

# Global Warming and Cumulative CO2

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## Abstract

This publication analysis a correlation between the cumulative CO2 emissions and the global surface temperature change.

The change in global surface temperature was calculated as the difference in the two most recent 31 years neighboring periods, and the change in the cumulative CO2 emissions is the difference between the actual values in the centers of the periods.

This approach resulted in 0.000556°C/GtCO2 for the year 2000 and 0.000745°C/GtCO2 for the year 2021.

## Glossary

ACCO2 acceleration of change in cumulative CO2 emissions, tCO2/y<sup>2</sup> (ton CO<sub>2</sub> per year per year)

Ave average

CCO <sub>2</sub>	global cumulative CO <sub>2</sub> emissions according to publication [1] [2], CO <sub>2</sub> emissions produced from fossil fuels and cement production only – land use change is not included
CO <sub>2</sub>	emissions of Carbon Dioxide, CO <sub>2</sub>
CO <sub>2</sub> →GW	relation between global cumulative CO <sub>2</sub> emissions according to publication [1] [2], and change in global surface temperature as in Formula 1, °C/GtCO <sub>2</sub>
dCCO <sub>2</sub>	change in CCO <sub>2</sub> between the centers of two periods as in Formula 1, GtCO <sub>2</sub>
dGW	change in average GW between two most recent 31 years periods as in Formula 1, °C
GtCO <sub>2</sub>	Giga-ton of CO <sub>2</sub> , 10 <sup>9</sup> ton, 10 <sup>9</sup> ton, 1,000,000,000 ton of CO <sub>2</sub>
GWA	Global Warming Acceleration, annual change in the global warming rate, °C/y <sup>2</sup> [3]
GWR	Global Warming Rate – average change in global surface temperature per year in the trendline period, °C/y [3]
OWID	Our World in Data – Internet site [1] [2]
Ref	reference
tCO <sub>2</sub>	ton CO <sub>2</sub>
VCCO <sub>2</sub>	velocity of change in cumulative CO <sub>2</sub> emissions, tCO <sub>2</sub> /y
VCO <sub>2</sub> →GW	velocity of change in CO <sub>2</sub> →GW, °C/(GtCO <sub>2</sub> ,y)

## Cumulative CO2

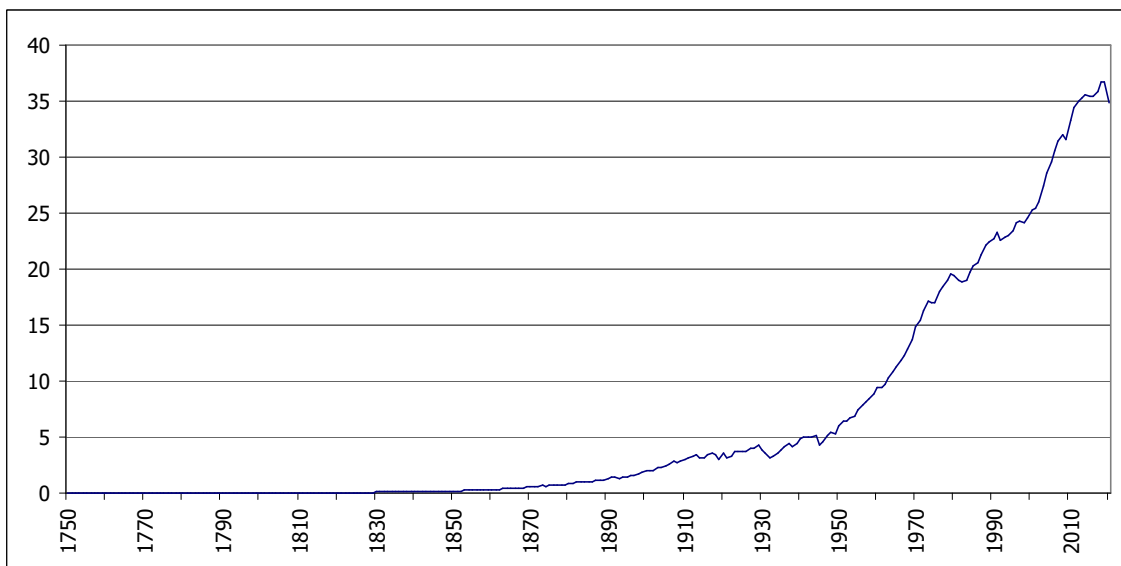
The annual changes in cumulative CO2 were calculated in the publication “*Global Warming: Velocity and Acceleration of Change in Cumulative CO2 Emissions*” [3] based on publications [1] [2].

Table 1 - Database of global cumulative CO2 emissions [1] [2]

Source of data	OWID
Reference	[1] [2]
Baseline year	1749
From year	1750
To year	2020
Period, years	271
CO2 from fossil fuels	Yes
CO2 from cement production	Yes
CO2 from other sources	No
Other GHG	No
Land use change	No
Units	ton CO2
Resolution	1 ton CO2/y

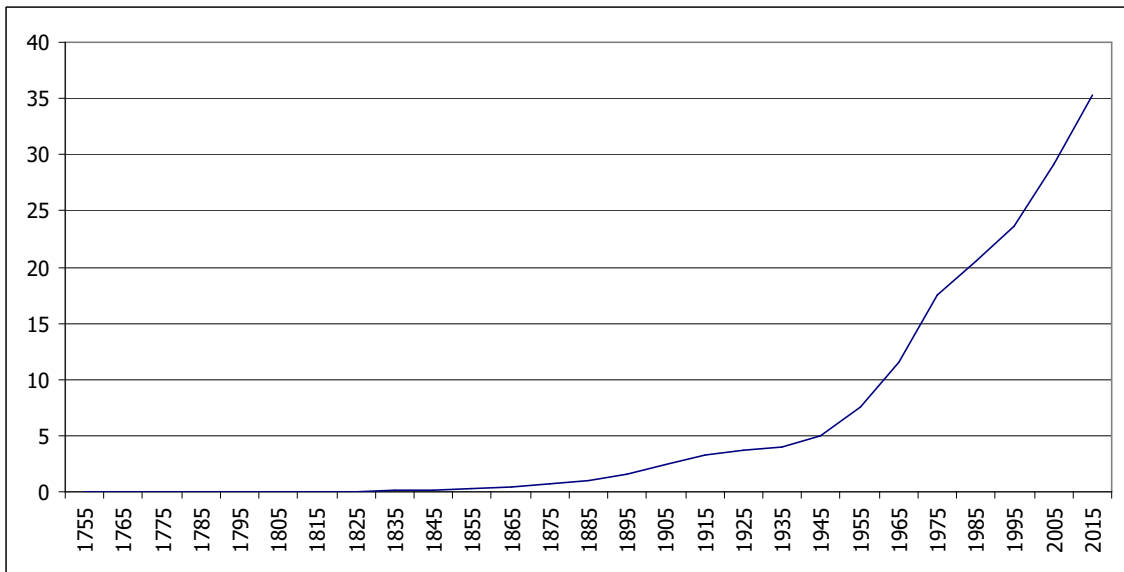
The database is from publication [1] [2], CO2 emissions produced from fossil fuels and cement production only – land use change is not included.

Chart 1 - Annual change in cumulative CO2 emissions [GtCO2/y] [3]



The change in 2019 was +36.70 GtCO2/y and in 2020 +34.81 GtCO2/y.

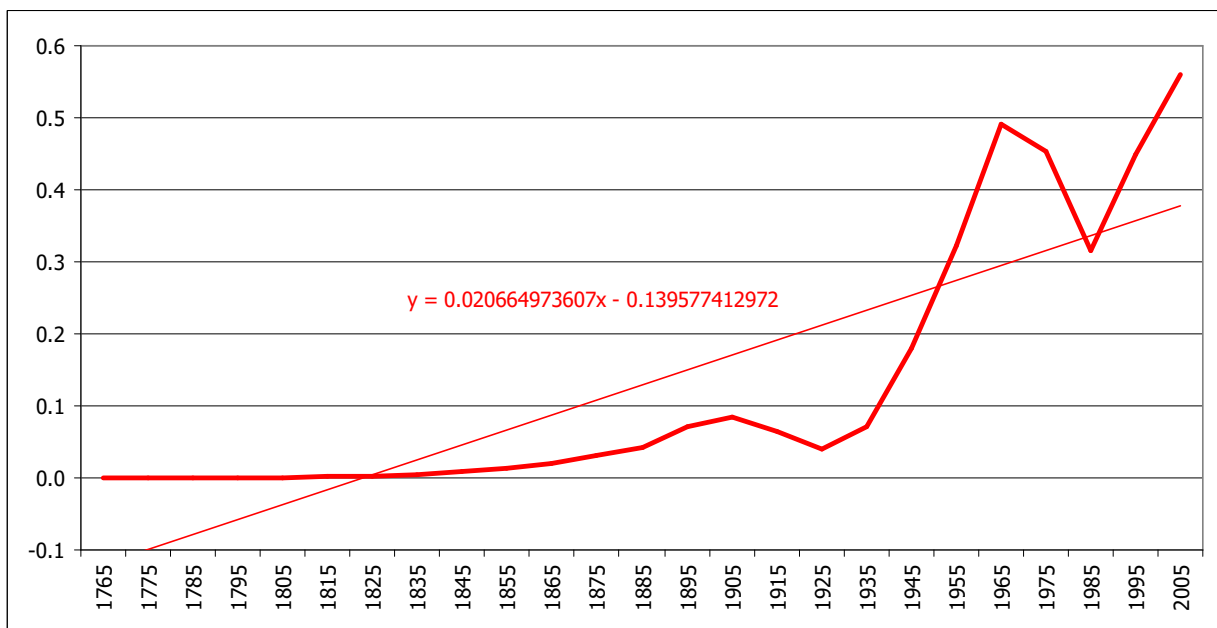
Chart 2 - Velocity of change in cumulative CO2 emissions, VCCO2  
[GtCO2/y] [3]



Axis x is the center of the 11 years period applied for the calculation

The average change in cumulative CO2 emissions in the period 1990-2020 is 0.559 GtCO2/y.

Chart 3 - Acceleration of change in cumulative CO2 emissions, ACCO2  
[GtCO2/y<sup>2</sup>], [Giga-ton CO<sub>2</sub> per year per year] [3]

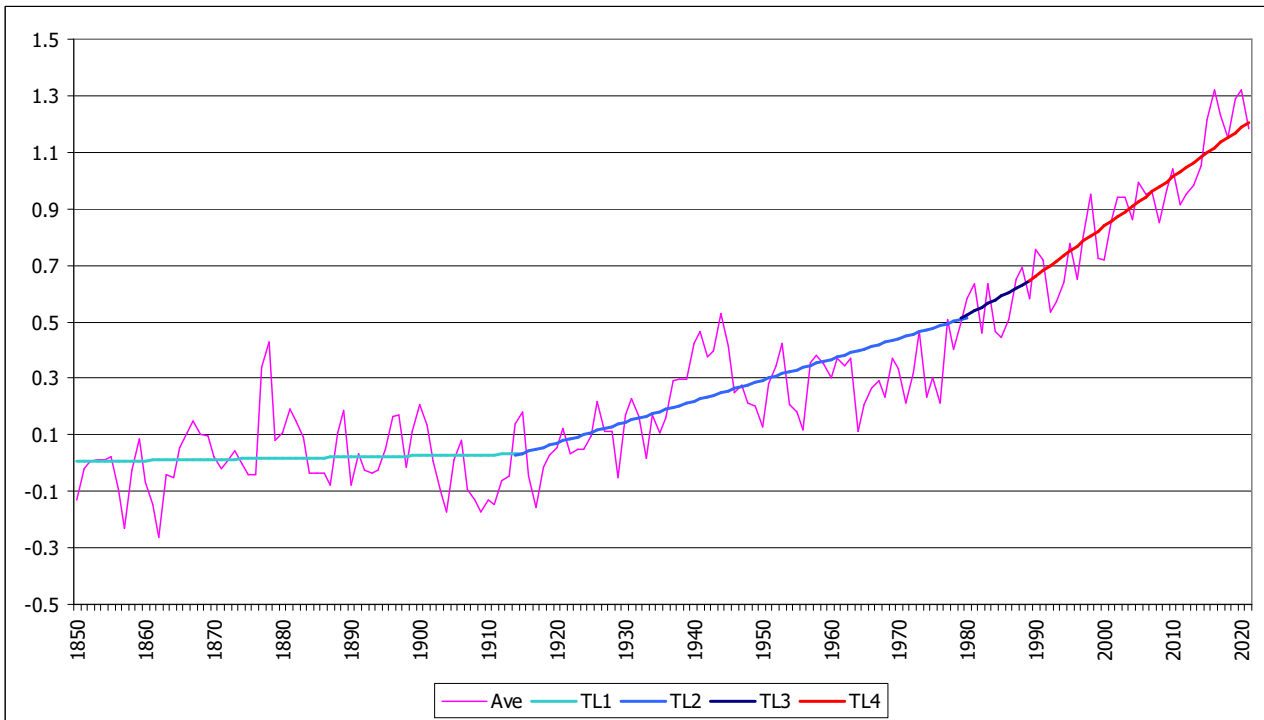


Axis x is the center of the trendline period (2005 is the center of the 1990-2020 trendline period)

## Global Surface Temperature Changes

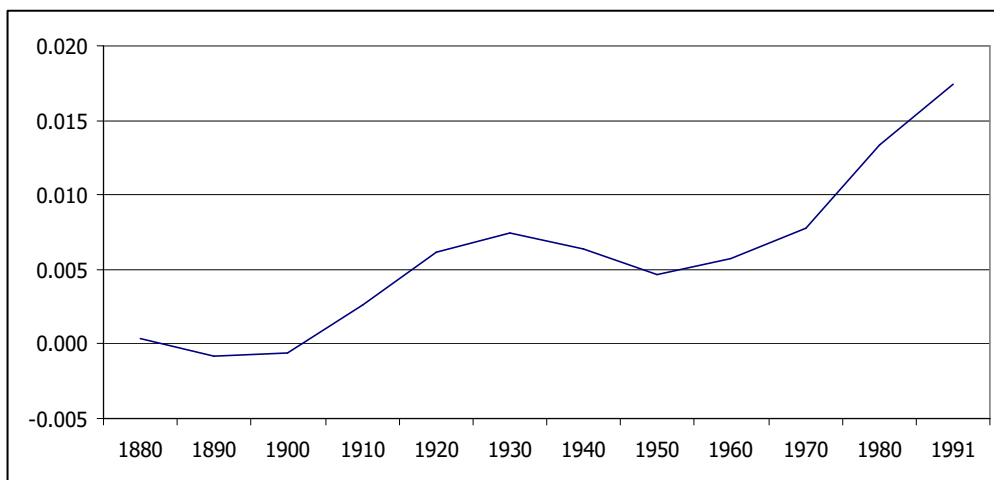
The dataset of global surface temperature changes for land and ocean converted to 1850-1900 baseline is publicly available in publication [9]. The dataset is based on NASA [4] [5], NOAA [6], and Berkley Earth [7] [8].

Chart 4 - Trendlines, land+ocean, 1850-1900 baseline [°C] [10]



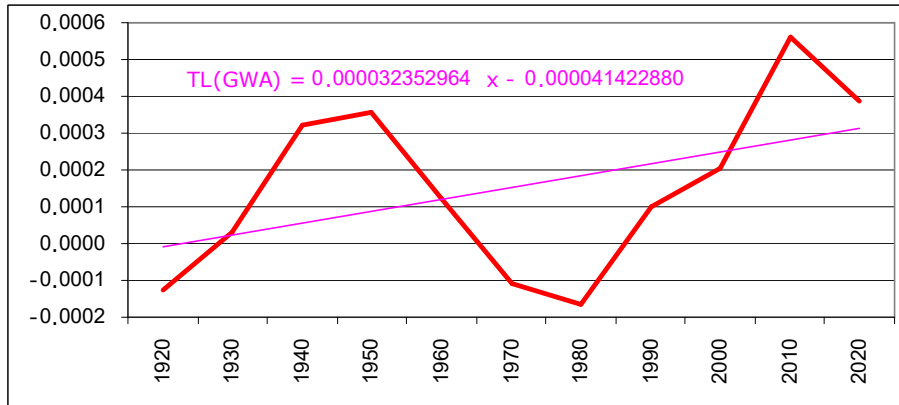
Ave average of all databases [°C]

Chart 5 - GWR – Global Warming Rate, land+ocean [°C/y] [10]



Axis x is the center of the 61 years trendline period

Chart 6 - GWA - Global Warming Acceleration, land+ocean [°C/y<sup>2</sup>]  
[10]



Axis x is the **end** of the 61 years trendline period

### Correlation between Cumulative CO2 Emissions and Global Temperature

Formula 1 - CO2 to global warming, CO2→GW, average GW in two 31 years periods, and CCO2 in the center of the periods

$$CO2 \rightarrow GW = dGW / dCCO2$$

CO2→GW relation between global cumulative CO2 emissions according to publication [1] [2], CCO2, and the change in global surface temperature, GW, °C/GtCO2

dGW change in average GW between two 31 years periods, °C

dCCO2 change in CCO2 between the centers of two periods, GtCO2

Two most recent 31 neighboring periods were selected in this work for the determination of CO2→GW: 1961-1991 and 1991-2021.

Table 2 - Application of Formula 1 for the year 2000

		1940-1970	1970-2000	Δ
Center	year	1955	1985	
Ave GW	°C	+0.307	+0.548	+0.241
CCO2	GtCO2	264.04	698.46	434.42
CO2→GW	°C/GtCO2			0.000556

Table 3 - Application of Formula 1 for the year 2021

		1961-1991	1991-2021	$\Delta$
Center	year	1976	2006	
Ave GW	$^{\circ}\text{C}$	+0.425	+0.938	+0.513
CCO2	GtCO2	524.92	1,212.72	687.80
CO2→GW	$^{\circ}\text{C}/\text{GtCO2}$			<b>0.000745</b>

$$\text{CO2} \rightarrow \text{GW} = 0.000745^{\circ}\text{C}/\text{GtCO2}$$

Table 4 - Velocity of change in CO2→GW, VCO2→GW [ $^{\circ}\text{C}/(\text{GtCO2},\text{y})$ ]

		1985	2006	$\Delta$
Center of Period	year	1985	2006	21
CO2→GW	$^{\circ}\text{C}/\text{GtCO2}$	0.000556	0.000745	+0.000190
VCO2→GW	$^{\circ}\text{C}/(\text{GtCO2},\text{y})$			<b>+0.000009</b>

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