

Parameter Extension Simulation (PES) and Large Scale Motion Simulation (LSMS) of turbulent flows

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Turbulent flows are often observed phenomena in everyday surroundings and prevalent processes in industry. I proposed two mathematical methods for simulating turbulent flows in this study. They are parameter extension simulation (PES) and large scale motion simulation (LSMS). PES is defined as a calculation of the turbulent flow for the desired parameter values with the help of a reference solution. A typical PES calculation is composed of three consecutive steps: Set up the asymptotic relationship between the desired solution and the reference solution; Calculate the reference solution and the necessary asymptotic coefficients; Extend the reference solution to the desired parameter values. The reference solution is a special large eddy simulation (LES) method in which a weighting coefficient and an artificial force distribution are used to model part of the turbulent motions. The reference solution is expected to capture the large scale motions of turbulent flows, so this method is called LSMS. The proposed methods will be used to simulate four types of turbulent flows to demonstrate its applications. They are decaying homogeneous and isotropic turbulence, smooth wall channel flows, rough wall channel flows, and compressor blade cascade flows. The numerical results will be validated by the DNS and experimental data.