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# Transonic Buffet Simulation using a Partially-Averaged Navier-Stokes Approach

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Transonic buffet is defined as self-sustained shock oscillation occurring at transonic regime around aircraft and wings. The shock motion occurs in conjunction with alternated flow separation and reattachement, making the flow prediction by means of CFD particularly challenging. While no consensus is found on the capability of URANS to predict the buffet, hybrid RANS/LES methods have significant, often prohibitive, CPU cost. Therefore, the capability of Partially-Averaged Navier-Stokes (PANS)[1] simulations to predict transonic buffet at a reasonable cost was investigated in this work. In particular, numerical simulations the flow around the supercritical airfoil OAT15A[2] at high Reynolds number were performed using the HMB3 solver of the University of Glasgow[3]. The presence of the wind tunnel walls was accounted in the computation, and the results were compared with those for a configuration with reduced spanwise length and periodic boundary conditions applied at the sides. The comparison showed the impact of the wind tunnel walls, that induce strong flow three-dimensionality, not present in the quasi-2D simulation. The method worked fairly well at both pre-buffet conditions, where the URANS results are recovered, and post-buffet conditions (Fig 1, right), where shock oscillations were predicted, working on fine and coarse grids. In this latter case, the level of unsteadiness at the trailing edge is underpredicted (black line in figure) and the reasons will be discussed in detail. Using the same grid and timestep, the performance of PANS was better than URANS, that could not predict the buffet, in this case. When a finer grid was

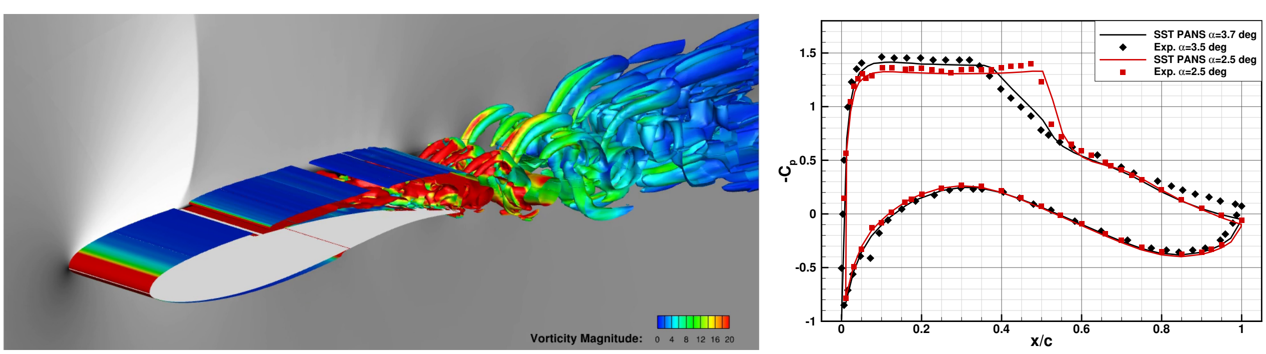


**Figure 1**: Left: Q-Criterion ($Q = 10$) isosurface coloured by vorticity magnitude; Mach number isocontour on the background; right: time averaged pressure coefficient at pre- (red) and post- (black) buffet conditions.

adopted, three-dimensional structures were resolved in the separated region, as indicated from the isosurface of the Q-Criterion in Fig. 1 (left), and were dissipated in the wake because of the combined action of the diffusion and the grid coarsening. Moreover, the enhanced resolution around the airfoil allowed to highlight the development of acoustic waves at the trailing edge that propagate upstream on both the sides of the airfoil and energise the shock, in agreement with the experimental findings.


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