Global Average Temperature Data
Compilation of Sources at August 2019

Rick Bradford, 1st September 2019

There are three different sources of global temperature information,

- Satellites
- Weather balloons
- Ground based direct temperature measurements

Satellites do not measure temperature directly. They measure radiances in various wavelength bands, from which temperature may be inferred. One advantage of satellite measurements is that they can provide data over a wide range of altitudes, from the low atmosphere (low troposphere) to the low stratosphere. However, satellite data requires heavy processing and the application of corrections to convert to temperatures. Different workers can thus derive different temperatures starting with the same satellite data. Here I include datasets from UAH (University of Alabama in Huntsville) and RSS (Remote Sensing Systems, a private research company based in Santa Rosa, California). The satellites in question are variously referred to as the NOAA satellites or as NASA satellites. Launched by NASA these satellites are financed and operated by the National Oceanic and Atmospheric Administration (NOAA).

Weather balloons carry equipment to measure atmospheric temperatures, as well as pressures and humidity, and do so at a range of altitudes. They transmit the data to a ground station using a device mounted below the balloon called a "radiosonde" (hence balloon data is often referred to in the literature as "radiosonde data"). Here I quote data from RATPAC (Radiosonde Atmospheric Temperature Products for Assessing Climate) which is a project run by NOAA-NCEI (see below).

Ground based temperatures are obtained from a very large number of land-based stations plus ocean-based measurements from buoys and ships. Global temperatures are obtained by "suitable averaging" over both sources, a phrase which covers a multitude of complexities. Three sources using ground measurements quoted here are NASA-GISS (Goddard Institute for Space Studies), NOAA-NCEI (National Centres for Environmental Information) and the Hadley Centre, part of the UK's Meteorological Office.

Note that all these data sources are from the USA except for Hadley, which is UK.

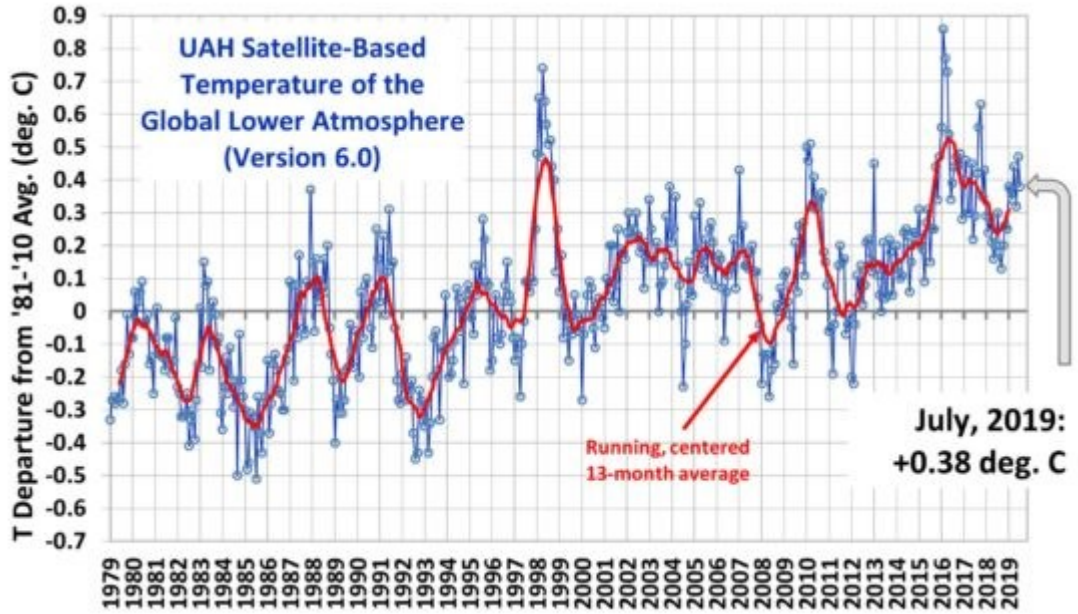
All these sources show upward trends over the last 40 to 60 years.

Table 1: Summary of Trends

Source	Trend (ºC/decade)	Year from which this trend was measured	From
UAH	0.145	1979	satellite
Hadley Centre	0.166	1977	ground
RATPAC	0.179	1960	balloons
NOAA NCEI	0.184	1970	ground
RSS	0.204	1980	satellite
GISS	0.204	1967	ground

Graphs of global averaged temperatures from these sources follow. Note in particular that, where given, temperatures in 1850 to 1880 were ***higher*** than those in 1900 to 1920. Note also that different sources use different zero datums for the temperature 'anomaly'.

UAH Dataset: NOAA Satellite Data as Analysed by Roy Spencer and John Christy (from http://www.drroyspencer.com/latest-global-temperatures/ downloaded 30/8/19).



Trend from -0.2ºC in 1979 to 0.38ºC in 2019 and hence a trend of 0.58/40 ºC per year or 0.145 ºC per decade.

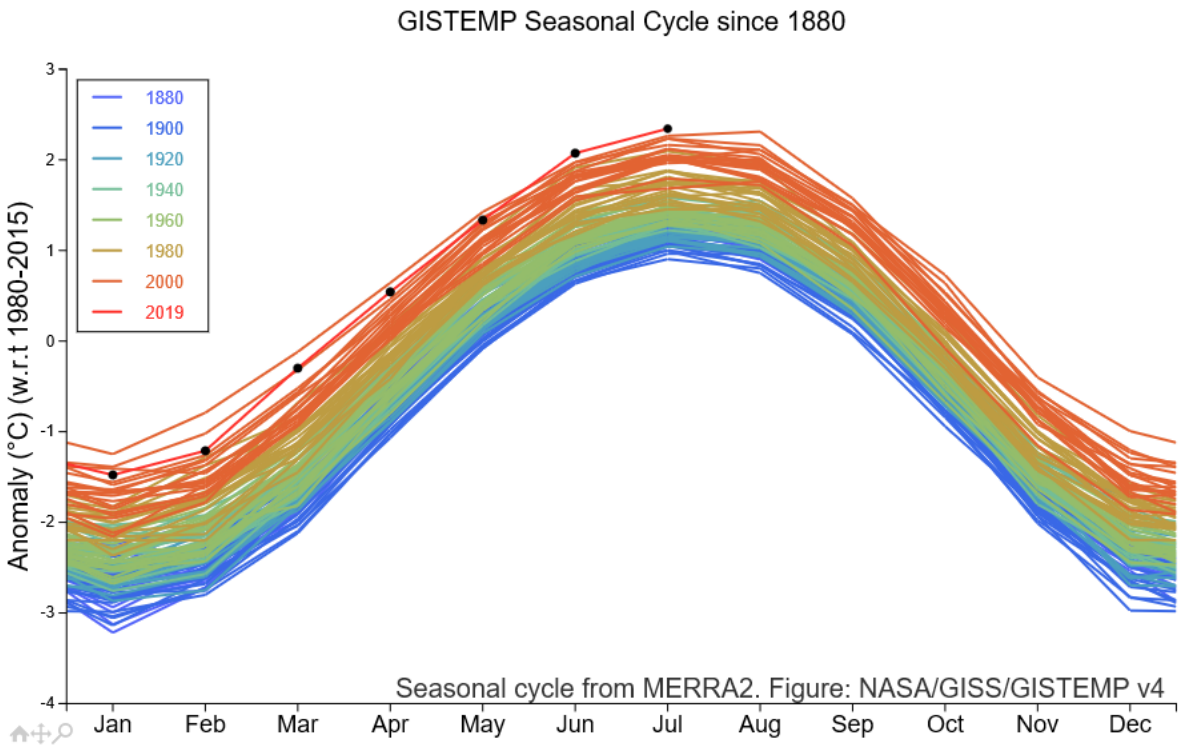
The table below summarizes the adjustments that have been applied to the UAH TLT dataset. The 'trend correction' refers to the change in global mean decadal temperature trend in degrees Celsius/decade as a result of the correction.

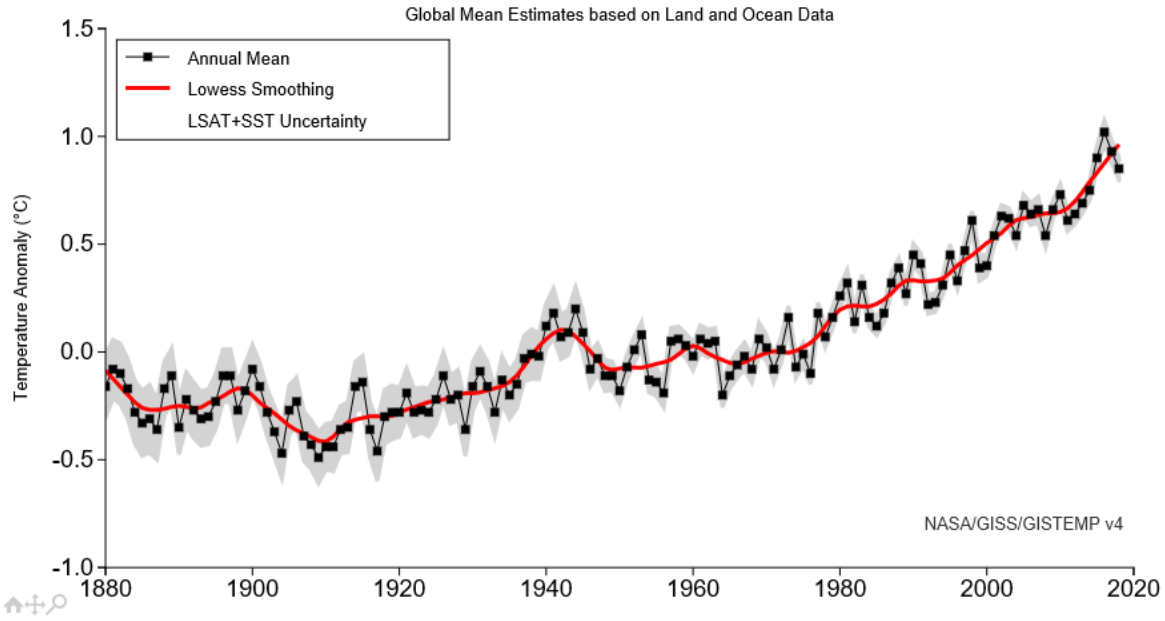
UAH version	Main adjustment	Trend correction	Year
A	Simple bias correction		1992
B	Linear diurnal drift correction	-0.03	1994
C	Removal of residual annual cycle related to hot target variation	0.03	1997
D	Orbital decay	0.10	1998
D	Removal of dependence of time variations of hot target temperature	-0.07	1998
5.0	Non-linear diurnal correction	0.008	2003
5.1	Tightened criteria for data acceptance	-0.004	2004
5.2	Correction of diurnal drift adjustment	0.035	2005
5.3	Annual cycle correction	0	2009
5.4	New annual cycle	0	2010
6.0 beta	Extensive revision	-0.026	2015

The sum of all these corrections is +0.043 without which the UAH data would give a trend of only 1.0 ºC/decade.

Note that the orbital decay correction alone accounts for most of the reported trend, i.e., 0.10 deg.C per decade out of the 2019 trend of 0.145 deg.C per decade.

NASA GISS (dataset GISTEMPv4) from https://data.giss.nasa.gov/gistemp/





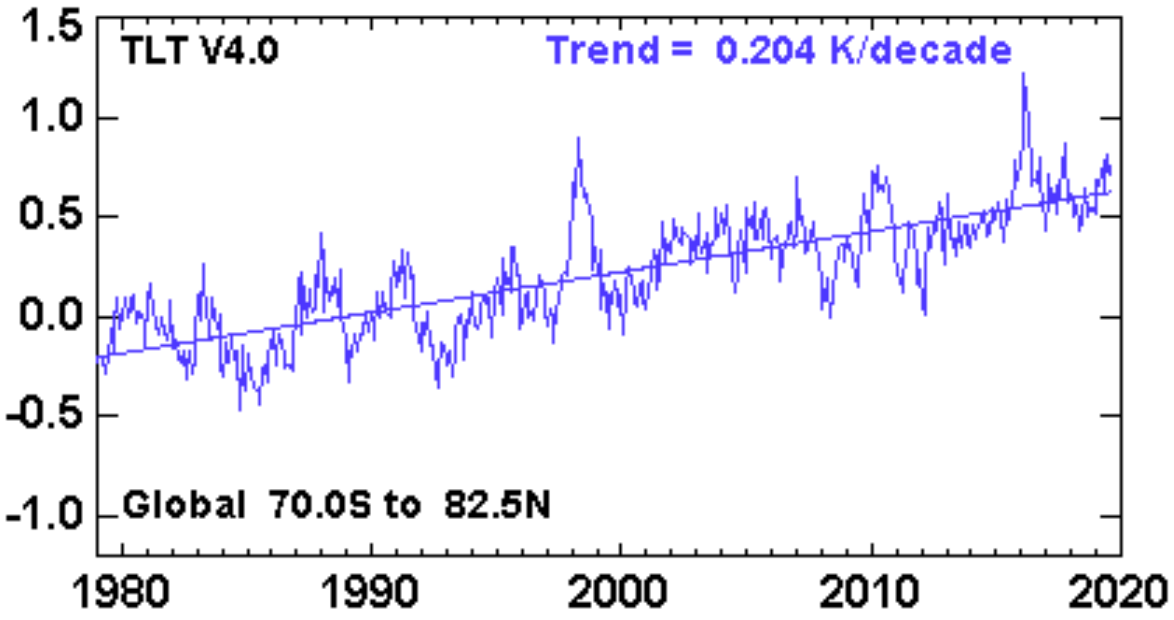
https://data.giss.nasa.gov/gistemp/graphs_v4/

Anomaly increase from -0.06°C in 1966 to 1.0°C in 2018, hence a trend since 1966 of 1.06/52 deg.C/yr or 0.204 deg.C/decade.

Temperature increase since 1880 about 1.1°C (as of 2018)

RSS (Remote Sensing Systems) see http://www.remss.com/support/data-shortcut/

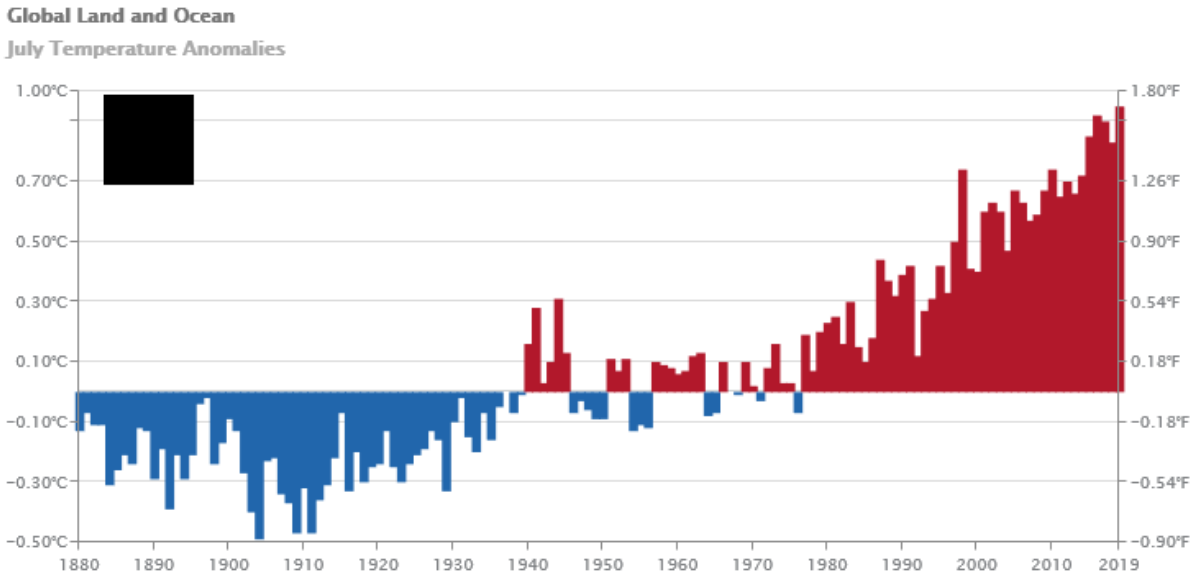
RSS global temp at 2019: trend is 0.204 deg.C/decade
http://images.remss.com/msu/msu_time_series.html



NOAA-NCEI (National Centres for Environmental Information)

https://www.ncdc.noaa.gov/cag/global/time-series

Trend, 1970 – 2019: 0.184 deg/C/decade



Anomaly -0.1 deg.C in 1880; 0.9 in 2019, so total change since 1880 about 1.0 °C.

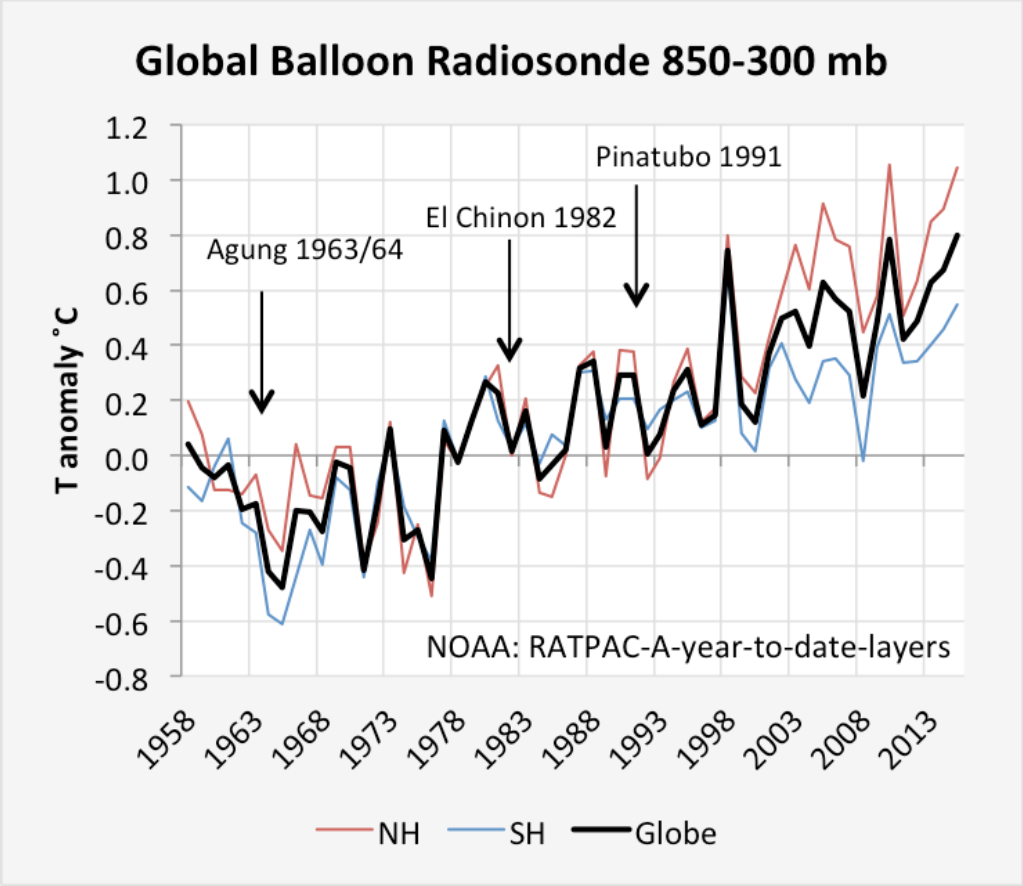
Recent trend: anomaly 0 in approx. 1970, so trend = 0.9/49 = 0.184 degC/decade

RATPAC https://tamino.wordpress.com/2018/10/17/global-temperature-in-the-air-up-there/

RATPAC stands for Radiosonde Atmospheric Temperature Products for Assessing Climate

Provided by NOAA-NCEI (to 2018) https://www.ncdc.noaa.gov/data-access/weather-balloon/radiosonde-atmospheric-temperature-products-accessing-climate

A plotting of the RATPAC data from http://euanmearns.com/ratpac-an-initial-look-at-the-global-balloon-radiosonde-temperature-series/ is, (to 2016)



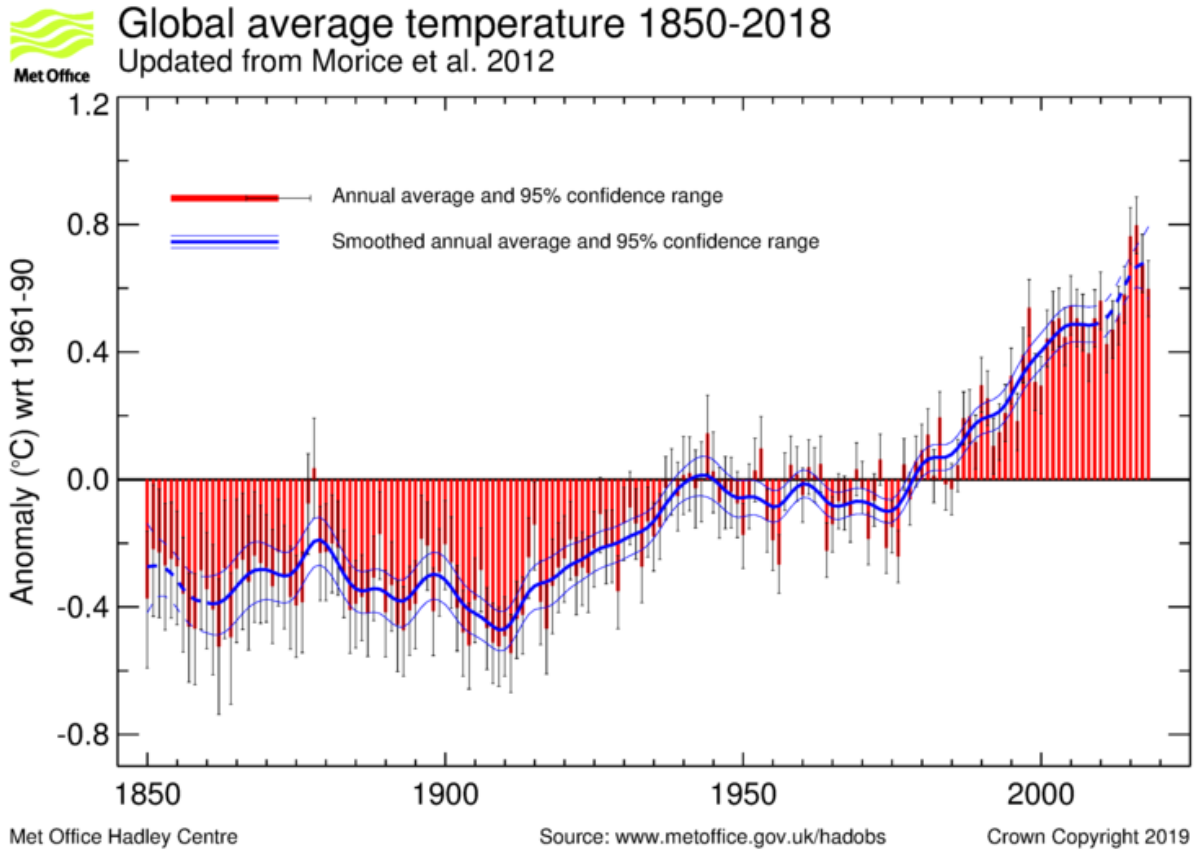
NH = Northern Hemisphere; SH = Southern Hemisphere

850 to 300 mb (millibar) refers to atmospheric pressure and is hence a measure of the balloon's altitude when these data were collected. This pressure range corresponds to the lower troposphere, and hence is consistent with other data herein.

Drawing a trend line through the data, the anomaly in 1958 is about -0.39ºC rising to about 0.65ºC in 2016, hence a trend of 1.04oC/58 years or 0.179ºC/decade.

UK Met Office Hadley Centre

HadCRUT4 dataset. The dataset is a collaborative product of the Met Office Hadley Centre and the Climatic Research Unit at the University of East Anglia. The gridded data are a "blend" of the CRUTEM4 land-surface air temperature dataset and the HadSST3 sea-surface temperature dataset.



Increase of 0.68 degC between 1977 and 2018, hence current slope 0.166 degC/decade

Increase from 1850 to 2018 = 0.96 degC

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