

Environment -- Heating Up: Atmosphere, Debate

By [Bill Dietrich](#)

One thing is clear in the confusing debate over global warming: The atmosphere has heated up in the past 100 years. That's about where agreement ends. Research continues to show how complex a question the trapping of greenhouse gases is.

Four years ago, NASA's James Hansen startled Congress - and surprised some of his fellow scientists - by testifying that he believed global warming had already started.

Since Hansen gave his warning, the world has recorded the three warmest years on historical record. Here in Seattle, residents just enjoyed the warmest winter ever.

Thus it seems an appropriate time to check back on whether the director of NASA's Goddard Institute for Space Studies is being proved right.

There is no unanimity among scientists. But most agree the world has warmed up by about 1 degree over the past century, that the past decade has been unusually toasty, and that more of the same is probably on the way.

Scientists believe the warming can be linked to the increase of "greenhouse gases" such as carbon dioxide and methane put into the atmosphere by human burning, industry and farming. These gases help trap the sun's heat that would otherwise leak back into space.

How much warming will come remains highly uncertain, however, as is the question of whom it will harm or help. In general, new information has persuaded scientists to back away from the most catastrophic forecasts of flooding seas, melting ice caps and instant deserts.

Trying to find evidence of global change in local weather is difficult. For example, this winter's temperatures, which averaged about 4 degrees above normal, were caused not by greenhouse warming but by the periodic El Nino effect, which shifts warm water in the equatorial Pacific every half dozen years or so. That shift affects weather patterns in the

western U.S., typically warming us and drenching Southern California and Arizona.

Yet even El Nino is being watched carefully as a potential clue to larger changes. Warren Washington, a scientist at the National Center for Atmospheric Research in Boulder, Colo., says some computer simulations suggest global warming could increase the frequency and severity of El Ninos.

Hansen's warning drew enormous media attention when he gave it in 1988 because Washington, D.C., was gripped in a heat wave, the Midwest was plagued with drought and Yellowstone Park caught fire.

Since then, scientists have concluded that 1990 was globally the warmest year of the past century and that 1991 - cooled in part by the atmospheric dust thrown out by the Philippines' Pinatubo volcano - was second warmest. The next warmest years, in order, were 1988, 1987, 1983, 1981, 1980, and 1986.

One mystery - perhaps solved by University of Washington scientist Robert Charlson - is why the globe has not already heated up as much as greenhouse predictions would predict. While the amount of warmth-trapping carbon dioxide in the atmosphere has climbed about 30 percent since pre-industrial times, one exhaustive study failed to find any evidence that the U.S. has gotten warmer at all in the past century. Other studies suggest that worldwide temperatures have risen roughly 1 degree, still less than expected.

Charlson suspects the same hazy pollution that is adding greenhouse gases is reflecting sunlight back into space, temporarily masking greenhouse effects. "Should we think of this as a benefit of dirty air?" asks Charlson. "No. It just shows how complex the system is."

Meanwhile, there is no dispute we are continuing to change our blanket of air by pumping greenhouse gases out of everything from car tailpipes to rice paddies and continuing to leak chemicals called chlorofluorocarbons that break down its protective ozone layer.

(While the greenhouse and ozone problems both involve our atmosphere, the two are different. Global warming is caused by the addition of gases to the atmosphere that trap the sun's heat. Ozone depletion is caused by a chemical breakdown of the ozone molecules that intercept ultraviolet radiation from the sun, which in turn can increase skin cancer, eye

cataracts, and damage crops and plankton in the oceans.)

In a nutshell, here is recent thinking on global warming:

-- There is no disagreement among scientists that the greenhouse effect exists. If atmospheric gases did not trap the sun's heat the way greenhouse glass traps heat, the Earth would be about 50 degrees colder than it is and its oceans would be frozen. Chilly Mars is an example of a planet where a thin atmosphere fails to capture heat, while cloudy Venus, hot enough to melt lead, demonstrates a greenhouse effect gone to extremes.

-- The amount of greenhouse gases in the atmosphere has fluctuated throughout the Earth's history because of natural phenomena such as volcanoes, which eject gases into the atmosphere. Air bubbles trapped in ancient ice show that climate and atmospheric carbon dioxide are closely linked.

The dinosaurs, which lived 100 million years ago, inhabited a planet averaging 27 degrees warmer than today's.

We are now living in a warm interglacial period about 10,000 years old. Because past interglacials lasted about that long, some scientists have argued that without global warming, we are due for a new ice age to start.

-- The burning of fossil fuels such as coal and oil, the destruction of forests, and the production of methane from rice farming and farm animals have increased the atmosphere's greenhouse gases since the start of the Industrial Revolution. Carbon dioxide, for example, has increased from 270 to 350 parts per million, and total greenhouse gases are at about 410 parts per million.

Astronaut Tamara Jernigan recently showed disturbing photographs taken from the space shuttle to a conference of educators at the UW. One stunning 1991 shot showed 3 million square kilometers of the Amazon basin in Brazil covered with smoke from burning tropical forest.

-- There remains enormous disagreement and uncertainty on how much and how fast the climate will change because of this increase. Hansen believes global warming has already

started. Richard Lindzen of the Massachusetts Institute of Technology argues there are so many natural counterbalances to warming that a doubling of current levels of carbon dioxide will lead to a temperature increase of less than 1 degree.

-- Scientists have backed off the most catastrophic scenarios of soaring heat and melting ice caps, at least for the next century. Early computer models forecast temperature increases of up to 8 degrees over the next 100 years. More recent ones that take into account cooling mechanisms and the full depth of the heat-absorbing ocean predict a range of 2 to 4 degrees.

Concern about sea level rises has also lessened. The initial fear was that the West Antarctic Ice Sheet might collapse and melt, raising sea level by 30 feet. That is now considered unlikely in the 21st century. As a result, sea level is forecast to increase just 1.5 feet to 5 feet, partly from melting of ice and partly because the oceans expand as they warm.

Sea level worldwide has risen about 3 to 4 inches the past century. In Washington state that has meant a 5-inch rise in Seattle's Elliott Bay because the land here has subsided slightly. No rise has occurred on the Pacific coast because the land there is being pushed up faster by geologic forces than the ocean is rising.

Is any of this necessarily bad?

"This winter is an indication of what climate change might be if it persists in the future," noted Richard Gammon, a professor of atmospheric chemistry at the UW. Roughly speaking, he said, increasing the temperature a degree is like shifting the climate a degree of latitude northward. For example, a 4-degree increase in average temperature would give Blaine at the Canadian border the climate of Salem, Ore., and Salem the climate of Redding, Calif.

So what's wrong with that?

Plenty, said Gammon. "Douglas fir requires cold to reset its biochemistry. Salmon require certain stream temperatures and flows. We're talking about no more hemlock and Douglas fir, no more salmon, less snow on Mount Rainier."

Add to that less skiing, drier summers with more forest fires, more fights over water, more endangered species, more invading species.

Simply put, global warming means wrenching change at an unprecedented pace, he warned. While humans may gain as much crop productivity in the north as they lose in the south, for individual farmers or regions there could be disastrous dislocation.

"I look for global warming signals everywhere," Gammon said. Coral reefs worldwide seem to be dying, he noted, for unknown reasons. Toxic algae blooms such as red tides seem on the increase. Forest fires are up sharply, including a 1987 one in China that was the greatest in recorded history, burning an area equal to western Washington and western Oregon combined. Some marine mammals in Alaska and the North Atlantic, such as sea lions and seals, have recently been in unexpected decline.

"When I see phenomena like domoic acid on the coast (an algae bloom that makes shellfish poisonous and which has temporarily shut down Washington's razor clam season) I ask, 'Is this the canary in the coal mine?' " signaling global warming, Gammon said.

Other scientists say pinning such changes to global climate change is premature. They are still waiting for faster computers to run the enormously complex simulations that try to predict what global warming would mean. "Right now we are more computer limited than scientist limited," noted Charlson.

According to NOAA's Washington, most computer models at this point suggest increased drought in the Midwest but more precipitation in the Pacific Northwest. Worldwide, global warming might produce more rain because of increased evaporation from the oceans.

However, some models suggest that while winters in the Pacific Northwest would be wetter, summers would be drier. And if this winter is any indication, change could also shrink the low-elevation snowpack important for water storage.

Such forecasts remain uncertain, however. For example, one study has suggested that ozone depletion has a side effect of actually cooling the lower stratosphere through a complex mechanism. In other words, one type of pollution that is destroying the ozone shield may be counteracting another type of pollution that would increase the greenhouse

effect.

One big unknown is the role of the sun. Its sunspot activity varies on a cycle ranging from seven to 17 years, and its radiation dims slightly on 70-year cycles. There are orbital cycles that affect the tilt of the Earth at periods of roughly 20,000 and 41,000 years, and a shift between elliptical and circular orbits every 100,000 to 400,000 years. Scientists have theorized these cycles could explain the ice ages, but that idea remains controversial.

More important in the short term is the role of water vapor produced by the increased evaporation that global warming would cause.

At one time scientists tended to think the increased cloud cover would trap more heat, accelerating the greenhouse effect. Now they believe more clouds would reflect away more heat into space than they trap, countering global warming. Increased snowfall would also reflect more heat into space.

There are other mysteries. Not all the carbon humans spew out ends up in the atmosphere, and scientists are trying to determine how much is absorbed by the oceans or by plants on land. Also puzzling is why the temperature increases observed to date seem to be mostly rises in nighttime lows, not daytime highs.

The Bush administration argues that science is still too uncertain to make drastic modifications to industry and vehicles that could cripple the economy. The U.S. remains the world's biggest greenhouse gas contributor because of the size of its economy, and has resisted calls by other nations to set goals for reduction.

A recent study by four environmental groups, however, concluded that while the cost of lowering carbon dioxide emissions 70 percent over the next 40 years would be \$2.7 trillion, it would save so much fuel and electricity that it would save \$5 trillion, for a net benefit of \$2.3 trillion.

Are we heating up? Certainly the debate is.

And for scientists such as the UW's Gammon, "There is no doubt the climate is warming."

