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ABOUT CLIMATE CHANGE

I read with interest your June issue on energy with its emphasis on the climate. As I began to read the articles, I was anticipating an objective view of opinions on climate change and found what appears to be a one-sided view regarding man's impact and effect on climate, that is, the view that "humans are largely responsible" for the current warming of the climate due to fossil fuel burning. This is the conclusion of the Intergovernmental Panel on Climate Change (IPCC), which was **not** authored by the scientists contributing to the IPCC but by a group of "policy makers" with an agenda. This is the main reason I do not see this group as a credible organization. As far as there being no "serious debate that carbon dioxide will cause Earth's surface to warm," as stated in the article by Daniel Schrag (*Elements* 3: 171-178), there are many scientists who will take issue with that (for starters, the 60 scientists who signed an April 6, 2006, letter urging Canadian prime minister Stephen Harper to withdraw from the Kyoto Protocol). Indeed, the debate has just begun, although the forum for such a debate hardly seems available. I would now like to make some points regarding this subject.

The most significant greenhouse gas is water vapor, **not** CO₂, which makes up less than 0.04% of the fixed atmospheric volume; water vapor can be as high as 4%. The human-derived portion of the total emitted CO₂ is around 20% (i.e. 0.008% of the atmosphere). Carbon dioxide is at such a small level in our atmosphere that it is often referred to as a trace gas. Hence, geological carbon dioxide sequestration seems to be an awful lot of fuss and money for a trace gas.

Methane does not appear much in the mix of discussions, and yet it is 10 times more effective than CO₂ as a greenhouse gas.

With regards to the actual cause of climate change, there are proxy studies that show "paleoclimatic and paleoproductivity records full of cycles that corresponded to various sunspot cycles" (Tim Patterson, Carleton University). Dr. Niv Shariv, prominent astrophysicist in Israel, states that solar activity can explain a large part of the global warming in the 20th century.

Concerning glaciers and ice caps, many seem to believe that the glaciers of Greenland and the Antarctic ice cap are at a "tipping point" with potential melting on the way, and they even go so far as to suggest a rapid meltdown. However, the Danish Meteorological Institute reported that the past two decades were the coldest in Greenland since the 1910s. A 2005

study in the *Journal of Glaciology* states that "the Greenland ice sheet is thinning at the margins and growing inland, with a small overall mass gain." The January 14, 2002, issue of *Nature* reports that Antarctica, as a whole, has been dramatically cooling for decades. The September 2006 issue of the British journal *Philosophical Transactions of the Royal Society, Series A: Mathematical, Physical, and Engineering Sciences* states that satellite measurements of the Antarctic ice sheet showed significant growth between 1992 and 2003. These satellite data cover 72% of the ice sheet and are showing growth at a rate of 5 mm per year.

Hardly "tipping points" toward a warming climate.

Kevin Selkregg
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About Climate Change RESPONSE FROM DANIEL SCHRAG

Mr. Selkregg makes many points that I hear often from climate change "skeptics." Alas, most of them are simply incorrect.

① The IPCC report was indeed authored by scientists—not by policy makers with an agenda as he states. Moreover, because the IPCC works on a consensus view of the participating scientists from around the world, the report errs on the conservative side in avoiding issues that are contentious or highly uncertain, even though these issues are often the most important as they are often associated with very high consequence, albeit low-probability, events.

② There is no serious debate that increasing CO₂ will cause the Earth's surface to warm. CO₂ is a greenhouse gas and absorbs infrared radiation coming from the Earth's surface. In fact, we measure CO₂ concentration by measuring its infrared absorption. What is contentious is exactly how much the surface will warm.

③ Mr. Selkregg points out that water vapor is the most important greenhouse gas in Earth's atmosphere—which I explained in my article on page 173: "Water vapor itself is the most important greenhouse gas, acting as an amplifier of other forcings, such as CO₂." The important point is that water vapor in Earth's atmosphere adjusts on very short timescales—hours to days to weeks. This means that it responds to other greenhouse gases with longer residence times, such as CO₂. For similar reasons, I did not discuss methane in the article. It is true that it is a more powerful greenhouse gas than CO₂, but its concentration is much lower (less than 1.7 ppm) and its residence time is less than 10 years, so as emissions rise over the century, it will become even less important relative to CO₂.

④ The suggestion that solar forcing can explain much of the 20th century warming is simply inconsistent with the vast majority of studies on this subject. The irony here is that the changes in radiative forcing due to solar changes (which we know quite well) are very tiny compared to the radiative effects of CO₂. This means that those who propose that solar forcing plays an important role in recent warming trends are implicitly embracing some huge amplification from positive feedbacks in the atmosphere such as water vapor. The logical conclusion from this is that we should be even more frightened at continued CO₂ emissions as the atmosphere must be even more sensitive than our current understanding. Moreover, given the evidence discussed in my article that there are no natural cycles that explain the recent warming trend, it seems like an amazing coincidence that the Sun has caused an abrupt and unprecedented warming at exactly the same time as CO₂ has started to rise.

④ Regarding ice caps, again, Mr. Selkregg is misinformed. The best and most reliable data on mass loss from Greenland and Antarctica comes from the Gravity Recovery and Climate Experiment, or GRACE. These satellite measurements show net mass loss from Greenland and Antarctica, each equivalent to approximately 0.5 mm per year of sea level rise (see various papers by Isabella Velicogna and John Wahr for more information). As far as the future of Greenland or West Antarctica is concerned, I stated in my article that "we do not know enough about glacial melting to be able to predict whether these ice sheets will decay smoothly or whether there is the possibility for threshold behavior resulting in a very rapid collapse." Here again is an example of how conservative the IPCC reports have been; their sea level projections include only the continued melting of ice at the current rate (10 cm of sea level rise over the century). I would argue that this greatly misrepresents the risk of future sea level rise as melting is unlikely to remain constant as the Earth continues to warm. Recent reduction in the extent of summertime Arctic sea ice underscores this risk, as many glaciologists believe that an ice-free Arctic ocean in the summer increases the risk of rapid mass loss of ice from Greenland.

Finally, regarding Mr. Selkregg's claim that my article is "one-sided", I feel an obligation to provide as accurate a view as I can, not a balanced one. I hope that most readers of *Elements* can appreciate the distinction.

Daniel P. Schrag
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