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A case study of processes relevant for the development of nocturnal low-level clouds over southern West Africa

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During the summer monsoon season in southern West Africa, stratiform low-level clouds (LLC) form frequently during the night with typical cloud-base height of several hundred meters above ground and covering extensive areas. These clouds have a distinct diurnal cycle, as they often persist long into the following day, with the cloud-base height which rises after sunrise and consequently transitioning into convective clouds. Up to now, spatial and temporal investigations of LLC in this region have been performed based on satellite images, synoptic observations and few modeling studies, while high-quality observational data sets were rare. Due to these limitations, processes which control formation and dissolution of LLC are still not fully understood. Moreover, understanding of these processes has important practical implications, such as improving operational forecast and predictions of West African monsoon in weather, seasonal and decadal climate simulations.

In order to fulfill this gap, a comprehensive field campaign within the framework of the Dynamics-aerosol-chemistry-cloud-interactions over West Africa (DACCIWA) project was conducted in June and July 2016 at three supersites in Ghana, Benin and Nigeria. The comprehensive data set consists of remote sensing and in situ data, which enable the investigation of cloud characteristics, dynamic and thermodynamic conditions at high temporal and vertical resolutions.

In this study we analyze processes relevant for the development of low-level stratus clouds during one typical night case in July 2016, using the data from a supersite at Savè (Benin). The LLC formed around 00 UTC and persisted during the night until 07 UTC at a height of about 300 m above ground. Subsequently the cloud base started to rise due to growing convective boundary layer. A marked feature observed during this night is the arrival of the low-level jet (LLJ) several hours before the formation of LLC. Therefore, the role of the LLJ and the associated horizontal advection on the formation of LLC is discussed. Further, the effect of temperature and moisture change on the relative humidity tendency during the night is examined. Finally, the heat-budget analysis, based on radiosonde profiles performed every 1.5 h during the night, reveals the importance of different processes for formation, maintenance and dissolution of stratus clouds.