ACINN Graduate Seminar, Innsbruck University
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Wake vortex measurements and numerical simulations

Anton Stephan

Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Deutschland

Wake vortices are generated by a flying aircraft in a natural way through the creation of lift. The complex wake structures in the aircraft's near-field roll-up to a vortex system of two counterrotating vortices further downstream. The generated two-vortex system can persist for several minutes, possessing a high amount of kinetic energy and thereby posing a potential hazard to following aircraft. A landing aircraft generates a highly complex flow field in terms of structure and relevant scales. The flow around the main wing, fuselage, slat, flap, jet engine, and tailplane, as well as the interaction with the ground and the sudden lift reduction during touchdown substantially affect the generated wake vortices.

Real wake vortex flows can be investigated by measurements using a light detection and ranging (LIDAR) device. An emitted laser beam is reflected and scattered by aerosols moving with the vortex flow. The detected signal provides the particle position and the phase shift of the photons, which reveals the velocity toward the detector by the Doppler shift. A major challenge in experimental wake vortex physics is the development of accurate algorithms deducing the mainvortex characteristics such as position and circulation from the raw signal.

The coupling of RANS and LES simulations is an innovative methodology to simulate the aircraft flight through a computational domain, generating a wake in a realistic way. For this purpose a precomputed high-fidelity steady RANS flow field is swept through the LES domain. This method includes all stages of wake-vortex evolution, from roll-up to vortex decay as well as the interaction with the ground during the landing phase. Numerical simulations as well as LIDAR measurements complement each other leading to valuable insights in wake vortex physics and the improvement of monitoring and analysis.