Geophysical Research Abstracts
Vol. 20, EGU2018-2229, 2018
EGU General Assembly 2018

Characterization of turbulence-cloud interaction in nocturnal boundary-layers

Metodija Shapkalijevski (1), Vera Schemann (2), and Nikki Vercauteren (1)

(1) Department of Mathematics and Computer Sciences, Freie Universität Berlin, Berlin, Germany, (2) Institute for Geophysics and Meteorology, University of Cologne, Cologne, Germany

In this study, as a part of the High Definition Clouds and Precipitation for advancing Climate Predictions (HD(CP)^2) project, the interaction between nocturnal boundary-layer (NBL) turbulence and low-level clouds is investigated.

The first part of this study is focused on data analysis of long time series from meteorological and remote sensing measurements from several well-established experimental sites in Germany and the Netherlands. By using clustering methodology, an extended data analysis of the influence of external forcing parameters on the NBL flow regimes has been performed, and regime occupation statistics have been subsequently analyzed. The NBL flow regimes have been represented via the bulk thermal stratification and shear conditions, as influenced by the external larger-scale forcing variables, cloud state and the geostrophic wind speed. The clustering technique separated two different turbulent regimes under stable and weakly-stable conditions, with smooth transition between these two regimes. The analysis showed that the cloudy conditions are related to weakly-stable regime, and the geostrophic wind variability is found to be important forcing for the regime transition from stable to weakly-stable conditions. The results of this analysis are consequently used in developing of a stochastic-based turbulence closure for the NBLs that accounts for the large-scale (and often intermittent) effects on the flow, which can be used in large-scale models to advance the cloud and precipitation predictions.

In the second part of this study, the initial cloud (state) formation as driven by large-scale motions in NBL is examined. For that purpose, a realistic case study over Jülich experimental site in Germany has been developed. By comparing high-quality remote sensing observation of the velocity and cloud state, it has been shown that the low-level jet (LLJ) was responsible for the developed turbulence in the NBL and subsequent cloud formation.To further explain and characterize the mechanism of NBL turbulence-cloud formation, a high resolution output (starting from 624 m horizontal resolution and nesting to up to 78 m) from the ICOsahedral Nonhydrostatic atmospheric large-eddy model (ICON-LEM) was produced for a domain of 110 km (diameter) over the Jülich experimental site. It was found that the high-resolution model was able to reproduce the velocity field and the turbulence structures caused by the LLJ in NBL, but underestimated the cloud formation. Reasons for model underestimation of the low-level clouds as driven by the LLJ have been subject of discussion in this case study.