Detective Name_____ Class Period_____

El Niño and La Niña: Criminals of Climate

Objective: You will determine and identify past El Niño and La Niña events by analyzing qualitative and quantitative data.

Introduction: Welcome to Criminal Climatology Bureau (CCB), where crimes against the climate are solved to ensure a greener future! As you detectives know by now, climate is affected by several different factors. These factors include:

- Latitude
- Altitude
- Prevailing Winds
- Large Bodies of Water
- Mountain Ranges

Between every two to seven years two mysterious forces affect the climate drastically. These forces are a brother and sister team that go by the nicknames El Niño and La Niña. These two siblings pack a serious punch to climate but in two very different ways. Read the short profile on each below.

El Niño: **Crimes committed**: Creates Cool Wet areas in the Western Pacific leading to Droughts, Wild Fires and lack of food. In the Eastern Pacific, he causes flooding to Central America and Southern United States. In the Northern United States, he causes warm weather and deprives students of snow days.

How does he commit his crimes? He weakens surface winds causing warm ocean water to move from the western Pacific to build up on the shores of the Eastern Pacific.

La Niña: **Crimes committed**: Creates Warm Dry areas in the Western Pacific leading to Flooding, Strong Monsoons and lack of food. In the Eastern Pacific, she causes very dry weather to Central America. In the United States, she causes blizzards with her biting cold and love for snow.

How does she commit her crimes? She strengthens surface winds causing very cold ocean water to be brought up to the surface on the Eastern Pacific Coast.

Instructions: As the brightest team the CCB has, you will work with your team to review four different case studies to determine who committed each crime against the climate. You will be given a folder for each case, inside the folder you will find:

- A case study
- SST(Sea Surface Temperature) Map
- A Global Diagnostic Map

Using these three items determine which sibling committed the crime. For each case write the name of the case, who committed crime (Perpetrator), and three pieces of evidence to support your decision. In addition, locate and label the areas affected by the ENSO event of the map given.

Crime Sheet

Case Name_____ Perpetrator (El Niño or La Niña)_____

Evidence

- _____
- _____
- _____

Location of event

Case Name_____ Perpetrator (El Niño or La Niña)_____

Evidence

- _____
- _____
- _____

Location of event

Case Name_____ **Perpetrator (El Niño or La Niña)**_____

Evidence

- _____
- _____
- _____

Location of event

Case Name_____ **Perpetrator (El Niño or La Niña)**_____

Evidence

- _____
- _____
- _____

Location of event

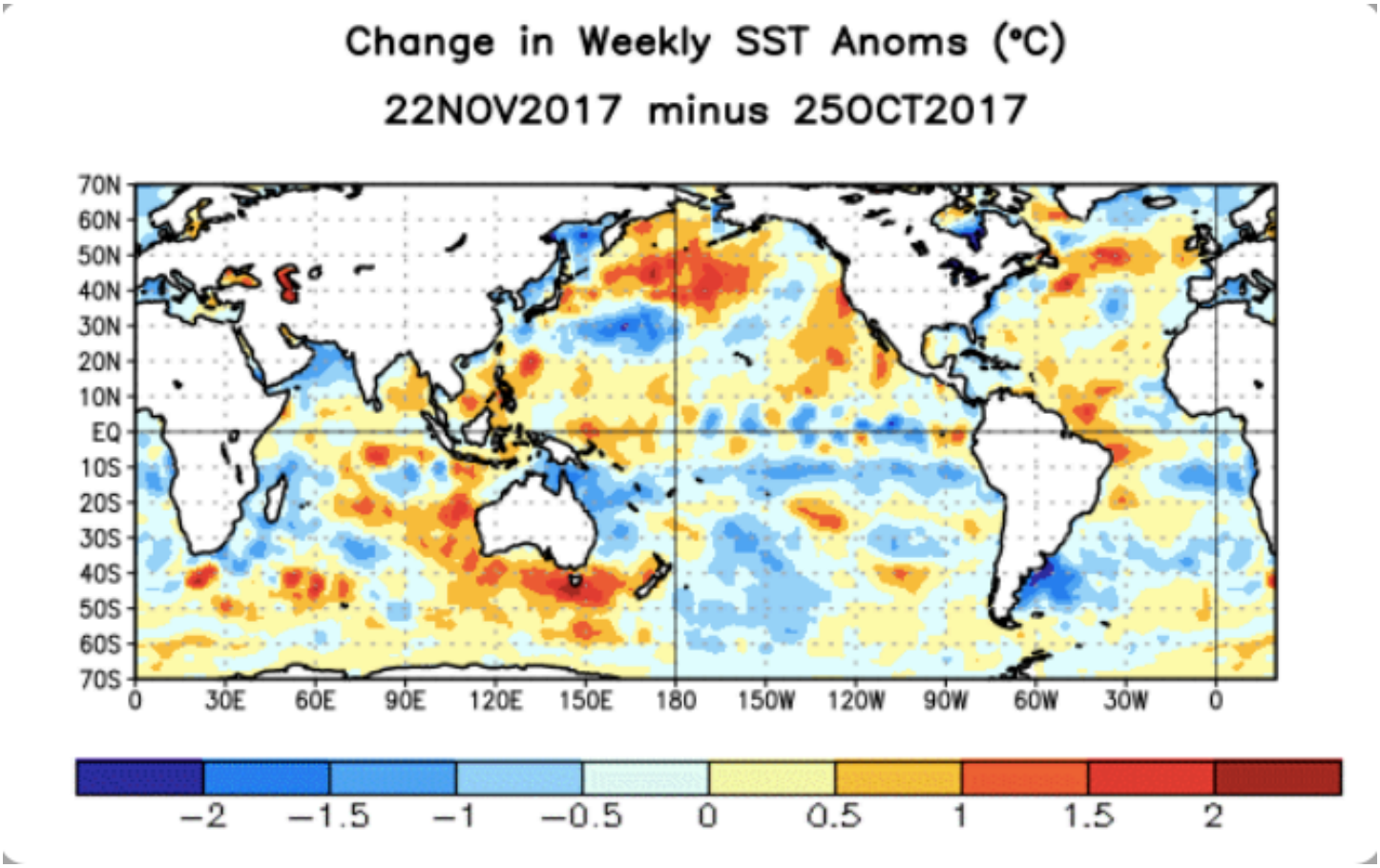
Conclusion:

Analyze the image below (a colored copy is available on google classroom) created based on the average sea surface temperature data taken from October 25, 2017 until November 22, 2017.

a. What ENSO event (El Niño or La Niña) do you predict this Winter? _____

b. What evidence did you use to make your decision? _____

_____



Name: ENSO EVENT 1997

Date: December 1997

Location: Australia and North America

Description: After weeks of stifling hot temperatures of over 1000 F and very little rain, a huge wildfire blazes through Queensland, Australia. Fire Fighters and Government officials believe that a portion of land the size of Rhode Island (1,212 square miles) can burn. Officials expect the damages to cost over 60 million dollars.

Overall, the winter (December 1997- February 1998) was the second warmest and seventh wettest since 1895. Severe weather events included flooding in the southeast, an ice storm in the northeast, flooding in California, and tornadoes in Florida. The winter was dominated with wetter than normal conditions across much of the southern third of the country and warmer than normal conditions across much of the northern two-thirds of the country.

Name: ENSO EVENT 2007

Date: 2007

Location: United States

Description: A strengthening Oscillation also has implications for weather in the United States. In the fall of 2007, this was particularly true for the American Southwest, which had already experienced unusually dry conditions. Bill Patzert explains of NASA's Jet Propulsion Laboratory. "It keeps the Pacific jet stream farther north, toward Oregon, Washington, and Canada, so the U.S. Southwest and Southeast get less moisture." Southern California received just 8.1 centimeters (3.2 inches) of rain during the winter of 2006– 2007, making it the region's driest winter in 130 years. Patzert also cited eight consecutive years of dry conditions in the Colorado River watershed "This is the least amount of flow on the Colorado River in a century," he said.

Name: ENSO EVENT 2011

Date: Winter, 2011

Location: MidWest

Description: The January 31 – February 2, 2011 North American winter storm, also called the 2011 Groundhog Day Blizzard was a powerful and historic winter storm, situated around the United States and Canadian on Groundhog Day. The storm is the most recent winter storm to rank as a Category 5 on the Regional Snowfall Index. During the initial stages of the storm, some meteorologists predicted that the system would affect over 100 million people in the United States. The storm brought cold air, heavy snowfall, blowing snow, and mixed precipitation on a path from New Mexico and northern Texas to New England and Eastern Canada. The Chicago area saw between 1 and 2 feet of snow and blizzard conditions, with winds of over 60 mph. With such continuous winds, the Blizzard kept going north and affected Eastern and Atlantic Canada. The most notable area affected in Canada was Toronto and the Greater Toronto Area. Blizzard conditions affected many other large cities along the storm's path, including Tulsa, Oklahoma City, Kansas City, St. Louis, Springfield, El Paso, Las Cruces, Des Moines, Milwaukee, Detroit, Indianapolis, Dayton, Cleveland, New York City, New York's Capital District, and Boston.] Many other areas not normally used to extreme winter conditions, including Albuquerque, Dallas and Houston, experienced significant snowfall or ice accumulation. The central Illinois National Weather Service in Lincoln, Illinois issued only their fourth blizzard warning in the forecast office's 16-year history. Snowfall amounts of 20 to 28 inches were forecast for much of Northern and Western Illinois.

An ice storm ahead of the winter storm's warm front also brought hazardous conditions to much of the American Midwest and New England, and many areas saw well over 1 in (2.5 cm) of ice accumulation. Numerous power outages, flight cancellations, airport closures, road closures, roof collapses, rail and bus cancellations, mail stoppages, and school, government, and business closures took place ahead of and after the storm; many of these disruptions lasted several days. Several tornado touchdowns were reported in Texas and a tornado watch was issued for parts of Alabama ahead of the cold front in the warm sector of the storm. In addition, thundersnow (winter thunderstorm) was recorded at some locations, increasing the overall snowfall rate. At least 24 deaths were reported to be related to the storm, many of them in shoveling or auto-related incidents. The total damages from the ice storm alone may exceed $1 billion USD.

Name: ENSO EVENT 1988

Date: December 1988

Location: North America

Description: Scientists observed a series of processes that the cold surface temperature anomaly set into motion that made it directly responsible for the severe North American drought in the Great Plains region. They found that the atmospheric circulation patterns leading to the dry spell began in April of that year, about 10 days before the onset of the drought, and persisted through June.

Name: ENSO EVENT 1982 Date: December 1982 Location: United States Effects on the U.S. and other parts of the world including floods in some places and drought in others that weren't seen as related at the time. In the U.S. these included a cooler and wetter than average winter across South while the North was warmer and drier than average.

Elsewhere, its effects included an unusually large numbers of central Pacific hurricanes with five hitting French Polynesia and the strongest hurricane on record, up to that time to hit Hawaii, Iwa, which was that year's 12th eastern Pacific hurricane. In contrast, only six tropical storms formed in the Atlantic Basin that year and only two became hurricanes.

Name: ENSO EVENT 2015

Date: May 2016

Location: Australia

Description: The Bureau of Meteorology, which was the first to declare the ENSO event had begun a year ago, on Tuesday said sea-surface temperatures in the tropical Pacific had dropped back to neutral conditions. Other indicators, such as the resumption of the typically westward-blowing tradewinds, also supported proof of the event's demise.

"Outlooks suggest little chance of returning to ENSO levels, in which case mid-May will mark the end of the 2015-16 ENSO year," the bureau said in its fortnightly update.

As predicted, the stalling of the Pacific trade winds had led to a massive build up of warmth in Pacific waters. During the 2015 year, the ocean took in less heat from the atmosphere, providing a natural spurt to temperatures that built on the background warming from climate change.

Globally, the past 12 months have each set a record for that month, with four of the past five months smashing records for how much temperatures have departed from the long-term norms.

"The last 12 months to April have been the warmest on record for Australia," Dr Braganza said. "And this month's been pretty warm too."

The typical drop in rainfall for eastern and southern Australia associated with an ENSO event has also been in evidence, with many inland regions unusually dry.

Name: ENSO EVENT 2009

Date: 2009

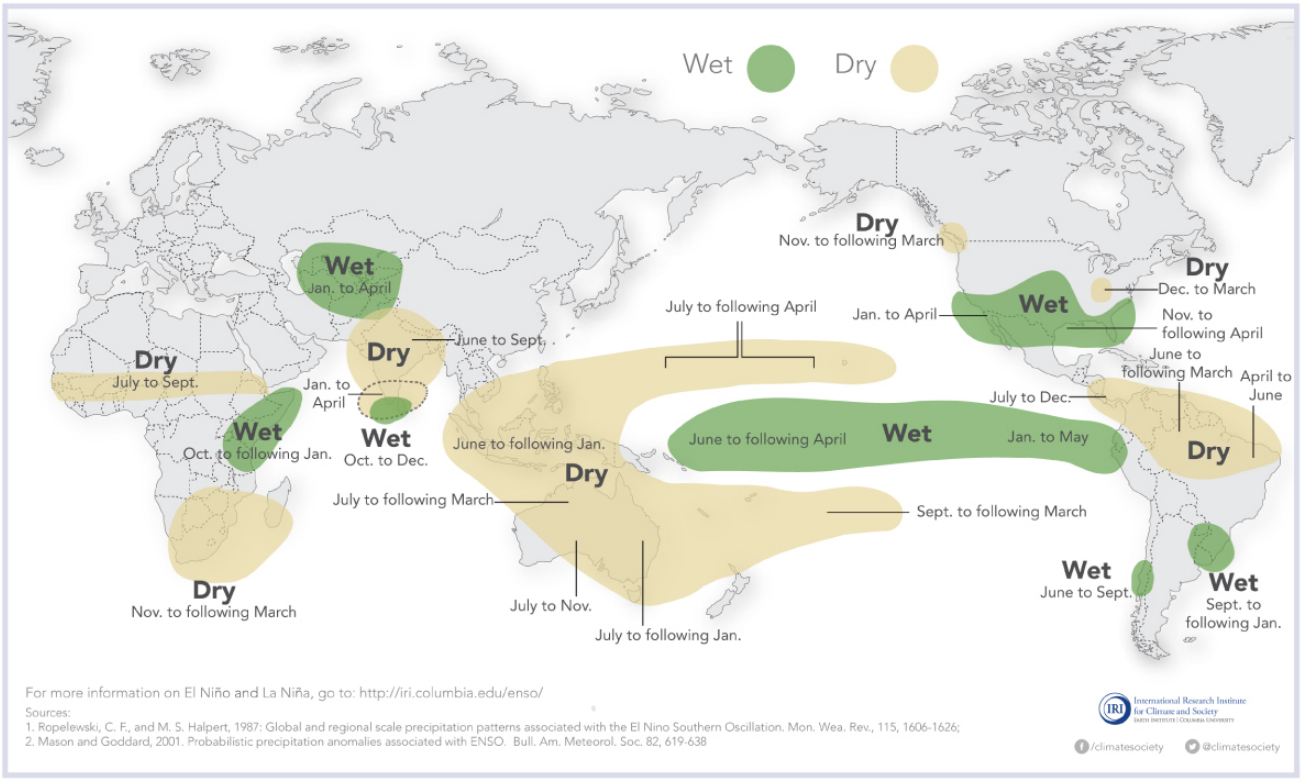
Location: United States

Description: An Oscillation event developed in the fall of 2009 and persisted through the winter. Historically, the Pacific Northwest experiences drier and warmer winters. True to form, this winter was warmer and drier than normal in WA. Mean temperatures were between 1 and 3 degrees F above normal for each of the WA climate divisions and precipitation totals were between 4 and 13 inches below normal for the western half of the state and between 1 and 4 inches below normal for the eastern half. The Olympic Peninsula was an exception with near-normal precipitation). There is a somewhat more complicated story with regards to snowpack for WA this year. Had winter been defined as only December through February, the snowpack would have been drastically below normal for the season. Fortunately, a series of late season storms in late March and early April produced a marked increase in snowpack. Some locations (i.e., Hurricane Ridge, Mount Baker, Paradise, and Timberline) got up to 45" of new snow between March 1 and April 15 (mountain snow). By April 22, the snow water equivalent (SWE), i.e., the amount of water contained in the snowpack, rose to roughly 80% of normal for the Cascades as a whole, and actually above normal in the Olympic Mountains. On the other hand, the SWE remained considerably below normal in the Spokane and Lower Snake regions in the eastern portion of the state.

One of the largest ENSO events in 50 years likely delivered to the region relatively warm air and clouds, which help seal in heat, according to the study, published in the journal Nature Communications.

El Niño and Rainfall

El Niño conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one El Niño to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.



La Niña and Rainfall

La Niña conditions in the tropical Pacific are known to shift rainfall patterns in many different parts of the world. Although they vary somewhat from one La Niña to the next, the strongest shifts remain fairly consistent in the regions and seasons shown on the map below.