SCIENCE NEWS OF THE WEEK

How to Trigger an Ice Age

The heat balance of the earth is a fairly dicey situation. A small change in the planet's mean temperature can convert it from our more or less hospitable home to a deep-frozen, ice-covered ball. Paleontology gives us evidence that in fact such ice ages have happened several times in the earth's history. Various mechanisms have been proposed from time to time as causes of the change in temperature.

A suggestion that has gained much attention in the last year or two is that the occurrence of ice ages is somehow connected to the passage of the solar system through the spiral arms of our galaxy. The sun, like the other stars, moves in an orbit around the center of the galaxy, carrying its planets with it. In pursuing this orbit the solar system passes through one spiral arm after another. In the spiral arms the clouds of gas and dust that occupy the space between the stars are particularly thick. Now Christopher P. McKay and Gary E. Thomas of the University of Colorado propose a chemical mechanism by which this encounter with interstellar matter could have caused the ice ages. Their paper is scheduled for publication in the March GEOPHYSICAL RESEARCH LETTERS.

Although upwards of 40 different molecular species have been identified in interstellar clouds, the overwhelmingly major fraction of the interstellar matter consists of molecular hydrogen. McKay's and Thomas's ice age scenario is based on the assumption that such a cloud has a density of at least 1,000 hydrogen molecules per cubic centimeter. That, they say, has been shown to be thick enough to stop the solar wind before it reaches the earth's orbit. With the solar wind prevented from reaching the earth, the earth would be bathed directly in the matter of the interstellar cloud. As the earth moved through the cloud, it would be hit by more than 7 billion hydrogen molecules per square centimeter per second for periods of about 100,000 years.

The second major assumption in the theory is that at the time of these interactions the earth possessed an oxygenating atmosphere similar to the one it now has. The oxygen in the atmosphere is mostly in the form of molecules, but there is a small proportion of atomic oxygen. The atomic oxygen is highly reactive, and when it meets the hydrogen molecules coming in from the interstellar cloud, it dissociates them, leaving a residue of atomic hydrogen and forming a number of hydrogen-oxygen compounds, including hydroxyl radicals, water, hydrogen peroxide and hydrogen dioxide. These things react in various ways among themselves, and the net result is an increase in water and atomic hydrogen in the atmosphere. The water tends to diffuse downward — some of it even finds its way to the oceans. The atomic hydrogen diffuses upward.

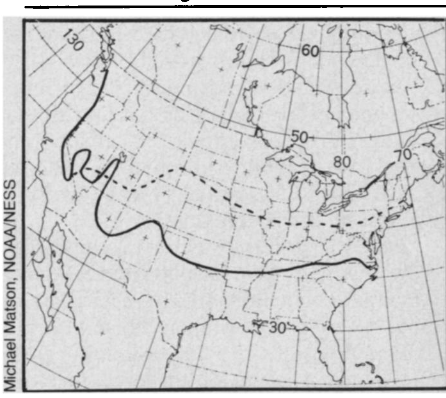
These chemical changes alter the physics of the atmosphere in a chain of ways. There will be a large increase in the molecular hydrogen in the ionosphere. That increase will "virtually destroy" the ionospheric F layer, because the hydrogen is 1,000 times as efficient as nitrogen in recombining with electrons and forming neutral atoms.

The increase in atomic hydrogen (and other compounds involving odd numbers of hydrogen atoms) in the upper atmosphere will react with the ozone and deplete the ozone concentration above 50 kilometers from the surface. The reduced ozone allows the solar ultraviolet radiation to penetrate deeper into the atmosphere (by about 6 kilometers), and this lowers the average height and temperature of the mesopause (the upper boundary of the mesosphere).

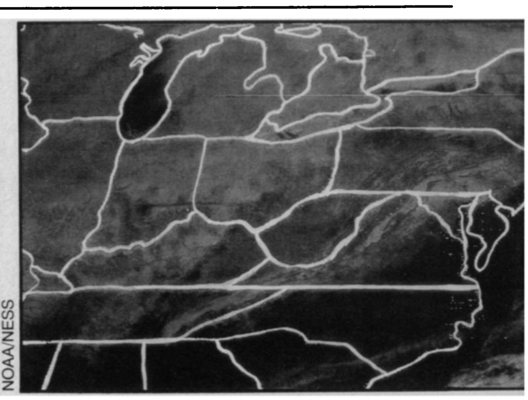
Meanwhile, the increase in water vapor saturates the upper mesosphere. The lowering and chilling of the mesopause causes the condensation of a layer of ice clouds in the mesosphere that become a permanent feature extending over almost the whole world. At present such mesospheric ice clouds appear only at high latitudes in summer — the so-called noctilucent clouds. The ice clouds change the albedo of the earth, and the change in albedo lowers the average surface temperature by 1° K. "A 1° K surface cooling sustained over a period of several thousand years is probably enough to trigger an ice age of substantially longer duration," McKay and Thomas conclude.

They point out that the theory applies only to long-term ice ages. Cooling due to the presence of mesospheric ice clouds is likely to be "unimportant" in explaining the occurrence of short-term ice ages, such as the one that happened about 20,000 years ago. The sun's last passage through a spiral arm, the only place where an encounter with a cloud dense enough to cause the chain of events laid out in this theory is likely, ended about a million or ten million years ago. The available paleoclimatic records go back through the last three immersions in spiral arms — which happen about every 200 million years — and they seem to indicate a sequence of ice ages since Precambrian times at intervals of about 200 million to 500 million years. □

February sets snow cover record



Michael Matson, NOAA/NESS



NOAA/NESS

February 1978 (bottom) snow cover was 1.9 x 10^6 km^2 more than the 10-year average. Jan. 23, 1978, GEOS-2 image shows midwest, southern and eastern U.S. snow cover.

Snow freaks and ski bums will love the latest data from the National Environmental Satellite Service: Snow covered 74 percent of North America during parts of February 1978 — the most area covered in North America during 12 years of satellite monitoring.

The 17.6 million square kilometers covered in February 1978 included parts of the West and Pacific Northwest that normally escape snowfall. The February snow cover a year ago — a mere 15.7 million square kilometers — did not reach the parts of Washington, Oregon, California, Nevada and Arizona covered this year, according to Donald Wiesnet, senior research hydrologist with NESS.

January 1978 also broke a 12-year record. Snow covered 72 percent of North America in January 1978, compared with the 70 percent record set in January 1977. This February's record snow blanket in North America boosted the total area covered in the northern hemisphere to 47.3 million square kilometers, tying with January 1977 for the 12-year record in that hemisphere.

The monthly average snow line, which is computed from satellite photos and land mass tables, shows only the area covered by snow and does not reflect snow depth, NESS scientist Michael Matson stressed. More coverage means a different, not worse, winter, Wiesnet added. □