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Analysis of Nocturnal Low Level Clouds breakup over Southern West Africa during Monsoon season

Maurin Zouzoua (1), Fabienne Lohou (2), Marie Lothon (2), Cheikh Dione (3), Paul Assamoi (1), and Véronique Yoboue (1)

(1) Laboratoire de Physique de l'Atmosphère et de Mécanique des Fluides, Université Félix Houphouet Boigny, Abidjan, Côte d'Ivoire, (2) Laboratoire d'Aérologie, Université de Toulouse, CNRS, UPS, France, (3) African Center for Meteorological Applications for Development, Niamey, Niger

During monsoon season in West Africa, nocturnal stratiform low-level clouds (LLC) frequently form over the southern continental part of this region. Those clouds with their base only a few hundred meters above ground, cover an extensive area. They persist into the following day, sometimes until mid-afternoon. Due to their presence, atmospheric boundary layer (ABL) diurnal cycle and regional climate are affected. However, those clouds are still poorly represented in numerical weather prediction and climate models.
Within the framework of the DACCIWA (Dynamics-Aerosol-Chemistry-Cloud-Interactions over West Africa) project, a concerted measurement campaign was conducted in June and July 2016. The campaign included ground-based measurements at three supersites, Savè (Benin), Kumasi (Ghana), and Ile-Ife (Nigeria). One of the objectives was to evaluate hypothesizes on mechanisms controlling LLC life cycle, formulated by previous studies performed using remote sensing observations and numerical simulations. The DACCIWA comprehensive data set allowed to characterize LLC and to confirm some mechanisms controlling formation and maintenance of these clouds. Nonetheless, their dissipation under daytime conditions has not been well documented yet. In this study, we use ground-based measurement at Savè supersite from instruments such as ceilometer, near surface meteorological and energy balance stations, radiometer, and radiosonde to analyze locally LLC evolution of 23 cloudy nights free of precipitation. Additionally, satellite derived products are used for regional analysis.
Based on the analysis of the selected days, three LLC breakup scenarios are defined, depending on the shear driven turbulence in the subcloud layer. For the first scenario (strong turbulence intensity), fragmentation of cloud deck occurs while it rises up under solar heating condition, and low stratus progressively becomes cumulus cloud. When the turbulence intensity is low and, consequently, the subcloud layer not well mixed, two scenarios can occur. On the one hand, shallow cumulus form below LLC with convectively mixed layer, followed by LLC dissipation. On the other hand, the convective boundary layer top progressively reaches LLC base and finally merges with it, so that LLC seem coupled with the surface. In this third scenario, transition from low stratus to cumulus cloud is also observed. The next step is to analyze boundary layer atmospheric conditions associated with the various scenarios. We aim to identify the main processes governing LLC evolution under daytime conditions, and also to study the impact of LLC on convective boundary layer development.