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Numerical Simulation of the turbulent flow around a wing

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In this talk the simulation of turbulent flow around a 3D-wing will be presented. For the simulations the compressible flow model TAU is used which is developed by the German Aerospace Center DLR. The model domain consists of two grids which are communicating with each other by using the chimera technique. The primary grid is the unstructured body-fitted grid that contains the wing and the secondary grid is a cartesian grid upstream of the wing on which the turbulent flow is simulated. During the simulation the cartesian grid is moved towards the wing and in a short distance in front of the wing the grid is stopped and the turbulent flow is passed to the primary grid where it can interact with the wing.

Since, the earth surface is not simulated there is no source for atmospheric turbulence in the model. That means that the simulation has to be initialised with an already turbulent wind field. For this purpose a synthetic turbulence generator is used that takes the statistics of measurement data from the atmospheric boundary layer and generates a three-dimensional wind field with the same statistics. The statistics used as input comprise the energy spectrum, the correlation matrix and the variances. In the future it is planned to improve the turbulence generator to also consider coherent structures of the turbulent flow.

With this simulation strategy it is possible to simulate the flight of a wing through realistic atmospheric boundary layer turbulence in different weather situations and investigate the effects of the turbulence on the wing. Especially during flights with high angle of attack and at low altitudes it is of interest to investigate how the angle of stall is influenced by the turbulent flow and which scales of the turbulence have an significant effect on the lift and drag produced by the wing.

The talk will cover the simulation strategy with TAU and the generation of the synthetic turbulent wind fields based on measurements. Furthermore, results from simulations will be shown and discussed.