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LIGHTNING APPARENT SOURCE OF ENVIRONMENTALLY IMPORTANT GASES

Lightning may be a source of two environmentally significant gases in the atmosphere.

Laboratory tests conducted at NASA's Langley Research Center, Hampton, Va., showed that an electrical discharge approximately equal to that of lightning can produce trace amounts of carbon monoxide and nitrous oxide.

Although the annual global rates of production due to lightning appear to be several orders of magnitude below that due to other sources, the level of nitrous oxide became twice as great and carbon monoxide was increased 100-fold in the vicinity of the laboratory lightning bolt.

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Carbon monoxide initiates a complex series of chemical reactions that are believed to lead to the production of beneficial ozone in the lower atmosphere, or troposphere, at altitudes from 10 to 15 kilometers (6 to 9 miles). Lightning adds to the already large man-made sources of carbon monoxide.

Nitrous oxide, ironically, is harmful because it leads to ozone destruction. It doesn't destroy ozone in the lower atmosphere, but rises and diffuses into the stratosphere, and is chemically transformed to a gas that depletes the Earth's protective ozone layer.

The highly-concentrated ozone layer, about 24 km (15 mi.) above the surface of the Earth, absorbs much of the lethal solar ultraviolet radiation, thus shielding inhabitants of the Earth.

The major source of nitrous oxide in the lower atmosphere is thought to result from the action of microscopic bacteria on solid nitrogen compounds in the soil. This diffusion of nitrous oxide from the soil to the stratosphere takes about 25 years, so that it may be several decades before a measureable decrease in the ozone layer can be detected.

Nitrous oxide produced by lightning, however, may take only hours or days to reach the stratosphere, carried in the rapid updrafts of thunderstorms. Lightning flashes an estimated 500 times a second somehwere around the Earth. Tropical thunderstorms, especially, may be frequent conduits of nitrous oxide.

NASA researcher Dr. Joel S. Levine and his associates reported on the lightning studies, experimental results and theoretical calculations. Working with him were Langley's William E. Howell, Materials Division; the late Ron E. Hughes, Bionetics Corp.; and Prof. William L. Chameides, University of Florida. Levine is in the Atmospheric Environmental Sciences Division of Langley.

Man's environmental responsibilities are not lessened by the finding of lightning-produced carbon monoxide and nitrous oxide, according to Levine, "because we know that man's activities are, in fact, altering the environment. Before we can assess man's impact fully, however, we must understand the natural processes, such as lightning, that alter the composition of the Earth's atmosphere."

Information obtained by the recent NASA Pioneer Venus space probe and U.S.S.R. Venera missions suggests that lightning is a feature of the Venus atmosphere.

The discovery led to the suggestion, based on theoretical calculations, that lightning may be a significant source of carbon monoxide in the Venutian atmosphere.

Levine and his Langley associates verified the theoretical calculations. Measurements made in the Lightning Facility and the Gas Analysis Laboratory, determined that carbon monoxide was increased dramatically in simulated Venutian atmospheric samples.

Recent photographs of the dark side of Jupiter, obtained by NASA's Voyager spacecraft, indicate that lightning also may be a feature of the Jovian atmosphere.

In early lightning studies, predating NASA, other researchers discovered that lightning may have been important in the biological processes that led to the origin of life on Earth, by converting nitrogen in the atmosphere from a gas to solid forms. They, in turn, were carried by rain into the oceans. One group of those solid forms of nitrogen would probably have been nitrates, essential building blocks in the origin of life. Lightning also may have supplied the energy that led to the formation of complex organic molecules, the precursors of life on Earth.

Lightning was known previously to be a source of nitric oxide, a compound important to the chemistry of the lower atmosphere. Nitric oxide molecules have a single nitrogen atom (NO); nitrous oxide has two (N_2O). The production of gases by lightning results from the high temperatures which occur in the electrical discharge.

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