ALERT - Towards a Save Landing

A new LES-based system for short-range forecasting of near-surface high-impact weather at airports

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In Short

- Severe weather conditions like dense fog and strong gusts impose high risks onto airport environments.
- The parallelized large-eddy simulation model PALM will be used to explicitly resolve fog and gust risks.
- An operational LES-based forecasting system for airport environments will be developed.

The quality of weather forecast and warning products strongly relies on the quality of parametrization of all those processes that cannot be resolved by operational numerical weather prediction (NWP) models due to their coarse grid resolution. Particularly, turbulent processes in the atmospheric boundary layer (ABL) are still parameterized in state-of-the-art NWP models. However, turbulent processes are the key factor for various high-impact weather conditions relevant for the operation of airports. The stable boundary layer (SBL) regime for example is closely linked to the formation of fog. Dense fog usually forms in the nighttime ABL and can have a strong impact on the economy and also on personal safety. Low visibility is a major issue for the operation of airports. The life cycle of fog, from formation after sunset to dissipation in the morning hours, and its microstructure, however, are not well understood and the quality of operational fog forecast is still a weak point of NWP models. Recently, it has been shown that small-scale surface heterogeneities and airport buildings can significantly modify the formation time of fog, which clearly point out that the surface properties are essential for an accurate forecast of critical atmospheric conditions at airports and that traditional forecast systems are often inadequate in such conditions. In the neutral boundary layer, severe wind gusts associated with strong-wind events like winter storms are regarded as the most expensive natural disaster in Germany. Small spatial and temporal scales of gusts lead to a lack of observational studies and hence verification data to improve wind gust estimation (WGE) models used in NWP models. A comparison of different approaches for WGE in the COSMO-CLM model of the german weather service (DWD) showed that empirical gust estimation models still have advantages over a physically based approach. However, a deeper understanding of the shape and life cycle of wind gusts is needed to improve current WGE models. A major task for the operation of airports is a good prediction of wind gust effects on airplanes during final approach. Airport environments in Germany are commonly characterized by relatively flat terrain, accompanied by airport buildings of varying shape and size. Such topography elements have the potential of modifying the local flow conditions significantly and are thus suspect to be an important factor for wind gusts on the runway, particularly in strong-wind conditions.

The operation of airports during such foggy or strong-wind conditions currently relies on operational NWP and regional model data. These models can neither resolve the relevant near-surface processes that lead to fog or wind gusts, nor can they account for small-scale surface heterogeneity, such as airport buildings or vegetation and soil heterogeneity. A logical approach to achieve a more reliable forecast for airport areas would be the use of an LES model, coupled to or forced by an NWP model. This LES model can resolve the turbulence in the ABL as well as the interactions with airport buildings and the surface.

In the course of the DWD project 2015EMF-13 (codename ALERT) a tested and evaluated LES-based forecasting system for airport environments will be developed. The system will act as a magnifying lens and will be suitable for the forecast of high-impact weather conditions related to the turbulent processes in the near-surface ABL that cannot be adequately represented in state-of-the-art NWP models. The system eventually will allow the operational forecast of critical conditions relevant for aviation and airport operation, namely the forecast of dense fog ad severe wind gusts in stormy weather. It will be driven by NWP model data and shall run fast enough at operational level with reasonable (limited) computational resources.

Unlike current NWP models, the LES-based system aims at explicitly resolving the effects of the actual airport buildings and other surface properties, such as vegeation, impervious surfaces and soil on the boundary layer turbulence. This will allow to explicitly predict e.g. effects of wake turbulence generated by airport buildings on aircraft during final approach (see Fig. 1).

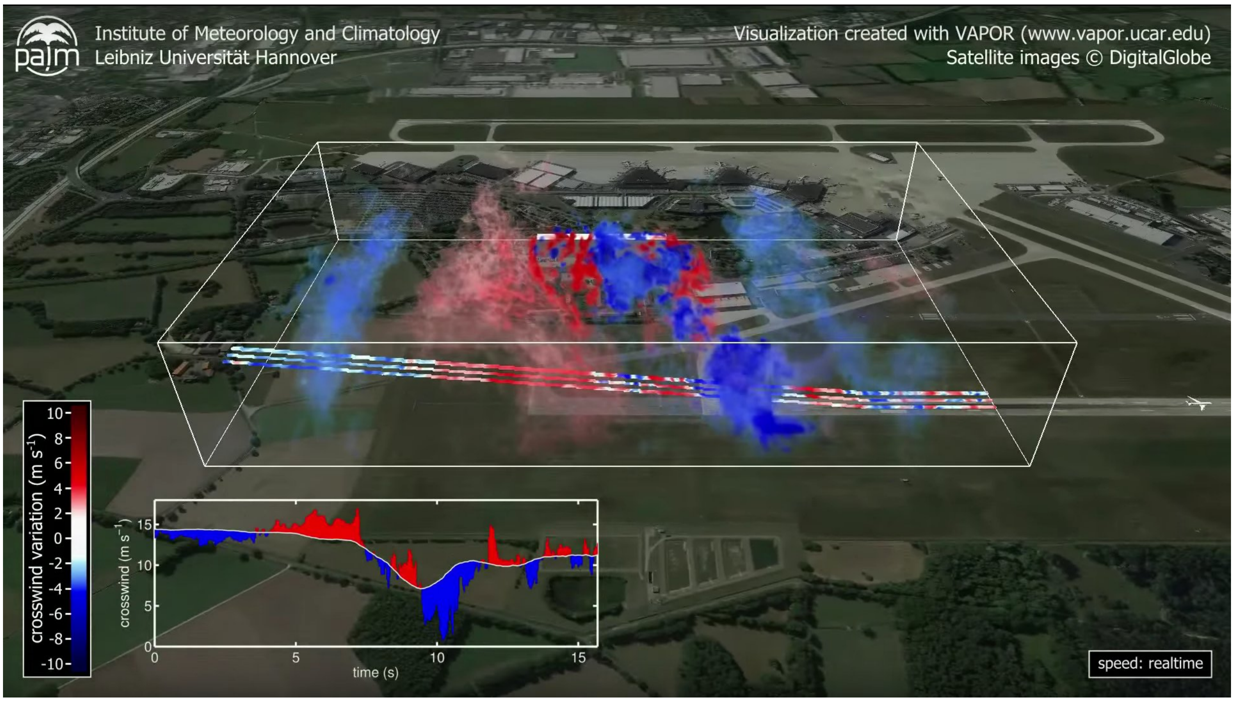

Figure 1: *This snapshot from an animation [1] displays the influence of airport-building induced turbulent crosswind on an aircraft during final approach. The airport building generates strong turbulence with resulting crosswind variations of up to 10m/s. The aircraft encounters these strong crosswind variations within seconds. Behind the building the encountered crosswind drops from more than 15m/s down to almost 0m/s. The animated data was generated with PALM [2,3]*

WWW

https://www.muk.uni-hannover.de

More Information

[1] H. Knoop, C. Knigge, S. Raasch, (2015) *TIB AV-Portal*. doi:10.5446/17745

[2] B. Maronga et al. (2015) *Geosci. Model Dev.* 8.8 pp. 2515-2551. doi:10.5194/gmd-8-2515-2015

[3] See also: https://palm.muk.uni-hannover.de

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