Earth's start is full of mysteries and laughing gas

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The Oceans Melting Greenland (OMG) field campaign team is flying NASA's G-III aircraft at about 40,000 feet. On a clear day, this altitude also provides a stunning perspective of one of the world's two great ice sheets. The other is Antarctica. NASA

Storms on the sun release clouds of solar matter known as coronal mass ejections (CMEs). They hit the Earth's atmosphere like cannonballs and then fizzle through the thinnest parts of Earth's protective magnetic field, sending waves of light dancing across the polar night skies. They can disrupt communications and fry electrical grids. If Earth's protection was just a bit weaker, and more of that explosive solar matter reached the surface, life would be in danger.

However, CMEs may have helped make life on Earth possible. A recent study published in Nature Geoscience offers the theory that many strong CMEs from a stormy young sun could have warmed our infant planet, giving rise to life about 4 billion years ago.

"It shows how even harmful things in moderation can be helpful, especially in the very early stage," said Dimitar Sasselov, an astronomer at Harvard University in Massachusetts who was not involved in the study.

At The Start, Not Quite So Sunny

The new research seeks to explain the "faint young sun paradox." When the universe began, the sun was 30 percent fainter, and cooler, than it is today. Although the sun was much cooler, the water on Earth stayed warm enough to be liquid. The fact that the water did not freeze has been a mystery, or paradox, to scientists for a long time.

It's generally thought that greenhouse gases helped keep the planet toasty. However, figuring out which gases were present and how they got into the atmosphere has proved a challenge. Violent volcanoes would have produced carbon dioxide but not enough to make up for a 30 percent cooler sun. Some methane gas and water vapor, which also trap heat, could have helped, but there was probably not enough around at the time to do the job.

Nitrous oxide, the "laughing gas" you get at the dentist, produces a greenhouse effect 300 times more powerful than carbon dioxide. Molecular nitrogen - two nitrogen atoms bound together - makes up 80 percent of the atmosphere today, but it's also very hard to break apart, and even now complicated biological processes are needed to do so. Before life, Earth had no way to get inert gas, a gas that does not change easily, to interact with other molecules. However, life couldn't exist unless nitrogen teamed up with other elements. This leaves scientists with another paradox. For life to begin, what does not change had to change.

All of this was on the mind of Vladimir Airapetian, an astronomer and lead author of the Nature Geoscience study, who was studying ways that CMEs could harm Earth today. As he learned more about the intense solar storms, he found himself thinking about the infant suns he studied as a graduate student in Romania decades ago.

A Bunch Of "Big Babies"

Those new, small stars, he knew, tend to behave like "big babies."

"When [stars] are young, they explode much more frequently," Airapetian said, much as newborns throw tantrums. He found that those early, frequent storms would have been powerful enough to cut through the Earth's magnetic field and rush into the lower atmosphere. There, they would have provided the energy needed to blast apart molecular nitrogen and persuade it to mix with other gases, such as carbon dioxide and methane. The interaction would produce nitrous oxide.

Real-world observations seem to prove this theory, since the level of nitrous oxide in the upper atmosphere gets higher after summer lightning storms. Airapetian thinks that frequent, powerful CMEs could have had an even more lasting effect.

That's just the beginning. Airapetian's team of chemists pointed out that, in addition to producing nitrous oxide, these changes would have created hydrogen cyanide, which is deadly. But in the right doses on early Earth (when there was nothing around for it to kill), hydrogen cyanide would have helped give rise to amino acids, the building blocks for proteins that life desperately needs.

Look What's "Cooking"

"And now it becomes really, really interesting," Airapetian said. With the right temperatures and the right ingredients, "life can start the process of cooking."

Sasselov, the Harvard astronomer, said this study builds on what is already known about how greenhouse gases may have helped warm the Earth. Other studies show that micrometeorites could have turned nitrogen into nitrous oxide, but "this might be a case where having two possibilities is better than one," he said. Neither mechanism would have produced very many nitrous oxide molecules, and early Earth needed as many greenhouse gases as it could get.

"The point about this kind of mechanism of producing additional greenhouse gas is ... you can add it to the other ones," he said. "The more the merrier."

Both agree that the study could teach scientists about worlds far beyond our own. If intense solar storms can help explain how life got started on Earth, they may help us find other planets where life could be in the process of "cooking."

"Our ultimate goal is to find something like that," Airapetian said. "When we find it, that's when I'll be happy. Now I'm half-happy."

Quiz

1 Which of the following sentences from the article BEST supports a central idea of the article?

(A) They hit the Earth's atmosphere like cannonballs and then fizzle through the thinnest parts of Earth's protective magnetic field, sending waves of light dancing across the polar night skies.

(B) Some methane gas and water vapor, which also trap heat, could have helped, but there was probably not enough around at the time to do the job.

(C) There, they would have provided the energy needed to blast apart molecular nitrogen and persuade it to mix with other gases, such as carbon dioxide and methane.

(D) Neither mechanism would have produced very many nitrous oxide molecules, and early Earth needed as many greenhouse gases as it could get.

2 Read the sentence from the article.

As he learned more about the intense solar storms, he found himself thinking about the infant suns he studied as a graduate student in Romania decades ago.

Does this sentence support the MAIN idea of the article? Why or why not?

(A) No, the main idea of the article focuses specifically on our sun, not infant suns in general.

(B) Yes, the main idea of the article is that the wild storms on our sun when it was young helped lead to life on Earth.

(C) Yes, the main idea of the article is that our infant sun had many interesting behaviors that may have contributed to life on Earth.

(D) No, the main idea of the article focuses on how life started on Earth, not on what occurred on infant suns.

3 Which of the following BEST explains how the author initially conveys that scientists are still unsure of how life started on Earth?

(A) by describing the recent study published in Nature Geoscience as a theory

(B) by stating that the sun was both fainter and cooler when the universe first began

(C) by stating that a Harvard scientist thinks the recent study builds on what is already known about greenhouse gases

(D) by explaining that scientists studying the Earth's beginnings believe that both sun storms and meteors played a part

4 How does the author develop the idea of the importance of solar storms to Earth's history?

(A) by describing the various effects that solar storms can have on life on Earth today

(B) by explaining that solar storms used to affect Earth more frequently than they do today

(C) by describing a variety of studies that focus on how solar storms send solar matter to Earth

(D) by explaining how solar storms of long ago may have had the power to help create new gases on Earth