

<https://fr.theepochtimes.com/grandes-rivieres-atmospheriques-cause-dinondations-monde-entier-26820.html>

Climate science: An update



Ben Santer

Program for Climate Model Diagnosis
and Intercomparison

Climate Safe California: “What the
science requires”

Climate change is now in our backyards



Top 5 climate stories of 2020 in Scientific American

1. Record-breaking wildfires in Australia and U.S.
2. Record 30 named storms in 2020 Atlantic hurricane season
3. 2020 is second-warmest year globally (or tied for warmest)
4. COVID-driven decrease in fossil fuel emissions
5. Biden/Harris Administration announces intention to rejoin Paris Agreement

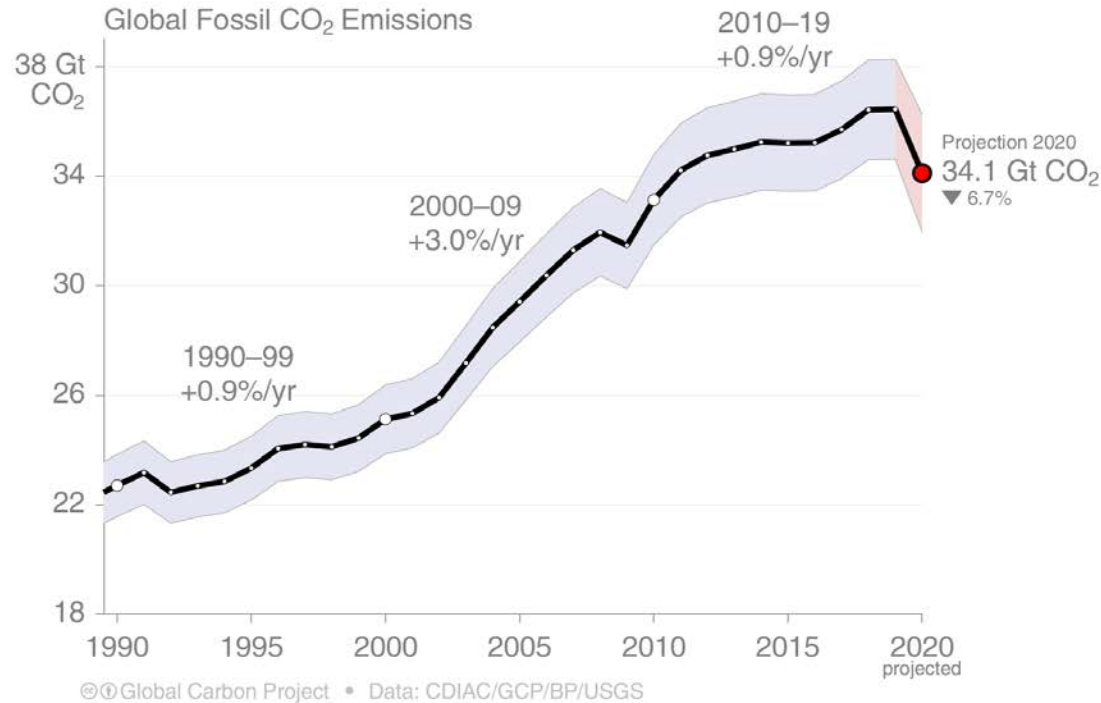


Top 5 climate stories of 2020 in The Atlantic

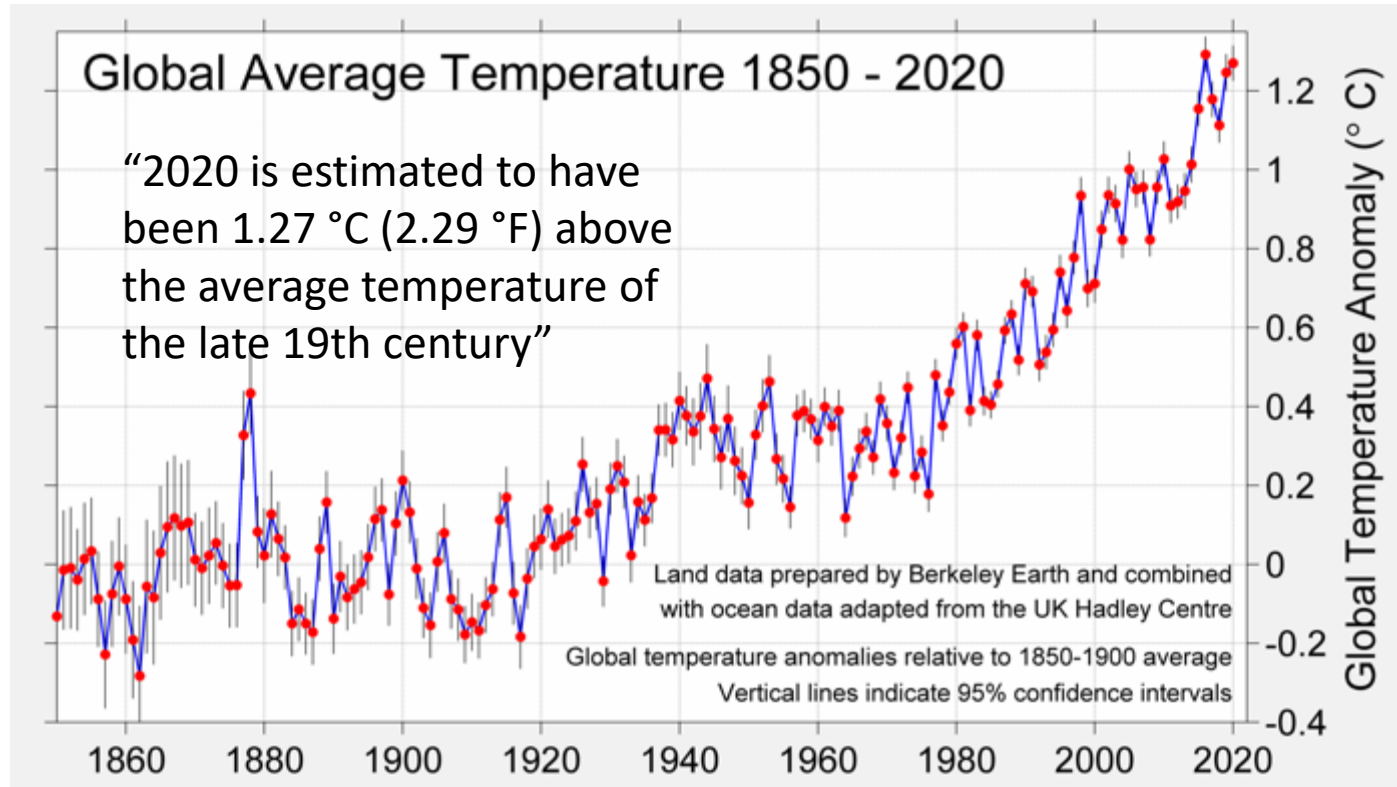
1. President Xi Jinping's announces that China aims to start reducing its carbon pollution by 2030—and achieve net-zero by 2060
2. European Union leaders pledge a new target of 55 percent greenhouse-gas reduction by 2030 (up from a 40 percent reduction)
3. COVID-driven decrease in fossil fuel emissions
4. Markets begin to consider the cost of climate change—and the benefits of the energy transition (“The year that the climate became the economy”)
5. Bipartisan bill to phase out hydrofluorocarbons



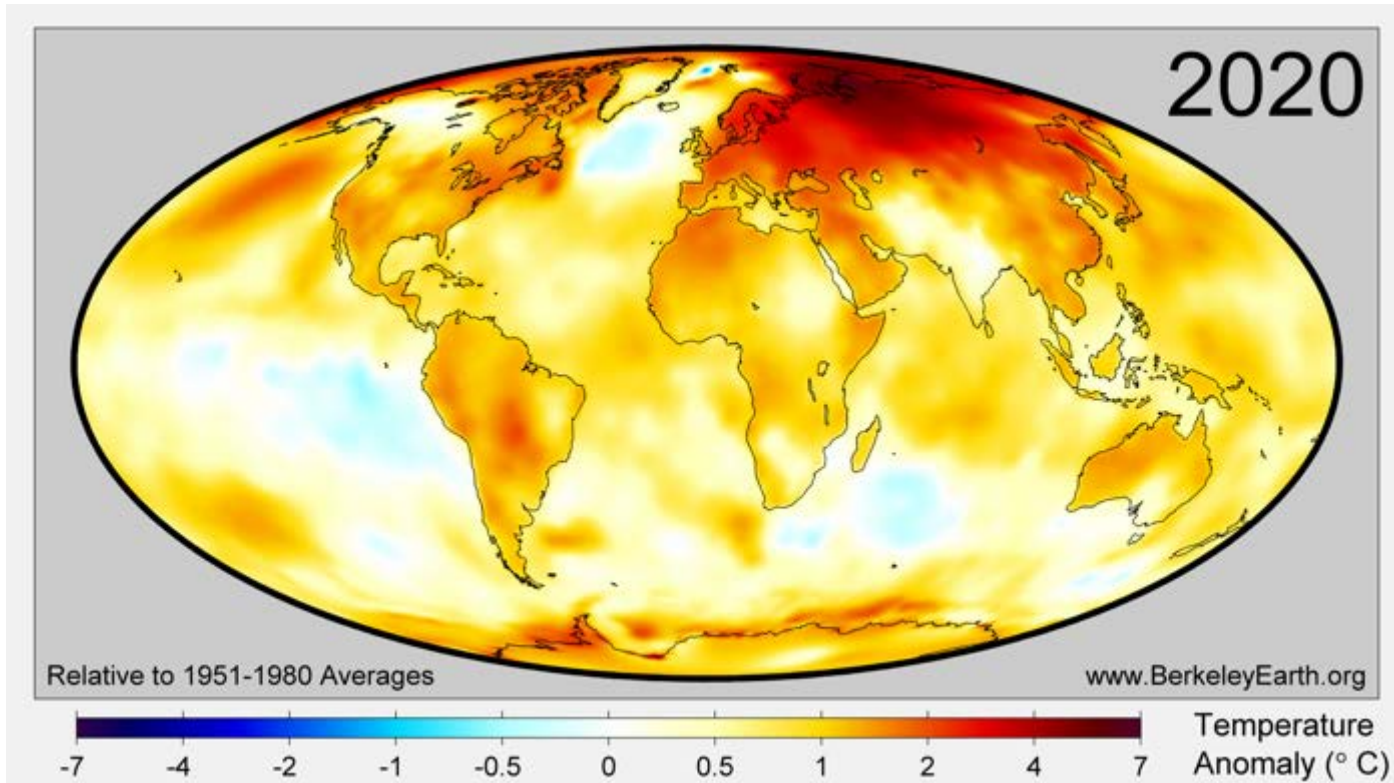
Climate news in 2020: Impact of COVID-19 on fossil fuel emissions



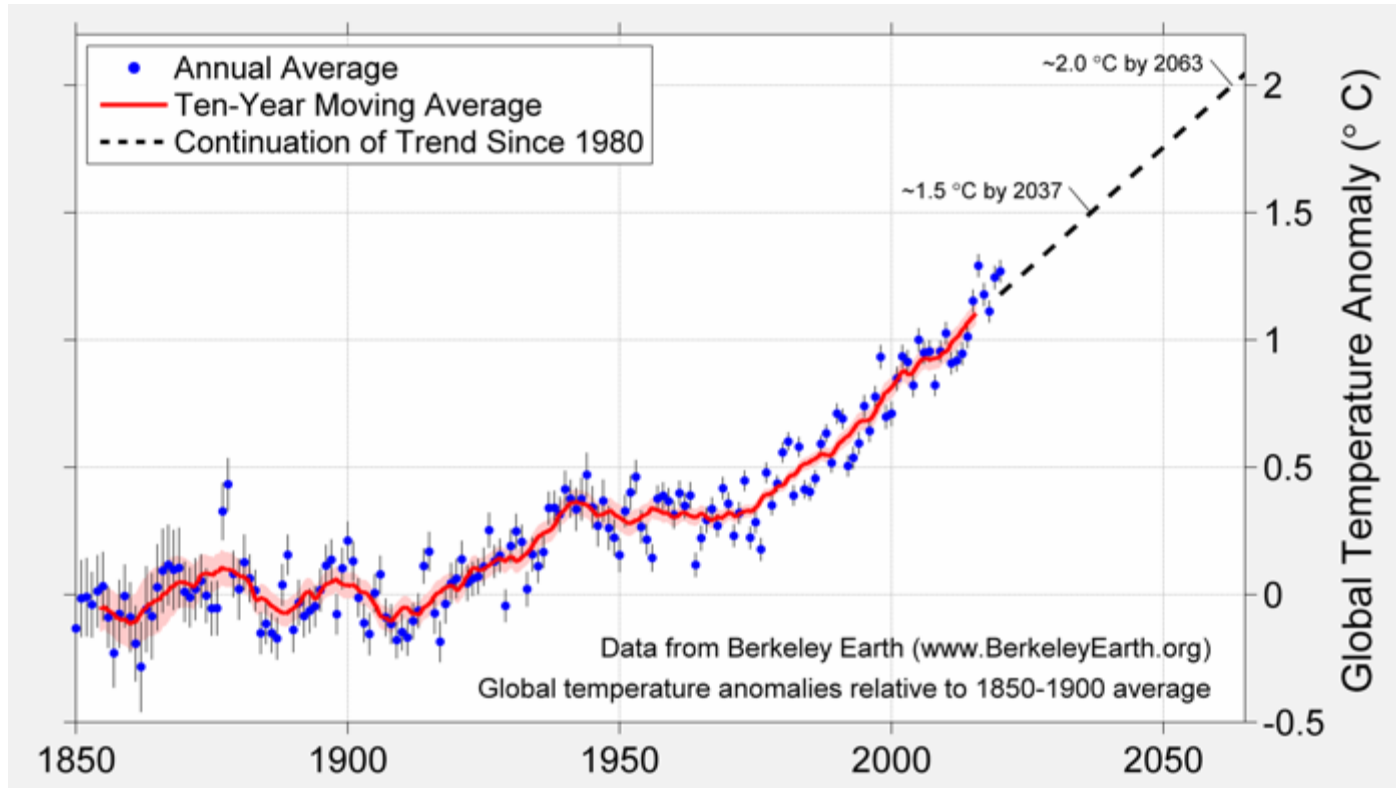
Climate news in 2020: Global-mean surface temperature



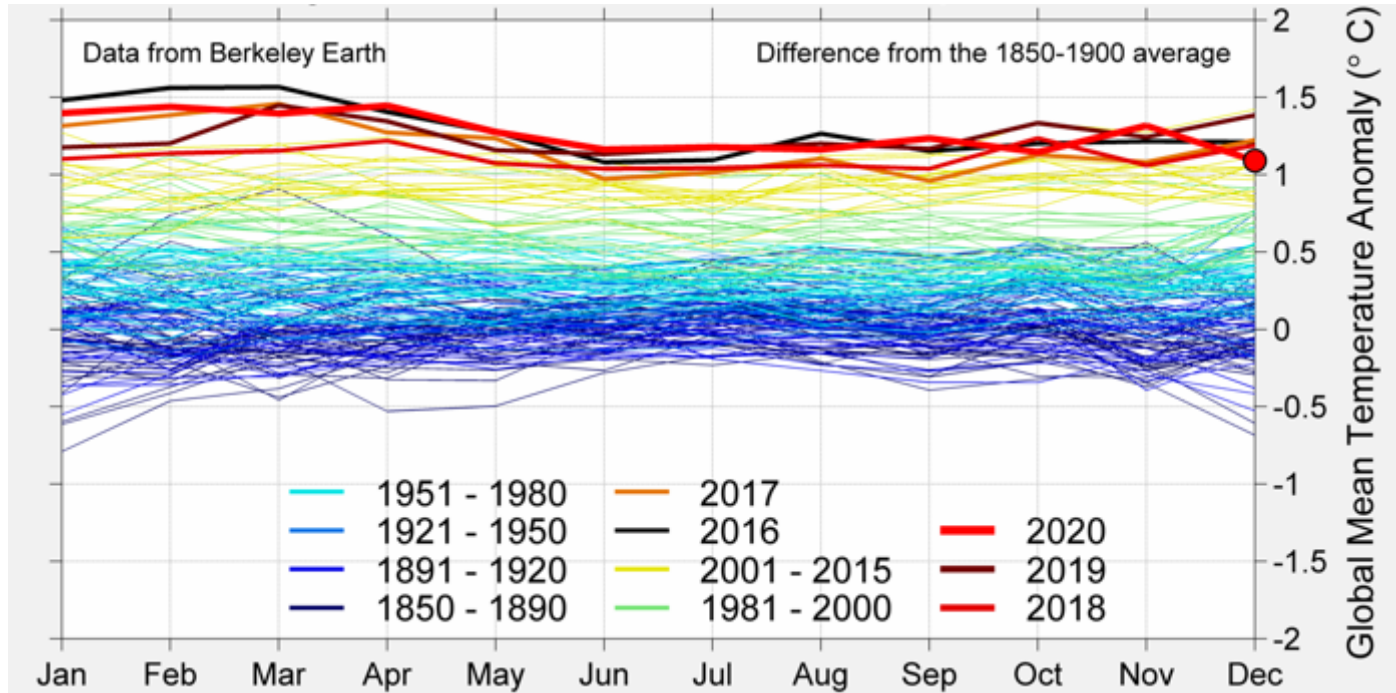
Regional aspects of surface temperature changes in 2020



What would happen if current global warming trends continue?

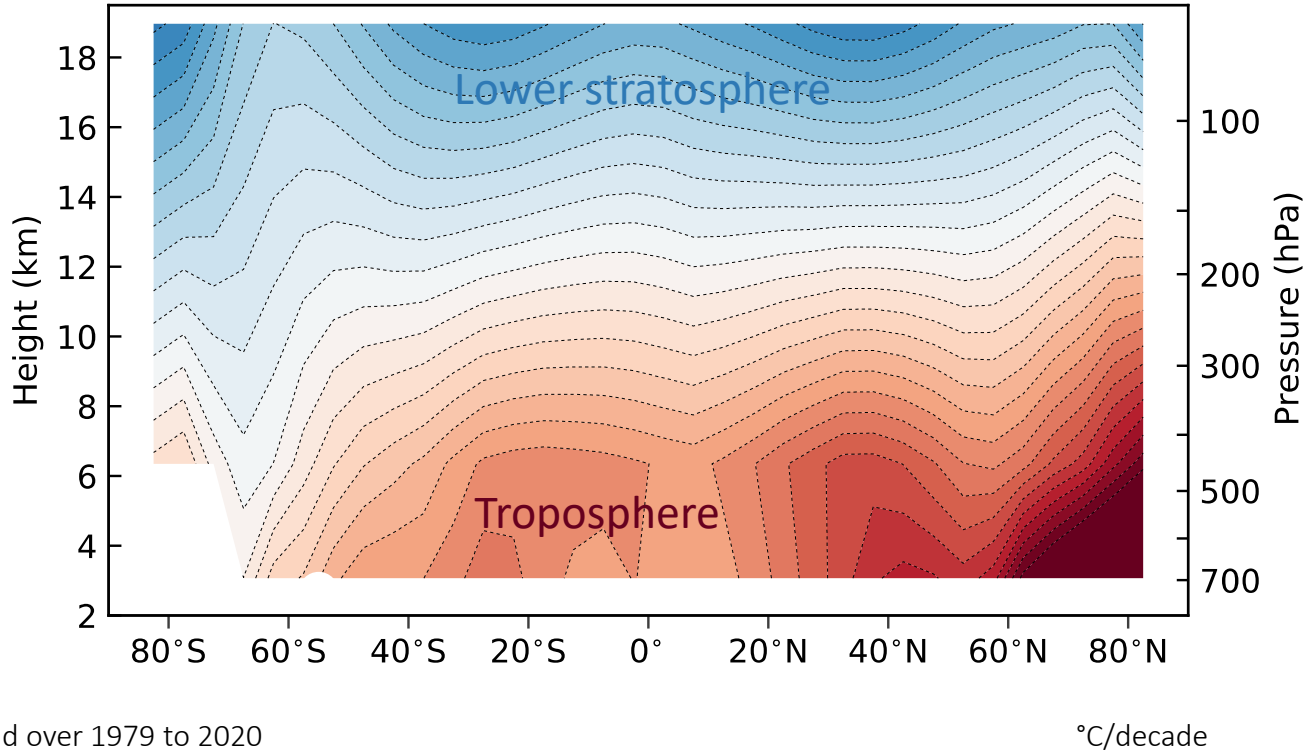


Seasonal aspects of surface temperature changes

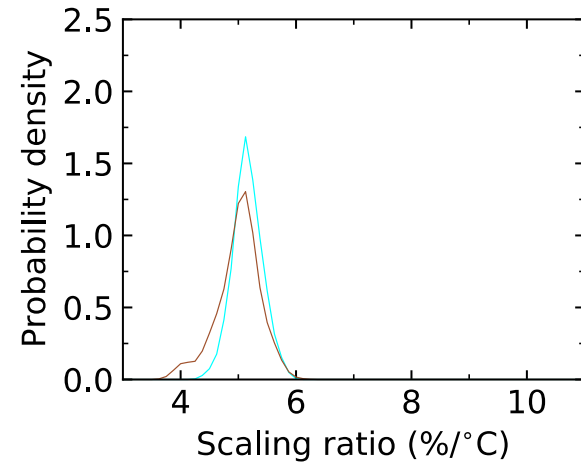
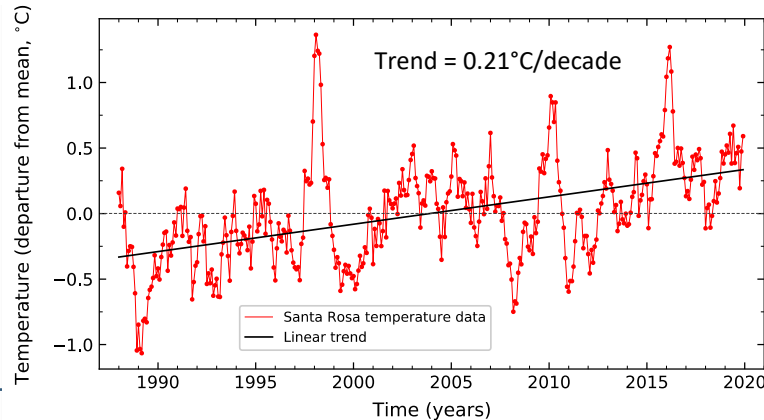


Vertical “fingerprint” of atmospheric temperature changes

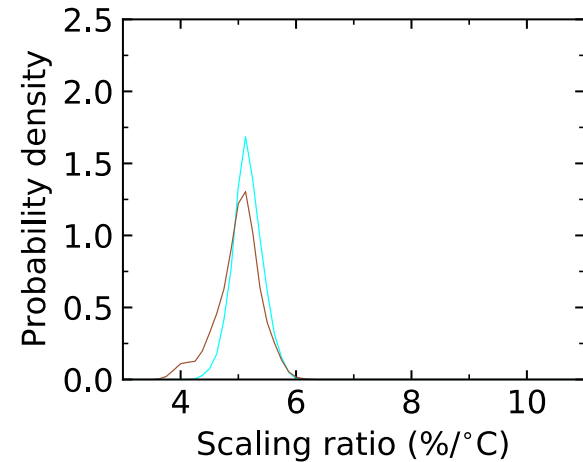
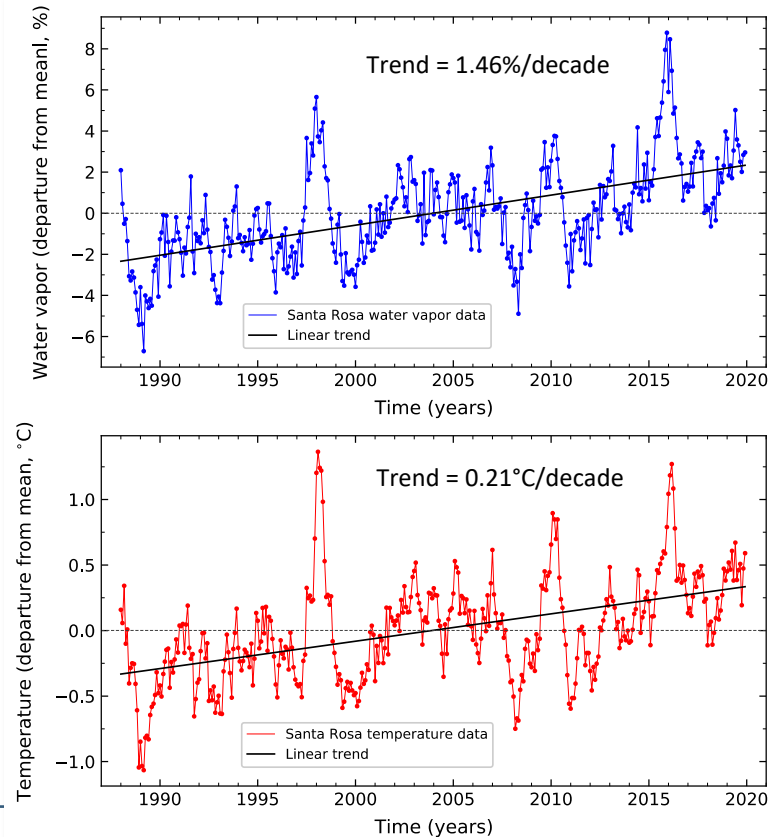
Satellite
observations
(Santa Rosa, CA)



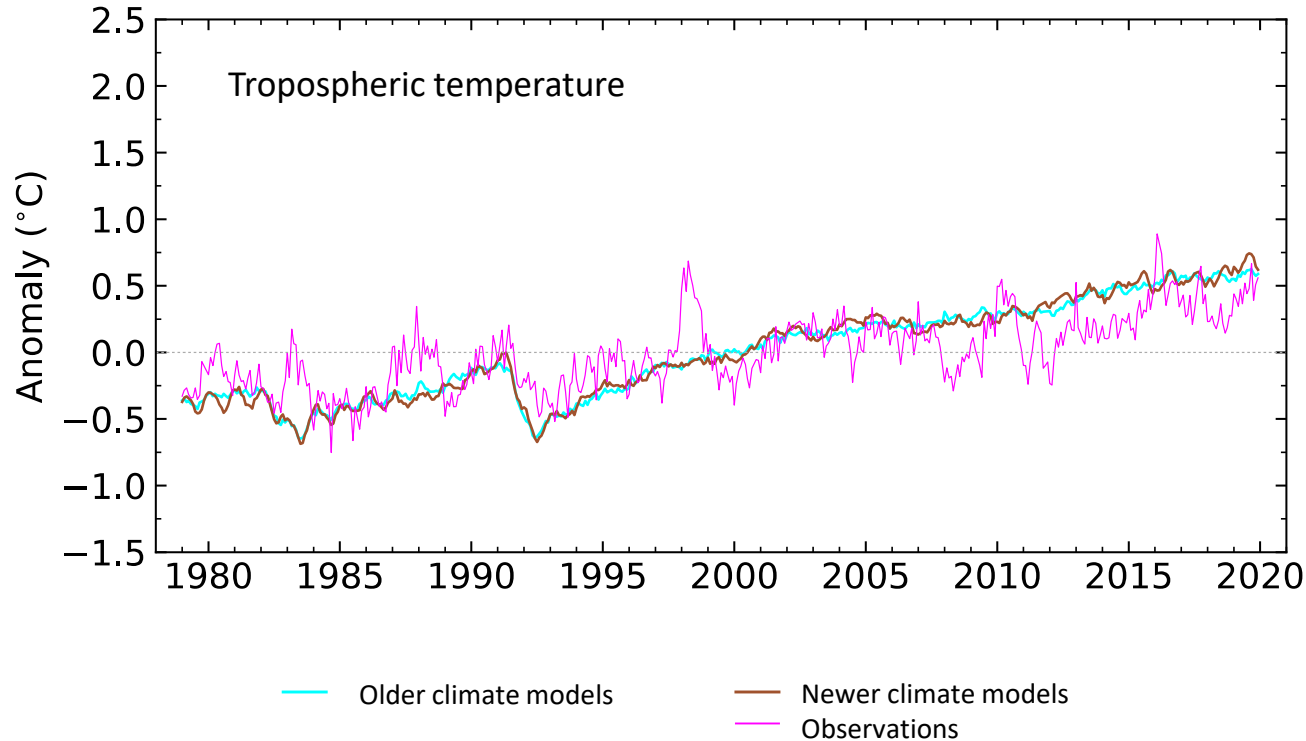
Atmospheric moisture and temperature in the tropics



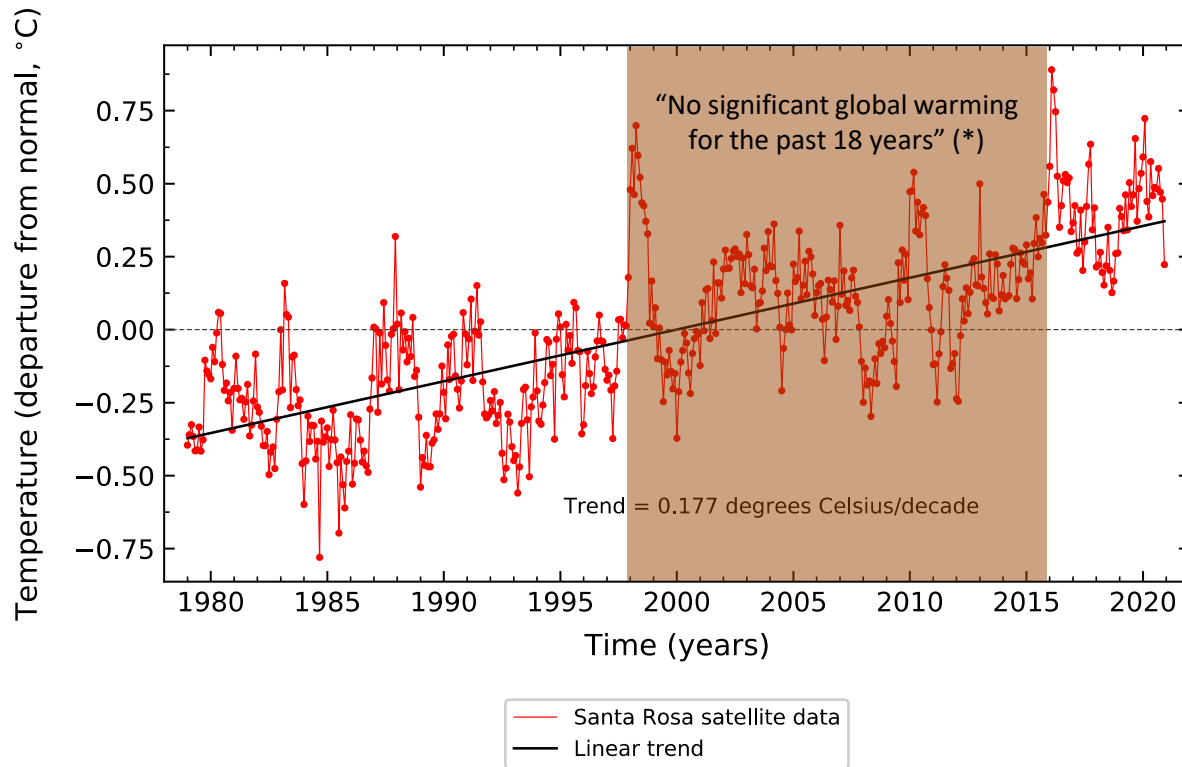
Atmospheric moisture and temperature in the tropics



Why is the size of tropospheric warming important?



Tropospheric temperature has been the focus of hearings in the U.S. Senate



*Source of quote: Senator Ted Cruz, U.S. Senate Committee on Commerce, Science and Transportation, "Data or dogma?" hearing, Dec. 8, 2015. Figure: Ben Santer

Lesson learned: Speak science to power

Comparing Tropospheric Warming in Climate Models and Satellite Data

BENJAMIN D. SANTER,^a SUSAN SOLOMON,^b GIULIANA PALLOTTA,^a CARL MEARS,^c
STEPHEN PO-CHEDLEY,^d QIANG FU,^d FRANK WENTZ,^c CHENG-ZHI ZOU,^e JEFFREY PAINTER,^a
IVANA CVIJANOVIC,^a AND CÉLINE BONFILS^a

^a Program for Climate Model Diagnosis and Intercomparison, Lawrence Livermore National Laboratory,
Livermore, California

^b Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts
^c Remote Sensing Systems, Santa Rosa, California

^d Department of Atmospheric Sciences, University of Washington, Seattle, Washington

^e Center for Satellite Applications and Research, NOAA/NESDIS, Camp Springs, Maryland

(Manuscript received 25 April 2016, in final form 20 September 2016)

“...the validity of the statement that satellite data show no significant tropospheric warming over the last 18 years is assessed. This claim is not supported by the current analysis: in five out of six corrected TMT records, significant global-scale tropospheric warming has occurred within the last 18 years”.

Lesson learned: Declare your values















Photo by Ben Santer



Photo by Ben Santer



Photo by Ben Santer



Photo by Ben Santer





Photo by Ben Santer



Photo by Ben Santer





Ben Santer
santer1@llnl.gov

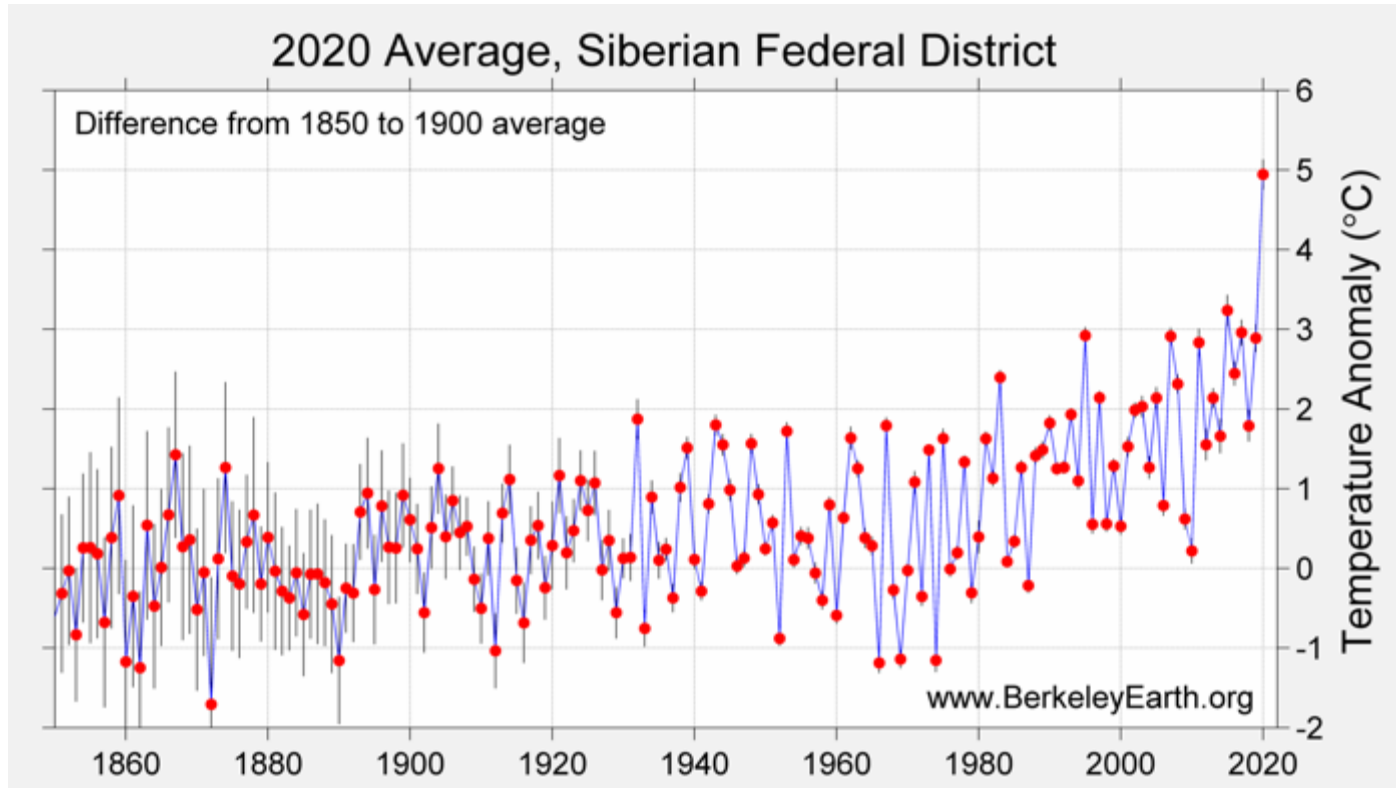
This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.



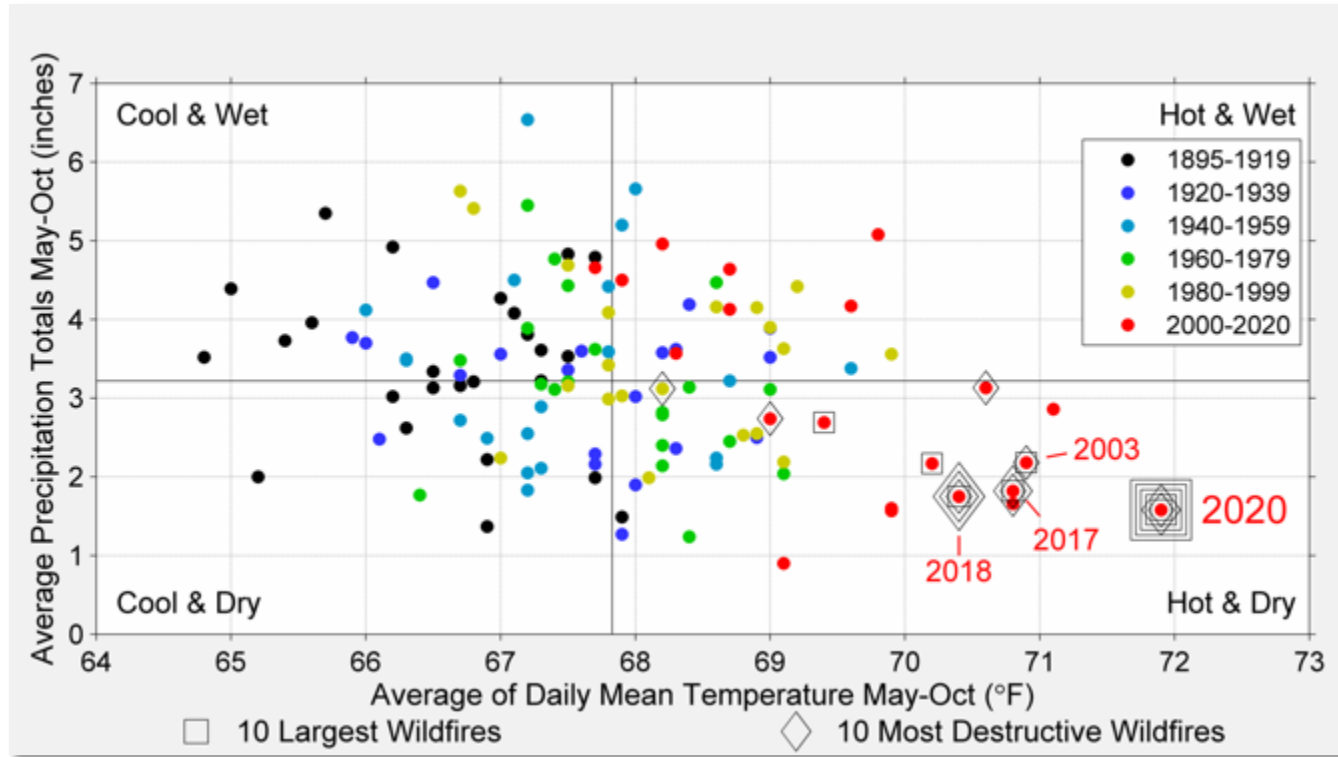
EXTRA SLIDES



Climate news in 2020: Record-breaking warmth in Siberia



Climate news in 2020: The changing fire season in California



Climate news in 2020: Focus on tipping points

Evidence that tipping points are under way has mounted in the past decade. Domino effects have also been proposed.



A. Amazon rainforest
Frequent droughts

B. Arctic sea ice
Reduction in area

C. Atlantic circulation
In slowdown since 1950s

D. Boreal forest
Fires and pests changing

F. Coral reefs
Large-scale die-offs

G. Greenland ice sheet
Ice loss accelerating

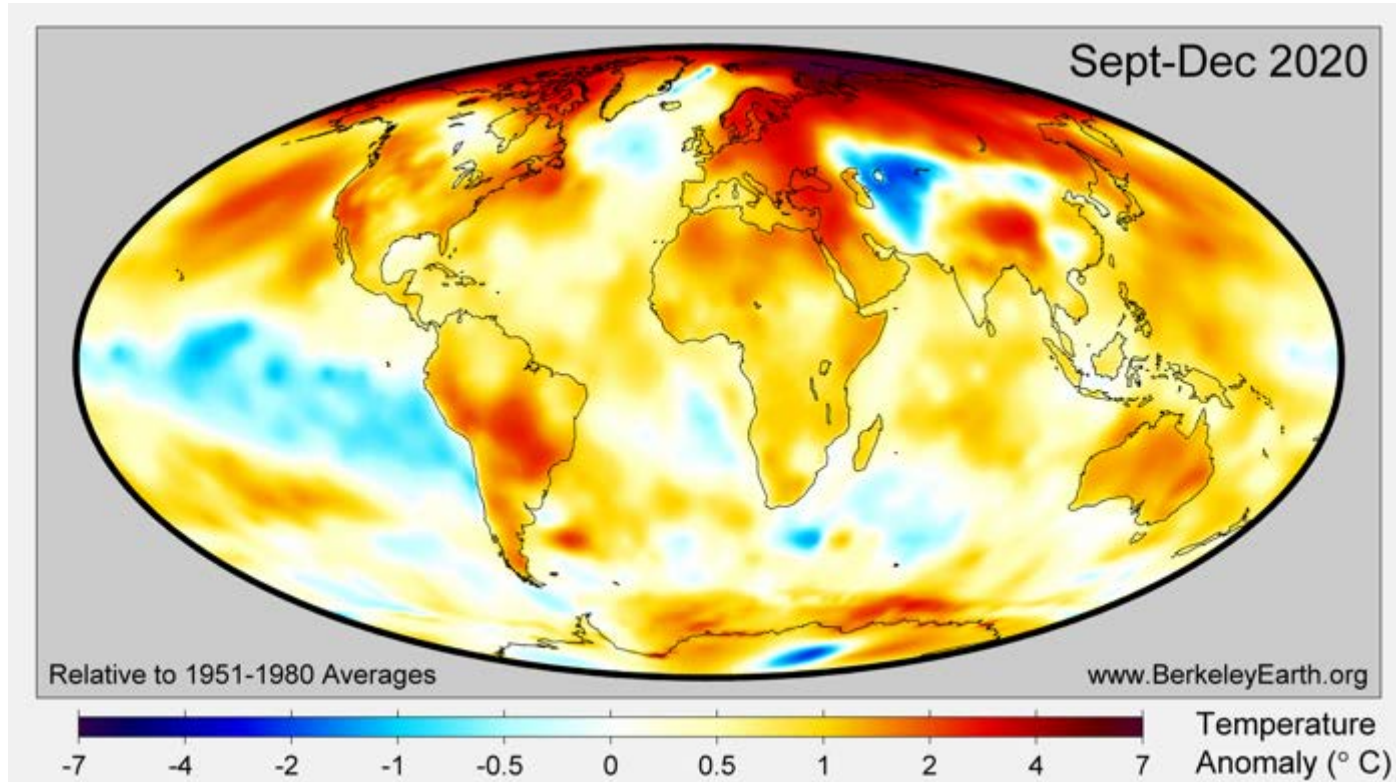
H. Permafrost
Thawing

I. West Antarctic ice sheet
Ice loss accelerating

J. Wilkes Basin, East Antarctica
Ice loss accelerating

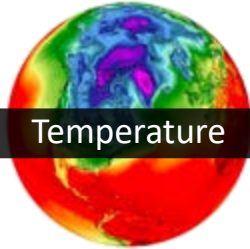
©nature

Climate news in 2020: La Niña conditions at the end of the year

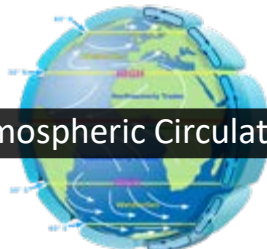


Human fingerprints on climate are ubiquitous

- Climate scientists have identified human “fingerprints” in many different aspects of the climate system – not just in temperature



Temperature



Atmospheric Circulation



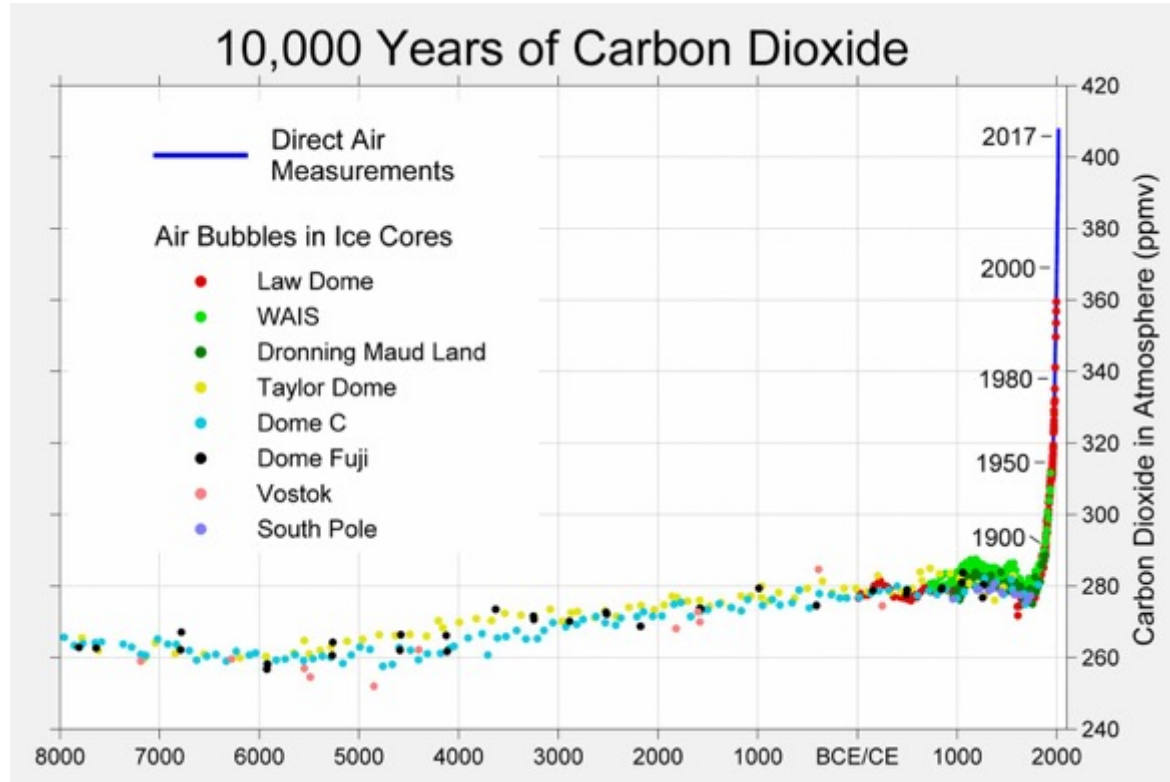
Hydrological Cycle



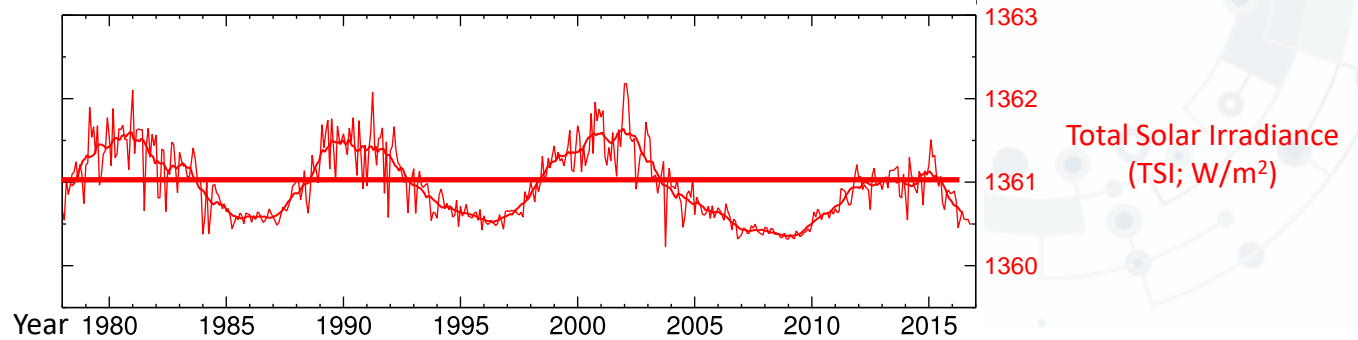
Snow and Ice

- Changes in different climate variables are physically and internally consistent, and are independently monitored with a wide range of instruments

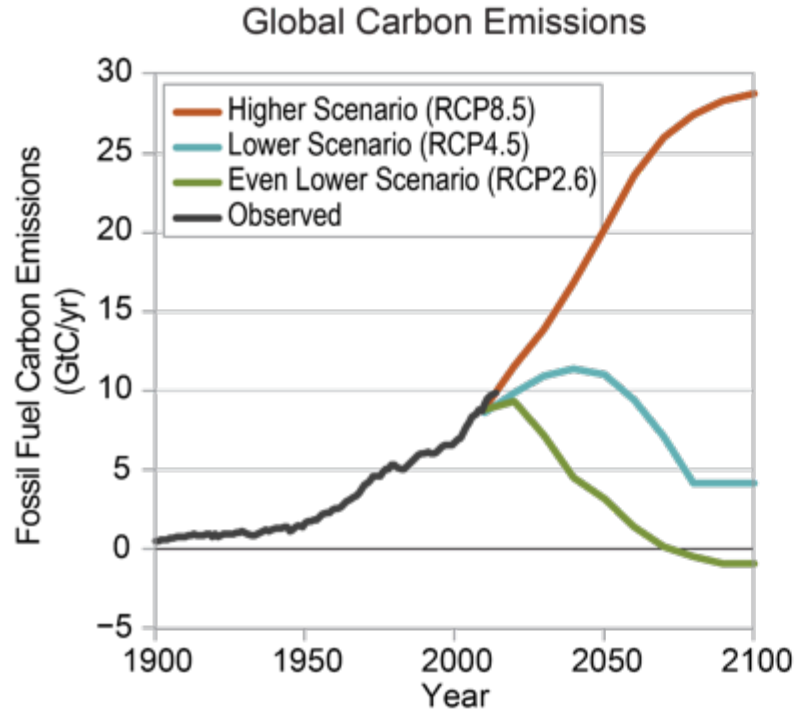
Carbon dioxide in Antarctic ice cores



Consistency checks

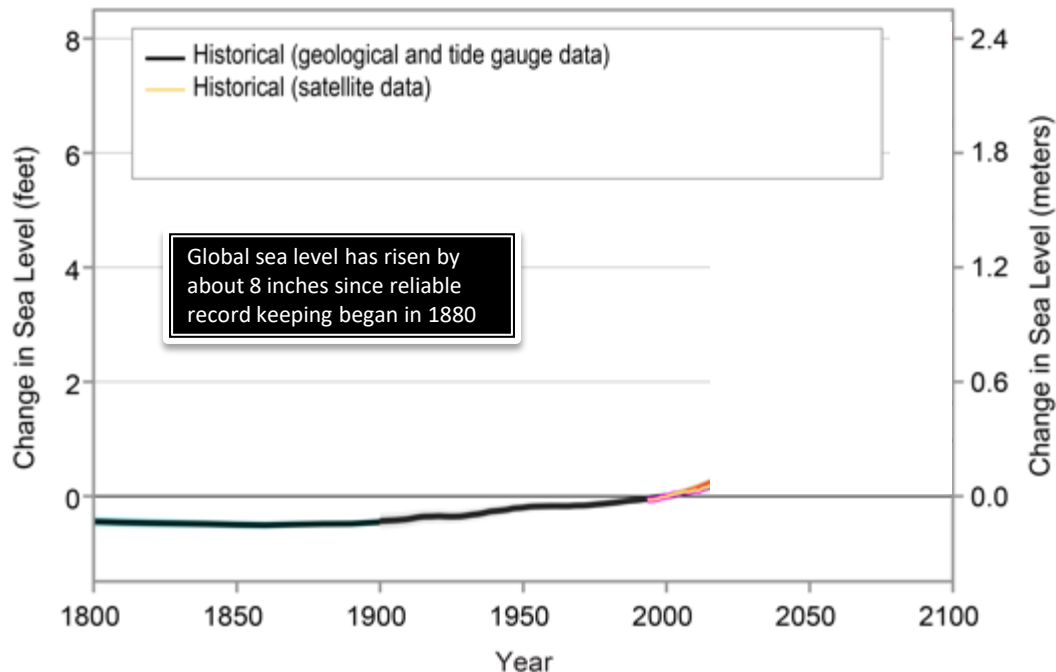


Projected changes in emissions and global-mean temperature



Source: <https://nca2018.globalchange.gov/chapter/2/>

Projections of global-mean sea level changes from the Fourth National Climate Assessment



There are many ways of using your voice

1. Advance the science
2. Provide Congressional testimony
3. Write opinion pieces in newspapers
4. Produce blogs, podcasts, videos, “climate art”
5. Give public lectures
6. Use social media to share stories and science
7. Engage with your political representatives
8. Talk to friends, family, and colleagues about climate science
9. Join effective organizations (NCSE, Climate Generation, CCL)

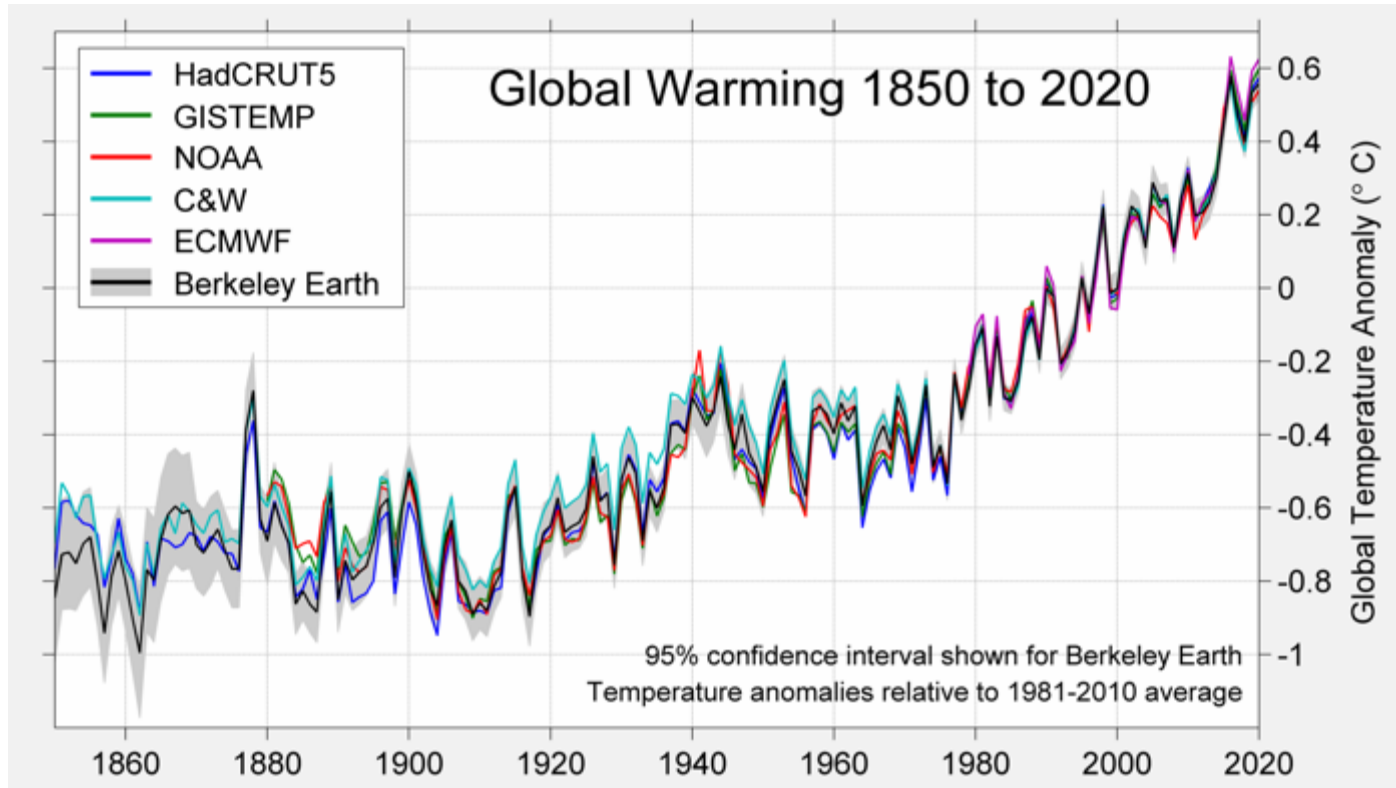


Resources

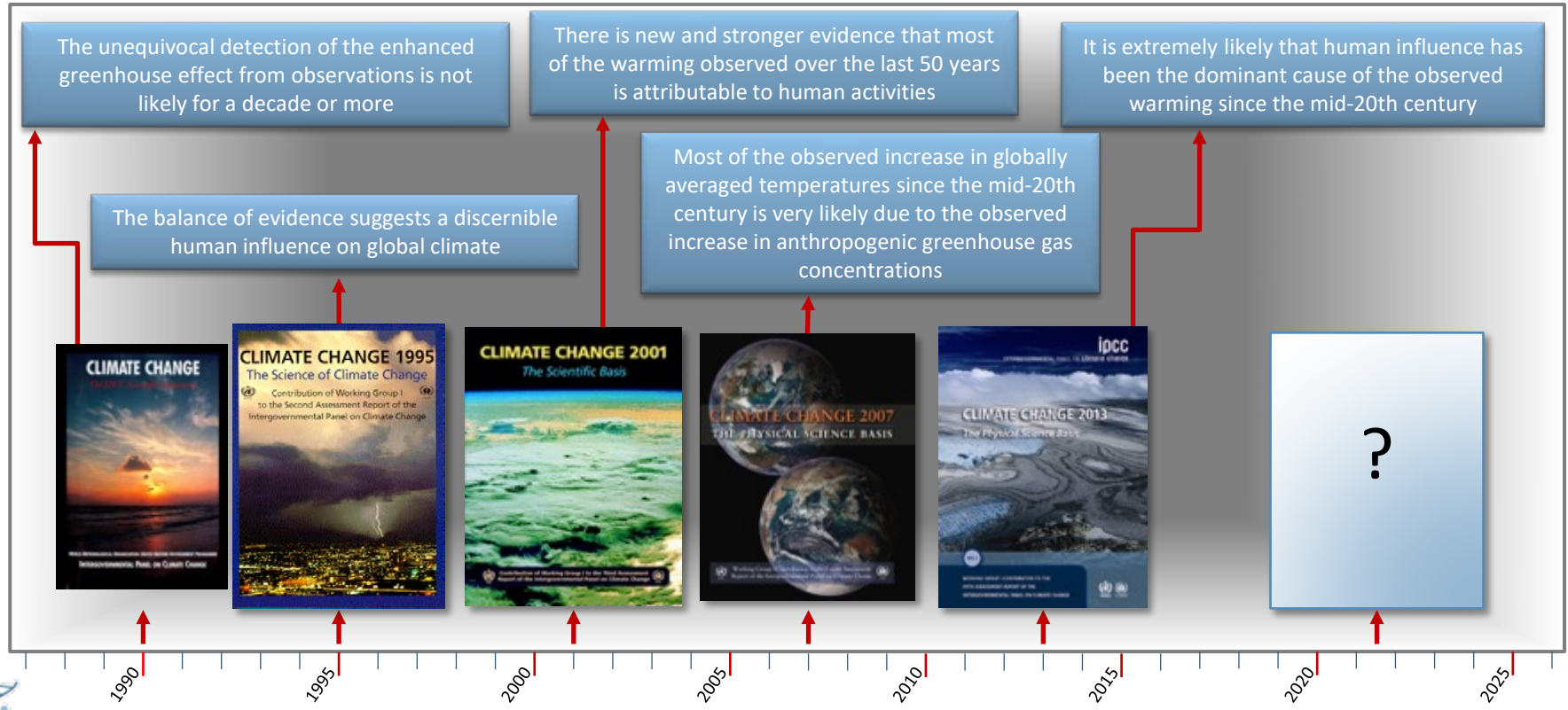
- National Center for Science Education (<https://ncse.ngo>)
 - ➔ “We help ensure students across the country get the accurate, effective evolution and climate science education they deserve”
- Union of Concerned Scientists (<https://www.ucsusa.org>)
 - ➔ “Our mission: to use rigorous, independent science to solve our planet's most pressing problems... we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future”
- Juneau Icefield Research Program (<https://juneauicefield.org>)
 - ➔ “Training, teaching, and inspiring the scientific leaders of tomorrow”
- Climate Generation (<https://www.climategen.org>)
 - ➔ “Empowers individuals and their communities to engage in solutions to climate change”



Surface temperature



Progress in identifying human effects on climate



How was scientific progress made?

- Improved (and more) climate models
- Better understanding of “forcings” that affect climate
- Improved (and longer) observed climate records
- “Benchmarking” of climate models
- Community-wide analysis of climate model results
- Infrastructure for sharing climate model output
- “Climate fingerprinting”

