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Only the Greenhouse Gas, Water Vapor, Measurably Warms the Earth

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Abstract:

Data is available for the 61 greenhouse gases (GHGs) in Table 2.14 of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) to calculate their contribution to global warming in degrees Celsius. The procedure is described in the recently published study Reliable Physics Demand Revision of the IPCC Global Warming Potentials. In the current study, the contribution was calculated for each 61 GHG. The sum of the contributions of the 61 GHGs was 0.00833°C out of 26°C, which, for this example, is the difference in temperature between Pond Inlet and Amsterdam. This amount of temperature is too small to measure. Thus, with all other GHGs except water vapor eliminated as warming gases, water vapor is the only GHG that causes measurable warming of the Earth's atmosphere. This is the exact result of the mathematical model of the Earth's atmosphere developed in 1904 by Willis Carrier, i.e., the psychrometric chart, which is now a computer program, i.e., Humidair. Thus, the two methods used 120 years apart are robust and give the same result, confirming the unique role of water vapor in the temperature of Earth's atmosphere and the virtually non-temperature role of the 61 GHGs.

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1. INTRODUCTION

This study continues our previous research, the *Reliable Physics Demand Revision of the IPCC Global Warming Potentials*, which can be accessed at <https://doi.org/10.29169/1927-5129.2024.20.05>. The findings of that study revealed that the warming effect of carbon dioxide (CO₂) at 418 ppm was 0.00829°C out of 26°C, in an example where 26°C is the temperature difference between Pond Inlet and Amsterdam. Additionally, the study demonstrated that the warming effects of methane (CH₄) and nitrous oxide (N₂O) are too small to measure.

Our current research is comprehensive, aiming to estimate the warming effect of all 61 greenhouse gases (GHGs) listed in Table 2.14 of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) [1]. The results of this study are Excel calculations for greenhouse gases in Table 2.14 of AR4 Rev 3.xlsx. This is the file "Excel calculations for GWP Mar 10 2024.xlsx" of Reference [2], with Sheet 2 added. Sheet 2 provides the warming effects of the 61 GHGs in Table 2.14 expressed as degrees Celsius in column Q.

Except for CO₂, CH₄, and N₂O, the remaining GHGs in Table 2.14 are measured in ppt, parts per trillion. Although the amounts of some gases were not

available, they are probably less than those with values assigned.

Measuring the amount of each gas in the atmosphere as parts per trillion in dry air is possible. Using the method of Reference [2], this measured amount can be used to estimate the warming in degrees Celsius.

Table 2 of Reference [2, 3] represents a proven method for calculating the grams of a specific gas per kilogram of dry air. Another example is sulfur hexafluoride (SF₆), which, according to Table 2.14, has the highest SAR (100-yr) value of 23,900. In Table 2 [2], SF₆ falls under "trace species." The concentration value of SF₆ is 8.5 ppt, which is $(8.5/1,000,000,000) = 0.000000085$ ppt = 0.0000000000000085ppm. From this value, the moles of SF₆ per mole of dry air is 0.00000000000000000085 moles per mole of dry air. From line 42 and Cell Q42, the contribution of SF₆ to the 26°C between Pond Inlet and Amsterdam is 0.0000000045°C. This robust value is too small to have a measurable effect on the Earth's temperature.

2. THE PSYCHROMETRIC MODEL

The psychrometric mathematical model of the Earth's atmosphere is a graph, as in Figure 1. It is robust and has proven reliable and accurate since 1904 through the practical experience of many Heating, Ventilation,

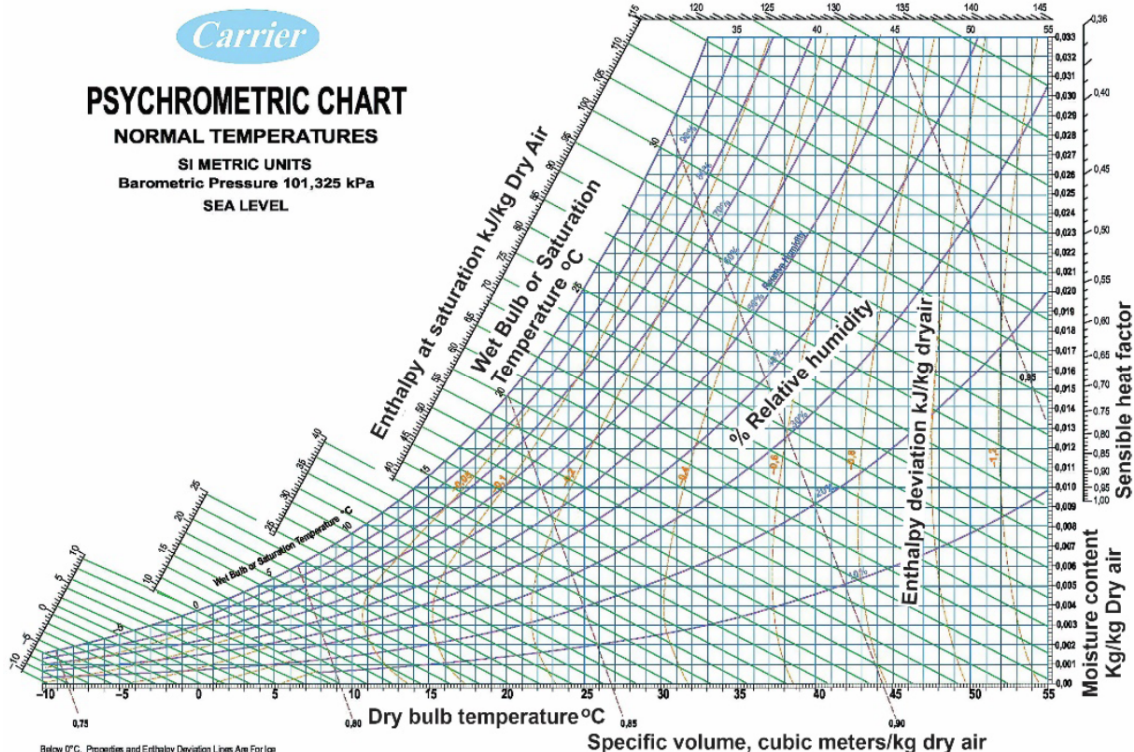


Figure 1: The psychrometric chart developed by Willis Carrier in 1904.

and Air Conditioning Engineers who used it to design ventilation systems for various building types. The chart [4] was the primary source of psychrometric information until the Humidair [5] computer program under the Excel spreadsheet was developed. A different but free online version is now available [6].

Table 1 shows the nine most common psychrometric properties of the Earth’s atmosphere that are included in the psychrometric chart of Figure 1.

Table 2 shows a partial listing of the many capable scientists who provided the science Willis Carrier used to construct the psychrometric chart.

Both tables are adapted from Tables 1 and 2 from Reference [4] for improved legibility.

Water vapor in the psychrometric model relies on the measurable properties in Table 1: dry bulb and wet bulb temperatures, dew point, relative humidity, and barometric pressure. Specific enthalpy, specific volume, humidity ratio, and water vapor pressure can be calculated.

The psychrometric model uses water vapor as the only GHG affecting the Earth’s temperature. It does not include warming by CO₂ and the other GHGs in Table

2.14. We now know why—the warming effects of the different GHGs, except water vapor, are too small to measure. That is why the competent scientists listed in Table 2 could not find their warming effects.

3. METHODOLOGY

The methodology is the same as that used in *Reliable Physics Demand Revision of the IPCC Global Warming Potentials* [2]. The calculations for this study are in the file: “Excel calculations for GWP with Sheet 2 May 14 2024.xlsx.” Row 6 for CO₂ in Sheet 2 is the same as Row 13 in Sheet 1. Thus, the reader can see that the calculations for CO₂ are the same in both rows. This confirms that the calculations are the same. The calculations for all the GHG gases in Table 2.14 use the same method.

The method is to determine the moles of CO₂ per mole of dry air, calculate the grams of CO₂ per kilogram of dry air, and use the specific volume ratio to convert the grams of CO₂ from the value at Pond Inlet to the value at Amsterdam. Then, the change in the heat content of the CO₂ from Pond Inlet to Amsterdam will be calculated. Knowing the degrees Celsius from Pond Inlet to Amsterdam of 26°C and the difference in heat content of 39.2kJ (cell AD13, Sheet 1), calculate the kilojoules per degree Celsius of 1.508. Divide the

Table 1: Nine of the most Common Psychrometric Properties of the Earth’s Atmosphere [4]

Measurable psychrometric properties				Calculable psychrometric properties			
Description	Symbol	SI unit	IP unit	Description	Symbol	SI unit	IP unit
Dry bulb Temp.	T db	°C	°F	Specific Enthalpy	h	KJ/Kg	Btu/lb
Wet bulb Temp.	Twb	°C	°F	Specific Volume	V	M ³ /kg	Ft ³ /lb
Dew Point Temp.	T dp	°C	°F	Humidity Ratio	W	kg _m /kg _{da}	lb _m /lb _{da}
Relative Humidity	RH	%	%	Water vapour pressure	Pwh	Pa	In Hg or psia
Barometric	P	Pa	In Hg or psia				

Table 2: A Partial Listing of Scientists who Contributed to Psychrometric Data Before 1900 [4]

James Apjohn	J.F. Daniell	Charles LeRoy
Ludwig Achim von Arnim	Francesco Eschinardi	John Leslie
Richard Assman	Gabriel Daniel Fahrenheit	Charles P. Marvin
Ernest Ferdinand August	William Ferrel	Edme Mariotte
Amadeo Avogadro	Joseph Louis Gay-Lussac	Sir Isaac Newton
Carl Wilhelm Böckman Jr.	James Glaisher	Blaise Pascal
August Bravais	James Hutton	Joseph Priestly
Anders Celsius	James Ivory	Henri Victor Regnault
Jacques Alexander César Charles	Julius Juhlin	Bénédict de Saussure
John Dalton	Antoine Laurent Lavoisier	C.W. Scheele

difference in heat content of CO₂ by 1.508 to obtain the temperature contribution of CO₂ at 0.00829°C (cell Q6, Sheet 2).

Cell Q74 (Sheet 2) is the sum of all the GHGs in Table 2.14, 0.00833°C. It is close to the value for CO₂ alone, 0.00829, in cell Q6 (Sheet 2). Of the GHGs that are too small to measure, CO₂ is $(0.00829/0.00833) = 99.5\%$ of the total. The values at two significant figures are the same, i.e., 0.0083°C.

The amount of most gases in parts per trillion (ppt) can be found on the Internet. The source for each value used in this study is in column "Q."

4. DISCUSSION

Many scientists are unfamiliar with the psychrometric chart and the method for calculating the warming effect of CO₂ and the other "warming" gases in Table 2.14. However, the process is scientifically sound. The same processes apply to the revised Global Warming Potentials in Table 7.15 of the IPCC Sixth Assessment Report of WG1 [7].

These studies make many research studies and papers obsolete and will attract criticism. The studies are not just based on science but on proven and robust science. Any attempt to challenge our conclusions must demonstrate the scientific inaccuracies in our methods. This includes the information in Tables 2 and 3 of Reference [2] and how psychrometric data determines the enthalpy and the specific volume. These studies provide a robust foundation for future research in climate science.

Many people recognize that water vapor is the GHG that most affects the Earth's warming. They do not realize that water vapor is the only measurable GHG affecting the Earth's temperature. There is some minor warming by all 61 GHGs in Table 2.14, but the total is too small to measure. This is not a surprise because the atmosphere levels for all but CO₂ are measured as parts per trillion. That is why they are trace species.

Many climate models include warming caused by various levels of CO₂. These models give results that are usually far above the actual temperature because they include warming by CO₂ that is virtually non-existent.

Two independent methods enacted 120 years apart come to the same conclusion: water vapor is the only greenhouse gas with a measurable warming effect on

the Earth's atmosphere. Section 2 describes the method for developing the psychrometric mathematical model.

The technology used in this independent study was unavailable when the psychrometric model was developed in 1904. For example, (1) daily accurate and consistent measurements of CO₂ in the atmosphere as the number of molecules of CO₂ per million molecules of dry air; (2) measurement of many greenhouse gases as parts per trillion, ppt; (3) a large number of weather stations linked by AccuWeather; (4) AccuWeather results readily available on a smartphone; (5) the psychrometric mathematical model available as the computer program, Humidair; (6) a computer spreadsheet program, such as Excel, to facilitate calculations in Humidair and to plot graphs.

Our research, echoing Willis Carrier's conclusion in 1904, has reaffirmed that water vapor is the sole GHG that significantly warms the Earth. Despite the vast time gap, the convergence of our findings with those of Carrier underscores the robustness and enduring relevance of this understanding. This is a significant milestone in climate science.

5. CONCLUSIONS

5.1. Water vapor is the only greenhouse gas with a measurable warming effect on the Earth's atmosphere.

5.2. None of the 61 greenhouse gases identified in Table 2.14 of IPCC report AR4 have a measurable warming effect on the Earth's atmosphere. The sum of the warming effects of the 61 greenhouse gases does not have a measurable impact on the Earth's temperature.

5.3. This study's results are consistent with water vapor in the psychrometric model and confirm its validity.

5.4. The psychrometric mathematical model of water vapor in the Earth's atmosphere has been proven accurate since its invention in 1904. An excellent working knowledge of it would be helpful for anyone studying weather or climate.

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