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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The observed diurnal cycle of nocturnal low-level stratus clouds over southern West Africa: a case study" *by* Karmen Babić et al.

Anonymous Referee #1

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The study focuses on a diurnal variation of low level clouds (LLC). The analyses are well presented with field observations. The authors concluded that temperature advection played the major role on the formation of the LLC.

Although the authors briefly mentioned the possible explanation of the LLC formation as a result of vertical turbulent mixing, I would still challenge the authors to think more about the role of turbulent mixing in the growth of the LLC.

Because of difficulties of calculating temperature advection, the authors relied on estimating temperature advection as a residual term with several assumptions. The temperature decrease around 2100 UTC could be due to the vertical transport of cold air

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Discussion paper

from the radiatively cooled surface by turbulent mixing associated with the increase of wind speed especially considering of non-local turbulence eddies (Sun et al. 2016, BLM), which is clearly demonstrated in Fig.4. That is, as the surface was radiatively cooled, the cold air adjacent to the surface was generated. Once wind speed increased, the cold air was transported upward by the enhanced vertical mixing. As a result, the air below the NLLJ was relatively well mixed, which is shown in the vertical temperature profiles and the decrease of the specific humidity, q, at 4 m (Fig. 6). The decreased air temperature led to the increase of RH, the formation of the LLC, and the thickening of the LLC. The evolution of the NLLJ should be associated with the vertical stable stratification of the air below. The increase of the wind speed could not be fast at the beginning of the NLLJ formation due to the stable stratification. As the stable stratification was reduced by the vertical turbulent mixing, the air layer below the NLLJ approached near neutral, and the downward sensible heat flux would be relatively small. Then, the air temperature would remain stationary as the cold air cannot be generated at the surface fast enough especially with the formation of the LLC, which is indeed evident in Fig. 4a. The timing of the sharp temperature decrease and the wind speed increase around 2100 UTC seems to be an indication of the role of the vertical turbulent mixing. The role of vertical mixing could also be seem in vertical variations of specific humidity, which are not shown in the manuscript but should be similar to vertical variations of potential temperature. If the advection plays a significant role in the LLC formation, I would expect a continuous increase of specific humidity after 2100 UTC as advection would bring in a different air mass into the study site. The initial small increase of specific humidity at 4 m around 2100 UTC could be due to the vertical transport of water vapor from the air layer below 4 m, and the steady decrease of q with time in Fig. 6d also suggests the important role of vertical mixing as the high q air was transported upward and the low q air was transported downward.

I am not saying that the temperature advection didn't play any role on the LLC formation. However, vertical turbulent mixing associated with the wind speed increase could play a major role in the LLC formation based on the observations presented in the manuscript. A close look at the timing of all the observations may help to determine different roles of horizontal advection and vertical turbulent mixing.

Minor comments:

What is the surface type? Any observation evidence for a constant albedo? What is the vertical resolution of the microwave radiometer? Is the vertical divergent of radiative fluxes sensible to the vertical distributions of liquid water and water vapor? Figure 2. It will be helpful to add explanation of different color bars for nighttime and daytime, and why the nighttime technique for detecting the cloud cover cannot be used for daytime. L. 19. "...without a clear cloud radar signal." Is this an instrument issue or no clouds?

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