

Impact of Nocturnal Low-level Jets on the Terrestrial CO₂ Fluxes

Henrique Duarte

Crop and Soil Sciences Seminar

Wednesday April 29, 2009 at 3:35 PM

Room 2401, Miller Plant Sciences Building

Low-level jets (LLJ from now on) are a common atmospheric phenomenon, corresponding to a wind speed maximum close to the surface. The LLJs have been attracting attention from the scientific community because of the several impacts they can impose to the Earth's surface, including the blow-up phenomenon of forest fires, triggering of thunderstorms, high wind shear conditions near the ground (with serious implications for aircraft landings), and enhancement of turbulence and terrestrial fluxes, which is the point of interest of this study. The energy and mass fluxes between the surface and the atmosphere are usually obtained using the eddy-covariance technique, from high frequency measurements of vertical wind speed and CO₂ concentration. The use of this technique during nighttime, however, is challenging, because of the high atmospheric stability and the intermittent turbulence caused by different atmospheric phenomena, including gravity waves, density currents, and low-level jets. Their exact impact on the nocturnal CO₂ fluxes is unknown. Gap-filing techniques have been used to avoid the nocturnal problematic. However, a great part of the CO₂ net ecosystem exchange (NEE) is due to nocturnal respiration. The recent NEE estimations for different ecosystems, therefore, contain a reasonable degree of uncertainty. A better understanding of the impact of the low-level jets on the turbulence properties close to the surface and consequently on the CO₂ fluxes is one step towards better nocturnal CO₂ fluxes estimations and consequently better NEE estimations. The impact of LLJs on CO₂ fluxes has been recently assessed by other few authors, where it is shown that LLJs have the potential to enhance fluxes. Those are pioneer results, and they have to be validated. Also, the link between LLJs and CO₂ fluxes has to be explored more in depth. With that purpose, eddy-covariance and wind profile data collected in Plains-GA in 2008, as part of a research project funded by the U. S. Department of Energy, are being analyzed. The specific objectives of this study are 1) to understand the LLJ climatology for the experimental site, and 2) to assess quantitatively the influence of the LLJ height and speed on the CO₂ fluxes. Preliminary results show that LLJs are present in almost every night during the experiment in Plains, with typical height between 100 and 200 m and typical speed around 15 m/s.

References

- Corsmeier, U., N. Kalthoff, O. Kolle, M. Kotzian, and F. Fiedler. 1997. Ozone concentration jump in the stable nocturnal boundary layer during a LLJ event. *Atmos. Environ.* 31: 1977-1989.
- Karipot, A., M.Y. Leclerc, G. Zhang, T. Martin, G. Starr, D. Hollinger, J. H. McCaughey, and G. R. Hendrey. 2006. Nocturnal CO₂ exchange over a tall forest canopy associated with intermittent low-level jet activity. *J. Theor. Appl. Climat.* 85(3-4): 243-248.
- Karipot, A., M.Y. Leclerc, G. Zhang, K. Lewin, J. Nagy, and G. Starr. 2008. Influence of nocturnal low-level jet on turbulence structure and CO₂ flux measurements over a forest canopy. *J. Geophys. Res.* 113 (D10102): 1-12.