Low-dissipation methods and models for the simulation of turbulent subsonic flow

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Abstract

More and more often computer simulations of airflow are used as a tool in the design of airplanes with lower fuel consumption. In this research project, which is a collaboration of the University of Groningen and the Netherlands Aerospace Centre NLR, new computer methods and models for the accurate simulation of airflow around aircraft have been developed. In practice the flow around aircraft is often turbulent. For accurate simulations of turbulent airflow, it is important that the simulation method does not dissipate the energy of the turbulent whirling. Therefore this research focuses on simulation methods and models with low energy dissipation. A new mathematical analysis of energy conservation in simulation methods has been proposed, an existing simulation method has been improved, and new coarse-grained models for turbulence have been derived. The proposed methods and models have been assessed, and a new turbulence model with minimum energy dissipation gives promising results. The developed simulation method has been used to perform an accurate simulation of the airflow around a delta wing. This simulation took more than two months on 1920 cores of the national supercomputer of the Netherlands, and provides a detailed picture of the transition from orderly to turbulent flow.

The transitional flow above a delta wing at chord Reynolds number $Re = 150,000$.

References