Water Vapor Rules
the Greenhouse System

Just how much of the "Greenhouse Effect" is caused by human activity?

It is about 0.28%, if water vapor is taken into account-- about 5.53%, if not.

This point is so crucial to the debate over global warming that how water vapor is or isn't factored into an analysis of Earth's greenhouse gases makes the difference between describing a significant human contribution to the greenhouse effect, or a negligible one.

Water vapor constitutes Earth's most significant greenhouse gas, accounting for about 95% of Earth's greenhouse effect (4). Interestingly, many "facts and figures" regarding global warming completely ignore the powerful effects of water vapor in the greenhouse system, carelessly (perhaps, deliberately) overstating human impacts as much as 20-fold.

Water vapor is 99.999% of natural origin. Other atmospheric greenhouse gases, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and miscellaneous other gases (CFC's, etc.), are also mostly of natural origin (except for the latter, which is mostly anthropogenic).

Human activities contribute slightly to greenhouse gas concentrations through farming, manufacturing, power generation, and transportation. However, these emissions are so dwarfed in comparison to emissions from natural sources we can do nothing about, that even the most costly efforts to limit human emissions would have a very small-- perhaps undetectable-- effect on global climate.
For those interested in more details a series of data sets and charts have been assembled below in a 5-step statistical synopsis.

Note that the first two steps ignore water vapor.

1. Greenhouse gas concentrations
2. Converting concentrations to contribution
3. Factoring in water vapor
4. Distinguishing natural vs man-made greenhouse gases
5. Putting it all together

**Note:** Calculations are expressed to 3 significant digits to reduce rounding errors, not necessarily to indicate statistical precision of the data. All charts were plotted using Lotus 1-2-3.

**Caveat:** This analysis is intended to provide a simplified comparison of the various man-made and natural greenhouse gases on an equal basis with each other. It does not take into account all of the complicated interactions between atmosphere, ocean, and terrestrial systems, a feat which can only be accomplished by better computer models than are currently in use.

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**Greenhouse Gas Concentrations:**
Natural vs man-made (anthropogenic)

1. The following table was constructed from data published by the U.S. Department of Energy (1) and other sources, summarizing concentrations of the various atmospheric greenhouse gases. Because some of the concentrations are very small the numbers are stated in parts per billion. **DOE chose to NOT show water vapor as a greenhouse gas!**

<table>
<thead>
<tr>
<th></th>
<th>Pre-industrial baseline</th>
<th>Natural additions</th>
<th>Man-made additions</th>
<th>Total (ppb) Concentration</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>288,000</td>
<td>68,520</td>
<td>11,880</td>
<td>368,400</td>
<td><strong>99.438%</strong></td>
</tr>
<tr>
<td>Methane (CH4)</td>
<td>848</td>
<td>577</td>
<td>320</td>
<td>1,745</td>
<td><strong>0.471%</strong></td>
</tr>
<tr>
<td>Nitrous Oxide (N2O)</td>
<td>285</td>
<td>12</td>
<td>15</td>
<td>312</td>
<td><strong>0.084%</strong></td>
</tr>
</tbody>
</table>
The chart at left summarizes the % of greenhouse gas concentrations in Earth's atmosphere from Table 1. This is not a very meaningful view though because 1) the data has not been corrected for the actual Global Warming Potential (GWP) of each gas, and 2) water vapor is ignored.

But these are the numbers one would use if the goal is to exaggerate human greenhouse contributions:

Man-made and natural carbon dioxide (CO2) comprises 99.44% of all greenhouse gas concentrations (368,400 / 370,484) -- (ignoring water vapor).

Also, from Table 1 (but not shown on graph):

- **Anthropogenic** (man-made) CO2 additions comprise (11,880 / 370,484) or 3.207% of all greenhouse gas concentrations, (ignoring water vapor).

- **Total combined anthropogenic greenhouse gases** comprise (12,217 / 370,484) or 3.298% of all greenhouse gas concentrations, (ignoring water vapor).

The various greenhouse gases are **not equal** in their heat-retention properties though, so to remain statistically relevant % concentrations must be changed to % contribution relative to CO2. This is done in Table 2, below, through the use of GWP multipliers for each gas, derived by various researchers.

### Converting greenhouse gas concentrations to greenhouse effect contribution

(using global warming potential)

1. Using appropriate corrections for the Global Warming Potential of the respective gases provides the following more meaningful comparison of greenhouse gases, based on the conversion:

   \[(\text{concentration}) \times (\text{the appropriate GWP multiplier}) = \text{greenhouse contribution}.\]
TABLE 2.

Atmospheric Greenhouse Gases (except water vapor) adjusted for heat retention characteristics, relative to CO2

<table>
<thead>
<tr>
<th></th>
<th>Multiplier (GWP)</th>
<th>Pre-industrial baseline (new)</th>
<th>Natural additions (new)</th>
<th>Man-made additions (new)</th>
<th>Tot. Relative Contribution</th>
<th>Percent of Total (new)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>1</td>
<td>288,000</td>
<td>68,520</td>
<td>11,880</td>
<td>368,400</td>
<td>72.369%</td>
</tr>
<tr>
<td>Methane (CH4)</td>
<td>21 (2)</td>
<td>17,808</td>
<td>12,117</td>
<td>6,720</td>
<td>36,645</td>
<td>7.199%</td>
</tr>
<tr>
<td>Nitrous Oxide (N2O)</td>
<td>310 (2)</td>
<td>88,350</td>
<td>3,599</td>
<td>4,771</td>
<td>96,720</td>
<td>19.000%</td>
</tr>
<tr>
<td>CFC's (and other misc. gases)</td>
<td>see data (3)</td>
<td>2,500</td>
<td>0</td>
<td>4,791</td>
<td>7,291</td>
<td>1.432%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>396,658</td>
<td>84,236</td>
<td>28,162</td>
<td>509,056</td>
<td>100.000%</td>
</tr>
</tbody>
</table>

**NOTE:** GWP (Global Warming Potential) is used to contrast different greenhouse gases relative to CO2.

Compared to the concentration statistics in Table 1, the GWP comparison in Table 2 illustrates, among other things:

- **Total carbon dioxide (CO2)** contributions are reduced to 72.37% of all greenhouse gases (368,400 / 509,056)-- (ignoring water vapor).

Also, from Table 2 (but not shown on graph):

- **Anthropogenic** (man-made) CO2 contributions drop to (11,880 / 509,056) or 2.33% of total of all greenhouse gases, (ignoring water vapor).

**Total combined anthropogenic greenhouse gases** becomes (28,162 / 509,056) or 5.53% of all greenhouse gas contributions, (ignoring water vapor).

Relative to carbon dioxide the other greenhouse gases together comprise about 27.63% of the greenhouse effect (ignoring water vapor) but only about 0.56% of total greenhouse gas concentrations. Put another way, as a group methane, nitrous oxide (N2O), and CFC's and other miscellaneous gases are about 50 times more potent than CO2 as greenhouse gases.

To properly represent the total relative impacts of Earth's greenhouse gases Table 3 (below) factors in the effect of water vapor on the system.
**Water vapor** overwhelms all other natural and man-made greenhouse contributions.

3. **Table 3**, shows what happens when the effect of water vapor is factored in, and together with all other greenhouse gases expressed as a relative % of the total greenhouse effect.

**TABLE 3.**

| Role of Atmospheric Greenhouse Gases (man-made and natural) as a % of Relative Contribution to the "Greenhouse Effect" |
|---|---|---|
| Based on concentrations (ppb) adjusted for heat retention characteristics | Percent of Total | Percent of Total--adjusted for water vapor |
| Water vapor | 95.000% |
| Carbon Dioxide (CO2) | 72.369% | 3.618% |
| Methane (CH4) | 7.100% | 0.360% |
| Nitrous oxide (N2O) | 19.000% | 0.950% |
| CFC's (and other misc. gases) | 1.432% | 0.072% |
| Total | 100.000% | 100.000% |

As illustrated in this chart of the data in **Table 3**, the combined greenhouse contributions of CO2, methane, N2O and misc. gases are small compared to water vapor!

Total atmospheric carbon dioxide (CO2) -- both man-made and natural-- is only about 3.62% of the overall greenhouse effect-- a big difference from the 72.37% figure in **Table 2**, which ignored water!
Water vapor, the most significant greenhouse gas, comes from natural sources and is responsible for roughly 95% of the greenhouse effect (4). Among climatologists this is common knowledge but among special interests, certain governmental groups, and news reporters this fact is under-emphasized or just ignored altogether.

Conceding that it might be "a little misleading" to leave water vapor out, they nonetheless defend the practice by stating that it is "customary" to do so!

Comparing natural vs man-made concentrations of greenhouse gases

4. Of course, even among the remaining 5% of non-water vapor greenhouse gases, humans contribute only a very small part (and human contributions to water vapor are negligible).

Constructed from data in Table 1, the charts (below) illustrate graphically how much of each greenhouse gas is natural vs how much is man-made. These allocations are used for the next and final step in this analysis-- total man-made contributions to the greenhouse effect. Units are expressed to 3 significant digits in order to reduce rounding errors for those who wish to walk through the calculations, not to imply numerical precision as there is some variation among various researchers.
Putting it all together: total human greenhouse gas contributions add up to about 0.28% of the greenhouse effect.

5. To finish with the math, by calculating the product of the adjusted CO2 contribution to greenhouse gases (3.618%) and % of CO2 concentration from anthropogenic (man-made) sources (3.225%), we see that only \((0.03618 \times 0.03225)\) or 0.117% of the greenhouse effect is due to atmospheric CO2 from human activity. The other greenhouse gases are similarly calculated and are summarized below.

<table>
<thead>
<tr>
<th>Based on concentrations (ppb) adjusted for heat retention characteristics</th>
<th>% of Greenhouse Effect</th>
<th>% Natural</th>
<th>% Man-made</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water vapor</td>
<td>95.000%</td>
<td>94.999%</td>
<td>0.001%</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>3.618%</td>
<td>3.502%</td>
<td>0.117%</td>
</tr>
<tr>
<td>Methane (CH4)</td>
<td>0.360%</td>
<td>0.294%</td>
<td>0.066%</td>
</tr>
<tr>
<td>Nitrous Oxide (N2O)</td>
<td>0.950%</td>
<td>0.903%</td>
<td>0.047%</td>
</tr>
<tr>
<td>Misc. gases (CFC’s, etc.)</td>
<td>0.072%</td>
<td>0.025%</td>
<td>0.047%</td>
</tr>
<tr>
<td>Total</td>
<td>100.00%</td>
<td>99.72</td>
<td>0.28%</td>
</tr>
</tbody>
</table>

When greenhouse contributions are listed by source, the relative overwhelming component of the natural greenhouse effect, is readily apparent.
From Table 4a, both natural and man-made greenhouse contributions are illustrated in this chart, in gray and green, respectively. For clarity only the man-made (anthropogenic) contributions are labeled on the chart.

- Water vapor, responsible for 95% of Earth's greenhouse effect, is 99.999% natural (some argue, 100%). Even if we wanted to we can do nothing to change this.

- Anthropogenic (man-made) CO2 contributions cause only about 0.117% of Earth’s greenhouse effect, (factoring in water vapor). This is insignificant!

- Adding up all anthropogenic greenhouse sources, the total human contribution to the greenhouse effect is around 0.28% (factoring in water vapor).

The Kyoto Protocol calls for mandatory carbon dioxide reductions of 30% from developed countries like the U.S. Reducing man-made CO2 emissions this much would have an undetectable effect on climate while having a devastating effect on the U.S. economy. Can you drive your car 30% less, reduce your winter heating 30%? Pay 20-50% more for everything from automobiles to zippers? And that is just a down payment, with more sacrifices to come later.

Such drastic measures, even if imposed equally on all countries around the world, would reduce total human greenhouse contributions from CO2 by about 0.035%.

This is much less than the natural variability of Earth's climate system!

While the greenhouse reductions would exact a high human price, in terms of sacrifices to our standard of living, they would yield statistically negligible results in terms of measurable impacts to climate change. There is no expectation that any statistically significant global warming reductions would come from the Kyoto Protocol.

"There is no dispute at all about the fact that even if punctiliously observed, (the Kyoto Protocol) would have an imperceptible effect on future temperatures -- one-twentieth of a degree by 2050."

Dr. S. Fred Singer, atmospheric physicist
Professor Emeritus of Environmental Sciences at the University of Virginia,
and former director of the US Weather Satellite Service;
in a Sept. 10, 2001 Letter to Editor, Wall Street Journal
Research to Watch

Scientists are increasingly recognizing the importance of water vapor in the climate system. Some, like Wallace Broecker, a geochemist at Columbia's Lamont-Doherty Earth Observatory, suggest that it is such an important factor that much of the global warming in the last 10,000 years may be due to the increasing water vapor concentrations in Earth's atmosphere.

His research indicates that air reaching glaciers during the last Ice Age had less than half the water vapor content of today. Such increases in atmospheric moisture during our current interglacial period would have played a far greater role in global warming than carbon dioxide or other minor gases.

"I can only see one element of the climate system capable of generating these fast, global changes, that is, changes in the tropical atmosphere leading to changes in the inventory of the earth's most powerful greenhouse gas--water vapor."

Dr. Wallace Broecker, a leading world authority on climate
Lamont-Doherty Earth Observatory, Columbia University,
lecture presented at R. A. Daly Lecture at the American Geophysical Union's spring meeting in Baltimore, Md., May 1996.

Known causes of global climate change, like cyclical eccentricities in Earth's rotation and orbit, as well as variations in the sun's energy output, are the primary causes of climate cycles measured over the last half million years. However, secondary greenhouse effects stemming from changes in the ability of a warming atmosphere to support greater concentrations of gases like water vapor and carbon dioxide also appear to play a significant role. As demonstrated in the data above, of all Earth's greenhouse gases, water vapor is by far the dominant player.

The ability of humans to influence greenhouse water vapor is negligible. As such, individuals and groups whose agenda it is to require that human beings are the cause of global warming must discount or ignore the effects of water vapor to preserve their arguments, citing numbers similar to those in Table 4b. If political correctness and staying out of trouble aren't high priorities for you, go ahead and ask them how water vapor was handled in their models or statistics. Chances are, it wasn't!

References:

1) Current Greenhouse Gas Concentrations (updated October, 2000)
Carbon Dioxide Information Analysis Center
(the primary global-change data and information analysis center of the U.S. Department of Energy)
Greenhouse Gases and Climate Change (data now available only to "members")
IEA Greenhouse Gas R&D Programme,
Stoke Orchard, Cheltenham, Gloucestershire, GL52 7RZ, United Kingdom.

2) Greenhouse Gases and Global Warming Potentials (updated April, 2002)
U.S. Environmental Protection Agency

3) Warming Potentials of Halocarbons and Greenhouses Gases

4) References to 95% contribution of water vapor:
   b. Global Deception: The Exaggeration of the Global Warming Threat
      by Dr. Patrick J. Michaels, June 1998
      Virginia State Climatologist and Professor of Environmental Sciences, University of Virginia
      Energy Information Administration; Official Energy Statistics from the U.S. Government
   d. Personal Communication-- Dr. Richard S. Lindzen
      Alfred P. Slone Professor of Meteorology, MIT
   e. The Geologic Record and Climate Change
      by Dr. Tim Patterson, January 2005
      Professor of Geology-- Carleton University
      Ottawa, Canada
      Alternate link:
   f. EPA Seeks To Have Water Vapor Classified As A Pollutant
      by the ecoEnquirer, 2006
      Alternate link:
   g. Air and Water Issues
      by Freedom 21.org, 2005
      Citation: Bjorn Lomborg, p. 259. Also: Patrick Michaels and Robert Balling, Jr. The Satanic Gases, Clearing the Air About Global Warming (Washington, DC: CATO Institute, 2000), p. 25.
   h. Does CO2 Really Drive Global Warming?
      by Dr. Robert Essenhigh, May 2001
i. Solar Cycles, Not CO2, Determine Climate

Alternate link:  

5) Global Climate Change Student Guide
Department of Environmental and Geographical Sciences
Manchester Metropolitan University
Chester Street
Manchester
M1 5GD
United Kingdom

6) Global Budgets for Atmospheric Nitrous Oxide - Anthropogenic Contributions
William C. Trogler, Eric Bruner, Glenn Westwood, Barbara Sawrey, and Patrick Neill
Department of Chemistry and Biochemistry
University of California at San Diego, La Jolla, California

7) Methane record and budget
Robert Grumbine

Useful conversions:

- 1 Gt = 1 billion tons = 1 cu. km. H20
- 1 Gt Carbon(C) = ~3.67 Gt Carbon Dioxide(CO2)
- 2.12 Gt C = ~7.8 Gt CO2 = 1ppmv CO2

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