Solar Energy and urban morphology, evaluation and mapping of the shading index and the Urban Heat Island at the city scale.

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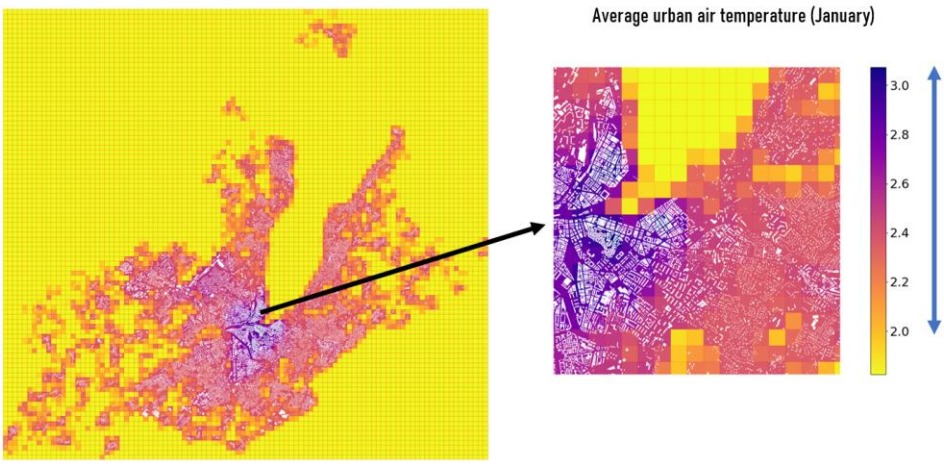
The massive deployment of solar energy in cities imply to have a better knowledge of the available resource as well as the operating conditions. In this work we will present two studies that aim at better understanding and modelling the resource and environmental conditions in cities.

Building rooftops represent one of the most valuable resources to harvest solar energy in cities. Nevertheless, this potential is limited by the urban morphology impacting the shading conditions. Here we present a general methodology to assess the impact of urban form on solar harvesting. To this aim, a new GIS-based approach is developed to extract meaningful morphological parameters at a very large scale.

The urban heat island (UHI) phenomenon, *i.e.* the increase of the urban air temperature compared to the rural surrounding areas, is a major issue for modern cities. It is mostly due to the urban distribution of the solar resource, (radiative properties of the urban fabric, thermal properties of the buildings, presence of green areas). Urbanization is responsible for an air temperature increase that may reach up to 12°C at the peak. This condition strongly increases the vulnerability of modern cities, impacting negatively building energy consumption, public health, air pollution, thermal comfort, ecosystems, economics, and productivity. Concerning solar energy, UHI negatively affect the efficiency of urban PV systems.
In the last decades, different types of Urban Climate Models have been proposed, ranging from the city
This study aims to evaluate and map the UHI phenomenon at the scale of the whole Canton of Geneva (about 300 km^2) identifying the different microclimate conditions through unsupervised clustering techniques. A specific clustering algorithm (Gaussian Mixture Model) is here used to quantitatively derive homogeneous local microclimate zones by grouping similar urban microclimate features (related to urban form, vegetation, human activity level, building materials and surface characteristics) into the same zone without resorting to an external classification. In the present study ten homogeneous microclimate zones have been detected in the Greater Geneva area through clustering and the urban microclimate parameters of each zone are used as an input to the Urban Weather Generator (UWG) model, a parametric tool capable of accurately predicting the urban air temperatures at the district level. The developed workflow consents to simulate the spatio-temporal variation of the UHI at the city-scale and on a yearly basis with the same accuracy as a local scale model and restricted computational time. The results evidence that the average intensity of the UHI is about 0.5-1°C in winter and 1.5-2.5°C in summer, with a variation of about 0.5°C depending on the local urban features. The results have been also experimentally validated towards two weather stations within the city of Geneva, evidencing an average error of about 0.15°C.
Finally, these macroscale model are used to extrapolate the future temperatures in cities, considering the global warming and the environmental strategies deployed by cities.

**Presenter*


Average urban air temperature (January)
3.0
2.8
2.6
2.4
2.2
2.0