Science – in Short

Chapter Summaries
of
A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate

Climate Working Group
United States Department of Energy
July 23, 2025

Climate Working Group (2025) A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate. Washington DC: Department of Energy, July 23, 2025

An Overview by Friends of Science Society @2025

A more nuanced report on climate science.

Climate Working Group:

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Except for slide 4, 6, and 7 all images from ppt stock photos.

Secretary Chris Wright

(From the foreword)

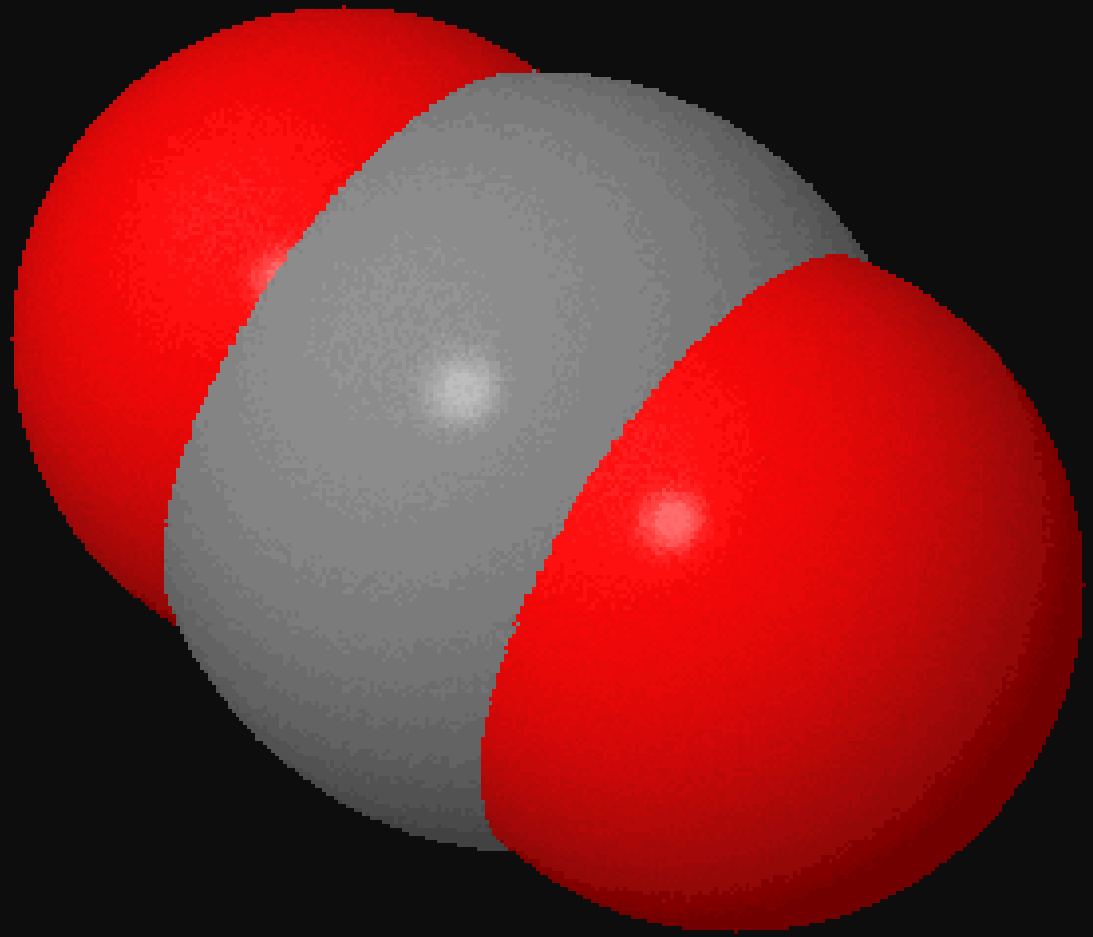
The rise of human flourishing over the past two centuries is a story worth celebrating. Yet we are told—relentlessly—that the very energy systems that enabled this progress now pose an existential threat. Hydrocarbon-based fuels, the argument goes, must be rapidly abandoned or else we risk planetary ruin.

That view demands scrutiny. That's why I commissioned this report: to encourage a more thoughtful and science-based conversation about climate change and energy. With my technical background, I've reviewed reports from the Intergovernmental Panel on Climate Change, the U.S. government's assessments, and the academic literature. I've also engaged with many climate scientists, including the authors of this report.

What I've found is that media coverage often distorts the science. Many people walk away with a view of climate change that is exaggerated or incomplete. To provide clarity and balance, I asked a diverse team of independent experts to critically review the current state of climate science, with a focus on how it relates to the United States.

1 CARBON DIOXIDE AS A POLLUTANT

- **Chapter summary:**
- Carbon dioxide (CO2) differs in many ways from the so-called Criteria Air Pollutants. It does not affect local air quality and has no human toxicological implications at ambient levels. It is an issue of concern because of its effects on the global climate.

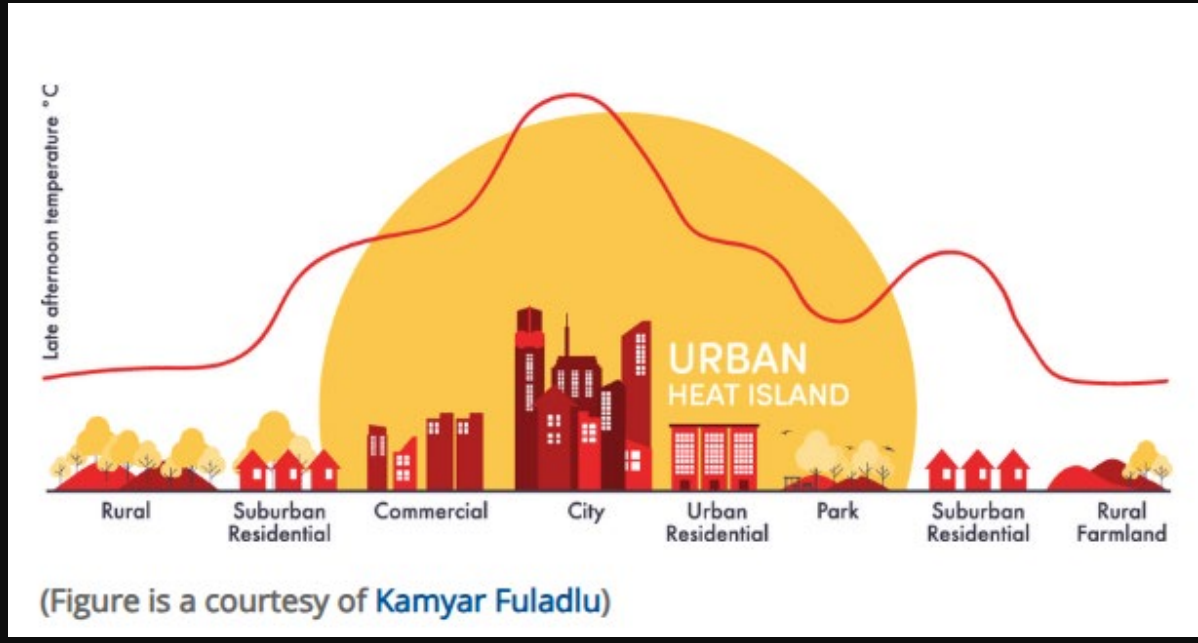


2 DIRECT IMPACTS OF CO2 ON THE ENVIRONMENT

- **Chapter summary:**
- **CO2 enhances photosynthesis and improves plant water use efficiency, thereby promoting plant growth**. Global greening due in part to increased CO2 levels in the atmosphere is well-established on all continents.
- **CO2 absorption in sea water makes the oceans less alkaline.** The recent decline in pH is within the range of natural variability on millennial time scales. Most ocean life evolved when the oceans were mildly acidic. Decreasing pH might adversely affect corals, although the Australian Great Barrier Reef has shown considerable growth in recent years.

3 HUMAN INFLUENCES ON THE CLIMATE

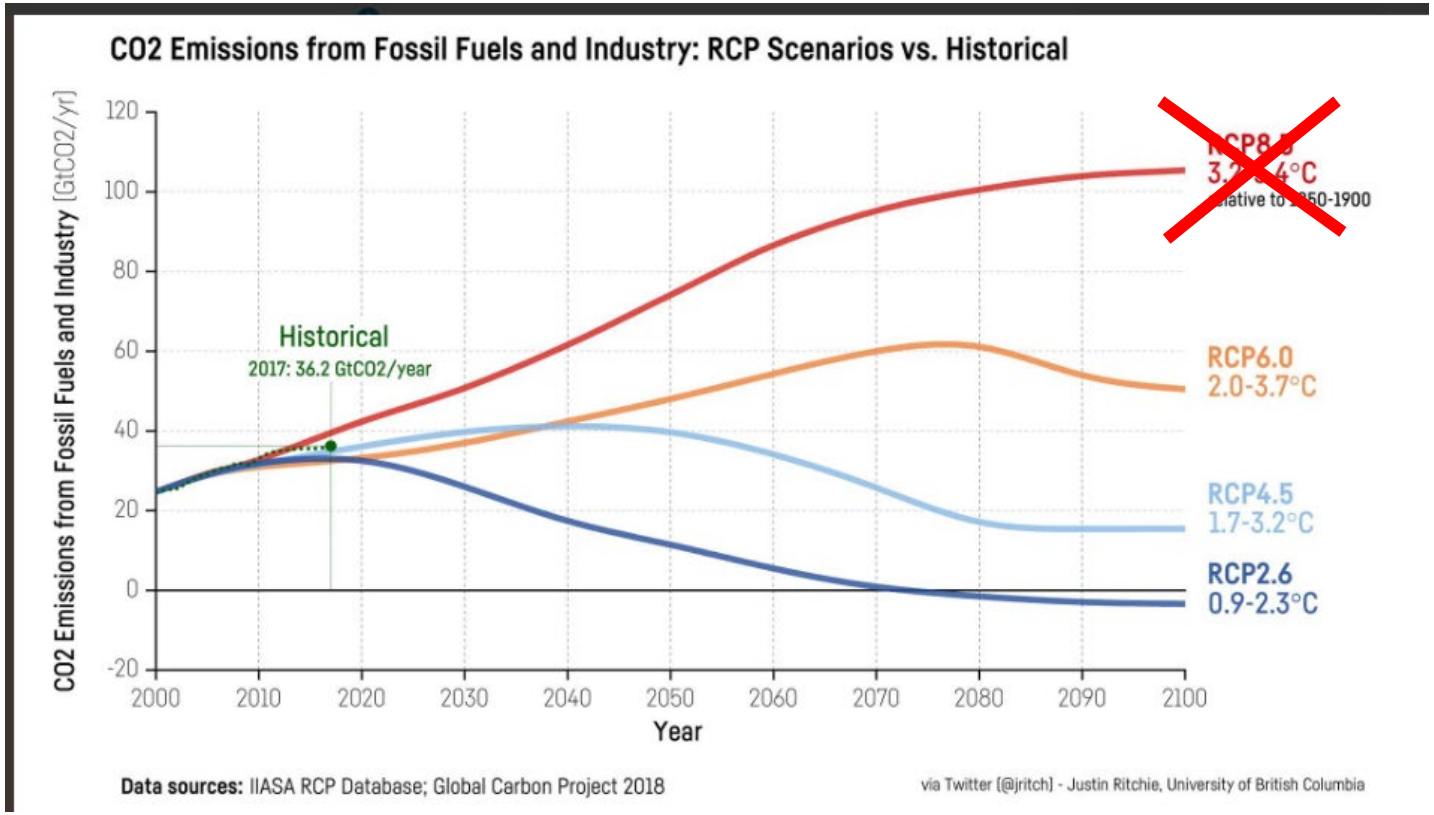
- **Chapter Summary:**
- **The global climate is naturally variable on all time scales. Anthropogenic CO2 emissions add to that variability by changing the total radiative energy balance in the atmosphere.**
- **The IPCC has downplayed the role of the sun in climate change but there are plausible solar irradiance reconstructions that imply it contributed to recent warming.**
- Climate projections are based on IPCC emission scenarios that have tended to exceed observed trends. **Most academic climate impact studies in recent years are based upon the extreme RCP 8.5 scenario that is now considered implausible; its use as a business-as-usual scenario has been misleading.**
- Carbon cycle models connect annual emissions to growth in the atmospheric CO2 stock. While models disagree over the rate of land and ocean CO2 uptake, all agree that it has been increasing since 1959.
- **There is evidence that urbanization biases in the land warming record have not been completely removed from climate data sets**.



(Figure is a courtesy of Kamyar Fuladlu)

https://community.wmo.int/en/activity-areas/urban/urban-heat-island

RCP 8.5 is implausible. NOT Business-as-Usual.

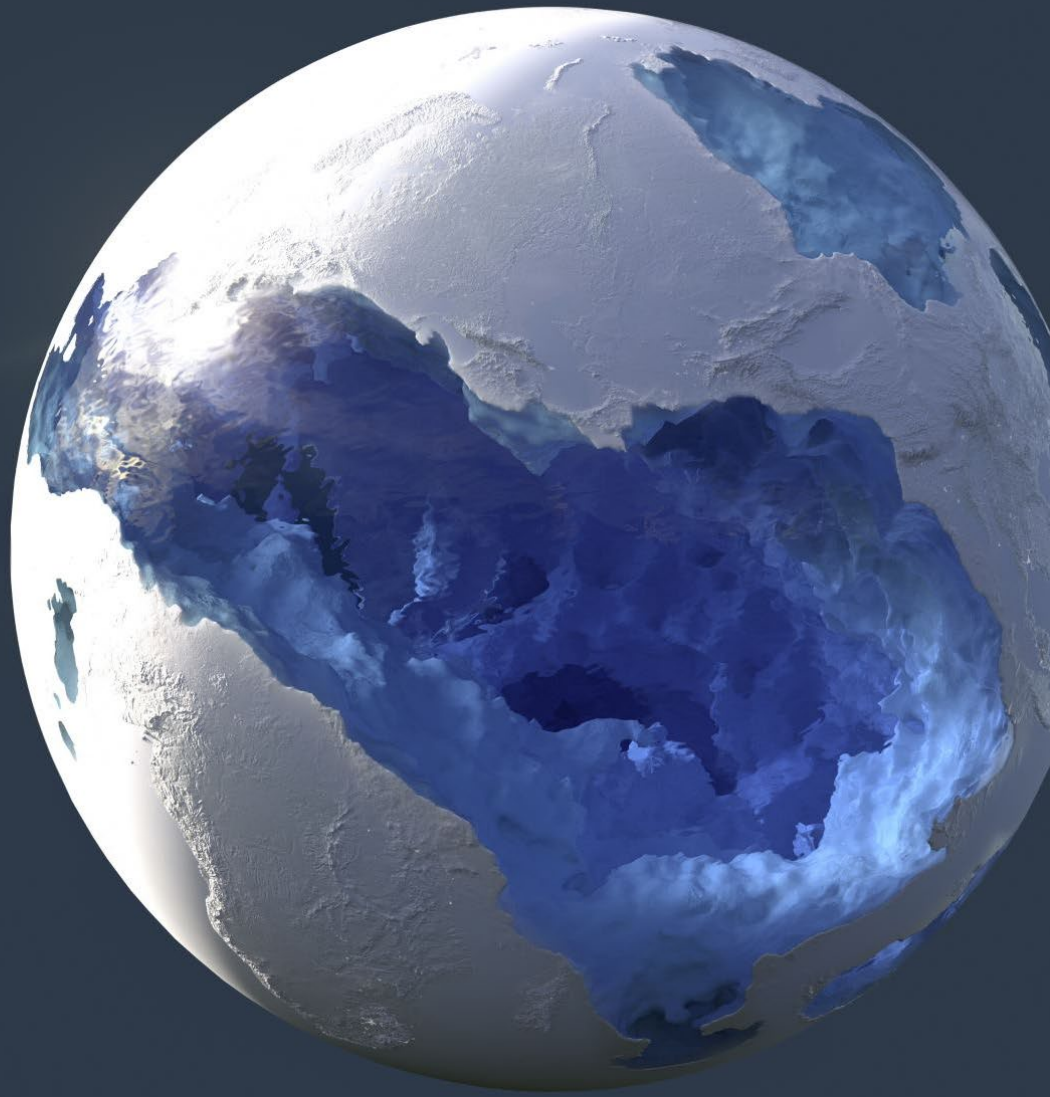


4 CLIMATE SENSITIVITY TO CO2 FORCING

- **Chapter Summary**
- **There is growing recognition that climate models are not fit for the purpose of determining the Equilibrium Climate Sensitivity (ECS) of the climate to increasing CO2.** The IPCC has turned to data-driven approaches including historical data and paleoclimate reconstructions, but their reliability is diminished by data inadequacies.
- Data-driven ECS estimates tend to be lower than climate model-generated values. The IPCC AR6 upper bound for the likely range of ECS is 4.0°C, lower than the AR5 value of 4.5°C. This lowering of the upper bound seems well justified by paleoclimatic data. The AR6 lower bound for the likely range of ECS is 2.5°C, substantially higher than the AR5 value of 1.5°C. This raising of the lower bound is less justified; evidence since AR6 finds the lower bound of the *likely* range to be around 1.8°C.

5 DISCREPANCIES BETWEEN MODELS AND INSTRUMENTAL OBSERVATIONS

- **Chapter summary**
- **Climate models show warming biases in many aspects of their reproduction of the past several decades.** In response to estimated changes in forcing they produce too much warming at the surface (except in the models with lowest ECS), too much warming in the lower-and mid-troposphere and too much amplification of warming aloft.
- Climate models also produce too much recent stratospheric cooling, invalid hemispheric albedos, too much snow loss, and too much warming in the Corn Belt. The IPCC has acknowledged some of these issues but not all.

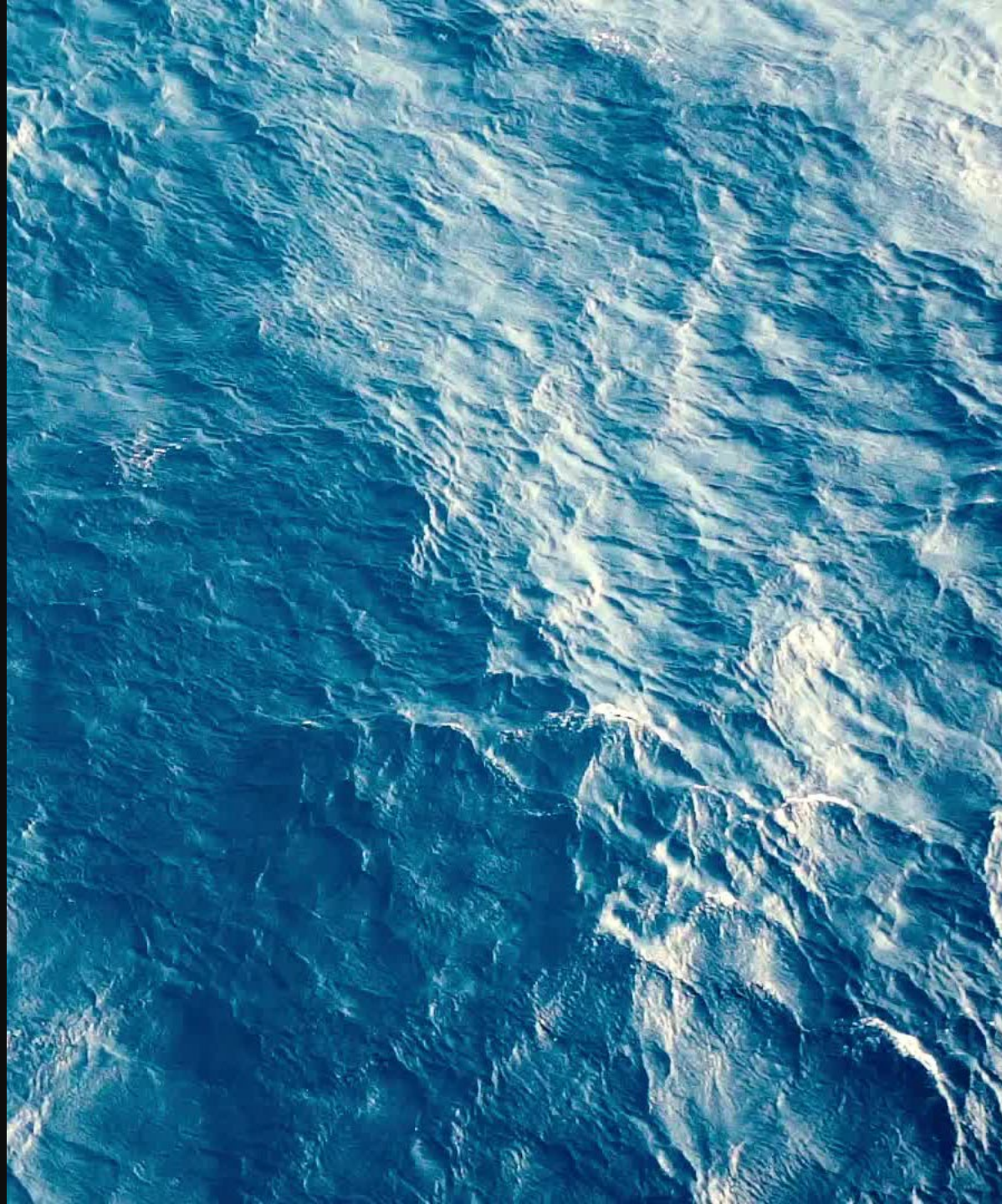


6 EXTREME WEATHER

- **Chapter Summary**
- **Most types of extreme weather exhibit no statistically significant long-term trends over the available historical record.** While there has been an increase in hot days in the U.S. since the 1950s, a point emphasized by AR6, numbers are still low relative to the 1920s and 1930s. Extreme convective storms, hurricanes, tornadoes, floods and droughts exhibit considerable natural variability, but long-term increases are not detected. Some increases in extreme precipitation events can be detected in some regions over short intervals but the trends do not persist over long periods and at the regional scale. **Wildfires are not more common in the U.S. than they were in the 1980s. Burned area increased from the 1960s to the early 2000's, however it is low compared to the estimated natural baseline level. U.S. wildfire activity is strongly affected by forest management practices.**

7 CHANGES IN SEA LEVEL

- **Chapter Summary**
- **Since 1900, global average sea level has risen by about 8 inches. Sea level change along U.S. coasts is highly variable, associated with local variations in processes that contribute to sinking and also with ocean circulation patterns.** The largest sea level increases along U.S. coasts are Galveston, New Orleans, and the Chesapeake Bay regions - each of these locations is associated with substantial local land sinking (subsidence) unrelated to climate change.
- **Extreme projections of global sea level rise are associated with an implausible extreme emissions scenario** and inclusion of poorly understood processes associated with hypothetical ice sheet instabilities. In evaluatingAR6 projections to 2050 (with reference to the baseline period 1995-2014), almost half of the interval has elapsed by 2025, with sea level rising at a lower rate than predicted. U.S. tide gauge measurements reveal no obvious acceleration beyond the historical average rate of sea level rise.



8 UNCERTAINTIES IN CLIMATE CHANGE ATTRIBUTION

- **Chapter summary**
- **“Attribution” refers to identifying the cause of some aspect of climate change, specifically with reference to anthropogenic activity.** There is an ongoing scientific debate around attribution methods, particularly regarding extreme weather events. Attribution is made difficult by high natural variability, the relatively small expected anthropogenic signal, lack of high-quality data, and reliance on deficient climate models. **The IPCC has long cautioned that methods to establish causality in climate science are inherently uncertain and ultimately depend on expert judgement.**
- Substantive criticism of the main IPCC assessments of the role of CO2 in recent warming focus on inadequate assessment of natural climate variability, uncertainties in measurement of solar variability and in aerosol forcing, and problems in the statistical methods used for attribution.
- **The IPCC does not make attribution claims for most climate impact drivers related to extreme events.** Statements related to statistics of global extremes (*e.g.* event probability or return times, magnitude and frequency) are not generally considered accurate owing to data limitations and are made with low confidence. Attribution of individual extreme weather events is challenging due to their rarity. Conflicting claims about the causes of the 2021 Western North America Heatwave illustrate the perils of hasty attribution claims about individual extreme events.

9 CLIMATE CHANGE AND U.S. AGRICULTURE

- **Chapter summary**
- **There has been abundant evidence going back decades that rising CO2 levels benefit plants, including agricultural crops, and that CO2-induced warming will be a net benefit to U.S. agriculture.** The increase in ambient CO2 has also boosted productivity of all major U.S. crop types. There is reason to conclude that on balance **climate change has been and will continue to be neutral or beneficial for most U.S. agriculture**.

10 MANAGING RISKS OF EXTREME WEATHER

- **Chapter summary**
- **Trends in losses from extreme weather and climate events are dominated by population increases and economic growth. Technological advances such as improved weather forecasting and early warning systems have substantially reduced losses from extreme weather events**. Better building codes, flood defenses, and disaster response mechanisms have lowered economic losses relative to GDP. The U.S. economy's expansion has diluted the relative impact of disaster costs, as seen in the comparison of historical and modern GDP percentages. Heat-related mortality risk has dropped substantially due to adaptive measures including the adoption of air conditioning, which relies on the availability of affordable energy. **U.S. mortality risks even under extreme warming scenarios are not projected to increase if people are able to undertake adaptive responses.**

11 CLIMATE CHANGE, THE ECONOMY, AND THE SOCIAL COST OF CARBON

- **Chapter summary**
- **Economists have long considered climate a relatively unimportant factor in economic growth**, a view echoed by the IPCC itself in AR5. Mainstream climate economics has recognized that CO2-induced warming might have some negative economic effects, but they are too small to justify aggressive abatement policy and that trying to “stop” or cap global warming even at levels well above the Paris target would be worse than doing nothing. An influential study in 2012 suggested that global warming would harm growth in poor countries, but the finding has subsequently been found not to be robust. Studies that take full account of modeling uncertainties either find no evidence of a negative effect./2

Cont...

- **Social Cost of Carbon (SCC) estimates are highly uncertain due to unknowns in future economic growth, socioeconomic pathways, discount rates, climate damages, and system responses**. The SCC is not intrinsically informative as to the economic or societal impacts of climate change. It provides an index connecting large networks of assumptions about the climate and the economy to a dollar value. Some assumptions yield a high SCC and others yield a low or negative SCC (i.e. a social benefit of emissions). The evidence for or against the underlying assumptions needs to be established independently; the resulting SCC adds no additional information about the validity of those assumptions. **Consideration of potential tipping points does not justify major revisions to SCC estimates**.

12 GLOBAL CLIMATE IMPACTS OF U.S. EMISSIONS POLICIES

- Chapter Summary
- U.S. policy actions are expected to have undetectably small direct impacts on the global climate and any effects will emerge only with long delays.

12.3 Concluding thoughts

- **This report supports a more nuanced and evidence-based approach for informing climate policy that explicitly acknowledges uncertainties**. The risks and benefits of a climate changing under both natural and human influences must be weighed against the costs, efficacy, and collateral impacts of any “climate action”, considering the nation’s need for reliable and affordable energy with minimal local pollution. Beyond continuing precise, un-interrupted observations of the global climate system, it will be important to make realistic assumptions about future emissions, re-evaluate climate models to address biases and uncertainties, and clearly acknowledge the limitations of extreme event attribution studies. **An approach that acknowledges both the potential risks and benefits of CO2, rather than relying on flawed models and extreme scenarios, is essential for informed and effective decision-making.**

Read the Full Report!

- A Critical Review of Impacts of Greenhouse Gas Emissions on the U.S. Climate

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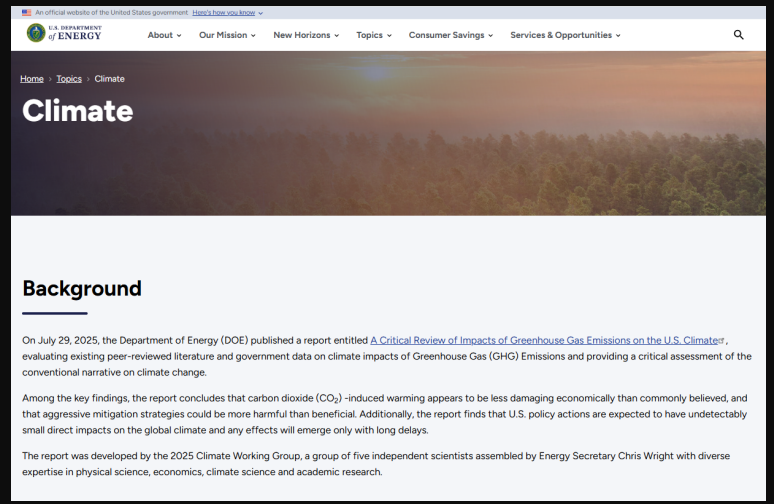

https://www.energy.gov/topics/climate

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