Climate science: An update

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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

![Graph showing global fossil CO₂ emissions from 1990 to 2020, with a notable decrease in 2020 due to COVID-19.]
Climate news in 2020: Global-mean surface temperature

“2020 is estimated to have been 1.27 °C (2.29 °F) above the average temperature of the late 19th century”
Regional aspects of surface temperature changes in 2020

Figure courtesy of Berkeley Earth. http://berkeleyearth.org/wp-content/uploads/2021/01/2020_Global_Map.png
What would happen if current global warming trends continue?

Seasonal aspects of surface temperature changes

Figure courtesy of Berkeley Earth. http://berkeleyearth.org/wp-content/uploads/2021/01/2020_Seasonal_Wrap.png
Vertical “fingerprint” of atmospheric temperature changes

Satellite observations (Santa Rosa, CA)

Temperature trend over 1979 to 2020

°C/decade

Figure from Santer et al., Proceedings of U.S. National Academy of Sciences, 2013 (updated)
Atmospheric moisture and temperature in the tropics

Trend = 0.21°C/decade

Figures from Santer et al., Journal of Climate (submitted)
Atmospheric moisture and temperature in the tropics

Figures from Santer et al., Journal of Climate (submitted)

Trend = 1.46%/decade

Trend = 0.21°C/decade

Climate Safe California, Jan. 26th, 2021
Why is the size of tropospheric warming important?

![Tropospheric temperature graph]

Figure from Santer et al., Journal of Climate (submitted)
Tropospheric temperature has been the focus of hearings in the U.S. Senate

"No significant global warming for the past 18 years" (*)

*Trend = 0.177 degrees Celsius/decade

*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

“...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”.

Santer et al., Journal of Climate, 2017
Lesson learned: Declare your values
EXTRA SLIDES
Climate news in 2020: Record-breaking warmth in Siberia

![Graph showing temperature anomaly from 1850 to 2020 in Siberian Federal District](http://berkeleyearth.org/wp-content/uploads/2021/01/2020_Siberia.png)
Climate news in 2020: The changing fire season in California

Figure courtesy of Berkeley Earth: http://berkeleyearth.org/october-2020-temperature-update/
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

- **E. Coral reefs**
  Large-scale die-offs

- **F. Greenland ice sheet**
  Ice loss accelerating

- **G. West Antarctic ice sheet**
  Ice loss accelerating

- **H. Permafrost**
  Thawing

- **I. Wilkes Basin, East Antarctica**
  East Antarctica

- **J. Permafrost, Thawing**

[https://www.nature.com/articles/d41586-019-03595-0](https://www.nature.com/articles/d41586-019-03595-0)
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.

- 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

Figure courtesy of Robert Rohde, UC Berkeley
Consistency checks
Projected changes in emissions and global-mean temperature

Source: https://nca2018.globalchange.gov/chapter/2/
Global sea level has risen by about 8 inches since reliable record keeping began in 1880.
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](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](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](https://juneauicefield.org))
  - “Training, teaching, and inspiring the scientific leaders of tomorrow”

- Climate Generation ([https://www.climategen.org](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

The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more.

The balance of evidence suggests a discernible human influence on global climate.

There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.

Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.

It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

The Science of Climate Change

The Scientific Basis

The Physical Science Basis

Climate Safe California, Jan. 26th, 2021
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”