Correlation between El Niño Southern Oscillation Index and Variations of Normalized Difference Vegetation Index in the Northeast North Carolina

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ABSTRACT

When trade winds over a region called NINO 3.4 in the Pacific Ocean are reversed and the sea surface temperature warms over several months in the area it is called an El Niño Southern Oscillation (ENSO). The purpose of the project is to observe how the ENSO can affect northeast North Carolina's vegetation. The sea surface temperature (SST) of NINO 3.4 region will be used because it is the common index used to measure for El Nino. Normalized difference vegetation index (NDVI) for northeast North Carolina will be used, because it reveals the amount of vegetation present in the area of interest. The data was collect from the National Aeronautics and Space Administration dataset website, Giovanni, from the years of 2002-2016 for both the SST and the NDVI. After the data was collected the linear and nonlinear regression for SST versus time, NDVI versus time and SST versus NDVI was created, to show the correlation of the data and whether it had a seasonal variation. The linear regression of both SST versus time, NDVI versus time and SST versus NDVI R squared indicates the correlation were weak, but they still correlate because of the P-values which were good. The nonlinear regression reveals SST having a weak correlation and weak seasonal variation, but NDVI data indicated a strong correlation and a seasonal variation. Overall ENSO and NDVI is shown to have a weak correlation.

INTRODUCTION

An El Niño Southern Oscillation (ENSO) is when the trade winds over a region in the Pacific Ocean known as area NINO 3.4 are reversed and the sea surface temperature (SST) in that area warm slightly over several months. This is an irregular occurrence that develops in late December. Even though it begins in the Pacific Ocean it can cause catastrophic weather worldwide, such as fires, droughts and flooding. In this project the area of interest is northeast North Carolina.

The question was what effects can an ENSO have on vegetation? Vegetation can be effected by the amount of rain that was received in an area, or the temperature conditions in an area. In North Carolina during an El Niño, it can produce more rain and the temperatures can fluctuate. The goal of this project was to see how the ENSO can affect northeast North Carolina's vegetation. This was done by using NINO 3.4 Index sea surface temperature (SST) and the normalized difference vegetation index (NDVI). The reason NINO 3.4 region was used was because it was the common index used to measure the SST for El Niño. The location where the NINO 3.4 Index was located is 120 W – 170 W, 5N-5S. The years of the ENSO that occurred during the years that the data that was collected showed were the years 2002-2003, 2004-2005, 2006-2007, 2009-2010, and 2015-2016.

NDVI is calculated by satellite and shows how much vegetation was present on a portion of the Earth at a period of time, normally observed monthly. The satellite can pick up the wavelength that showed how

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dense that wavelength was in a location and show the amount of vegetation in a general area. The satellite can pick up on this because plants does photosynthesis and the satellite can see the amount of chlorophyll in the plant leaves and can detect the visible light from 0.4 to 0.7 ụm. Plants that have more green leaves absorb most of the red light that hits it and it absorbs less near infrared light. The NDVI area that was observed was northeast North Carolina, which the exact location in North Carolina was 35.45N-36.54N, 78.002W-75.87W.

METHODOLOGY

I. COLLECTING DATA

The data of the SST of NINO 3.4 Index came from the year's July 2002 to February 2016 and NDVI of northeast North Carolina July 2002 to March 2016 from the National Aeronautics and Space Administration (NASA) dataset website Giovanni "The Bridge Between Data and Science". For both SST of NINO 3.4 Index and NDVI of northeast North Carolina the time series area-averaged was used and the platform type was the MODIS Aqua satellite. The SST used the 4 micron day and night 4km for its dataset.

II. LINEAR REGRESSION

The next step in the project was to create the linear regression for the SST versus NDVI, SST versus time and NDVI versus time. The purpose of using linear regression was to show if there an increase, decrease or no change in the data. It also showed correlation between the two data. The most important information in the linear regression were the R Squared and the P-value. The R Squared showed the correlation of the data, which the closer the number is to one means the stronger the correlation, but the closer the number is to zero it means the weaker the correlation. The P-values shows what the probability of the intercept and the x variable is equal zero. The higher the P-value is the closer it is to zero and the lower it is there is a high chance it is not equal to zero. The software used to create the linear regression was Microsoft Excel. First NDVI and time was used to see if there was a correlation. Then SST and time was used to see if there was a correlation and lastly NDVI and SST was combined to see if there was a correlation.

III. NONLINEAR REGRESSION

The purpose of the nonlinear regression was to show the seasonal variations of the data. The important information in the nonlinear regression were the R Squared, the b variable and the P-values. The R Squared and P-values were the same as the linear regression, but the b variable showed if there is a seasonal variation. The closer it was to 365 it will mean there is a season variation. The software used to do the nonlinear regression was Sigma Plot. Only SST versus time and NDVI versus time was done for the nonlinear regression.

RESULTS

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SUMMARY OUTPUT	
Regression Statistics	
R Square	0.01(
	Coefficient
Intercept	23.64
X Variable 1	0.00(

Table 1: Linear Regression of SST

SUMMARY OUTPUT	
Regression Statistics	
R Square	0.000
	Coefficients
Intercept	0.691
X Variable 1	0.000

Table 2: Linear Regression of NDVI

SUMMARY OUTPUT	
Regression Statistics	
R Sqr	0.0006
	Coefficients
Intercept	0.6914
X Variable 1	0.0000

Table 3: Linear Regression of SST vs. NDVI

Data Source: Data 1 in Notebook1

Equation: Waveform, Sine, 4 Parameter

f = y0+a*sin(2*pi*x/b+c)

R sqr		
0.1913		
	Coe.	P
a	0.6648	<0.0001
b	1127.8416	<0.0001
c	4.7387	0.2968
y0	26.6947	<0.0001

Table 4: Nonlinear Regression of SST

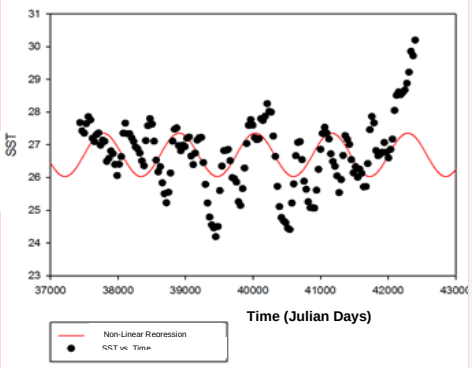

Figure 1: Nonlinear Regression SST of NINO 3.4 Index in Julian Days

Data Source: Data 1 in Notebook1		
Equation: Waveform, Sine, 4 Parameter		
f = y0+a*sin(2*pi*x/b+c)		
R sqr		
0.9374		
	Coe.	P
a	0.1426	<0.0(
b	366.2723	<0.0(
c	-6.2800	<0.0(
y0	0.6215	<0.0(

Table 5: Nonlinear Regression of NDVI

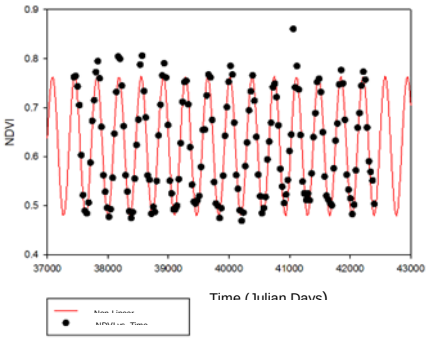

Figure 2: Nonlinear Regression of NDVI of the northeast of North Carolina in Julian Days

DISCUSSION

After doing the linear regression it revealed there was a weak correlation between the sea surface temperature and time. This was shown from the R squared which was very low and being close to 0. The P-values however were low, so since they were low it means that the intercept and the x-variable had a high chance of not equaling to zero. The nonlinear regression showed there was not a seasonal variation. This was shown by the low R squared being 0.1913 and the b coefficient, which it supposed to be close to 365 to show seasonal variation, was 1127. The belief was because of the El Niño and La Niña that was why there was not a correlation.

After conducting the linear and nonlinear regression for the NDVI we concluded that there is a seasonal variation for NDVI. The nonlinear had a higher R squared value showing that correlation for the seasonal variation. The R squared for the linear regression was low showing a weak correlation but the P-value for the x-variable was high and the intercept was low.

After inserting the NDVI and SST together and performed a linear regression it showed weak correlation. The R squared and P-values were low. This means there was a weak correlation between the two, because of the R squared. The P-value for the intercept was low so it is a high chance it is not equal to zero, but the P-value was higher for the x variable 1 which means there is not a low probability of it not being zero. Then we reviewed the nonlinear graphs to see if there was a correlation with whether a two months after an ENSO effected the vegetation and there was not a correlation with that.

FUTURE WORK

Does El Niño or La Niña have any effect on extreme weather in northeast North Carolina, such as the rainfall, drought, or tornadoes? We choose this because many sources have said that El Niño has effect on the upper atmosphere and changes the weather pattern. The changes of the weather patterns has effect on different weather events and we wanted to see if that correlated our area specifically.

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