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TRANSITION MODELING AND PREDICTION IN CFD SOLVERS WITH FOCUS ON PRACTICAL APPLICATIONS

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ABSTRACT

During the last two decades, methods of Computational Fluid Dynamics (CFD) have become a widespread analysis and design tool for many engineering problems. Their success has raised the vision for future aircraft design almost entirely relying on numerical simulation. This requires reliable simulations not only for the design point, but also for off-design conditions.

With the large increase in computer resources and performance, highly complex configurations may be tackled using very large computational grids. Reliable turbulence models and transition prediction tools play a major role in order to obtain quantitatively accurate results. In particular at the borders of the flight envelope where interactions between the laminar-turbulent transition, the turbulence model, and their impact on flow separation need to be predicted accurately, the modeling of transition and turbulence is an essential element in a CFD solver. Improving the prediction quality for rotating geometries, and unsteady configurations, often in situations of bypass transition, are also relevant questions.

Despite the fact that transition can be more or less successfully calculated by Direct Numerical Simulation or by Large Eddy Simulation (LES), Reynolds-averaged Navier-Stokes (RANS) simulations will remain the prevalent tool for carrying out large scale simulations for industrial applications in the next decades. Hybrid methods based on RANS/LES or Scale-adaptive Simulation (SAS) approaches may also be considered for scale resolving simulations of practical problems of minor but still relevant complexity. How the prediction and modeling of transition is realized and handled within these methodologies will be the focus of the Minisymposium.

The Minisymposium addresses the recent status and progress in transition prediction and modeling in CFD solvers and their application to problems of practical relevance. It comprises different approaches (stability based e^N methods, transition criteria, transport equation methods and transition-turbulence models), the coverage of different transition mechanisms, the presentation and discussion of implementation issues and challenges, accuracy and reliability issues from both a technical aspect (conditions for generating a

solution) and a physical aspect (conditions so that the model yields the correct solution). Eventually, the presentation of application cases is of high importance. Here, the focus will be placed on applications of industrial relevance with focus on the following topics: applicability of each modeling approach on large computer systems, impact on computing time, problems linked to geometrical complexity of the configuration, limitations due to the complexity of the computer system, restrictions and possible ways towards elimination of restrictions and limitations.