The Climate Problem: Solutions and Opportunities

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Essential Points

Presentation starts by stating main points and policy implications

- Though there remain important uncertainties in detailed outcomes, there is ample evidence that climate change presents significant risks.

- Technological energy developments, largely based on U.S. science and innovation, provide the basis for large economic opportunities

- Roadblocks to innovation and development, mostly in the form of cumbersome and outdated regulations, are preventing the U.S. from reaping the economic benefits of its own innovations
Important Points about Climate and Climate Science

- Current understanding of climate science built on much more than giant climate models

- Although many uncertainties remain in climate projections, current evidence points to serious climate risk to future generations
“Any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth's surface by 4°; and if the carbon dioxide were increased fourfold, the temperature would rise by 8°.” – Världarnas utveckling (Worlds in the Making), 1906
Scientific Predictions, Dating Back More than 100 Years, Are Well Verified by Observations

Slide title is a complete sentence that states the main takeaway

Data sources: Temperature: NASA GISS Global Land-Ocean; CO2: NASA GISS
Earlier Predictions in Accord with Advanced Understanding of Climate Physics

Single Column Model Results

Arrows are added to emphasize key points of figures

3.1 °C/doubling

IPCC Estimate: 1.5-4.5 °C
Increased CO$_2$ Fingerprint: Stratosphere Cools While Troposphere Warms

Top of the stratosphere (TTS) 1979-2006 temperature trend.

Lower Troposphere

Tropospheric temperature trend from 1979-2012 based on satellite measurements (RSS).

Data source: http://www.remss.com/data/msu/data;
Data description: http://www.remss.com/msu/msu_data_description.html
Risks

- Increasing sea level

- Increasing hydrological events… droughts and floods

- Increasing incidence of high category hurricanes and associated storm surges and freshwater flooding

- More heat stress and other health risks

- Armed conflict
Benefits

- Some increase in plant productivity
- Reduction in health problems related to cold weather
Sources of Uncertainty

- Cloud Feedback
- Water Vapor Feedback
- Ocean Response
- Aerosols
A Probabilistic Estimate of Global Mean Temperature Increase

Increase in Global Temperature (°C)

1 2 3 4 5 6 7

1.83 4.64

Safe

Costly Adaptation

Existential Risk

Source: 100000 PAGE09 runs

Chris Hope, U. Cambridge
courtesy Tim Palmer
CO₂ Will Go Well Beyond Doubling
Atmospheric CO$_2$ assuming that emissions stop altogether after peak concentrations

Global mean surface temperature corresponding to atmospheric CO$_2$ above

Source: Solomon et al., *PNAS*, 2009
Several aspects of climate science are well established.

Projections remain uncertain; this uncertainty is not likely to diminish in the near future.

Outcome probability distributions are broad and contain dangerous tail risks that become central risks late in the century.

Lifetime of CO$_2$ in atmosphere measured in millennia; cannot afford to wait for more certainty.