N2: Heat and vapor transport at the soil-atmosphere interface in urban areas

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Introduction

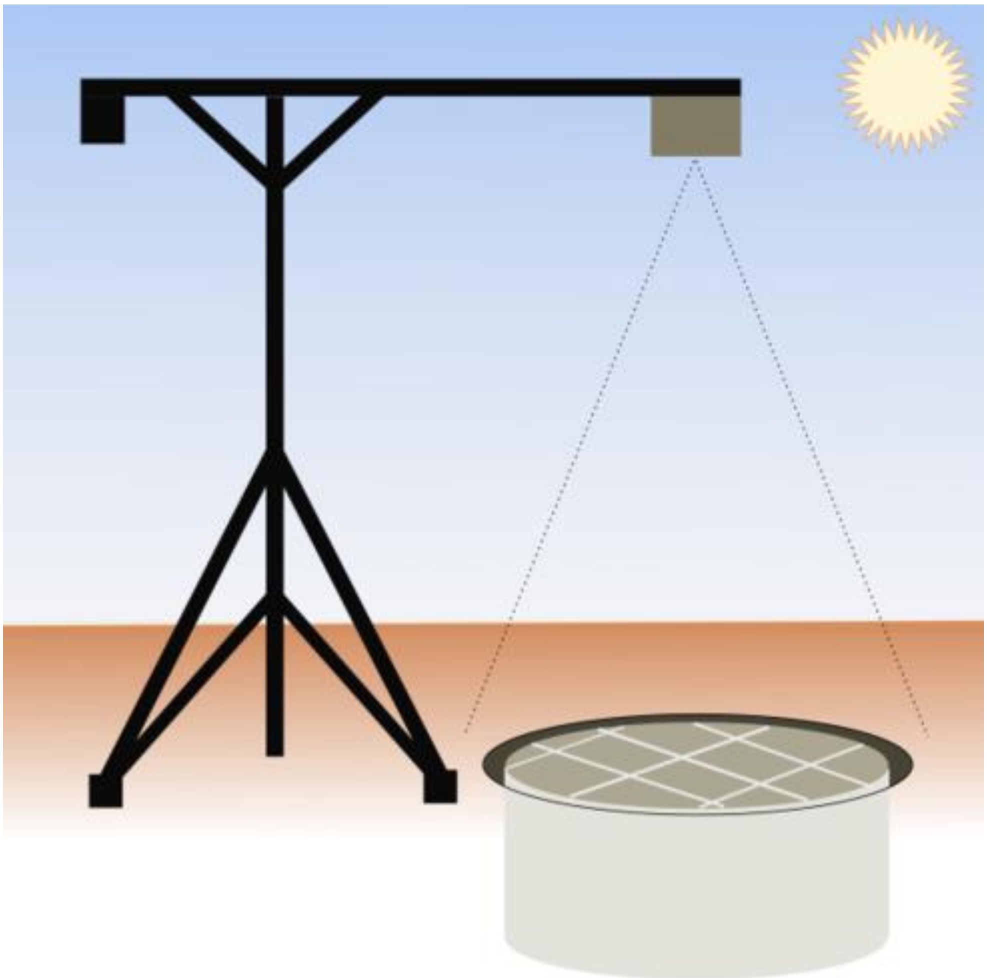
The majority of urban surface energy balance models rely on simulated surface thermal properties in combination with meteorological methods to produce their outputs. As a part of this modeling process, surface types are necessarily simplified into general categories, such as concrete, asphalt or vegetated surfaces. However, numerous small scale studies have noted that the permeability of pavements can also have significant effects on the local surface energy balance. Due to the heterogeneous distribution of these pavements, they would be very difficult to simulate across an urban area. One potential solution could be the use of remote sensing, which has often been used to account for spatial heterogeneity in land surface models.

Aims

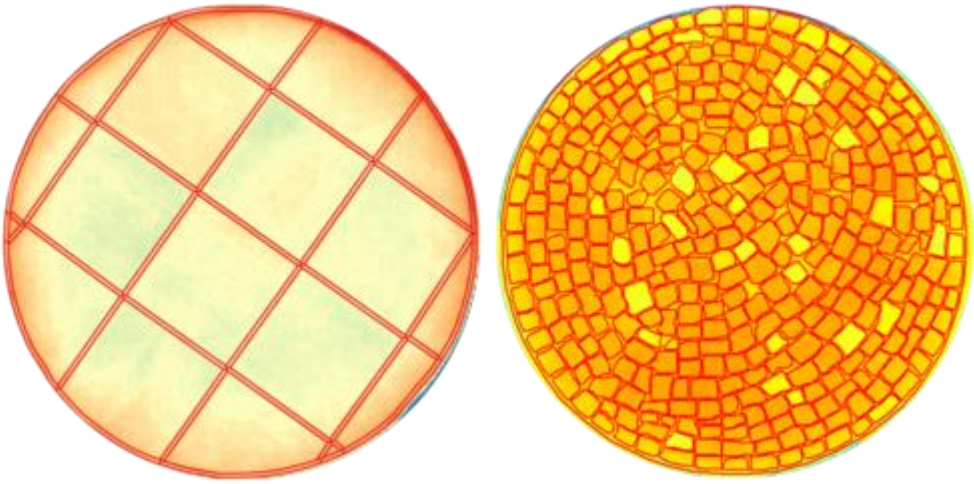
The main aim of this project is to investigate the utility of remote sensing information for assessing the heat fluxes of partially sealed surfaces in urban areas. Secondary aims include an assessment of the importance of spatial scale, a comparison of one and two dimensional modeling methods, and an assessment of the thermal dynamics of neighboring surfaces to partially sealed surfaces.

Methods

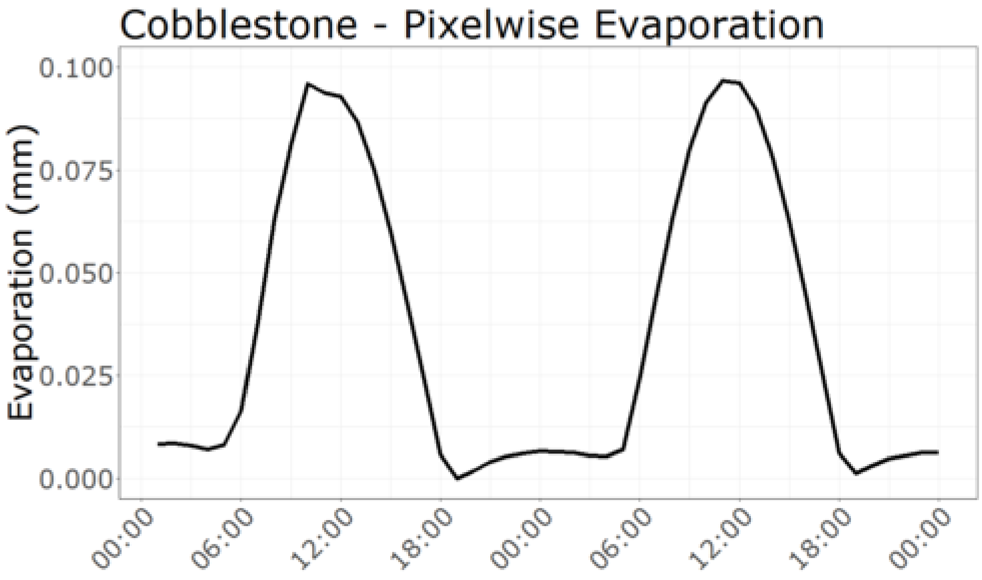
In general, surface energy balance methods are used in this project to determine heat fluxes in the different types of partially sealed surfaces. These methods vary somewhat by the respective scale of observation. At the small scale, a thermal camera is positioned over two lysimeters representing typical urban surfaces in Berlin. This camera collects ten minute imagery. Ground heat flux is validated using a Fourier-series-based temperature profile method using embedded sensors in the lysimeters, and evaporation is validated using the weighing lysimeters. At a larger scale, an unmanned aerial vehicle is used as a platform for the thermal camera, and imagery is collected in the spring, summer and fall over various types of partially sealed surfaces (again using the lysimeters as validation points). Solar radiation and other meteorological data are collected from a nearby tower.

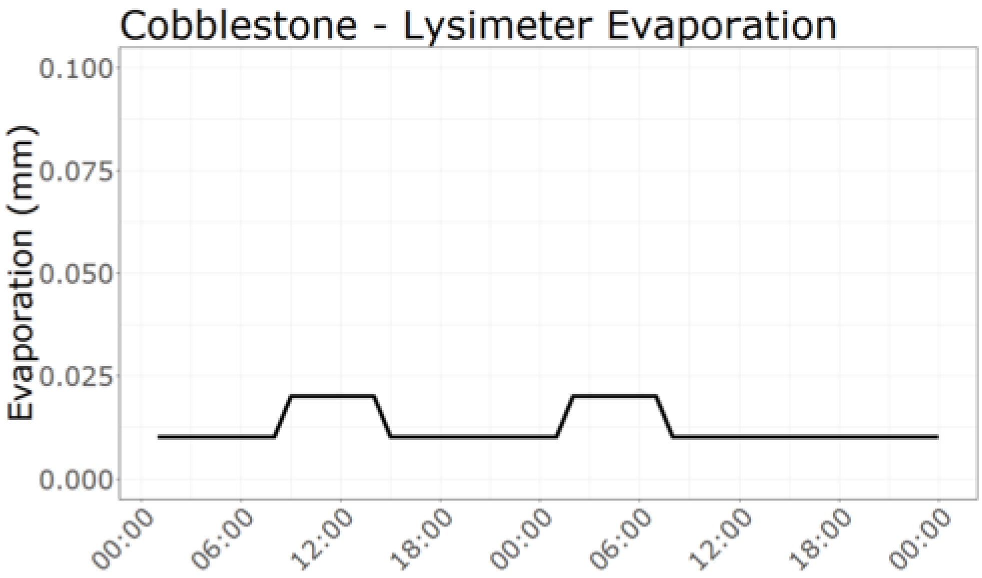


Tripod setup with lysimeter.



Thermal image of paved lysimeters with stone boundaries outlined in red.





Modeled versus actual evaporation.

Drone in flight.

Results

The first results suggest the difficulty in using remote sensing to determine latent evaporation in non-vegetated surfaces. The amount of evaporation which occurs in these surfaces is typically smaller than the amount of error in models used to estimate this evaporation. Therefore, this study will shift the focus more to the estimation of heat flux and the transition between one dimensional to two dimensional models using remote sensing data as a means to improve the parameterization of urban heat flux models.

Collaborations

Other UWI projects: T1

Common Topics: Urban soil - atmosphere interface, Modeling