NIST Climate Portfolio Update
Visiting Committee on Advanced Technology

Disaster Resilient Buildings, Infrastructure, and Communities

Jason Averill
Chief, Materials and Structural Systems Division

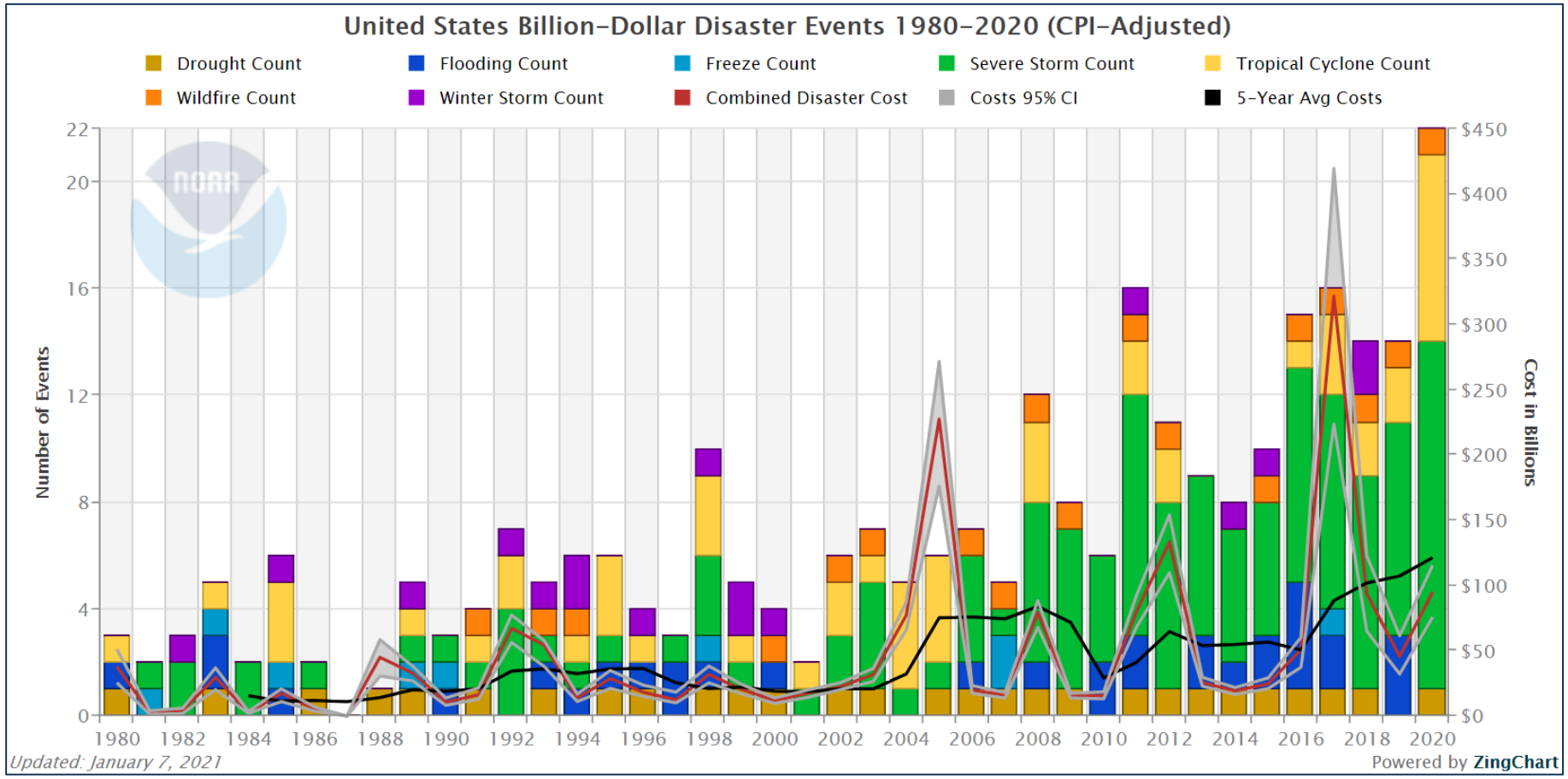
National Institute of Standards and Technology
U.S. Department of Commerce

NIST Gaithersburg
October 26, 2021

Disaster-Resilient Buildings, Infrastructure, and Communities Goal

Goal: To reduce the risk and enhance the resilience of buildings, infrastructure, and communities to natural and manmade hazards through advances in measurement science.

Disaster Resilient Buildings, Infrastructure, and Communities



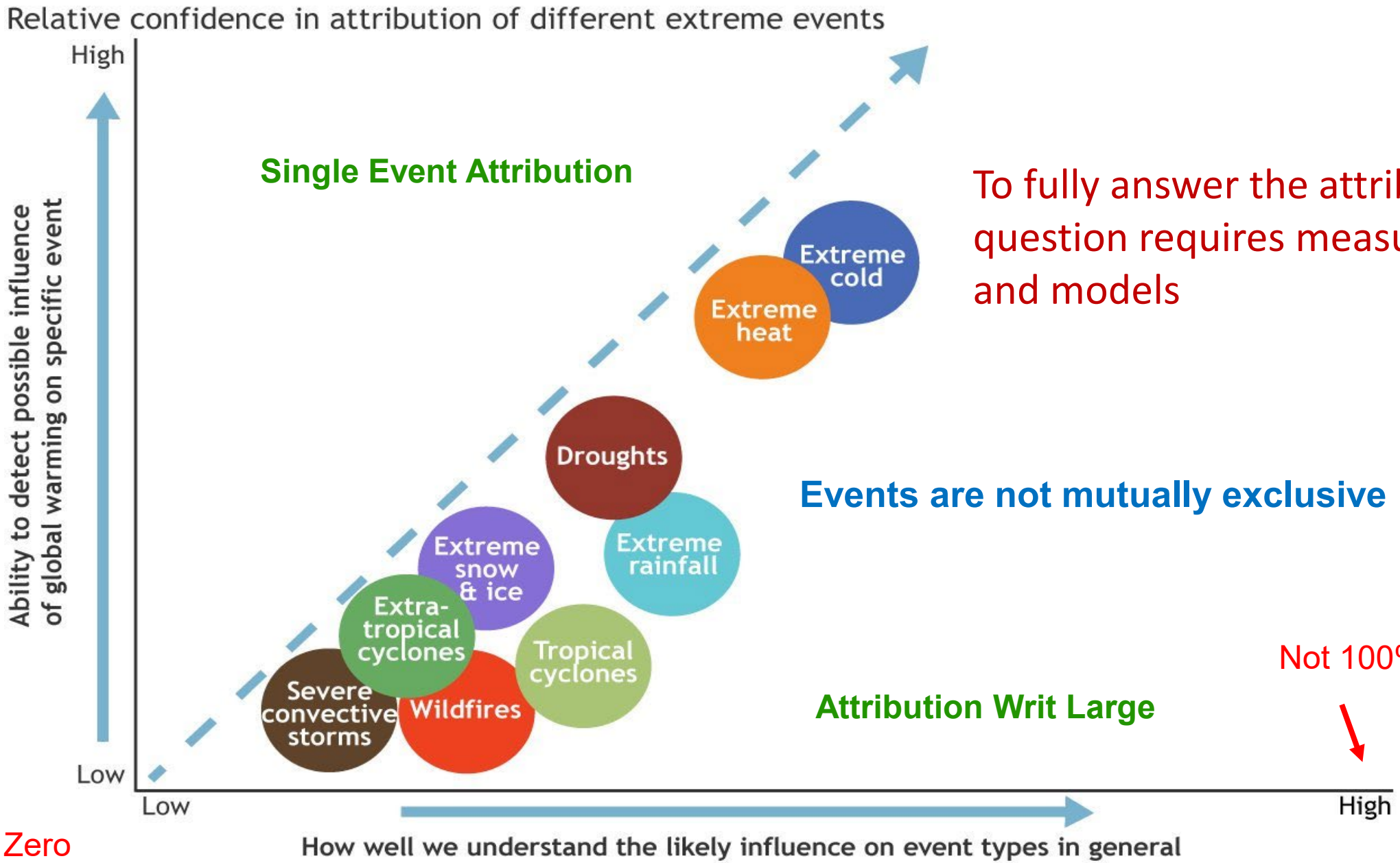
Through Oct 8, 2021:
18 weather/climate disaster events with losses exceeding $1 billion :

- 9 severe storms,
- 4 tropical cyclones,
- 2 floods,
- 1 drought,
- 1 wildfire, and
- 1 winter storm.

The 1980–2020 annual average is 7.1 events (CPI-adjusted);
the annual average for the most recent 5 years (2016–2020) is 16.2 events (CPI-adjusted).

https://www.ncdc.noaa.gov/billions/ (collected 10/19/21)

NAS Extreme Event Attribution Report 2016



Single Event Attribution

To fully answer the attribution question requires measurements and models

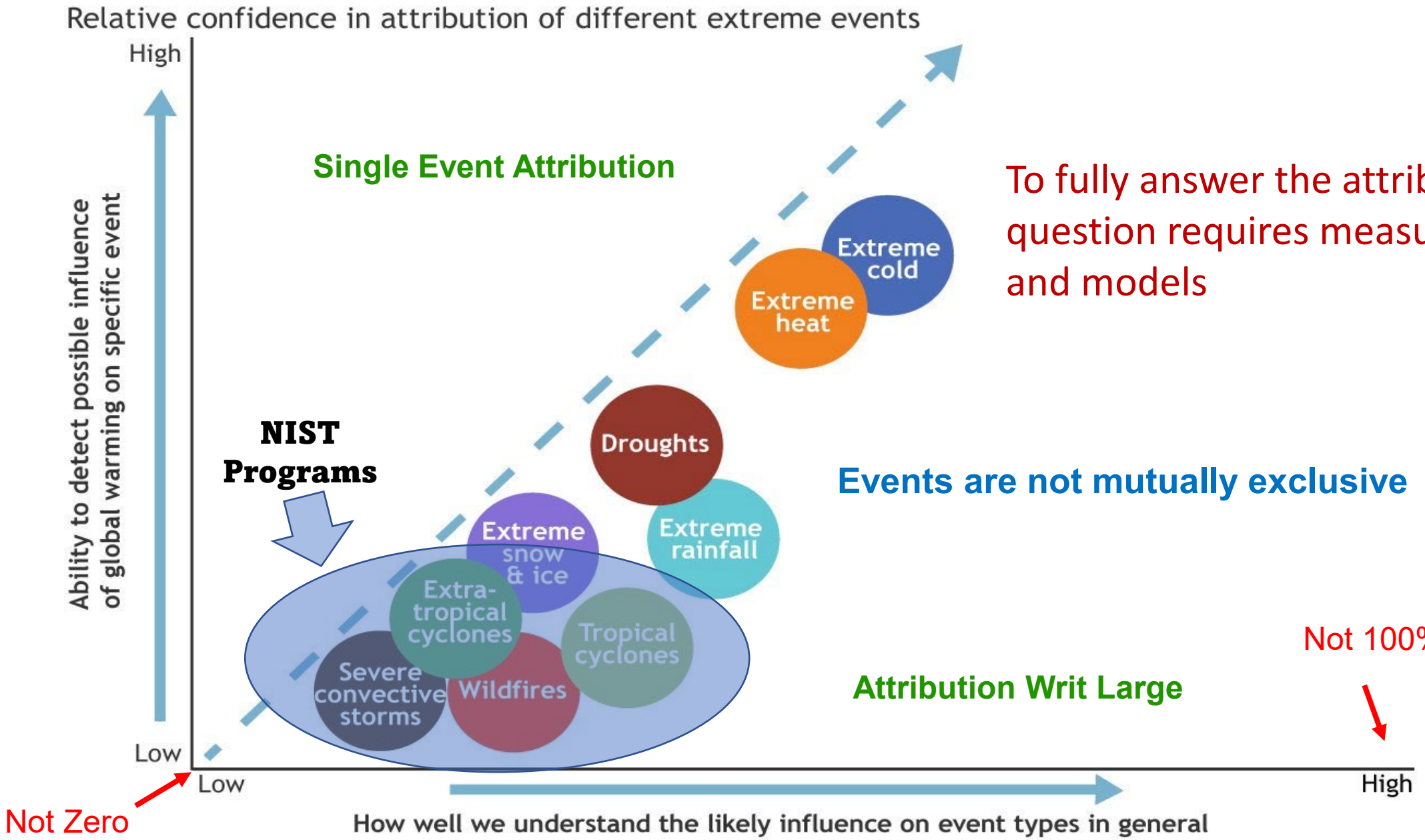
Events are not mutually exclusive

Not 100%

Attribution Writ Large

Not Zero

NAS Extreme Event Attribution Report 2016



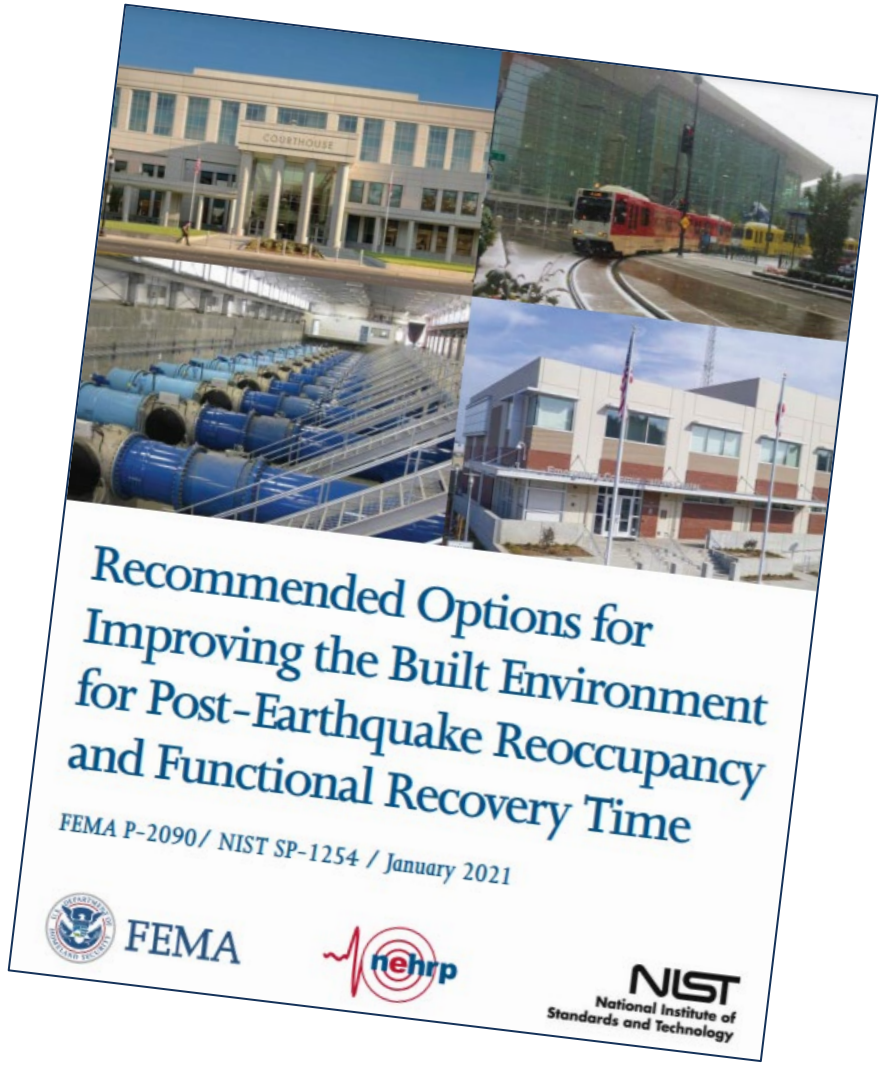
To fully answer the attribution question requires measurements and models

Events are not mutually exclusive

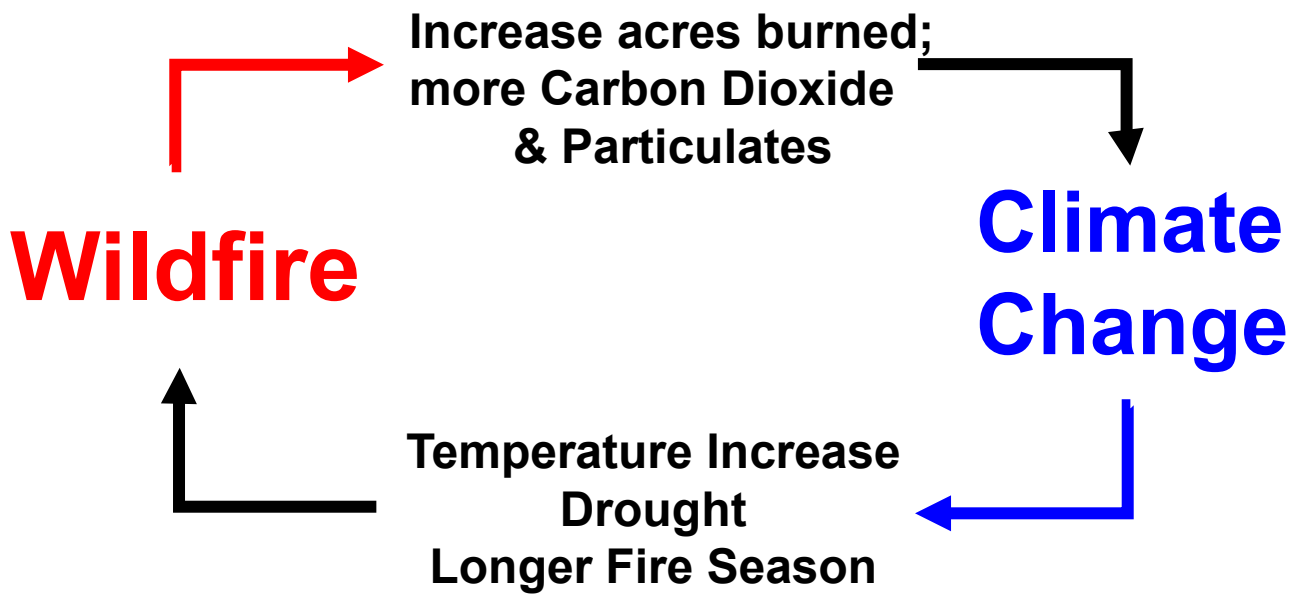
Changing Expectations

Citizens and community leaders now expect more than life safety from the built environment. Interruptions to schools, health care, employment, supply chain, & government services are less tolerated.

- These services are often unavailable due to damages to buildings, power, water/wastewater, communications, roads, bridges, and public transportation.



Example: Wildfires and Climate Change



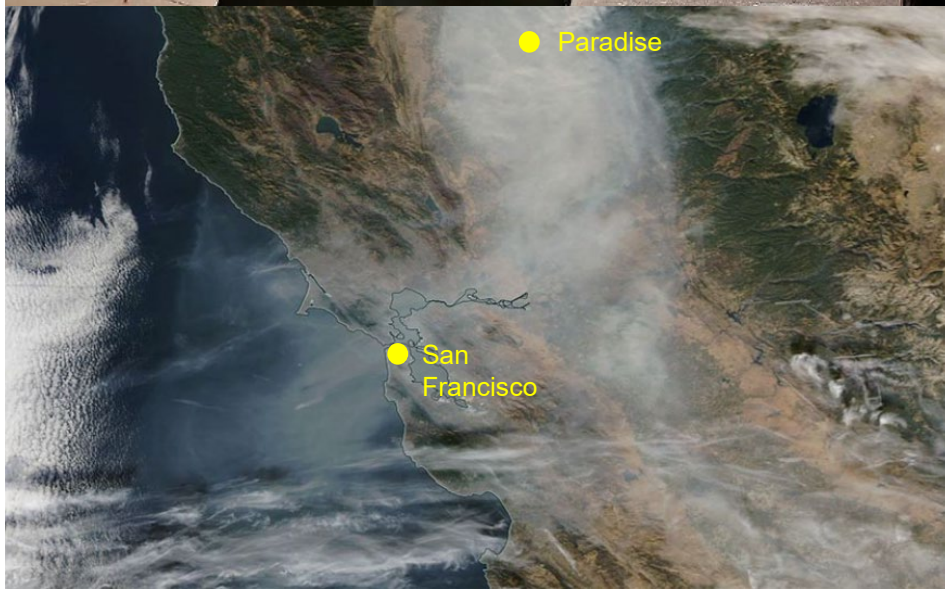
Camp Fire, Paradise, CA, Nov 2018
from NASA Earth Observatory/Aqua/MODIS.

- **Global Wildfires**
  - Annual Global Carbon emission estimate (2017)
    - Carbon dioxide - 7.32 billion tons
    - Particulates- 46 million tons
    - About 24% of total carbon emissions
  - Summer wildfire season are 40 to 80 days longer than 30 years ago
  - Emit between 5 and 30 tons of carbon per hectare (2 to 12 t/acre) burned (brush vs forest)

- California- wildfire emission 25% of CO_2 fossil fuel energy emissions
- Australia- 90% of industrial CO_2 emissions
- Other major sources are fires in
  - Brazil
  - Siberia
  - Indonesia…..

Van Der Wert, G. et al., Global Fire Emissions Estimates during 1997-2016, Earth Syst. Sci. Data, 9, 697-720, 2017
https:www.futuredirections.org.au/publication/wildfires-greenhouse-gas-emisions-and_climate-change/
Alberts, E. C., Off the Chart: CO_2 from California fires dwarf state's fossil fuel emissions, Mongabay News, 9/18/2020

Smoke from Camp Fire (2018)



- Destroyed over 19,000 structures
- Paradise CA –
  - San Francisco CA - 275 km (171 miles)
  - Sacramento CA – 142 km (88 miles)
- Sacramento, CA –
  - Worst air pollution for any major city on Earth (11/16/2018)
  - Beating out big cities in India and China
  - 24 hour PM 2.5 – > 145 μg/m3

Masters, J., Smoke from Camp Fire Making Sacramento the Most Polluted City, Weather Underground, November 16, 2018

NWIRP Strategic Plan

Goal A
Improve Understanding of Windstorm Processes and Hazards

Objective 1: Advance understanding of windstorms and associated hazards

Objective 2: Develop tools to improve windstorm data collection and analysis

Objective 3: Understand long term trends in windstorm frequency, intensity, and location

Objective 4: Develop tools to improve windstorm hazard assessment

Goal B
Improve Understanding of Windstorm Impacts on Communities

Objective 5: Advance understanding of windstorm effects on the built environment

Objective 6: Develop computational tools for use in wind and flood modeling on buildings and infrastructure

Objective 7: Improve understanding of economic and social factors influencing windstorm risk reduction measures

Objective 8: Develop tools to improve post-storm impact data collection, analysis, and archival

Objective 9: Develop advanced risk assessment and loss estimation tools

Goal C
Improve Windstorm Resilience of Communities Nationwide

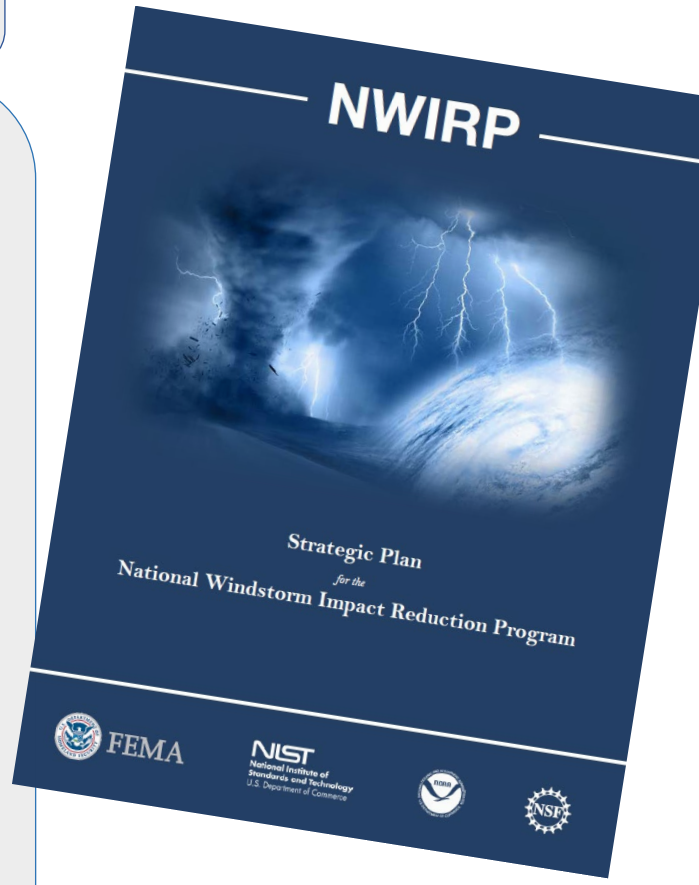
Objective 10: Develop tools to improve the performance of buildings and other structures in windstorms

Objective 11: Support the development of windstorm-resilient standards and building codes

Objective 12: Promote the implementation of windstorm-resilient measures

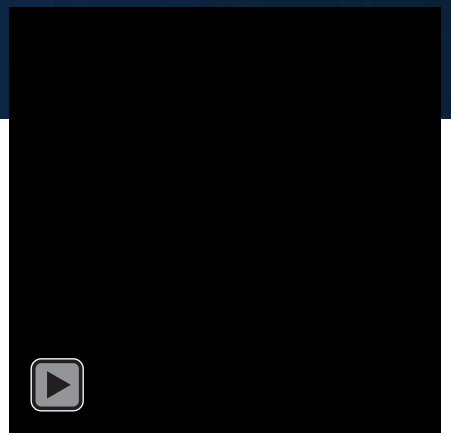
Objective 13: Improve windstorm forecast accuracy and warning time

Objective 14: Improve storm readiness, emergency communications and response



Selected Current Priorities

- Structure to structure fire exposure
- Source Term Characterization
  - Composition of smoke
  - Indoor Air Quality
- Material Weathering Research
- SERI Physical Infrastructure Research
- Functional Recovery



Corner view during test

NIST Special Publication 1244

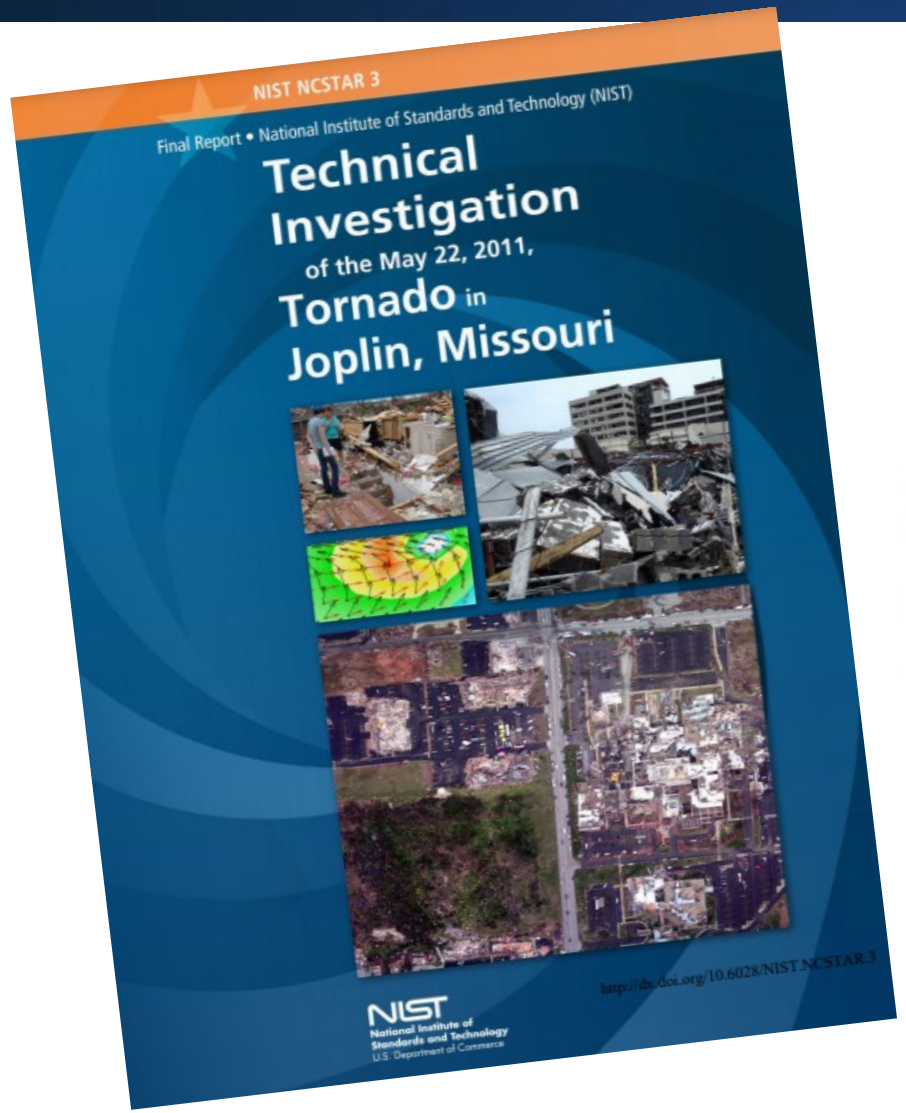
Research Needs Concerning the Performance of Fiber Reinforced (FR) Composite Retrofit Systems for Buildings and Infrastructure

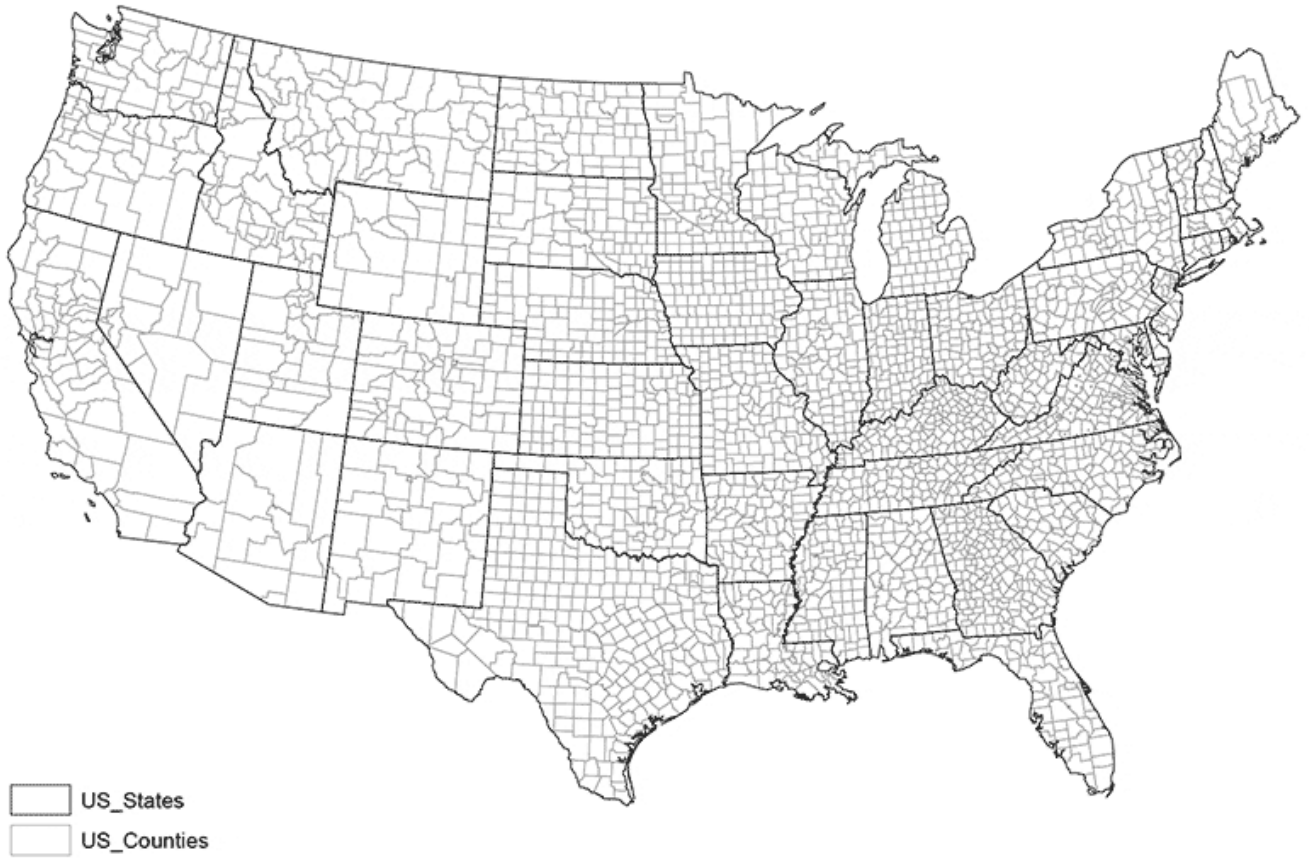
David Goodwin
Siamak Sattar
Jazalyn Dukes
Jae Hyun Kim
Chiara Ferraris
Li-Piin Sung

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.1244

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Impact: NIST Tornado Hazard Maps



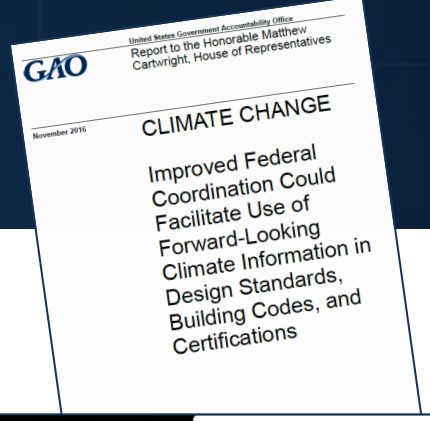


https://www.nist.gov/news-events/news/2021/06/major-new-building-standard-can-map-out-tornado-threat-first-time

Other Program Impacts

- ARC, EDGE$, and IN-CORE for community resilience modeling
- Identified building component vulnerabilities to WUI firebrand attack and importance of fire fighting resource allocation, pre-fire planning, and post-fire data collection
- Developed Firebrand Generator, Emberometer for real time tracking of embers, and Burn Observation Bubble
- Developed data collection protocols for WUI and flooding damages, as well as standardized survey protocols

Climate Science and Building Codes Workshop



January 2021

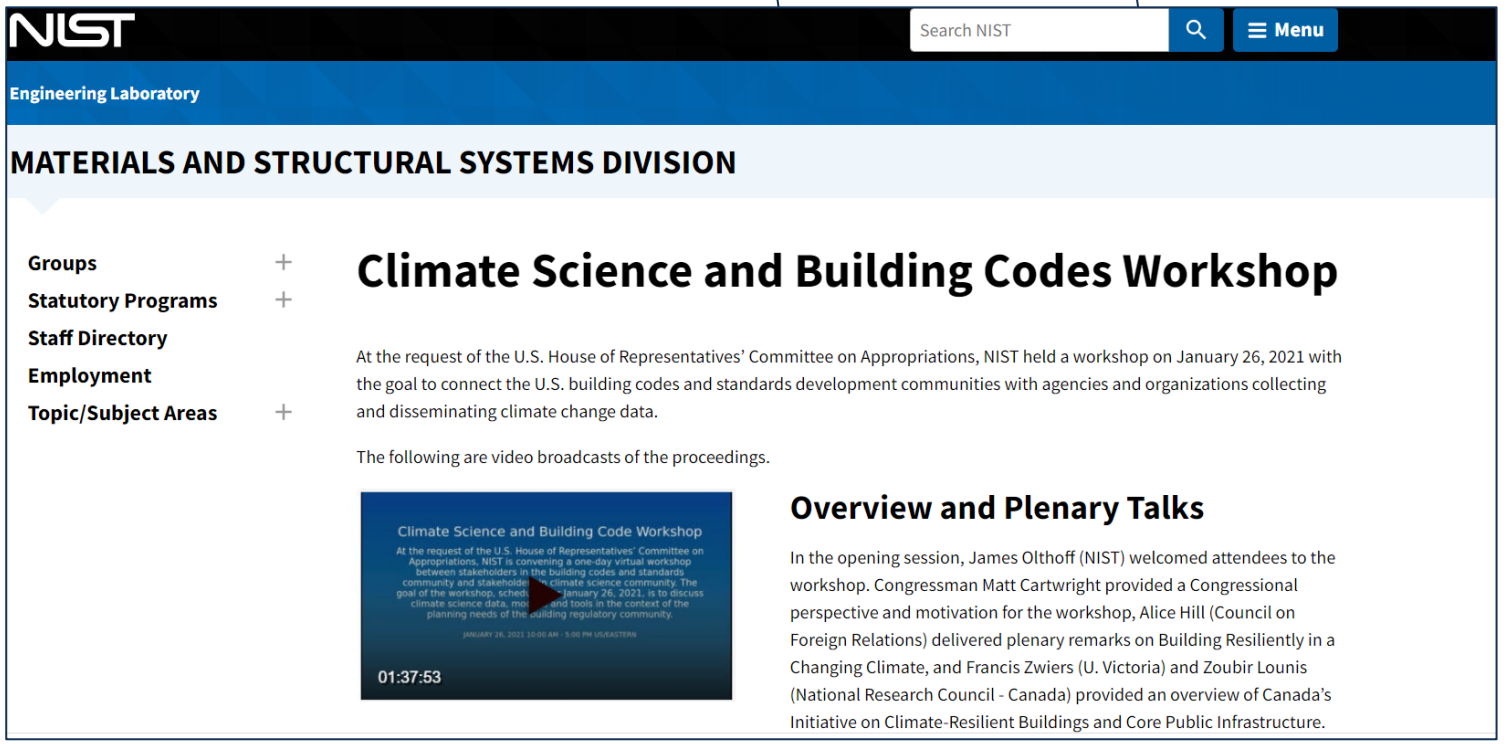
- Dr. Alice Hill, Keynote
- Rep. Cartwright

Building Codes

- ASCE
- ASHRAE
- Broward County, FL
- ICC
- NFPA
- GSA

Climate Science

- DOE/LBNL
- EPA
- NASA
- NOAA
- USACE



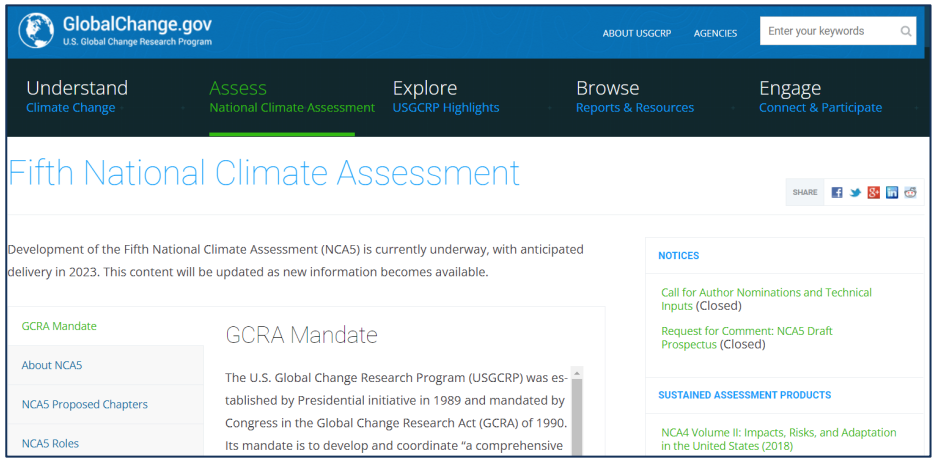
https://www.nist.gov/el/materials-and-structural-systems-division-73100/climate-science-and-building-codes-workshop

Summary

Are we designing buildings and infrastructure today that will withstand the hazards of tomorrow?

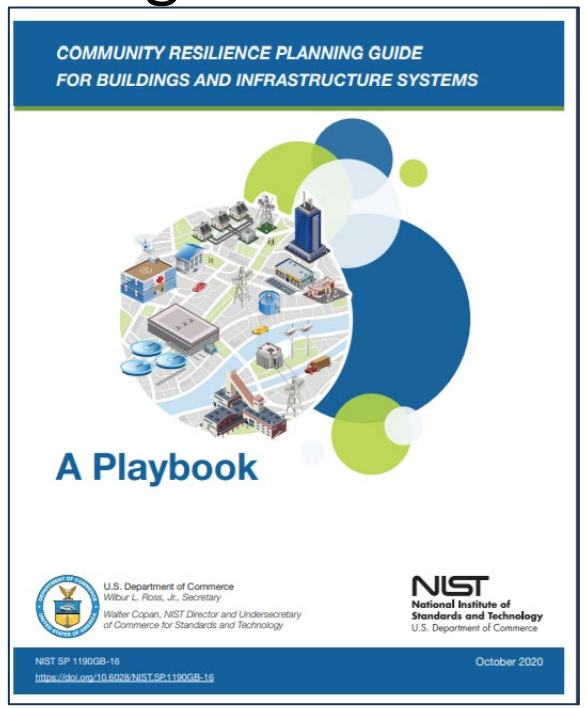
1. Measure the hazard

2. Quantify nonstationarity



https://www.globalchange.gov/nca5

3. Design for resilience



https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190GB-16.pdf