

Re: AAPG on Global Climate Change

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- *From:* bobg@xxxxxxxxxx (Robert Grumbine)
 - *Date:* Thu, 22 Feb 2007 17:05:38 -0000
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In article <12tosh8gtaempca@xxxxxxxxxxxxxxxxxxxxxx>, Jo Schaper <jospamnotschaper34@5socket78dot9net> wrote:

Robert Grumbine wrote:

In article <12tmc5houm0e8ea@xxxxxxxxxxxxxxxxxxxxxx>, Jo Schaper <jospamnotschaper34@5socket78dot9net> wrote:

<snip>

My guess where the 95% figure came from was it was not pulled entirely out of a hat, but resulted when someone tried to compare the percentages of H₂O (g) to other known greenhouse gases on a ppm basis in a 'typical' part' of the atmosphere. This difficulty with this is, of course, that H₂O is constantly variable-- with a little manipulation, you can come up with any large number you like, because it is true that H₂O is more greatly abundant than even CO₂ or other trace greenhouse gases. For example: take .0038 (CO₂) and divide by .02 (midpoint of 0 to .04 often given for % of atmosphere which is water vapor) This gives .19 or 2% CO₂ vs 98% water vapor. I could see how someone could get such a number, then use Kentucky windage, and get from there to water vapor being 95% of all greenhouse gases.

An interesting calculation, which I'll keep in mind next time that William and I go looking for the source of the 95% figure.

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It's also incorrect. Water vapor approaching 4% of the atmosphere (40 g/kg mixing ratio) is suitable for near-saturation in extremely warm air, say 35 C (I'm being fast and loose with water vapor saturation curve; you can research the details if you're so inclined. The gist of the argument is unchanged). For ballpark purposes, the atmosphere is near saturation (70% relative humidity), so you're ok there. Where this goes wrong is that the atmosphere isn't near 35 C for much of its volume and the saturation pressure drops rapidly with temperature (approximately halving for each 10 C cooling). Temperature drops rapidly with elevation (ballpark 6.5 C per km). Upshot being that that 2% is itself a very high number for water vapor (saturation at, say, 25 C — a temperature above global average surface temperature of 15 C at any rate).

The outcome of the 70% RH over the globe, through the depth of the atmosphere is a global average column of water vapor is equivalent to 2 cm liquid H₂O at the surface (it is the 2 cm which is a hard figure, not the above saturation curve numbers). About 20 kg/m². Surface pressure being 10⁵ Pa gives an atmospheric mass of 10,000 kg/m² (roundly). So water is not 2%, but 0.2%. CO₂, at 380 ppm, is 0.038%. If we take these as the only gases of interest (by number counts they're the most common greenhouse gases, but as they're both saturated in their band centers, number counts aren't the best way to look for their climate effects), then H₂O is 84% by number.

[snip]

Thanks for the clarification of my math error. The difficulty was in sourcing down some place where both the CO₂ and H₂O were available in the same units. Most of the places I found CO₂ in ppm, but the H₂O in percent, not in ppm, because those authors had excluded H₂O as irrelevant to the discussion, not being an anthropogenic gas for the most part.

I sympathize with the problem. It's one of my complaints with my colleagues, at least for their public pages. Once you're fairly adept in the field, the conversion isn't hard. But we're supposed to be communicating, at least some of the time, with folks who aren't.

One of the interesting things (to me at least) is that if you follow the distribution of water vapor vs. CO₂ through the depth of the atmosphere, you find that as you go higher up, CO₂ becomes increasingly important, eventually being the dominant greenhouse gas (or at least dominant w.r.t. H₂O, O₃ may be more important than CO₂ at those levels). This is offshoot of the fact that CO₂ doesn't condense and is chemically stable — so its concentration is nearly constant through the depth of the atmosphere. With H₂O dropping rapidly with temperature, it drops under 380 ppm in, iirc,

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the lower stratosphere.

(Decimal points and unit conversions—the main reasons I gladly defer to others in math calculations!)

Looking at the whole water vapor pressure/temperature variability problem over the whole planet gives me the willies over how that can be modeled with any accuracy, even with a computer. Talk about a moving target...

But then we get back to observables. The atmosphere doesn't reach much supersaturation, so if we observe temperature, we can easily put an upper bound on the H₂O vapor levels. And temperature is both easy to observe, and a single observation is generally representative of a large area. The latter is useful, and itself derived from observation. If your house is warmer than usual today, then temperatures for a couple of hundred km radius around you are also likely warmer than usual. This can be, and is, made rigorous in the field.

But H₂O vapor is also fairly easy to observe, at least where there aren't clouds (which, I grant, is a major limitation) — H₂O vapor has strong lines in the microwave around 22 and 87 GHz, and satellites with sensors there have been flying since 1978 and ca. 1984, respectively. (Plus radiosondes have been observing it, at least for the lower atmosphere, where most of the water is, for a half century.)

These different sources are then used to decide how bad the models are — whether the weather models or the climate. In some cases, the answer is 'surprisingly not-bad'. Sometimes even 'good'.

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Robert Grumbine <http://www.radix.net/~bobg/> Science faqs and amateur activities notes and links. Sagredo (Galileo Galilei) "You present these recondite matters with too much evidence and ease; this great facility makes them less appreciated than they would be had they been presented in a more abstruse manner." Two New Sciences