

Cumulative CO2 Emissions of International Transport

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Abstract

The dataset of global cumulative CO2 emissions is from 1750. The baseline of this dataset is 1749.

The dataset includes also international transport cumulative CO2 emissions from 1950. The baseline of international transport is 1949.

This work considers the year 1783, when the first steamship was built, as the first year of the international transport CO2 emissions.

In this work, the global cumulative CO2 emissions including international transport are converted to the 1875 baseline, similar to the Global Warming baseline (1850-1900).

The international transport cumulative CO2 emissions caused a 0.032°C temperature increase in 2020, 2.5% of the Global Warming.

Keywords: Climate Change, Global Warming, Global Warming baseline, CO2 emissions, CO2 emissions baseline, international transport, international transport emissions

Glossary

Ave	average
BL	baseline
CCO2	global cumulative CO2 emissions according to publication [1] [2], CO2 emissions produced from fossil fuels and cement production only – land use change is not included, tCO2
CO2	emissions of Carbon Dioxide, CO2
CO2→GW	correlation between cumulative CO2 emissions and global warming = 0.000745°C/GtCO2 [3]
GtCO2	Giga-ton of CO2, 10 ⁹ ton, 10 ⁹ ton, 1,000,000,000 ton CO2
MtCO2	Mega-ton CO2, 10 ⁶ ton, 10 ⁶ ton, 1,000,000 ton CO2
OWID	Our World in Data – Internet site [1] [2]
Ref	reference
tCO2	ton CO2

Formula for Average Annual Change

Formula 1 - Average annual change of parameter X in period 1990-2020 [%/year]

$$rX = (X2/X1)^{1/(y2-y1)} - 1$$

rX	average annual change of parameter X in period from y1 to y2, %/year
X1	value of parameter X at the beginning of the period
X2	value of parameter X at the end of the period
y1	beginning of the period = 1990
y2	end of the period = 2020

Correlation between Cumulative CO2 Emissions and Global Warming

The correlation between cumulative CO2 emissions and Global Warming was analyzed in the publication “*Global Warming and Cumulative CO2*” [3].

The correlation is:

Formula 2 - Correlation between Cumulative CO2 Emissions and Global Warming
[3] [$^{\circ}\text{C}/\text{GtCO}_2$]

$$\text{CO}_2 \rightarrow \text{GW} = 0.000745^{\circ}\text{C}/\text{GtCO}_2$$

Dataset

Table 1 - Dataset [1] [2]

	World	International Transport
Source of data	OWID	OWID
Reference	[1] [2]	[1] [2]
From year	1750	1950
To year	2020	2020
CO2 from fossil fuels	Yes	Yes
CO2 from cement production	Yes	
CO2 from other sources	No	
Other GHG	No	No
Land use change	No	
Units	tCO2/y	tCO2/y
Resolution	1 tCO2/y	1 tCO2/y
Cumulative CO2 emissions baseline	1749	1949

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

Dataset Baselines

Total global CO2 emissions per year are from 1750 [1] [2]. This is also the first year of calculations of the cumulative CO2 emissions of the world, which means that for this parameter the baseline is 1749.

However, international transport CO2 emissions are from 1950 and the first year of the cumulative CO2 emissions is 1950 [1] [2], which means that for this parameter the baseline is 1949.

International Transport Data

According to the publication [1] [2] the CO2 emissions of international transport in 1950 were 128,393,888 tCO₂/y and the cumulative CO2 emissions in 1950 are also 128,393,888 tCO₂. This indicates that the baseline for cumulative CO2 emissions of international transport in publication [1] [2] is 1949.

The annual average change in CO2 emissions of international transport in the period 1950-2020 is 2.98%/y.

Table 2 - CO2 emissions of international transport 1950-2020 [tCO₂/y]

CO2 emissions 1950	tCO ₂ /y	128,393,888
CO2 emissions 2020	tCO ₂ /y	1,004,232,513
annual average change	%/y	2.9820%

This work considers the year of construction of the first steamship as the first year of international transport CO2 emissions. The first steamship was built in 1783 [wikipedia.org/wiki/Steamboat].

This allows calculations of the annual average change in international transport CO2 emission for the period 1783-1950 considering 128,393,888 tCO₂/y in 1950 and a rough estimation of 100 tCO₂/y in 1783.

Application of Formula 1 results in an 8.8%/y annual average change in international transport CO2 emission for the period 1783-1950, compared to 3.0%/y in the period 1950-2020.

Table 3 - Extrapolation of CO2 emissions data for international transport 1950-1783 [tCO2/y]

Start year	1783	
End year	1950	
years	167	
International transport CO2 emissions 1783	100	tCO2/y
International transport CO2 emissions 1950	128,393,888	tCO2/y
annual average change	8.7873%	%/y

This approach adds 1,458,263,621 tCO2 to the cumulative CO2 emissions above the 1949 baseline [6].

Cumulative CO2 Emissions Baselines

Table 4 - Global cumulative CO2 emissions baselines, including international transport [tCO2]

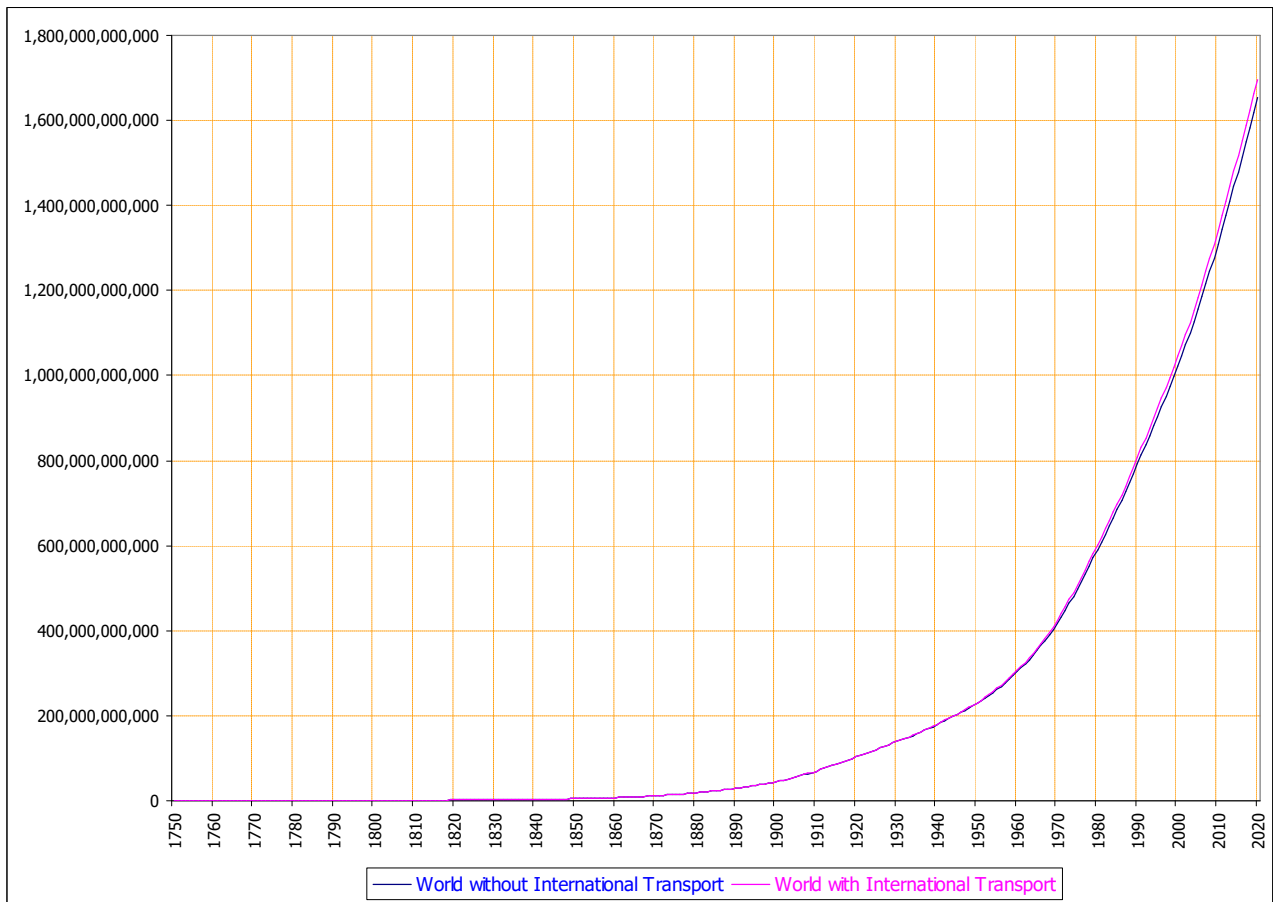
year	CCO2 BL=1749 tCO2	CCO2 BL=1849 tCO2	CCO2 BL=1875 tCO2	CCO2 BL=1990 tCO2
1749	0			
1750	9,350,528			
1849	4,562,519,056	0		
1875	14,915,579,842	10,353,060,786	0	
1990	807,604,637,285	803,042,118,229	792,689,057,443	0
2020	1,696,524,177,053	1,691,961,657,997	1,681,608,597,211	888,919,539,768

Table 5 - Global cumulative CO2 emissions baselines, without international transport [tCO2]

year	CCO2 BL=1749 tCO2	CCO2 BL=1849 tCO2	CCO2 BL=1875 tCO2	CCO2 BL=1990 tCO2
1749	0			
1750	9,350,528			
1849	4,562,198,917	0		
1875	14,912,710,795	10,350,511,878	0	
1990	791,558,963,255	786,996,764,337	776,646,252,459	0
2020	1,652,820,504,061	1,648,258,305,143	1,637,907,793,265	861,261,540,806

Cumulative CO2 Emissions Above 1749 Baseline

Chart 1 - World cumulative CO2 emissions above 1749 baseline [tCO2]



Cumulative CO2 Emissions Above 1875 Baseline

The publication “*Global Warming Datasets Converted to 1850-1900 Baseline*” [4] considers the 1850-1900 baseline as the most appropriate for calculations of the Global Warming.

Accordingly, the cumulative CO2 emissions should be also above a similar baseline.

The “similar” baseline to the 1850-1900 period is the year 1875. The cumulative CO2 emissions data will be converted in this work to the 1875 baseline.

Table 6 - Cumulative CO2 emissions above 1875 baseline [6]

	1990 BL=1875 tCO2	2020 BL=1875 tCO2
World without international transport	776,646,252,459	1,637,907,793,265
International transport	16,042,804,984	43,700,803,946
World with international transport	792,689,057,443	1,681,608,597,211
International transport to world	2.1%	2.7%
annual average change of international transport to world ratio		0.86%

The dataset of cumulative global CO2 emissions above 1875 baseline including international transport can be found in [6].

Global Cumulative CO2 Emissions and Global Warming

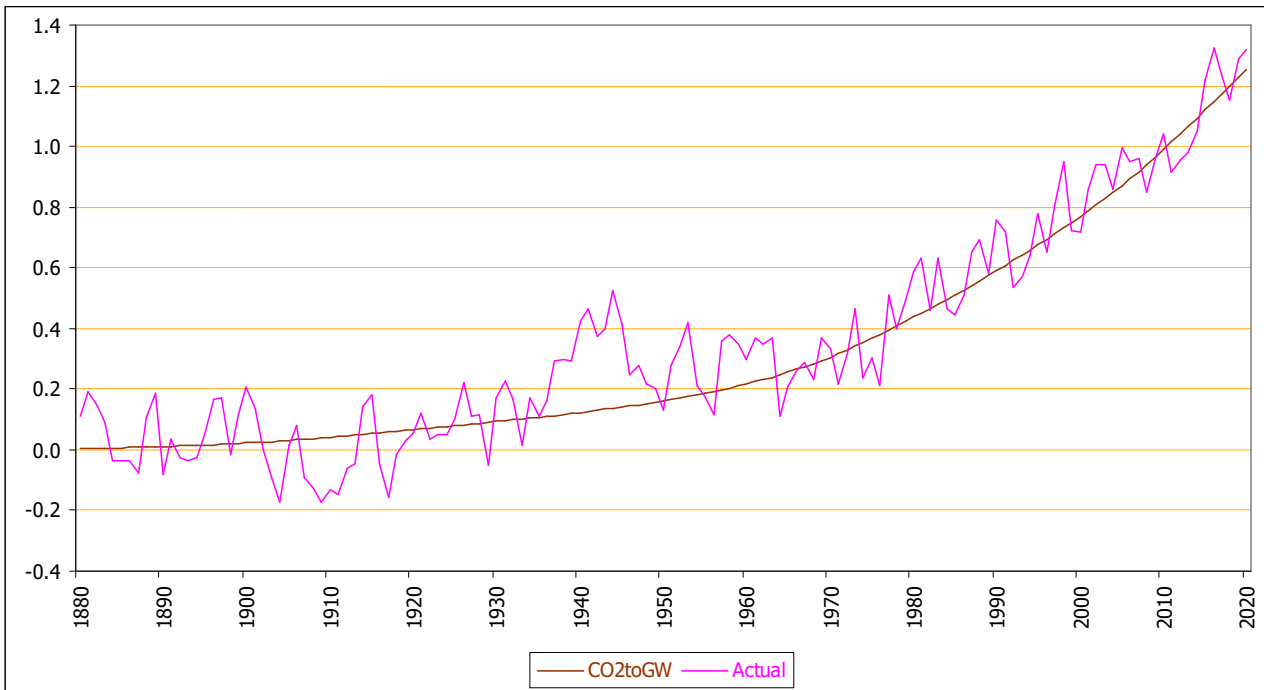
Bringing global cumulative CO2 emissions and Global Warming data to the same baseline (1850-1900/1875) allows direct calculations of global surface temperature change (Global Warming) using Formula 2.

The Global Warming dataset above the 1850-1900 baseline can be found in publication [5].

Table 7 - Global cumulative CO2 emissions and Global Warming above 1850-1900/1875 baseline

		1990	2020
Cumulative CO2 emissions without international transport	tCO2	776,646,252,459	1,637,907,793,265
CO2→GW [3]	°C/GtCO2	0.000745443	0.000745443
Cumulative CO2 emissions without international transport	°C	0.579	1.221
International transport	tCO2	16,042,804,984	43,700,803,946
International transport	°C	0.012	0.033
International transport to world		1.6%	2.5%
Cumulative CO2 emissions including international transport	tCO2	792,689,057,443	1,681,608,597,211
Cumulative CO2 emissions including international transport	°C	0.591	1.254
Actual Global Warming	°C	0.757	1.319
Δ	°C	0.166	0.066

Chart 2 - Global cumulative CO2 emissions converted to Global Warming, and actual Global Warming above 1850-1900/1875 baseline [°C]



Forecast 2020-2100

The annual average change in international transport CO2 emissions in the period 1990-2020 is 1.979%/y.

The forecast for the 2020-2100 period is based on the same annual average change, 1.979%/y.

Table 8 - Forecast of CO2 emissions 2020-2100

CO2 emissions 1950	MtCO2/y	128
CO2 emissions 1990	MtCO2/y	558
annual average change 1950-1990	%/y	3.741%
CO2 emissions 2020	MtCO2/y	1,004
annual average change 1990-2020	%/y	1.979%
annual average change 2020-2100	%/y	1.979%
CO2 emissions in 2100 forecast	MtCO2/y	4,815
cumulative CO2 emissions 2020 BL=1875	MtCO2	43,701
cumulative CO2 emissions 2100 BL=1875	MtCO2	240,088

Changes in this Version

Added 2020-2100 forecast based on annual average changes 1990-2020.

References

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