

Effect of CO₂ concentration on temperature in empirical experiments

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Climate change theory had intrigued me for years and because of that I began to wonder why no empirical experiment of the effects of CO₂ has been reported under natural conditions for nearly a hundred years. With cheaper electronics carbon dioxide sensors began to enter into consumer devices allowing simple experiments at a weather stations with an RH, CO₂, and temperature sensor.

The greenhouse phenomenon was first discovered by Josef Fourier in 1824 and in 1896 Svante Arrhenius published an article [1] based on moon radiation measurements made by Langley Observatory. Based on these measurements and many assumptions Arrhenius made his theory of how CO₂ and H₂O cause the greenhouse effect. He calculated that doubling CO₂ concentration would increase the temperature about 5 °C which is still valid based mainly on Arrhenius' studies.

At the time of Arrhenius no measurements were available over the 8µm range so his data did not cover for example the 15µm band and in the light of current knowledge he mixed H₂O and CO₂ absorption bands highlighting the importance of CO₂. The single-layer greenhouse effect model used by Arrhenius gives almost zero temperature rise when doubling carbon dioxide if realistic carbon absorption values are used [2].

The great critic of Arrhenius theory among the contemporaries was Knut Ångström [3] whose assistant Mr Koch conducted an experiment in Tenerife in 1896 where two 40 cm glass tubes were placed side by side in a wooden tube that could be adjusted precisely in the direction of solar radiation. One of the tubes was filled with clean air and the other with CO₂. The experiment was repeated several times for three days and based on the measurements the CO₂ containing tube was not found to absorb IR radiation any better than the control tube with pure air.

After that Mr. Koch made laboratory tests to measure the thermal radiation of the earth at temperatures of 100 °C, 80 °C and 72 °C. At a temperature of 100 °C and a pressure of 780 mm Hg it was found that 10% of the CO₂ absorption remained on the 30 cm layer. When the pressure was reduced to 2/3 it accounted for 0.4% of total radiation. Referring to the above mentioned Ångström concluded that no more than about 16% of the earth's thermal radiation could be absorbed by CO₂ and secondly that the overall absorption is very little dependent on changes in atmospheric carbon dioxide.

One of the Arrhenius contemporaries Professor R.W. Wood [4] also conducted his own experiments with glass and rock salt plates. He built enclosed greenhouses with these plates but he did not observe any significant temperature difference between the glass or rock salt covered greenhouses so he concluded that Arrhenius conclusions on radiative forcing could not be true.

After the experiments of Knut Ångström and R.W.Wood there was apparently no need for other experiments and the matter was buried until it came up again with theories of climate change. It is strange however that experiments with today's technology and instruments have not been reported although they could be assumed to have been performed.

Due to the above I performed a simple experiment on pairs of test containers that lasted about a year. From summer 2019 to summer 2020 I tested the effect of CO₂ on different pairs of test containers under natural conditions. Inside the test containers were weather station sensors with a carbon dioxide sensor to monitor the CO₂ concentration in addition to the normal weather sensors. One of the test containers had outdoor air and the other had an elevated CO₂ concentration. Initially the concentration of the control container was about 1000 ppm and then 5000 ppm or more. The test series of the year produced just over 113260 measurements [5].

In practice the sensors were inside closed test containers and the measurement data was transferred by radio to a base station which transferred the data to a cloud server where the results were and still are readable. In practice the measurement events were fully automated and the only task left was to monitor that the carbon dioxide content of the control container remained correct.

Arrhenius's assumption was based on the idea that back-radiation of the greenhouse gas would amplify the greenhouse effect as concentrations increase. Like Professor Wood did in his study it was worth testing whether the material in the test container somehow affects the result. In principle glass does not transmit ground level radiation but PET plastic and for example fresh film allow heat radiation to pass through from the earth's surface. Therefore the test containers were both glass and various plastic containers. If the greenhouse theory were to be valid in the 15 μ m area there should have been a significant temperature difference in the CO₂ concentrations used in the test containers. The sizes of the test containers ranged from just under a liter to about 50 liters and the materials ranged from glass to PET plastic and further to fresh film.

None of these variations produced a noticeable temperature difference between the test containers. Therefore the CO₂ concentration does not seem to have any effect on the greenhouse effect around the 15 μ m range. The result would confirm prof. Wood's 1909 observation that the greenhouse effect would be explained by the lack of convection in a confined space.

The majority of the experimental stages were such that the CO₂ concentration was 10 times or even higher but no significant change in temperature was observed between the experimental containers in the one-year experiment. Small temperature differences arose between the test containers presumably because the containers came and went into the shade at somewhat different times. Likewise the shadows of the clouds hit the test containers slightly apart at slightly different times. The average temperature difference between the test containers was -0.019 °C. Both test containers developed a similar greenhouse phenomenon in the sunshine regardless of CO₂ concentration.

The measurements are confirmed by the observations and interpretations made by Prof. Wood and Ångström in the early 20th century. Perhaps my experiments are a bit more unscientific but the measurement tools are incomparably better and collecting observations every few minutes to cloud gives a completely different way to monitor phenomena.

The experiments show that greenhouse theory arguments that the aim to explain the practical warming of a greenhouse with radiative forcing are false. Although the rise in temperature in cars, homes and greenhouses is due to the absorption of greenhouse gases the energy absorbed is relaxed through collisions into the movement of all air gas particles which raises the temperature.

If convection in the former is inhibited then the temperature rises until it reaches equilibrium with the heat leakage. In practical greenhouses there isn't radiative forcing or back radiation which appears in the more detailed research reports of reference 5.

Perhaps the value of the experiment is that it highlights that no empirical experiment on the effects of CO₂ has been published to since the beginning of the early 1900. I have shared the results among some physicists and climate scientists. Based on the feedback I received I am apparently not the first to perform such an experiment but for some reason empirical experiments have not been reported to the public whether they were of this type or repetitions of Mr. Koch's experiment.

References

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[4] R.W. Wood, (1909) XXIV. Note on the theory of the greenhouse, The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 17:98, 319-320, DOI: 10.1080/14786440208636602

[5] Antti M. Järvenpää; Practical experiments of absorption at the room temperature and the solar radiation; 20.9.2019; document In_Out201909c.pdf and One GHG report 31.5.2021, in www page <http://antti.jarvenpaa.fidisk.fi/ilmastonmuutos/index.html> The site also contains the full data set of the study, which can be downloaded as a csv file