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Climate Change Fact Sheet

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Key Climate Facts

On August 14, 2006, Dr. James E. Hansen, Director of the NASA Goddard Institute for Space Studies testified in the case of the Association of International Automobile Manufacturers et. al. v. the Secretary of Vermont, Agency of Natural Resources et. al. with regard to climate change. A number of Hansen's key points are summarized below. It should be noted that this testimony is the personal opinion of a private citizen, and does not necessarily represent the views of NASA or its affiliates.

CURRENT STATUS

- The United States is responsible for almost four times the CO₂ emissions of any other country.
- The two largest and fastest growing sources of emissions are vehicle emissions and power plants.
- Atmospheric CO₂ and methane (CH₄) concentrations are now far outside the range that has existed for hundreds of thousands of years.
- Because the rate of CO₂ emissions is increasing, the atmospheric concentration of CO₂ will reach double pre-industrial levels by 2050.
- The pre-industrial atmospheric concentration of CO₂ was 280 parts per million (ppm), and is currently 382 ppm. Doubling CO₂ concentrations would lead to an atmospheric concentration of 560 ppm.
- An additional amount of global warming "in the pipeline" is probably ~0.5°C (~1°F). [This is warming that will occur even if all CO₂ emissions ceased today.]
- The Earth's climate sensitivity is 0.75±0.25 °C per watt/square meter of climate forcing.

"BUSINESS AS USUAL"

- In "Business-as-Usual" [BAU] scenarios the annual growth [of CO₂ concentration] continues to increase at typically 2% per year, achieving annual growth of about 4 ppm/year by mid century.
- "Business-as-Usual" fossil fuel use will lead to global warming of at least 5°C by 2100.
- If warming approaches the range 2-3°C, it is virtually certain that there will be large-scale disastrous climate impacts for humans as well as for other inhabitants of the planet.
- Global warming of 1°C (1.8°F) above year 2000 temperature would be a large climate change and 3°C (5.4°F) would yield "a different planet."

ICE SHEETS AND SEA LEVEL RISE

- The primary issue about sea level concerns the likelihood that global warming will reach a level such that ice sheet disintegration begins to proceed in a rapid non-linear fashion on either Greenland, West Antarctica, or both.
- The Intergovernmental Panel on Climate Change's (IPCC's) baseline projection of about 45 cm of sea level rise by 2100 (with range 10-90 cm) relative to 1990 assumed no contribution from Greenland or Antarctica.
- The temperature of Greenland over the first several years of this century is ~1°C above that of a 1950-1985 reference period. Under BAU, it is projected Greenland will warm another ~5°C.
- Satellite measurements determined that Greenland and West Antarctica each were losing mass at a rate

of about 200 cubic kilometers (about 50 cubic miles) of ice per year in 2005.

- Earthquakes near the outlets of major ice streams on Greenland between 1993 and 2005, with magnitudes between 4.6 and 5.1, are an indication that large pieces of the ice sheet lurch forward and then grind to a halt from friction with the ground. The annual number of these Greenland earthquakes, or ice quakes, has quadrupled since seven were recorded in 1993.
- Once the process is set in motion, ice sheet disintegration can accelerate rapidly due to positive feedbacks.
- It is nearly certain that the West Antarctica and/or Greenland ice sheets would disintegrate at some point if global warming approaches 3°C, as it would with a Business-as-Usual greenhouse gas scenario.
- Sea level has risen several meters per century in the past from ice sheet disintegration. About 14,000 years ago, sea level rose approximately one meter every 20 years for 400 years—a total rise of 20 meters.
- If Business-as-Usual global warming of 2-3°C occurs, sea level rise of at least 25±10 meters is likely. Dr. James Hansen has testified he expects about six meters of sea level rise by 2100.
- The effects of a rising sea level would not occur gradually, but rather they would be felt mainly at the time of storms through increased storm surges.

ABRUPT CHANGE

- The climate system is capable of abrupt changes and surprises. Once an abrupt climate change occurs it can be difficult or impossible to reverse the climate change on a time scale relevant to civilization.
- The occurrence of abrupt climate changes this century is practically certain if we continue with Business-as-Usual greenhouse gas emissions.
- In my [Hansen's] opinion there is no significant doubt (probability > 99%) that such additional global warming of 2°C would push the Earth beyond the tipping point and cause dramatic climate impacts, including eventual sea level rise of at least several meters, extermination of a substantial fraction of the animal and plant species on the planet, and major regional climate disruptions.

ALTERNATIVE SCENARIO

- The Alternative Scenario requires a moderate reduction of CO₂ by mid-century, and a sharper reduction in the second half of the century such that annual growth in concentration goes to zero at 2100, causing atmospheric CO₂ to peak at ~475 ppm in 2100.
- The Alternative Scenario keeps total warming below 1°C (beyond that in 2000).
- If CO₂ emissions continue to grow at their present rate, the increase in CO₂ between 2000 and 2015 make it implausible to achieve the Alternative Scenario.
- This implies we have approximately ten years to stem the increase in CO₂ emissions before the Alternative Scenario becomes implausible.
- The non-CO₂ portion of the Alternative scenario—reducing methane emissions, aerosol, black carbon and other GHGs—is essential for success in climate management.
- The emission standards proposed by the California Air Resources Board are consistent with attainment of the vehicles portion of the Alternative Scenario.
- The conclusion is that there can be large benefits in limiting the climate forcing and climate change, even though it is impossible to avoid anthropogenic effects entirely.

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