Global Warming Datasets Converted to 1850-1900 Baseline

Joseph Nowarski, M.Sc., ME – Energy Conservation Expert
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Abstract

This publication includes global warming databases converted to the uniform baseline. The publication includes NASA, NOAA and Berkeley Earth databases of global surface temperature changes in the period 1850-2021 for land+ocean, 1750-2021 for land only and 1880-2021 for ocean only. The databases are converted to the 1850-1900 baseline showing minor differences between them. 61 years linear trendlines indicate constant increase of global warming reaching in 2021 0.017 °C/y for land+ocean, 0.026 °C/y for land only, and 0.012 °C/y for ocean only.

Glossary

Ave	average
BL	baseline
CF	conversion factor between baselines or reference periods
DB	dataset, database
LBL	Berkeley Earth, Lawrence Berkeley Laboratory
Ref	reference
TL	trendline

Units

The temperature change unit is °C.
Global warming rate, global warming per year is in °C/y.

Global Warming Databases

There are few databases of annual averages of global surface temperature changes.
Each database applies its own baseline.

This work includes the following databases:

- NASA (1) (2)
- NOAA (3)
- Berkeley Earth (LBL) (4) (5) (6) (11)

Global Warming Baselines

The EU aims to be climate-neutral by 2050 – an economy with net-zero greenhouse gas emissions (7).
The EU policy is "*in line with the Paris Agreement to keep the global temperature increase to well below 2°C and pursue efforts to keep it to 1.5°C*" (7).
The EU determines the "global temperature increase" according to the IPCC baseline 1850-1900 (8).
IPCC Report 2011 (8) page 5 note 9: "*The period 1850–1900 represents the earliest period of sufficiently globally complete observations to estimate global surface temperature and, consistent with AR5 and SR1.5, is used as an approximation for pre-industrial conditions*".

However, all main databases apply other baselines than IPCC and EU. NASA (1) (2) and Berkeley Earth (4) (5) (6) apply the 1951-1980 baseline, and NOAA(3) applies the 20th century baseline, 1901-2000.
The NASA and NOA databases are from 1880 and not 1850.
It takes a lot of effort to find conversion factors between the IPCC 1850-1900 baseline and the main exiting databases, which have different baselines. The example of such efforts may be a long blog on site Climate Lab Book - Defining 'pre-industrial' (10), concluded with the following statement of Mark Bassham: "*IPCC AR5 (WG1 report), Figure 12.40 (page 1100) indicates a difference between 'pre-industrial' temperatures and the 1980-1999 Reference Period (non-standard, only 20 years long instead of the usual 30) of EXACTLY 0.5°C. Note that 'pre-industrial' means different things to different IPCC Chapter Lead Authors".*

Conversion to 1850-1900 Baseline

All data in this work are above the 1850-1900 baseline.
The publication "Global Warming Baselines Conversion Factors" (12) includes the conversion factors to 1850-1900 baseline applying all 3 above baselines (1) (2) (3) (4) (5) (6) (11) and other reference periods.

Table 1 - Conversion factors to 1850-1900 baseline (12) (°C)

from BL:	Land+Ocean	Land	Ocean
1850-1900	+0.00	+0.00	+0.00
1901-2000	+0.28	+0.49	+0.23
1951-1980	+0.31	+0.49	+0.29

Publically available Excel file (13) includes all datasets applied in this work converted to 1850-1900 baseline using the above conversion factors.

Linear Trendline Formula

Formula 1 - Linear trendline

$$T(y) = (y-n) * a + b$$

T(y)	global surface temperature above 1850-1900 baseline in year y (°C)
n	the year before the trendline start point, i.e., for trendline in period 1961-2022 n=1960
a, b	parameters related to the linear function displayed on Excel trendline chart and detailed for each dataset

Period Applied for Calculations of Trendlines

The period applied in this work for calculations of trendlines is 61 years. The display period of the trendlines is usually different and depends on the crossing point between the trendlines.

Global Surface Temperature Changes over Land and Ocean

Table 2 - Global warming databases, land+ocean

	NASA	NOAA	LBL
Reference	[1] [2]	[3]	[4] [5]
Units	°C	°C	°C
From	1880	1880	1850
To	2021	2020	2021
Years	142	141	172
Baseline (BL)	1951-1980	1901-2000	1951-1980
BL years	30	100	30
Decimal places	2	2	3
Ave in BL	+0.0003	+0.0004	+0.0171

Chart 1 - Global surface temperature changes above 1850-1900 baseline, land+ocean (°C)

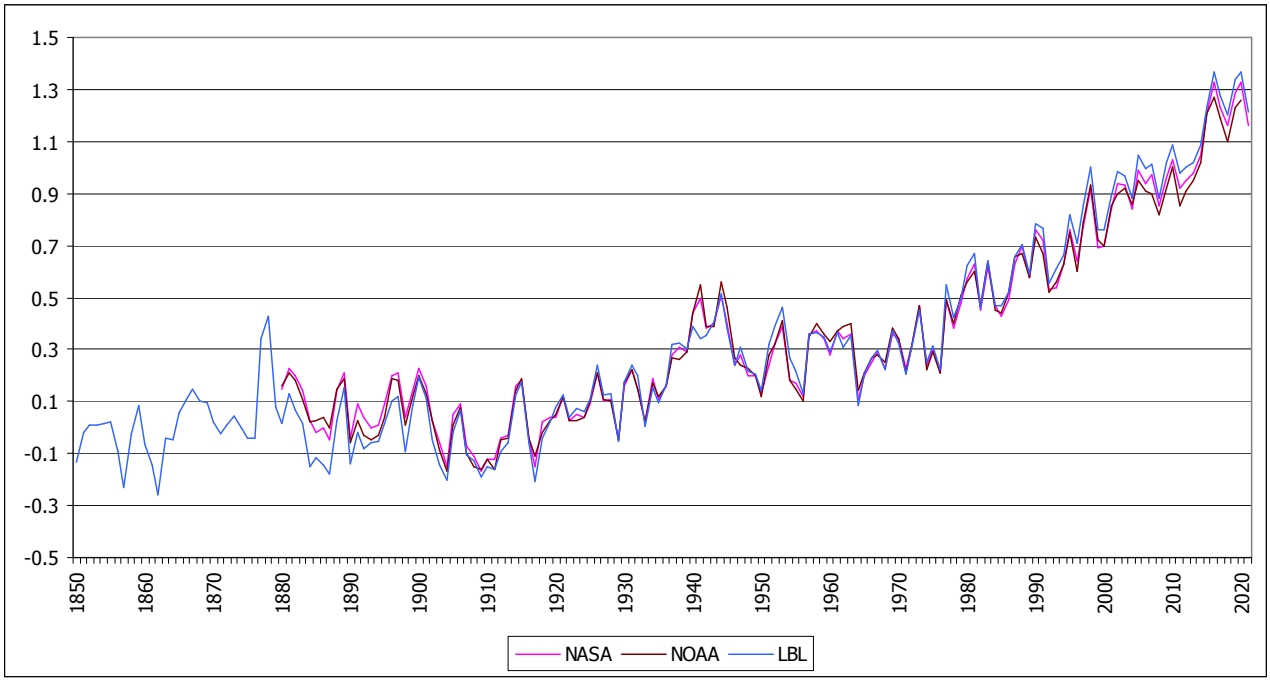


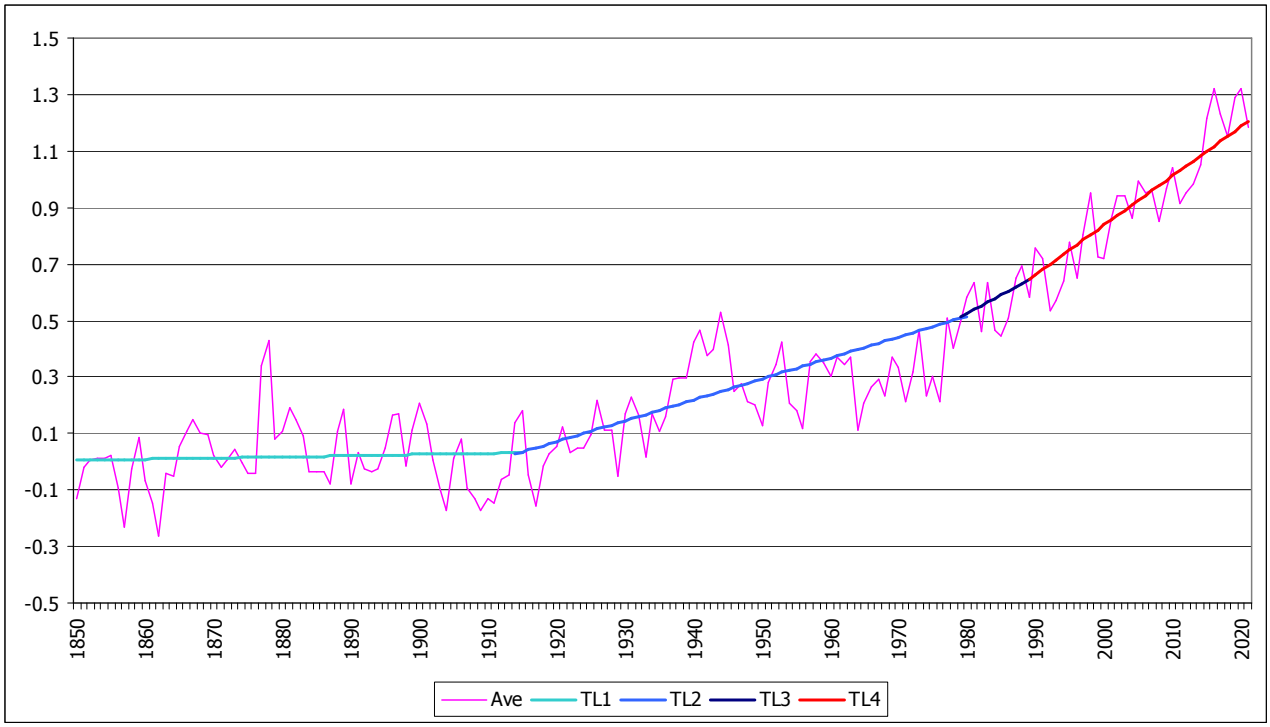
Table 3 - Trendlines, land+ocean, 1850-1900 baseline, (°C)

Trendline #	Trendline period for calculations from	To	years	Display from	to	years	Trendline formula n	a	b
TL1	1850	1910	61	1850	1915	66	1849	0.000416975145	0.004319672131
TL2	1900	1960	61	1914	1980	67	1899	0.007406046184	-0.084614754098
TL3	1950	2010	61	1979	1989	11	1949	0.013361977790	0.109975409836
TL4	1961	2021	61	1989	2021	33	1960	0.017436347611	0.140372131148

The parameter "a" is the average global warming per year in the trendline period, °C/y. For the last trendline 1961-2021 the global warming per year was 0.017 °C/y, 0.004 °C/y more than in the 1950-2010 trendline, 11 years before.

More about changes of global warming per year parameter can be found in the publication "Acceleration of Global Warming" (14).

Chart 2 - Trendlines, land+ocean, 1850-1900 baseline (°C)



Ave average of all databases (°C)

Global Surface Temperature Changes over Land

This work includes two databases of global surface temperature changes over land:

- NASA (1) (2)
- Berkeley Earth (LBL) (6)

Table 4 - Global warming databases, land only

	NASA	LBL
Reference	[1] [2]	[6]
Units	°C	°C
Records	annual	monthly
from	1880	1750
to	2021	2021
years	142	272
Baseline (BL)	1951-1980	1951-1980
BL years	30	30
Decimal places	2	3
Ave in BL	+0.0010	+0.0010

Chart 3 - Global surface temperature changes above 1850-1900 baseline, land only (°C)

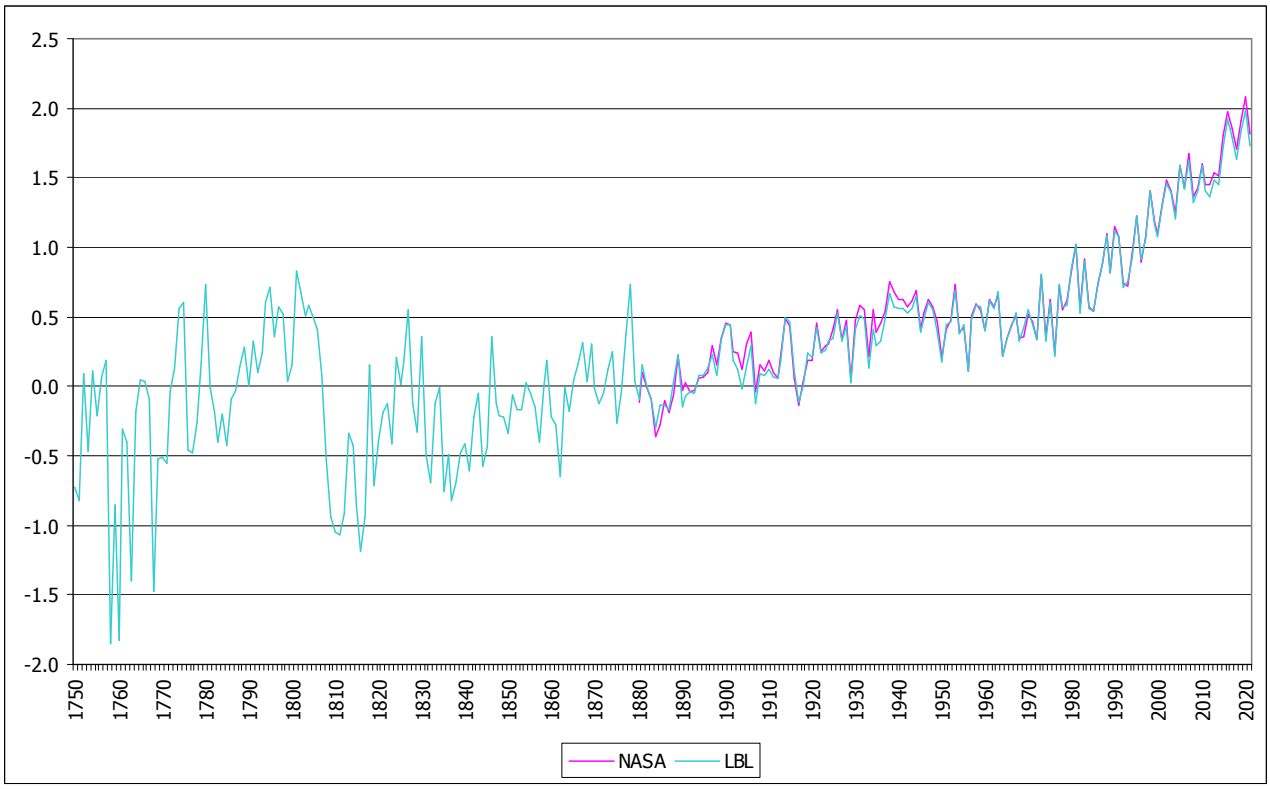
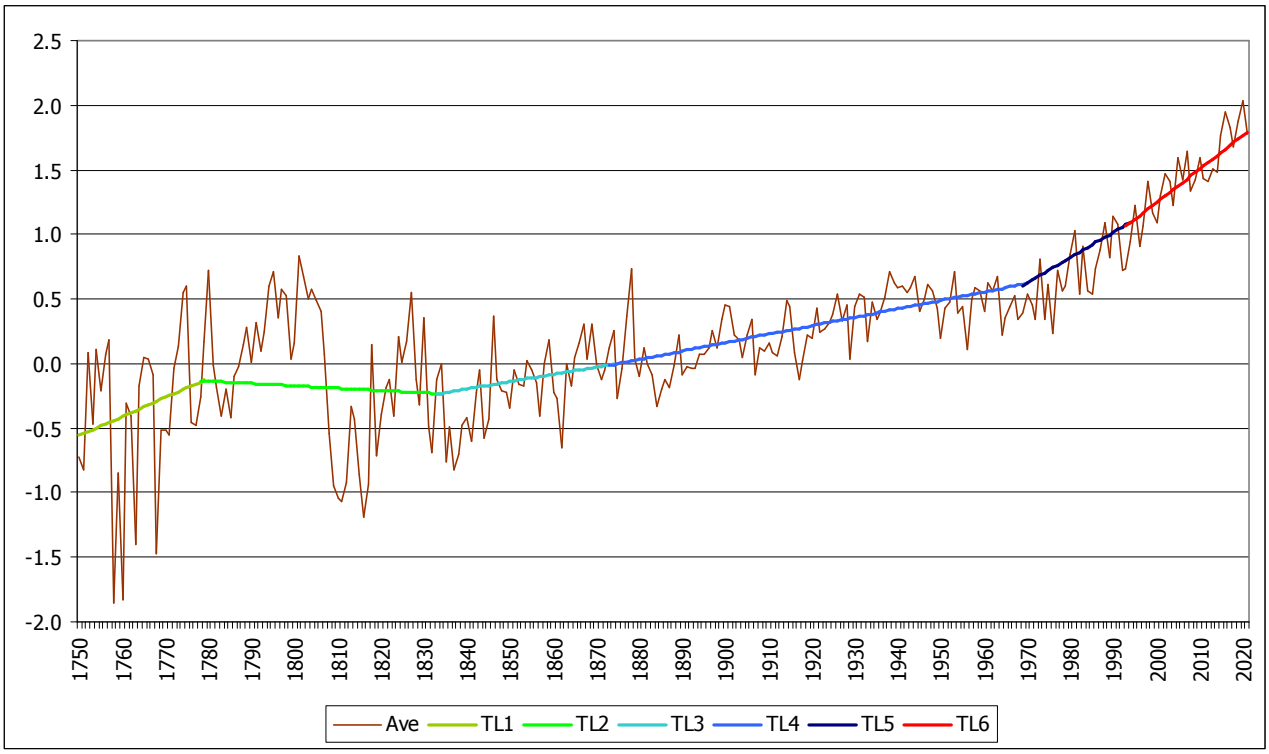


Table 5 - Trendlines, land only, 1850-1900 baseline (°C)

Trendline	Trendline period for calculations			Display			Trendline formula		
#	from	to	years	from	to	years	n	a	B
TL1	1750	1810	61	1750	1779	30	1749	0.014804048283	-0.572888984103
TL2	1800	1860	61	1778	1834	57	1799	-0.001781614666	-0.170401092896
TL3	1850	1910	61	1833	1874	42	1849	0.005582830954	-0.145000819672
TL4	1900	1960	61	1873	1970	98	1899	0.006540525295	0.155676092896
TL5	1950	2010	61	1969	1994	26	1949	0.019617995329	0.177271789617
TL6	1961	2021	61	1993	2021	29	1960	0.025827694782	0.213182991803

Chart 4 - Trendlines, land only, 1850-1900 baseline (°C)



For the last trendline 1961-2021, the global warming per year for land only was 0.026 °C/y, 0.006 °C/y more than in the 1950-2010 trendline, 11 years before.

Global Surface Temperature Changes over the Ocean

Table 6 - Global warming databases, ocean only

	NASA
Reference	[1] [2]
Units	°C
Records	annual
from	1880
to	2021
years	142
Baseline (BL)	1951-1980
BL years	30
Decimal places	2
Ave in BL	+0.0007

Chart 5 - Global surface temperature changes above 1850-1900 baseline, ocean only (°C)

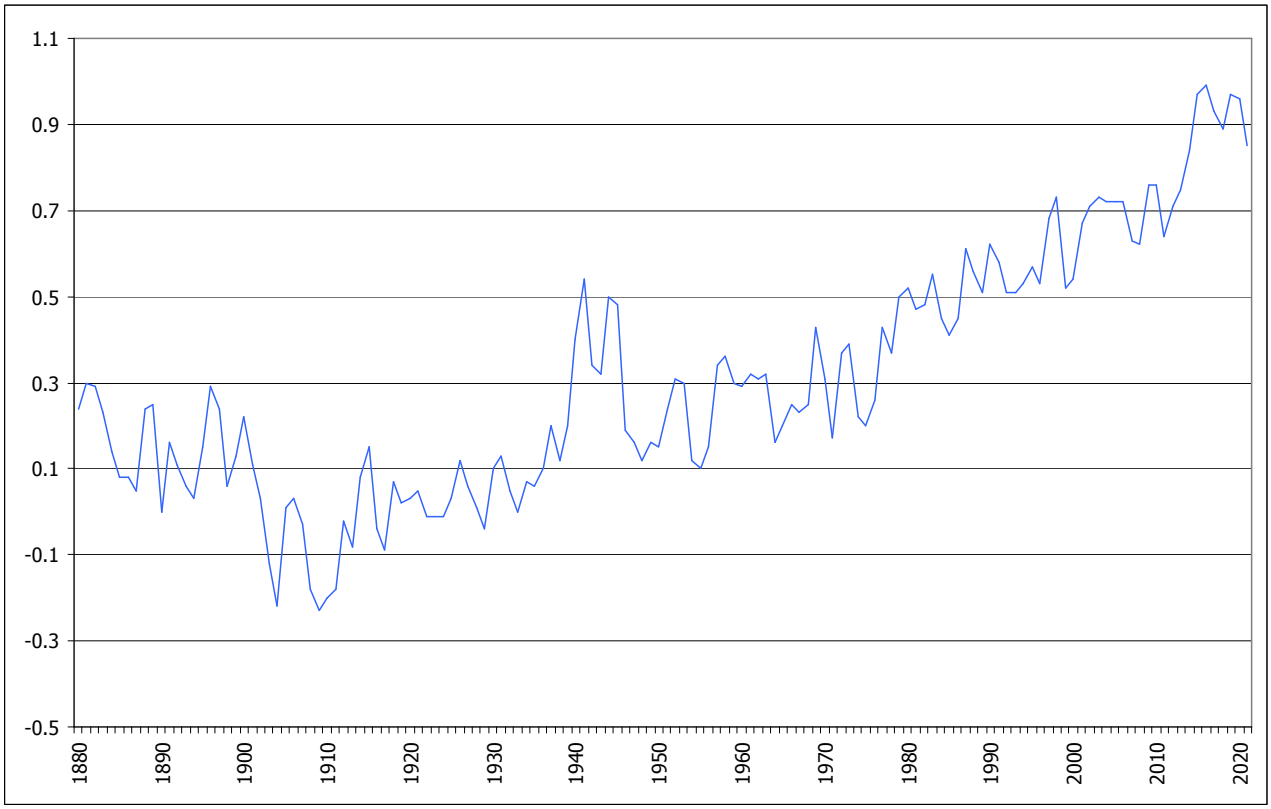
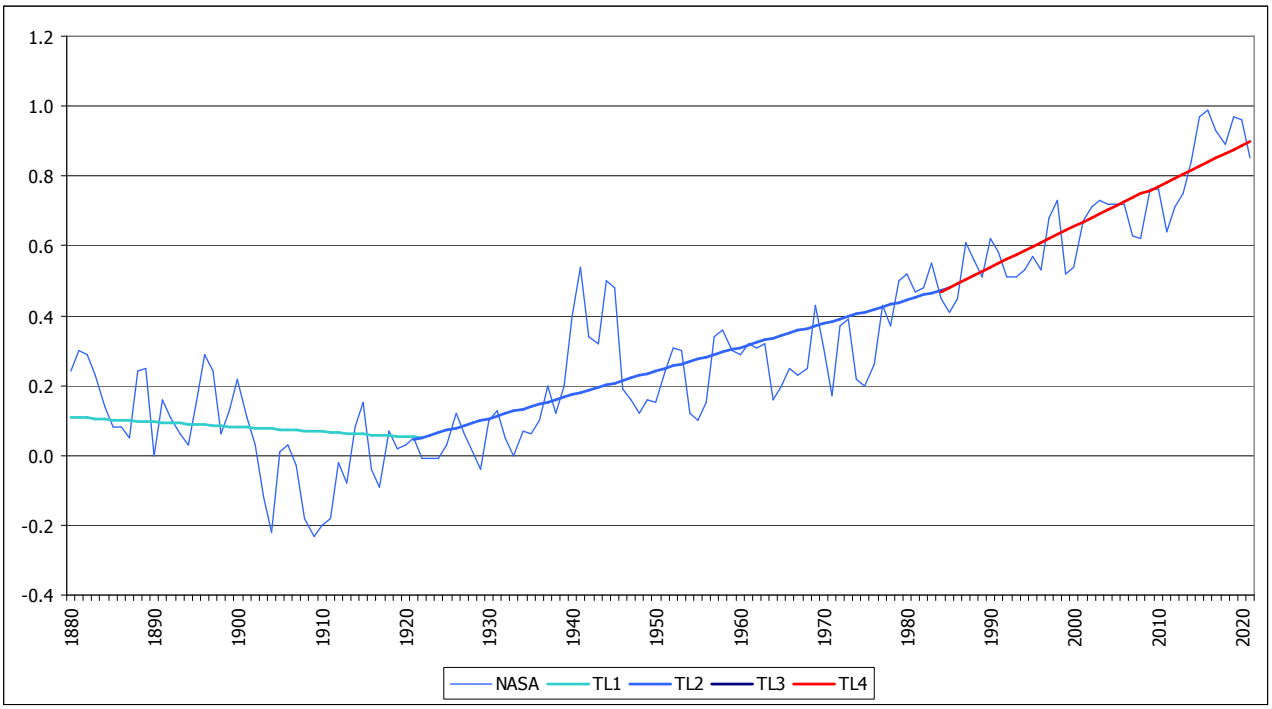


Table 7 - Trendlines, ocean only, 1850-1900 baseline (°C)

Trendline	Trendline period for calculations			Display			Trendline formula		
#	from	to	years	from	to	years	n	a	b
TL1	1880	1940	61	1880	1922	43	1879	-0.001396615547	0.110836065574
TL2	1900	1960	61	1921	1985	65	1899	0.006790058170	-0.104590163934
TL3	1950	2010	61	N/A	N/A	0	1949	0.009488630354	0.143885245902
TL4	1961	2021	61	1984	2021	38	1960	0.011652035960	0.188950819672

In the case of ocean only, the trendline TL3 1950-2010 could not be applied to the chart along with TL4 1961-2021, due to too small differences. However, the TL3 "a" parameter can be compared to the TL4, indicating a change in the global warming per year parameter.

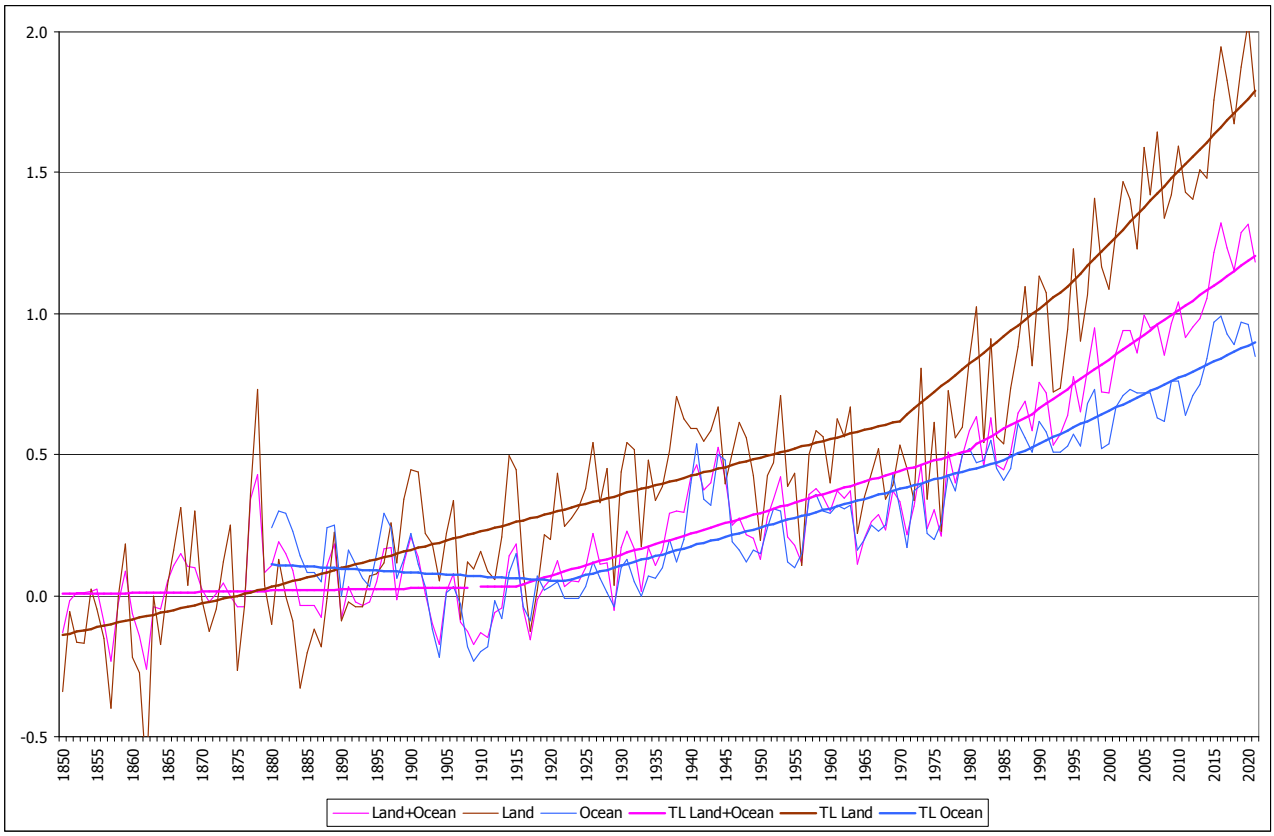
Chart 6 - Trendlines, ocean only, 1850-1900 baseline (°C)



For the last trendline 1961-2021 the global warming per year was 0.012 °C/y, 0.003 °C/y more than in the 1950-2010 trendline, 11 years before.

All Trendlines

Chart 7 - Trendlines 1850-1900 baseline (°C)



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