Earth Science

Discrepancies in global warming data

The Earth has warmed substantially over the last century. That's what scientists conclude when they look at several temperature records compiled by separate teams, all showing a similar degree of global warming. But a new analysis of the separate records reveals that the data do not agree in their details, raising questions about whether scientists can use these records to decipher the cause of the warming.

"All these records turn out to be different, which means that we cannot really rely on [them]," says Anastasios A. Tsonis of the University of Wisconsin-Milwaukee.

He and James B. Elsner of Florida State University in Tallahassee compared three records of average annual temperatures in the northern hemisphere, compiled over the past 97 years. Previous comparisons, using standard statistical techniques, showed a high degree of consistency among the records. But Tsonis and Elsner contend those techniques do not work well with such small data sets. Instead, they used a newer statistical technique called bootstrapping (SN: 7/27/91, p.56), which they call ideal for studying small data sets. From each of the temperature records, a computer generated 1,000 sets of simulated data. Tsonis and Elsner then compared the averages of those sets. In the July GEOPHYSICAL RESEARCH LETTERS, they report that the bootstrap procedure uncovered significant discrepancies among the three records.

The long-term warming trend seen in each record is real, Tsonis says, but he now questions the veracity of the finer details – the shorter-term warmings or coolings in the records. Without such confidence, he says, it's impossible to tell whether the long-term warming results from a natural fluctuation in the climate or from the greenhouse gases accumulating in the atmosphere.

James Hansen, a climate expert at NASA's Goddard Institute for Space Studies in New York City, contends that the new findings merely point out that the records contain inherent uncertainties, a problem already recognized by researchers. Despite the uncertainties, he and other climatologists believe the records contain reliable information.

Tsonis and Elsner argue, however, that the records may not be as trustworthy as scientists think.

Lower levels of atmospheric cleanser

Hydroxyl radicals (OH) play the role of atmospheric janitor: They react with scores of gases, removing both pollution and natural compounds from the air. They reduce the levels of certain greenhouse gases and also some ozone-harming chemicals. But new research indicates that scientists have overestimated global levels of OH.

Atmospheric concentrations of OH change so rapidly that chemists cannot assess its levels by measuring the compound itself. Instead, they calculate its concentrations by gauging levels of methyl chloroform, a pollutant that reacts with OH. The less methyl chloroform, the higher the OH level.

This approach is based on the assumption that the OH reaction is the only one removing methyl chloroform from the atmosphere. However, measurements made in the tropical Pacific now show that reactions in the ocean also reduce atmospheric methyl chloroform, reports James H. Butler of the National Oceanic and Atmospheric Administration in Boulder, Colo. The new findings reveal that global OH levels range 5 to 10 percent lower than once thought – an indication the atmosphere cannot clean itself of key pollutants as quickly as experts had believed. The revision will affect current efforts to replace ozone-destroying chlorofluorocarbons with less destructive industrial chemicals. If the substitutes survive longer in the atmosphere than previously assumed, they will harm the ozone layer more than scientists had estimated, Butler warns.

Health Physics

Janet Raloff reports from Washington, D.C., at the annual meeting of the Health Physics Society

What makes nuclear shipping casks weep?

Highly radioactive wastes are shipped by truck and rail in thick, carefully sealed stainless steel casks. Federal regulations allow these casks to travel with trace quantities of removable external contamination. But about 10 years ago, cask recipients began documenting a puzzling phenomenon: Even meticulously cleaned casks, shipped out with only one-tenth the allowed level of external contamination, would sometimes arrive with up to 10 times the federal limit.

Tests at the University of Missouri in Columbia now indicate that the surface of a newly cleaned cask typically carries 100 times more chemically bound ("fixed") contamination than removable contamination. And while most of the removable contaminants wash off, some of the fixed cesium and cobalt becomes unfixed, or "weeps," during transport, notes program director Phil C. Bennett of Sandia National Laboratories in Albuquerque, N.M.

The new tests also show that soaking the steel casks at a low pH tends to cause cobalt to free itself from the surface and go into solution, Bennett says. Although casks are routinely soaked during and after loading in storage pools of spent fuel, these pools are not acidic enough to cause weeping. But Bennett suspects that acid rain or wet, acidic road dirt might trigger cobalt weeping on traveling casks.

The weeping detected on one dry sample of cask material stored for five months suggests that diffusion may act as a slower release process, he adds. However, the major factor behind cesium weeping, which accounts for half to two-thirds of the transit-induced removable contamination, "remains elusive," Bennett says. "We're attacking this problem with all the vigor we've got."

Wood ash: The unregulated radwaste

While cleaning ashes from his fireplace two years ago, Stewart A. Farber mused that if trees filter and store airborne pollutants, they might also harbor fallout from the nuclear weapons tests of the 1950s and 1960s. On a whim, he brought some of his fireplace ash to Yankee Atomic Electric Co.'s environmental lab in Bolton, Mass., where he manages environmental monitoring. Farber says he was amazed to discover that his sample showed the distinctive cesium and strontium "signatures" of nuclear fallout – and that the concentration of radioactivity "was easily 100 times greater than anything [our lab] had ever seen in an environmental sample."

Since then, he has obtained wood-ash radioactivity assays from 16 other scientists across the nation. These 47 data sets, representing trees in 14 states, suggest that fallout in wood ash "is a major source of radioactivity released into the environment," Farber says. With the exception of some very low California readings, all measurements of ash with fallout-cesium exceeded – some by 100 times or more – the levels of radioactive cesium that may be released from nuclear plants (about 100 picocuries per kilogram of sludge). Ash-cesium levels were especially high in the Northeast – probably because naturally high levels of nonradioactive cesium in the soil discourage trees from releasing fallout-derived cesium through their roots, he says.

Industrial wood burning in the United States generates an estimated 900,000 tons of ash each year; residential and utility wood burning generates another 543,000 tons. Already, many companies are recycling this unregulated ash in fertilizers. The irony, Farber says, is that federal regulations require releases from nuclear plants to be disposed of as radioactive wastes if they contain even 1 percent of the cesium and strontium levels detected in the ash samples from New England. If ash were subject to the same regulations, he says, its disposal would cost U.S. wood burners more than $30 billion annually.