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The impact of rainfall on urban warming worldwide

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Abstract

Cities modify local climate and generally increase air and surface temperatures compared to the surrounding rural areas. Background climatic conditions have a strong impact on the intensity of urban warming but it is unclear whether changes in convection efficiency (Zhao et al. 2014) or climate-vegetation interactions (Gu and Li 2018) cause the observed increase in urban-rural surface temperature differences (ΔT_s) with mean annual precipitation (MAP). Here we present a global analysis of summertime urban heat islands and demonstrate that the linear ΔT_s – MAP relation proposed by Zhao et al. (2014) is valid only for low precipitation regimes. At the global scale, the sensitivity of urban warming to MAP is nonlinear due to different biophysical forcings that vary across climatic zones (Fig. 1). Specifically, the ΔT_s – MAP relation is largely controlled by urban-induced changes in evapotranspiration while rural albedo and convection efficiency explain the urban cooling effect observed in arid regions. Such a nonlinear response of urban warming to MAP has important implications for the design of climate-specific heat mitigation strategies.

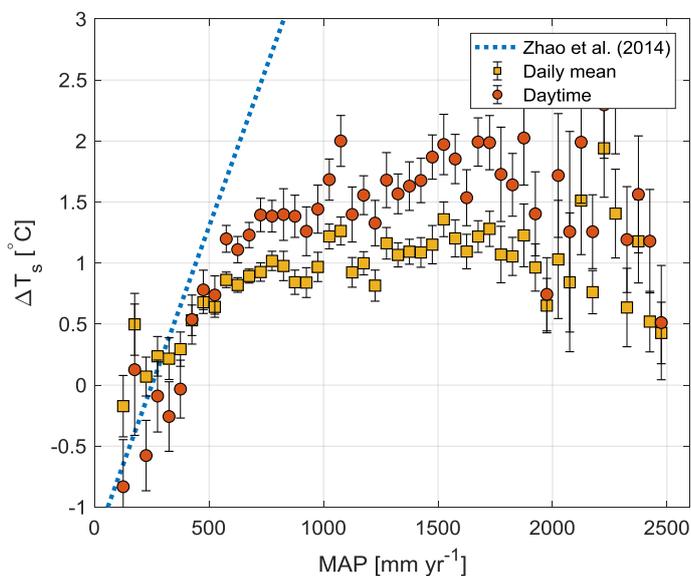


Fig 1: Urban-rural surface temperature difference (ΔT_s) as a function of mean annual precipitation (MAP). Binned data are presented by mean \pm SEM. The linear relation proposed by Zhao et al. (2014) is also plotted for reference.

References

Gu, Y., and Li, D. (2018). A modeling study of the sensitivity of urban heat islands to precipitation at climate scales, *Urban Climate*, 24, 982–993

Zhao, L., Lee, X., Smith, R. B., and Oleson, K. (2014). Strong contributions of local background climate to urban heat islands, *Nature*, 511(7508), 216.