CARBON EMISSIONS AND ATMOSPHERIC CO_2
A concise, scientific explanation

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The following is a concise, scientific explanation of the email recently sent to the Canadian Prime Minister. The email's subject line is "The Misguided Narrative on Carbon Emissions".

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Carbon Emissions and Atmospheric CO_2

This email addresses a critical question regarding carbon emissions from fossil fuels and their impact on atmospheric CO_2 levels. It provides a clear and concise explanation based on scientific principles.

Question

Do carbon emissions (commonly referred to as carbon dioxide or CO_2) increase the CO_2 content of the atmosphere?

Answer

No, the impact is negligible. From a practical perspective, the increase in atmospheric CO_2 due to carbon emissions is so small—approximately 0.0006 parts per million (ppm) annually—that it is effectively inconsequential and cannot be measured with precision. Below, I explain why this is the case.

Explanation

The Earth's carbon cycle involves a complex system where CO_2 is stored primarily in the atmosphere and oceans, collectively referred to as the "System." The oceans contain approximately 50 times more CO_2 than the atmosphere, with a total carbon content of roughly 40,000 gigatons of carbon (GtC).

CO_2 in the System interacts through both physical and chemical processes:

Physical Interaction (Henry's Law): CO_2 in the atmosphere (CO_2 (g)) is in equilibrium with dissolved CO_2 in the ocean's surface layer (CO_2 (aq)), as described by:
CO_2 (g) ⇌ CO_2 (aq)

Chemical Reactions: CO_2 reacts with highly buffered seawater, striving for chemical equilibrium through the following reactions:

CO_2 (g) + H_2O ⇌ H_2CO_3(aq)

H_2CO_3(aq) ⇌ CO_2(aq) + H_2O

H_2CO_3(aq) ⇌ H^+(aq) + HCO_3^-(aq)

HCO_3^-(aq) ⇌ H^+(aq) + CO_3^{2-}(aq)

$CaCO_3$(s) ⇌ Ca^{2+}(aq) + CO_3^{2-}(aq)

H_2O ⇌ H^+(aq) + OH^-(aq)

These processes ensure that the System continuously adjusts to maintain equilibrium. When CO_2 is added to the System, whether from natural or anthropogenic sources, the carbon distributes across all subsystems (atmosphere, oceans) in proportion to their existing carbon content at equilibrium.

Calculation
Annual CO_2 emissions from fossil fuels are approximately 10 GtC.

The total carbon in the System is 40,000 GtC.

The proportional increase in the System’s carbon content due to fossil fuel emissions is:
(10 / 40,000) × 100 = 0.025%.

Applying this percentage to the atmosphere, where the annual CO_2 increase is approximately 2.4 ppm, the contribution from fossil fuel emissions is:
0.025% of 2.4 ppm = 0.0006 ppm.

Thus, fossil fuel emissions account for only 0.0006 ppm of the annual atmospheric CO_2 increase, with the remaining 2.3994 ppm attributable to other factors, such as rising sea surface temperatures (SST).

Conclusion

The contribution of carbon emissions from fossil fuels to atmospheric CO_2 levels is negligible, at approximately 0.0006 ppm per year. This minimal impact underscores the dominant role of natural processes, such as ocean-atmosphere interactions, in driving observed changes in atmospheric CO_2 concentrations.

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