Climatic Wake-up Call

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What Would Jesus Do About Global Warming??

Three Key Questions…

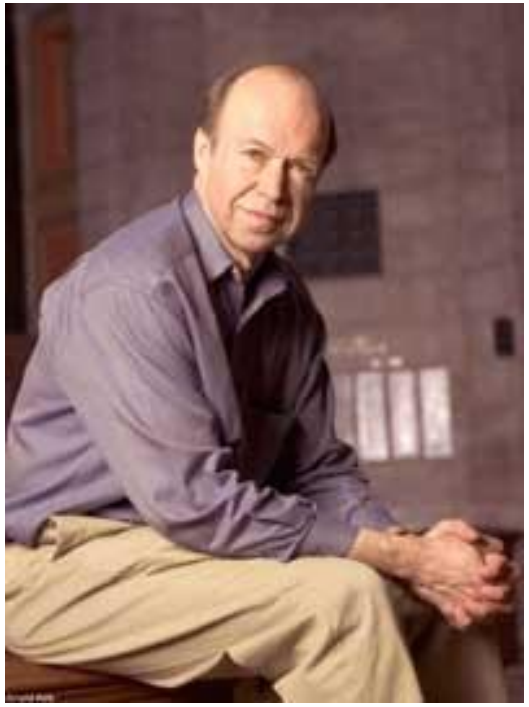
- How bad *could* it get?
- How *quickly* could it get that bad?
- What should we do about it?
  - I will talk mostly about the first two points today.

James Hansen

- NASA Goddard Institute for Space Studies

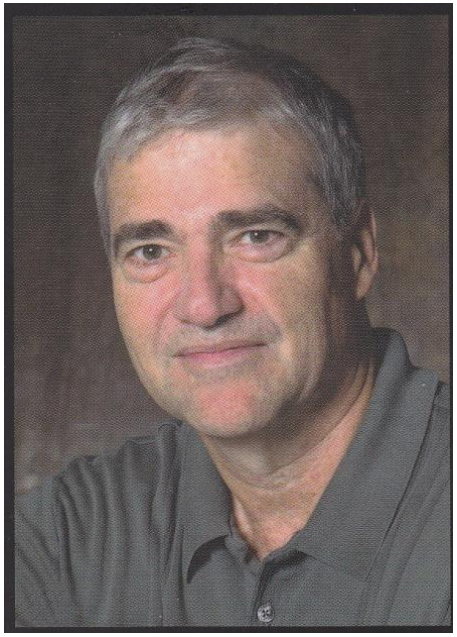
- James Hansen, Makiko Sato, Pushker Karecha, Gary Russell, David W. Lea, and Mark Siddall. "Climate Change and Trace Gases." *Philosophical Transactions of the Royal Society* A, **365**, 1925—1954, 2007.

- George Monbiot: reading this article made his hands "shake."



Peter Ward

- Highly accomplished paleobiologist.
- Professor of Biology and Earth and Space Sciences at the University of Washington; astrobiologist with NASA.
- *Under a Green Sky: Global Warming, the Mass Extinctions of the Past, and What They Can Tell Us About Our Future.* Smithsonian Books/Collins, New York, 2007.
- *The Medea Hypothesis: Is Life on Earth Ultimately Self-Destructive?* Princeton University Press, 2009.



Ward on Climate Skeptics

"There is no doubt that planet Earth is radically changing through global warming. Those resisting this conclusion are doing so for political, economic, or deficit-of-intelligence reasons, not as a result of scientific fact." (Ward, 2009, p. 143)

- But…there is also deficit-of-information and surfeit-of-misinformation.

Muir Glacier, 1941 to 2004

Lessons of Paleoclimate

- Paleoclimate: study of past climate changes and what may have caused them.
- Methodology: what has happened in the past is a pretty good guide to what can happen in the future.
- *Sometimes* there are new things “under the sun,” however!

Hansen et al. (2007)

- Pattern of previous 4 to 5 glacial terminations:
  - Slow increase in northern insolation due to Milankovitch cycles;
  - This leads to some warming and melting;
  - This leads to release of GHGs (CO2 and methane) + albedo flip;
  - This accelerates the warming and melting; which accelerates the release of GHGs and albedo flip…
  - Result: at peak deglaciation, sea level rises 4– 5 metres/century

Apparent Pattern Right Now…

- Anthropogenic GHG release (including CFCs, a new factor) + deforestation;
- Slow warming and some melting;
- Albedo flip + release of further GHGs (especially methane);
- Accelerated warming and melting;
- Further albedo effects and GHG release;
- Assuming BAU (business-as-usual) for humans;
- Probable 3 deg. C global mean temperature increase over next century *or less*; 10 deg. C (+/-) near poles;
- Takes us to temperature regimes that *in the past* have been associated with sea levels 10 m higher (+/-)

- Amazingly, sea level correlates closely with global mean temperature over the past several million years; what a surprise!

How Close are We Now?

- Paleoclimate suggests that 350 – 400 ppm CO2-equivalent is danger level.
- We are currently at almost 390 ppm CO2, perhaps 450 ppm CO2-equivalent; increasing at about 3 ppm/year; rate of increase is increasing as well.
- Draw your own conclusions about implications for action…!
- How lucky do we feel?

Ward: Larger Scale

- Hansen: 3 million year time scale; Ward: 3 billion year time scale.
- Ward calls himself a paleobiologist or geobiologist; he could also be called a paleopathologist; studies those episodes of mass death called mass extinctions.
- Recent work (much since 2005) on mass extinctions is leading to a paradigm shift in our picture of the history of life on Earth---with large implications for the human project.

Extinction Is So Final…

- There have been 12 (+/-) major mass extinctions in past half billion years.
- Best known is KT event, 65 mya, when dinosaurs (and much else) were wiped out.
  - Now definitively linked to major impact, Chixulub Crater in Yucatan Pensinsula; Deccan Traps may have played a role also.
- Biggest was end-Permian extinction, 251 mya; well over 90% of all plants and animals were wiped out.
  - Not obviously caused by impact.

Questioning the Obvious…

- How come it took so long for complex, multicellular life to take hold on Earth?
  - Life has existed on Earth for at least 3.7 by; metazoan, aerobic life has flourished only for .6 by or so; why?
  - Not *merely* because it takes that long for complexity to evolve!
  - No; up until .6 bya, it was *impossible* for complex aerobic life to exist!
    - Snowball Earth (2.3, and .7 bya, Earth froze over for 50—100 my)
  - Our main concern here: there were long periods when oceans were anoxic ("Canfield Seas") and were dominated by anaerobic microbes, often releasing toxic H2S.

Anoxia and Extinction

- Study of geological deposits shows that most mass extinctions in past 500 my (up to Paleocene extinction 55 mya) are associated with anoxic conditions in the seas.
- Here's how it probably goes:
  - Large increase in GHG (mostly CO2) due to massive volcanism (flood basalt episodes, such as Siberian traps);
  - This leads to global warming;
  - This leads to oceanic stagnation: when poles are nearly as hot as equator, ocean currents slow down; waters do not mix;
  - Deep waters become anoxic (as in Black Sea today): but then sometimes…
  - Anoxic layer reaches the surface; accelerated by sunlight; massive release of H2S which directly poisons plants and animals; damages ozone layer;

Under a Green Sky

- Oceans turn into purple bacterial glop, skies turn green (from sulfur);
- Nitrogen-fixing bacteria in seas are inhibited (further inhibiting phytoplankton);
- This condition is called a Canfield Sea;
- And this can lock in for millions of years until enough CO2 is absorbed to cool things down and allow oceanic circulation again.
- This has happened *many times*!

Humbling Paradigm Shift

- Anaerobic, sulfur-metabolizing bacteria have been the *dominant* life-form in the past 2 by or more.
- Much less than half of that period has been dominated by aerobic organisms (like us and the dinosaurs).
- The organisms of the Canfield Sea, which once owned the planet for hundreds of millions of years, are always ready to come back and produce another mass extinction of their ancient enemy, aerobic life.

Could This Really Happen Again?

- Ward: "Carbon dioxide is carbon dioxide, be it from a volcano or a Volvo."
- From where we are now it would likely take a few thousand years to get to another Canfield Sea; first the ice caps have to melt…
- But we are doing things now that could move us in this direction.
- Hansen's concerns are what we should worry about first; but it is wise to keep the larger picture in mind.
- We must *never* let the CO2-equiv. concentration approach 1000 ppm, which paleoclimate shows is when there is a serious risk of anoxic seas.

A Dangerous View

- “Maybe someday the idea of human beings answering to an independent authority called How Things Are in Themselves will be obsolete. In a thoroughly de-Platonized, fully Protagorean culture the only answerability human beings would recognize would be to one another. It would never occur to them that ‘the objective’ could mean more than ‘the agreed-upon upshot of argument’.”
  - Richard Rorty, 1999

Better Philosophy, From a Non-Philosopher

- “Nature’s best thermometer, perhaps its most sensitive and unambiguous indicator of climate change, is ice. When ice gets sufficiently warm, it melts. Ice asks no questions, presents no arguments, reads no newspapers, listens to no debates. It is not burdened by ideology and carries no political baggage as it crosses the threshold from solid to liquid. It just melts.”
  - Henry Pollack (*A World Without Ice*, 2009, p. 114)

Cautious Optimism….

- There is so much of the probable future of this planet that is depressingly predictable, because it has all happened before.
- The one thing that is new is the creative ape; in the 3.7 by of life on earth, there has never been a species that could (if it chose) foresee its future and hit upon *creative* solutions to its problems.
- When we humans act like other animals we are embarrassingly easy to predict;
- When we base our actions on our creative intelligence we are capable of *surprising* adaptivity; which is it going to be??

Paul A. M. Dirac (1902—1984)

Thought it was self-evident that because of our science, the human species will survive in the universe indefinitely…

Though perhaps not on this planet!

(See G. Farmelo, *The Strangest Man: The Life of Paul Dirac*, 2009.)