Greenhouse Gas Emissions in an Urban Environment

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INTRODUCTION

Increasing atmospheric carbon dioxide (CO_2) concentration is a well-known effect of fossil-fuel burning, but sources of methane (CH_4) and nitrous oxide (N_2O) are less well understood. Cities are potential hot spots for greenhouse gas (GHG) production. We sought to investigate GHG fluxes in terrestrial and aquatic urban patch types around the Phoenix metropolitan region.

QUESTIONS

Q1: How are emissions of CO_2, CH_4, and N_2O distributed across the urban landscape?

Q2: Are aquatic/semi-aquatic/episodically aquatic ecosystems hot spots for the production of these gases?

Q3: What physical and/or chemical variables contribute to GHG production?

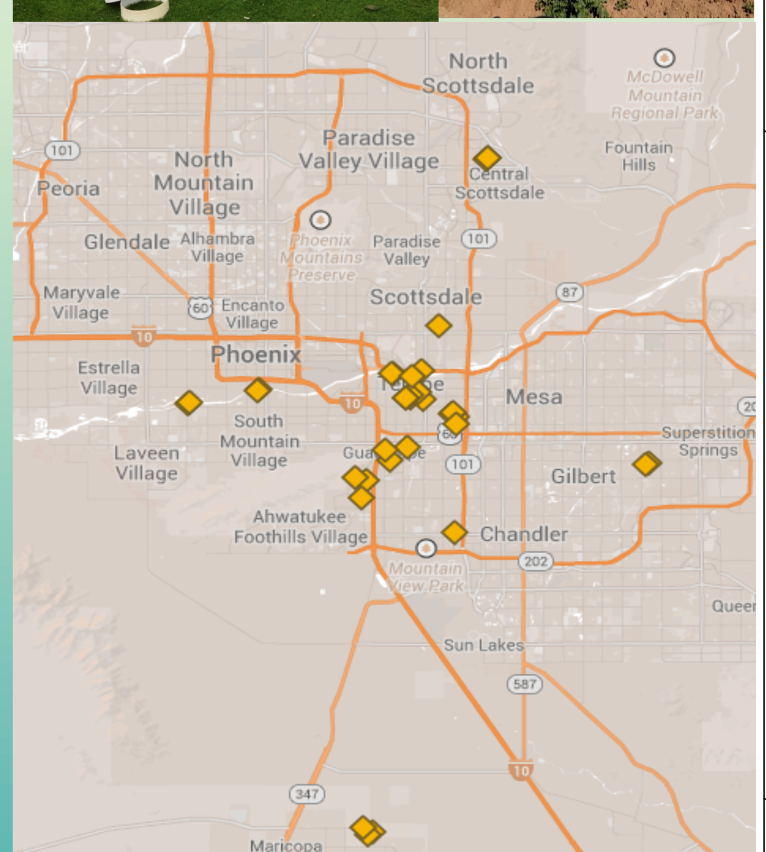
METHODS

We collected GHG samples for two seasons (March and June) from three patch types; terrestrial, aquatic, and periodically flooded.

- Gas samples were taken from chambers designed to trap soil gas emissions.
- Periodically flooded sites were experimentally manipulated by wetting the soil.
- CO2, N2O, and CH4 concentrations were measured on a Shimadzu Gas Chromatograph.

We collected soil samples from each terrestrial chamber.

- Soils were analyzed for soil moisture, temperature, percent organic matter, and extractable inorganic nitrogen (summer only) using KCl extraction



	Code	Patch Type
Aquatic	C	Canal
	L	Lake
	TW	Treatment Plant Wetland
	RW-W	Riverine Wetland (water)
Flooded Environments	IL	Irrigated Lawn
	RB-M	Retention Basin – Mesic
	W-M	Wash – Mesic
	RW-S	Riverine Wetland (soil)
	IA	Irrigated Agricultural Fields
	RB-X	Retention Basin – Xeric
	W-X	Wash – Xeric
Terrestrial	ML	Mesic Landscape (turf grass)
	XL	Xeriscaped Landscape
	FA	Fallow Agricultural Fields

RESULTS

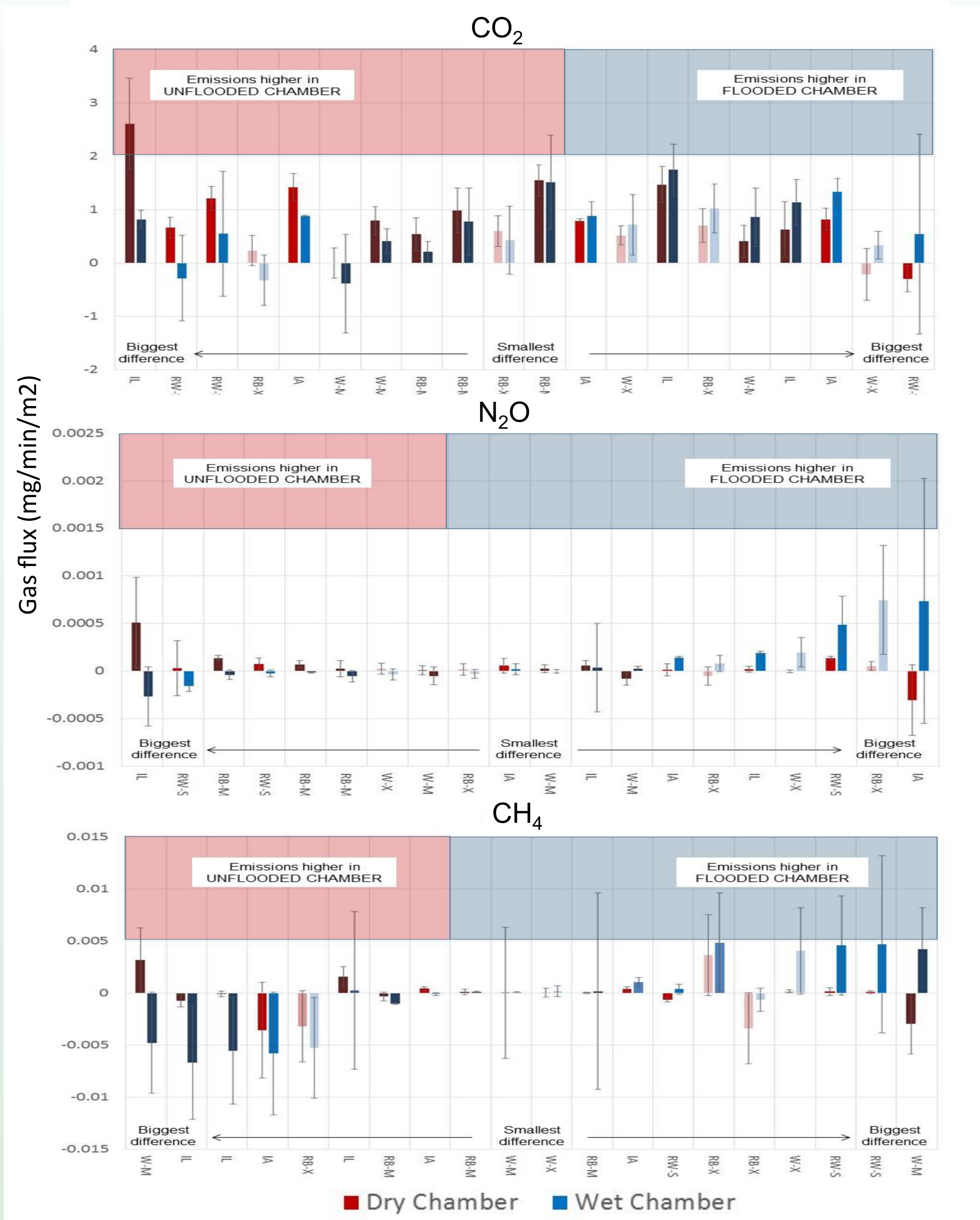


Figure 1. Emissions of CO_2, N_2O, and CH_4 in periodically flooded patch types during Winter 2013. We sampled three replicate patches of each patch type. Bars represent one standard error of the mean.

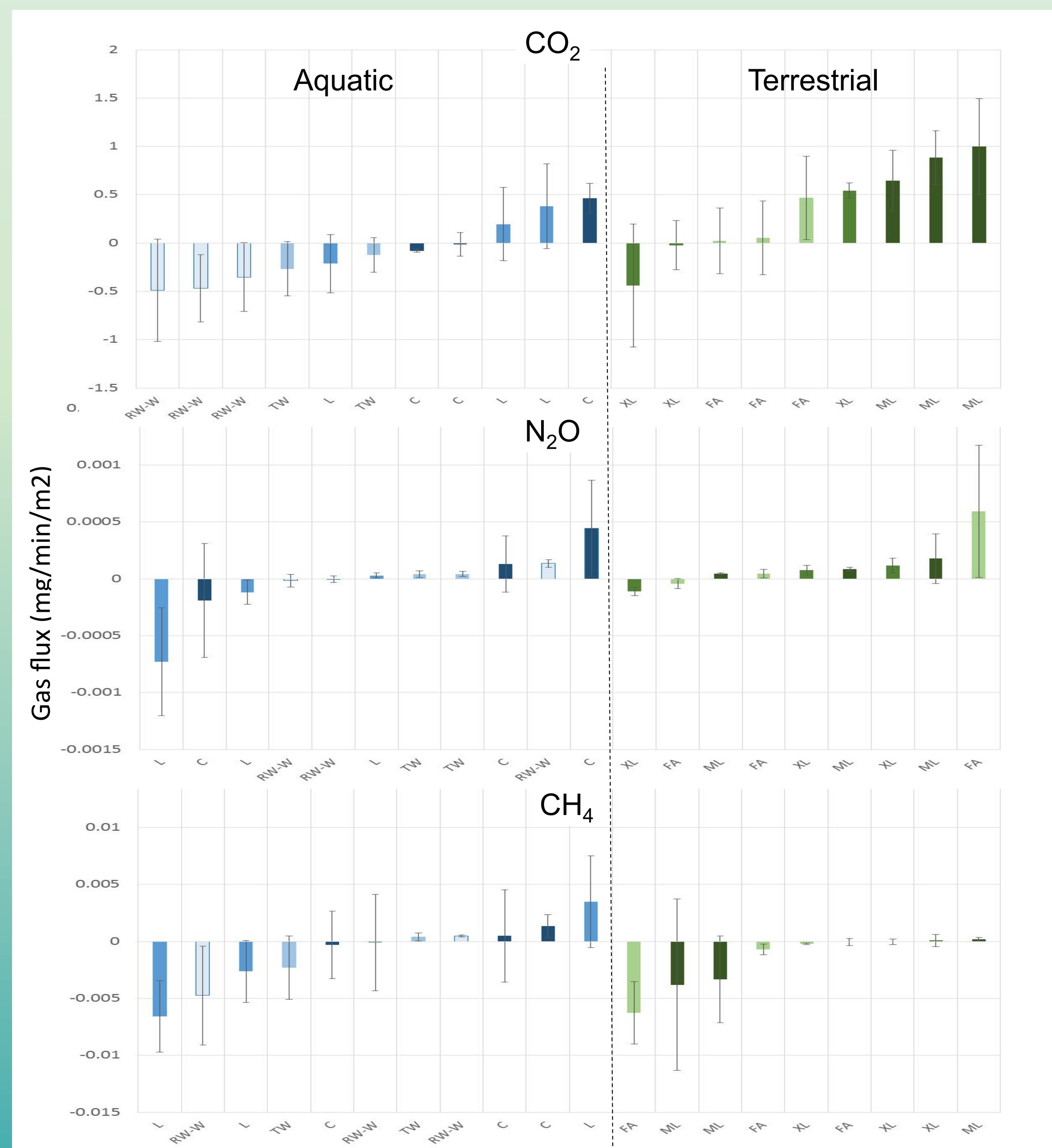


Figure 2. Emissions of CO_2, N_2O, and CH_4 in aquatic and terrestrial patch types during Winter 2013.

- Patch types showed substantial within-site variation in CO_2, N_2O, and CH_4 fluxes during Winter 2013 (Figs. 1 & 2).
- Generally, CO_2 emissions were highest within all patch types compared to CH_4 and N_2O (Fig. 1 & 2).
- Some patch types demonstrated uniformly low (e.g., xeriscaped landscape) or high (e.g., canals) emissions of all three gases (Fig. 1 & 2).
- Other patch types, like turf grass and wetlands, had high emissions of one trace gas (e.g., CH_4) and not another (e.g., CO_2) (Figs. 1 & 2).
- Flooded xeric sites (retention basins, washes) tended to be unresponsive or had higher emissions in “wet” chambers. Mesic flooded sites tended to have higher GHG emissions in “dry” chambers (Fig. 1).

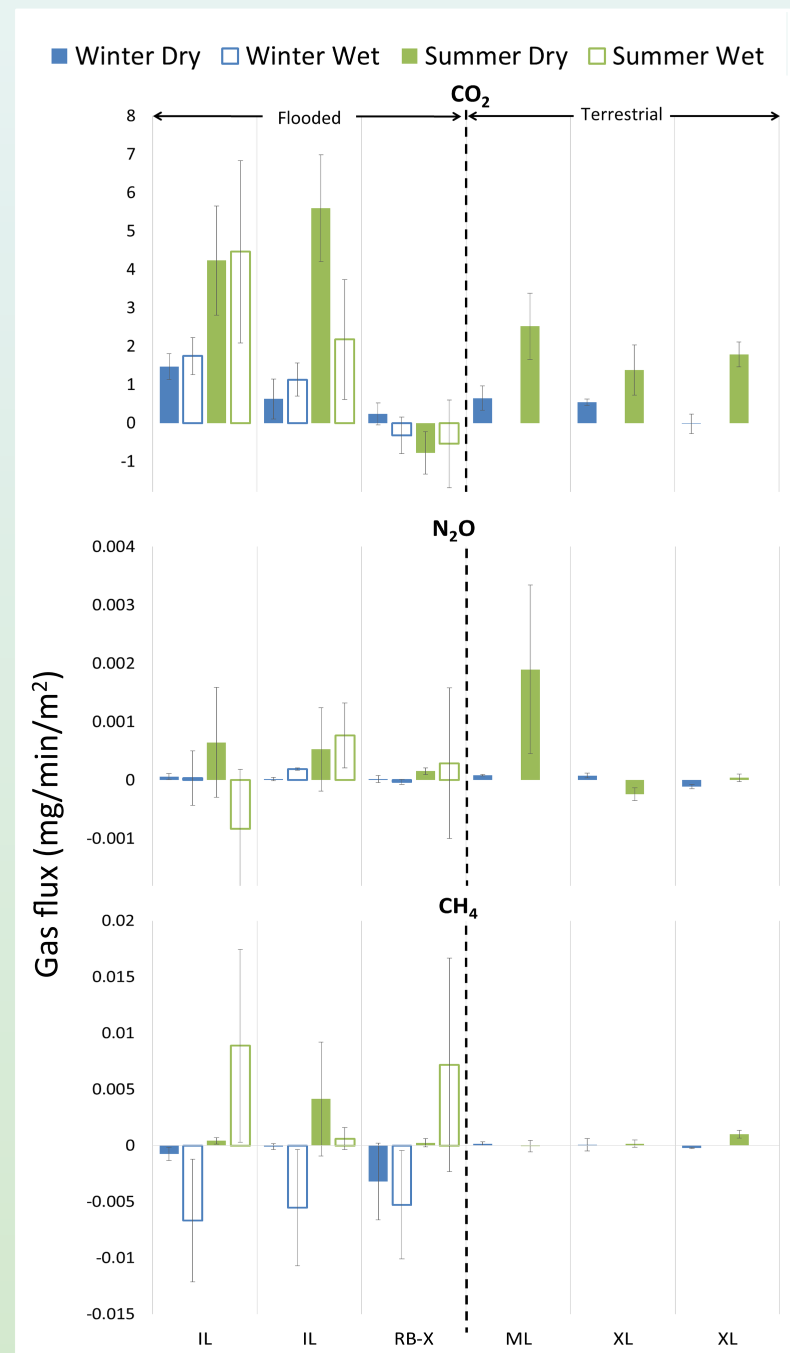


Figure 3. GHG emissions of a subset of patch types during Winter and Summer of 2013.

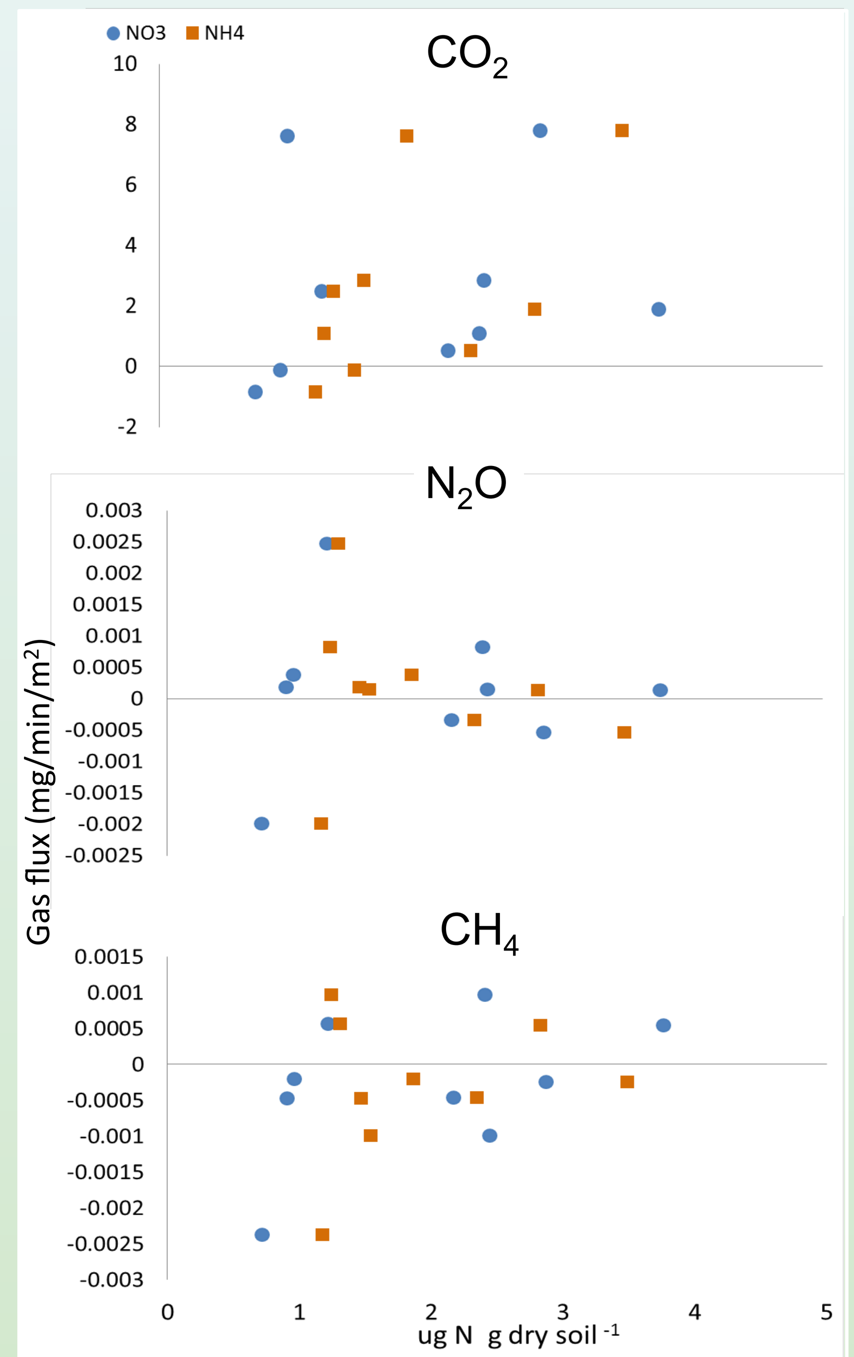


Figure 4.GHG emissions in Winter vs. soil-extractable NO3 and NH4.

- The subset of data for winter and summer generally shows higher emissions of all gases in summer than in winter (Fig. 3)
- Winter emissions data suggest a possible positive relationship between soil-extractable inorganic N and CO_2 and CH_4 flux (Fig. 4).
- Overall, ambient % organic matter and soil moisture did not show strong relationships with GHG emissions

CONCLUSIONS and FUTURE DIRECTIONS

- Patterns suggest that heterogeneity in urban design inherently results in spatial variation in GHG emissions.
- Flooding in cities, whether intentional or incidental, is a key factor driving temporal patterns of GHG fluxes (data not shown).
- Different design elements of the urban landscape will need to be managed differently to reduce GHG emissions.
- Future work will incorporate additional samples collected during the summer and fall seasons, when we expect emissions to be higher.