Less reticence on nonlinear climate change

Science is inherently conservative, based as it is on scepticism and the demand for evidence. We seek reasons for our beliefs, and this is why science claims a special status as a source for reliable knowledge. That's not to say, however, that scepticism and caution are cost-free.

On scientific matters with practical implications — climate change and what to do about it, for example — reticence may even diminish the influence of the scientific perspective. This is the view, at least, of NASA climate scientist James Hansen, the victim last year of Bush Administration efforts to prevent the flow of information from scientists to the public. In a recent paper, Hansen now suggests that the habitual reticence of scientists may be "inhibiting communication of a threat of potentially large sea-level rise".

The problem, he argues, stems from strong nonlinearity in the physics, which could make polar ice sheets melt much faster than generally expected, raising sea levels next century by several metres (www.arxiv.org/physics/0703220). As white snow melts into darker wet ice, for example, it begins to absorb more solar energy, melting faster still. This nonlinear mechanism may already be at work in the ice sheets of Greenland and Antarctica, which satellite data show to be losing 150 km^3 of ice each year, twice as fast as they were a few years ago.

But the operative phrase here is "may be at work". There are so many factors involved that no one can be absolutely sure. The sheer complexity of ice-sheet physics, or of any other part of the climate process, demands computational models able to integrate many factors, but these always seem open to legitimate criticism given the number of parameters they contain. The latest and biggest model may be 'the best', in some sense, but that doesn't mean it is any good. Hence, the reticence.

Even so, one can be cautious about specific mechanisms and outcomes, but far more vocal on general points that seem beyond dispute. Most public discussion of climate change — and many other matters of policy — remains largely dominated by linear thinking with its expectations of continuity and the legitimate extrapolation of trends. Yet we know that such expectations are unrealistic for nonlinear systems, which generically exhibit phase transitions and bifurcations. Talk

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of a catastrophic shutdown of the North Atlantic Conveyor, or of possible 'runaway' global warming, isn't irresponsible hysteria; it's plausible speculation that is consistent with everything we know about nonlinear systems. We'd all be better off, as the British theoretical ecologist Robert May once argued, "if more people realized that simple nonlinear systems do not necessarily possess simple dynamical properties."

Human activity has not only significantly altered the concentration of atmospheric CO_2 — from about 280 to 380 p.p.m. — but has done so at a rate that is historically unprecedented. Even without any climate modelling, this knowledge alone is cause for concern. What we shouldn't be reticent about are the inherent dangers of strongly disturbing a highly nonlinear system that we're not close to understanding, and on which our lives depend. We may not know the future, but we can have confidence that it won't unfold gradually and predictably. There will probably be plenty of surprises, driven by instabilities and positive feedbacks. Precaution would seem very well-advised.

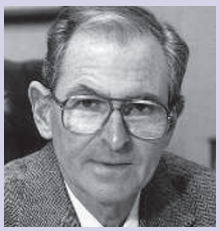
Mark Buchanan

The future of oil

Time to look again at the oil situation. How much did nature make for us and how much is left? A simple extrapolation of pumping rates suggests about two trillion barrels, with just over one trillion barrels left in the ground. That's a 40-year supply at current rates of consumption, but that may be the wrong way to look at it. We're close to the half-way point, the point at which the rate of extraction of oil ought to start declining — but demand continues to increase, especially in China and India. There may be hard times ahead.

But let's look again at the one trillion barrels of so-called 'proved reserves' in the ground, waiting to be pumped. That amount suddenly increased by about 400 billion barrels in the late 1980s in the regions represented by OPEC (Organization of Petroleum Exporting Countries) alone. But there were no major oil discoveries in OPEC states during that period. Instead, OPEC changed its quota rules for how much each country could pump so that they were based in part on the country's proved reserves — and the additional reserves appeared as if by magic.

The fact is, we've been pumping oil faster than we've discovered it for the past 25 years. That means the reserves ought to have declined during that period, but instead they have steadily increased. Much



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of it is obviously political oil, not geological oil. Nobody seems to know how much oil is actually in the ground. The implications of that are truly frightening.

What we need is a 'Manhattan Project'-style effort to kick the fossil fuel habit now, while there are still fossil fuels in the ground. Unfortunately it seems very unlikely that we will have the kind of visionary political leadership to make that possible. Instead we will probably muddle through using oil, coal and other resources until they all start to run out. By that time it may be too late to save our civilization.

David Goodstein