



## **Plume or bubble? The interaction of urban heat island and city-scale atmospheric circulations**

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Large-scale circulations around a city are strongly influenced by the Urban Heat Island (UHI) and by regional wind patterns. Depending on the relative importance of these two factors, city-scale circulations fall into three different regimes: (1) plume regime where the wind advection is the dominant process in the atmosphere, (2) bubble regime where the atmospheric boundary layer (ABL) is mainly driven by the thermal convection generated by the UHI, and (3) the transitional regime where both wind advection and thermal convection play important roles in the ABL. The bubble regime is usually associated with low urban air quality due to recirculation of warm and polluted air parcels into the city; on the other hand, in the case of plume regime, the city is thought to experience more significant ventilation. In this study, we use large eddy simulations (LES) to probe these different possible flow regimes. First, we use dimensional analysis to reduce the problem to two controlling dimensionless parameters: (i) the ratio of convective velocities that contrasts urban and rural buoyancy fluxes, and (ii) the ratio of the average inflow velocity and the thermal convection velocity over the rural area. Then using LES and these parameters, we find the criteria for categorizing the circulations into the three regimes and elucidate the resulting differences in flow and ventilation patterns with implications for urban air quality.