Global Warming:
A closer look at the numbers

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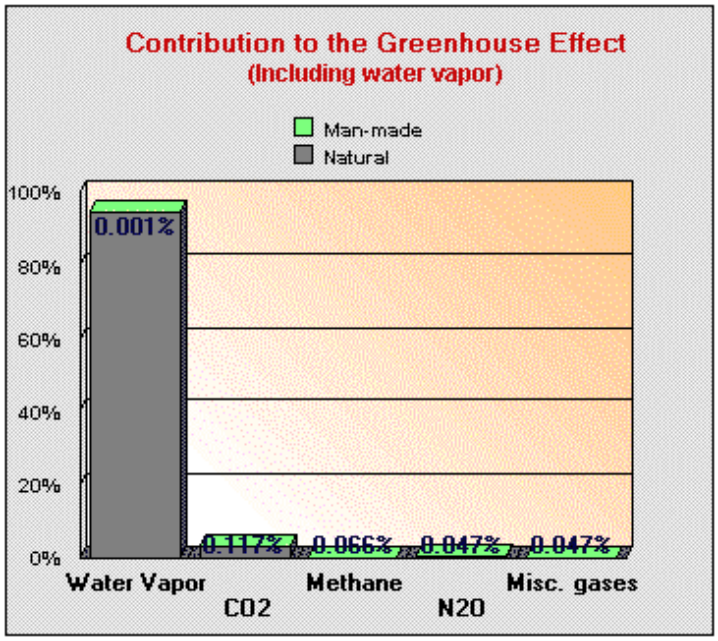
Water Vapor Rules the Greenhouse System

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 (5)**. 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 activites 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.*

Greenhouse Gas Concentrations:

Natural vs man-made (anthropogenic)

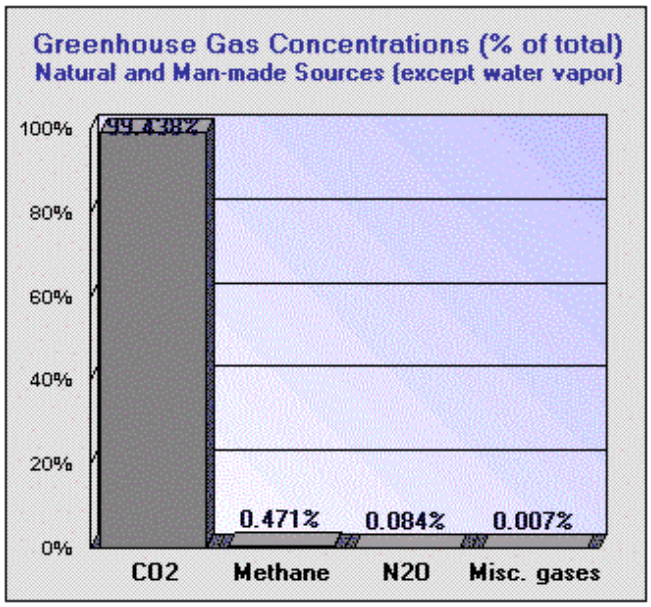
1. The following table was constructed from data published by the U.S. Department of Energy **(1)** summarizing concentrations of the various atmospheric greenhouse gases, and supplemented with information from other sources **(2-7)**. Because some of the concentrations are very small the numbers are stated in parts *per billion*. **DOE chose to NOT show water vapor as a greenhouse gas!**

TABLE 1.

The Important Greenhouse Gases (except water vapor)
U.S. Department of Energy, (October, 2000) (1)

(all concentrations expressed in parts per billion)	Pre-industrial baseline	Natural additions	Man-made additions	Total (ppb) Concentration	Percent of Total

Carbon Dioxide (CO2)	288,000	68,520	11,880 (2)	368,400	**99.438%**
Methane (CH4)	848	577	320	1,745	**0.471%**
Nitrous Oxide (N2O)	285	12	15	312	**0.084%**
Misc. gases (CFC's, etc.)	25	0	2	27	**0.007%**
Total	289,158	69,109	12,217	370,484	100.00%



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*)

2. 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:

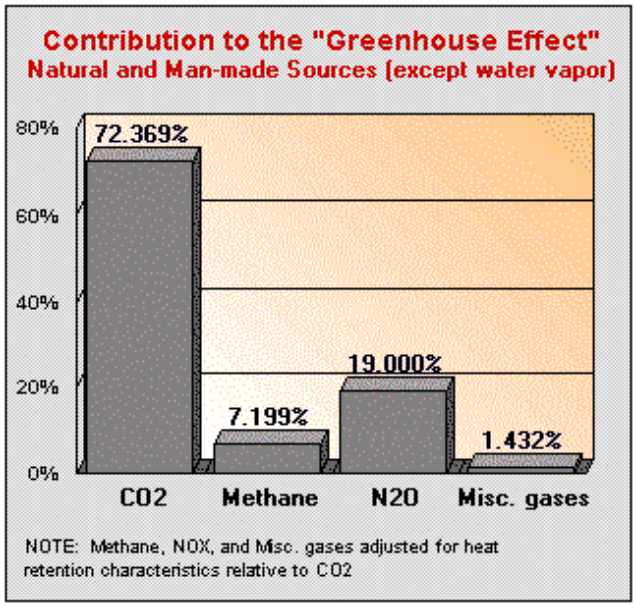
(*concentration*) X (the appropriate GWP **multiplier (3) (4)** of each gas relative to CO2 **) = greenhouse *contribution*.**:

TABLE 2.

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

This table adjusts values in **Table 1** to compare greenhouse gases equally with respect to CO2. (#'s are unit-less)	**Multiplier (GWP)**	Pre-industrial baseline (new)	Natural additions (new)	Man-made additions (new)	Tot. Relative Contribution	Percent of Total (new)
Carbon Dioxide (CO2)	1	288,000	68,520	11,880	368,400	**72.369%**
Methane (CH4)	21 **(3)**	17,808	12,117	6,720	36,645	**7.199%**
Nitrous Oxide (N2O)	310 **(3)**	88,350	3,599	4,771	96,720	**19.000%**
CFC's (and other misc. gases)	see data **(4)**	2,500	0	4,791	7,291	**1.432%**
Total		396,658	84,236	28,162	509,056	100.000%

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.

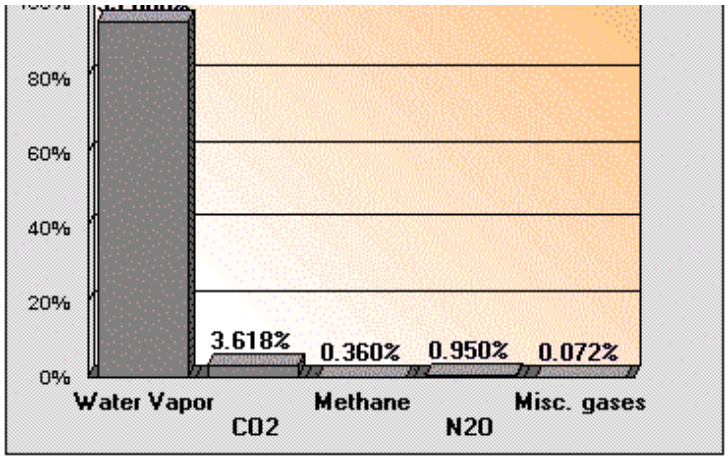
TABLE 3.

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!

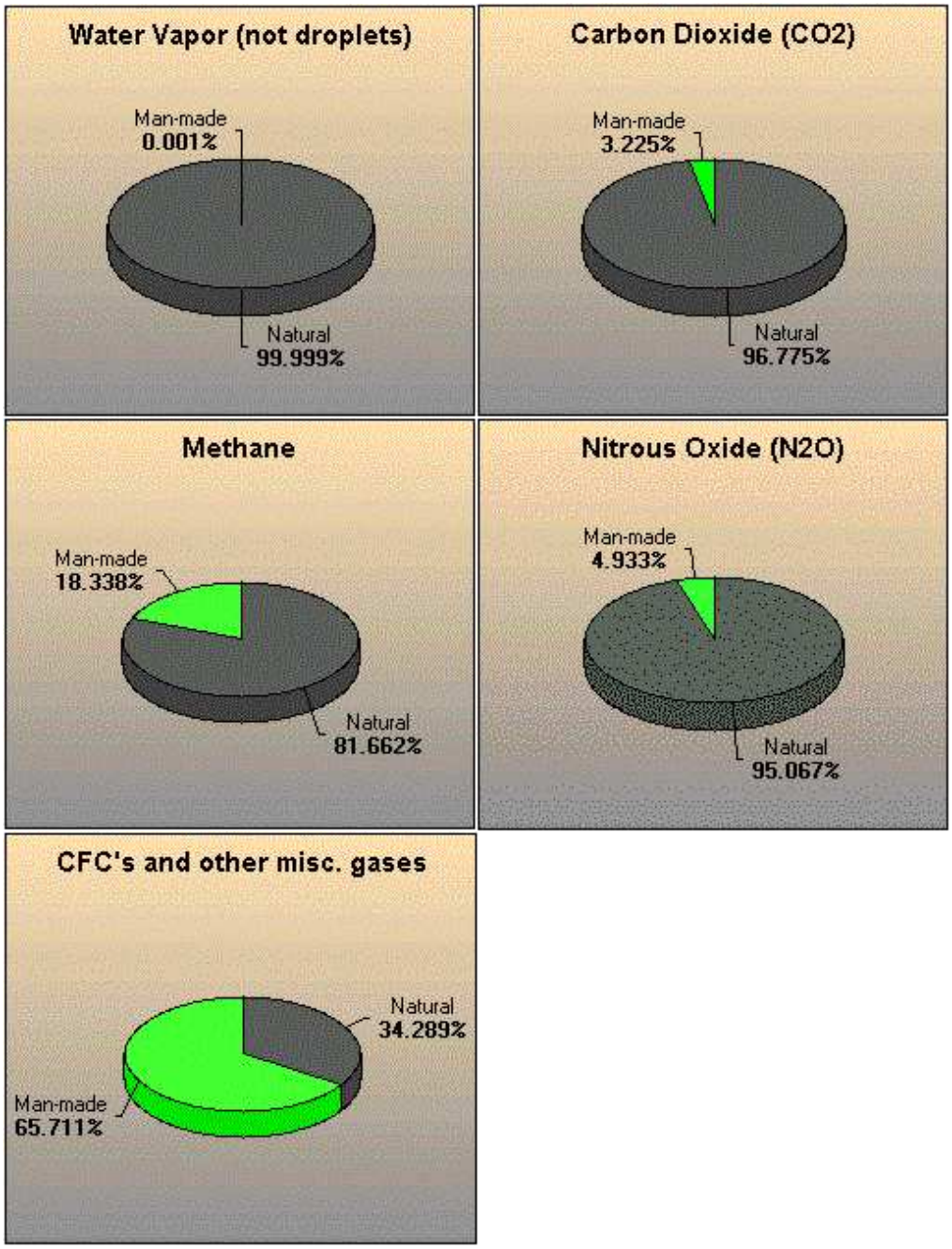
Water vapor, the most significant greenhouse gas, comes from natural sources and is responsible for roughly **95% of the greenhouse effect (5)**. Among climatologists this is common knowledge but among special interests, certain governmental groups, and news reporters this fact is under-emphasized or 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.



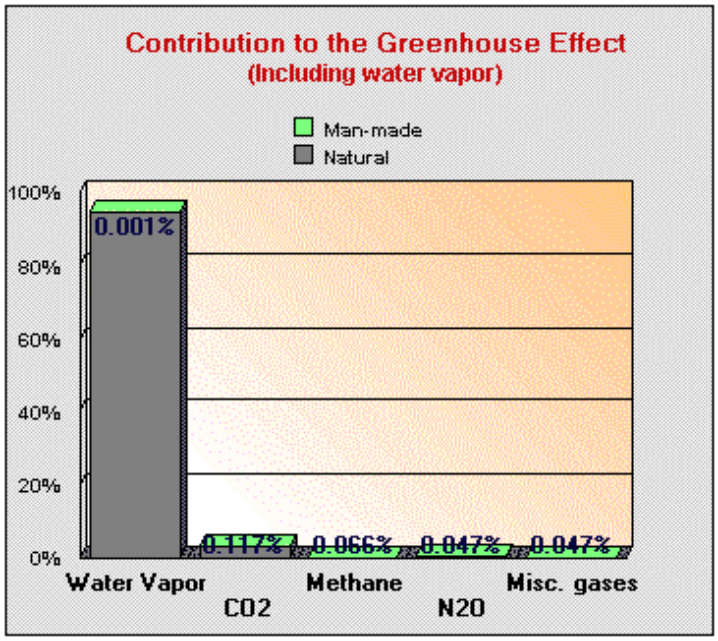
Putting it all together:
total human greenhouse gas **contributions**
add up to about **0.28%** of the **greenhouse effect**.

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 X 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 4a.

Anthropogenic (man-made) **Contribution to the "Greenhouse Effect," expressed as % of Total (water vapor INCLUDED)**

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



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!**

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(the primary global-change data and information analysis center of the U.S. Department of Energy)
Oak Ridge, Tennessee

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) "Carbon cycle modelling and the residence time of natural and anthropogenic atmospheric CO2:on the construction of the 'Greenhouse Effect Global Warming' dogma;" Tom V. Segalstad, University of Oslo

3) Greenhouse Gases and Global Warming Potentials (updated April, 2002)
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Chemical formulae and global warming potentials from Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996), pp. 119 and 121. Production and sales of CFC's and other chemicals from International Trade Commission, Synthetic Organic Chemicals: United States Production and Sales, 1994 (Washington, DC, 1995). TRI emissions from U.S. Environmental Protection Agency, 1994 Toxics Release Inventory: Public Data Release, EPA-745-R-94-001 (Washington, DC, June 1996), p. 73.

Estimated 1994 U.S. emissions from U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-1994, EPA-230-R-96-006 (Washington, DC, November 1995), pp. 37-40.

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by Dr. Patrick J. Michaels, June 1998
Virginia State Climatologist and Professor of Environmental Sciences, University of Virginia

c. Greenhouse Gas Emissions, Appendix D, Greenhouse Gas Spectral Overlaps and Their Significance
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:

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by the ecoEnquirer, 2006
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g. Does CO2 Really Drive Global Warming?
by Dr. Robert Essenhigh, May 2001
Alternate link:

h. Solar Cycles, Not CO2, Determine Climate
by Zbigniew Jaworowski, M.D., Ph.D., D.Sc., 21st Century Science and Technology, Winter 2003-2004, pp. 52-65
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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