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Influence of low-level jets on the nocturnal budget of turbulence kinetic energy in a forest canopy

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In the north Florida, nocturnal low-level jets (LLJ) occur in about 50% of the half-hour measurement periods. Here it is studied how the turbulence kinetic energy (TKE) in a forest canopy is influenced by the turbulence generated in the shear layer below the LLJ wind speed maximum. The data recorded in April-June 2004 during the experimental campaign at the AmeriFlux site located in a flat terrain near Gainesville, Florida, is analyzed. The mean tree height of the pine plantation was 13.5 m in 2004. Among other sensors, ultrasonic anemometers (CSAT3, Campbell Scientific Inc., and 8100, RM Young Inc.) were placed at six levels in the canopy and at nine levels above the canopy on the 30 m tall tower. Wind profile up to 700 m above ground, on average, was measured by the phased-array Doppler sodar (PA2, Remtech Inc.).

The first period of the simultaneous measurements (21 April – 22 May) was characterized by a stronger wind shear (0.024 s^{-1}, averaged over all nighttime half-hour periods available) between 30 m and 100 m. According to the investigations already published, this indicates a more frequent occurrence of stronger LLJs. On the contrary, in the second period (10-25 June) the average wind shear was weaker (0.019 s^{-1}). Weaker LLJ activity in the June period can be documented by the streamwise wind velocity variance in the layers above 100 m: It was half as large in comparison with the April/May period. Stronger LLJ activity may generate a larger downward flux of TKE, which was recorded at the tower top in the April/May period, although both downward and upward TKE fluxes occur at that level. While a more intensive turbulent mixing above the canopy top in the April/May period (TKE two times larger than TKE in the June period) was accompanied by a moderate dynamic stability (Richardson number Ri = 0.2), the June period was characterized by a strong stability (Ri = 0.6). The magnitudes of the shear production and turbulent transport terms of the TKE budget in the lower canopy reached larger values in the stronger LLJ cases. In the June period, the buoyant production term in the lower canopy was mostly positive at night, which corresponded to a slightly unstable stratification. By contrast, turbulence in the April/May period was more often able to penetrate effectively down to the lower canopy, which resulted in a stable stratification and a negative buoyant production term in that layer. Selected nights with a stronger, resp. weaker LLJ activity will be described in more detail.