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Effects of spatiotemporal changes in anthropogenic heat emission on 14-km resolution global climate

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This study contributes to the growing body of research on improving urban representation in climate models by investigating the global impacts of anthropogenic heat emissions (AHE). Since the 1970s, it has been recognized that AHE from urban areas can influence the global climate. Recent regional climate models (RCM) have confirmed the significance of AHE in forming urban heat islands. The objectives of this work are twofold: to develop two methods for incorporating an anthropogenic heat emission dataset into a Global Climate Model (GCM), and to test the impacts of AHE on the whole Earth by analyzing multiple short-term time-lagged "branch" ensembles. The approach is designed to be applicable to any geospatial dataset of AHE and GCM. The study uses the Nonhydrostatic Icosahedral Atmospheric Model (NICAM) as the GCM, which was modified to read hourly inputs of AHE in units of W/m^2 . The surface modules pertaining to land were also modified to consider AHE as excess sensible heat, set either from the surface driver or from the land surface model. The global climate for July 2023 was modeled using the Tsubame supercomputer at a resolution of 14 km. Multiple time-lagged branches were generated starting from a month-long control case that does not consider AHE. After filtering out internal variabilities using ensemble statistics, it was found that air temperatures increased globally. While the study agrees with previous RCM studies, this study finds that the AHE's influence propagates to wider areas after a day, beyond typical boundaries of RCMs. This work provides a potential link between the common gaps in scale between urban climate and global climate studies.

