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The definitive cause of La Nina and El Nino events

Burl Henry *

Retired Senior Engineer, IBM Corp, US.

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Abstract

Rather than being strictly random events, it has been proven that all La Ninas and El Ninos are caused by the increase or decrease of reflective SO2 aerosols in Earth's atmosphere, from both volcanic eruptions and industrial activity.

Although volcanic eruptions are random events, an eruption usually signifies a forthcoming La Nina/El Nino cycle, and thus can have some predictive value.

Keywords: Global Warming; Climate Change; ENSO; SO2 Aerosols

1. Introduction

All references are consistent in maintaining that an El Nino is a naturally occurring phenomenon, which, historically (since 1850), has occurred, roughly, every 2 to 7 years, and is the warm phase of the El Nino-Southern Oscillation (ENSO) cycle, with La Nina being the cool phase.

This explanation, however, as will be shown, is totally incorrect.

2. Material and methods

A WoodforTrees.org plot of Jan-Dec average anomalous global temperatures for the years 1950 to 2020 was downloaded and annotated with the dates of all La Ninas and El Ninos for that period [1], the dates of American Business recessions, and the names and dates of all VEI4 and higher volcanic eruptions that occurred during those years [2]. Such eruptions are known to decrease global temperatures [3], and can result in the emergence of a La Nina, as well as a volcanic-induced El Nino.

3. Discussion

The 70 year period between 1950-2020 was chosen as being long enough to be representative of our climate since the Little Ice Age (LIA), which ended circa 1850, and short enough for its graph to be reasonably legible upon the page.

The annotated graph is shown below:

* Corresponding author: Burl Henry

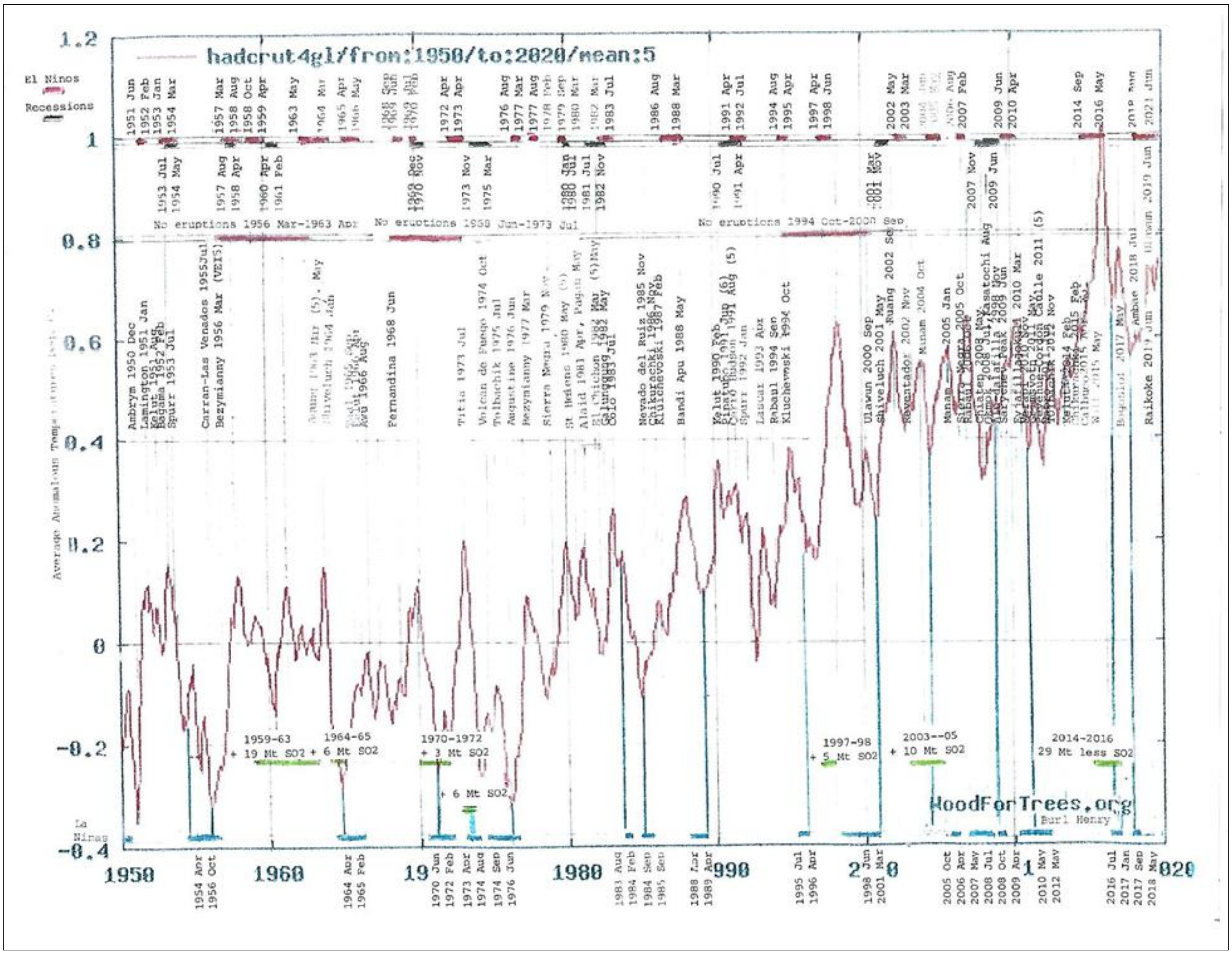

Figure 1 Volcanic eruptions 1950-2020 and their correlations with La Ninas and El Ninos

Regarding the graph, the dates of all El Ninos are shown at the top, over a red bar showing their duration.

The dates of American business cycles are shown just underneath, with a black bar representing their duration.

Centrally, all VEI4 and larger volcanic eruptions are located and identified.

The dates of all La Ninas are shown at the bottom, with a blue line spanning heir duration.

Not all volcanic eruptions result in the formation of a La Nina, but for those that did, a blue line has been dropped down to its corresponding La Nina, from its point of lowest temperature, which varies, but averages 17 months after the date of an eruption. (see Table 2, below).

Also noted are several instances where temperatures have decreased but are not related to a volcanic eruption. They were due to increased levels of industrial SO2 aerosol emissions into the atmosphere, and are identified by dates and amounts with a green line underneath. Since 1979, satellites have been used to measure the amount of SO2 emitted by a given volcanic eruption [4]. For a VEI4, the average amount is 0.2 Megatons, causing enough cooling to result in an occasional La Nina. The Industrial emissions noted are in the range of 3 to 19 million tons, and therefore have a larger climatic effect.

Immediately after an eruption has reached its lowest temperature, temperatures begin rising, as their SO2 aerosols settle out of the atmosphere, with some of the projections from that point intersecting the red El Nino bars at the top of the graph, identifying a volcanic-induced El Nino.

Other temperature increases not related to a volcanic eruption occur during industrial recessions, where decreases in SO2 aerosol levels due to idled foundries, factories, etc, result in warming, with some of the warming increasing enough to result in an El Nino, as shown by a black bar preceding an El Nino, at top.

Temperatures also increase when there are volcanic "droughts", i.e. periods of more than about 3 years, where there have been no volcanic eruptions, and any existing SO2 aerosols from previous eruptions have had time to settle out.

Three such periods are shown on the graph, with a long red bar spanning their dates, which are given above the bars.

Temperatures begin rising during those intervals, after the SO2 aerosols from the last eruption have settled out, but in each instance, the warming was halted by an increase in Industrial SO2 aerosols, identified by the green lines and dates mentioned above. They could also have been ended by a volcanic eruption.

The rising temperature trend since circa 1980 is due to the removal of industrial SO2 aerosols from the atmosphere due to global "Clean Air" efforts

The El Nino data shown in the graph is summarized in Table 1, below:

Table 1 El Ninos and their Causes, 1950-2020

EL NINO CAUSES, 1950-2020				
			(Cause of less SO2)	
Dates of El Ninos	Recesions	Volcanos inducing El Ninos	Volcanic Droughts	Clean Air Decreases
1951 Jun-1952 Feb	1948 Nov-1949 Oct	Ambrym 1950 Dec (VEI4)		
1953 Jan-1954 Mar	1953 Jul-1954 May	Bagama 1952 Mar (VEI4)		
1957 Mar-1958 Aug	1957 Aug-1958 Apr	Carran los Venados 1955 Jul (4)		
1958 Oct-1959 Apr		Bezymianny 1956 Mar (VEI5)		
1963 May-1964 Mar			7 year drought, 1956-63	
1965 Apr-1966 May		Shiveluch 1964 Jan (VEI4+)		
1968 Sep-1969 Apr		Kelut 1966 Apr, Awu 1966 Aug (VEI4's)		
1969 Jul-1970 Feb				-6 Mt, 1969-70
1972 Apr-1973 Apr			6 year drought, 1968-73	
1976 Aug-1977 Mar		Fuego 1974 Oct (VEI4)		
1977 Aug-1978 Feb		Augustine 1976 Jan (VEI4)		
1979 Sep-1980 Mar		Bezymianny 1977 Mar (VEI4+)		
1982 Mar-1983 Jul	1981 Jul-1982 Nov	El Chicon 1982 Apr (VEI5)		
1986 Aug-1988 Mar		Nevado del Ruiz 1985 Nov (VEI4)		
1991 Apr-1992 Jul	1990 Jul-1991 Mar			
1994 Aug-1995 Apr		Pinatubo 1991Jun (VEI6), Cerro Hudson1991 Aug (VEI5)		
1997 Apr-1998 Jun		5 yr drought 1994-2000 plus		-7.7 Mt 1996-97
2002 May-2003 Mar	2001 Mar-2001 Nov	Shiveluch 2001 May (VEI4)		
2004 Jun-2005 May		Reventador 2002 Nov (VEI4)		
2005 Aug-2007 Feb		Manam 2005 Jan (VEI4?)		
2009 Jun-2010 Apr	2007 Nov-2009 Jun	Chiaten 2008 May (VEI4)		
2014 Sep-2016 May		Tolbachik 2012 Nov (VEI4)		-28 Mt 2014-16
2018 Aug-2019 Jul		Chikurachki 2015 Feb (VEI4)		-16 Mt 2016-19
2019 Jul-2021 Jun		Bogoslof 2017 May (VEI4)		

Table 2, below, is a similar listing of the causes of the La Ninas

Table 2 Causes of La Ninas, 1950-2022

CAUSES OF LA NINAS, 1950-2022						
Dates of La Ninas	Volcanos and VEI	Increase in Industrial SO2 (Mts)	Months to LaNina onset	El Nino onset	Months to El Nino	Recession
1949 Aug- 1951 Mar	Hekla 1947 Mar	6 1949-50	31	1951 Jun	51	1948 Nov--1949 Oct
1954 Apr-1956 Oct	Spurr 1953 Jul (4)	9 1955-56	9	None	-	
1964 Apr-1965 Feb	Agung 1963 Jun (5)	6 1964-65	10	1965 Apr	22	
1967 Nov-1968 May	Kelut 1966 Apr (4)	4 1967-68	19	1968 Sep	29	
1970 Jun-1972 Mar	Fernanda 1968 Jun (4)	3 1970-72	24	1972 Apr	46	1969 Dec-1970 Nov
1973 Mar-1974 Aug		6 1972-73	12	None	-	
1974 Sep 1976 Jun	TiaTia 1973 Jul (4)	6 1974-78	13	1976 Aug	37	
1983 Aug-1984 Feb	El Chichon 1982 Apr (5)	2 1982-83	16	None	-	
1984 Sep-1985 Sep	Colo 1983 Jul (4)	2 1984-85	14	1986 Aug	37	
1988 Apr-1989 Apr	Kluchesko 1987 Feb (4)	-	14	None	-	
1995 Jul-1996 Apr	Lascar 1993 Apr 19 (4)	-	27	1999 Apr	41	
1998 Oct--2001 Mar		5 1997-98	9	2002 May	-	
2005 May-2006 Apr	Manam 2004 Oct (3?)	-	12	None	-	
2007 May 2008 Jul	Sierra Negra 2005 Oct (4)	-	18	2009 Jun	44	
2008 Oct-2009 Apr	Rabaul 2006 Oct (4?)	-	24	None	-	
2010 May-2012 May	Okmok 2008 May (VEi4)	-	26	2014 Sep	62	
2016 Jul-2017 Jan	Calbuco, Wolf 2015 Apr, May	-	15	None	-	
2017 Sep-2018 May	Bogoslof 2017 May (4?)	-	16	2018 Aug	39	
2019 Jul -2020 Mar	Ambae 2018 Jul (4?)	-	12	None	-	
2020 Jul-2021 Jun	Raikoke 2019 Jun (4?)	Yes, China	13	None	-	
2021 Jul-2022 Dec	Sinabung 2019 Feb (4)	and India	29	None	-	
			Avg:17Mo.		Avg.41Mo	

Included in this Table are the times from the date of an eruption to its La Nina, and its El Nino, and the average times for their occurrences. Temporary recession warming during the cooling period after an eruption may delay its La Nina and El Nino.

(Not shown on the chart is the recession of 2007 Nov-2009 Jun).

4. Conclusion

All La Ninas and El Ninos that occurred in the 70 years between 1950 and 2020 have been shown to have been due to changing levels of SO2 aerosols in the atmosphere, which affects the intensity of the Sun's rays that strike the Earth's surface, causing the observed cooling or warming events.

As such, the warming or cooling of the ENSO region in the Pacific Ocean does NOT affect world-wide temperatures, since the whole world is simultaneously being cooled or warmed by the changing levels of SO2 aerosols, which brings about the ENSO changes. For extreme warming events, geo-engineering by injecting SO2 aerosols, or perhaps, just water, high above selected regions (such as the ENSO region) could be used to bring about more benign temperatures. Volcanoes do this regularly.

References

[1] Google: "Cold and Warm Episodes by Season"

[2] Volcanoes of the World, Third Edition (2010) Siebert, et. al., Smithsonian Institution, University of California press.

[3] NASA Fact Sheets: Google: "Atmospheric Aerosols: What Are They, and Why Are They So Important?"

[4] Google: "Global Volcanism Program"