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Mitigating the influence from AC heat release on urban microclimate using Photonic Cooling technologies

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The observed warming trend in regional climate is expected to continue in the future, aggravating urban heat loads and reducing human comfort as extreme temperatures are amplified in cities due to the urban heat island (UHI) effect. Next to adverse health effects, this development results in an increase in urban air conditioning (AC) usage, again negatively influencing the outdoor urban microclimate due to AC waste heat release. Photonic cooling, a technology where radiative materials are used that reflect and/or transmit shortwave solar radiation and have high emission for thermal radiation (8 to 13 μm) to space hence maintaining a temperature significantly below the ambient temperature, could potentially be used as an alternative building cooling technique and help mitigate UHI development due to anthropogenic AC heat release. The exploratory project 'Photonic Cooling', funded by the Austrian Research Promotion Agency through the 'City of the Future' program, aims at evaluating the potential of practical and cost-effective photonic cooling techniques for the cooling of buildings, using Vienna as a case study. To quantify the future development of the Viennese UHI, the resulting changes in cooling demand and its effect on urban temperatures, a modelling approach is used. On the basis of simulations with the MUKLIMO_3 urban climate model for the city of Vienna, using EURO-CORDEX regional climate model runs for different representative concentration pathways as inputs, changes in urban temperature for the 2021-2050 period relative to the 1971-2000 period are determined. These results are then used as input for an empirical model to determine future cooling demand in terms of AC electricity use in buildings. Based on urban modelling results, a relation between AC heat release and urban temperature increase is established. Combined with the modelled future cooling demand this information is used to quantify the influence from conventional AC systems on the urban microclimate, illustrating the benefit of using passive photonic cooling techniques to cover cooling demands instead.