Climate Change 5 — How Out of Balance Are We?

In the preceding white paper, we talked about the three most important human-emitted greenhouse gasses (GHGs): CO_2, methane, and N_2O. We noted that we are emitting trillions of tons of these gasses into the atmosphere each year. But the atmosphere is big. Have we significantly altered the concentration of these gasses in the atmosphere? If so, by how much?

Our direct measurement of these gasses in the atmosphere began in about 1850. We are fortunate, however, because the composition of the atmosphere affects several natural processes that leave permanent records. Scientists can measure them and infer the composition of the atmosphere hundreds of thousands of years into the past. Individually, we might not have full confidence in any one of the proxies. When they converge to give similar answers, however, it increases our confidence greatly. And that is what has occurred.[i]

The graph at right shows the concentration of CO_2 for the last 400,000 years from several converging data sources. The concentration has cycled down and up four times. This regular variation is due to *Milankovitch Cycles,* well-understood cycles in the intensity of the sun.[ii] The current increase is the part of the graph inside the dashed ellipse; it has been expanded in the box on top. The increase has extended far higher than in previous cycles. Similar patterns have been observed with methane and N_2O.

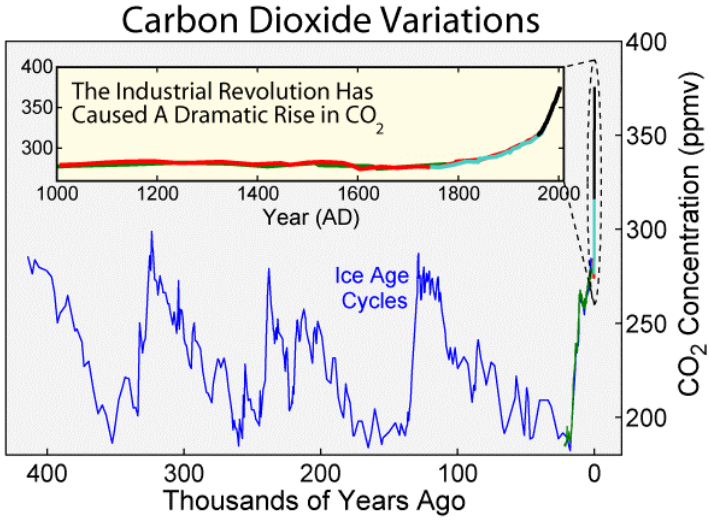

Image by Robert A. Rhohde from publicly available data. Used by permission. Retrieved online 2/28/2008 at http://www.globalwarmingart.com/wiki/Image:Carbon_Dioxide_400kyr_Rev_png.

Viewing the data over a smaller period of time shows that the levels of CO_2, methane, and N_2O were roughly constant for 2000 years prior to 1800. Then they began increasing dramatically as the Industrial Revolution gathered steam, so to speak. In the last 200 years they have increased roughly 38%, 52%, and 18%, respectively. There are no known natural events to account for such dramatic increases.[iii]

The conclusion: atmospheric concentrations of CO_2, methane, and N_2O are unnaturally high. Concentrations were consistent with natural variation until the Industrial Revolution, after which they increased dramatically. It is likely that human activities caused the dramatic increase.

[i] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[ii] If you want a primer on Milankovitch Cycles, see *Milankovitch cycles,* Wikipedia. Retrieved online 2/28/2008 at http://en.wikipedia.org/wiki/Milankovitch_cycles.

[iii] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.