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Titan Laboratory: Early Earth Haze May Have Spurred Life

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(Source: **University of Colorado at Boulder**)

Hazy skies on early Earth could have provided a substantial source of organic material useful for emerging life on the planet, according to a new study led by the University of Colorado at Boulder.

In a study published in the Proceedings for the National Academy of Sciences the week of Nov. 6, the research team measured organic particles produced from the kind of atmospheric gases thought to be present on early Earth. The laboratory experiment modeled conditions measured by the Huygens probe on Saturn's moon, Titan, last year during the NASA-European Space Agency's Cassini mission, according to Margaret Tolbert of CU-Boulder's Cooperative Institute for Research in Environmental Sciences, one of the study's authors.

The researchers mimicked Titan's hazy skies by exposing methane gas to an ultraviolet lamp, then added carbon dioxide gas to the mix to see if conditions that were probably present on early Earth would produce a similar organic haze. "It turns out that organic haze can form over a wide range of methane and carbon dioxide concentrations," said Tolbert. "This means that hazy conditions could have been present for many millions or even a billion years on Earth while life was evolving."

According to co-author Melissa Trainer of CU-Boulder's Laboratory for Atmospheric and Space Physics, the study was the first to measure the chemical properties of aerosols by irradiating methane and carbon dioxide with ultraviolet light. "We found that you can make a lot of organic material virtually out of thin air," said Trainer, who completed her doctoral degree in CU-Boulder's chemistry and biochemistry department at CU in May 2006 under Tolbert.

Scientists believe the atmospheric chemistry of Titan might hold valuable clues to understanding the climate on Earth when life was just forming, said Trainer. Titan is an unusual solar system moon in that it has an atmosphere -- in this case one thick with organic aerosol particles that form through photochemical processes when sunlight reacts with methane gas, she said.

According to the study, a similar haze hanging over Earth early in its history could have supplied more than 100 million tons of organic material to the planet's surface each year. "As these particles settled out of the skies, they would have provided a global source of food for living organisms," said Trainer.

Previous efforts to understand early life on Earth have focused on extreme environments like hydrothermal vents, where energy and nutrients are plentiful, said Tolbert. The new study shows that such a high-energy food source could have been produced globally early in Earth's history, possibly expanding the habitable domain for early life, she said.

In addition to serving as a source of organic material, a haze layer over Earth could have shielded living organisms from harmful UV rays and helped to regulate Earth's early climate, according to the study. The haze may have contributed to the geologic record on Earth by depositing organic carbon into some of the planet's most ancient rocks, said Alexander Pavlov, a study co-author and former LASP researcher now at the University of Arizona. Organic carbon is believed by scientists to be of biological origin.

Other authors on the study included LASP's Owen Toon, H. Langley Dewitt and Jose

Jimenez of CIRES, and Christopher McKay of NASA's Ames Research Center in Moffett Field, Calif.

"It's exciting to see that the early Earth experiments produced so much organic matter," said Carl Pilcher, director of NASA's Astrobiology Institute, headquartered at NASA Ames. "An organic haze produced this way on early Earth could have contributed to the formation and sustenance of life."

The study was funded by the NASA Solar System Exploration Division's Exobiology program and the NASA Astrobiology Institute. CIRES is a joint research endeavor of CU-Boulder and the National Oceanic and Atmospheric Administration.

Contact: Margaret Tolbert, (303) 492-3179 Margaret.Tolbert@colorado.edu Melissa Trainer, (303) 492-1433 Adriana Bailey, (303) 492-6289 Jim Scott, (303) 492-3114