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Explicit representation of cities in the ORCHIDEE land surface model

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Cities alter the interactions between the surface and the atmosphere by modifying energy and water budgets. This is caused by the low albedo of urban environments, its high thermal conductivity, the increased surface roughness, and by greater surface imperviousness. Since the beginning of the 21st century, advances in high-performance computing allowed steady refinement of the numerical grids of climate models at the kilometer scale. At this resolution, representing the urban environment explicitly is necessary, as simplifying it to bare soil no longer suffices for accurate energy and water budget assessments and satisfies e.g. the representation of heat waves or urban runoff. In the ORCHIDEE model of the IPSL, cities are currently represented as bare soil, which fails to account for specific urban processes. To enhance ORCHIDEE's performance and study the impacts of specific urban processes on energy and water fluxes, an urban land cover was added to the existing land cover classes taken into account by the model. For this urban class, we prescribed specific parameters for soil imperviousness (though hydraulic conductivity), surface roughness, albedo, and thermal conductivity. All those parameters are cell-dependent, i.e. they account for the diversity of urban environments and cities as characterized by the WUDAPT database (Ching et al., 2018). By comparing model simulations with and without the urban module, we assess the sensitivity of simulated turbulent fluxes, infiltration, soil moisture, runoff, drainage, temperature, and compare them to available observations over France.