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THE GREENHOUSE EFFECT: PERCEPTIONS AND MISPERCEPTIONS[1]

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Dr. J. Murray Mitchell, a senior research climatologist with the National Oceanic and Atmospheric Administration, warns that although a detectable change in the earth's climate is small in magnitude, anytime the average global temperature changes even a little bit, it usually signals that there are much larger changes taking place, particularly in the Arctic and sub-Arctic regions. Admitting that the ideal way to plot global climate changes would be to go back at least ten centuries, Dr. Mitchell cites a Japanese Meteorological Agency study, based on data from about 120 weather stations around the world, showing that weather extremes in the middle latitudes have become more frequent in the past 30 years. Says Dr. Mitchell, "The world does seem to be cooling off in the past 20 years or so. If the temperature of large parts of the earth fell by two or three degrees, this probably would be enough to start building up the ice sheets, the way the last ice age began."

Dr. Mitchell's comments appeared in the Spring 1975 issue of NOAA, the quarterly magazine of the National Oceanic and Atmospheric Administration. Mitchell, was aware, as were most climatologists at the time, that since the 1940s the average temperature of the Northern Hemisphere had fallen about three-tenths of one degree Celsius, or about one-half of one degree Fahrenheit. Although Dr. Mitchell was skeptical of a relationship between cooling and drought, a theory in vogue at the time, he did state that any time the polar regions become colder, middle latitude climate patterns undergo complex fluctuation that could include frequent and extended droughts.

Substitute "greenhouse effect" for "new ice age" and huge chunks of dialogue exchanged among climatologists just 15 years ago could stand side by side with the current media reports of an impending global warming trend. Indeed, the popular media has done what the media is notorious for doing, whether tackling issues of lifestyle, politics or science. They have found a buzzword—in this case, "greenhouse effect." For instance *Discover* magazine, a consumer science monthly, featured a cover line on its October 1988 issue which read, "The Greenhouse Effect: Last Summer Was Just a Warmup". Needless to say, the majority of climatologists who have been studying the greenhouse would not dare make such a bold statement.

Influenced largely by the magnitude of the drought of 1988, the greenhouse effect has been the subject of television specials and magazine cover stories. Likewise, it has been the subject of numerous seminars, at the international, national and regional levels. Most nursery industry seminars and trade shows feature speakers who discourse on the greenhouse effect.

Already policy makers around the world, are considering, or have already passed laws designed to reduce carbon dioxide and the other man-made pollutants believed to contribute to the greenhouse effect. Nuclear power may even reemerge as an energy source of choice. Unlike coal, nuclear power is not a source of greenhouse gases.

1. Presented at the annual conference of the International Society of Arboriculture in St. Charles, Illinois in August 1989.

Any action taken to reduce pollution is highly desirable and should be encouraged at all costs. However, when journalists, or for that matter, elected officials make blanket statements about the greenhouse effect, they often do so with a disregard for what scientists are saying about the greenhouse effect. With a few notable exceptions, the scientific community continues to emphasize that the greenhouse effect is a theory—a highly credible theory, but a theory nonetheless.

To give the subject some historical perspective, scientists have speculated about the effects of excessive carbon dioxide and other pollutants in the atmosphere at least since the 1940s. Dr. Mitchell, the above-noted ice-age advocate, was also aware of the greenhouse effect theory. In the same NOAA article he cautioned that another manmade pollutant—carbon dioxide,—had increased in the atmosphere 10 to 12 percent since the dawn of the industrial revolution. "All other things being equal," he said, "the presence of carbon dioxide in the air impedes cooling and tends to warm the climate. It's like putting a sheet of glass over yourself and trapping the sun's heat passing through, as in a greenhouse."

It's worth noting, incidently, that when asked by an interviewer to speculate about the possibility of a dust-generated cooling trend and a carbon dioxide generated warming trend cancelling each other out, Dr. Mitchell had this to say: "I would put my bet on carbon dioxide warming as being the dominant for two reasons. First, the cooling effect of particles is probably less than we have calculated in the past. Second, I think it will be a lot easier to clean up particles if and when we decide it is important to do so. These particles don't stay in the air long. But the carbon dioxide, what we've already put into the atmosphere,—will stay there for decades after we've stopped burning fossil fuels. In fact it will take centuries to remove that carbon dioxide. So even if we stop polluting the air with carbon dioxide, its effect will go on for a very long time.

One difference between the atmospheric research of today and that of the mid-1970s is that computer-generated modeling has become vastly more refined. Indeed some of the world's largest and most sophisticated computers are in the employ of climatologists. With these models, scientists try to incorporate every weather-influencing factor imaginable, as well as data based on past weather records, into a program and then create countless climatic scenarios for the future.

It is from these models that scientists have speculated, for instance, on the world's wheat and corn belts moving hundreds of miles north into Canada and the U.S.S.R., that India will become much wetter than it already is, that vast portions of the earth's mid-latitude areas will become deserts, and that cities such as Miami, Fla., Atlantic City, NJ, and Galveston, Texas, will be largely innundated by the rising sea level brought on by melting polar ice caps.

As a side note, similar computers models were employed several years ago to test the hypothesis that a nuclear war would loft enough smoke and dust into the atmosphere to block sunlight and plunge the earth into a nuclear winter, another theory the press had a field day with in its time.

Bear in mind, however, that weather scientists will be the first to admit that these models are very speculative. Just to illustrate the complexity of trying to ferret out the diverse natural phenomena that produces weather, scientists at the University of Chicago announced last January that for the first time, with the use of three-dimensional computer models—they have determined how much clouds cool the earth.

According to Veerabhadran Ramanathan, leader of this U. of C. team, "The largest uncertainty in understanding climate change, from the drought of last summer to an ice age lasting thousands of years, is the way the clouds interact with sun's radiation. He terms the cooling effects of clouds as "suprisingly large." Clouds cool the earth by intercepting sunlight and reflecting it back into space. Ironically, clouds can also warm the earth by trapping the infrared radiation emitted from the ground, which is why cloudy nights are often warmer than cloudless ones. What the U. of C. are suggesting though, that despite this dual capability of clouds, clouds over the ocean's mid-latitude storm tracks have a cooling effect on the earth that far outweighs the heating effects of clouds elsewhere.

Ramanathan adds that until now climatologists

have had no way to verify mathematical models of weather systems that include clouds. The U. of C. research on clouds, which took 14 years, is based largely on data gathered over a period of one month by a National Aeronautics and Space Administration satellite. To properly understand just one month of cloud data, the team spent four years performing the computer analysis.

To use a local example of how complex weather patterns can be, the Illinois State Water Survey stated that torrential rainstorms appear to have increased from the turn of the century to the present. This study, entitled "Frequency Distributions of Hydroclimatic Characteristics of Heavy Rainstorms in Illinois," or as it more commonly known, "Bulletin No. 70," predicts that deluges, like the one that dumped almost four inches in five hours earlier this month in Chicago, could happen more often and in bigger doses than previously expected. Even considering that this storm was generated from the remnants of Hurricane Chantal, it is at least the third ten-year storm to occur in the past three years. In fact the Chicago area has experienced two hundred-year storms over the past five years.

One question mark concerning last year's drought is how clouds in the spring and summer of 1988 might have differed from normal. This is currently still under study at U. of C.

At about the same time the U. of C. scientists announced their findings on clouds, researchers with the National Center for Atmospheric Research in Boulder, Colorado announced that the freakish weather responsible for the drought of 1988 was due to the interaction of La Nina and El Nino, two massive currents in the tropical Pacific. El Nino, is an abnormally warm mass of water, while La Nina is a mass of cold water that periodically wells up from the depths of the Pacific along the equator and drifts for thousands of miles.

Using computer modeling comparable to that used by the U. of C., the NCAR researchers have suggested that a rare double whammy of El Nino and La Nina occurred last year. The cold water of La Nina clashed with the warm water of El Nino southeast of Hawaii. The consequent disruption of tropical weather patterns distorted the path of the jet stream across North America. The jetstream pushed rain-producing weather away from the interior of the United States. In typical fashion, these researcher's stress that although last summers drought was caused by climactic events probably unrelated to the greenhouse effect, their research in no way disproves the greenhouse effect theory.

A handful of prominent climatologists, most notably Dr. James Hansen, director of the National Aeronautic and Space Administration's Institute for Space Studies at Columbia University, have stuck out their necks and directly blamed last year's drought on the greenhouse effect. Using computer models as sophisticated as any used by the abovementioned climatologists, Hansen asserts that the average global temperature has risen by nearly 1 degree Fahrenheit over the century. He also notes, correctly as it turns out, that the average temperatures in the 1980s are the highest on record.

Hansen even has an argument for what seems to be a contradiction in the greenhouse effect theory—warmer temperatures increase evaporation over the oceans and should, hence, result in more precipitation over the land. However, according to models created by Princeton's Syukuro Manabe and by Walter Orr Robert of the Center for Atmospheric Research, warmer temperatures alter global precipitation patterns as well as increase precipitation. More rain is falling, but with less snow cover to cool the atmosphere, moist air is rising higher where prevailing currents shift it northward. This is what happened during last year's drought, when much of the rain that should have fallen in the U.S. interior, was dumped in northern Canada.

Hansen's stature in the scientific community is such that the White House's Office of Management and Budget, routinely alters Hansen's warnings about the greenhouse effect when he's invited to testify before Congress. In the latest incident, Hansen's assertion that his latest computer models predict substantial increases in the global temperature, with subsequent severe droughts and storms was softened and qualified with a much greater degree of uncertainty.

Meanwhile, National Oceanic and Atmospheric Administration scientists just published a study based on an examination of climate data extending

back nearly 100 years. Their conclusion: although the nation's weather in individual years or even for periods of years has been hotter or cooler or drier or wetter than normal, there has been no trend one way or the other.

Nonetheless, as did the NCAR researchers, Dr. Kirby Hanson, the meteorologist who led the study, told the New York Times earlier this year that these findings do not necessarily cast doubt on theories that the greenhouse effect is already causing warmer temperatures. He noted for instance, that because the study used only data gathered from weather stations scattered throughout the United States, the findings reflect the climatic history of only a small percentage of the earth's surface. One theory to explain this is that the heat, dust and smoke released into the atmosphere by the city, triggers bigger than usual rainfalls from passing storm systems.

Almost all among Hansen's colleagues accept the greenhouse effect. Where most differ with Hansen is whether the greenhouse effect is already affecting global weather patterns. Numerous tests have strongly suggested that after remaining in a rough equilibrium of about two hundred parts per million, the amount of carbon dioxide in the earth's atmosphere has almost doubled since the industrial revolution. Likewise, methane levels have risen, largely from the guts of cattle, from the burning of wood, from landfills and from flooded rice paddies. With the increased use of nitrogen-based fertilizers, nitrous oxide levels have also risen. But most scientists are too leery of the unpredictability of long-range weather forecasting to drop the other shoe and say, "Yes, this has caused a significant disruption of global weather patterns."

A typical attitude is that expressed by Norton D. Strommen, chief meteorologist with the U.S. Agriculture Department's World Agricultural Outlook board. "Models such as those developed by Hansen are only as good as the information going into them, and there's too much we're uncertain of."

One of the questions most frequently asked by the nursery industry, is whether to expect a continued trend of droughts as a result of the greenhouse effect. Cynthia Rosenzweig, a Goddard Institute geographer who assists Hansen with his research says flatly, "I think it's too early to make hard decisions on how to cope with the greenhouse effect." As news editor of American Nurseryman magazine, I spoke with numerous hard-hit nurserymen, particularly in the Midwest, who have resolved to replace much of their current stock with drought-tolerant plants. Considering the number of municipalities across the nation that have enacted water-rationing statutes and considering that many regions of the country continue to experience soil-water deficits as a result of last summer's drought, the practice of encouraging the growing of drought-tolerant plants is a prudent idea. If indeed, the greenhouse effect is upon us, then all the better that we're cultivating drought-tolerant plants.

But again, to put this into perspective. Consider the computers, satellites and radar with which meteorologists chart weather patterns. The accuracy of short-term forecasting has about doubled over the past three decades. The National Weather Service plans to spend $1 billion in the next five to ten years to upgrade its current network of computers, radar and ground systems. Once this system is in place, meteorologists will very accurately be able to track the big weather systems, the high and low pressure systems and the jet stream. Even with the upgrade, however, the Weather Service will probably not venture to make forecasts beyond 90 days, and will probably only venture to predict that weather temperature and precipitation levels will either be normal, above-normal, or below-normal for broad geographical regions.

Perhaps the best news to come out the greenhouse effect craze, as far as arborists are concerned, is the good press trees have received. The American Forestry Association has launched a campaign to plant 100 million new trees in American cities by 1992. On the industrial front, a Connecticut utility, AES Thames, has developed a program to help compensate for the carbon dioxide that will be produced by one of its power plants. Through a $2 million grant to CARE, the international relief and development organization, the utility will assist in a reforestation program in Guatemala. A spokesperson for the utility commented last December that this program, which will eventually reforest 385 sq. miles, is the first

attempt by a coal-fired plant to slow the greenhouse effect.

Although no additional announcements have yet been made, at least several utilities are studying similar programs. As for the grain of salt that should be taken with this otherwise noble effort, scientists who have studied the effects of global deforestation estimate that it would be necessary to plant an area half the size of the continental U.S., or an area equivalent to one-third of the world's arable land to compensate for the man-made pollutants released into the air. Indeed, the net loss of global forestland each year is an area roughly the size of Tennessee.

But anything that rekindles the public's respect and fascination for trees and for forestlands is virtuous, and time may show that this may rival the reduction of carbon dioxide, methane and other atmospheric pollutants as the greenhouse effect theory's legacy to our planet.

Just be wary of any discussion of the greenhouse effect, or for that matter of pesticides, hazardous waste, electromagnetic pollution or any of the numerous technologically complex issues with which our society is grappling that does not contain at least as many qualifiers as assertions.

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Abstract

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Pesticides are designed to be toxic chemicals. They control unwanted pests such as insects, weeds, fungi, nematodes and rodents by poisoning these target organisms. Because humans may also be exposed to these toxic chemicals, the potential exists for human poisoning as well. Much of people's inability to focus on the most important pesticide issues may stem from the difficulties in distinguishing the concept of pesticide toxicity from risk of pesticide exposure. The toxicity of a pesticide describes the types of toxic effects a pesticide may produce and gives an indication of the amount of pesticide required to cause such effects. In terms of potential human health effects, we must consider the concept of risk rather than that of pesticide toxicity. We often tend to react to the mere presence of a pesticide rather than to the actual pesticide levels detected.