Ideas and Perspectives Human breath raises the atmospheric CO2 and affects the climate

Bernd Lindemann[1]

[1]Universität des Saarlandes

November 24, 2022

Abstract

The CO2 emission of human breath will not increase the CO2 of the atmosphere and raise the temperature, or so science journalists forcefully claim, because the emission is recycled by green plants, which take up CO2 to generate our food. Emission and retrieval are assumed to be in perfect balance, no CO2 is left to escape into the atmosphere. This faulty argument dominated the literature for years. A correct analysis would take all CO2 fluxes into account. It would add the simultaneous emissions, including the emission of breath (B) and subtract from this sum (S) the fluxes of all sinks (P) to obtain the overall flux of CO2 escaping into the atmosphere per year (S-P). Then the escape-flux due to breath-emission is found to be b = B (1 - P/S). Thus human breath increases the atmospheric CO2 , after all.

Ideas and Perspectives

Human breath raises the atmospheric CO_2 and affects the climate

Bernd Lindemann [1]

(1) Universität des Saarlandes, UKS, Dept. Physiology, Campus Homburg, 66424 Homburg, Germany

Key point: When calculating changes in atmospheric CO_2, all fluxes of CO_2 into and out of the atmosphere must be included jointly. It is misleading to balance the flux of just one emitter to equilibrium and conclude that this emitter will not affect the atmosphere.

Abstract

The CO_2 emission of human breath will not increase the CO_2 of the atmosphere and raise the temperature, or so science journalists forcefully claim, because the emission is recycled by green plants, which take up CO_2 to generate our food. Emission and retrieval are assumed to be in perfect balance, no CO_2 is left to escape into the atmosphere. This faulty argument dominated the literature for years. A correct analysis would take all CO_2 fluxes into account. It would add the simultaneous emissions, including the emission of breath (B) and subtract from this sum (S) the fluxes of all sinks (P) to obtain the overall flux of CO_2 escaping into the atmosphere per year (S-P). Then the escape-flux due to breath-emission is found to be b = B (1 – P/S). Thus human breath increases the atmospheric CO_2 , after all.

Keywords: Climate, CO_2, Respiration, Footprint, CO_2-cycle.

Acknowledgements. Professor Karl-Ernst Kaissling (Max Planck Institut, Seewiesen, Starnberg, Germany) and Professor Bert Menco (Northwestern University, USA) and Dr. Christian Reick, Max-Planck-Inst. for Meteorology, Hamburg, provided valuable comments. Thank you!

Data Availability Statement: “There are no data associated with this publication”.

Plain Language Summary

The carbon-dioxide (CO_2) emission of human breath, summed over mankind, amounts to values which should be able to alter the climate. Yet the emission will not increase the CO_2 level of the atmosphere and raise the temperature with the greenhouse effect, or so science journalists forcefully claim, because the emission is recycled by green plants, which take up CO_2 to generate our food. Emission and retrieval are assumed to be in perfect balance, no CO_2 is left to escape into the atmosphere. This argument, however, is faulty. A correct analysis would take all CO_2 fluxes into account. It would add the simultaneous emissions, including the emission of breath (B) and subtract from this sum (S) the fluxes of all sinks (P) to obtain the overall flux of CO_2 escaping into the atmosphere per year (S-P). Then the smaller escape-flux due to breath-emission amounts to b = B (1 – P/S). Thus human breath increases the atmospheric CO_2 , after all.

Prof. Dr. Bernd Lindemann
Universität des Saarlandes
UKS, Dept. Physiology
Campus Homburg
Eschenweg 12
66424 Homburg, Germany
049 6841 62349
mail@bernd-lindemann.de

Introduction: The breathing of 7,7 10^9 humans already emits more than 2 pentagram of CO_2 per year [e.g.Palmer, 2009], reaching climatic significance. However, an effect of this emission on atmosphere and climate was forcefully denied by several authors of www-contributions, because the emission is recycled by green plants, which take up CO_2 to generate our food [Alexander, 2010; Palmer, 2009; Withers, 2009]. Emission and retrieval are assumed to be in perfect balance, no CO_2 is left to escape into the atmosphere.

This somewhat surprising result, which has dominated the literature for years, will now be reconsidered. Can we expect an effect of breath-emission on the atmospheric CO_2 content? To answer this we estimate the atmospheric change in CO_2 due to breathing in relation to the change arising from all emitters of CO_2.

Definitions: Let the constant fluxes of CO_2 into and out of the atmosphere be

B = emission due to human breathing [Pg CO_2 / year]
D = emission due to breathing of animals
E = other emissions
F = emission due to burning of fossil fuels
S = B + D + E + F

Q = re-uptake of CO_2 by photosynthesis [Pg CO_2 / year]
T = re-uptake of CO2 by binding to solids on land and in oceans
U = other re-uptake.
P = Q + T + U

AF = Airborne fraction = (1 – P / S), about 45% [*Ciais and al.*, 2013: p.544; *Gloor et al.*, 2010: p.7742; *Goosse*, 2015: p.59; *Keeling*, 1973].
EF = escape-flux = S – P = AF $*$ S. Airborne net-flux of CO_2 directed into or out of the atmosphere, escaping re-uptake.

Derivations: The emissions B,D,E,F share a limited CO_2 re-uptake capacity P. Emitted CO_2 in excess of P escapes into the atmosphere. We add all emission fluxes, B + D + E + F = S and subtract from them all re-uptake fluxes Q + T + U = P. The result S - P is already the airborne escape-flux of CO_2 into the atmosphere. This overall EF is the fraction of an emission escaping re-uptake, summed over all emissions.

Let the EF of single emissions into the atmosphere be b, d, e, f. Their relative values b/B, d/D, e/E, f/F are the same across all emitters, because the CO_2 gas arising from different sources in different rates is physically indistinguishable. It can distribute in one way only, as AF. Then the relative EFs are

$$b / B = d / D = e / E = f / F = 1 – P / S = AF.$$

The single-emission escape-fluxes amount to

$$b = B (1 – P / S), \quad d = D (1 – P / S), \quad e = E (1 – P / S), \quad f = F (1 – P / S),$$

Each single EF depends on S, therefore it depends on all the other emissions which add into S. With P < S the equations indicate under-compensation of S by P, rather than perfect balance (S = P). **The flux b is our result. It indicates the rate of change of atmospheric CO_2 due to the breathing of men.**

Perfect balance or b = 0 results only when S = P. This condition, however, is the divide which separates the range of over-compensation (S < P) from the range of under-compensation (S > P). It is unlikely that S, being the sum of four unrelated constant fluxes, should exactly equal P, the sum of another three unrelated constant fluxes. With S = P unlikely, perfect balance is unlikely too.

Note that perfect balance would extend over all emissions jointly. To have only one of several emissions in flux-equilibrium is impossible. Further, emissions due to, say, the burning of fossil fuel and those due to breathing of animals (or, generally, to the consumption of photosynthetic products) are treated equally, as their escape-flux is equally based on B, D, E, F sharing Q, T and U. Thus all CO_2-cycling is done between S and P in a macro-cycle, there is no need for additional small cycles involving just one of several emitters.

Small-cycles: The approach of Brian Palmer and other authors of www-contributions is different. It begins by noting that the CO_2 liberated by breathing was taken up before by (a small part of) photosynthesis. The CO_2 is caught in a small breathe-out-and-take-up cycle of perfect balance, therefore cannot affect atmospheric CO_2. The same is true for all emitters which utilise molecular products of photosynthesis for food. Only the burning of fossil fuel, the CO_2 of which is taken to be not recycled, can increase the CO_2-content of the atmosphere [*Alexander*, 2010; *Palmer*, 2009; *Withers*, 2009].

The initial assumption of these authors is that any small-cycle, which involves just one emitter feeding on photosynthetic products, goes along with perfect balance, the EF is always = 0. Thus analysis is restricted to S=P. This restriction seems unnecessary and, in fact, misleading, since an establishment of the condition S=P, which separates the range P>S from P<S, is very unlikely, as detailed above.

Further, breath emission covers more than the single point S=P, for which alone the conclusion is true. Human breathing is well possible in the ranges S<P (or b<0) and S>P (or b>0), where an effect on the atmospheric CO_2 is obvious. It is described by b = B (1 – P / S), where b is the airborne breath emission of humans.

The conclusion that human breath emission B cannot affect the atmosphere is based on the faulty assumption that emissions other than the one in focus can be disregarded. Rather, when calculating changes in atmospheric CO_2, all fluxes of CO_2 into and out of the atmosphere must be considered jointly. It is misleading to balance the flux of just one emitter to equilibrium and conclude that this emitter will not affect the atmosphere.

In conclusion: Breath-CO_2 is expected to increase atmospheric CO_2 , thus enhancing the greenhouse-effect and raising the global temperature. Not only industrial activity but even the physiological processes of our body affect the climate, provided the population of CO_2-emitting humans and animals becomes large enough.

References

Alexander, K. (2010). "https://www.klimafakten.de/behauptungen/behauptung-wer-atmet-verstaerkt-den-treibhauseffekt (Toralf Staud, redaction) ".

Ciais, P. and e. al. (2013). "Carbon and other biogeochemical cycles." Climate Change: The physiccal science basis(5th assessment report).

Gloor, M., J. L. Sarmiento, et al. (2010). "What can be learned about carbon cycle climate feedbacks from the CO2 airborne fraction? ." Atmos. Chem. Phys **10**: 7739-7751.

Goosse, H. (2015). Climate System Dynamics and Modelling. Cambridge, UK, Cambridge University Press.

Keeling, C. D. (1973). The carbon dioxide cycle: Reservoir models to depict the exchange of atmospheric carbon dioxide with the oceans and landplants. Chemistry of the Lower Atmosphere. I. Rasool. New York, Plenum 251-329.

Palmer, B. (2009) "7 Billion Carbon Sinks. How much does breathing contribute to climate change?" https://slate.com/news-and-politics/2009/08/are-you-heating-the-planet-when-you-breathe.html

Withers, N. (2009) "https://www.sciencefocus.com/planet-earth/how-much-does-human-breathing-contribute-to-climate-change/ " BBC Science Focus Magazine