METEOROLOGY

Earth's cooling climate

Decline in temperatures since 1940 raises question of man's role

by Kendrick Frazier

At a meeting of meteorologists a few weeks ago at the University of Wisconsin, the keynote speaker began with five statements:

- We know the climatic history of the earth.
- We know how the present climate compares with the past.
- We know the causes of climatic change, or the potential for change.
- We know where the climate is heading in the future.
- We know to what extent man is affecting climate and to what extent he will be doing so in the future.

None of them are necessarily true.

"I choose to call those five statements myth, not fact," says Dr. J. Murray Mitchell Jr. of the Environmental Science Services Administration. For climatology is a relatively young science. Important as the long-term state of the atmosphere is to the survival of life on this planet, knowledge about it is appallingly scanty.

If the total 5-billion-year age of the earth were represented as a year, the 200 years for which we have meteorological measurements would be only a second. And even though, from the historical and geological record, scientists have been able to piece together some picture of the climate of the last tenth of the earth's history, they know essentially nothing about the other nine-tenths.

Yet despite the uncertainty, the recent record is good enough to produce some conclusions. For instance:

The world's climate has changed significantly within the last century, overthrowing an earlier view of substantial climatic stability. And it has raised many perplexing and even disturbing questions, including the fear that man may be responsible for changes he will never be able to reverse.

A central, agreed-upon climatological fact is that the average temperature for the entire earth rose gradually from the 1880's until the early 1940's. At that time a cooling trend suddenly set in which is continuing today.

The worldwide average yearly temperature increased a total of 0.6 degrees C. up to 1940. The cooling since then has cut that increase back by half.

The increments do not seem significant. Yet the fluctuation is believed to indicate a systematic change in the earth's heat budget—the balance of incoming and outgoing energy—during the last century. And the data seem to indicate larger changes in key areas, such as the Arctic, which affect the pattern of atmospheric circulation worldwide.

The recent cooling has been enough, according to British climatologist Dr. Hubert H. Lamb, to have shortened the average growing season since 1950 by about two weeks in comparison with the warmest decades. It has also doubled the frequency of snow on the ground in most inland districts of England since the 1930's.

"How long the current cooling trend continues is one of the most important problems of our civilization," says Dr. Mitchell. "We need to know if it is due to natural causes or man's effects. If it continues for 20 more years, an icebreaker like the Manhattan (SN: 9/27, p. 265) couldn't even begin to get through the Northwest Passage. And if it continues for 200 to 300 years, we would be in another ice age."

Climatologists would dearly love to know what is responsible for the cooling. Considering only the rising carbon dioxide levels in the atmosphere, they would have expected the warming to continue.

Since late in the 19th century man through the combustion of fossil fuels has been releasing carbon dioxide into the atmosphere at an ever-accelerating rate. It is now estimated that about half of all fossil carbon dioxide released by human activity during that time has remained in the atmosphere. The concentration has risen from the generally accepted 19th century figure of 290 parts per million to about 322 parts per million today. It is expected to reach about 368 parts per million by the year 2000.

Carbon dioxide molecules allow shortwave solar radiation to pass through to the earth's surface. But the portion of the light then re-emitted from the surface at longer infrared wavelengths cannot pass back out. This energy is in effect trapped, and warming results.

Work by Drs. Syukuro Manabe and Richard T. Wetherald of ESSA's Geophysical Fluid Dynamics Laboratory has shown that at least a third of the warming from 1880 to 1940 can be attributed directly to the carbon dioxide buildup. Factors responsible for the other two-thirds are not known.

What then, climatologists ask, could possibly account for the sudden downturn in temperatures since 1940, in spite of continued inputs of carbon dioxide? Some meteorologists feel it may be due to little-understood relationships involving the large-scale exchange of heat between the atmosphere and the oceans.

But Dr. Reid A. Bryson of the University of Wisconsin points to studies indicating that the amount of dust and other particulate matter in the atmosphere has increased dramatically in recent decades, a change that could counteract the thermal effect of carbon dioxide buildup.

Over Washington, D.C., for instance, ESSA scientists have found that atmospheric turbidity increased 57 percent between 1905 and 1964; over a town in Switzerland, it increased 88 percent from 1920 to 1958.

A Soviet climatologist examined dust trapped in the snowfields of the high Caucasus. He found little variation for the 140 years up to 1930, followed by a dramatic rise to 19 times the previous level by 1963. The increase generally parallels the expansion of industrial activity in Eastern Europe.

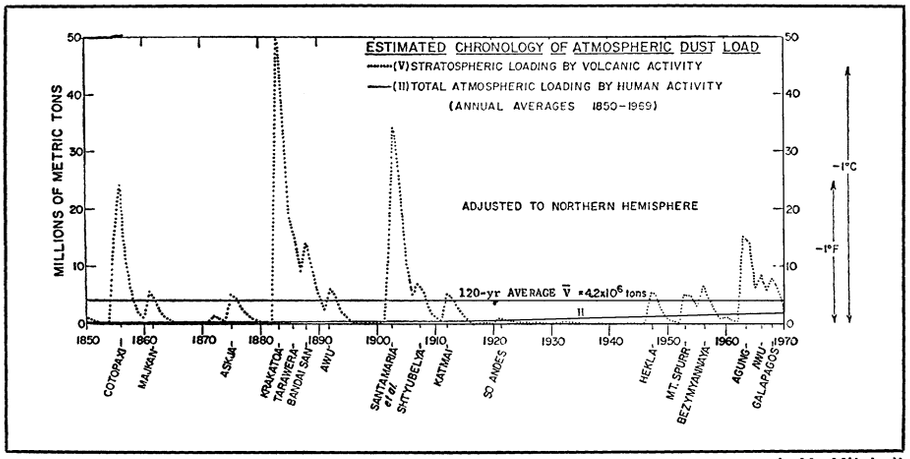
Turbidity over the Pacific Ocean apparently increased 30 percent between 1957 and 1967, other studies show.

Studies of trends over the continents are sensitive to wind effects. Nevertheless, the number of smoky days in Chicago rose from about 20 per year in the decades prior to 1930 to a high of about 320 per year in 1948, before falling off somewhat as the frequency of east winds decreased.

Dr. Bryson attributes the greater part of these turbidity increases to human activity. Most is due to outpouring of smoke and other particles by industry, although agricultural burning and other such activities over large parts of the underdeveloped world contribute large amounts as well.

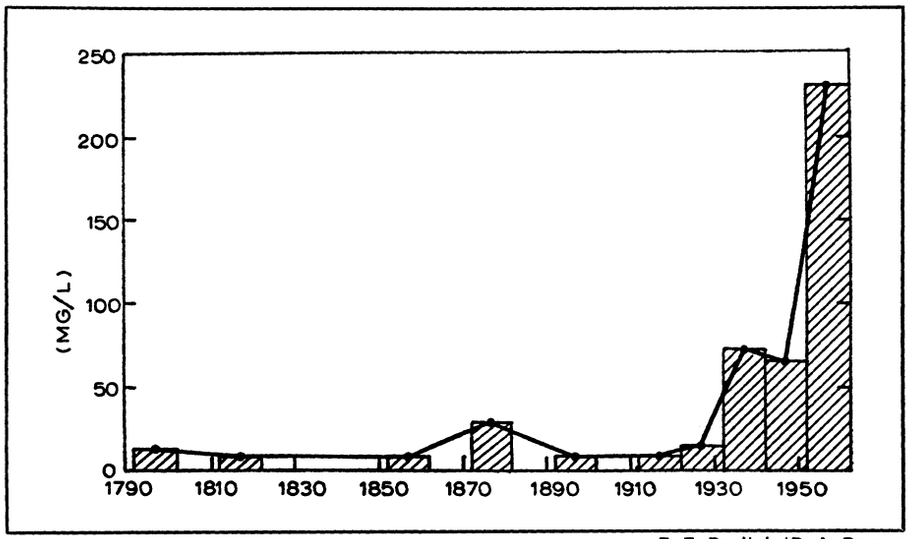
Atmospheric dust tends to cut down on the amount of sunlight that can reach the earth. The cooling that results, Dr. Bryson feels, has overpowered the opposite-acting warming tendencies of carbon dioxide. There is good evidence that the strength of the direct solar beam, as measured by observatories at the earth's surface, has been declining since the 1940's.

"I believe that increasing global air pollution, through its effect on the reflectivity of the earth, is currently



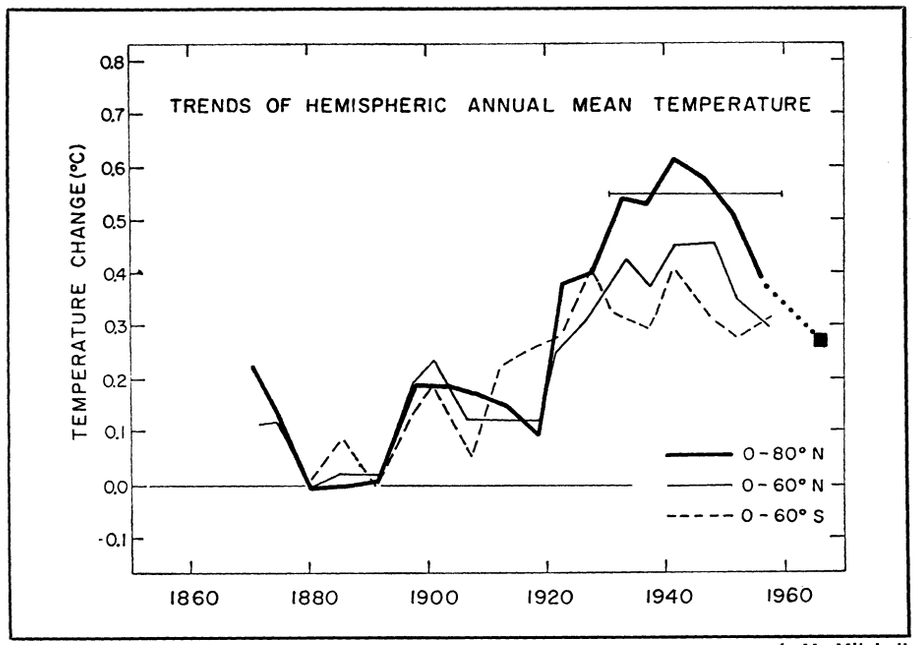
J. M. Mitchell

Volcanoes, human activity add millions of tons of dust to the atmosphere.



F. F. Davitaia/R. A. Bryson

Dustfall over high Caucasus Mountains rose dramatically after about 1930.



J. M. Mitchell

Global mean annual temperatures: Up until the 1940's, steady decline since.

dominant and is responsible for the temperature decline of the past decade or two," he says.

Dr. Mitchell agrees with the suggestion that dust and smoke spewed into the atmosphere are responsible for the cooling. But he blames nature, not men. "My view is that most of the dust can be attributed to volcanic eruptions, not man's activities," he declares. "Volcanic activity has increased tremendously in the last two decades."

He has compiled evidence that the volcanic load has been increasing much more rapidly in the past quarter-century than has the human-spawned particulate loading.

"The series of latter-day eruptions, beginning with Hekla in 1947, marked the introduction of a large dust load that coincided closely with the period of abruptly reversed global temperature change," says Dr. Mitchell. "To find earlier episodes of similarly large volcanic dust loading, one has to look back as far as 1915—when, incidentally world mean temperatures are also known to have been relatively low.

"It therefore seems that nature rather than man is to be held primarily responsible for the relatively abrupt cooling in recent years."

But even in his view, man plays a part. There is evidence, he says, that human activity is loading the atmosphere with dust and other particles faster than it is contributing to the buildup of carbon dioxide. If this difference in rates continues, Dr. Mitchell expects the cooling effect of human-derived particulate loading alone to surpass the warming effect of human-derived carbon dioxide sometime after the turn of the century. And this would compound the cooling effect due to dust from natural sources.

Whether nature or man is principally to blame, the key questions concern how serious the cooling effect is and whether the cooling will continue. Climatologists can do little more than bewail the lack of suitable data to carry the analysis further. "We just don't have the information to know," says Dr. Bryson. "And we jolly well better get it."

He and other climatologists are unhappy that neither the Global Atmospheric Research Program (SN: 8/6, p. 185) nor the World Weather Watch intends any systematic observations of dust densities and distribution.

"I think it is deplorable we know so little about the dust content of the atmosphere," says Dr. F. Kenneth Hare of the University of Toronto. "It is time this profession insisted on synoptic worldwide measurments of global dust content. It may well be fundamental to the future of the atmosphere." □