Climate Alphabet Soup

Caribbean climate is driven by a number of large scale systems spanning both the Atlantic and Pacific Oceans. These systems oscillate with periodicities of months or years, and help to determine the cyclical nature of the region's temperature and rainfall. The most well-known of these drivers is the El Niño-Southern Oscillation, which will be the focus of this exercise. Below is information on El Niño, after which a table is provided to show other such systems.

What is El Niño?

El Niño conditions refer to periods when the eastern Pacific Ocean off the coast of Peru and Ecuador is abnormally warm. La Niña refers to the opposite conditions when the eastern Pacific Ocean is abnormally cold. In normal conditions, when neither El Niño or La Niña are present, very warm sea surface temperatures are found only in the western Pacific Ocean while cold water upwells in the east, as shown in Figure 3.7.1. This warm surface results in atmospheric convection or rising air in the west, while the air sinks in the east. The resulting atmospheric circulation, shown in blue, is called the Walker circulation. In El Niño conditions the pool of warm water expands into the central and eastern Pacific, cutting off the upwelling, as shown in Fig. 3.7.2. The atmospheric circulation (blue) has changed and the area of atmospheric convection has now shifted to the coast of South America. El Niño events and normal conditions are caused by a seesaw pattern of ocean circulation, with warm water moving from west to east, then looping back from east to west. When warm water loops back from eastern to western Pacific (normal conditions) cold water will move from western to eastern Pacific. Sometimes the eastern Pacific then becomes colder than usual leading to a La Niña. El Niño events have a return cycle of about 3 to 5 years.

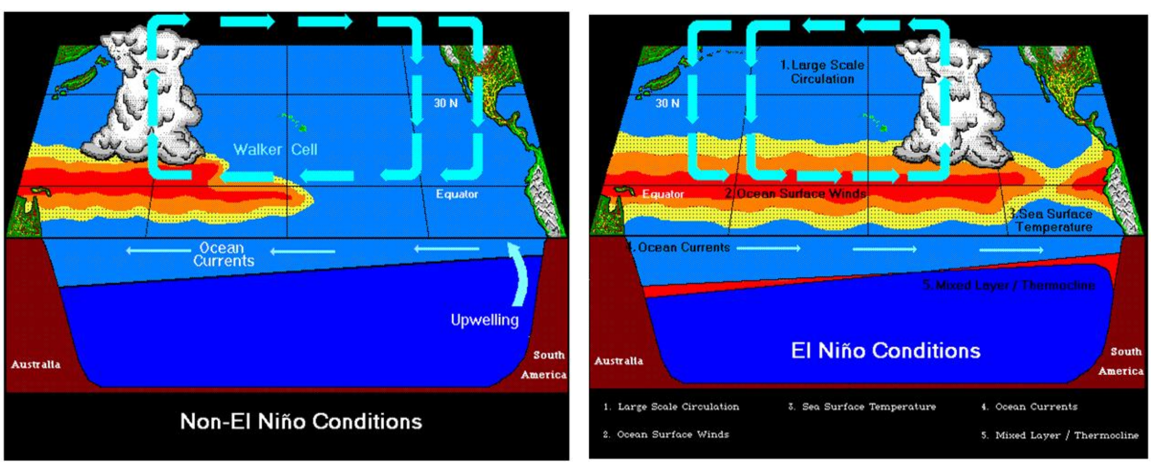

Figure showing Schematic diagram of the most common mode of circulation in and above the tropical Pacific Ocean (left panel); during an El Niño event (right panel). Source: http://www.unc.edu/courses/2008ss2/geog/111/001/ClimateForecasts/ClimateForecasts.htm

Table showing some of the Pacific and Atlantic systems that influence Caribbean rainfall variability and trends (Source: State of the Jamaican Climate 2012. PIOJ).

Ocean-Atmosphere Pattern	Comments	Caribbean	Some References
El Niño	• Warmer than normal eastern Pacific sea surface temperatures	• Caribbean drier and hotter than normal during year of onset • Diminished tropical Atlantic hurricane activity • December to March rainfall below normal in the south Caribbean and above normal in the north Caribbean; Jamaica is in the transition zone • May-July rainfall over Caribbean above normal in the year following onset	Gray, 1994 Chen et al., 1997 Giannini et al., 2000 Chen and Taylor, 2002 Taylor et al, 2002 Martis et al., 2002 Spence et al., 2004 Ashby et al., 2005 Stephenson et al, 2007 Jury et al., 2007
La Niña	• Cooler than normal eastern Pacific sea surface temperatures	• On average opposite effect with respect to an El Niño	See El Niño References
Atlantic warm pool	• Warmer than normal Atlantic ocean temperatures	• Caribbean wetter than normal	Wang and Enfield, 2001 Taylor et al, 2002 Wang and Enfield, 2012
North Atlantic Oscillation (NAO)	• Opposing pressure variations between Iceland and Azores • Modulates the behaviour of El Niño	• Positive NAO phase implies a stronger than normal NAH and amplifies the drying during a warm ENSO • Negative NAO phase amplifies the precipitation in the early rainfall season in the year after an El Niño	Giannini et al., 2001 Charlery et al., 2006 Jury et al., 2007 Jury, 2009
Atlantic Multidecadal Oscillation (AMO)		• Positive AMO amplifies tropical Atlantic hurricane activity	Goldenburg et al., 2001
Caribbean low level jet	• Wind intensification south of Jamaica below 600 hPa • Primary peak in July • Secondary peak in February	• Stronger than normal low level jet associated with drier Caribbean	Munoz et al., 2008 Whyte et al., 2008 Wang, 2007

Climate Alphabet Soup Exercise

This exercise will examine two (2) simple ways of finding the relationship between your country's rainfall and El Niño. The Nino3 index is often used to capture SSTs over the pacific, and will be used for this exercise.

Open the ***Climate Alphabet Soup Worksheet*** provided. Data are presented as seasonal anomalies, which are deviations from the mean climate.

Correlation

The first is correlation, which is a measure of dependence between two variables. Correlation values range from -1 to 1, where -1 represents a strong inverse relationship, 1 represents a strong direct relationship, and 0 indicates no relationship. For example, a value of 1 indicates that as Nino3 increases, so does rainfall.

To find the correlation, the function *correl* can be used. To use this function, type '=correl(time series 1, time series 2)', where rainfall would be highlighted as time series 1 and Nino3 as time series 2.

Linear Regression

Another method is to determine the equation of a model relating rainfall and Nino3. For this, we can do a linear regression using the function *slope*. To use this function, type '=slope(Y,X)', where Nino3 would be highlighted as X (the predictor) and rainfall as Y (the predictand).

The new model equation would then be (*slope* x *rainfall*) + *intercept*, where the function *intercept* calculates the point at which the graph crosses the y-axis.

Now make your own alphabet soup!

1. We will begin by copying your country's rainfall data from the ***Anomalies*** folder to the desktop. The data format now reflects seasons rather than months.

2. Paste observed seasonal data for your country for a 10 year period into the table labeled ***Exercise*** in the column Rainfall. Once that is done, copy Nino3 values from the sheet labeled ***nino3*** (in the same file) for the corresponding period and paste into the Nino3 column.

3. Below ***Exercise*** is a master table, in which the *correl*, *slope* and *intercept* functions have already been entered. This table examines the relationship between each season of Nino3 and each major rainfall season, namely MJJ (early wet), ASO (late wet) and NDJ (dry). Predictions will automatically be generated.

4. Plot your actual MJJ rainfall against the predicted rainfall of the Nino3 season with the strongest relationship.

5. Repeat with ASO and NDJ rainfall and corresponding Nino3 predictions.

6. Answer the following questions:
    a. Is there any influence of Nino3 on your country's rainfall throughout the year? When is it strongest?
    b. How can knowledge of a climatic relationship help in local forecasting of climate variables?
    c. Give one comment on each of your three (3) graphs. Would you trust any of your models?