

*Interaction of free-stream turbulence with the boundary layer of airfoils and the effects on the wall-pressure fluctuations and trailing-edge noise*

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Abstract:

This research provides new insights into the interaction of free-stream turbulence with a turbulent boundary layer, focusing on the effect of the characteristics of the undisturbed turbulent boundary layer on this interaction for cases of non-zero pressure gradient and the consequences on the airfoil noise. Measurements include velocity fluctuations across the boundary layer, wall-pressure spectrum, spanwise correlation length, convection velocity, and far-field noise. Two airfoils, instrumented with 84 remote microphone probes, were subjected to three different turbulence intensities at several angles of attack and inflow velocities. The results show the high influence of the boundary layer shape factor, friction velocity, wake's factor, and boundary layer thickness of the undisturbed inflow condition on the strength of the free-stream turbulence penetration in the boundary layer. The interaction of the free-stream turbulence with the large and the small turbulent structures within the turbulent boundary layer separately. The penetration of the free-stream turbulence is stronger in the outer part of the boundary layer when the turbulent structures are smaller, whereas in the inner part of the boundary layer, it is stronger when the turbulent structures are larger. The trailing-edge noise produced by the airfoils is significantly increased by the free-stream turbulence.