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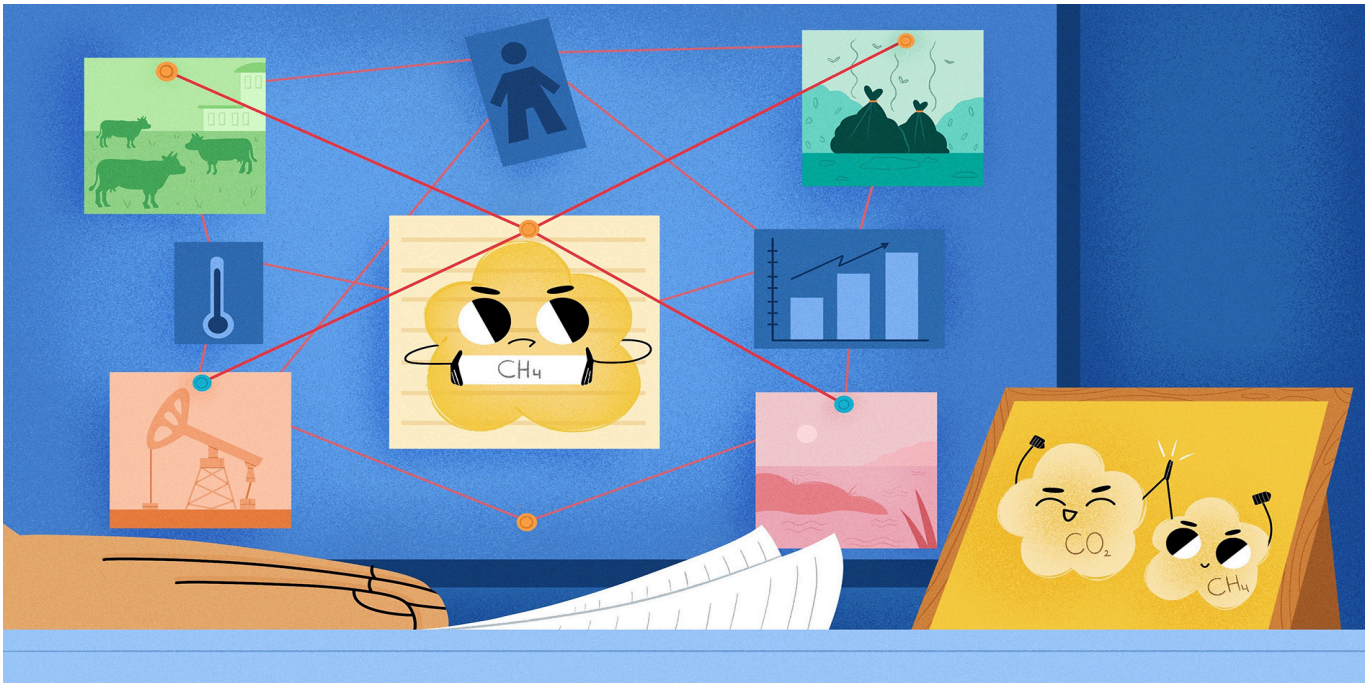

METHANE, THE NEGLECTED GREENHOUSE GAS

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YOUNG REVIEWERS:

MOMO
AGE: 12

While you have probably heard of carbon dioxide (CO_2) and its role in climate change, do you know about its less-famous partner, methane? Methane also warms our planet, and the amount of methane in the air has more than doubled since the Industrial Revolution, with especially rapid increases in recent years. Methane comes from human activities such as farm animals, landfills, and the fossil fuel industry, and natural sources like wetlands, especially as climate change makes wetlands bigger and warmer. Luckily, methane does not stay in the atmosphere as long as CO_2 does, which means that if we can reduce methane emissions now, we can make a substantial difference in keeping Earth healthier in our lifetimes. In this article, we will explain where methane comes from, describe its role in climate change, and tell you how both methane and CO_2 emissions can be reduced—sometimes by the same strategies!

CARBON DIOXIDE'S STEALTHY SIDEKICK

Does this sound like a story you might hear on the local news? Police are desperately trying to bust a gang of criminals that have

been brutally vandalizing a city. The detectives know the identity of the gang leader and are working day and night to catch him—but they are so focused on stopping the most obvious bad guy in the group that they do not pay much attention to the lesser-known gang members. Unobserved by the distracted authorities, these stealthy sidekicks keep getting away with smashing windows, toppling trees, and graffitiing buildings.

Overlooked vandals are not the only ones getting away with damage—something similar is happening in the fight against climate change, too. While it is certainly crucial to focus on the main culprit, carbon dioxide (CO_2), it is important to remember that there are "stealthy sidekicks" harming Earth's climate that have not been given as much attention. To combat climate change most effectively, we must be careful not to neglect these "less famous" greenhouse gases that are adding to climate damage.

In this article, we will tell you about an odorless, colorless, gas called **methane** (CH_4)—one of the neglected greenhouse gases [1]. We will explain how methane contributes to climate change, where it comes from, and how we can manage its levels to protect our planet.

METHANE

A potent greenhouse gas with a significant impact on global warming.

METHANE'S ROLE IN CLIMATE CHANGE

Methane is the second most important greenhouse gas driving climate change. The "news" about methane is both good and bad. The bad news is that the amount of methane in the atmosphere has more than doubled since the Industrial Revolution, with increased methane emissions causing about two-thirds as much warming as CO_2 to date [2]. But, on the bright side, methane is naturally cleared from the atmosphere much more quickly than CO_2: while CO_2 sticks around for centuries, most methane only stays in the atmosphere for about a decade. This means that while reducing CO_2 **emissions** is the most important thing people can do to protect Earth from climate change in the long term, reducing methane is the most important thing we can do to help our climate in the shorter term, to keep the planet as healthy as possible while you and your friends grow up.

EMISSIONS

The release of gases, such as carbon dioxide and methane, into the atmosphere where they trap heat and cause Earth's temperature to rise, leading to global warming.

COMPUTER MODELS

A computer program that uses math to simulate real-world events or systems, helping scientists understand and predict how things might behave.

Scientists who study Earth's climate often use powerful simulations called **computer models** to project how climate change will affect the world in the future. For example, they try to project how much of each greenhouse gas is likely to be emitted, and how those levels might change Earth's temperature, rainfall, or other aspects of the climate over time. Recently, scientists have noticed a disturbing trend—not only has the amount of methane in the atmosphere been rising rapidly since 2006, but it is also rising *even more* during this decade than it was during the last one, and *almost double* the amount that scientists projected using their computer models (Figure 1). This

dramatic increase means we must work even harder to keep this sneaky sidekick from causing climate damage.

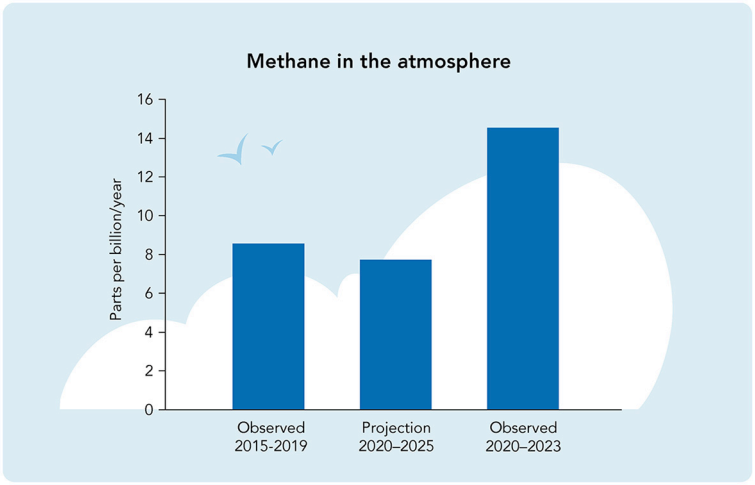

Figure 1

Methane has been rising in the atmosphere since 2006, but over the past few years, the observed increase in atmospheric methane has been greater than increases observed in the past and much greater than the increase projected by several computer models. Methane in the atmosphere is measured in parts per billion per year, which means that for every billion molecules of air, there has been an increase of methane molecules by the amount shown each year. These data tell us that taking steps to reduce methane release is an urgent goal.

To understand why methane levels are rising so quickly and unexpectedly, it helps to understand where methane comes from in the first place. That is a little complicated because some methane is produced by human activities, while some is generated by Earth's natural processes.

HUMAN SOURCES

You probably know that CO_2, the main culprit in climate change, mostly comes from burning fossil fuels (coal, oil, and natural gas). But do you know which human activities create the most methane emissions? The biggest source is agriculture, particularly raising animals called **ruminants** (such as sheep, goats, and especially cows) to feed people. These animals produce methane through their burps, farts, and poop as they digest the tough plant materials that they eat. Although methane production is a natural part of digestion, when billions of farm animals are raised around the world, the amount of methane seriously adds up.

Landfills, where people throw away and bury their garbage, are another major source of methane caused by humans. Methane is produced when **organic materials**, like food scraps and yard trimmings, break down where there is not much oxygen available, which happens as new garbage piles on top of older waste. Finally, methane is also emitted during the removal of fossil fuels from the Earth and while transporting them to where they are used. Some oil wells and coal mines may not have systems to capture the methane that is normally released while collecting these fuels. Additionally, leaks from oil and gas wells and in the pipelines that move fuels from

RUMINANTS

Animals that have special stomachs with multiple sections, allowing them to break down tough plant materials. Examples include cows, sheep, and goats.

ORGANIC MATERIAL

Any substance that comes from living organisms like plants and animals, including leaves, wood, food waste, and manure.

place to place can accidentally release a lot of methane into the atmosphere, as can releases that happen on purpose, for maintenance or safety reasons.

NATURAL SOURCES—BUT WITH A HUMAN TWIST...

Nature also has its own ways of creating this potent greenhouse gas. One of these is termites, which, despite their small size, emit methane as they digest tough plant materials—much like ruminants do! Wildfires are another small natural source. However, **wetlands** are the largest natural contributor to methane emissions, and some scientists believe them to be the biggest reason for the rapid increases they are seeing over the past decade. These waterlogged areas, such as marshes, bogs, and swamps, cover large areas of the Earth. Wetlands have the perfect conditions for methane-producing bacteria to flourish: lots of organic material that has fallen to the bottom where there is not much oxygen due to the overlying water, just like a landfill with many layers of waste!

WETLANDS

Areas of land where water covers the soil or is present at or near the soil surface for all or most of the year. Wetland ecosystems often contain unique plants and wildlife.

Although wetlands are a natural source of methane, there is an interesting twist—climate change can increase the amount of methane wetlands produce. Warmer temperatures and changes in rainfall patterns, both caused by climate change, can boost methane production. For example, higher temperatures can speed up the metabolism of methane-producing bacteria in wetlands, leading to more methane release. Changes in rainfall patterns can make wet areas larger, creating more environments for these bacteria to thrive. This is an example of a **feedback loop**, a cycle in which warming can increase methane release from wetlands, making the greenhouse effect worse and leading to *even more* warming (Figure 2). So, while wetlands are a natural source of methane, human activities still play a role.

FEEDBACK LOOP

A circle of actions in which something that happens affects the whole system, making it either do more of the same thing (positive feedback) or less (negative feedback).

REDUCING METHANE—EVERYONE CAN HELP!

Here is some more good news about methane: when it comes to reducing methane emissions, simple things we do in our everyday lives can have a big impact [3]! First, choosing what you eat can make a difference. For instance, eating a healthy diet that contains less meat and dairy, especially beef and cow's milk, is a powerful way to cut down on methane emissions. As we explained earlier, ruminants like cows and sheep produce methane during their digestion process. So, by opting for meals that include more plants and less meat, or choosing meat from animals that produce less methane (like chickens) you can help to reduce the amount of methane released into the atmosphere. This does not mean you have to give up beef altogether, but even skipping a couple burgers a week can contribute to the planet's health.

Figure 2

Wetlands naturally produce methane due to breakdown of organic materials in the absence of oxygen, but a feedback loop can increase the amount of methane released. When methane builds up in the atmosphere, it can help to trap the sun's heat near the Earth, causing global warming and contributing to climate change. Changes in rainfall patterns can increase the size of wetlands, and warmer temperatures can speed up the work of methane-producing bacteria, both of which cause even more methane to be produced... and the cycle continues.

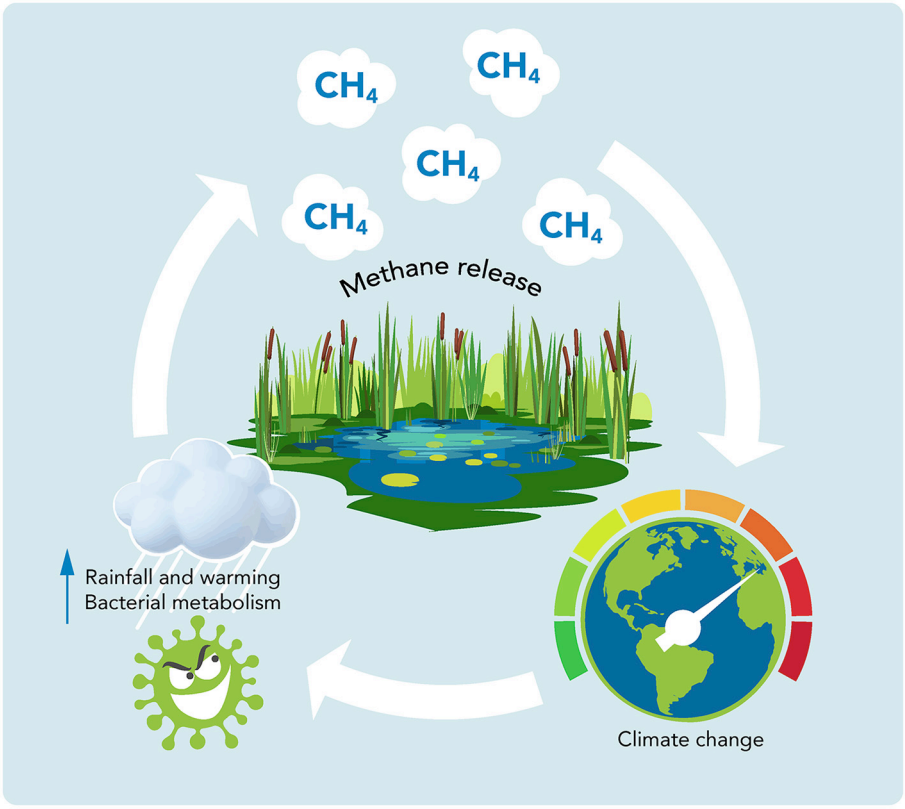

Figure 2

Being careful not to waste food is another important step in fighting methane. By paying attention to how much food your family buys, storing food properly, and trying to use all the food you purchase, you can help to reduce the amount of food that ends up in landfills. **Composting** food scraps and other organic materials instead of sending them to landfills also decreases methane emissions. Composting not only prevents methane from entering the atmosphere, but it can serve as a natural fertilizer to make soil healthier. These choices might seem small, but when millions of people start to adopt these habits, the impact can be huge!

COMPOSTING

The process of recycling organic waste into a nutrient-rich soil additive.

REDUCING CO_2 AND METHANE: A ONE-TWO PUNCH

Individual actions are important, but they are not enough. Societies and whole countries also need to act to reduce methane emissions [4]. But if we need to fight both CO_2 *and* methane to protect Earth's climate, does that mean the fight will be *twice as hard*? Fortunately, there are some really good ways to reduce both gases at once (Figure 3)! For example, remember how we said that producing fossil fuels, especially oil and natural gas, can leak lots of methane into the atmosphere? When societies work to reduce CO_2 emissions by saving energy or shifting away from fossil fuel use to renewable

sources (wind, solar, and hydroelectric power), this also cuts down on methane emissions.

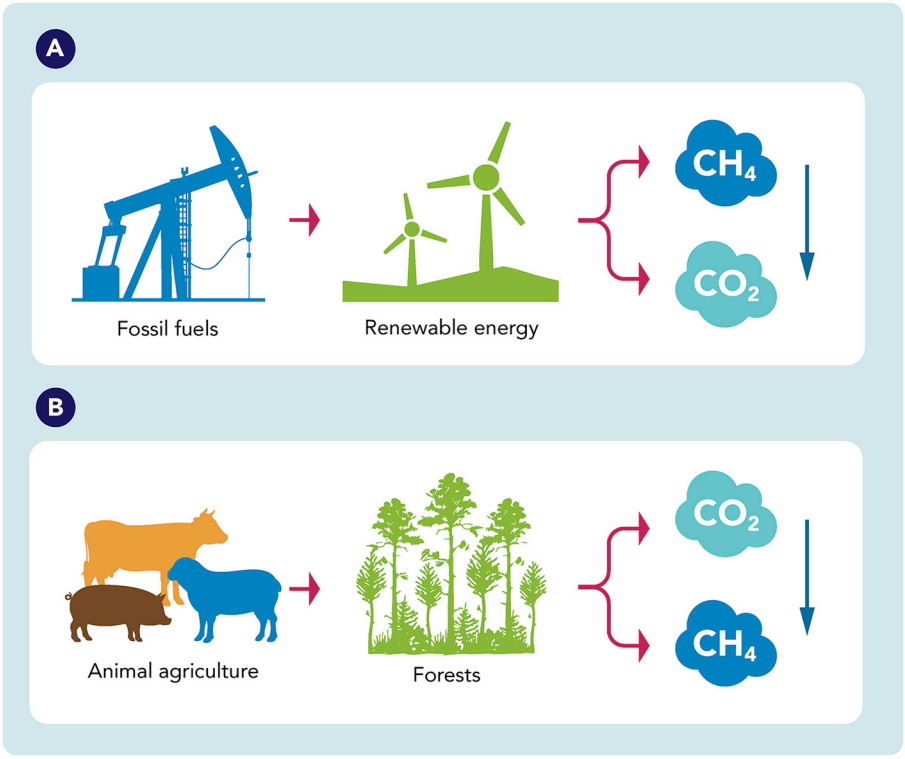

Figure 3

Even though we need to fight both CO_2 and methane emissions to protect the planet, luckily the fight is not twice as hard. **(A)** Some steps that we take to reduce CO_2 emissions can reduce methane emissions as well. For example, if we switch to renewable energy sources and use less fossil fuels, then the methane that is accidentally leaked during fossil fuel production will also be reduced. **(B)** Conversely, if we try to reduce methane emissions by eating less meat and animal products, trees could be planted on the land formerly needed to raise animals—and trees reduce CO_2 through photosynthesis.

The opposite scenario is true, too—strategies for reducing methane emissions can have the good "side effect" of decreasing CO_2. Did you know that methane itself can be used as a fuel, as it is the main component of natural gas? If methane is captured from landfills or farm waste before it escapes into the atmosphere, it can be burned to generate electricity and heat. Although burning methane produces CO_2, when we burn the type of methane produced by bacteria, it does not add CO_2 to the atmosphere like burning fossil fuels does. Because the bacteria are breaking down organic material that took the CO_2 from the atmosphere very recently, we are basically just putting it right back, not adding to the overall amount. Also, as we discussed earlier, changing our eating habits can decrease methane emissions... but can eating less meat also reduce CO_2 emissions? The answer is yes! If fewer animals are needed for food, the vast amounts of land needed to raise animals could instead be used to grow trees or other plants that help to remove CO_2 from the atmosphere! Overall, you can see that reducing methane and CO_2 are not just two separate steps we need to take to reduce greenhouse gases—they can work together to help us protect the planet.

So, spread the news: while CO_2 often gets center stage in the fight against climate change, methane, a less "famous" but very powerful greenhouse gas, is also warming up our planet. While it might be

neglected, the effect of methane on our climate, especially in the short term, is undeniably strong. By understanding methane's sources, effects, and the power every one of us has to fight methane emissions, we can work to nab both the main "bad guy", CO_2, and its stealthy sidekick, methane—important steps toward a cooler, safer world.

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YOUNG REVIEWERS

MOMO, AGE: 12

Momo loves to travel the world and see new places. Even so, she is a self-proclaimed couch potato when she's at home. The two extremes can coexist in one person! Her favorite couchmate is her fuzzy and affectionate dog, Lita.

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