

SCIENCE IN REVIEW

Warmer Climate on the Earth May Be Due To More Carbon Dioxide in the Air

By WALDEMAR KAEMPFERT

The general warming of the climate that has occurred in the last sixty years has been variously explained. Among the explanations are fluctuations in the amount of energy received from the sun, changes in the amount of volcanic dust in the atmosphere and variations in the average elevation of the continents.

According to a theory which was held half a century ago, variation in the atmosphere's carbon dioxide can account for climatic change. The theory was generally dismissed as inadequate. Dr. Gilbert Plass re-examines it in a paper which he publishes in the *American Scientist* and in which he summarizes conclusions that he reached after a study made with the support of the Office of Naval Research. To him the carbon dioxide theory stands up, though it may take another century of observation and measurement of temperature to confirm it.

Abundant Gases

In considering the theory, Dr. Plass reminds us that the most abundant gases in the atmosphere are nitrogen and oxygen. There is also a little argon. These cannot absorb much of the heat radiated by the earth after it has been warmed by the sun. If they could, the climate would be far colder than it is today, because the passage of heat to outer space would not be stopped.

Three other gases could check the radiation of heat. These are carbon dioxide (the gas that fizzes in ginger ale), water vapor and ozone. All these are relatively rare.

To explain what happens, Dr. Plass resorts to the familiar greenhouse analogy. The rays of the sun pass through the transparent glass, but the outgoing energy (heat) from the plants in the greenhouse cannot pass through. Heat is trapped in the greenhouse, with the result that it is warmer inside than outside.

The atmosphere acts like the glass of a greenhouse. Solar radiation passes through to the earth readily enough, but the heat radiated by the earth is at least partly held back. That is why the earth's surface is relatively warm. Carbon dioxide, water vapor and ozone all check radiation of heat.

Of the three gases that check radiation, carbon dioxide is especially important even though the atmosphere contains only 0.03 per cent of it by volume. As the amount of carbon dioxide increases, the earth's heat is more effectively trapped, so that the temperature rises.

All this was first brought to the attention of scientists by Tyndall in 1861. In his day the facilities for studying the atmosphere and measuring its temperature were crude. Today they are highly refined. According to Dr. Plass, the latest calculations indicate that if the carbon dioxide content of the earth were doubled the surface temperature would rise 3.6° C. and that if the amount were reduced by half the surface temperature would fall 3.8° C.

Striking Changes

Such a comparatively small fluctuation seems of no importance. Nevertheless it can bring about striking changes in climate. If the average temperature should fall only a few degrees centigrade, glaciers would cover a large part of the earth's surface. Similarly a rise in the average temperature of only 4° C. would convert the polar regions into tropical deserts and jungles, with tigers roaming about and gaudy parrots squawking in the trees.

Dr. Plass examines the various factors that enter into what is called the "carbon dioxide balance," including the exchange of carbon dioxide between the oceans and the atmosphere. That balance must be preserved. Photosynthesis (the process whereby plants with the aid of sunlight assimilate carbon dioxide to produce sugars and

starches) causes a large loss of carbon dioxide, but the balance is restored by processes of respiration and decay of plants and animals.

Despite nature's way of maintaining the balance of gases the amount of carbon dioxide in the atmosphere is being artificially increased as we burn coal, oil and wood for industrial purposes. This was first pointed out by Dr. G. S. Callendar about seven years ago. Dr. Plass develops the implications.

Generated by Man

Today more carbon dioxide is being generated by man's technological processes than by volcanoes, geysers and hot springs. Every century man is increasing the carbon dioxide content of the atmosphere by 30 per cent—that is, at the rate of 1.1° C. in a century. It may be a chance coincidence that the average temperature of the world since 1900 has risen by about this rate. But the possibility that man had a hand in the rise cannot be ignored.

Whatever the cause of the warming of the earth may be there is no doubt in Dr. Plass' mind that we must reckon with more and more industrially generated carbon dioxide. "In a few centuries," he warns, "the amount of carbon dioxide released into the atmosphere will be so large that it will have a profound effect on our climate."

Even if our coal and oil reserves will be used up in 1,000 years, seventeen times the present amount of carbon dioxide in the atmosphere must be reckoned with. The introduction of nuclear energy will not make much difference. Coal and oil are still plentiful and cheap in many parts of the world, and there is every reason to believe that both will be consumed by industry so long as it pays to do so.