When Will the Next El Niño Occur?

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Abstract

There is great interest in knowing when a future El Niño will occur. Most physical models forecast the future based on climate data from the recent past—about a year. The forecasted future is also a fraction of a year. This approach to predicting the future does not use the fact that the climate system may be in a phase-locked state in which sinusoidal oscillations of 2 or 3 years are observed. These states can last many cycles. Thus, if the climate system is in a phase-locked state, one may be able to make definite statements about the future independent of physical models. Douglass, Knox, Curtiss, Geise and Ray (DKCGR) have used the fact that the climate system is presently in a phase-loxked state of period 3 years to state (December 2016) that the next El Niño episode may show a maximum at about November of 2018. We present an updated analysis and state (September 2018) that if the climate system remains in a phase-locked state of period 3 years there will be an El Niño maximum at about November 2018. If that happens, there could be another El Niño maximum at about November 2021.

Keywords

Climate Shifts, Climatology, El Niño, Phase Locking

1. Introduction

The climate phenomenon known as El Niño is of great interest. See Philander [1]. A recent detailed study was published by Douglass, Knox, Curtis, Giese and Ray (DKCGR) [2] who studied the central Pacific sea surface temperature (SST) index SST3.4, which was introduced by Barnston *et al.* [3] and is commonly used as a proxy to study the El Niño/La Niña phenomena.

DKCGR found 18 distinct time segments of SST3.4 that showed sinusoid-like oscillations of period 2 or 3 years. The periodicities (2 or 3 years) and duration of these phase-locked segments were determined by the autocorrelation method (AM). In this method, if the time segment contains a periodic signal then the

delayed autocorrelation function of the signal will show a maximum at a delay equal to the period. The ends of the phase-locked segments are also determined. In addition, the end dates are close to the dates of climate shifts reported in [4]. The reason for the climate shifts is not known although Douglass [5] has suggested that the phase-locked sates may have upper and lower stability limits similar to the stability limits of the subharmonics of the 1-D nonlinear harmonic oscillator. See [6]. These oscillations are associated with the subharmonics of a climate forcing of Solar origin. Also, DKCGR defined an El Niño as the positive maximum of the anomaly index $aSST3.4$ (see next section) and found that the El Niños all were in these phase-locked segments. A total of 40 El Niño episodes since 1872 were found. Their list included all prior reports of El Niños.

El Niño episode 40 is in a phase-locked state of period 3 years and as of this date (September 2018) is ongoing.

Note: A link to the DKCGR paper is given at the end of the references.

2. Data

The basic data is the same SST3.4 as in DKCGR. One needs to create an anomaly index from $SST3.4$; Barnston *et al.* [3] created an anomaly index $Nino3.4$ by the "climatology method". However, it was shown that $Nino3.4$ contains false signals and a better anomaly index was created [7]. The first step is to remove the strong annual signal. This is achieved by applying a 12-month digital running average filter to $SST3.4$. This filter removes not only the annual signal, but also the harmonics. The particular filter used is a 6-1-5 filter where the center is on the "1".

An anomaly $aSST3.4$ is created by subtracting a 30-year average of $SST3.4$. From its definition the index $aSST3.4$ ends (March 2018) before the end (August 2018) of $SST3.4$.

How can the information in the 5 data valises be beyond to extend aSST3.4? R. S. Knox has proposed a data series of 5 values beyond the end of $aSST3.4$ that he calls "tapered average," which uses fewer than 12 values in the average. Specifically, he bases the final five months on modified filtered data: each point is taken as the average of points ending at the latest point of $SST3.4$ and beginning at the point symmetrically before it. Example: the point 4th from the end is averaged starting with the point 7th from the end. We will call this series $aSST3.4\_K$.

The $SST3.4$ data may be downloaded at [8].

3. The Most Recent Phase-Locked Segment

DKCGR identified eighteen phase-locked segments, the last one (labeled segment 11) began in 2009.

Figure 1 shows $aSST3.4$ (red) from 2007 through March 2018 and the 5 vaues of the Knox index $aSST3.4\_K$ (see Sec. 2). This time interval includes sagment 11. In DKCGR it was reported that $aSST3.4$ entered a phase-locked state of period 3 years in early 2009. This phase-locked segment is labeled segment 11, in
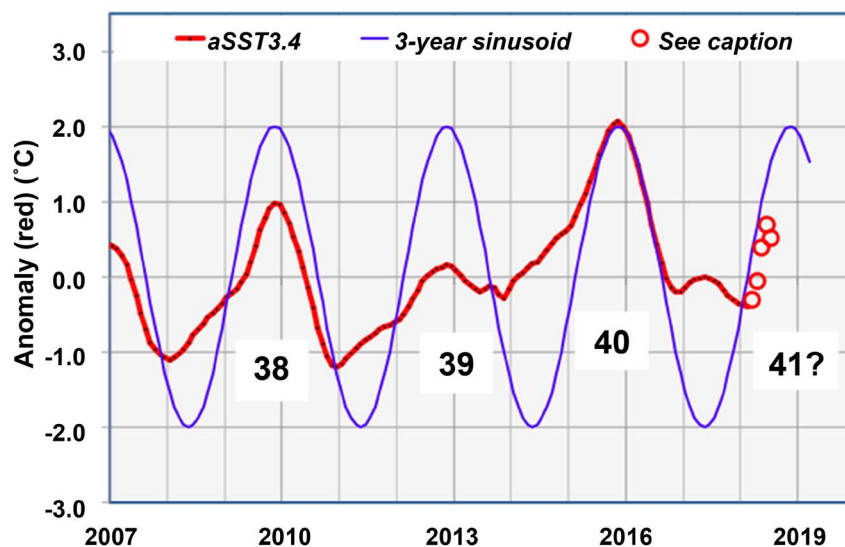
Figure 1. Update of the DKCGR data in *aSST*3.4 segment 11, showing the probable approach to a fourth El Niño in November 2018. Data for the solid red curve are 12-month centered running averages. The red circles are partially filtered (see Sec. 2). The blue curve is a sinusoid of period three years for reference.

which three maxima occur during November of 2009, 2012, and 2015. These 3 maxima are El Niño episodes 38, 39 and 40. If the phase-locked state in segment 11 persists then we would expect a 4th maximum (El Niño) during November of 2018.

Also shown is a sinusoid of period three years whose maximum was set at November. We note that *aSST*3.4 is periodic of period three years but the signal is not a pure sinusoid. One sees that the Knox data are increasing parallel to the sinusoid.

Will *aSST*3.4 show a 4th maximum (El Niño) at about November 2018? We will not know until *SST*3.4 data though to about February 2019 has been measured. We can say, however, that if a maximum (El Niño) occurs during November 2018, segment 11 continues and the possibly of a 5th El Niño during boreal winter of 2021 arises. Conversely, no maximum in November 2018 means the phase-locked state in segment 11 has certainly ended and a climate shift may well have occurred.

4. Summary

It was stated (in December 2016) by DKCGR: "If the climate system remains in this state, the next El Niño is likely to occur during boreal winter of 2018." As of this date (September 2018), it does appear that a 4th El Niño may occur then. If that happens, there could be a fifth El Niño maximum at about November 2021.

Acknowledgements

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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