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Urban Heat Has Large-scale Climate Effects

Researchers find that heat given off by metropolitan areas is enough to influence winter warming

Guang Zhang

The heat generated by everyday activities in metropolitan areas has a significant enough warming effect to influence the character of the jet stream and other major atmospheric systems during winter months, according to a trio of climate researchers.

Led by Guang Zhang, a research meteorologist at Scripps Institution of Oceanography, UC San Diego, the scientists report in the journal Nature Climate Change that the extra heat given off by Northern Hemisphere urban areas causes as much as 1 degree C (1.8 degrees F) of warming in winter. They added that this effect helps explain the disparity between actual observed warming in the last half-century and the amount of warming that computer models have been able to account for.

“What we found is that energy use from multiple urban areas collectively can warm the atmosphere remotely, thousands of miles away from the energy consumption regions,” said Zhang. “This is accomplished through atmospheric circulation change.”

The study, “Energy consumption and the unexplained winter warming over northern Asia and North America,” appears in online editions of the journal Jan. 27. The National Science Foundation, the U.S. Department of Energy, and NOAA supported the research.

Zhang, along with Ming Cai of Florida State University and Aixue Hu of the National Center for Atmospheric Research in Boulder, Colo., considered the energy consumption - from heating buildings to powering vehicles - that generates waste heat release. The world’s total energy consumption in 2006 was 16 terawatts (one terawatt equals 1 trillion watts). Of that, 6.7 TW were consumed in 86 metropolitan areas in the Northern Hemisphere.

Ming Cai. Photo: FSU Photographer Services/Bill Lax

The release of waste heat is different from energy that is naturally distributed in the atmosphere, the researchers noted. The largest source of heat, solar energy, warms Earth's surface and atmospheric circulations distribute that energy from one region to another. Human energy consumption distributes energy that had lain dormant and sequestered for millions of years, mostly in the form of oil or coal. Though the amount of human-generated energy is a small portion of that transported by nature, it is highly concentrated in urban areas. In the Northern Hemisphere, many of those urban areas lie directly under major atmospheric troughs and jet streams.

Zhang said the effect his team studied is distinct from the so-called urban heat island effect, an increase in the warmth of cities compared to unpopulated areas caused by human activities.

Aixue Hu. Photo: NCAR

The authors report that the influence of urban heat can widen the jet stream and strengthens atmospheric flows at mid-latitudes. They add that the warming is not uniform. Partially counterbalancing it, the changes in major atmospheric systems cool areas of Europe by as much as 1 degree C, with much of the temperature decrease occurring in the fall.

Overall, these changes have a noticeable but slight effect on global temperatures, increasing them worldwide by an average of about 0.1 degree C.

The study does not address whether the urban heating effect disrupts atmospheric weather patterns or plays a role in accelerating global warming, though Zhang said drawing power from renewable sources such as solar or wind provides a societal benefit in that it does not add net energy into the atmosphere.

The authors also contend that the urban heat effect accounts for the discrepancy between observed warming and winter warming simulated in the models used by the climate science community for analysis and prediction of climate. They suggest that the influence of energy consumption accompany heat-trapping gases and aerosols as necessary variables in computer models.

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