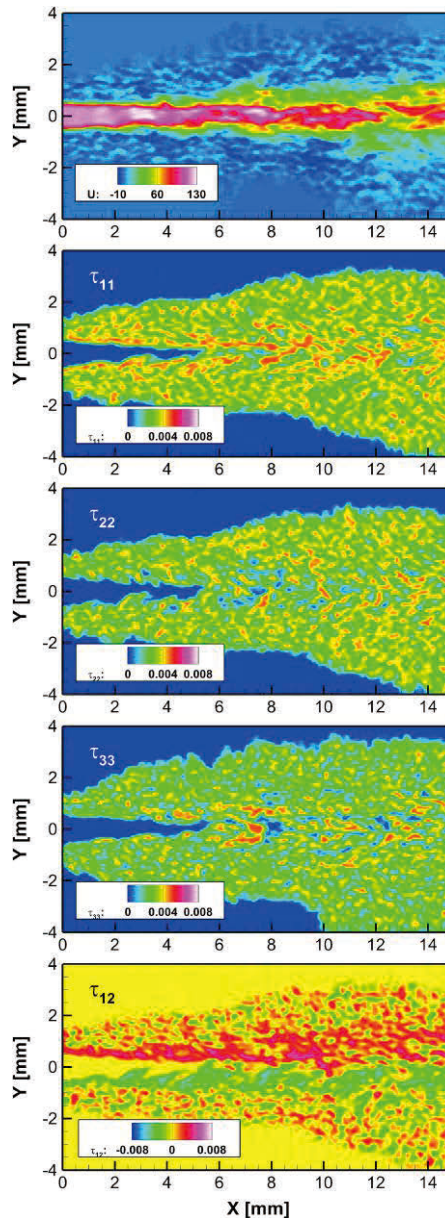


Fig. 1: Instantaneous contours of velocity u and SGS stresses (τ_{11} , τ_{22} , τ_{33} , and τ_{12}).

● Publications

- Non peer-reviewed papers

- 1) Shingo Matsuyama, "A priori test using DNS data of a turbulent plane jet for LES modeling with SGS stress transport equations", Proceedings of the JSFM Annual Meeting 2019, 2019.
- 2) Shingo Matsuyama, "LES of a Turbulent Plane Jet by an SGS Stress Transport Equation-based Model", Proceedings of the 33rd CFD Symposium, A09-4, 2019.
- 3) Shingo Matsuyama, "LES of a Turbulent Plane Jet by an SGS Stress Transport Equation-based Model", Proceedings of the 35th TSFD Symposium, 2019.

- Oral Presentations

- 1) Shingo Matsuyama, "A priori test using DNS data of a turbulent plane jet for LES modeling with SGS stress

transport equations", the JSFM Annual Meeting 2019, 2019.

2) Shingo Matsuyama, "LES of a Turbulent Plane Jet by an SGS Stress Transport Equation-based Model", the 33rd CFD Symposium, 2019.

● Usage of JSS2

● Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	OpenMP
Number of Processes	750 - 1500
Elapsed Time per Case	660 Hour(s)

● Resources Used

Fraction of Usage in Total Resources*1(%): 0.03

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2(%)
SORA-MA	303,526.40	0.04
SORA-PP	2.15	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	342.25	0.29
/data	1,628.02	0.03
/ltmp	279.02	0.02

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2(%)
J-SPACE	0.00	0.00

*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.