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Real-time flight simulation with highly resolved wind fields from a LES model

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An overproportioned number of accidents involving general aviation occur in complex terrain. According to the statistics included in the accident investigation reports published by the Swiss Transportation Safety Investigation Board, in some cases, pilots overestimated the energy reserves of their aircraft leading to a loss of control. In order to increase flight safety for private pilots in mountainous regions, on behalf of the Swiss Federal Office of Civil Aviation, the Centre for Aviation (ZAV) at the Zurich University of Applied Sciences develops an energy management system for general aviation, which displays the remaining airplane's energy reserves taking into account meteorological information. The research project comprises two phases: i) concept and feasibility study and ii) prototype development. The project is currently running in phase one. In this phase, the first implementation of the energy management system was completed. The system was evaluated in the ZAV's Research and Didactics Simulator (ReDSim). In order to generate highly resolved wind fields in the ReDsim, a well-established large-eddy simulation model, the Parallelized Large-Eddy Simulation (PALM) framework, was used in the concept study, focusing on a small mountainous region in Switzerland, not far from Samedan. For a more realistic representation of specific meteorological situations, PALM was driven with boundary conditions extracted from the COSMO-1 reanalysis of MeteoSwiss. The environment model in the ReDSim was modified to include a new subsystem simulating atmospheric disturbance. The essential variables (wind components, temperature and pressure) were extractred from the PALM output and fed into the subsystem after interpolation to obtain the values at any instant and any aircraft position. Within the subsystem, it is also possible to generate statistical atmospheric turbulence based on the Dryden turbulence model which refers to the military specification MIL-F-8785. This work focuses on the presentation of the PALM model setup and discusses the COSMO-1 forced PALM simulation results, including a statistical comparison of the simulation results with meteorological data from different meteorological reference stations.