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Mesoscale modeling the influence of water bodies on the urban heat island and human thermal comfort

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Due to the combination of rapid global urbanization and climate change, urban climate issues are becoming more important. Compared to rural areas, the temperature in cities is enhanced due to changes in the radiation balance. These changes are caused by differences in the albedo and anthropogenic heat, as well as the reduced vegetation in urban areas and thus reduced evapotranspiration rates. It is hypothesized that the urban heat island might be mitigated by enhanced evaporation by adding open water in the urban design. This study uses the WRF mesoscale model to investigate this hypothesis, by designing an academic circular city in which the water cover, spatial configuration, and temperature is varied.
Model results indicate that the cooling effect of water bodies depends on the size and distribution of individual lakes within the city with respect to wind direction. Bigger lakes on average show a higher influence close to their edges and in downwind areas. Several smaller lakes equally distributed within the urban area have a smaller cooling effect, but they can influence a much higher percentage of the city. Evaporation from open water bodies may lower the temperature, but it may also increase the humidity. Consequently, higher air humidity lowers human comfort and therefore the human thermal comfort improves less than suggested by the temperature effect only. In addition, in cases when the water is warmer than the air temperature (as occurs in autumn or at night) the water body has the reverse effect. The water body ends up heating the surrounding city, thus negating the intention. The achieved knowledge may help urban designers to implement water bodies to the cities in not only esthetical but also a practical way.