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

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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 CO_2.
- 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 CO_2 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.

Sensor Name	Manufacturer
CSAT3 Sonic Anemometer	Campbell Scientific, Inc.
LI-7500 Open Path Infrared Gas Analyzer	LI-COR, Inc.
EC150 Open Path Gas Analyzer	Campbell Scientific, Inc.

Figure 1: PACCAR Site

Figure 2: Cook Farm Site

Results

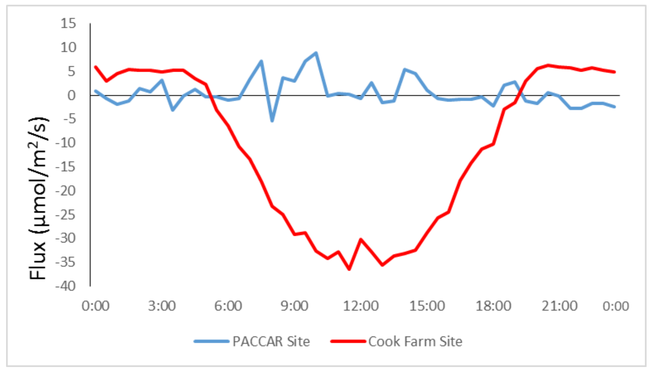

Figure 3: Mean CO_2 Diurnal Flux

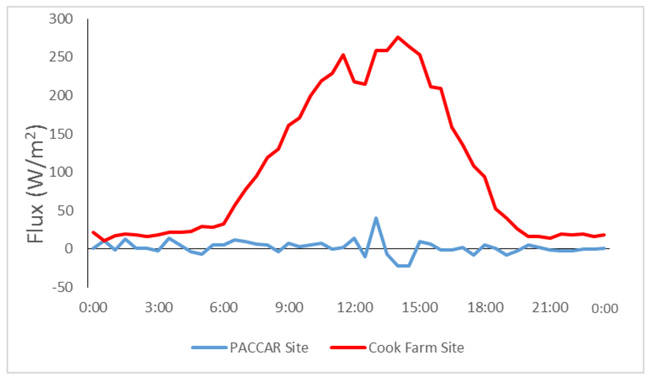

Figure 4: Mean Latent Heat Diurnal Flux

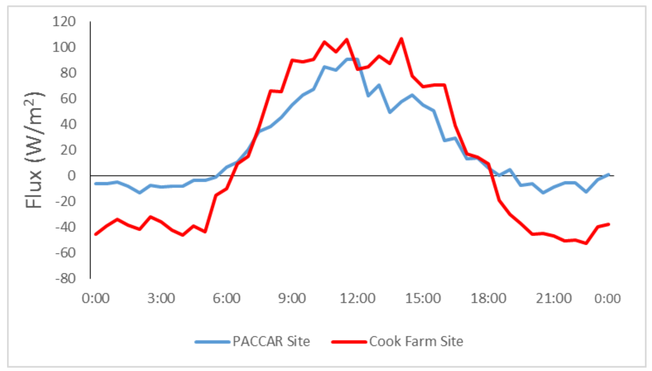

Figure 5: Mean Sensible Heat Diurnal Flux

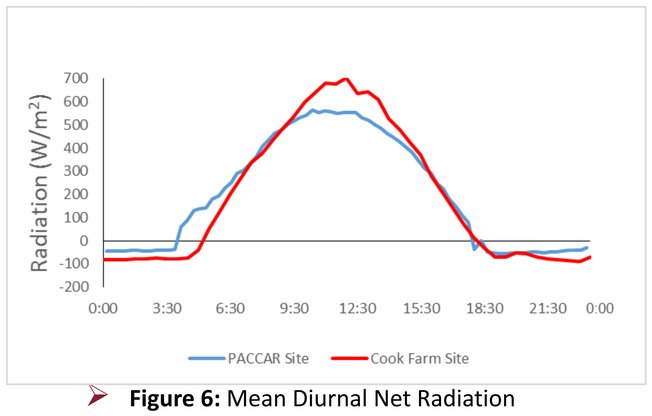

Figure 6: Mean Diurnal Net Radiation

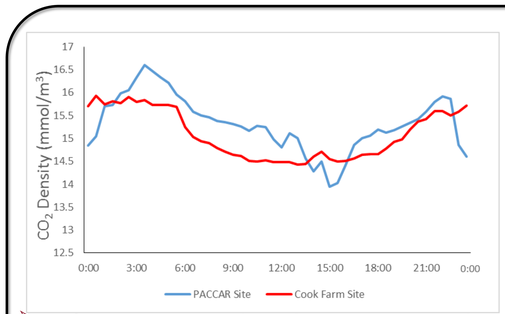

Figure 7: Mean Diurnal CO_2 Concentration

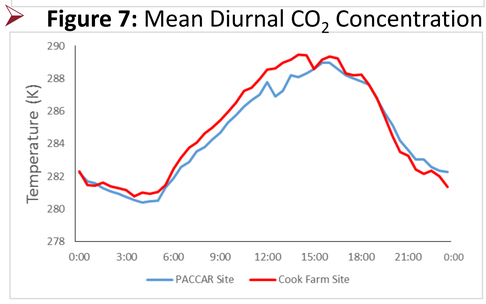

Figure 8: Mean Diurnal Temperature

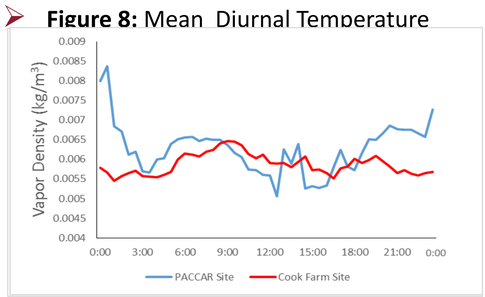

Figure 9: Mean Diurnal Vapor Density

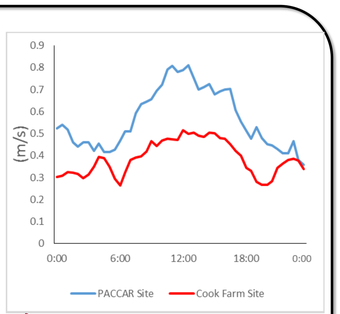

Figure 10: Mean σ w

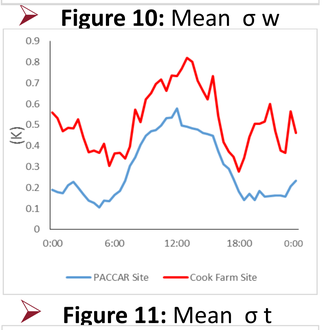

Figure 11: Mean σ t

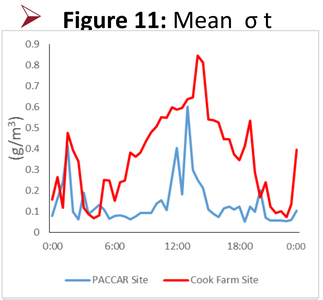

Figure 12: Mean σ q

Conclusions

- Only sensible heat and net radiation showed clear signs of a diurnal pattern at the PACCAR site. Latent heat and CO_2 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 CO_2 over an entire 24 hour period.
- Net radiation, CO_2, latent and sensible heat flux followed a distinct diurnal pattern at the agricultural site.
- The σw, σq, and σt in both locations peaked around noon each day, reaching their lowest (most consistent) levels in the early morning and late evening. σw 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.

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