Critique of the Fifth National Climate Assessment

EXECUTIVE SUMMARY

This report critically evaluates the Fifth National Climate Assessment (NCA5), finding it an inadequate basis for climate and energy policies. A detailed review of the foundational chapters on climate science raises several key concerns:

Scientific Integrity

- An advocacy tone, particularly in the Overview chapter, that is inconsistent with scientific objectivity
- Endemic overconfidence when stating conclusions, including inflated certainty levels and overstatement of findings from underlying sources
- No mentions of dissent, disagreement or controversies
- Policy prescriptions that ignore costs and tradeoffs

Flawed methodology

- Minimal discussion of observational inadequacies
- Use of short time periods for trend analyses; lack of a consistent rationale for choosing time scales
- Attribution is implied, not dissected
- Overemphasis on extreme scenarios for future emissions and sea level rise
- Inadequate traceable accounts to support key conclusions

Inadequate Review Process

- A review by the National Academy of Sciences, Engineering, and Medicine (NASEM) failed to identify some fundamental flaws in NCA5
- The NCA5 authors failed to adopt some improvements recommended by NASEM

The report shows NCA5 to be a biased and incomplete picture of climate science that skews toward excessive climate risk. Consequently, NCA5 should not be used as a basis for climate and energy policies.

1 INTRODUCTION

1.1 About this Report

This report responds to a request from the Office of Science and Technology Policy (OSTP) Director Michael Kratsios (reproduced in the Appendix) [MAY HAVE TO MODIFY THIS] that we assess the suitability of the Fifth National Climate Assessment (NCA5 2023) for informing climate and energy policies.

To conduct this assessment, we reviewed NCA5 itself, the National Academies of Science, Engineering and Medicine (NASEM) review of the Third Order NCA5 Draft, and the USGCRP responses to that review. We have drawn upon our long experience working on advisory reports, including for the NASEM, the Intergovernmental Panel on Climate Change (IPCC), and other organizations as writers, reviewers, and study leaders. We have reviewed recent scientific developments in a separate report to Energy Secretary Wright (Climate Working Group 2025) herein denoted "CWG25".

We find that NCA5 should not be relied on for policy making as it portrays an incomplete and misleading picture of current climate variability and how climate-related risks are or are not changing over time. NCA5 was selective and incomplete in its survey of climate science. The overall effect of its biases and omissions is an unfocused and excessively dire picture of climate risk.

To support our finding, the following sections of this chapter provide some background on the National Climate Assessments and the standards by which we have assessed NCA5. Chapters 2 through 7 detail important ways in which NCA5 fails to meet those standards. Finally, Chapter 8 summarizes our evaluation of NCA5 and makes recommendations for NCA6.

1.2 About the National Climate Assessments

The U.S. Global Change Research Program (USGCRP) was established by Presidential Initiative in 1989 and mandated by Congress in the Global Change Research Act (GCRA) of 1990 to develop and coordinate "a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change."

The National Climate Assessment (NCA) Reports evolved from the GCRA requirement to:

> Prepare and submit to the President and the Congress an assessment which (1) integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings; (2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and (3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

The five NCA Reports to date have interpreted this mandate in different ways:

- NCA1 (2000) was a multidisciplinary effort to study and portray in regional detail the potential effects of human-induced global warming on the United States.

- NCA2 (2009) was a relatively short report that not only focused on the potential consequences of climate change but also sought to identify potential adaptation measures and identify the highest priorities for future research.
- NCA3 (2014) was an expanded effort that continued along the lines of NCA2, and was distinguished by a comprehensive review process, including a review by the National Academy of Sciences. NCA3 introduced a traceability analysis for each key finding, including a description of uncertainties.
- NCA4 (2017/2018) was a further expanded effort that was published in two volumes: I Climate Science Special Report (CSSR), and II Impacts, Risk, and Adaptation in the United States. This was the first NCA report to devote significant effort to assessing climate science.
- NCA5 (2023) returned to a single volume format, reducing discussion of climate science to a cursory two chapters, with continuing focus on regional and sectoral impacts of climate change. NCA5 expanded its remit to topics that are arguably outside the purview of the USGCRP, focusing on "Climate Action" and policy recommendations with a social justice emphasis.

These successive interpretations of the NCA are poorly aligned with the GCRA's statutory requirements. Only NCA4 gives serious consideration to climate science, which receives the great majority of USGCRP funding, and even then NCA4 misrepresents some important points. Natural climate variability is essentially dismissed as unimportant in NCA4 and barely mentioned in NCA5 in most contexts, despite the mandate to include both human-caused and natural climate change. Most significantly, NCA5 has redirected the focus away from climate science and even the hazard elements of impacts, towards evaluation of societal vulnerabilities and advocacy for particular policy options, especially deployment of wind and solar power generation.

1.3 Standards for Assessing NCA Products

Beyond the statutory requirements stated above, another pertinent standard is President Trump's executive order of May 23, 2025, Restoring Gold Standard Science. It enumerates some of the characteristics of good science, namely that it should be:

i. reproducible;
ii. transparent;
iii. communicative of error and uncertainty;
iv. collaborative and interdisciplinary;
v. skeptical of its findings and assumptions;
vi. structured for falsifiability of hypotheses;
vii. subject to unbiased peer review;
viii. accepting of negative results as positive outcomes; and
ix. without conflicts of interest.

For an assessment of policy relevant science, it is also important to include statements about the strength of knowledge. The IPCC's approach to assessing strength of knowledge is based on judgment of the available evidence and agreement among experts. But there are more sophisticated knowledge characterizations for risk management. Here are the elements according to Aven (2017):

- The degree to which the assumptions made are reasonable/realistic based on background knowledge

- The degree to which data/information exists and are reliable and relevant
- The degree to which there is disagreement among experts (including those from different environments or academic fields)
- The degree to which the phenomena involved are understood and accurate models exist
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns (issues that are known to matter but are ignored, such as, in this context, natural variability).

2 NCA5 Overview Chapter: Advocacy language and unscientific tone

NCA5 Chapter 1, "Overview", holds a prominent place in the Report since it summarizes the entire report and is the only section that many will read. Chapter 1 is marred by an activist tone, language that aggressively promotes mitigation policies, and motivated optimism. As such, this chapter adds an imprimatur of scientific authority to naïve and simplistic declarations of opinion about public policy. Here are some examples.

Chapter 1 opens with:

> The more the planet warms, the greater the impacts. Without rapid and deep reductions in global greenhouse gas emissions from human activities, the risks of accelerating sea level rise, intensifying extreme weather, and other harmful climate impacts will continue to grow. Each additional increment of warming is expected to lead to more damage and greater economic losses compared to previous increments of warming, while the risk of catastrophic or unforeseen consequences also increases.

This statement presupposes that all warming is anthropogenic, that all warming is bad and causes economic damage, and that warming intensifies extreme weather. Such sweeping generalizations go well beyond what science has or can establish. The statement also refers to growing risks without reference to their magnitude – a small risk that increases might still be a small risk, and a large risk might be only incrementally worsened.

On the next page one finds:

> Each additional increment of warming leads to greater risks [here it lists 7 key components of society including food security and the economy] ... Without deeper cuts in global net emissions, climate risks to the US will continue to grow... Action to limit future warming and reduce risks can have near-term benefits and opportunities: low-carbon energy jobs, Improved air quality, Health benefits, Economic benefits..."

The authors write as if climate policy does not involve trade-offs and all measures to reduce future warming will be effective and beneficial. Neither the vast body of scholarship on climate science and economics nor historical experience support such simplistic claims (CWG25). Not every additional increment of warming leads to economic harms; in fact, NCA5 Chapter 19 acknowledges that there will also be benefits. Nor is climate policy guaranteed to benefit the economy; it could impose net costs. Such misleading statements are a disservice to policymakers.

Pages 8 and 9 of the Overview promote renewable energy options by noting, correctly, that the levelized costs of wind/solar generation have fallen sharply since 2010, and so offers this rationale for pursuing deep emission reductions:

> Recent growth in the capacities of wind, solar, and battery storage technologies is supported by rapidly falling costs of zero- and low-carbon energy technologies, which can support even deeper emissions reductions. For example, wind and solar energy costs dropped 70% and 90%, respectively, over the last decade, while 80% of new generation capacity in 2020 came from renewable sources.

Yet it has long been known that intermittent renewables generation must be supplemented by dispatchable generation to meet grid reliability standards, and that doing so (*e.g.*, through natural gas, fission, or storage) significantly increases the total cost of electricity. Further, there are yet unmet synchronization challenges in electrical grids with heavy penetration of wind and solar generation. NCA5 fails to acknowledge these facts. But more importantly, we see no reason for NCA5 to be discussing renewable energy technologies and economics in the context of its mandate.

Page 17 of the Overview introduces the discussion of risks from extreme weather events by saying "Harmful impacts from more frequent and severe extremes are increasing across the country." This creates the impression that extreme weather events are worsening and that disaster losses are driven by trends in extreme weather. While the section goes on to acknowledge that some of the increase is due to increases in the exposure and value of assets at risk, it then invokes the NOAA Billion Dollar Dataset as evidence of extreme weather getting worse. Scientists have shown that this is an invalid metric (CWG25 Section 10.2) since it measures the growth of vulnerable infrastructure, not the frequency of extreme weather, and indeed NOAA has recently withdrawn the data product. Even though the dataset was still distributed by NOAA at the time of the NCA5, the report authors failed to assess it skeptically and see that it was unfit for the purpose of measuring climate trends.

Page 23 of the Overview states, in large font:

> Climate changes are making it harder to maintain safe homes and healthy families; reliable public services; a sustainable economy; thriving ecosystems, cultures, and traditions; and strong communities.

This statement cannot be evaluated on scholarly grounds and so doesn't belong in a scientific assessment report. Its prominent inclusion points not only to the willingness of NCA5 authors to promote alarm, but also the ineffectiveness of the review process in eliminating such statements.

3 OVERCONFIDENCE WHEN STATING CONCLUSIONS

3.1 Inflated certainty levels

Overconfidence in stating conclusions has been an endemic problem in NCA Reports. The authors frequently make sweeping generalizations without appropriate caveats or acknowledging uncertainties. The overconfidence begins with inflated language to describe certainty levels.

NCA5 uses specific terms to convey information about scientific confidence associated with important findings, observations and projections. The Front Matter of NCA5 states that

> confidence in a finding is based on the type, amount, quality, strength, and consistency of evidence; the skill, range, and consistency of methods to detect, evaluate, attribute, and interpret climate trends; and the degree of agreement across scientific information sources.

Table 1 from the Front Matter provides calibrated language for confidence assessments:

Very high:	Strong evidence (established theory, multiple sources, well documented and accepted methods, etc.). High consensus
High:	Moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.). Medium consensus
Medium:	Suggestive evidence (a few sources, limited consistency, methods emerging, etc.) Competing schools of thought.
Low:	Inconclusive evidence (limited sources, extrapolations, inconsistent findings, poor documentation and/or methods not tested, etc.). Disagreement or lack of opinions among experts.

This terminology is obviously inflated: *high confidence* with just moderate evidence and medium consensus; *medium confidence* with only suggestive evidence and competing schools of thought. This inflation in terminology leads to overconfidence in conclusions.

Even with this inflated terminology, NCA5 further inflates the confidence level of many of its conclusions to well beyond what the IPCC has concluded with more thorough justification, and by incorrectly applying its own standards. An example is the conclusion about anthropogenic influence on climate change, arguably one of the most important scientific statements of the report.

Key Message 3.1 Traceable Account states:

> There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have unequivocally caused *all* global warming observed over the industrial era.

while the corresponding statements from IPCC AR5 and AR6 are

> **AR5:** It is *extremely likely* that *more than half* of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in greenhouse gas concentrations and other anthropogenic forcings together. (IPCC, 2013)
>
> **AR6:** The *likely* range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C. It is *likely* that well-mixed GHGs contributed a warming of 1.0°C to 2.0°C, other human drivers (principally aerosols) contributed a cooling of 0.0°C to 0.8°C, natural drivers changed global surface temperature by –0.1°C to +0.1°C, and internal variability changed it by –0.2°C to +0.2°C. It is *very likely* that well-mixed GHGs were the main driver of tropospheric warming since 1979.

The IPCC AR5 and AR6 statements provide likelihood assessments but not a confidence level. While NCA5 claims with *very high confidence* that fossil fuels have unequivocally caused *all* global warming, AR5 refers to "*more than half* of the observed warming" and AR6 provides a more nuanced statement that relates to a *likely* range of warming contributed to by human drivers.

3.2 Overstating findings in underlying sources

Although we did not do a detailed audit of NCA5's use of source material, spot checks suggest a pattern of overstatement.

Chapter 2 page 11 reports on an increase in precipitation in some areas and attributes it to "climate change":

> Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

NCA5 attributes the claim to Knutson and Zeng (2018). But Knutson and Zeng did not say these things nor did they analyze this particular period. For 1981-2010 they cautioned that observed changes are consistent with natural variability, and they did not claim attributable trends were observed over the United States.

As another example of overstating findings, NCA5's Chapter 2 page 18 states

> There is robust evidence that human-caused warming has contributed to increases in the frequency and severity of the heaviest precipitation events across nearly 70% of the US.

This is apparently attributed to Diffenbaugh *et al.* (2018) and Kirchmeier-Young and Zhang (2020). Diffenbaugh *et al.* presented ratios of observed occurrences of extreme events to simulated occurrence rates in CMIP6 models run with only natural forcings. They report that for 79% of the U.S., extreme rainfall events are currently more frequent than in simulations, and the ratio of occurrences will rise under future warming simulations. This is not "robust" evidence of anthropogenic influence since it requires readers to assume that climate models accurately simulate regional precipitation patterns, something that the IPCC AR6 states is uncertain (AR6 WGI SPM Box SPM 1.2, SPM Section C.1.3).

Kirchmeier-Young and Zhang used three global climate models to analyze extreme 1- and 5-day events in North America. They noted large differences among the three models in their simulated precipitation changes. Attribution results for the U.S. are reported in their online Supplement (Figure S4). Across six experiments (three models and two rainfall metrics) anthropogenic influence was detected in only one case. Also both cited references began their historical observational records only in 1961. Here again this is not "robust" evidence. It is merely suggestive, particularly since other studies have found natural variability to be predominant.

3.3 Example: Emergent constraints

Some of the overconfidence expressed by NCA5 arises by omitting discussion of counterevidence in the peer reviewed literature, ignoring dissent and disagreement. An example is the topic of "emergent constraints". NCA5 Chapter 3 page 17 invokes this concept to support its claim that key uncertainties in climate model projections have been reduced:

> An approach to reduce uncertainty in climate change projections has matured over the past decade. It is known as "emergent constraints." The term refers to strong statistical

> relationships between highly uncertain future climate parameters and observable trends or variations in the current climate, along with a physical explanation of this relationship.

Emergent constraints appeared in the climate modeling literature as an attempt to tie climate model behavior to climate observations in hopes of generating insight into real-world equilibrium climate sensitivity (ECS). Climate models exhibit a wide range of ECS values. The idea of emergent constraints is to examine whether the models with shared sensitivity values also share a common representation of some climate process (usually related to clouds) that might influence ECS. Suppose, for example, that in low-ECS models the total cloud fraction in the tropics is strongly correlated with that in the southern midlatitudes, but in high-ECS models the correlation is weak. Then researchers could examine whether the observed correlation is strong or weak and draw a conclusion about which type of model, and therefore which ECS value, is more likely.

A problem in the emergent constraint literature is that there has been a proliferation of proposed correlations with little physical basis. NCA5 alludes to this in the Traceable Accounts section (p. 3-40) but not in the main chapter text. As shown by Schlund *et al.* (2020), many emergent constraints patterned on CMIP5 models (Coupled Model Intercomparison Project Phase 5, used for the IPCC 5th Assessment Report) failed to work on CMIP6 models (used for the IPCC 6th Assessment Report). In other words, the correlations between ECS and cloud processes present in CMIP5 models were absent in CMIP6 models, indicating that they were likely spurious rather than clues to physical processes governing the climate system. As a result, emergent constraints estimated on CMIP5 models *increased* the uncertainty of ECS, rather than decreasing it as claimed by NCA5.

Yet NCA5 incorrectly described the use of emergent constraint analysis as an advance that reduced the uncertainty of ECS and climate model projections (p. 3-38):

> Emergent constraints have been widely applied to reduce the simulated spread in the climate feedbacks that shape climate sensitivity.

4 ARBITRARY AND AMBIGUOUS TREND ANALYSES

CWG25 Chapter 6 discussed the need for care in the choice of time scale when making claims about trends in extreme weather. We provided examples from analysis of river flooding, heatwaves, and extreme precipitation to show how assertions about apparent trends based on short data sets fall apart when considering longer versions of the same data sets. NCA5 uses varying time periods for trend analyses, especially in Chapter 2 (which is focused on trends), without explaining why shorter or longer intervals were chosen. For example, page 2-4 defines temperature trends over the interval since the late 1800s whereas page 3-29 presents temperature trends over 1972-2021. Page 2-11 compares rainfall over the 2002-21 versus 1901-1960 intervals, while page 2-18 uses the interval since the late 1950s to compute trends.

A further problem is that NCA5 uses the term "trend" repeatedly without indicating if it is statistically significant (*i.e.*, distinguishable from random variability); the ambiguity creates the impression all the observed changes were significant, but readers are left to speculate. All climate variables will drift up or down over any particular time interval. Identifying the change as a trend requires showing that it is statistically significant using a variance estimator suitable for the type of data being analysed. Of particular importance is choosing a method robust to the serial correlation that is frequently present in climate data. Throughout Chapters 1 to 3, references are made to "trends" without explaining how they were computed. The exception was on page 1-19 which refers to urban temperature trends being calculated using the Theil-Sen estimator, although that method does not seem to have been used elsewhere. The one case where reference is made to statistical significance is on Page 2-9, referring to a trend in Atmospheric Optical Depth, but there is no explanation of how significance was determined. Page 2-19 refers to regional trends in droughts being "robust" but again fails to explain how the term was defined.

4.1 Average and Extreme Precipitation

NCA5 did not continue the NCA4 precedent of using the post-1901 interval as the time scale for its precipitation discussion. Instead, it refers to changes "since the 1950s"; NCA5 Figure 2.8 suggests 1958 might be the intended start date. Under Key Message 2.2, "Extreme Events Are Becoming More Frequent and Severe", NCA5 states (p. 2-18):

> Rainfall is becoming more extreme
> Since the 1950s, there has been an upward trend in heavy precipitation across the contiguous US. This increase is driven largely by more frequent precipitation extremes, with relatively smaller changes in their intensity.

In addition to our concerns that inferences about trends are contingent on choice of time scale, if the intended meaning of this statement is that positive and significant trends are found in heavy precipitation events across CONUS, we cannot reproduce it. In CWG25 Section 6.4, in addition to referencing previous analyses in the climate literature we presented analyses of daily U.S. precipitation data for the Pacific Coast, Southeast and Northeast regions, in all cases finding both considerable regional heterogeneity and that trends in various measures of extreme precipitation detectable on one time scale are often not detected on longer or shorter time scales. Additional analysis of stations in the upper Midwest confirm this pattern.[1] Moreover the NCA5 statement was at odds with evidence in the peer-reviewed literature (discussed in CWG25 Section 6.4) to which authors of this report drew NCA5 authors' attention during the review process.

The following is a more accurate summary of what U.S. precipitation data show.

> There are regionally heterogenous changes in average and extreme precipitation. Positive trends in annual average rainfall and extreme events (defined either as the annual maximum or the number of exceedances of the 99th percentile value) are generally weak or non-existent when looking at samples exceeding 130 years in length. Significant trends can be found when beginning the sample in the 1950s although in most cases the trends weaken and become insignificant when looking at the post-1980 interval. This argues against attribution of changes in precipitation to anthropogenic warming, which becomes the strongest post-1980.

4.2 Heatwaves

In contrast to NCA5, NCA4 examined heat extremes across the entire 20th century, pointing out that peak heat wave activity was reached in the 1930s and has decreased since then, and that recent increases are confined to areas west of the Rockies. NCA4 stated:

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[1] See details at https://www.nsstc.uah.edu/data/ushcn_jrc/SI.Precipt_trends_reproducing.pdf, which provides access to data and code.

[The] warmest daily temperature of the year increased in some parts of the West over the past century, but there were decreases in almost all locations east of the Rocky Mountains. In fact, all eastern regions experienced a net decrease, most notably the Midwest (about 2.2°F [1.2°C]) and the Southeast (roughly 1.5°F [0.8°C]).

Since the mid-1960s, there has been only a very slight increase in the warmest daily temperature of the year (amidst large interannual variability). Heat waves (6-day periods with a maximum temperature above the 90th percentile for 1961–1990) increased in frequency until the mid-1930s, became considerably less common through the mid-1960s, and increased in frequency again thereafter. As with warm daily temperatures, heat wave magnitude reached a maximum in the 1930s.
(NCA4 pp. 190-191)

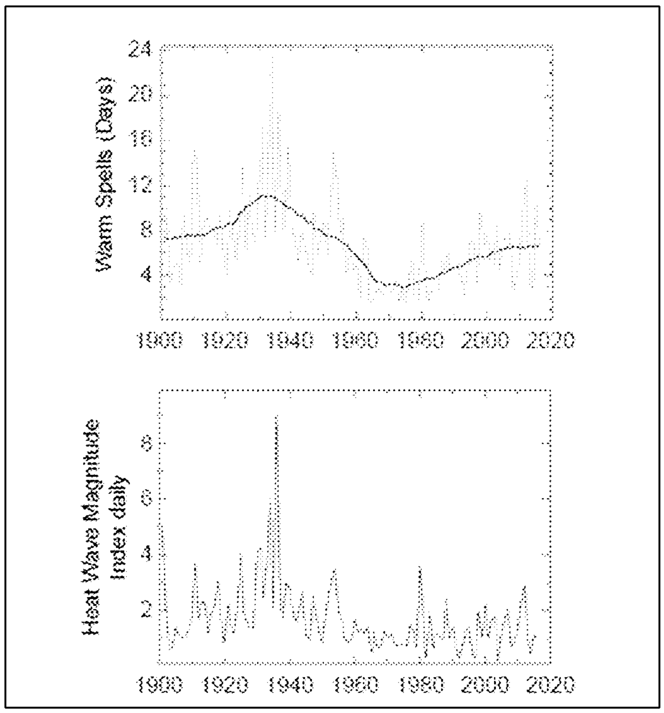
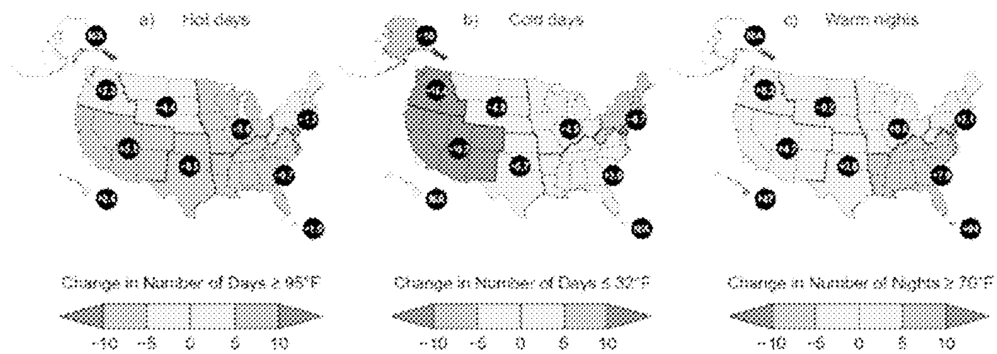


FIGURE 3. U.S. Heat waves since 1900. Reproduction of NCA4 Figure 6.4

Contrast this careful and factual language of with? NCA4 with NCA5 Key Message 2.2: "Extreme Events Are Becoming More Frequent and Severe." This blanket statement is followed by NCA5 Figure 2.7 (reproduced as Figure 4 below) which shows the number of hot days, cold days and warm nights (respectively in panels a—c) over the period 2002-2021 compared to 1901-1960. Presumably these are annual counts, although this is not stated in the caption.

Observed Changes in Hot and Cold Extremes



Hot days have increased in the West, hot nights have increased nearly everywhere, and cold days have decreased.

Figure 2.7. Over much of the country, the risk of warm nights has increased while the risk of cold days has decreased. The risk of hot days has also increased across the western US. This figure shows the observed change in the number of (a) hot days (days at or above 95°F), (b) cold days (days at or below 32°F), and (c) warm nights (nights at or above 70°F) over the period 2002–2021 relative to 1901–1960 (1951–1980 for Alaska and Hawai'i and 1956–1980 for Puerto Rico). Data were not available for the US-Affiliated Pacific Islands and the US Virgin Islands. Figure credit: Project Drawdown, Washington State University Vancouver, NOAA NCEI, and CISESS NC.

FIGURE 4: Reproduction of NCA5 Figure 2.7.

Close inspection shows that this figure actually contradicts the NCA5 Key Message with respect to heatwaves and instead reinforces the position of NCA4. Notwithstanding Key Message 2.2, the leftmost panel in NCA5 Figure 2.7 above shows that over most of CONUS the number of extreme heat days has *decreased* in recent decades compared to the prior century.

The accompanying discussion in NCA5 becomes convoluted as it appears to be aimed at supporting the Key Message despite the contrary evidence. NCA5 Chapter 2 elaborates on Key Message 2.2 by stating (page 2-16):

> Observations show an increase in the severity, extent, and/or frequency of multiple types of extreme events. Heatwaves have become more common and severe in the West since the 1980s (*high confidence*).

But while it mentions the increase in hot days in the West, it fails to mention the decrease everywhere east of the Rockies. On the next page (page 2-17) it raises the comparison to the 1930s and then switches to discussing global counts:

> By some measures, the most extreme heatwaves on record in the United States occurred during the Dust Bowl era of the 1930s. … Globally such heatwaves are becoming more frequent, and in recent decades the western United States has been following those trends.

The reference to a global trend seems to be an attempt to tie heatwaves to anthropogenic climate change. But the obvious question, unaddressed by NCA5, is why one region follows the global pattern of increasing heatwaves while most of the country is trending in the opposite direction. These issues are addressed in Chapter 6 of CWG25, demonstrating that the range and magnitude of extreme temperatures are driven more by natural variability than by anthropogenic forcing. The analysis in CWG25 shows that for both (a) hot days (≥ 95°F) and (b) number of days in heatwaves, the current decade is no hotter than a century ago in the U.S. Thus, the NCA5 claim that "multiday heatwaves

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have become hotter, more frequent, larger, and longer lasting in recent decades," is simply false when expanding the temporal and spatial domains to encompass all available data (Chapter 6 and Figure 6.3.6 of CWG25).

NCA5 then pointed to the dramatic Pacific Northwest heatwave of 2021. CWG25 Section 8.6.1 discusses this event in detail, reviewing the multiple peer reviewed studies that explained the unusual meteorological context was unrelated to human-caused climate change, a point omitted from the NCA5 discussion.

NCA5 finally addresses the declining heatwave trend in CONUS east of the Rockies but attempts to reframe it by focusing on urban warm spells.

> [The] number of very hot days has actually decreased across the central and eastern regions due to summer cooling trends in the region (Figure 2.7; Ch. 22). This does not, however, mean the central and eastern US are not affected by heat. The impacts of extreme high temperatures are more severe if such conditions persist for several days, and overall, multiday heatwaves have become hotter, more frequent, larger, and longer lasting in recent decades. Across 50 large US cities, the US Global Change Research Program heatwave indicator (https://www.globalchange.gov/indicators/heat-waves) shows that the average number of heatwaves has doubled since the 1980s, and the length of the heatwave season has increased from about 40 days to about 70 days.

We discussed this part of NCA5 in CWG25 Section 6.3. The figure referenced by NCA5 uses a short time period which begins in the 1960s, the coldest decade in the last 100 years, thus suppressing any comparison to the 1930s. Further, nighttime temperatures in urban areas have increased faster than daytime temperatures (which NCA5 acknowledges), but this is a signature of urban heat islands and is not a good metric of climate change. CWG25 found that the occurrence of hot days (≥ 95° F) has recently increased in the West but declined since 1899 in the remainder of the country and in the nationwide average.

5 Inadequate Traceable Accounts

NCA3 began the practice of including a section on Traceable Accounts at the end of each chapter. This is the description from NCA5:

> Each chapter concludes with a section entitled Traceable Accounts, which provides information on the overall process used to develop the chapter as well as a separate Traceable Account section for each Key Message. These Traceable Accounts describe the supporting evidence behind each Key Message, the process and rationale authors used in reaching their conclusions, and the author team's expert assessment of the confidence in and, where applicable, likelihood of these conclusions. As such, Traceable Accounts provide information about the state of the science, document sources of uncertainty, identify research gaps, and allow traceability to data and resources.

The Traceable Accounts for each Key Message includes the following sections:

- Description of Evidence Base
- Major Uncertainties and Research Gaps

- Description of Confidence and Likelihood

The Traceable Accounts could have addressed the statutory requirement that the NCA discuss scientific uncertainties. They could also help satisfy the Executive Order for Restoring Gold Standard Science by addressing reproducibility, transparency, communication of error and uncertainty, and skepticism of findings and assumptions. However, the Traceable Accounts in NCA5's Chapters 2 and 3 are uneven, often superficial and uninformative.

An example of a deficient Traceable Account is NCA5's Key Message 2.2: "Extreme Events are Becoming More Frequent and Severe". The "Description of the Evidence Base" offers two paragraphs, the first summarizing the findings and the second generically describing the types of data that can be used for storms. "Major Uncertainties and Research Gaps" focuses on the uneven distribution across U.S. populations due to differences in exposure and vulnerability. The only limitations in data referred to are the lack of a long-term record of lightning and the lack of homogenized daily and hourly temperature data apart from reanalysis products.

But the most astonishing deficiency is in the "Description of Confidence and Likelihood." One of the statements in Key Message 2.2 is:

> Hurricanes have been intensifying more rapidly since the 1980s (*high confidence*) and causing heavier rainfall and higher storm surges (*high confidence*).

The Description of Confidence and Likelihood includes the following statement:

> Basic physical understanding and climate models both provide robust explanations for the links between climate change and observed changes in these extremes: this is why the authors also have high confidence that storms are delivering more rainfall and high confidence that storm surges are becoming higher.

No reference to journal publications or a specific data set is made anywhere in the chapter regarding hurricane-induced precipitation or storm surge to support this *high confidence* conclusion.

The Traceable Accounts for the various Key Findings of Chapter 3 have some substantial inconsistencies. Consider

> Key Message 3-1: Human activities have caused global warming.
> Confidence and Likelihood: "There is *very high confidence* that emissions of GHGs from human activities, fossil fuel use in particular, have *unequivocally* caused all global warming observed over the industrial era. There is also *very high confidence* that changes in natural climate drivers have had globally small and regionally variable long-term effects over this period."

The Uncertainties section addresses only uncertainties in radiative forcing by greenhouse gases, ignoring the great uncertainty in model responses to that forcing (CWG25 Chapters 4 and 5) In contrast, the Traceability Analysis of Key Message 3-4 ("Humans Are Changing Earth System Processes") raises the problem that relatively little is known about the role of natural variability at the regional scale. From its Description of Evidence Base:

In the last decade, there has been increasing recognition of the role of regional-scale natural variability in the past and future evolution of climate, as well as the fact that regional natural variability signals can be competitive with forced anthropogenic signals.

And from its Major Uncertainties and Research Gaps:

For example, the true natural variability of the climate system on decadal to centennial timescales could be larger than what we estimate from GCMs, which would further increase the irreducible uncertainty stemming from natural variability.

These statements are among the most scientifically credible in the entire NCA5 and they directly undercut the confidence assigned to Key Message 3-1.

There is also a generic problem in tracing NCA5's Traceable Accounts. The Front Matter of NCA5 states:

Each figure and some tables are accompanied by a metadata survey, which can be accessed in the online version of the report by clicking on the eyeball icon above the figure or table (see the table below for explanations of additional icons used throughout the report). The metadata survey describes data sources, figure or table development methods, copyright information, and other important documentation.

Clicking on the 'eyeball' icon does not reveal the metadata information; instead a "Contact Us" email appears, addressed to the USGCRP. This is an inadequate way to archive the metadata information.

In summary, the Traceable Analyses examined here, with few exceptions, fail to meet the stated objectives of the NCA.

6 OVEREMPHASIS ON EXTREME SCENARIOS

To respond to the GCRA mandate to "project major trends for the subsequent 25 to 100 years," NCA5 relies on projections of future climate change based on estimates of future emissions (the so-called SSP scenarios) and/or specified levels of radiative forcing (the RCP scenarios). For the most part, NCA5 uses scenarios developed for the IPCC Assessment Reports.

CWG25 Section 3.2.1 presented a critical assessment of past and current IPCC scenario envelopes, showing that they have tended to overshoot observed emissions. IPCC AR6 published in 2021 stated that "The likelihood of high-emission scenarios like RCP8.5 and SSP5-8.5 is considered low in light of recent energy sector developments." and that same year UN Climate Negotiators (COP) stopped using scenarios above 4.5.

NCA5 makes the following observations about the scenarios they use:

NCA5 authors were advised to assess the full range of scenarios available. (Front Matter)

Scenarios of future emissions and land-use change are developed as plausible alternatives, but no relative likelihood is attached to them. Some recent studies, however, have argued that the highest scenario, SSP5-8.5, is no longer plausible without a reversal of current trends in the adoption of renewables and energy efficiency. (Key Message 3.3 Traceable Analysis)

Despite acknowledging the issue, NCA5 otherwise ignored the problem. A keyword search of mentions of NCA5 RCP/SSP scenarios finds over 50% referred to the extreme emissions scenarios RCP8.5/SSP5-8.5. Further, nine NCA5 figures (5.2, 6.9, 7.4, 11.3, 14.6, 22.13, 22.19, 27.9, 29.13) included *only* the 8.5 scenarios.

The problem of relying on extreme scenarios is particularly acute for NCA5's sea level rise projections. The sea level rise scenarios used in NCA5 do not relate directly to the SSP emissions scenarios, but rather to specified amounts of sea level rise by 2100. Table 4 of NCA5's "Guide to Using this Report" reproduced below shows that Low relates to 0.3 m (0.98 feet), Intermediate-Low relates to 0.5 m (1.64 feet), Intermediate relates to 1.0 m (3.28 feet), Intermediate-High relates to 1.5 m (4.92 feet), and High relates to 2.0 m (6.56 feet).

Table 4. Descriptive Terms for Common Sea Level Rise Scenarios Used in NCA5

Future global mean sea level rise and sea level rise along United States coastline are shown for five scenarios in feet (and meters), relative to a 2000 baseline. The US values shown in the right half of the table are averaged across the US coastal regions, including the contiguous US, Alaska, Hawai'i and the US-Affiliated Pacific Islands, and the US Caribbean. The national values shown in the table differ substantially from regional values. For example, sea level rise is higher in the Gulf Coast and lower or even negative in some parts of Alaska. In the next 30 years (2020–2050), sea level along the contiguous US coasts is expected to rise 0.92 feet (0.28 m), the same amount of sea level rise observed over the last 100 years (1920–2020). See Chapter 9 for regional sea level information. Adapted from Sweet et al. 2022.[3]

Sea Level Rise Scenario Descriptor	Global Mean Sea Level			United States		
Year	2050	2100	2150	2050	2100	2150
Low	0.49 (0.15)	0.98 (0.3)	1.31 (0.4)	0.59 (0.18)	0.98 (0.3)	1.64 (0.5)
Intermediate-Low	0.66 (0.20)	1.64 (0.5)	2.62 (0.8)	0.75 (0.23)	1.64 (0.5)	2.95 (0.9)
Intermediate	0.92 (0.28)	3.28 (1.0)	6.23 (1.9)	0.89 (0.27)	3.28 (1.0)	6.89 (2.1)
Intermediate-High	1.21 (0.37)	4.92 (1.5)	8.86 (2.7)	1.12 (0.34)	4.92 (1.5)	8.86 (2.7)
High	1.41 (0.43)	6.56 (2.0)	12.14 (3.7)	1.38 (0.42)	6.56 (2.0)	12.46 (3.8)

TABLE 1: Reproduction of Table 4 from the Front Matter of NCA5

Considering only projections representing processes quantified with at least medium confidence, IPCC AR6 assessed global mean sea level projections for all emissions scenarios (including implausible extreme emissions scenarios) for 2100 to fall between 0.2 and 1.6 m (5th—95th percentile range). By contrast, the range of sea level rise scenarios considered by NCA5 extends to 2.0 m. Further, NCA5 fails to include plausible lower scenarios, such as 0.2 m cited by the IPCC, which also corresponds to the average rate of sea level rise over the past century.

Chapter 9 of NCA5 offers the following predictions of sea level rise:

> "Under a range of potential global warming levels, average sea level along US coastlines is *likely* to be between 12 and 20 inches above 2000 sea levels in 2050 (Figure 9.2)."

The observed global sea level rise from 2000-2024 is only approximately 3.4 inches (0.28 feet). NCA5 is thus projecting a sea level rise during 2025 and 2050 along U.S. coasts that is 2.5 to 4.9 times the global rate observed during 2000-2024, an exceedingly implausible outcome. Chapter 9 further states:

> "There is *high confidence* and it is *likely* that sea levels will rise about 11 inches (likely range of about 9–13 inches) between 2020 and 2050"

This implies a rate of increase more than double the rate from 2000 to 2024, again an implausible outlook. In summary, NCA5 presents future sea level rise scenarios that are not directly relatable to either SSP/RCP emissions scenarios or to plausible global warming levels. The NCA5 scenarios include two that are higher than the 95th percentile for the extreme emissions scenario RCP8.5 and include hypothesized ice sheet processes in which there is low confidence. Projections to 2050 require rates of sea level rise from 2025 to 2050 that are more than double the rate observed during 2000-2024. Further, NCA5 ascribes *high confidence* to these sea level rise projections. CWG25 Section 7.3 provides further context for USGCRP projections of extraordinary sea level rise in the next 25 years.

More generally, NCA5's inclusion of, and even focus on, implausible extreme scenarios creates projections of alarming impacts that are very unlikely to be driven by anthropogenic warming.

7 Conflation of Natural and Anthropogenic Climate Changes

NCA5's Glossary defines "climate change" as a change in climate for any reason. This is technically correct, but at variance with IPCC usage, which also corresponds to the popular connotation, in which the term refers specifically to anthropogenically-caused change. The distinction is not academic- it is central both to attribution questions and to projections, since anthropogenic changes depend on emission rates, while natural changes are unavoidable. Having defined climate change broadly NCA5 then fails to distinguish natural and anthropogenic changes in context with the effect of implicitly over-attributing changes to greenhouse gas emissions.

The discussion on NCA5 page 2-4 begins "Human activities are changing the climate", then goes on to list evidence for anthropogenic GHG emissions and climate warming. The next paragraph begins "Climate change is happening now in the United States. Including Alaska, the continental US has been warming about 60% faster than the planet as a whole since 1970." The implication is that the warming of CONUS faster than the planetary average is an effect of GHG emissions. But it is an artifact of the Earth's surface being 70 percent ocean. Since the ocean warms more slowly than land, comparison of any land surface outside the tropics with the global average would show the land surface to be warming faster than the global average, regardless of the cause of the warming.

The same page goes on to say "Climate change is already affecting people in the United States. Extreme heat was estimated to be responsible for more than 700 deaths per year between 2004 and 2018 although some estimates put heat-related mortality closer to 1,300 deaths annually." But extreme heat has always occurred naturally, and whether natural or not, it has always been a risk to human health. As to trends, the data show that adaptation has caused the mortality burden of extreme heat to drop substantially in recent decades (CWG25 Section 10.3.1).

Consider also the NCA5 statement on precipitation cited in Section 3.2:

> Many eastern regions of the country are getting wetter (Figure 2.4). Average annual precipitation from 2002-2021 was 5%-15% higher relative to the 1901-1960 average in the central and eastern US, a trend attributable to climate change.

The attribution is superfluous because the statement is a tautology by NCA5's definition of climate change. Its gratuitous inclusion effectively attributes the observed trend to greenhouse gas emissions.

Exploitation of the ambiguity inherent in the term "climate change" is endemic to NCA5. The NASEM review (pp. 23-24) flagged this problem as follows:

> The draft NCA5 report frequently describes "change" but does not consistently distinguish between natural variability and climate change. This lack of clarity can be misleading for the reader by creating the misconception that some impacts that are the result of the combination of natural variability and climate change are instead solely due to climate change… it is important for NCA5 authors to accurately identify the multiple drivers of change (including global change), in addition to climate change, and accurately attribute impacts. Clearly describing impacts due to natural variability, climate change, or a combination of the two is important not only for informing policy decisions, but also for building public understand [sic] and trust in the report's messages. Climate change and natural variability should be clearly defined in the glossary and natural variability could be introduced in chapter introductions when the concept is important for understanding key messages.

This could have been easily addressed, for example by reserving the term "climate change" for anthropogenic changes and using "climate variability" for natural changes. But the NCA5 authors seemingly ignored the recommendation.

A separate but related issue is use of the term "climate change" to refer to increases in socioeconomic vulnerabilities that have anthropogenic causes unrelated to GHGs. NCA5 page 1-19 states "Climate change exacerbates inequalities." But the issue discussed is the negative correlation between neighborhood-level income and land surface temperatures in urban areas. To the extent the correlation is real, the most likely explanation is that low-income households concentrate where housing is less expensive, which might be in neighborhoods with less nearby parkland and tree cover; that has nothing to do with CO_2 emissions.

8 SUMMARY EVALUATION OF NCA5 AND RECOMMENDATIONS FOR NCA6

This chapter summarizes our evaluation of NCA5 relative to OSTP's charge: whether NCA5 (1) complied with the USGCRP's statutory obligation; (2) adheres to the core tenets of Gold Standard Science; and (3) can suitably inform federal climate and energy policy. The points made in this summary analysis refer to specific sections of this report as well as to the CWG25 report.

8.1 Compliance with USGCRP's statutory obligation

As cited in Section 1.2 of this report, the Global Change Research Act requires an assessment that:

(1) integrates, evaluates, and interprets the findings of the [Global Change Research] Program and discusses the scientific uncertainties associated with such findings;

(2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and
(3) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

We deem NCA5 to have fallen short when evaluated against these criteria because of the following major shortcomings (see indicated section for details):

- Inadequate assessment of the relevant topics in climate science and the hazard components of climate impacts (such as hurricanes and floods). NCA5 instead focuses on evaluation of societal vulnerabilities (such as flood infrastructure, access to air conditioning, etc.), "Climate Action," and policy recommendations with a social justice emphasis (Chapter 2).
- Overconfidence in conclusions and inadequate assessment of uncertainties (Chapter 3)
- Inadequate discrimination between natural and human-induced causes of trends and impacts (Chapter 7)
- Inadequate analysis of climate trends by relying on short time periods (Chapter 6)
- Uncritical evaluation of emission scenarios and climate model simulations in making projections for the next 25 to 100 years (Chapter 6).

8.2 Adherence to the tenets of Gold Standard Science

With respect to the tenets of Gold Standard science listed in Section 1.3 of this report, we have identified the following major shortcomings in NCA5:

- **Lack of reproducibility.** In the few examples that we examined closely, we identified an instance where we could not reproduce the findings of the NCA5, a task that should require only rudimentary data analysis (Section 4.1)
- **Lack of transparency.** In many instances, the Traceable Account fails to justify the Key Finding. Metadata was not readily accessible. (Chapter 5)
- **Inadequate communication of error and uncertainty.** The Traceable Account for each Key Message provides a section on Major Uncertainties and Research Gaps; most of the accounts that we examined were superficial and uninformative. (Chapter 5)
- **Not skeptical of findings and assumptions.** The main text of the chapters is, with few exceptions, not skeptical of its findings and assumptions and does not mention dissent or disagreement. (Chapters 3 and 5)
- **Some hypotheses and Key Messages are not falsifiable.** Key Message 13.4 is but one of many examples: "Equitable Distribution of Transportation Trade-offs and Benefits Requires Community Involvement." See discussion in Chapter 2.
- **Assumption that all changes are harmful** due to warming and additional atmospheric CO_2 (Chapter 2)
- **Inadequacy of the peer review process.** The review of the NCA5 Third Order Draft by National Academies of Science, Engineering and Medicine (NASEM) identified some of the deficiencies we have noted, but the NCA5 authors were not obligated to adopt the NASEM recommendations. More importantly, we've identified many other deficiencies in NCA5; the NASEM review did not point them out and thus lacked the rigor expected of NASEM reports.

8.3 Suitability for informing Federal climate and energy policy

We assess that the selection and presentation of information in NCA5 makes it an unreliable basis for U.S. climate and energy policy making. For each of the elements of knowledge characterization suitable for risk management listed in Section 1.3, here are specific examples where NCA5 falls short:

- The degree to which the assumptions made are reasonable/realistic based on background knowledge
  - NCA5 focused on implausibly extreme scenarios for emissions and sea level rise and made policy recommendations without adequate consideration of the costs
- The degree to which data/information exists and are reliable and relevant
  - NCA5's unjustified assumptions about model reliability, and its use of short time periods for analysis, does not support its high-confidence conclusions
- The degree to which there is disagreement among experts, including those from different environments or academic fields
  - While NCA5 was an interdisciplinary effort, the concerns we have raised all point to a failure to canvass or communicate the full range of evidence, including data and research findings that speak against Key Messages.
- The degree to which the phenomena involved are understood and accurate models exist
  - NCA5 is not appropriately skeptical of the ability of climate models to attribute the causes of warming and extreme events or to project future climates, especially at the regional level
- The degree to which the knowledge has been thoroughly examined with respect to unknown knowns
  - A major NCA5 shortcoming is its dismissal of natural climate variability in many contexts where it should have been a major consideration

NCA5 is also problematic for informing policy because by describing everything everywhere as threatened by climate change, frequently with exaggerated language, it fails to provide guidance for policymakers who need to prioritize and allocate scarce resources for adaptation and risk management. Likewise, it advocates for ambitious mitigation policies without a proper analysis of risks and costs. The NASEM Review of the NCA5 underscores the endemic nature of this problem - their review appears to be written by authors who share many of the biases of the NCA5 team, with an inordinate focus on social and policy issues.

NCA4 was in some respects a better policy-informing assessment than NCA5. It offered a more thorough consideration of climate science, consistently used data back to 1901, and had less of an advocacy tone. But it too engaged in some misleading hyperbole, for example in its presentation of heat extremes. NCA4's Part I said (prominently and with *Very High Confidence*) on Page 19 of the Executive Summary:

> There have been marked changes in temperature extremes across the contiguous United States. The number of high temperature records set in the past two decades far exceeds the number of low temperature records.

and offered this figure in support:

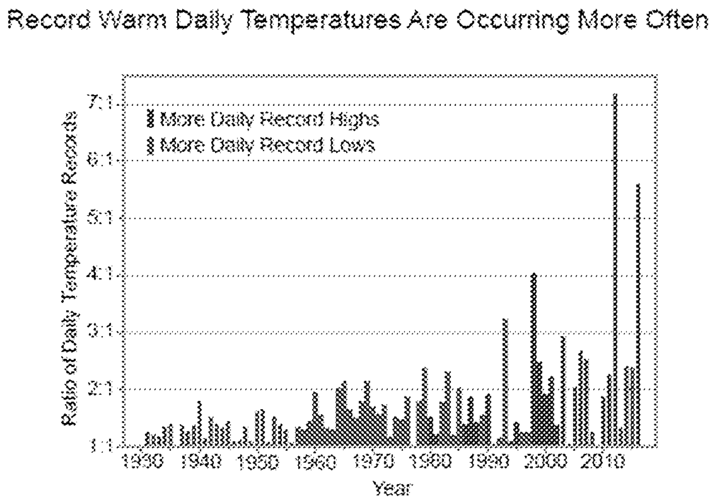


Figure ES.5: Observed changes in the occurrence of record-setting daily temperatures in the contiguous United States. Red bars indicate a year with more daily record highs than daily record lows, while blue bars indicate a year with more record lows than highs. The height of the bar indicates the ratio of record highs to lows (red) or of record lows to highs (blue). For example, a ratio of 2:1 for a blue bar means that there were twice as many record daily lows as daily record highs that year. (Figure source: NOAA/NCEI). *From Figure 6.5 in Chapter 6.*

FIGURE 5: Reproduction of Figure ES.5 from NCA4

The figure appears to show that record warm daily temperatures are occurring more often. But the underlying data (see CWG Figure 6.3.3) show the opposite: extreme heat in the U.S. peaked in the 1920s and 1930s and declined thereafter. Despite its misleading title, what Figure ES.5 shows is the *ratio* of annual warm and cold event counts. Both types of extremes declined over the sample interval, but cold events declined more than warm ones, so the ratio went up. By graphing the ratio instead of simple counts, NCA4 created a visual impression opposite to what is in the data.

NCA4 also shares with NCA5 the tendency to describe everything everywhere as under threat from climate change, undermining its usefulness for policymakers. For instance, while it contains a chapter on potential adaptation responses (Volume 2 Chapter 28) it downplays the value of such planning by stating as Key Message 2 (p. 1310) that "Climate change outpaces adaptation planning: Successful adaptation has been hindered by the assumption that climate conditions are and will be similar to those in the past."

8.4 NCA5 and the 2025 Texas Floods

To the extent an NCA should assist regional policymakers set priorities for future disaster management, we can look back at NCA4 and NCA5 and ask what relevant information they provided for the Texas Hill Country, where the tragic events of July 2025 took place. We first note that while the region in question is historically prone to flooding, the Environmental Protection Agency Climate Change Indicators record[2] shows decreasing flood frequency and magnitude since 1965 in that region; in other words the flood risk predates anthropogenic climate change and is not apparently exacerbated by it. Likewise daily precipitation records for nearby Austin are available back to 1873 and show no increase in annual average or maximum precipitation (see CWG25 Section 6.4 for links

[2] See https://www.epa.gov/climate-indicators/climate-change-indicators-river-flooding

to data). Hence the key contribution an NCA could make is explaining the historical context of extreme rainfall events and flood risks, rather than speculations about far future changes that might occur.

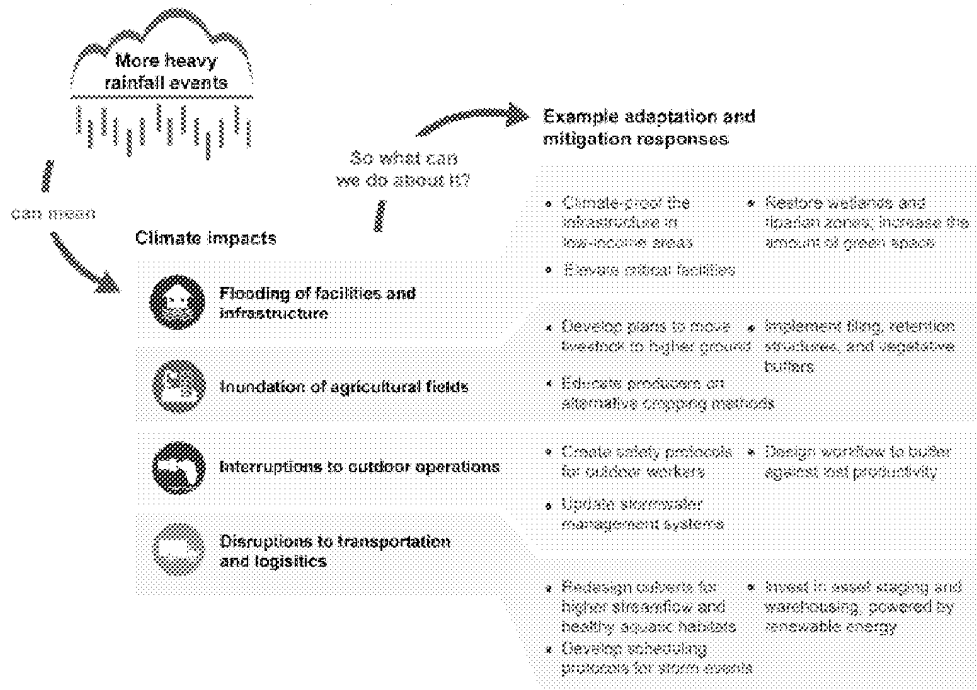
The NCA4 section on the Southern great Plains states that precipitation trends are not clearly attributed to anthropogenic forcing (pp. 213-214) and that "no formal attribution of observed flooding changes to anthropogenic forcing has been claimed" (p. 241). This supports the view that the focus of resource allocation should be adapting to the known current risk profiles of the Hill Country and that there is little to be gained by trying to forecast changes under greenhouse forcing, nor would GHG emission reductions be an effective way to reduce future flood risks. However, as noted above, NCA4 undermines its own usefulness by claiming in Volume 2 Chapter 28 that climate change is happening so quickly that historical data is uninformative for planning purposes.

NCA5 presents no data on precipitation patterns in the Southern Great Plains and no information on specific high risk zones. Instead it makes sweeping unsubstantiated claims to the effect that every climate risk is getting worse over time. For example, in Chapter 26 (Southern Great Plains) the first Key Message is (p. 26-7):

> Climate change is beginning to alter how we live in the Southern Great Plains, putting us at risk from climate hazards that degrade our lands and waters, quality of life, health and well-being, and cultural interconnectedness (*high confidence*). Many climate hazards are expected to become more frequent, intense, or prolonged; to broaden in spatial extent; and to result in more people experiencing costly, deadly, or stressful climate-related conditions (*very likely, high confidence*). To address the growing risk, effective climate-resilient actions include implementing nature-based solutions; valuing Indigenous, traditional, and local knowledges; and infusing climate change solutions into community planning (*medium confidence*).

This is both inaccurate and useless for local authorities charged with setting priorities and making resource allocation decisions. The same chapter presents rainfall projections through the mid-21st century (Figure 26.10) that imply drying thoughout southern TX, but no explanation is given as to how this reconciles with projections elsewhere in NCA5 (Figure 2.12 p. 2-25) of increasing extreme precipitation in the same region. The first discussion of regional trends in heavy rainfall events is on page 26-22 which focuses entirely on sports teams having to move events indoors which results in "increasing participation costs and decreasing access to sports, especially for lower-income populations." ~~Adaptation advice consists of the following cartoon on page 26-19:~~ DELETE THIS FIGURE, DOESN"T BELONG IN CONCLUSIONS CHAPTER

Resilience Actions to Address the Impacts of Heavier Rainfall Events on Businesses



Resilience actions can help businesses and industries reduce the negative consequences of more heavy rainfall events.

Figure 26.11. An increased number of heavy rainfall events affects business and industry across the Southern Great Plains through flooding of facilities and infrastructure, inundation of agricultural fields, interruptions to outdoor operations, and disruptions to transportation and logistics. The example adaptation and mitigation actions can increase resilience and reduce negative impacts. Figure credit: See figure metadata for contributors.

~~**FIGURE 6: screenshot of NCA5 Figure 26.11**~~

~~The advice is so vacuous it could have been written by someone who has never studied the topic. Combined with pervasive advocacy for renewable energy NCA5 was worse than simply unhelpful: if planners based serious decisions on it they would have misallocated resources away from potentially beneficial measures towards worthless ones.~~ A BIT SNARKY, the ABOVE TEXT SPEAKS FOR ITSELF

8.5 Recommendations for NCA6

While we have assessed NCA5 to be scientifically inadequate and unsuitable as a basis for decision-making, one can imagine a different National Climate Assessment that meets statutory and policymaker requirements. The goal should be not to persuade, but to impart understanding by being objective, transparent and complete. A suitable NCA would be an important complement to IPCC assessments to the extent that its analysis and conclusions differ where appropriate from the "consensus" of the IPCC reports and additional topics are addressed. Such a report would promote a more open scientific discussion and a more informed policy debate.

We recommend that the NCA6 have a narrower scope than NCA5, refocusing on climate science, including natural climate variability, with topics to include:

- How the climate has varied in the past. The U.S. has the best and longest meteorological records and they should be examined and displayed in their entirety. Trend analyses should include longest periods available and employ suitable statistical methods. Local paleoclimate data should be considered where available. Analysis should demonstrate not only how the climate has varied and changed, but also regional heterogeneity. Standard, easily understandable metrics should be employed.
- The range of climatic and weather conditions, including extremes, that have occurred in the past and can reasonably be expected to occur in U.S. regions over the near future.
- A critical survey of current global and regional modeling capabilities and their suitability for regional impact assessments and projections. This would include an assessment of their ability to reproduce observed changes. It should also discuss alternative methods for generating scenario projections on regional and decadal scales, along the lines of Chapter 10 of the IPCC AR6 WGI Report.
- Assessment of the impacts of recent historical climate variability and change on ecosystems and society. Where long-term data indicate a detectable regional change, regional projections can be made for the period 2030-2050. Emissions scenarios exceeding RCP4.5/SSP2-4.5 and ECS values exceeding 4°C should not be used. Regional projections to 2100 have no credibility at this time and so should not be included in NCA6.

It is important that climate projections be assessed in context of current science capabilities. The pressures toward spatially or temporally precise projections should be resisted as the current models are not up to the task (an example is discussed in CWG25 Section 5.8). In that light, the many pages of NCA5 devoted to projected regional and sectoral impacts have little value.

A key effort that would aid NCA6 would be the development of more complete and accurate observational datasets, including daily US surface temperature and precipitation, from which to more accurately assess changes in properties such as extremes since the 19th century. CWG25 put considerable effort into creating such time series to overcome misleading information now contained in the official NOAA quality-controlled datasets utilized in the NCAs and by climate analysts in general. Examples of deficiencies in current, official datasets are given in supplementary material here [Link] which motivate this recommendation.

Given the substantial deficiencies and biases in NCA5 that we have identified, producing an objective NCA6 report with the current NCA organizational construct would be a challenge. A NASEM review could help, but only if the selected participants reflect full viewpoint diversity and do not simply mirror the assumptions and biases of past NCA teams. We regard the CWG25 report to be a good start on NCA6 in terms of scope and objectivity, including adherence to the tenets of Gold Standard Science.

More broadly, we recommend a rewrite of the Global Change Research Act. The current mandate is vague and off point, allowing successive NCA teams to interpret the mandate as they see fit. Moreover, it is becoming increasingly clear that current and foreseeable models are not fit-for-purpose to describe regional climates, let alone usefully project them for 25 to 100 years. Further, the use of the term "global change" is ambiguous and outdated.

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10 APPENDIX: CHARGE TO THE REVIEW

ABOUT THE AUTHORS

[Insert updated bios]

Supporting evidence for revisiting and revising the NOAA climate data archive for NCA6.

In support of the recommendation to revisit the NOAA/NCEI official, quality-controlled datasets we show two examples that directly relate to determining changes in extremes over long periods. Aside from the fact that considerable station data have yet to be keyed into computer-readable files, is the overly sensitive nature of the quality-control algorithms that search for and eliminate data that were judged to be erroneous, but in fact were accurate. As would be expected, extreme values are unfortunately natural targets for such algorithms. Two examples follow.

An Example of Temperature Problems, Newport OR

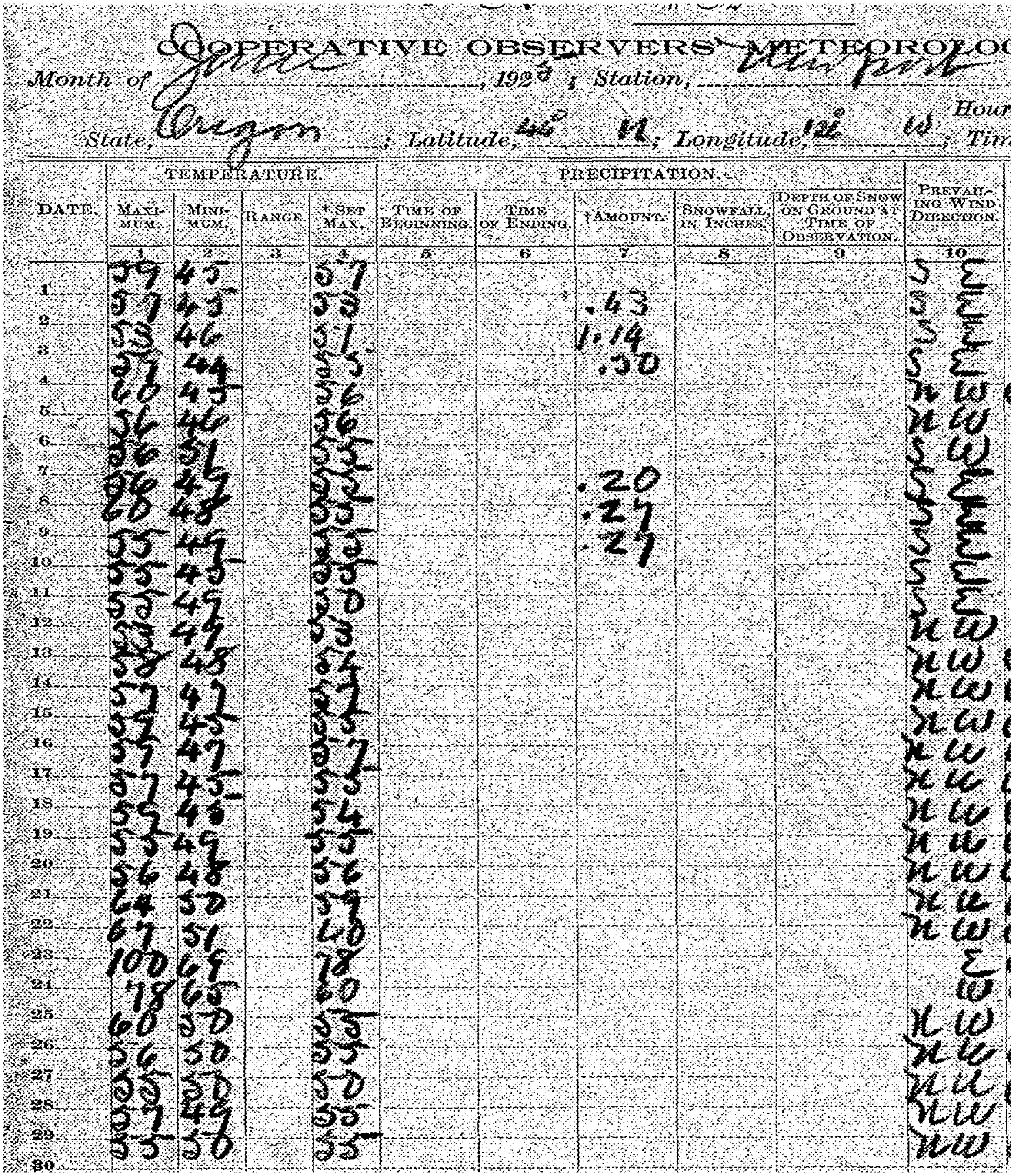
When searching for the top ten extreme high temperatures in the NOAA database for Newport OR on the Pacific Coast the results returned are listed in Table 1.

Rank	Temperature °F	Date
1	94.0	1980-10-02
2	91.0	1993-09-26
-	91.0	1981-09-06
-	91.0	1957-09-22
5	90.0	1985-06-17
-	90.0	1962-09-17
-	90.0	1907-10-09
8	89.0	2006-09-02
-	89.0	1976-09-09
-	89.0	1975-09-21

Table 1. Results returned from the NOAA quality-controlled database when queried on 18 July 2025 for the ten hottest daily temperature values in Newport OR. https://scacis.rcc-acis.org

However, in our effort to replace missing values so as to provide the most complete datasets for various analyses, several Newport temperatures above 94°F were discovered but listed as missing in the database, mostly in the early part of the record. The quality-control algorithm apparently determined that these values exceeded certain criteria.

Below in Fig. 1 is the actual form for June 1925 in Newport indicating the temperature on 24 June reached 100°F, exceeding the "official" hottest value by 6 °F. The entry on the 24th is accompanied by the wind direction of easterly, "E", which is the classic case of offshore wind producing extreme temperatures. Other stations nearby had excessively high temperatures as well, yet the algorithm determined Newport's 100 °F to be erroneous. In the dataset utilized in CWG25, we replaced many of these "missings" with observed values which provided us a better (not perfect) indication of the distribution of extreme events through time (see Figs. 6.3.3 to 6.3.6 in CWG25).



COOPERATIVE OBSERVERS' METEOROLO[GICAL RECORD]

Month of June, 1925; Station, Newport

State, Oregon; Latitude, 44° N; Longitude, 124° W; Hour ... Tim[e]

DATE.	TEMPERATURE. Maximum. (1)	Minimum. (2)	Range. (3)	* Set Max. (4)	PRECIPITATION. Time of Beginning. (5)	Time of Ending. (6)	† Amount. (7)	Snowfall, in Inches. (8)	Depth of Snow on Ground at Time of Observation. (9)	Prevailing Wind Direction. (10)
1	59	45		57						[illegible]
2	57	45		53			.43			[illegible]
3	53	46		51			1.14			[illegible]
4	[illegible]	44		55			.30			[illegible]
5	60	45		56						[illegible]
6	56	46		56						[illegible]
7	56	51		55						[illegible]
8	58	47		52			.20			[illegible]
9	60	48		55			.27			[illegible]
10	55	49		[illegible]			.27			[illegible]
11	55	43		50						[illegible]
12	56	49		50						[illegible]
13	[illegible]	47		53						[illegible]
14	[illegible]	48		54						[illegible]
15	57	41		57						[illegible]
16	57	43		53						[illegible]
17	57	47		57						[illegible]
18	57	45		53						[illegible]
19	55	46		54						[illegible]
20	55	49		55						[illegible]
21	56	48		56						[illegible]
22	64	50		57						[illegible]
23	67	51		60						[illegible]
24	100	64		78						[illegible]
25	78	65		60						[illegible]
26	60	50		55						[illegible]
27	56	50		55						[illegible]
28	55	50		50						[illegible]
29	57	49		55						[illegible]
30	55	50		55						[illegible]

Figure 1. Cooperative Observer's Form for Newport OR (COOP ID 356032), June 1925. Note the 100°F reading on the 24th is listed as missing in the NOAA/NCEI "quality controlled" public datafiles.

An example of Precipitation Problems, Holdenville 2SSE OK.

As with our temperature datasets, we replaced missing daily precipitation data with observed values. If the data were missing for the particular station, we substituted the values from a nearby station. In the case of Holdenville 2SSE OK, a number of missing values appeared in the NOAA quality-controlled archive that otherwise were known to have been recorded by the observer. Table 2 lists the daily rainfall for Holdenville 2SSE for July 1950 from the "quality-controlled" NOAA archive and from the actual form (similar to Fig. 1).

Year	Month	Day	NOAA Q-C	COOP FORM
1950	7	1	0	0
	7	2	0	0
	7	3	0.02	0.02
	7	4	0.22	0.22
	7	5	0.59	0.59
	7	6	0	0
	7	7	0	0
	7	8	0	0
	7	9	0.22	0.22
	7	10	M	4.55
	7	11	0	0
	7	12	0	0
	7	13	0.04	0.04
	7	14	0.05	0.05
	7	15	0	0
	7	16	0	0
	7	17	M	2.87
	7	18	0	0
	7	19	0	0
	7	20	1.1	1.1
	7	21	M	2.95
	7	22	1.3	1.3
	7	23	0	0
	7	24	0	0
	7	25	1.39	1.39
	7	26	0	0
	7	27	0	0
	7	28	0.11	0.11
	7	29	1.02	1.02
	7	30	0.18	0.18
	7	31	0.09	0.09

Table 2. Daily precipitation values for Holdenville 2SSE OK (COOP ID 344235), July 1950. The official NOAA Q-C values are those that scientists and the public receive. The last column contains the values recorded by the observer on the original form. Note the three days of heaviest rainfall are set to "missing" in the official archive but are clearly recorded on the observer's form (red).

Stations near Holdenville also recorded excessive rainfall on the three days indicated as missing, so the evidence is substantial that the observer recorded accurate daily totals. This has bearing on the calculations of extreme events. A query of the NOAA database for extreme monthly precipitation indicates the value according to the observer's form (16.70") would have been the wettest July in the entire record, and fourth highest of all months (queried on 18 July 2025). However, because July 1950 has only three "missing" days, its monthly total is considered valid at 6.33" so it does not appear on the list of extreme monthly totals. [The precipitation stations utilized in CWG25 Figs. 6.4.1 to 6.4.5 and in this Review of NCA5 were all serially complete.]

There are many other such cases, but these two serve as examples to motivate our recommendation for NOAA to revisit their datasets to develop accurate, complete-as-possible, long-term time series of daily meteorological variables from the Cooperative Observers forms and other sources. This requires a combination of AI techniques and the experience of trained climatologists to discern whether values are legitimate or truly erroneous (of which there are also many). This is a tedious process but one that ultimately provides scientists and the public with the type of information needed to confidently assess threat levels of various rarely-observed weather phenomenon and how they may be changing through time.