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How can we improve the representation of cities in a climate model for East Africa?

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With more than 1.5 million inhabitants, the capital city of Kampala, Uganda, is one of the most populated areas in Sub-Saharan Africa. Moreover, with a growth rate of more than 4 percent, it is considered as one of the fastest growing cities on the planet. As current and future impacts of this urbanization on the regional climate is still unknown, some recent studies developed frameworks in order to apply urban climate models over this city. Brousse et al. (2019) uses the simple urban canopy scheme TERRA URB embedded in the COSMO-CLM model. Although this scheme has already proven its validity in several cases (Wouters et al., 2016; Demuzere et al., 2017), obtaining input parameters for the urban canopy model valid for Kampala is difficult. In fact, as urban climate models requires thermal and geometrical canopy input variables, Local Climate Zones are often considered as powerful tools for parameterization of the model following the WUDAPT framework (Ching et al., 2018). Yet the values extracted out of the ranges proposed by Stewart and Oke that were applied until now, are mostly derived out of Western cities. Therefore in order to improve the parametrization of the urban climate model and to validate the applicability of the LCZ scheme over East African cities, this study sets up a methodology for obtaining a novel range of parameters per LCZ class within the city of Kampala.

In situ data were obtained during a field exercise in the summer months of 2018. A representative sample of measuring points was selected along transects throughout the city of Kampala. This selection required a point coverage that is proportional to the spatial occurrence of each LCZ class. This sampling procedure permitted the acquisition of about 1300 measurement points. Measured variables consist of quantitative (road width, distance between houses, heights of buildings) and qualitatively estimated (vegetation fraction, road-wall-roof material) variables needed (in)directly by the urban parametrization scheme. Combining these measurements with the LCZ map created by Brousse et al. (2018) allow for the definition of a more trustworthy representation of the city of Kampala.

The new ranges obtained from the field campaign are thoroughly examined for each of the abovementioned parameters and compared with the defaults, focusing on physical explanations for statistically significant differences between LCZ classes. First, based on deviations from default settings, the potential effect of the tropical urban structure on the local climate is estimated. In a next step, the results of this study will serve as input for the urban parametrization scheme. Online coupled with a high resolution climate model, the effects of the newly defined urban presence on the regional climate in larger Kampala will be explored.