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A COMPARISON OF METHODS FOR INTRODUCING SYNTHETIC TURBULENCE

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The design and performance of modern aero engines is heavily dependent on the correct modelling of turbulent flow structures in CFD. Since Reynolds-averaged Navier-Stokes modelling faces serious issues when it comes to complex flow phenomena in turbomachinery, scale resolving simulations are indispensable to provide in-depth knowledge of turbulence [1]. Especially for Large Eddy Simulations, the prescribed inflow conditions of spatially evolving turbulent flow simulations are of utmost importance for the accurate reproduction of physics. In order to create these turbulent inflow conditions, DLR's turbomachinery suite TRACE applies the concept of synthetic turbulence generation (STG) suggested by Shur et al. [2], using Fourier reconstruction of the fluctuating velocity field. The present paper compares two approaches to introduce the synthetically generated velocity field into the CFD domain: an inflow boundary condition and a source term formulation by Schmidt and Breuer [3]. In case of the boundary condition the velocity fluctuations are added to the mean velocity components at the inlet panel of the computational domain. The volume source term, which was originally combined with an STG method based on a digital filter concept, uses an additional source term in the momentum equation to add the fluctuating velocity field at the desired location in the volume. The functionality of these methods in combination with the STG is verified and validated in the generic test case of spatially decaying homogeneous isotropic turbulence. Furthermore, the spatial variation and anisotropy of turbulent statistics in a turbulent boundary layer as well as the development length of the different combinations, needed to reach a fully developed flow, are analysed for a turbulent channel flow.

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