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Surface factors governing the stratocumulus breakup and evolution in southern West Africa: A LES study

Xabier Pedruzo-Bagazgoitia (1), Fabienne Lohou (2), Cheikh Dione (2), Marie Lothon (2), Norbert Kalthoff (3), Bianca Adler (3), Karmen Babić (3), and Jordi Vilà-Guerau de Arellano (1)

(1) Meteorology and Air Quality Section, Wageningen University and Research, The Netherlands (xabier.pedruzobagazgoitia@wur.nl), (2) Laboratoire d'Aérologie, Université de Toulouse, CNRS, UPS, France, (3) Karlsruhe Institute of Technology (KIT), Germany

The role of boundary-layer clouds as part of the Western African Monsoon system is investigated. The system encompasses the interaction between large-scale phenomena such as the (southerly) monsoon flow, the African Easterly Jet and the (northerly) Harmattan wind, and the role of smaller scale processes driven by turbulence and the sea-vegetation transition on the lower troposphere, such as the frequently observed nocturnal low-level jet. As observed during the DACCIWA project campaign, low stratocumulus clouds recurrently appear inland during the night, sometimes prevailing until the next afternoon while in other cases they break up in the morning and disappear or transform to convective clouds. These observations rise two research questions: Do surface conditions affect the cloud breakup? Is the direct or diffuse character of radiation relevant for the cloud transition?

In our study we focus on the local effect of the surface and radiation on the breakup of stratocumulus and the subsequent transition to convective clouds during the morning transition. We design an idealized Large Eddy Simulation (LES) experiment in which the surface is coupled to the cloud dynamics based on radiosoundings launched during the campaign at the supersite of Savé (Benin), which is located about 180 km north of the Gulf of Guinea. This experiment includes the most relevant factors for the evolution of the boundary layer and stratocumulus in the morning. By systematically breaking down the complexity of the system, we study the relevance of atmospheric stability (by modifying the atmospheric lapse rates), and the partition of evaporation and sensible heat flux on the evolution, break up and transition of the stratocumulus cloud layer. Previous studies have shown that diffuse radiation controlled by clouds and aerosols can locally enhance evaporation. Therefore, particular emphasize is put on the determination of the role of direct and diffuse radiation during the cloud transition on the vegetated canopy, and the impact on the surface fluxes and cloud dynamics.