Anthropogenic heat effects on simulated global climate using the Community Earth System Model

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Abstract

Rapid urbanization and human activities are leading to increases in emissions of heat and pollutants, collectively known as anthropogenic emissions. While the global effects of pollutants and greenhouse gas emissions are studied rather extensively, the global effects of anthropogenic heat emissions (AHE) are yet to be deeply understood.

To better understand the effects of AHE on global climate, a recent global AHE dataset is prescribed as boundary inputs into an earth systems model to overcome the shortcomings of a simplified bottom-up building energy model (BEM), which makes simple assumptions by regarding anthropogenic heat emission release into the atmosphere as functions of target indoor temperatures and simulated outdoor temperature. By introducing *AH4GUC* [1] as forcing data into the Community Earth System Model (CESM) [2] and comparing the results with the default case that uses BEM, the performance of the approach could be verified.

Using the updated CESM with the FHIST component set (i.e. land and atmospheric models are coupled with the other models such as oceans as prescribed), hourly simulations were conducted in order to investigate the effects of the diurnal AHE in the simulated global meteorology. It can be seen that in the initial days of the simulation, the direct regional effects could be seen but after a month since the simulation, the AHE shows a more synoptic effect with mid-latitude regions showing alternate warming and cooling patterns. The patterns were further investigated using Self-Organized Maps (SOM) [3], a machine-learning model. Further investigation are needed by running the model with perturbed conditions and other years to confirm consistency in the pattern effects of AHE. By showing how the clusters are distributed along time, it was found that AHE travels following specific patterns, at least in a coupled simulation environment. Moreover, the effects of non-linearity of the system was demonstrated and distinguished from the noise.

This research provides new understanding of the effects of AHE on global climate and potentially offers insights into how to control its impact. The methodology used in this research can be used as a framework for further studies and can contribute to improvements of AHE in global simulation models.

References

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