THE BLOOMBERG CARBON CLOCK

The **Bloomberg Carbon Clock** tracks the level of CO_2 in the atmosphere measured in parts per million. In mid-May the number exceeded 414 parts per million [ppm]. The number up-to-the-second can be found at: https://www.bloomberg.com/graphics/carbon-clock/.

From the website comes the following observations based on graphs presented on their website:

- "The higher the number climbs over time, the greater the risks from climate change. When the U.S. started measuring airborne CO_2 in 1958, it stood at 316 ppm.

- "Don't be fooled when the CO_2 level falls each year between May and October. That's when vegetation in the Northern Hemisphere absorbs carbon from the air. At summer's end, the carbon levels climb back up. For decades, the lowest CO_2 level of any given year has been higher than the year before. So in the long run......even when CO_2 is going down, it's going up.

- "The CO_2 level is now around 400 ppm [the number in mid-May 2020 exceeds 414 ppm]. The danger zone? 450 ppm, which we may hit by 2040. Beyond that, the warming Earth and its inhabitants will likely experience extreme weather events, increased sea-level rise, and their consequent ecological and economic impacts."

The methodology below gives more than most people want, but it demonstrates a rigor to the Clock. The progression of ever-increasing CO_2 levels reinforces the concerns about global warming and the need for remedial actions.

Methodology

What the Clock Shows

Fossil-fuel burning and deforestation are the main drivers of global warming. The CO_2 they give off makes up more than 75 percent of annual climate pollution. The Bloomberg Carbon Clock is a real-time estimate of the global monthly atmospheric CO_2 level.

The following methodology is a nontechnical explanation of how the carbon clock works. The full version, which includes all the math and science underpinning the project, can be found HERE.

The graphic draws on CO_2 data released from the NOAA Mauna Loa Observatory. The Scripps Institution of Oceanography pioneered CO_2 monitoring in March 1958 at the observatory in Hawaii. The National Oceanic and Atmospheric Administration started a parallel effort there in

May 1974. Today, NOAA maintains a global network of observatories, sampling towers, flights, and flasks to measure the composition of the atmosphere.

To estimate real-time atmospheric CO_2 levels between data releases, and forecast them, we analyze the three most recent years of data and use an average of the most recent four weekly data releases. That analysis is then fed into an algorithm. Each new weekly data point starts a new analysis that yields updated daily clock values and a trend line (shown in yellow on the graphic).

Two projections are made each week, a four-week daily forecast that runs the clock, and an annual forecast that projects the current trend one year into the future. The latter is appended to the graphic where the data end.

The Forecast

The carbon clock projections are the result of two mathematical procedures:

1. The "wavelet": This is an equation that "learns" the long-term trend line of CO_2 and adds on the seasonal peaks and troughs—the squiggles that pass above or below the trend line every half-year or so. It calculates the long-term trend from monthly data over the previous three years, which it uses to derive an initial rough daily forecast for one month into the future.

2. The Singular Spectrum Analysis (SSA) algorithm: This is a statistical tool that improves on the wavelet. It calculates the probable future trend of the data by running possible forecasts over and over until they start to converge. When they do, it quits, and outputs its best estimate for every day of the month. The final step is to use linear interpolation–basically an advanced mathematical method for connecting the dots—to turn the daily values into the second-by-second readings seen on the Clock. The clock displays eight decimal digits, determined by the model.

The shaded areas adjacent to the yellow trend line are “uncertainty bars,” which represent an average of the difference between the wavelet- and the SSA-determined trends. The year-ahead forecast on the graphic has shade bars that show where the projected path of CO_2 is likely to fall with 95 percent confidence.

About CO_2

The background atmospheric CO_2 concentration is uniform around the world. Daily, weekly, monthly, and annual averages all differ superficially because of short-term variation—basically, weather—that can mask the long-term upward trend. Because the Bloomberg Carbon Clock is projected from the average of the four most recent NOAA weekly estimates, it may be slightly lower or higher than shorter-term measures at any given moment.

The Scripps CO_2 program maintains a helpful graphic on its website that displays CO_2 data averaged over several time periods. The hourly, daily, and weekly averages each show decreasing levels of variability. The long-term trend becomes more focused monthly and annually.

SOURCES

CO_2 Data:

The Scripps CO_2 time-series is known as the Keeling Curve, after the scientist who initiated and maintained it for almost a half-century, Charles David Keeling.

The animated graphic below the Clock is a combination of several CO_2 time series. Moving from the top right, to the bottom left, the Curve is assembled from these sources:

The Year Ahead: The model projects forward one year, to give a visual estimate of the trajectory of CO_2. The annual forecast carries a 95% confidence band. The forecast trend is shown as an extension of the yellow historic trend; they are determined the same way, by the average of the difference between the wavelet and the SSA algorithm results.

May 1974 to the Present: Mauna Loa Observatory average CO_2 record, maintained by NOAA.

Weekly

Monthly

March 1958 to April 1974: Scripps Institution of Oceanography Mauna Loa averages.

Weekly

Monthly

Ice Core Record: Fossilized air trapped in Antarctic and Greenland ice has allowed scientists to estimate atmospheric CO_2 content going back 800,000 years. The highest value in this record is 298.6 ppm, seen about 330,000 years ago. These records are available online as the Antarctic Ice Core Revised Composite CO_2 Data.

Earth Images:

Satellite images of the Earth were made by the Japan Meteorological Agency weather satellite, Himawari-8. The imagery is processed at Colorado State University in cooperation with the

National Oceanic and Atmospheric Administration and the Japan Meteorological Agency. The images were assembled into video by Blacki Migliozzi, with advice from Dan Delany. The image archive can be found here.

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Credits

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