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Session:

The grey-area improved σ-DDES approach: Formulation review and application to complex test cases

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Abstract

At the HRLM5, an improved Delayed DES (DDES) variant called σ-DDES aiming at mitigating the Grey Area problem was presented, which refers to a region of undefined modelling between the RANS and LES part of the hybrid simulation, by accelerating the transition from RANS to LES in free shear layers [1]. We subsequently published verification results for fundamental test cases particularly affected by the Grey Area to highlight the benefits of using the σ-DDES model over standard DDES [2]. The approach uses both an alternative LES model form, which can autonomously discern between 2-component flow states and fully 3D turbulence, as well as a modified formulation of the LES filter width.

Having assessed the new DDES variant over the past two years for more complex configurations in a pressure-based general purpose CFD solver, we present the experiences gained in this contribution. Following a review of the model formulation based on the common SA- and SST-RANS background models, results for different complex test cases are discussed, one of which is the rudimentary landing gear (RLG) at $M = 0.12$ and $Re_D = 10^6$ shown in Fig. 1. The functionality and effectiveness of the σ-DDES model is assessed on different grid types with topologies and resolution typical for industrial purposes, and implications for Grey Area mitigation are discussed. In general, σ-DDES proves to be a powerful extension of standard DDES, with very encouraging aerodynamic and aeroacoustic results obtained. Although the full paper will predominantly feature low Mach number applications, it is worth mentioning that the σ-DDES model has also been successfully used in a different density-based CFD code for jet noise prediction [3], thus underlining the general flexibility of the method.

Besides additional application examples such as a three-element high-lift configuration, the full paper will also include a discussion about some practically relevant modelling aspects of DDES, such as the shielding capability of attached boundary layers or the application of a hybrid

blending scheme, and the experiences made regarding these issues for complex cases with the σ-DDES model.

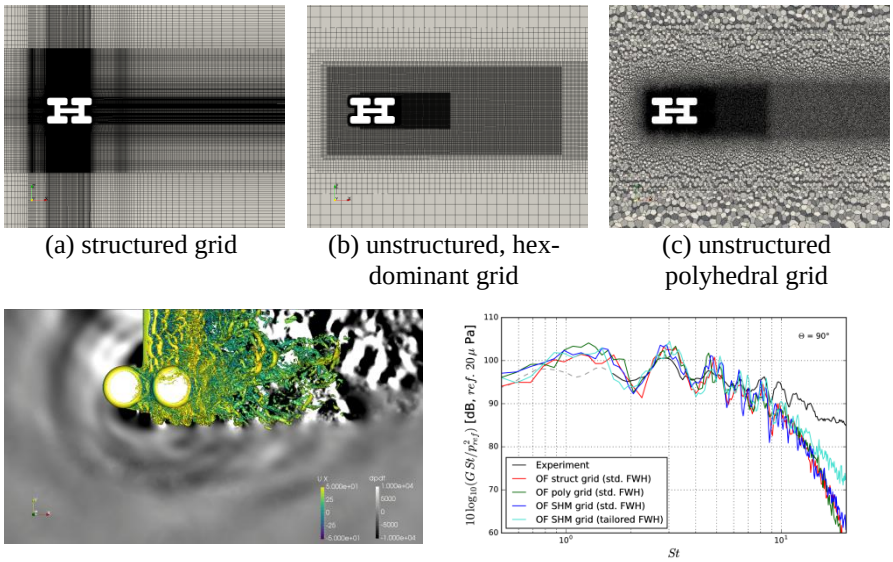

Fig. 1 Application of grey-area improved σ-DDES model to aeroacoustics of a rudimentary landing gear on different grid types (top), unsteady flow field and acoustic farfield spectra at observer location $\theta = 90°$ (bottom).

References

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