



Comparing Deep Learning-based downscaling and the SURFEX land surface model on representing temperature extremes and the urban heat island in Paris

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Understanding and simulating urban climate processes, as well as how climate change affects cities is crucial for designing effective mitigation and adaptation strategies and policies. However, producing climate projections at the city scale requires very high-resolution physically-based models, which are computationally demanding and time-consuming to run. Deep Learning (DL) downscaling and offline simulations of land surface models offer cost- and time-effective alternatives.

Here, we present a comparison between DL-based downscaling and offline simulations performed using the SURFEX land surface model for the city of Paris, France. Two lightweight 3-layer Convolutional Neural Network (CNN) architectures are trained to downscale ECMWF ERA5 reanalysis for the 2004-2012 period. The CNNs generate hourly predictions of 2-meter temperature (T2m) at point-level (using data from 24 in-situ observational stations) and Land Surface Temperature (LST) at a spatial resolution of ~5 km, respectively. The SURFEX land surface model (versions 8.1 and 9.0) is run at two different spatial resolutions (5 km and 1 km) for the 2013-2022 period. DL and SURFEX output are compared in terms of their representation of T2m, LST, and their respective urban heat island (UHI), surface urban heat island (SUHI) and extremes, in present climate (2013-2022). DL-based downscaling presents improved performance metrics in relation to SURFEX. DL also presents a diurnal cycle closer to the observations. Both DL-downscaling and SURFEX replicate the Parisian UHI effect, described in previous studies and in the observational data used to train the CNNs. This work supports the use of DL-based downscaling for urban climate studies as a viable alternative to more computationally and time-heavy approaches.

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