Spatial impacts of urban structures on micrometeorological variables

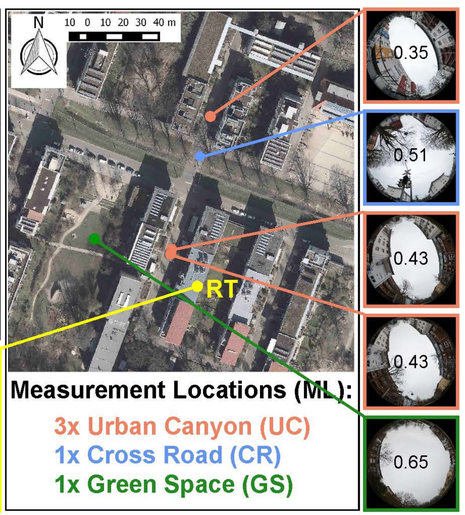
Merle Koelbing, Tobias Schuetz, Markus Weiler

Introduction

The heterogeneity of urban surfaces including buildings and vegetation causes high variability of micrometeorological variables on a small spatial scale. This makes it difficult to observe or even predict climate conditions, particularly evapotranspiration, with high resolution on the scale of entire cities. However, information on evapotranspiration on a microscale is essential, for example, for city planners to implement rain harvesting systems or mitigation strategies against heat.

- A dataset is collected representing the spatial influence of urban structures on the microclimate.
- The impact of several urban structures on the microclimate is quantified in relation to reference measurements.

Materials and Methods



Observed variables:

Variable		
air temperature	T_a	[°C]
relative humidtiy	rh	[%]
infrared radiation temperature (90° FOV)*)	$T_{ir,N,E,S,W,up,down}$	[°C]
shortwave radiation (180° FOV)	SW^{in}; SW^{out}	[W/m²]
wind speed**)	ws	[m/s]
wind direction**)	wd	[°]

*) at MLs only **) not shown in this study

Results

Overview on measurement days

date	timespan	$n_{rotations}$	T_a mean [°C]	rh mean [%]	SW^{in} mean [W/m²]
			RT		
2015-11-26	12h -14h	2	**4.0** *+/-0.20*	**94.4** *+/-1.05*	**48.2** *+/-39.59*
2015-12-11	10h -14h	4	**9.5** *+/-0.30*	**56.9** *+/-4.90*	**128.0** *+/-43.00*
2016-01-15	10h -12h	2	**2.1** *+/-0.12*	**70.5** *+/-0.56*	**90.3** *+/-33.30*

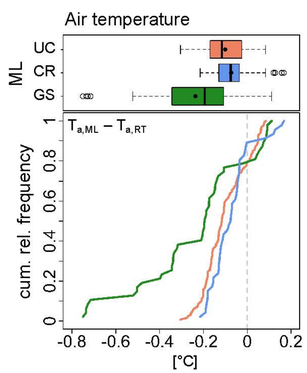
Evapotranspiration (ET):

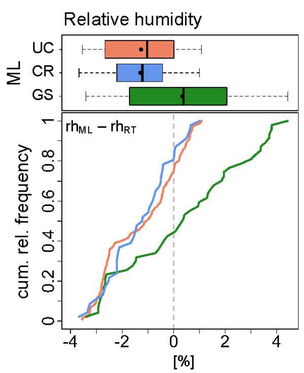
$ET = f(T_a, rh, R_n, ws^{**})$

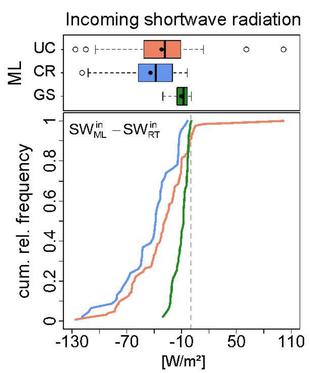
measured deducible

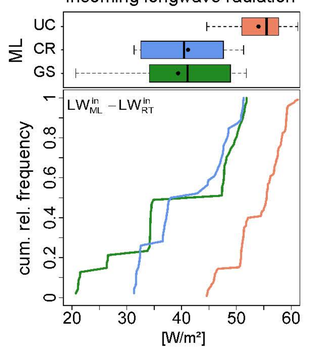
Net Radiation (R_n):

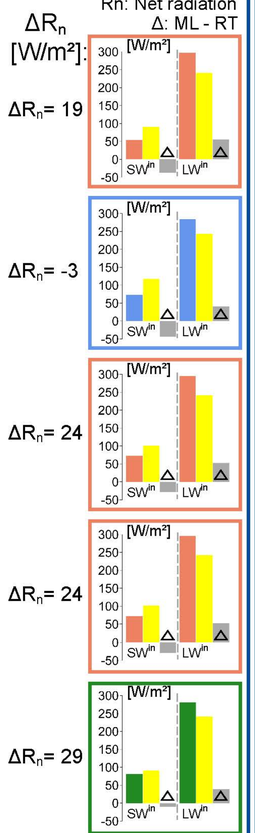
$R_n = SW^{in} - SW^{out} + LW^{in} - LW^{out}$







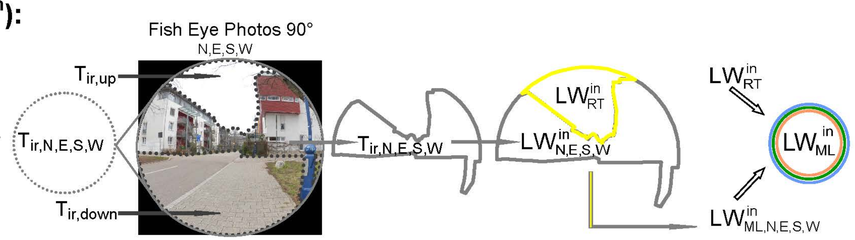




Incoming longwave radiation (LW^{in}):

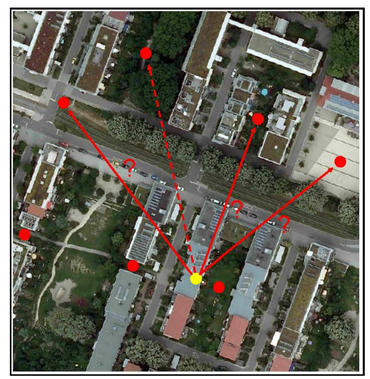
- **RT:** according to Baur & Philips (1934) using rh and Ta measurements
- **ML:** derived from $T_{ir,N,E,S,W,up,down}$

Fractions for sky and above ground objects are estimated by evaluating Fish Eye Photos.



Conclusions and Outlook

- The chosen method is a suitable approach to assess the spatial variability of micrometeorological variables in an urban surrounding.
- Changes in microclimatic conditions are a function of space and time. The temporal variation can be eliminated by taking reference measurements into account.
- We observed a distinct pattern for ΔR_n as a function of ML.



- We will examine additional locations and cover seasonal effects as well.
- Empirical spatial-temporal transfer functions for specific urban surroundings and seasons will be derived. This allows a spatially differentiated parameterization of urban ET on a microscale throughout the year.

Have a look at Freiburg, Germany, where future measurements will be performed!

Hydrology, Faculty of Environment and Natural Resources, University of Freiburg, Germany
merle.koelbing@hydrology.uni-freiburg.de
www.hydrology.uni-freiburg.de