Research on combustor simulation

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Abstract

For the development of a jet engine combustor with high environmental compatibility, we develop the combustion calculation code that can capture the pressure propagation and chemical reaction with practical calculation cost. In addition, a verification calculation of this calculation code is conducted on the scramjet test engine of DLR.

Reasons for using of JSS2

It is necessary to use supercomputer to conduct development and verification of the combustion calculation code.

Achievements of the Year

In this research, the implementation of the combustion calculation code based on compressible flamelet model to a density- based fluid analysis solver, FaSTAR (FAST Aerodynamic Routines) was conducted. Then, an artificial neural network (ANN) model was applied to reduce the calculation cost when referring to the flamelet library. The ANN model has 2 input units (mixture fraction and scalar dissipation rate), 3 hidden units, and output units corresponding to mass fraction of each chemical species (As an example, Fig.1 shows the ANN model of OH mass fraction). In addition, we introduced the variance of the mixing fraction to the Flamelet library, which was conventionally obtained by mixing fraction and scalar dissipation rate. By this, the effect of turbulence of each species mass fraction was taken into account, and the precision of the Flamelet library has been improved (Fig2: Extension of the Flamelet library by the probability probability function method).

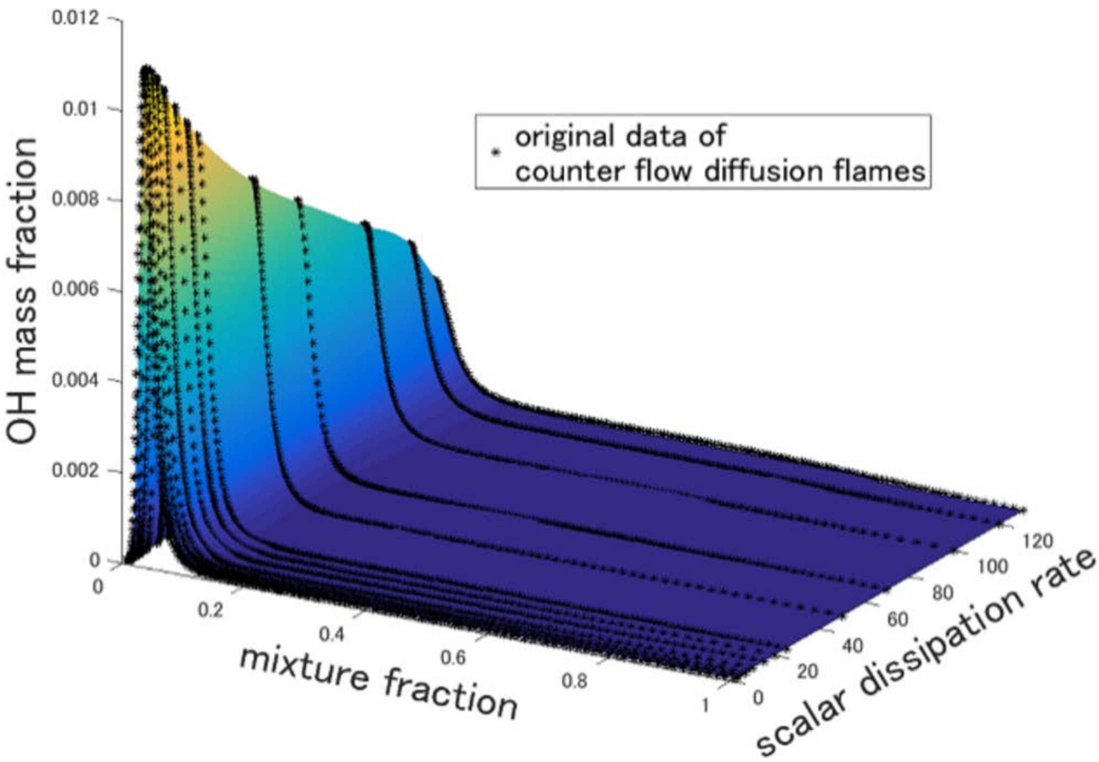

Fig.1 OH mass fraction generated by ANN

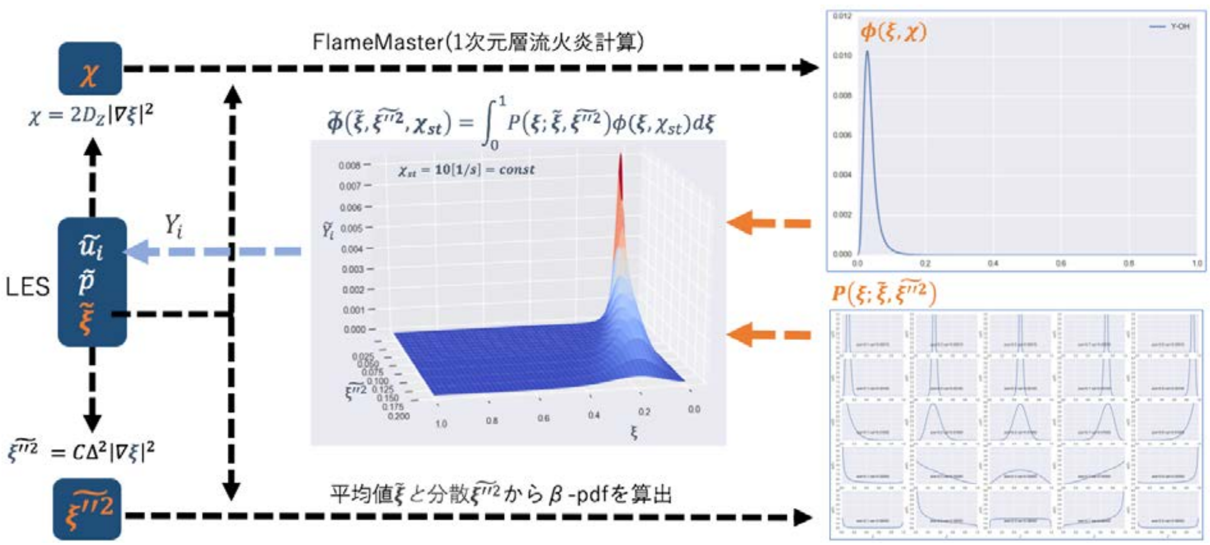

Fig.2 Extension of the Flamelet library by the probability probability function method

Publications

- Non peer-reviewed papers

1) Rui Toyonaga, Himeko Yamamoto, Yasuhiro Mizobuchi, Tetsuya Sato, Numerical investigation on supersonic combustion in SCRAMJET engine by FaSTAR, JAXA Special Publication, 2017.12
2) Himeko Yamamoto, Rui Toyonaga, Yasuhiro Mizobuchi, Tetsuya Sato, Numerical analysis of jet lifted flames using G- equation, JAXA Special Publication, 2017.12

- Presentations

1) Himeko Yamamoto, Rui Toyonaga, Yasuhiro Mizobuchi, Tetsuya Sato, Numerical study on flame structure of jet lifted flames by FaSTAR, 57th Aerospace Propulsion Conference of Japan Society for Aeronautical and Space Science, 2017.3
2) Himeko Yamamoto, Rui Toyonaga, Yasuhiro Mizobuchi, Tetsuya Sato, Numerical analysis of jet lifted flames using G- equation, 49th Fluid Dynamics Conference/ 35th Aerospace Numerical Simulation Symposium, 2017.6
3) Himeko Yamamoto, Rui Toyonaga, Yusuke Komatsu, Koki Kabayama, Yasuhiro Mizobuchi, Tetsuya Sato, Improvement of compressible flamelet model using artificial neural network, The Asian Joint Conference on Propulsion and Power, 2018.3

Usage of JSS2

Computational Information

Parallelization Methods	MPI
Thread Parallelization Methods	N/A
Number of Processes	2 - 1024
Elapsed Time per Case	150.00 hours

Resources Used

Fraction of Usage in Total Resources*1 (%): 0.22

Details

Computing Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage*2 (%)
SORA-MA	1,746,759.24	0.23
SORA-PP	980.73	0.01
SORA-LM	361.16	0.19
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage assigned(GiB)	Fraction of Usage*2 (%)
/home	476.84	0.33
/data	9,765.63	0.18
/ltmp	1,953.13	0.15

Archiver Resources		
Archiver System 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