THE AGGRAVATED THREAT OF GLOBAL CLIMATE CHANGE

CLIMATE CHANGE AND THE FLORIDA KEYS

FACT SHEET 2

FKNMS/NOAA SOCIOECONOMIC RESEARCH AND MONITORING PROGRAM

The views and recommendations are the author's and are not necessarily endorsed by NOAA.

A RISKIER FUTURE

The IPCC scenario stories and numerical projections remain based on what was known in the second half of the 1990s. The stories were used to build the emissions scenarios for IPCC's Third Assessment Report (2001), which were then reviewed in the Fourth Assessment Report (AR4) in 2007. While it was acknowledged then that the threat of climate change had intensified, the scenario stories were not updated, and emissions scenarios published since 2000 were found to be reasonably comparable with the original projections.

New scientific evidence since the writing of AR4 strongly suggests that climate change is accelerating, and the emissions scenarios are getting outdated as described in a background paper for the main *Climate Change and the Florida Keys* report. The findings provided a basis for a critical review of the original scenarios in the main project report. These updates must suffice until IPCC publishes new scenarios for its Fifth Assessment Report, due in 2013.

ATMOSPHERIC CO_2 MUST BE REDUCED, NOT ALLOWED TO INCREASE

As late as 2007, IPCC estimated that even its most benign global scenario, the environmentally friendly scenario B1, was likely to result in 545 parts per million carbon dioxide (ppm CO_2) by the end of the century, even though the expected global temperature rise would be limited to between 1.1 and 2.9^{O}C. Leading climatologist James Hansen, director of NASA's Goddard Institute for Space Studies, has long advocated that if humanity wishes to preserve a habitable planet for coming generations, the level of atmospheric CO_2 will need to be reduced from the current 390 ppm to "at most" 350 ppm.

This is expected to be compatible with a global temperature rise of 2^{O}C from preindustrial levels. The scientific consensus is that 350 ppm CO_2 is the safest level to aim for, though risks remain. The Copenhagen climate change conference in December 2009 endorsed the principle of "<350 ppm CO_2 for +2^{O}C", perhaps the most positive result of that event.

FEEDBACK EFFECTS

Before 2000, climate models did not incorporate what is known as positive feedback between climate and biosphere. Doing so has greatly increased the temperature at which the CO_2 level stabilizes in these models. Even today when the global temperature has risen by less the one degree Celsius above the preindustrial level, there have been dramatic reductions of the Arctic sea-ice cover, the Greenland and Antarctic ice caps are threatened,

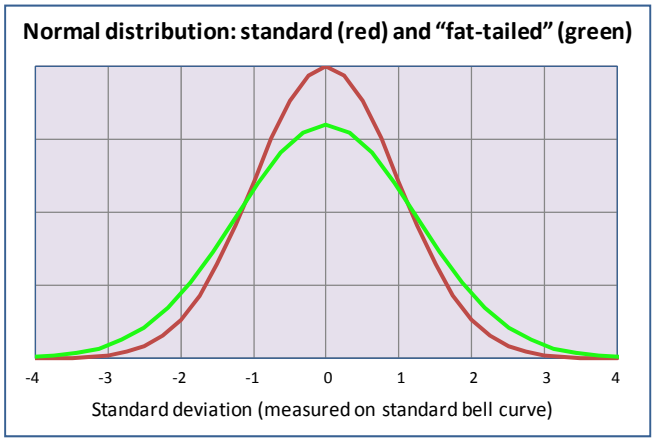
and huge amounts of methane could escape into the atmosphere from thawing permafrost. In the Arctic, a so-called "albedo flip" occurs when sunlight is no longer reflected back by the white sea-ice but is absorbed into a dark polar sea, thus hastening the melting process. Major sea-level rise would follow collapse of the Greenland ice sheet. Elsewhere, the Amazonian rainforests might perish and with them the most important carbon sink on earth.

Coral reefs are among the most sensitive ecosystems on the planet. They live close to their thermal tolerance level and are therefore highly vulnerable to even small rises in sea temperatures. Coral bleaching events appear to have started when atmospheric CO_2 levels were only 320 ppm. In addition, it is now recognized that the reefs are threatened by ocean acidification as the sea absorbs increasing quantities of CO_2 from the atmosphere. The acidification directly affects organisms with calcareous skeletons. Corals are especially vulnerable because their skeleton is made of aragonite, which is more soluble than the more common calcium carbonate, calcite.

Ocean acidification was recognized as a major threat quite recently, but marine scientist Charlie Veron has called it the most serious climate change problem, affecting all calcareous marine organisms and causing domino effects from one oceanic ecosystem to another.

ADDING TO THE UNCERTAINTY

Climate models recognizing nonlinear feedback effects make them less predictable, increasing the band between best and worst case change. Events have pushed the findings on climate change toward the upper boundaries of the projected ranges. Worst cases have moved closer to the center of the probability distribution, most often represented by the "bell curve" or normal distribution represented by the red curve below.



Harvard economist Martin Weitzman has found that serious events deemed highly improbable based on the standard bell curve have become less so – the probability distribution has become flatter and has acquired a "fat tail" (illustrated by the green curve). Devastating catastrophic events that were previously considered extremely improbable may remain improbable, but less so than was previously thought to be the case. The "fat tail" is a factor for which we must plan seriously in the general consideration of climate change.

TOWARDS "SIX DEGREES"

British science writer Mark Lynas in 2007 wrote a far-reaching review of global warming. He showed how even the global temperature change of one degree Celsius we are currently approaching has had significant effects (including mass coral bleaching). Each additional degree of global warming increases the impact and cost of climate change, and the

likelihood of catastrophic positive feedback impacts. This is based on impeccable scientific evidence known when Lynas wrote his book in 2007, evidence strengthening by the day.

CLIMATE CHANGE BELIEF AND DENIAL

Disturbingly, the gap between scientific evidence and political reality widened in 2009 and 2010. The scientific evidence is disadvantaged in the public and political mind by the inability of climate models to produce precise results. While logically the increased risk of realizing worst cases should be mobilized as additional evidence that the world must insure against climate change, the fact that the impact of atmospheric pollution cannot be predicted exactly has become an argument against the very existence of climate change.

The scientific evidence is up against public and political opinion influenced by those interested in maintaining the status quo. The fear remains that vested interests will prevail and little action will be taken in the fight against climate change. The scenario analysis in this project, taken through to the local Florida Keys level, represents a science-based effort to ensure that climate change will be tackled as a real and urgent problem.

HHG, November 2, 2010

Further reading

Climate Change and the Florida Keys, in particular Sections 1.7 and 7.2.2-7.2.4, 7.3.2-7.3.4, 7.4.2-7.4.4, and 7.5.2-7.5.4, which describe the changes to the four global scenarios from the original IPCC versions in 2000.

Background Paper 1, *Changing Global Scenarios*, on how climate change has become more urgent since the original stories were written in the 1990s.

Fact Sheets 1 (*Scenario Planning and the IPCC*) and 6 (*Scenarios for the Keys*).

James Hansen et al. (2008), 'Target atmospheric CO_2: Where should humanity aim?' *Open Atmospheric Science Journal*. http://pubs.giss.nasa.gov/docs/2008/2008_Hansen_etal.pdf.

IPCC (2001), *Climate Change 2001: Synthesis Report.* http://www.ipcc.ch/ipccreports/tar/vol4/pdf/front.pdf.

Mark Lynas (2008), *Six Degrees: Our future on a hotter planet.* National Geographic, Washington, DC. (Originally published in Great Britain in 2007.)

Nebojsa Nakicenovic and Rob Swart (ed.) (2000), *IPCC Special Report on Emissions Scenarios* (2000). http://www.grida.no/climate/ipcc/emission/.

Rajendra Pachauri and Andy Reisinger (ed.) (2007), *Climate Change 2007: Synthesis Report.* IPCC. (http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html).

Charlie Veron et al. (2009), 'The coral reef crisis: The critical importance of <350 ppm CO_2'. *Marine Pollution Bulletin*, 58: 1648-1436.

Martin Weitzman (2009), 'On modeling and interpreting the economics of catastrophic climate change.' *The Review of Economics and Statistics*, Vol. XCI, No. 1:1-19. February.

Pictured: Gathering storm over Marathon (HHG 2007)