

**COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES**

HEARING CHARTER

The State of Climate Science and Why it Matters

Wednesday, February 13, 2019
10:00 a.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, February 13th, the Committee on Science, Space, and Technology will hold a full Committee hearing entitled “*The State of Climate Science and Why it Matters.*” The purpose of this hearing is to provide a big-picture assessment of the current state of climate science. The Committee will receive expert testimony on recently published significant climate reports and discuss report findings that include the physical mechanisms of climate change, risks to human society at different levels of warming, and the need for adaptation and mitigation.

WITNESSES

- **Dr. Natalie M. Mahowald** - Irving Porter Church Professor of Engineering, Faculty Director for the Environment, Atkinson Center for a Sustainable Future, Cornell University
- **Dr. Robert Kopp** – Director, Rutgers Institute of Earth, Ocean, and Atmospheric Sciences, and Professor, Department of Earth and Planetary Sciences, Rutgers University
- **Dr. Jennifer Francis** – Senior Scientist, Woods Hole Research Center
- **Dr. Joseph Majkut** – Director of Climate Policy, Niskanen Center
- **Dr. Kristie Ebi** - Rohm & Haas Endowed Professor in Public Health Sciences, Director, Center for Health and the Global Environment (CHAnGE), University of Washington

BACKGROUND

The State of Climate Science

While the understanding of the basic physical mechanisms of climate change has not changed significantly over the last 20 years, recent research has provided even stronger evidence in support of the scientific consensus that the climate is warming and it is primarily driven by the emissions of greenhouse gases due to human activities. In addition, there is significant literature on the contemporary impacts of climate change to human and ecological systems, as well as extensive analysis of likely future impacts given different levels of warming. Several recent national and international reports, described below, have assessed and synthesized the current state of scientific understanding of climate change and related impacts, as well as the costs and benefits of different mitigation strategies.

Recent Climate Reports

IPCC Special Report on Global Warming of 1.5°C. Released in October 2018, the Intergovernmental Panel on Climate Change (IPCC)¹ Special Report on Global Warming of 1.5°C² (IPCC SR1.5) was produced separately from the periodic assessments required under the United Nations Framework Convention on Climate Change (UNFCCC). The IPCC SR1.5 was commissioned by world leaders, including some from small island nations, under the 2015 Paris Agreement.³ While the final pledges under the Paris Agreement would limit warming to 2°C, some countries requested a study on how the risks of warming of 1.5°C above preindustrial levels would compare to the risks of warming of 2°C. The report's 91 authors and review editors from 40 countries drew its conclusions through a review of over 6,000 studies. Apart from comparing the risks of 1.5°C to 2°C, it provides context for these targets by showing where they fall on the current emissions trajectory.

The report found that limiting warming to 1.5°C rather than 2°C would have wide-ranging benefits. However, doing so “would require rapid, far-reaching and unprecedented changes in all aspects of society,” including cutting global carbon emissions to net zero by 2050, and boosting renewable energy to make up over 50 percent of the U.S. energy mix by 2050. It is estimated that achieving this goal would require five times the current investment in low carbon technologies, as well as high prices on carbon emissions. The scientific literature has demonstrated lower risks at 1.5°C compared with 2°C in every category addressed. In fact, one of the biggest differences between this report and past IPCC assessments is that it provides an unprecedented level of granularity in differentiating the risks of a 1.5°C world compared with a 2°C world. Though the IPCC SR1.5 finds it is more difficult to transition global carbon emissions to a level that would limit warming to 1.5°C than to 2°C, it would avoid enormous losses to global Gross Domestic Product (GDP). The U.S. could lose around 1.2 percent of its GDP for every additional 1°C of warming above the current levels. The IPCC SR1.5 concludes that though technology to limit warming to 1.5°C does exist, global political trends make this outcome difficult, even nearly impossible, to achieve.

Fourth National Climate Assessment. The National Climate Assessment is a congressionally mandated report published quadrennially by the U.S. Global Change Research Program (USGCRP), a federal program directed by Congress to coordinate 13 member federal agencies⁴

¹ The Intergovernmental Panel on Climate Change (IPCC) was created by the United Nations Framework Convention on Climate Change (UNFCCC), a multilateral agreement signed by President George H.W. Bush and ratified by the Senate. It is an international body that develops non-policy-prescriptive reports; these reports do not produce their own science but rather synthesize current climate science to inform decision makers and the public and are usually released every 5 to 6 years. (<https://www.ipcc.ch/>)

² IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

³ A multilateral agreement to limit climate change to 2C signed by 195 countries in 2016. <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

⁴ The 13 agencies are the Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, the Interior, State, and Transportation, as well as the Environmental Protection Agency, National Aeronautics and Space

that conduct or apply research on global environmental change.⁵ *Volume I of the Fourth National Climate Assessment (NCA4 Vol 1): Climate Science Special Report*,⁶ released in 2017, examines the latest science on the physical drivers of climate change, climate models and projections, changes in temperature and extreme weather, ocean acidification, and sea level rise. More than 300 scientists in the 13 member agencies wrote this 470-page volume, and its conclusions are based on the evaluation of over 1,500 climate science studies. The final product was then peer reviewed by the National Academies of Science, Engineering and Medicine (NASEM).

The report is consistent with the last twenty years of climate science, which has confirmed that since the turn of the century, climate change is occurring and is caused by carbon pollution released by human industrial activity. More robust evidence now exists showing the correlation between human activities and increases in global temperature, the warming and further acidification of our oceans, rising sea levels, and disappearing arctic ice sheets. The conclusions of the report are scientifically conservative; the authors required a large amount of evidence and a high number of studies supporting a finding before including it in the report's conclusions. Though NCA4 Vol 1 does not provide policy recommendations or assess climate mitigation or adaptation strategies, it does note that limiting global warming to 2°C will require major reductions in greenhouse gas emissions.

Volume II of the Fourth National Climate Assessment (NCA4 Vol 2): Impacts, Risks, and Adaptation in the United States,⁷ released in November 2018, is a 1,524-page report that exhaustively outlines the effects and risks of climate change in the U.S., which is broken into 10 geographic regions,⁸ and 16 national topics.⁹ The NCA4 Vol 2 shows how climate change is increasingly impacting our communities, and how mitigation and adaptation strategies can improve the circumstances. Key scientific advances since the Third National Climate Assessment (NCA3) include advances in attribution of human influence on climate and extreme weather events, rapid changes for ice loss globally, as well as increases in ocean acidification, warming and deoxygenation. Following feedback received after the publication of the NCA3, the NCA4 provided its analysis in a more localized format to better describe and communicate specific climate change impacts on different regions across the country. The NCA4 Vol 2 finds that under high emissions scenarios with limited or no adaptation, losses are great: a predicted \$141 billion

Administration, National Science Foundation, Smithsonian Institution, and U.S. Agency for International Development.

⁵ It was established by Presidential Initiative in 1989 under George H. W. Bush, and mandated by Congress in the Global Change Research Act of 1990. (<https://www.globalchange.gov/about/legal-mandate>)

⁶ USGCRP, 2017: *Climate Science Special Report: Fourth National Climate Assessment, Volume I* [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp., doi: 10.7930/JOJ964J6.

⁷ USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: [10.7930/NCA4.2018](https://doi.org/10.7930/NCA4.2018)

⁸ Regions include Northeast, Southeast, U.S. Caribbean, Midwest, Northern Great Plains, Southern Great Plains, Northwest, Southwest, Alaska, Hawai'i & U.S.-Affiliated Pacific Islands.

⁹ National topics include Our Changing Climate, Water, Energy Supply, Delivery & Demand, Land Cover & Land-Use Change, Forests, Ecosystems, Ecosystem Services, & Biodiversity, Coastal Effects, Oceans & Marine Resources, Agriculture & Rural Communities, Built Environment, Urban Systems, & Cities, Transportation, Air Quality, Human Health, Tribes & Indigenous Peoples, Climate Effects on U.S. International Interests, Sectoral Interactions, Multiple Stressors, & Complex Systems.

from heat-related deaths, \$118 billion from sea level rise, \$32 billion in costs to infrastructure, and \$160 billion lost wages from two billion lost labor hours by the end of the century. It is very likely that some impacts are irreversible. However, many impacts can be avoided or substantially reduced if emissions of greenhouse gases are reduced.

Climate Change and Extreme Weather Events. The nascent field of extreme event attribution tries to determine how much of an extreme event can be attributed to climate change versus regular weather patterns. The field is advancing rapidly, and in 2016, the NASEM published *Attribution of Extreme Weather Events in the Context of Climate Change*,¹⁰ which looked at the consensus on to what extent scientists can estimate the influence climate change has on extreme weather events. Extreme event attribution teases out the effects of anthropogenic, or human-caused, climate change from other factors that influence climate, such as changes in solar activity and natural, internal processes of the climate system, such as El Niño.

The NASEM study found that climate change is exacerbating some extreme weather events, with temperature – such as heat waves and long-term warming – being the strongest influence of climate change on extreme events. It finds less certain links between climate change and the occurrence of tornadoes, hurricanes, or wildfires. However, the intensity of hurricanes, such as the extreme precipitation during Hurricane Harvey, has been linked to climate change.¹¹ Similarly, the Bulletin of the American Meteorological Society released a supplement in December 2018 entitled “Explaining Extreme Events of 2017 From a Climate Perspective”¹² which found that events ranging from the floods in South America to heatwaves in China were made more likely due to anthropogenic climate change. It is important to note that current scientific literature cannot definitively answer whether climate change “caused” an individual weather event to occur; rather that that climate change can alter the intensity or frequency of certain events.¹³ Nevertheless, the report marks the “second year that scientists have identified extreme weather events that they said could not have happened without warming of the climate through human-induced climate change.”¹⁴

Climate Change and Health. As scientific evidence of direct and indirect impacts of climate change on human health is becoming clearer, the global health community is actively framing climate change as a public health crisis. In 2018, the *Lancet Countdown Report: Tracking*

¹⁰ National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/21852>.

¹¹ Vano J, Dettinger M., Cifelli R *et. al*, “Hydroclimatic Extremes as Challenges for the Water Management Community: Lessons From the Oroville Dam and Hurricane Harvey.” Special Supplement to the Bulletin of the American Meteorological Society, Vol. 99 No. 12, December 2018. “Explaining Extreme Events of 2017 From a Climate Perspective.”

¹² Special Supplement to the *Bulletin of the American Meteorological Society*, Vol. 99 No. 12, December 2018. “Explaining Extreme Events of 2017 From a Climate Perspective.”

<https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/explaining-extreme-events-from-a-climate-perspective/>

¹³ National Academies of Sciences, Engineering, and Medicine News. 2016. *New Report Says Science Can Estimate Influence of Climate Change on Some Types of Extreme Events*.

<http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=21852>

¹⁴ <https://www.ametsoc.org/ams/index.cfm/publications/bulletin-of-the-american-meteorological-society-bams/explaining-extreme-events-from-a-climate-perspective/>

*Progress on Health and Climate Change*¹⁵ was released as a collaboration between researchers around the world. The Lancet Countdown tracks the connections between health and climate as well as how climate change solutions can mitigate health impacts. The Lancet Countdown finds that current public health challenges due to climate change will be further exacerbated as global temperatures rise and the nature and scale of our global response to climate change will determine global health for generations.

24th Conference of the Parties (COP24) Special Report: Health and Climate Change.¹⁶ During the Conference of Parties 23 (COP23) held in Bonn, Germany on behalf of the Republic of Fiji, Prime Minister Bainimarama of Fiji requested that the World Health Organization (WHO) prepare a report on health and climate change to be delivered at the COP24 in Katowice, Poland.¹⁷ The COP24 Special Report made many recommendations such as promoting actions to reduce global carbon emissions and other air pollutants, tracking progress in health due to climate change mitigation, and mobilizing subnational leaders to take action on this issue. They also recommended highlighting the health implications of climate adaptation and mitigation strategies.

The IPCC SR1.5 included health implications throughout its findings. Climate change impacts such as increased global temperatures, extreme weather events, and flooding and sea level rise can exacerbate the spread of infectious and vector borne diseases, degrade air quality, and endanger food and water security. Limiting warming to 1.5°C would have many public health benefits.

The key messages from the human health chapter of the NCA4 Volume 2 show that climate change is already affecting the health of all Americans through increased exposure to extreme weather events and infectious or vector-borne diseases, and through changes in air quality and mental health stress. The most vulnerable populations, such as lower-income communities, the elderly, children, and some communities of color, are likely to experience even greater health risks from climate change. However, adaptation measures can help reduce the impacts and risk of climate-related health impacts, and mitigation of greenhouse gas emissions has clear economic and health benefits.¹⁸

Evidence of Climate Change Impacts

Climate change is already affecting communities in direct and indirect ways. Some scientifically supported evidence of climate change impacts include:

Sea Level Rise. The average global sea level has risen approximately 7-8 inches since 1900, “with almost half this rise occurring since 1993 as oceans have warmed and land-based ice has melted.” By 2030, global mean sea level is *very likely* (emphasis theirs) to rise by 0.3-0.6 feet.¹⁹

¹⁵ Watts N, Amann M, Ayeb-Karlsson S, *et al.*: The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. *Lancet*. 2018; **391**(10120): 581–630.

[https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(18\)32594-7/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)32594-7/fulltext)

¹⁶ COP24 special report: health and climate change. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO. <https://apps.who.int/iris/bitstream/handle/10665/276405/9789241514972-eng.pdf?ua=1>

¹⁷ <https://www.who.int/globalchange/publications/COP24-report-health-climate-change/en/>

¹⁸ NCA4 Volume 2

¹⁹ NCA4 Volume 1

Global Temperature Rise. The planet has already warmed about 1°C above preindustrial levels, and at the current trajectory of carbon emissions, the world could reach anthropogenic global warming of 1.5°C as soon as 2030.²⁰

Shrinking Arctic Ice Sheets. Annually averaged arctic ice sheet extent has decreased over 3.5 percent every decade from 1979 to 2016, with the “annual arctic sea ice maximum in March 2017... the lowest maximum areal extent on record.”²¹

Warming Oceans. Over 90 percent of the heat attributed to anthropogenic emissions to date have been absorbed by the oceans, making them warmer. Global average sea surface temperature could increase by approximately 2.7°C by 2100 in a high emissions scenario.²²

Extreme Weather Events. Extreme weather events alone have cost the United States over \$1 trillion since 1980,²³ with the U.S. experiencing 14 weather and climate disasters totaling \$14 billion in 2018 alone.²⁴

Additional Reading

IPCC Special Report: Global Warming of 1.5°C: Summary for Policymakers
<https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/>

The 1.5 Health Report: Synthesis on Health & Climate Science in the IPCC SR1.5
https://www.who.int/globalchange/181008_the_1_5_healthreport.pdf

NCA4 Volume 1 Executive Summary
<https://science2017.globalchange.gov/chapter/executive-summary/>

NCA4 Volume 2 Summary Findings
https://nca2018.globalchange.gov/downloads/NCA4_Ch01_Summary-Findings.pdf

²⁰ IPCC SR1.5

²¹ NCA4 Volume 1

²² NCA4 Volume 1

²³ NCA4 Volume 1

²⁴ NOAA.gov, February 6th, 2018. “2018 was 4th hottest year on record for the globe.”
<https://www.noaa.gov/news/2018-was-4th-hottest-year-on-record-for-globe>