Historical and future temporal trends in the summer Urban Heat Island of Athens (Greece)

Tim van der Schriek, Konstantinos V. Varotsos, Dimitra Founda, and Christos Giannakopoulos
1 Institute for Environmental Research and Sustainable Development, National Observatory of Athens, Athens, Greece (cgiannak@noa.gr)

Historical changes, spanning 1971–2016, in the Athens Urban Heat Island (UHI) over summer were assessed by contrasting two air temperature records from established meteorological stations in urban and rural settings. When contrasting two 20-year historical periods (1976–1995 and 1996–2015), there is a significant difference in summer UHI regimes. The stronger UHI-intensity of the second period (1996–2015) is likely linked to increased pollution and heat input. Observations suggest that the Athens summer UHI characteristics even fluctuate on multi-annual basis. Specifically, the reduction in air pollution during the Greek Economic Recession (2008-2016) probable subtly changed the UHI regime, through lowering the frequencies of extremely hot days ($T_{\text{max}} > 37 \, ^\circ\text{C}$) and nights ($T_{\text{min}} > 26 \, ^\circ\text{C}$).

Subsequently, we examined the future temporal trends of two different UHIs in Athens (Greece) under three climate change scenarios. A five-member regional climate model (RCM) sub-ensemble from EURO-CORDEX with a horizontal resolution of 0.11° (~12 × 12 km) simulated air temperature data, spanning the period 1976–2100, for the two station sites. Three future emissions scenarios (RCP2.6, RCP4.5 and RCP8.5) were implanted in the simulations after 2005. The observed daily maximum and minimum air temperature data ($T_{\text{max}}$ and $T_{\text{min}}$) from two historical UHI regimes (1976–1995 and 1996–2015, respectively) were used, separately, to bias-adjust the model simulations thus creating two sets of results.

This novel approach allowed us to assess future temperature developments in Athens under two different UHI intensity regimes. We found that the future frequency of days with $T_{\text{max}} > 37 \, ^\circ\text{C}$ in Athens was only different from rural background values under the intense UHI regime. There is a large increase in the future frequency of nights with $T_{\text{min}} > 26 \, ^\circ\text{C}$ in Athens under all UHI regimes and climate scenarios; these events remain comparatively rare at the rural site.

This study shows a large urban amplification of the frequency of extremely hot days and nights which is likely forced by increasing air pollution and heat input. Consequently, local mitigation policies aimed at decreasing urban atmospheric pollution are expected to be also effective in reducing urban temperatures during extreme heat events in Athens under all future climate change scenarios. Such policies therefore have multiple benefits, including: reducing electricity (energy) needs, improving living quality and decreasing heat- and pollution related illnesses/deaths.