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# The contribution of urbanization to recent extreme heat events and white roof mitigation strategy in the Beijing-Tianjin-Hebei metropolitan area

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The UHI effect can aggravate summertime heat waves and strongly influence human comfort and health, leading to greater mortality in metropolitan areas. Many geo-engineering technological strategies have been proposed to mitigate climate warming, and for the UHI, increasing the albedo of artificial urban surfaces (rooftops or pavements) has been considered a lucrative and effective way to cool cities. The objective of this work is to quantify the contribution of urbanization to recent extreme heat events of the early 21st century in the Beijing-Tianjin-Hebei metropolitan area, using the mesoscale WRF model coupled with a single urban canopy model and actual urban land cover datasets. This work also investigates a simulation of the regional effects of white roof technology by increasing the albedo of urban areas in the urban canopy model to mitigate the urban heat island, especially in extreme heat waves.

The results show that urban land use characteristics that have evolved over the past ∼20 years in the Beijing-Tianjin-Hebei metropolitan area have had a significant impact on the extreme temperatures occurring during extreme heat events. Simulations show that new urban development has caused an intensification and expansion of the areas experiencing extreme heat waves with an average increase in temperature of approximately 0.60°C. This change is most obvious at night with an increase up to 0.95°C, for which the total contribution of anthropogenic heat is 34%. We also simulate the effects of geo-engineering strategies increasing the albedo of urban roofs. White roofs reflect a large fraction of incoming sunlight in the daytime, which reduced the net radiation so that the roof surface keep at a lower temperature than regular solar-absorptive roofs. Urban net radiation decreases by approximately 200 W $m^{-2}$ at local noon because of high solar reflectance of white roofs, which cools the daytime urban temperature afer sunrise, with the largest decrease of almost -0.80°C at local noon. Moreover, the nighttime temperature also shows slightly cooler, approximately 0.2°C, because there is still considerable heat which is stored in the daytime released from urban surfaces at night. The results also suggest that increasing the albedo of urban roofs can reduce the urban mean temperature by approximately 0.51°C during summer extreme heat events. In urban areas, white roofs can counter 80% of the heat wave results from urban sprawl during the last 20 years. These results suggest that increasing the albedo of roofs in the Beijing-Tianjin-Hebei metropolitan area is an effective way of countering some hazards of heat waves.

Using a regional climate model, we proposed that white roofs may be an effective strategy to complement urban heat wave mitigation efforts as a way of further slowing the rate of global temperature increase in response to continued greenhouse gas emissions.