

Global Climate Change: Was it Impacted Upon by the COVID-19 Industry 'Lock-downs'?

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Abstract

Evidence is emerging that the policies adopted by the world's nations to deal with the COVID-19 pandemic may have had an unanticipated consequence in relation to the Earth's climate. For much of 2020, and continuing into 2021, many nations have seen the imposing of industry 'lock-downs' as the strategy of choice to bring COVID-19 under control. In so doing, an involuntary experiment, which provides insight as to how a future transitioning away from a carbon-based economy might address global climate change, may have been conducted.

An analysis of trends in the Global Mean Temperature (GMT) data* to Feb-2021 has been undertaken, and its results are intriguing. In analysing the data, the manner in which short-term fluctuations in the GMT are driven by the El Niño Southern Oscillation (ENSO) phenomenon** is established as being somewhat more significant than other drivers of global climate. The impact of the ENSO phenomenon also displays a seasonal cycle, being particularly strong in the northern winter.

The long-term trend in GMT is described in terms of a third-order polynomial, with the impact of the ENSO phenomenon eliminated. This enables an assessment of the influence of other GMT drivers. For example, in Jun-1991, when the Mount Pinatubo eruption took place, the departure of GMT from trend was +0.15°C. Fifteen months later, it was -0.36°C. That drop of 0.51°C is largely attributed to the injection of volcanic gases, such as Sulphur Dioxide, into the stratosphere by the eruption.

In Feb-2020, the departure of GMT from trend was +0.18°C. A year later, it was -0.27°C. That drop of 0.45°C requires explanation. That it coincides with a year of industry 'lock-downs' suggests that it might be a consequence of those 'lock-downs'. The primary purpose of this paper is to explore the validity, or otherwise, of this suggestion.

*<https://data.giss.nasa.gov/gistemp> **<http://www.bom.gov.au/climate/enso/soi/>



The Cataclysmic (June) 1991 Eruption of Mount Pinatubo, Philippines. Fact Sheet 113-97 ([usgs.gov](https://pubs.usgs.gov/fs/1997/fs113-97/))
<https://pubs.usgs.gov/fs/1997/fs113-97/>

The 1991 Mount Pinatubo eruption (shown above) led to a temporary cooling of the earth's atmosphere. This paper poses the question: Has more than a year of industry 'lock-downs' to address the COVID-19 pandemic resulted in a similar outcome to this, and other, volcanic eruptions?

PROLOGUE

The *raison d'être*, for what has prompted the following, is illustrated at Fig 1. Fig 1 shows that, in Feb-2020, the third highest Global Mean Temperature (GMT) Departure from Normal (DfN) (+1.25 °C) was registered (the all-time high was +1.37°C in Feb-2016). It then shows that, in the following 12 months, whilst much of industry was in 'lock-down' mode, the DfN fell to +0.65°C in Feb-2021, well below the long-term trend, and the lowest such reading since +0.58°C was registered in Jul-2014. The paper asks the question: 'Did the lock-downs contribute to this apparent reversal of trend?'

1. INTRODUCTION

Aside from what is the main driver of very long-term changes in the earth's climate, the Milankovitch orbital cycles¹, we have the key driver of the well-known century-scale observed upward (and accelerating) trend in Global Mean Temperature^{2,3,4} (GMT), namely, increasing Carbon Dioxide⁵ (CO₂). There are also numerous drivers of short-term fluctuations in a range of parameters defining the earth's climate. These drivers include the El Niño Southern Oscillation⁶ (ENSO) phenomenon, volcanic eruptions, the sunspot cycle⁷ (these are referred to in the paper) and many more. Evidence is now emerging that the policies adopted by the world's nations to deal with the coronavirus disease of 2019 (COVID-19) pandemic may also have had an impact – an unanticipated consequence – in relation to the Earth's climate. To explain, for much of 2020, and continuing into 2021, many nations have seen the imposing of industry 'lock-downs' as the strategy of choice to bring the COVID-19 under control. In so doing, an involuntary experiment, which provides insight as to how a future transitioning away from a carbon-based economy might address global climate change, may have been conducted.

Firstly, a comment on the GMT data. Three sets are utilised: from the NASA (1880-2021 data) – the 1951-80 Departure from Normal data; from the UK Met Office (1850-2021 data) – the 1961-90 Departure from Normal data; and, from the Bureau of Meteorology, Australia (1850-2021 data) – the GMT for 1961-90. These three data sets are blended in a manner described at Fig 2. Fig 3 highlights a significant drop in GMT over the past year (derived from NASA data², UK Met Office data³, Bureau of Meteorology, Australia, data⁴), with the (12-month average to the) May-2021 reading now significantly below the long-term trend. Fig 4 suggests that changes in the GMT, following the emergence of COVID-19, display similar characteristics to GMT changes in the wake

of some of our most significant recent volcanic eruptions.

2. DISCUSSION

An analysis of trend in the GMT data to May-2021 has been undertaken, that trend analysis revealing an accelerating upward rise in the GMT (Fig 5). Fig 6 shows that the upward trend is anticipated to accelerate to about 0.6°C per decade by the end of the current century. Fig 6 also shows that the upward trend is slightly stronger during the northern hemisphere's spring half of the year, than it is during other seasons, whilst Fig 7 underlines the influence of ENSO on short-term fluctuations in the trend. Fig 8 depicts the trend in what is the main century-scale driver of that upward trend, namely, increasing CO₂ over the past six decades from 310 to 420 parts per million.

Fig 9 shows that, in the year from Feb-2020 to Feb-2021, the 'raw' Departure from Trend of the GMT fell from +0.270°C to -0.356°C (a net fall of 0.626°C). Fig 10 demonstrates that short-term fluctuations in the GMT are driven (with a lag of three months) by the ENSO phenomenon.

A clear seasonal variation of that impact, particularly notable during the northern winter and spring, is illustrated by Fig 11. Fig 12 suggests that the net 'raw' Feb-2020 to Feb-2021 GMT fall (of -0.626°C) is somewhat reduced when the modifying impact of ENSO is considered (from +0.188°C to -0.284°C yielding a net fall of -0.472°C).

Fig 13 suggests that the 1991 Mount Pinatubo eruption led to a temporary cooling of the earth's atmosphere. In Jun-1991, when the Mount Pinatubo eruption took place, the Departure from Trend of the GMT was +0.190°C. Seventeen months later, it was -0.412°C. That net drop of 0.602°C may be attributed to the injection of volcanic gases, such as Sulphur Dioxide, into the stratosphere by the eruption.

What might we now say about whether more than a year of industry 'lock-downs' to address the COVID-19 pandemic has resulted in a similar outcome to the Mount Pinatubo eruption?

Although the GMT data provide evidence in support of an affirmative response to that question, there is no support from the recent atmospheric CO₂ data. After all, Fig 14 indicates a positive Departure from Trend of CO₂ throughout the period of the pandemic. Nevertheless, the jury appears to be still out, especially given that:

- Short-term fluctuations in CO₂ lag fluctuations in global mean temperature (Fig 15) by 5 months.
- Short-term fluctuations in CO₂ are also driven by the ENSO phenomenon, in this case with a lag of 12 months (Fig 16).

- Specifically, increases in CO₂ follow El Niño events (indicated by negative SOIs), especially in the late northern winters and late northern summers (Fig 17), whilst decreases in CO₂ follow La Niña events (indicated by positive SOIs).

So, the positive Departure from Trend of CO₂ during recent months may be a consequence of the previous 2019-2020 El Niño, bearing in mind that its impact was being felt as recently as Jun-2020, when the SOI was -9.6 (Fig 18). To this end, Fig 19 provides support for the proposition that, if one considers the impact of the ENSO phenomenon, the Departure from Trend of the CO₂ was turning negative by May-2021.

3. CONCLUDING REMARKS

This paper opened asking whether the policies adopted by the world's nations to deal with the coronavirus disease of 2019 (COVID-19) pandemic, such as the industry 'lock-downs' have had an impact on the earth's climate. The suggestion is that the data indicates that the consequence may have been a temporary cooling of the earth's atmosphere, the magnitude of that cooling having been like that which occurred in response to major historical volcanic eruptions (Fig 4).

On the other hand, however, the minimal response on the part of 'raw' trends in atmospheric CO₂ casts doubt on this suggestion (Fig 14). This is notwithstanding a slightly different indication from

Fig 19, derived considering the impact of the ENSO phenomenon.

So, the best one can say is that the jury is still out on the matter. As time passes, and new data becomes available for further analysis, one may be able to reach a more confident conclusion.

POSTSCRIPT

What has been presented in the foregoing is potentially very encouraging from the point of view of those who seek an indication of how a future transitioning away from a carbon-based economy might address global climate change. The imposition of industry 'lock-downs' as the strategy of choice to bring the COVID-19 under control, has coincided with a substantial fall in the 'raw' GMT over the year to Feb-2021 (depicted at Fig 1, which suggests that fall to be 0.60°C. Utilising a slightly different approach, at Fig 9, which suggests that fall to be 0.626°C) with GMT maintaining values below the long-term during the subsequent months. Fig 12, which has been constructed considering the impact of the ENSO phenomenon, suggests a reduction in that fall, albeit a slight one, to 0.472°C. Should future work confirm that the fall in GMT may be (at least partially) attributed to strategies implemented to address COVID-19, confidence will emerge in the strategies currently being increasingly applied to addressing climate change more broadly.

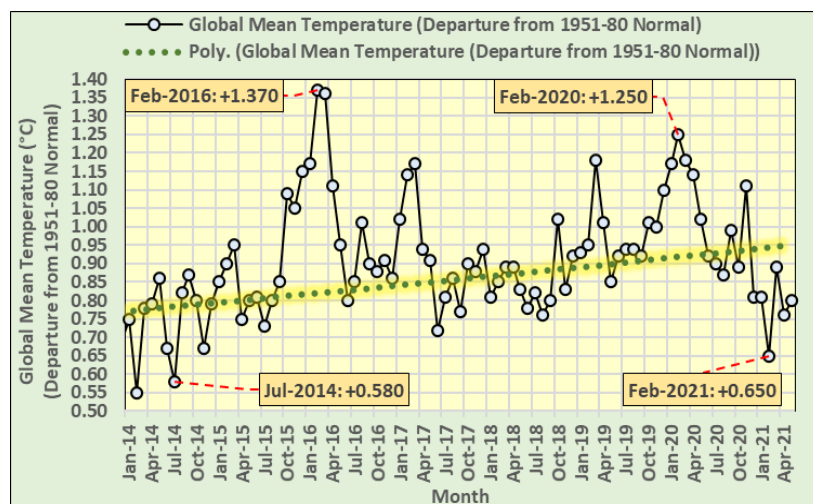


Fig 1 Recent Trend in GMT Departure from 1951-80 Normal

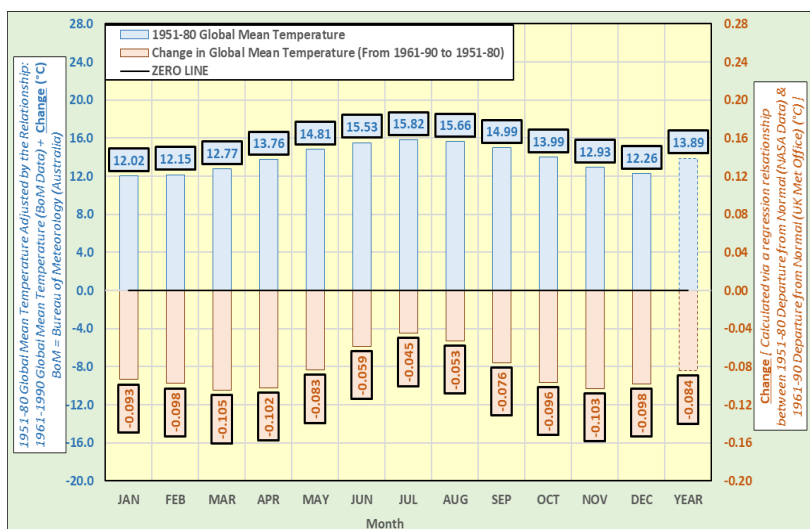


Fig 2 Blending the three GMT Data Sets

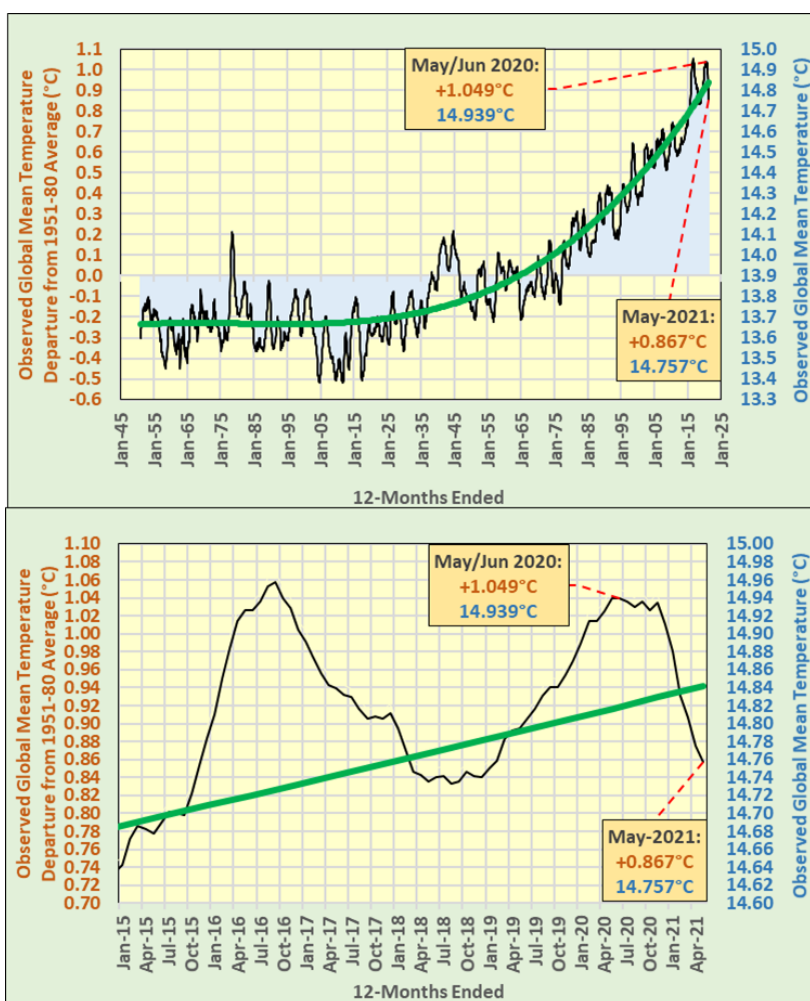


Fig 3 Observed Trend in GMT

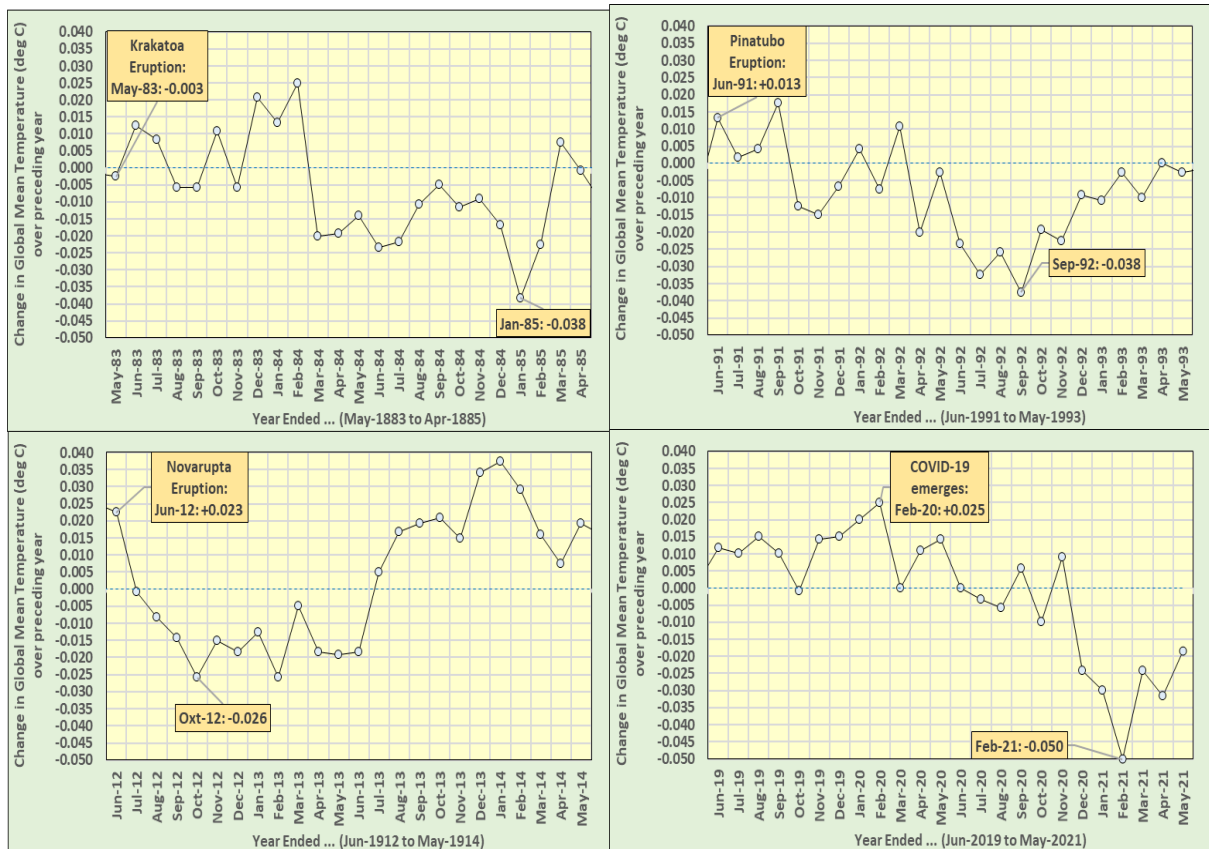


Fig 4 The impact of COVID-19 industry 'lock-downs' on GMT vs that of recent major volcanic eruptions

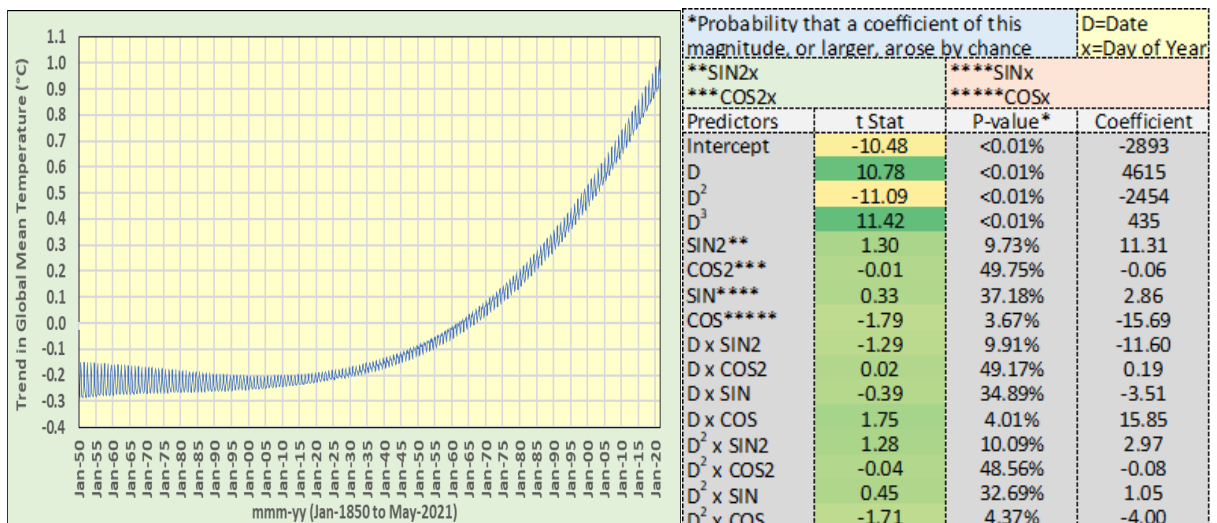


Fig 5 The Global Mean Temperature Trend

Comment: With $Date$, $Date^2$, and $Date^3$ being the most highly significant predictors indicates how appropriate it is to describe the accelerating upward trend in the Global Mean Temperature in terms of a 3rd order polynomial. That the product of $Date$ and COS Day of the Year is also significant, explains why that upward trend is slightly stronger during the northern spring (see Fig 6).

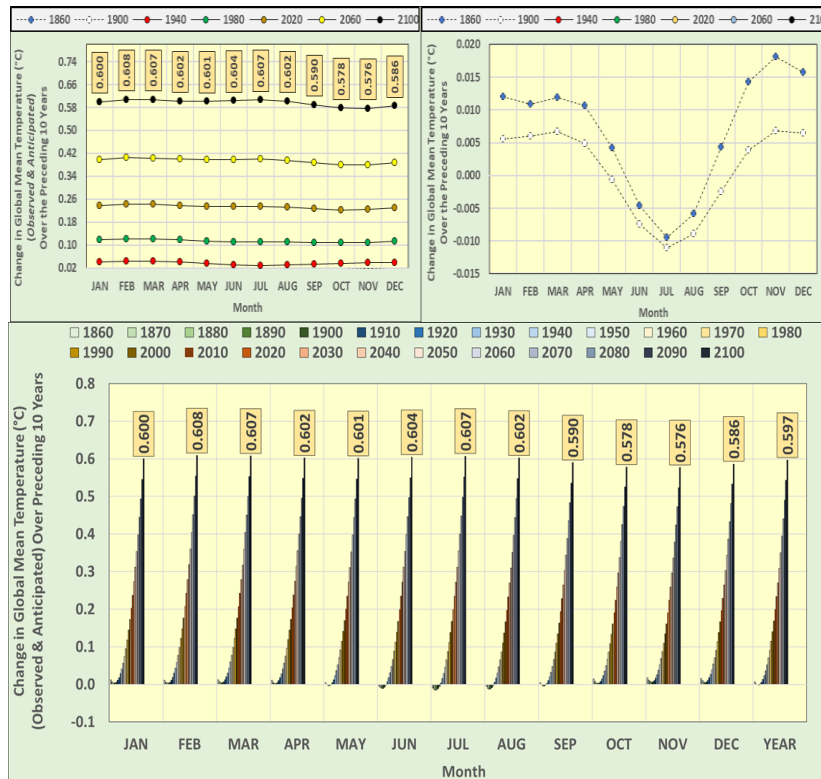


Fig 6 Seasonal Observed & Anticipated Global Mean Temperature Trend

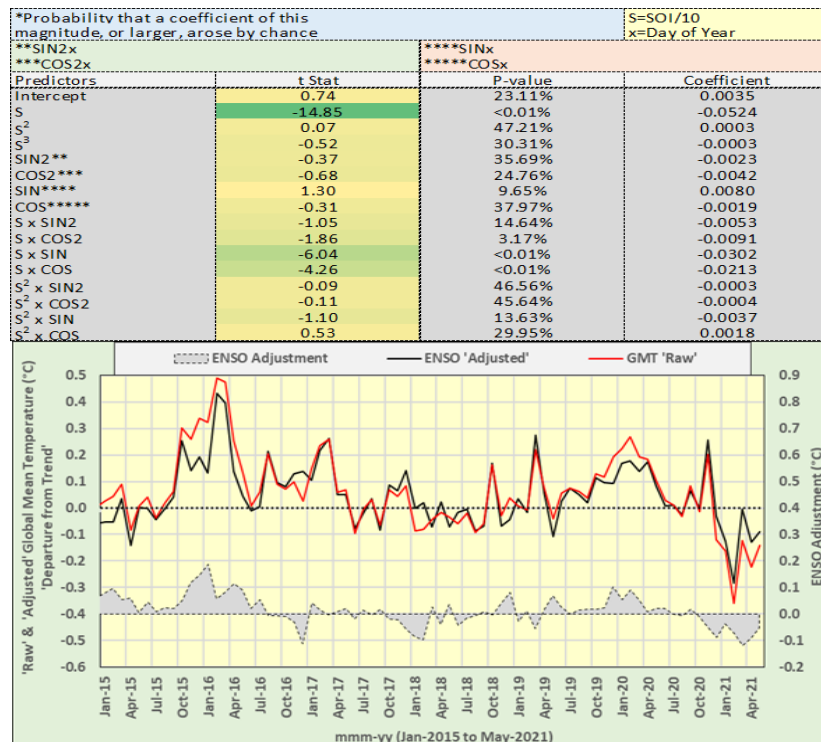


Fig 7 How ENSO Influences the Global Mean Temperature Trend

Comment: The SOI being the most highly significant predictor (negative) indicates how a short-term spurt in global warming often follows an El Niño event. That the product of (negative) *SOI* and, respectively, *SIN Day of the Year* and *COS Day of the Year*, are next in line, explains why this relationship is more pronounced during the northern winter/spring (see Fig 11). The graphic shows that the recent global cooling is partially (but only partially) a response to a developing La Niña.

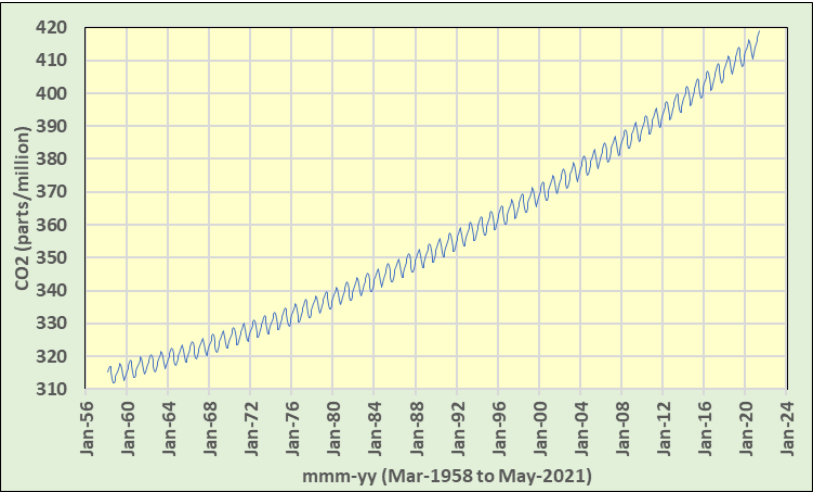


Fig 8 Trend in CO2

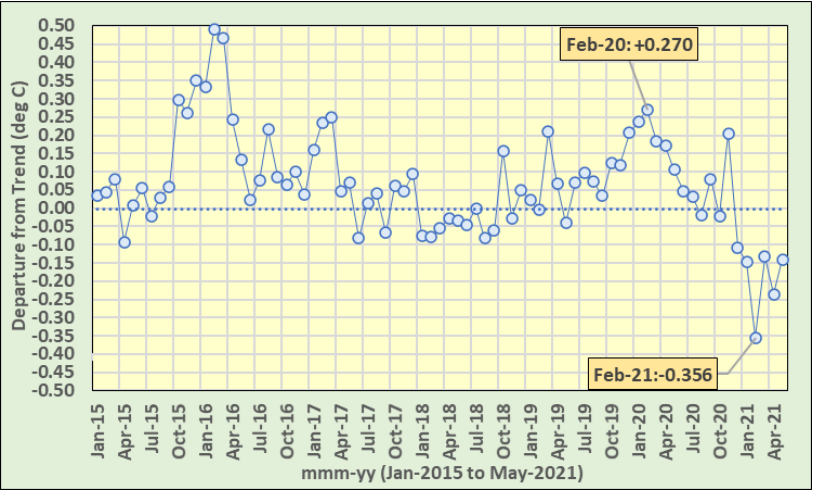


Fig 9 Observed Departure from Trend of GMT

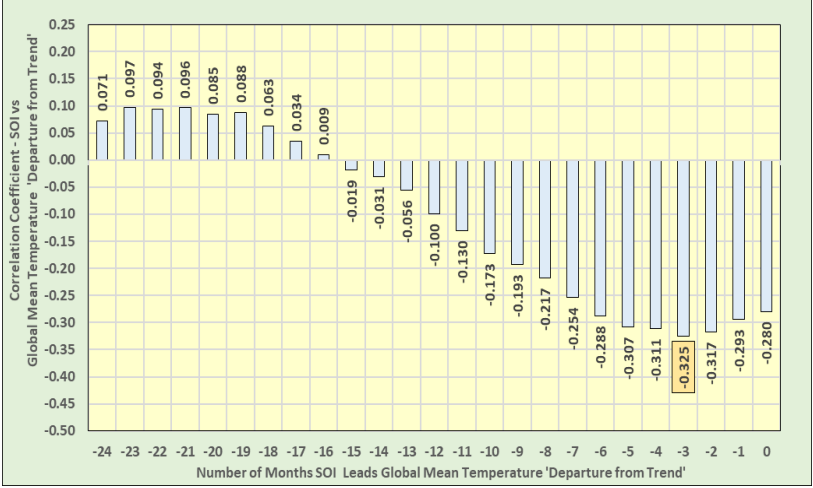


Fig 10 How SOI Leads GMT See Fig 7 & 11

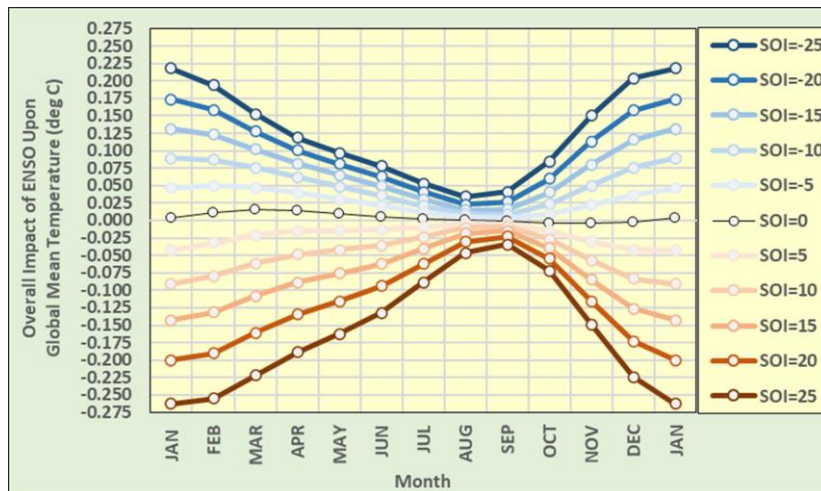


Fig 11 Seasonal Departure from Trend of GMT vs SOI See **Fig 7 & 10**

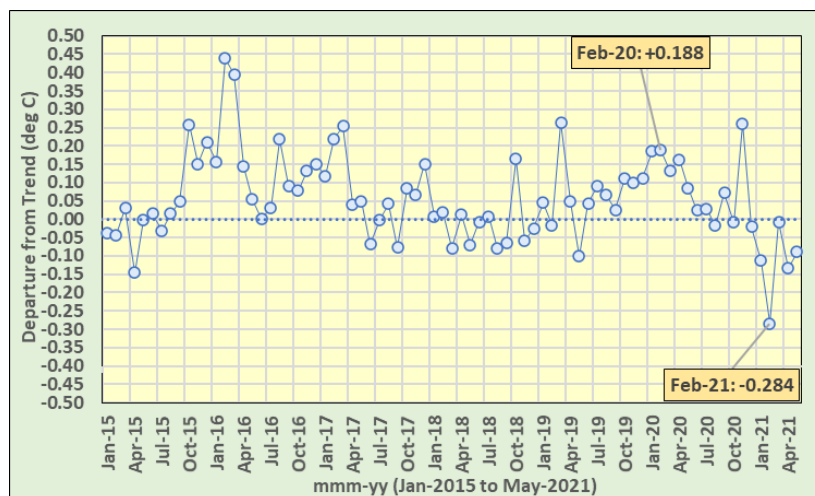


Fig 12 Departure from Trend of GMT(2015-21): ENSO Adjusted

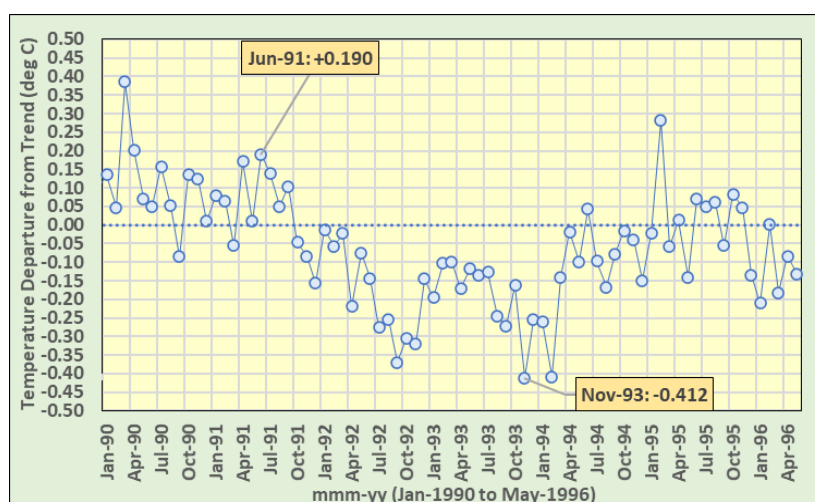


Fig 13 Departure from Trend of GMT (1990-95): ENSO Adjusted

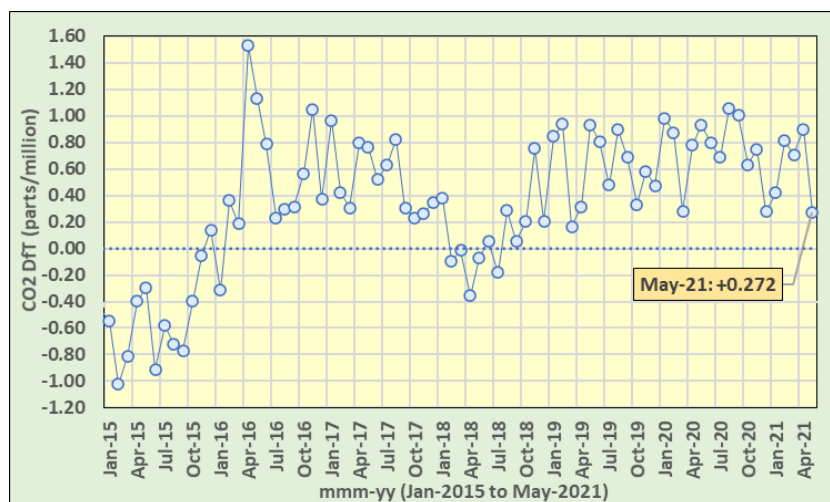


Fig 14 Departure from Trend of CO2 (2015-2021)

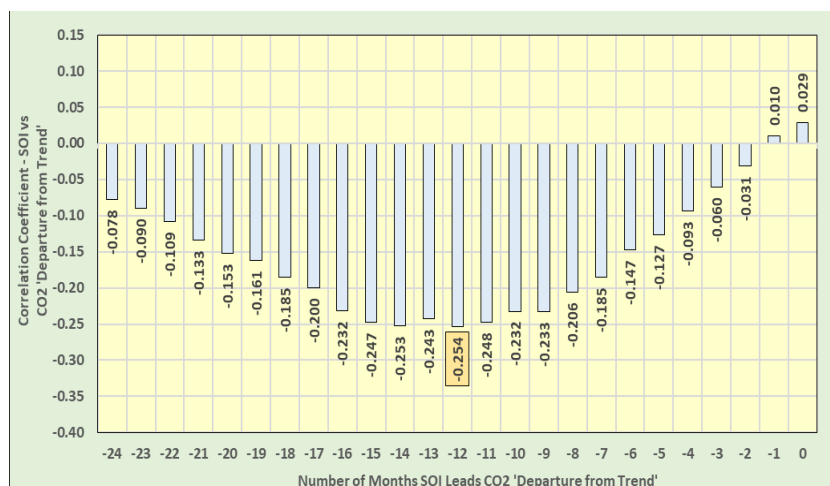


Fig 15 How GMT Leads CO2

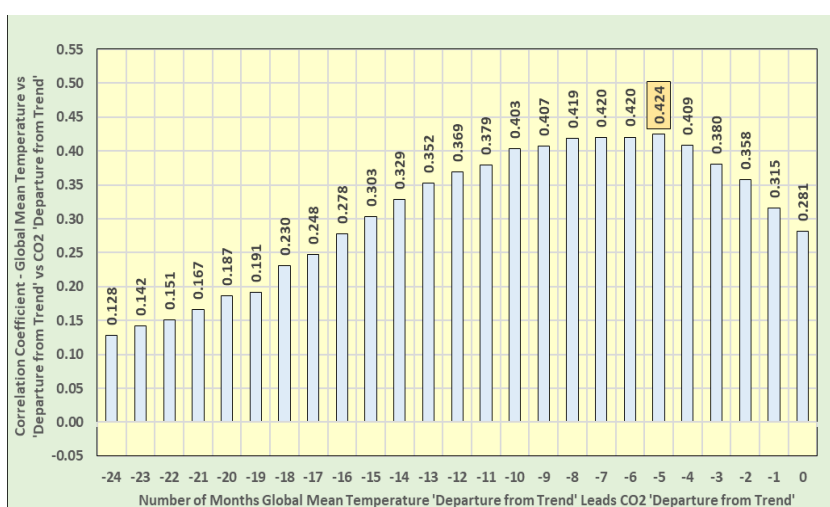


Fig 16 How SOI Leads CO2

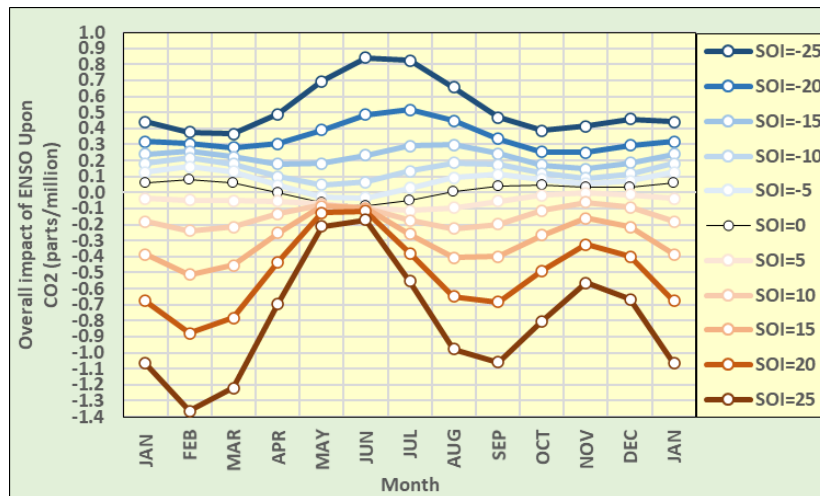


Fig 17 Seasonal Departure from Trend of CO₂ vs SOI

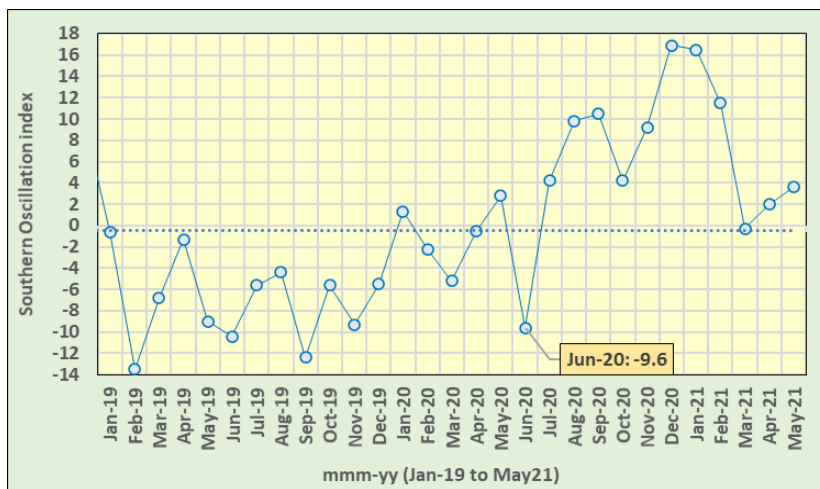


Fig 18 Monthly Southern Oscillation Index

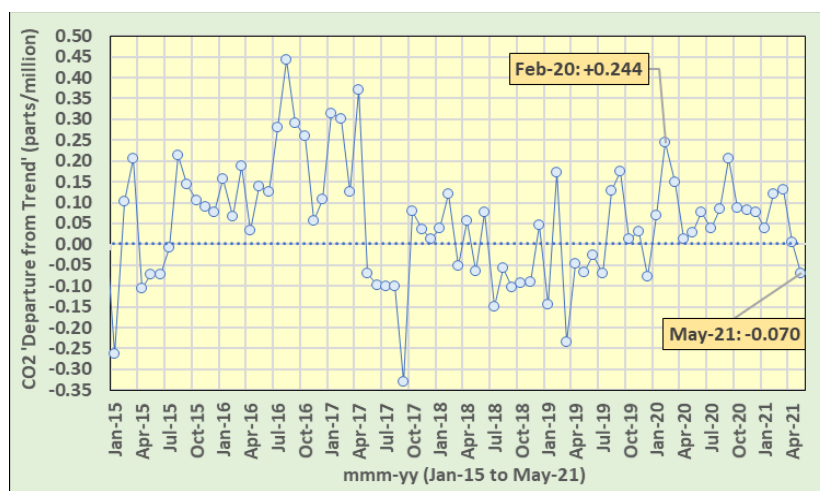


Fig 19 Departure from Trend of CO₂ (2015-21): ENSO Adjusted

APPENDIX

THE YEAR WITHOUT A SUMMER

A Volcanic Eruption Brings About Snow, Sleet, and Frost

By Michael Steinberg

November 21, 2017

<https://www.almanac.com/extra/year-without-summer>

'In 1816, a volcanic eruption (of Mount Tambora on the island of Sumbawa, near Bali, Indonesia) and cooling Sun brought about snow, sleet and frost. The world experienced a sudden drop in temperatures and an uptick in erratic weather patterns, causing massive food shortages across the Northern Hemisphere. At the time, Earth was already experiencing the concluding decades of the Little Ice Age, due to a period of relatively low solar activity from 1790 to 1830 known as the Dalton Minimum (Fig 20). May 1816, ... (had) the lowest sunspot number (0.1) to date since record-keeping on solar activity had begun. ... But it was not only solar activity that contributed to the summerless year. ... A 13,000-foot-high volcano (Mount Tambora) (Fig 21) ... was the primary cause of the *Year Without a Summer*. The eruption happened in April of 1815⁸ and was one of the greatest volcanic eruptions in history. ... Mt. Tambora ejected immense amounts of volcanic ash into the upper atmosphere, where it was carried around the world by the jet stream. The volcanic dust covered Earth like a great cosmic umbrella, dimming the Sun's effectiveness during the whole cold year. This resulted in a further reduction in solar irradiance, which brought record cold to much of the world during the following summer. Such an eruption would explain the appearance of the 1816 Sun as "in a cloud of smoke." ... The unusual cold played havoc with agricultural production in many parts of the world, directly or indirectly creating crop failures, dramatic increases in food prices, famines, cultural disruptions, and epidemics of cholera and other diseases.'

¹⁰Refer now to Fig 22, which shows both the post-eruption response of Central England temperatures and, also, the more recent trend. Fig 23 shows its seasonal nature, the upward trend being most pronounced in the northern hemisphere late autumn/winter, in November the mean temperature's departure from normal rising from -1.28°C in 1660, to $+0.88^{\circ}\text{C}$ in 2020, and thence to $+3.51^{\circ}\text{C}$ in 2100. By contrast, in June the upward trend is much weaker, the mean temperature's departure from normal rising from -0.46°C in 1660, to $+0.66^{\circ}\text{C}$ in 2020, and thence to $+2.42^{\circ}\text{C}$ in 2100. With Date, Date², and Date³ being the most highly significant predictors, as is the case with Global Mean Temperature, once again indicates how appropriate it is to describe the accelerating upward trend in the Central England Mean temperature in terms of a 3rd order polynomial. That the product of Date & both SIN Day of the Year (positive) and COS Day of the Year (negative) are also significant, explains why that upward trend is strongest during the northern late autumn/winter.

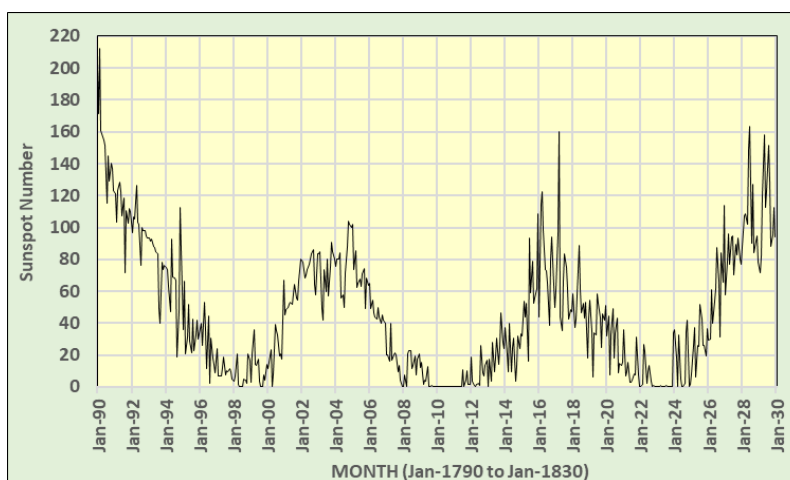


Fig 20 Sunspot Number Jan-1790 to Jan-1830⁹



Fig 21 Mount Tambor
Photo Credit: University of Arizona

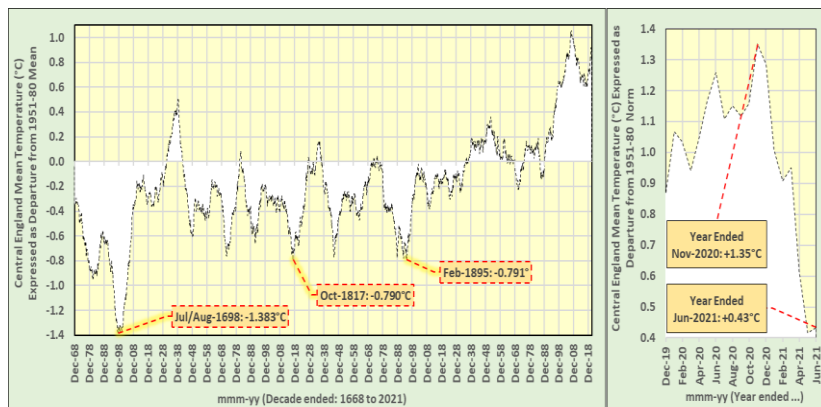


Fig 22 Central England Mean Temperature Trend (Historical & Recent)¹⁰

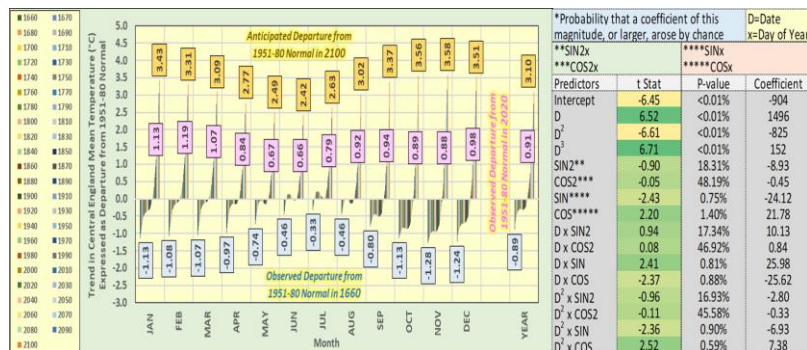


Fig 23 Central England Mean Temperature Trend (Observed & Anticipated)

- ¹ <https://climate.nasa.gov/news/2948/milankovitch-orbital-cycles-and-their-role-in-earths-climate/>
- ² <https://data.giss.nasa.gov/gistemp>
- ³ <https://www.metoffice.gov.uk/hadobs/hadcrut4/data/current/download.html>
- ⁴ <http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=global-timeseries>
- ⁵ <https://gml.noaa.gov/ccgg/trends/data.html>
- ⁶ <http://www.bom.gov.au/climate/enso/soi/>
- ⁷ <http://www.sidc.be/silso/datafile>
- ⁸ <https://www.almanac.com/extra/year-without-summer>
- ⁹ <http://www.sidc.oma.be/silso/>
- ¹⁰ <https://www.metoffice.gov.uk/hadobs/hadcet/cetml1659on.dat>

ACRONYMS: CO₂: Carbon Dioxide; COVID-19: coronavirus disease of 2019; GMT: Global Mean Temperature; SOI: Southern Oscillation Index; ENSO: El Niño Southern Oscillation.