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The signature of background climate and population on urban heat islands worldwide

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Cities modify the surface energy balance and generally increase air and surface temperatures compared to the surrounding rural land. City size and background climatic conditions such as precipitation have been shown to exert control on the intensity of urban heat islands (UHIs). However, it remains unclear whether changes in convection efficiency or climate-vegetation interactions cause the observed increase in UHI intensity with mean annual precipitation. A coarse-grained model that explicitly links urban population, global climate variability and urban-induced changes in surface temperature ΔT_s is introduced and tested on more than 30,000 cities. Data and model calculations reveal a nonlinear relation between urban warming and precipitation, largely controlled by energy and water limitations to evapotranspiration and changes in convection efficiency. By means of a sensitivity analysis, it is shown that the scaling of ΔT_s with city size is regulated by background climatic conditions. The efficiency of heat mitigation strategies aimed at increasing green cover and managing albedo is maximized in arid regions but declines with increasing precipitation. This outcome poses challenges to designing UHI mitigation strategies for tropical cities.