6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Jet-surface interaction noise using CFD mean flow within a Rapid-Distortion Theory approach

Vasileios Sassanis[1], Mohammed Afsar[2] and Adrian Sescu[1]

[1] Department of Aerospace Engineering, 330 Walker Engineering Lab, Mississippi State, MS 39762,
E-mail: vs501@msstate.edu, sescu@ae.msstate.edu, URL: www.ae.msstate.edu
[2] University of Strathclyde, 16 Richmond St., Glasgow G1 1XQ,
E-mail: mohammed.afsar@strath.ac.uk, URL: www.strath.ac.uk

Key Words: *Jet noise, Jet-Surface Interaction, Rapid Distortion Theory, Hybrid LES.*

In this paper, the leading- and trailing-edge effects of an embedded surface on the noise spectrum of a high-aspect ratio (8:1) jet exhaust operating at Ma_j of 0.98, (referred to as SP 7 and with an acoustic Ma_a of 0.9) are investigated.

From the breakdown of the jet exhaust gases into turbulence, three main noise components are generally observed: i) broadband jet noise, ii) scrubbing noise at the surface and iii) trailing/leading edge interaction noise. The main focus of this study is item (iii), where the effects of both the trailing- and leading-edge are examined.

The model is based on a recent development in Rapid-distortion theory of turbulence[1] in which mean flow inputs are obtained from a steady Reynolds-Averaged Navier Stokes Simulations (RANS) calculation using the commercially available Fluent software. This model is compared to the hybrid noise prediction obtained using an in-house, hybrid Large Eddy Simulations (LES)- Non-Linear Euler (NLE) code[2] that is able to calculate the near field turbulence and project it to the far field by solving the full Non-Linear Euler equations with source by employing an interpolation and penalization technique.

The Rapid-distortion theory shows very promising results in predicting the noise spectrum of a sheared flow interacting with the embedded surface. Results are presented and compared against the hybrid LES-NLE code.

REFERENCES

[1] Goldstein, M. E., Leib, S. J., & Afsar, M. Z., Generalized rapid-distortion theory on transversely sheared mean flows with physically realizable upstream boundary conditions: application to trailing-edge problem. *Journal of Fluid Mechanics*, *824*, 477-512, 2017.
[2] Sassanis, Vasileios, et al. "A hybrid approach for nonlinear computational aeroacoustics predictions." *International Journal of Computational Fluid Dynamics* 31.1: 1-20, 2017.