The Global Warming Is Real

An analysis of the effect of urban growth on U.S. climate records shows that a century of global warming is real; the magnitude of future warming remains uncertain

UNCERTAINTIES ABOUND concerning the magnitude of the coming greenhouse warming (*Science*, 6 January, p. 28), but most climatologists are now confident that the warming of the past century is real and not the product of an error in climate records, such as the progressive warming due to growing urban areas. In coming years the increasingly refined long-term climate record will be crucial in helping scientists decide how big a problem the greenhouse warming is going to be.

A nagging problem with the world's climate records has been the error due to growing towns and cities encroaching on weather stations. Cities are simply hotter than the countryside. In the fall, frost warnings go out first to the suburbs and only later to center city. Concrete, asphalt, and roof tops are not the same as trees, bushes, and grass. Vegetation evaporates water through its leaves, cooling the surface. Concrete has no leaves, and it absorbs and stores heat far more efficiently than does vegetation. This makes no difference to those looking for long-term temperature trends as long as the extent of urbanization around a weather station does not change. But if the city encroaches, the station will gradually warm, much as if the greenhouse were at work.

The so-called urban heat island effect has been the last type of error purged from one of the best regional climate records, the United States Historic Climate Network. Recently, Thomas Karl of the National Climatic Data Center in Asheville and his colleagues corrected the observations from all 1219 stations in the Historic Climate Network for the heat island effect. They compared each station with a nearby, rural station, that is, one near a population center of less than 700 persons. From these comparisons they developed an equation predicting the heating effect on the basis of current population alone.

In the United States, urbanization has noticeably warmed some towns with populations as small as 10,000 or less. But between 1901 and 1984, the expansion of urban heat islands had a minor effect on the Historic Climate Network, a warming of about 0.06°C. That is because its stations have remained predominantly rural.

Ideally, the same sort of analysis should be carried out on the stations used to estimate the globe's temperature during the past century. But the required pairs of rural and urban stations are not available. Instead,

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New York did not help create the global warming.

Philip Jones and his colleagues at the University of East Anglia and Karl have applied the Historic Climate Network relationship between population and the heat island effect to the U.S. stations used by the East Anglia group in estimating Northern Hemisphere landmass temperatures. They found that, according to the equation, the warm bias in the East Anglia set of stations over the period 1920 to 1980 was about 0.1° ± 0.05°C.

The next step was the extrapolation of the population-urbanization relationship in the United States to the entire Northern Hemisphere landmass. This could be only a "preliminary assessment of the scale of the urbanization effect" because the relationship must vary from place to place with the urban growth rate, the mix of building types, the proportion of paved area, local climate, and many other factors.

The East Anglia group and Karl estimated a range for the bias in the hemispheric data by first assuming that the U.S. heat island bias applies everywhere, giving a maximum bias of 0.1°C, and then that there is a heat island effect only in the 12% of the landmass represented by the United States, which gives a minimum bias of 0.01° to 0.02°C. By their best estimate, about 40% of the network—not 100% or 12% as assumed in their calculation of the range—would be affected by larger, growing heat islands. The true bias, the group thus reasons, must fall within the range of 0.01° and 0.1°C.

Jones and his coauthors conclude that "urbanization is unlikely to account for a substantial proportion of the warming trend" of the Northern Hemisphere landmass, which amounts to 0.32°C over the 20th century. The global warming over land was about 0.4°C during the past 100 years. They also note that similar warming trends have been found in records of sea surface temperatures in both hemispheres.

Not everyone shares that near certitude. Karl, for one. He had raised concerns about the contribution of urbanization to the East Anglia warming trend after it was published in 1986. Although he is a coauthor on the most recent paper, he still believes that the bias could be larger than 0.1°C. But no reasonable bias could explain away the warming entirely. "The long-term global warming is something on the order of 0.4°C during the past century," he says. "Is the bias 0.05° or 0.2°C? The chances that it is the same size as the warming are pretty remote. It's a matter of adjusting the rate of rise, not questioning the rise itself."

At several tenths of a degree, the past century's warming is just consistent with predictions made by models that are the least sensitive to greenhouse gases. More sensitive models—the ones predicting a large, especially rapid warming by the mid-21st century—call for a far larger warming by now than observed.

■ RICHARD A. KERR

ADDITIONAL READING

P. D. Jones, P. M. Kelly, C. M. Goodess, T. R. Karl, "The effect of urban warming on the Northern Hemisphere temperature average," *J. Climate*, in press.

T. R. Karl, H. F. Diaz, G. Kukla, "Urbanization: its detection and effect in the United States climate record," *J. Climate* 1, 1099 (1988).