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NOCTURNAL LLJ EVOLUTION AND ITS RELATIONSHIP TO TURBULENCE AND FLUXES

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A major objective of CASES-99 was to relate surface fluxes to features of the evolving stable boundary layer, such as the low-level jet (LLJ). In a recently completed study we used a combination of high-resolution Doppler lidar (HRDL: see Grund et al., 1999), a 60-m instrumented tower, and a 60-km triangle of Doppler-mini-sodar/profiler combinations to study the low-level jet (LLJ) over south-central Kansas during the CASES-99 field campaign (Banta et al. 2002). HRDL was built by ETL in cooperation with the National Center for Atmospheric Research (NCAR) and the Army Research Office (ARO). Using this collection of instrumentation, we determined the speed, height, and direction of the maximum speed in the LLJ and we investigated the frequency of occurrence, the spatial distribution, and the evolution through the night, of these LLJ characteristics.

The LLJ that forms the focus of this study is that which affects the shear and turbulence below the jet and near the surface, and thus was the lowest wind maximum. We found that this wind maximum, which was most often between 7 and 10 m s^{-1}, was generally at or below 100 m AGL as measured by HRDL at the CASES central site. Over the 60-km-triangle profiler array, the topography varied by ~100 m. The wind speed and direction of the jet max were relatively constant over this distance (with some tendency for stronger winds at the highest site) but the height of the max was more variable. Although this height was occasionally about equal at all 3 sites, indicating that the jet was following the terrain, more often it was not. The LLJ most often seemed to be relatively level, i.e., at the about same height MSL, although the vertical resolution of the profiler is an issue. In the behavior of the LLJ with time through the night, the jet-max height was again more variable than the speed; in fact on some nights the speed was quite steady.

Also available from HRDL data were vertical profiles of the velocity variance, which were shown to correlate well with TKE and turbulent fluxes measured on the nearby 60-m tower. An objective of this study is to relate episodes, bursts, or patches of enhanced turbulence as measured by HRDL between the surface and 250 m AGL, to characteristics or changes in the LLJ on several CASES nights with different LLJ speeds and heights. To address this we explore the relationship of HRDL high-variance periods to fluxes measured on the 60-m tower. We find that the HRDL high-variance episodes often corresponded to periods when TKE is generated aloft near the jet maximum and transported downward, in agreement with the ”upside-down” boundary-layer concept. Preliminary inspection of the data indicates that these episodes are sometimes related to bursts of fluxes at the surface, and sometimes not.

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