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Continental stratus over summertime West Africa: Observations and sepresentation in weather and climate models

Peter Knippertz[†]; Andreas Fink; Robert Schuster; Jˆrg Trentmann; Charles Yorke
[†] University of Leeds, United Kingdom
Leading author: p.knippertz@leeds.ac.uk

The last IPCC report showed large disagreement about potential precipitation changes over West Africa for the 21st century. This uncertainty hinders the development of adaptation and mitigation strategies for this particularly vulnerable area. The main reason is the notorious inability of climate models to realistically represent the complex West African monsoon (WAM) system. Here we will discuss non-precipitating, low-level, thin continental stratus over summertime southern West Africa. Despite its large influence on the surface energy budget and potential impacts on the WAM circulation as a whole, this phenomenon has received very little attention, which is partly due to the difficulties of current satellite observing systems to detect nighttime continental stratiform clouds. Recently available ground observations of incoming solar radiation and short-term forecasts made as part of the ERA-Interim re-analysis project suggest that satellite retrievals have a substantial positive bias on the order of 20 W m-2. Climate models used for the last IPCC report show an even larger bias, a huge spread and large differences in vertical cloud structures. Recent ground-based observations suggests that the stratus forms in relation to the strong summertime nocturnal low-level jet (LLJ) over the region. As soon as the LLJ reaches critical shear, turbulence is induced mechanically and mixes moisture, accumulated in the surface layer through evapotranspiration, upwards, resulting in condensation and cloud formation near the jet level. The stratus deck is often thick enough to persist until midday or afternoon, when it can transform into a broken stratocumulus or cumulus cloud deck. While ERA-Interim and the few available radiosondes indicate a clear reduction of LLJ momentum through these mixing events, IPCC models show a large positive bias of low-level wind speed consistent with too little cloud cover and too much incoming solar radiation.