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Conceptual model of diurnal cycle of low level clouds in southern West Africa

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During the monsoon season in West Africa, low-level clouds form almost every night and break up between 0900 UTC and the middle of the afternoon depending on the day. The low-level clouds have a strong impact on the radiation and energy budget at the surface and consequently on the humidity in the boundary layer and the afternoon convection. However, the low-level clouds are not correctly represented by weather prediction and climate models.

During the DACCIWA ground campaign, which took place in June and July 2016, three supersites in Benin, Ghana, and Nigeria were instrumented to document the conditions within the lower troposphere including the cloud layers. This comprehensive data set was used to analyse the diunal life cycle of the low-level clouds from the conditions before their formation to the various scenarios of their breakup. The results point out that the low-level clouds formation and dissolution depend on the contribution and interaction of several processes, which makes their numerical simulation difficult. However, a central dynamical feature is the Maritime Inflow combined with the nocturnal low level jet, which partly drives the advection and the buoyancy flux divergence, both contributing to the cooling of the atmosphere before the cloud formation. The low level jet again plays an important role during the cloudy period of the night by intensifying of the shear-driven turbulence. According to the turbulence intensity, three breakup scenarios of the low-level clouds have been defined. The reduction of the daily global radiation and, consequently, of the daily latent and sensible heat flux is highly correlated with the breakup time of the low-level clouds. The boundary layer development is then significantly affected: a factor of 4 can be found between the boundary layer height observed on days with early breakup time ($\sim$ 0800 UTC) and that observed on days with late breakup time ($\sim$ 1500 UTC).