Acta Scientific MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 9 Issue 3 March 2025

Review Article

CO_2, Methane, and the Benefits of Elevated Greenhouse Gases for Planetary Health

Robert Oldham Young*

Department of Research, Innerlight, Biological Research and Health Education Foundation, USA

***Corresponding Author:** Robert Oldham Young, Department of Research, Innerlight, Biological Research and Health Education Foundation, USA.

DOI: 10.31080/ASMS.2025.09.2033

Received: December 12, 2024

Published: February 12, 2025

Abstract

CO_2 and methane are often portrayed as detrimental to Earth's climate, yet emerging evidence highlights the positive role these gases play in supporting life on Earth. Increased CO_2 levels are driving global greening, boosting agricultural productivity, and enhancing biodiversity. Methane, while demonized, has a minuscule atmospheric concentration and short lifespan, rendering its warming potential marginal when scaled against other gases like water vapor and CO_2. Additionally, Earth's climate system is governed by an array of natural drivers that operate over millennia, including orbital cycles, solar activity, volcanic eruptions, and ocean-atmosphere interactions. This article challenges alarmist narratives surrounding greenhouse gases, emphasizing their ecological benefits and the importance of understanding natural climate drivers in crafting balanced policies.

Keywords: CO_2 Benefits; Global Greening; Agricultural Productivity; Methane Myths; Biodiversity; Natural Climate Drivers; Climate Alarmism

Introduction

CO_2 and methane have become central to the climate change narrative, with international efforts to curb these gases often ignoring their ecological benefits. Increased CO_2 levels contribute to global greening, enhanced agricultural yields, and improved water-use efficiency in plants [1,2]. Meanwhile, methane's relatively low atmospheric concentration and short-lived nature make its climate impact negligible when compared to water vapor and CO_2 [3,4]. Furthermore, Earth's climate is shaped by natural drivers such as solar cycles, volcanic activity, and oceanic interactions that have regulated temperatures for millennia [5,6]. This article critically examines these factors, debunks misconceptions, and highlights the unintended consequences of aggressive greenhouse gas policies.

In addition to CO_2 and methane, other greenhouse gases such as nitrous oxide (N_2O) and water vapor also contribute to the greenhouse effect. Although these gases are not the main focus of this review, their roles in climate dynamics are noteworthy. N_2O, for example, is a potent greenhouse gas with long atmospheric longevity, while water vapor acts as a natural amplifier of warming effects [43,44].

CO_2: The Lifeblood of Vegetation and Agriculture Global Greening

Satellite data reveal that increased CO_2 levels have driven significant global greening, with 25–50% of Earth's vegetated areas experiencing growth [7,8]. Key mechanisms include:

- **Enhanced Photosynthesis:** CO_2 is a critical input for photosynthesis. Elevated levels accelerate this process, enabling plants to grow faster and larger [9,10].
- **Improved Water-Use Efficiency:** Higher CO_2 reduces plant transpiration rates, allowing vegetation to thrive in arid and semi-arid regions [11,12].

Empirical evidence

- **Satellite Observations:** Zhu., *et al*. (2016) reported greening trends in sub-Saharan Africa, India, and the Amazon, demonstrating the global impact of CO_2 fertilization [8,13].
- **Desert Reclamation:** Elevated CO_2 has contributed to re-greening semi-arid regions, such as the Sahel in Africa, improving land productivity and combating desertification [14].

CO_2 and agricultural productivity crop yields and food security

Higher CO_2 levels have substantial benefits for agricultural systems

- **Increased Crop Yields:** Elevated CO_2 improves the growth rates of staple crops like wheat, rice, and maize [15,16].
- **Better Resource Efficiency**: Plants exposed to higher CO_2 require fewer nutrients and water, reducing dependency on synthetic fertilizers [17,18].

Meeting global food demand

Improved yields are critical for addressing food security as the global population grows. The United Nations Food and Agriculture Organization (UNFAO) reported significant increases in global grain production, attributed partly to the effects of rising CO_2 [19,20].

Methane: A Misunderstood gas contextualizing methane's role

Methane (CH_4) comprises only 1.9 ppm of the atmosphere, a minuscule fraction compared to CO_2 (~420 ppm) and water vapor (~10,000–40,000 ppm) [21,22]. Its key characteristics include:

- **Short Lifespan:** Methane naturally breaks down within a decade, converting into CO_2 and water vapor [23,24].
- **Overlapping Absorption Bands:** Methane's warming potential diminishes due to overlap with water vapor's absorption spectrum [25,26].

Natural drivers of climate change

Despite its lower atmospheric concentration, methane plays a significant role in climate dynamics due to its higher global warming potential compared to CO_2 over short timescales. Methane emissions from natural sources such as wetlands, as well as anthropogenic activities like agriculture and fossil fuel extraction, require careful consideration in climate models and policy discussions [45,46].

Policy implications

Methane policies, especially those targeting agricultural emissions and fossil fuel extraction, must balance climate objectives with economic and ecological considerations. While reducing methane emissions could mitigate short-term warming, it is essential to avoid unintended consequences, such as disruptions to food systems and ecosystems reliant on livestock. This highlights the need for comprehensive strategies that address both CO_2 and methane in an integrated manner [47,48].

Debunking the alarmism

While methane traps more heat per molecule than CO_2, its low concentration and rapid breakdown significantly reduce its climate impact. Targeting methane emissions, especially from livestock, diverts attention from more significant climate drivers like water vapor and solar cycles [27,28].

Biodiversity and ecosystem resilience

Elevated CO_2 levels support broader ecological health

- **Forests:** Enhanced tree growth increases carbon sequestration, provides wildlife habitat, and contributes to ecosystem stability [29,30].
- **Grasslands and Wetlands:** Increased CO_2 promotes plant diversity, improving ecosystem resilience and supporting herbivores [31,32].
- **Wildlife:** Greater vegetation cover boosts food availability and habitat quality, benefiting terrestrial and aquatic species [33,34].

Natural drivers of climate change

Milankovitch cycles

Milankovitch Cycles describe long-term changes in Earth's orbit, tilt, and axial wobble that regulate glacial and interglacial periods [35,36]:

- **Eccentricity (100,000 years):** Affects the shape of Earth's orbit and solar radiation distribution.
- **Obliquity (41,000 years):** Alters axial tilt, influencing seasonal contrasts.
- **Precession (26,000 years):** Changes the timing of seasons relative to Earth's orbital position.

Solar activity and volcanism

- **Solar Activity:** The Sun is the primary energy source for Earth's climate. Variations in solar output, such as sunspot activity and solar minimums, significantly impact temperatures [37,38].
- **Volcanism:** Volcanic eruptions release gases and aerosols that can cool or warm the planet. For example, Mount Tambora's eruption in 1815 caused the "Year Without a Summer" [39,40].

Ocean-atmosphere interactions

Phenomena such as the El Niño-Southern Oscillation (ENSO) and thermohaline circulation redistribute heat globally, driving regional climate variability independently of greenhouse gas concentrations [41,42].

Policy implications

Unintended consequences of CO_2 reduction

- **Food Security Risks:** Lower CO_2 levels could reduce crop yields, exacerbating global hunger [19,20].
- **Ecosystem Trade-Offs:** Policies to curb CO_2 may limit global greening and biodiversity improvements [11,12].

A balanced approach

Efforts to address environmental challenges should:

- Recognize the ecological and agricultural benefits of CO_2.
- Focus on reducing pollutants without undermining natural processes that sustain life.

Conclusion

CO_2 and methane are essential components of Earth's climate and biosphere. CO_2 drives global greening, enhances agricultural productivity, and supports biodiversity, while methane's role in warming is exaggerated. Additionally, natural climate drivers such as solar cycles, volcanic activity, and ocean-atmosphere interactions play critical roles in shaping global temperatures. Alarmism around greenhouse gases risks undermining food security, ecosystem resilience, and economic stability. A rational approach to climate policy must acknowledge the complexity of natural systems and prioritize solutions that protect both human and environmental health.

Bibliography

1. Ainsworth EA and Long SP. "What have we learned from 15 years of free-air CO_2 enrichment (FACE)?" *New Phytologist* 165.2 (2005): 351-372.
2. Zhu Z., *et al*. "Greening of the Earth and its drivers". *Nature Climate Change* 6.8 (2016): 791-795.
3. Taiz L., *et al*. "Plant Physiology and Development". *Sinauer Associates* (2015).
4. Franks P J., *et al*. "Sensitivity of plants to changing atmospheric CO_2". *New Phytologist* 197.4 (2013): 1077-1094.
5. Leakey AD., *et al*. "Elevated CO_2 effects on plant carbon, nitrogen, and water relations". *Journal of Experimental Botany* 60.10 (2009): 2859-2876.
6. Idso CD. "The Positive Externalities of Carbon Dioxide". Center for the Study of Carbon Dioxide and Global Change (2013).
7. NASA. "Carbon Dioxide Fertilization Greening Earth, Study Finds" (2016).
8. de Jong R., *et al*. "Spatial relationships between climatologies and global vegetation changes". *Global Change Biology* 19 (2013): 1953-1964.
9. UNFAO. United Nations Food and Agriculture Organization: World Grain Production 1961-2012 (2012).
10. Lisiecki LE and Raymo ME. "A Pliocene-Pleistocene stack of 57 globally distributed benthic δ18O records". *Paleoceanography* 20.1 (2005): PA1003.
11. Huybers P. "Early Pleistocene glacial cycles and the integrated summer insolation forcing". *Science* 313.5786 (2006): 508-511.
12. Lean JL. "Sun-climate connections". *Science* 361.6404 (2018): 10-15.

13. Shaviv N J. "Cosmic ray diffusion from the galactic spiral arms, iron meteorites, and a possible climatic connection". *Physical Review Letters* 89.5 (2002): 051102.

14. Robock A. "Volcanic eruptions and climate". *Reviews of Geophysics* 38.2 (2000): 191-219.

15. Trenberth KE. "The definition of El Niño". *Bulletin of the American Meteorological Society* 78.12 (1997): 2771-2777.

16. Svensmark H. "Cosmoclimatology: A new theory emerges". *Astronomy and Geophysics* 48.1 (2007): 1.18-1.24.

17. Beer J., *et al*. "The role of the sun in climate forcing". *Quaternary Science Reviews* 19.1-5 (1990): 403-415.

18. Huntington TG. "Evidence for intensification of the global water cycle: Review and synthesis". *Journal of Hydrology* 319.1-4 (2006): 83-95.

19. Molnar P and Cane M A. "El Niño's role in the late Cenozoic evolution of climate". *Nature* 415.6873 (2002): 849-853.

20. Boden T A., *et al*. "Global CO_2 emissions from fossil-fuel burning, cement manufacture, and gas flaring". *Carbon Dioxide Information Analysis Center* (2016).

21. Ciais P., *et al*. "Carbon and other biogeochemical cycles". In IPCC Fifth Assessment Report (AR5) (2013).

22. Stern DI. "Explaining global sulfur emissions". *Journal of Environment and Development* 11.2 (2002): 189-204.

23. HadCRUT4. "The Hadley Climate Research Unit annual global mean surface temperature dataset" (2017).

24. Idso CD and Idso SB. "Climate Change Reconsidered II: Biological Impacts". *Heartland Ins*titute (2014).

25. Munier S., *et al*. "Satellite Leaf Area Index: Global Scale Analysis of the Tendencies Per Vegetation Type Over the Last 17 Years". *Remote Sensing* 10.3 (2018): 424.

26. Stocker TF., *et al*. "The Physical Science Basis". In IPCC Fifth Assessment Report. Cambridge University Press (2013).

27. Wuebbles DJ and Hayhoe K. "Atmospheric methane and global change". *Earth-Science Reviews* 57.3-4 (2002): 177-210.

28. Schaefer H., *et al*. "A 21st-century shift from fossil-fuel to biogenic methane emissions indicated by $13CH_4$". *Science* 352.6281 (2016): 80-84.

29. Pretzsch H., *et al*. "Forest stand growth dynamics in Central Europe have accelerated since 1870". *Nature Communications* 5 (2014): 4967.

30. Pan Y., *et al*. "A large and persistent carbon sink in the world's forests". *Science* 333.6045 (2011): 988-993.

31. Tilman D., *et al*. "Future threats to biodiversity and pathways to their prevention". *Nature* 546.7656 (2017): 73-81.

32. Reich P B., *et al*. "Nitrogen limitation constrains sustainability of ecosystem response to CO_2". *Nature* 440.7086 (2006): 922-925.

33. Parmesan C. "Ecological and evolutionary responses to recent climate change". *Annual Review of Ecology, Evolution, and Systematics* 37.1 (2006): 637-669.

34. Hughes L. "Biological consequences of global warming: Is the signal already apparent?" *Trends in Ecology and Evolution* 15.2 (2000): 56-61.

35. Berger A and Loutre M F. "Insolation values for the climate of the last 10 million years". *Quaternary Science Reviews* 10.4 (1991): 297-317.

36. Imbrie J and Imbrie J Z. "Modeling the climatic response to orbital variations". *Science* 207.4434 (1980): 943-953.

37. Solanki SK., *et al*. "Unusual activity of the Sun during recent decades compared to the previous 11,000 years". *Nature* 431.7012 (2004): 1084-1087.

38. Gray LJ., *et al*. "Solar influences on climate". *Reviews of Geophysics* 48.4 (2010): RG4001.

39. Timmreck C. "Modeling the climatic effects of large explosive volcanic eruptions". *WIREs Climate Change* 3.6 (2012): 545-564.

40. Sigl M., *et al*. "Timing and climate forcing of volcanic eruptions for the past 2,500 years". *Nature* 523.7562 (2015): 543-549.

41. Trenberth K E and Fasullo JT. "An apparent hiatus in global warming?" *Earth's Future* 1.1 (2013): 19-32.

42. Rahmstorf S. "Ocean circulation and climate during the past 120,000 years". *Nature* 419.6903 (2002): 207-214.

43. Ravishankara AR., *et al*. "Nitrous oxide (N_2O): The dominant ozone-depleting substance emitted in the 21st century". *Science* 326.5949 (2009): 123-125.

44. Solomon S., *et al*. "Contributions of stratospheric water vapor to decadal changes in the rate of global warming". *Science* 327.5970 (2010): 1219-1223.

45. Saunois M., *et al*. "The Global Methane Budget 2000-2017". *Earth System Science Data* 12.3 (2000): 1561-1623.

46. Schaefer H., *et al*. "A 21st-century shift from fossil-fuel to biogenic methane emissions indicated by $13CH_4$". *Science* 352.6281 (2016): 80-84.

47. Smith P., *et al*. "Agriculture, Forestry, and Other Land Use (AFOLU)". In Climate Change 2014: Mitigation of Climate Change. IPCC Fifth Assessment Report (AR5) Cambridge University Press (2014).

48. Wuebbles D J and Hayhoe K. "Atmospheric methane and global change". *Earth-Science Reviews* 57.3-4 (2002): 177-210.