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Urban warming and air-conditioning use in a future climate: Evidence of a positive feedback

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Here we reveal that a positive feedback occurs caused by the interaction between urban warming and air-conditioning (AC) use when future urban climate projections are explored. A pseudo global warming (PGW) projection was undertaken with dynamical downscaling methods to 1 km (horizontal resolution) using a regional climate model coupled with an urban canopy model and a building energy model (RCM-UCM+BEM). Simulations undertaken included current climate and six future climates that are background temperature increases (global warming: ΔTgw) from current climate (+0.5 ºC, +1.0 ºC, +1.5 ºC, +2.0 ºC, +2.5 ºC, and +3.0 ºC) from global climate models (GCMs) simulation with IPCC the highest greenhouse gas emissions scenario (RCP8.5). The focus is for the Asian megacity of Osaka during August, which is a period that already has extreme AC use. The results show that anthropogenic heat emission from AC use (Qf, AC) are predicted to increase linearly from current to future climates with their increased ΔTgw. Additional urban warming (ΔTuw, CTRL) has a linear trend, especially at night with a slope (ΔTuw, CTRL /ΔTgw) of $\sim$1.42 ºC ºC^{-1}, which is higher than predicted when the projections do not include feedback ($\sim$1.18 ºC ºC^{-1}). The feedback impact on urban temperature is estimated up to about 20% of at +3.0 ºC climate. This result suggests that previous future projection studies (without feedback) possibly underestimate urban warming when ΔTgw is relatively large. Given the linear increase, it suggests that a simple parameterisation may be useful for estimating conditions that should be considered for assessing future impacts for mitigation of the urban heat island and adaptation of climate change in megacities.