Climate Change 4 — The Greenhouse Gasses

In the previous white paper we explained the concept of greenhouse gasses (GHGs) and how they work. This may cause you to wonder: are there other GHGs we haven't discussed? You bet. Two additional GHGs emitted by humans are out of balance; together with CO_2, they are the most important GHGs for climate change.

Each GHG varies in its *global warming potential,* its ability to warm the earth. Some have global warming potentials much higher than CO_2. But because CO_2 is the most important, its global warming potential is arbitrarily set to one, and the global warming potential of everything else is compared to that. CO_2 is the most important because we emit so much of it into the atmosphere: 6.5 trillion tons in the United States in 2004.[i] Ninety-four percent comes from the burning of fossil fuels. The top sources: coal burning power plants and automobiles.[ii]

The second most important GHG is methane. It's global warming potential is 21, meaning that per unit it warms the earth 21 times as much as CO_2. However, we emit less of it, and the overall effect from U.S. emissions is less than 1/10 the effect of our emissions of CO_2 —613 billion tons of CO_2 equivalent[iii]. The three largest sources of methane in the U.S. are landfills, leaking natural gas systems, and livestock (they belch and break wind).[iv]

The third most important GHG in the U.S. is nitrous oxide (N_2O). Its global warming potential is 310, much higher than CO_2. Much less is emitted, however, so the overall effect is, again, less than 1/10 of the effect of our emissions of CO_2 — 427 billion tons of CO_2 equivalent in the U.S. The vast majority of N_2O comes from fertilizer, which is broken down in the soil during farming.[v]

In the U.S. these three GHGs account for about 98% of the human-caused global warming effect. They tend to be persistent and to mix into different regions of the atmosphere, which means that once emitted, they continue to exert their effects over many, many years.

All sources agree that water vapor is the most abundant and most important GHG of all. Humans don't directly release lots of water vapor, it is supplied naturally to the atmosphere by evaporation and by plants. Without it, the earth would be frigid. CO_2, methane, and N_2O threaten the earth because they will throw water vapor out of balance. By warming the earth slightly, they will cause more water vapor to evaporate into the atmosphere, where it will cause more warming, which will cause more evaporation, etc. This positive feedback loop will lead to progressively higher levels of water vapor, which will cause the earth to warm. The effect will be only a few degrees, but most experts believe that it will be enough to throw the current climate system out of balance, causing large changes that will manifest differently in different places.

It is not yet possible to predict with precision how change will manifest in any given region. Climate models have converged towards some general patterns, but they predict average trends, not precise outcomes. Just before World War II, we knew that war was coming, but we did not know the specifics of where, when, how, or how bad. Today, we know climate change is coming, but we cannot predict with precision where, when, how, or how bad.

[i] Executive Summary, *U.S. greenhouse gas inventory report,* E.P.A. Retrieved online 2/18/2008 at http://www.epa.gov/climatechange/emissions/usgginv_archive.html.
[ii] id, p. 5.
[iii] A ton of CO_2 equivalent is the amount of global warming that would be caused by a ton of CO_2.
[iv] 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.)], p. 212. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Retrieved online at www.ipcc.ch.
[v] ibid.