fense Council suggests the formula might take into account both GNP and population, but adds that reaching international agreement would require lengthy negotiations.

There are some other nasty wrinkles that could complicate the process of adjusting the emission credits. Should an energy-efficient nation such as Japan, which releases relatively little greenhouse gas into the environment, be rewarded with additional credits? Should a nation that relies on nuclear power and therefore is also a small emitter—like France—get extra credits? Should Brazil, whose copious forests absorb carbon dioxide, be rewarded for that?

Even if the world's countries could agree on a standard, monitoring and enforcement would be difficult, according to Paul Portney of Resources for the Future. Controlling sulfur dioxide by trading rights is manageable because there are relatively few sources to monitor, Portney says. It would be much harder, he adds, to police the diverse sources of greenhouse gases, which include innumerable industrial boilers around the world—and even cows and rice paddies, which give off substantial quantities of the greenhouse gas methane.

William Nitze, who was the State Department's deputy assistant secretary for environment, health, and natural resources until his departure this month, favors experimenting at a national and bilateral level before attempting to devise an international system. Nitze adds, "I don't think you can go too far with the concept of emissions trading without setting a target and a timetable [for reducing emissions] first."

Robert Hahn, an economist at the American Enterprise Institute, argues that the scheme has been a successful domestic regulatory tool. But emissions trading on a global scale is simply too complex to manage, Hahn says. He thinks "politics is driving this proposal." Hahn says that to answer critics who say the Administration has been sluggish on global warming, "the President has to propose something at the IPCC."

Officials from at least one country agree in part with Hahn. According to Yasu-hiro Shimizu, environmental attaché at the Japanese embassy, "there is a general feeling among Japanese officials that emissions trading would be too complex to be effective."

Others are less critical. Rafe Pomerance of the World Resources Institute acknowledges emissions trading would be complex, but feels the proposal is "a constructive thing." Administration officials have previously said global warming was too little understood to do anything substantive yet. At least now, Pomerance says, the Administration "is talking about doing something."

■ MARJORIE SUN

Global Warming Continues in 1989

The greenhouse decade closed out with a strong showing. Nineteen eighty-nine ranks as one of the warmest years on record despite the chill of unusually cool water in the tropical Pacific, say climatologists Philip Jones and David Parker in their second annual report on the global temperature. The continued robustness of the warming trend that began in the mid-1970s lends support to claims that an intensifying greenhouse effect is behind it all, although that case has not yet been made definitively. Even at the current rate of global warming, says Jones, who works at the University of East Anglia in Norwich, "it will take another 10 years or so to be confident" that the greenhouse effect is with us.

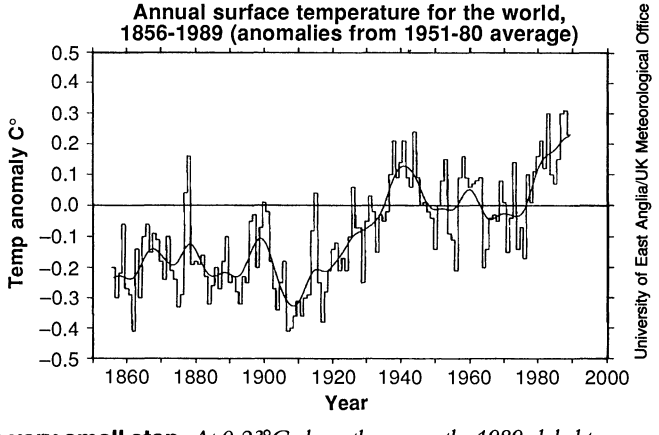
But there is little doubt that 1989 was a warm year, according to the surface temperatures compiled by Jones and by Parker, who is with the British Meteorological Office in Bracknell. Their results show the globe to have been 0.23°C warmer last year than during the reference period of 1951 to 1980. For comparison, the entire warming during the 134 years for which they have compiled temperature records amounts to less than 0.5°C. So the recent excess warmth is considerable; it makes 1989 the fifth warmest year in the record. The decade as a whole was hot too, standing at 0.2°C, or two standard deviations, above the reference period. Six of the ten warmest years on record fell in the sizzling 1980s.

The last year of the 1980s maintained the decade's warmth despite a strong push from the tropical Pacific Ocean toward the cold side. The temperature of the surface waters west of Peru along the equator has a strong effect on air temperatures around the globe, and especially in the tropics. When tropical waters warm during an El Niño, the global air temperature tends to rise about 6 months later. A sea surface cooling, called a La Niña, has the opposite effect.

A strong La Niña cooling, the first since 1975, arrived in mid-1988, just in time to cool the atmosphere during all of 1989. Jones estimates, from the effects of the El Niño–La Niña cycle in the past, that this La Niña would have made 1989 about 0.1°C cooler than 1988, which was the warmest year in the record. And that is just what happened. That La Niña's cooling did not break the warm spell, sending the global temperature back near normal, suggests that an increasing abundance of heat-trapping greenhouse gases could be behind the warming during the past 15 years.

Although the global warming trend is consistent with an increasing contribution by the greenhouse effect, direct signs that the greenhouse effect is intensifying are still hard to come by in the temperature record. Greenhouse models agree that if that is happening, the temperature increase should be most pronounced around the Arctic. Jones sees no such consistent pattern. Alaska, northwestern Canada, and northern Siberia warmed sharply in the 1980s, but the region from eastern Canada through Greenland and into Scandinavia cooled markedly.

The scarceness of corroborating signs aside, Jones retains a strong gut feeling about the recent temperature trend. "Personally, I still think the greenhouse is the most likely cause" of the global warming, he says. "The more there are of these warm years, the more the skeptics will have to find excuses." ■ RICHARD A. KERR



One very small step. *At 0.23°C above the mean, the 1989 global temperature falls short of a record but maintains the warming trend of the past 15 years.*