CHANGING CLIMATE

OUR FUTURE, OUR CHOICE

Recent Climate Change: The Last 140 Years

MUSEUM OF THE EARTH

1259 Trumansburg Rd,
Ithaca, NY 14850
(607) 273-6623 priweb.org

Full Disk Earth, Apollo 17, 1972. Credit:NYPL

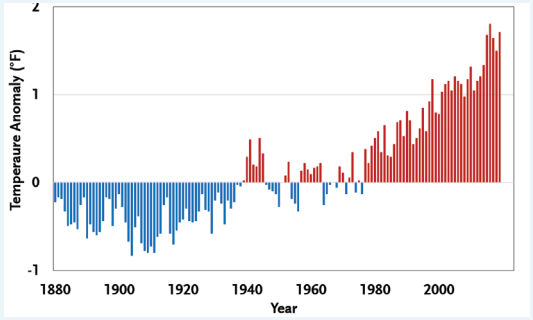
Introduction

The graphs on the wall in this exhibit may look big, but they compress a lot of information into a small space—800,000 years worth of data in only about 10 feet.

That's over 6,000 years per inch! Because of this, it can be hard to see the details of how Earth's climate has changed in recent times.

This pamphlet "zooms in" on the recent past and provides more detail on how Earth's temperature and atmospheric carbon dioxide (CO_2) concentration have changed over the last 140 years.

Earth's Temperature Over Time

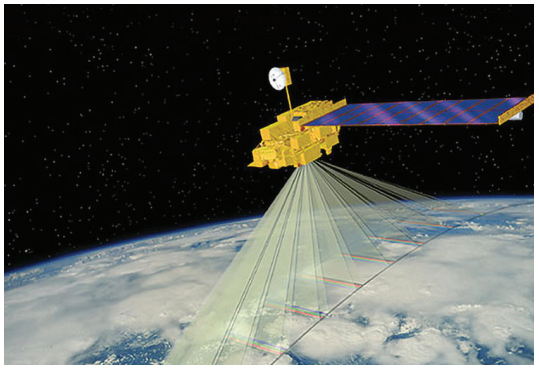


This graph[1] shows how the global annual surface temperature—both land and ocean—has varied from 1880 to 2019. The bar for each year is plotted relative to the temperature averaged over the base period of the 20th century (1901-2000.) When temperature differences are plotted relative to some base period, they are called "temperature anomalies." The data come from sensors on satellites and on the Earth's surface.

The graph shows several important phenomena:

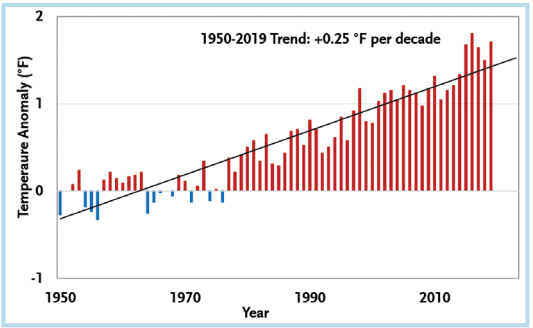
- There is a profound difference between the first half of the graph (1880-1949) and the second half (1950-2019). Annual temperatures are mostly below the 20th century average in the first half, and mostly above it in the second half.
- Weather is variable. The graph shows trends, but temperatures vary from year to year.
- The second half of the graph shows a clear warming trend. To the right is a plot of the data from 1950 to 2019 with a trend line added.

A technician checking sensors on a temperature monitoring buoy. Credit: NOAA



This satellite carries an instrument called MODIS that measures sea surface temperature. Credit: NASA

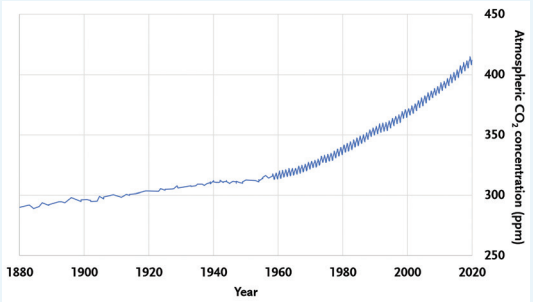
Temperature: A Closer Look



The graph shows a rate of temperature increase of 0.25 °F (0.14 °C) per decade. At that rate, temperatures would rise about 2 °F in a typical American's lifespan. That may not seem like a lot, but think about how you feel when you have a fever that is 2 °F above your normal temperature. The human metabolism can adjust to changes in temperature (except at extremes), but many natural systems, including animal and plant life, can be sensitive to small changes in temperature.

Temperature changes may seem small but add up quickly. Credit: Jarosław Kwoczała

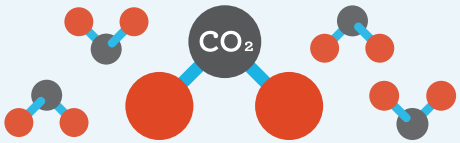
Atmospheric Carbon Dioxide Over Time



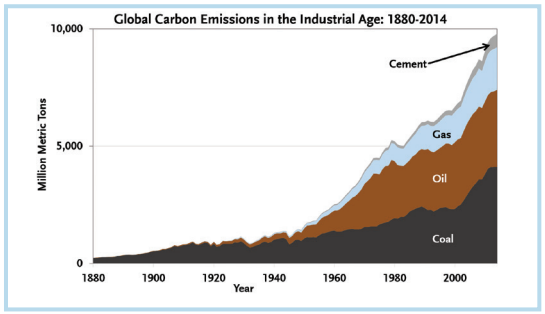
This graph shows how the concentration of CO_2 in the atmosphere has changed from 1880 to 2019. The concentration is expressed in parts per million (ppm). You're seeing a compilation of two data sets, one (1880-1957) from Antarctic ice core records[2] and the other (1958-2019) from direct measurements made at the Mauna Loa Atmospheric Observatory in Hawaii.[3]

Notice the upward trend of CO_2 with time—CO_2 is becoming more concentrated in the atmosphere, at an increasingly rapid rate. The rate of change of CO_2 concentration in the last hundred years is over 100 times faster than the fastest rate of increase in the 800,000 preceding years.

The sawtooth appearance of this graph from 1958 onward comes from the seasonal cycle of plant life in the Northern Hemisphere. When leaves emerge in the spring, plants draw down CO_2 through photosynthesis. When plants lose their leaves in the fall, CO_2 levels in the atmosphere increase. You might wonder why this sawtooth pattern doesn't appear before 1958. This is simply because prior to 1958, scientists were not measuring atmospheric CO_2 frequently enough during the year to see this effect.



Why Is Earth's Temperature Rising?



The Earth's temperature is rising because of increased CO_2 and other gases in the atmosphere, which warm the Earth through the greenhouse effect. The increased CO_2 is mainly (about 80%) the result of our burning fossil fuels, and partly from other human activities such as cutting down forests. The graph[4] above shows global carbon emissions over time from burning fossil fuels and producing cement.

How do we know that fossil fuel burning is the main cause of Earth's recent temperature increases? Scientists have ruled out other causes, and they have also measured a unique chemical fingerprint of fossil fuels in atmospheric carbon dioxide. For more detail on how we know this, see a section of the Digital Encyclopedia of Earth Science on Causes of Recent Climate Change: https://eartha-thome.org/de/recent-climate-change/causes/

References

1 NOAA National Centers for Environmental information, Climate at a Glance.https://www.ncdc.noaa.gov/cag/

2 MacFarling Meure et al., 2006. The Law Dome CO_2, CH_4 and N_2O Ice Core Records Extended to 2000 years BP. Geophysical Research Letters, Vol. 33, No. 14. https://www.ncdc.noaa.gov/paleo-search/study/9959

3 C. D. Keeling et al., 2001. Exchanges of atmospheric CO_2 and $^{13}CO_2$ with the terrestrial biosphere and oceans from 1978 to 2000. I. Global aspects, SIO Reference Series, No. 01-06, Scripps Institution of Oceanography, San Diego. https://sioweb.ucsd.edu/programs/keelingcurve/permissions-and-data-sources/

4 Graph by Jonathan R. Hendricks for PRI's Earth@Home project, using data from Boden, T. A. et al., Global, Regional, and National Fossil-Fuel CO_2 Emissions (1751 - 2014) (V. 2017). https://www.osti.gov/dataexplorer/biblio/dataset/

November 2020, by Abigail Gepner & Ingrid Zabel

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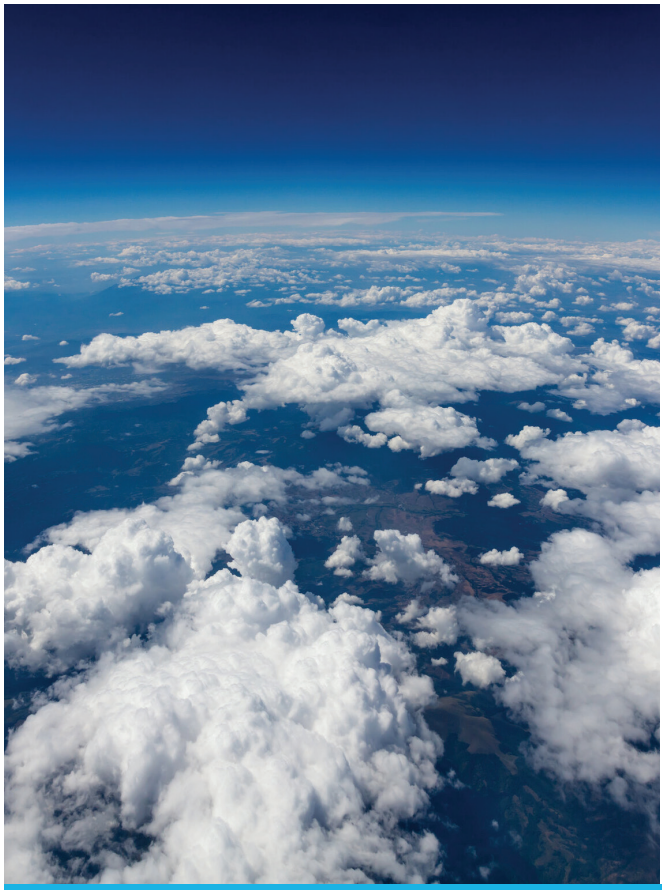

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