Sensitivity of the TEB model to building parameters, urban planning and spatial distributions of natural areas in an urban area. The Paris area example during the 2003 heat wave.

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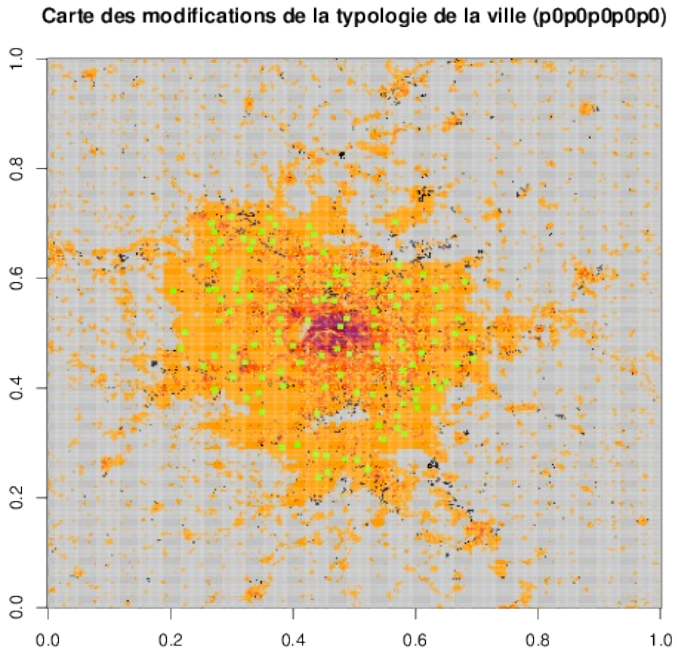
The study presented here aims at determining the most appropriate solutions, or elements of solutions, for city adaptation in future climatic changes, particularly during strong events as heat waves. The urban heat island (uhi) effect will receive special attention.

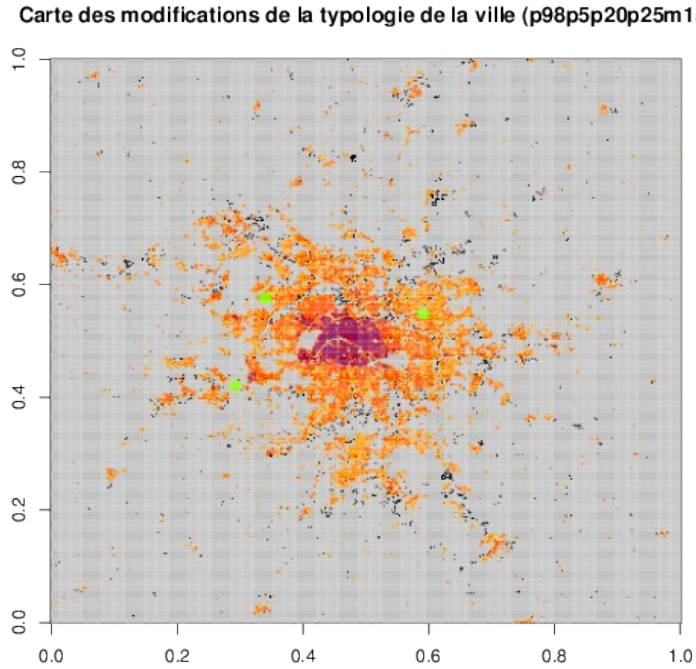
To achieve this goal numerical simulations of the energy balance of a city was performed with the TEB (Town Energy Balance) model designed at Météo-France. More particularly, we intend to investigate the sensitivity of this model to various sets of parameters describing cooling strategies. These include introduction of parks and lakes, city typology changes, material properties of walls, floors and roofs, albedos of external surfaces, roof greening, irrigation (gardens, streets), and heating/cooling temperature set point.

To illustrate the first two points, here are examples for parks and typology.



This first figure shows our initial urban area (Paris) where many parks have been introduced.

The second figure shows how typology transformations can modify the area. Here the city centre has been drastically densified ; consequently, the city is much less extended.



The simulations have been realized according a statistical experimental design based on a latin hypercube plan. Up to 24 TEB parameters are used to build the hypercube, and 500 simulations were performed on a supercomputer.

From the results given by the model (mainly 2D fields) scalar indicators are computed in order to estimate the main effects of the variability of the 24 parameters on the model. Among those indicators are the integrated (over the urban area) cooling energy or an estimation of the uhi between the hottest zone of the inner centre of the city and the coolest zone in the remote part of the urban area.

With each indicator scatter plots are realized and first order sensitivity coefficients are estimated from the linear regressions.

The figure below illustrate this kind of analysis.

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