On increasing global temperatures: 75 years after Callendar

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Abstract

In 1938, Guy Stewart Callendar was the first to demonstrate that the Earth's land surface was warming. Callendar also suggested that the production of carbon dioxide by the combustion of fossil fuels was responsible for much of this modern change in climate. We mark the 75th anniversary of Callendar's landmark study and demonstrate that his global land temperature estimates agree remarkably well with more recent analyses.

A brief history of understanding Earth's temperature

The discussion of the human influence on global temperatures has a long history. For instance, Fourier (1824) first discussed why the Earth was warmer than expected from solely considering solar radiation reaching the planet. Fourier ruled out geothermal effects, considered the temperature of outer space, and pondered about heat being trapped in the atmosphere, but did not come to any firm conclusions. Tyndall (1861) suggested a solution to this conundrum by experimentally demonstrating that gases such as carbon dioxide can effectively absorb infrared radiation, i.e. the 'greenhouse effect'.

Later, Arrhenius (1896) used the results of Tyndall and others to produce the first estimate of the sensitivity of global temperatures to increases in carbon dioxide. Much of this research was aimed at understanding historical climatic variations such as ice ages rather than any modern changes (e.g. Ekholm 1901). However, in the early 1900s, the theory that increases in atmospheric carbon dioxide could change the climate was not widely accepted.

Separately, widespread temperature records were being used to estimate the variability in global land air temperatures during the late 1800s (e.g. Köppen 1881), but no trend was evident. These activities eventually culminated in the work of Guy Stewart Callendar, who was a steam engineer and amateur climatologist.

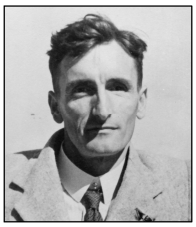
Callendar (1938) was first to show that Earth's land temperature had increased over the previous 50 years. Callendar also suggested that the production of CO_2 by the combustion of fossil fuels was responsible for a large part of this warming, which became known for a time as the 'Callendar Effect'.

Find out more.....

Callendar, 1938, *QJRMS*, doi: 10.1002/qj.49706427503
Hawkins & Jones, 2013, *QJRMS*, doi:10.1002/qj.2178

Callendar (1938)

In his 1938 paper, Guy Callendar used data from 147 weather stations to estimate an observed increase of global temperatures of around 0.3°C over the previous 50 years – the first evidence of a warming planet. Remarkably, Callendar did all the calculations in his spare time, without a computer!



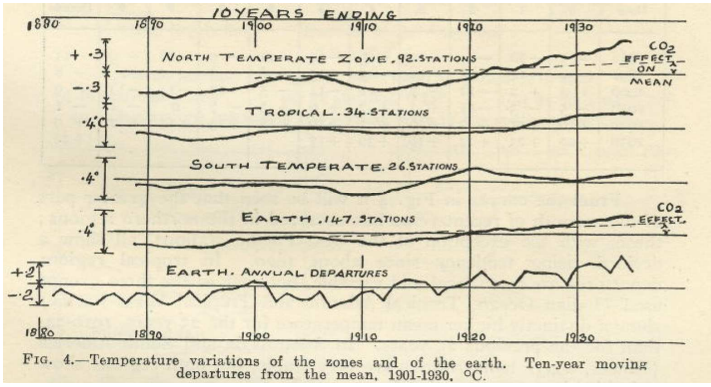


FIG. 4.—Temperature variations of the zones and of the earth. Ten-year moving departures from the mean, 1901-1930. °C.

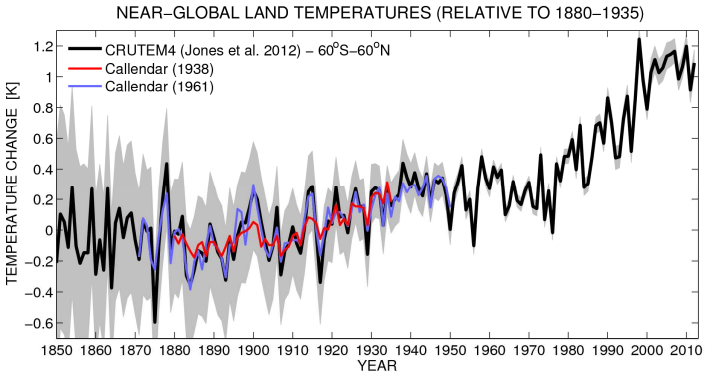
In addition, Callendar also estimated:

- Global CO_2 emissions, atmospheric concentrations & also the airborne fraction of CO_2.
- The expected effect of the observed increases in CO_2 on global temperatures - 0.15°C - which was around half that of the observed warming.

Some quotes from Callendar (1938):

- *"quite a moderate number of reliable temperature records may be used to give the period anomalies of very large areas"*
- *"few of those familiar with the natural heat exchanges of the atmosphere, which go into the making of our climates and weather, would be prepared to admit that the activities of man could have any influence upon phenomena of so vast a scale"*
- *"the combustion of fossil fuel [. . .] is likely to prove beneficial to mankind in several ways"*
- *"the return of the deadly glaciers should be delayed indefinitely"*

Were Callendar's estimates accurate?



Comparing CRUTEM4 estimates for annual near-global land temperatures with Callendar (1938) & an update in Callendar (1961). The agreements in trends and variability are striking.

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