Comparison of Surface Energy Budget and Carbon Dioxide Flux between Urban and Agricultural Environments

Nathan Sparks, Brandon Daub, Heping Liu, Eric S. Russell, Zhongming Gao, Raleigh Grysko, Jinshu Chi, Brian Lamb
Laboratory for Atmospheric Research, Washington State University, Pullman, WA 99163

Introduction

- Urban landscapes are complex environments, in which greenhouse gas concentrations and the transport of heat and moisture are altered by anthropogenic structures and activities. Eddy covariance methods are frequently used to estimate surface level turbulent fluxes of latent and sensible heat, and CO₂.
- By comparing flux estimates from an urban site to a operating agricultural site, it is possible to explore the differences of an urban rooftop landscape from a rural one in terms of surface energy budget and CO₂ fluxes.
- A 10 meter eddy flux tower was erected on the roof of the PACCAR Environmental Technology Building at Washington State University in Pullman, Washington. A similar 3 meter system was erected in a wheat field at the Cook agronomy farm 7.9 km to the northeast of the PACCAR site. Data were recorded from June 10 to June 17, 2016.

Method

- Eddy Covariance method: a technique for measuring the net emission or uptake of a scalar quantity using fast measurements of the vertical wind speeds and scalars.
- 10 Hz measurements over a 30 minute time scale.
- CO₂, temperature and water vapor density.
- PACCAR Site 46°43’46.7”N, -117°09’18.0”W.
- R. J. Cook Agronomy Farm 46°47’1.10” N, -117°4’39.36” W.

Results

- Only sensible heat and net radiation showed clear signs of a diurnal pattern at the PACCAR site. Latent heat and CO₂ flux did not show a consistent pattern throughout the day in the rooftop setting.
- The urban environment remained at a cooler temperature during the majority of the day than the rural one, with less latent heat flux.
- The urban environment experienced wider fluctuations of CO₂ over an entire 24 hour period.
- Net radiation, CO₂, latent and sensible heat flux followed a distinct diurnal pattern at the agricultural site.
- The ow, q, and t in both locations peaked around noon each day, reaching their lowest (most consistent) levels in the early morning and late evening. ow was greater at the PACCAR site than at the Cook Farm site.
- Further study could explore the surface energy budget of different urban surfaces and materials.

Conclusions

This work was supported by the National Science Foundation’s REU program under grant number AGS-1461292.