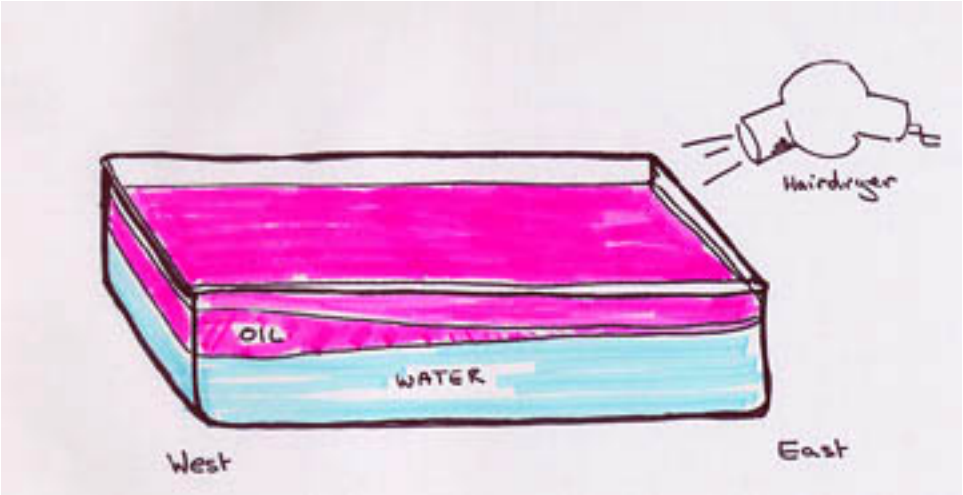
My NASA Data - Lesson Plans

Make Your Own El Niño in the Classroom



Overview

Check out this hands-on demonstration of the El Niño Effect, trade winds, and upwelling provided by NASA's Jet Propulsion Lab

Credit: JPL's Sea Level Program

Learning Objectives

- Model changes in the Pacific Ocean during the El Nino Event
- Analyze changes of sea surface temperature
- Communicate arguments based on evidence

Why Does NASA Study This Phenomenon?

Weather and climate change through complex links between the oceans and the atmosphere. Sources of variability in weather and climate around the world are changes in water currents, atmospheric pressure, and temperature in the oceans, especially the Pacific Ocean. These changes in the Pacific are often referred to as the El Niño Southern Oscillation, or ENSO. If you want to understand how interconnected our planet is—how patterns and events in one place can affect life half a world away—study the ENSO phenomenon.

Two types of changes are referred to as El Niño and La Niña.This lesson focuses on El Nino which is a condition that sometimes occurs in the Pacific Ocean, but it is so big that it affects weather all over the world. NASA works with the National Oceanic and Atmospheric Administration (NOAA) and other scientific institutions to track and study ENSO in many ways. From underwater floats that measure conditions in the depths of the Pacific to satellites that observe sea surface heights and the winds

high above it, scientists now have many tools to better understand ENSO events.

Although El Niño events are complex and evolve differently—as do their impacts and teleconnections—improved predictions would help communities to prepare for likely impacts and to minimize disruptions. With more advanced warning, resource managers and civic leaders could make adjustments to how they manage fisheries, which crops to plant, what resources to allocate to combating mosquitoes, and when to raise awareness of risks such as fire or mudslides. The United Nations (U.N.) Office for the Coordination of Humanitarian Affairs reported in April 2016 that 60 million people across Africa, Asia, the Pacific, and Latin America needed food assistance due to weather extremes from the 2015-16 El Niño. Looking back at 1997-98, the U.N. attributed more than 20,000 deaths and $36 billion in infrastructure damage to that El Niño. With the help of NASA and others, an improved understanding of this event may help mitigate these losses.

Essential Questions

- How is energy transferred among the various spheres of the Earth System?
- What other parts of the Earth System may experience the effects of El Nino and how?
- How are the different spheres of the Earth System affected by El Nino?

Cross-Curricular Connections

- 8th Grade 7.1: The physical processes that shape the patterns of Earth's surface: The four components of Earth’s physical systems (the atmosphere, biosphere, hydrosphere, and lithosphere) are interdependent
- 8th Grade 8.2: Characteristics and Geographic Distribution of Ecosystems: Physical processes determine the characteristics of ecosystems
- 12th Grade 7.1: The physical processes that shape the patterns of Earth's surface: The interactions of Earth's physical systems (the atmosphere, biosphere, hydrosphere, and lithosphere) vary across space and time.

Materials Required

- Clear plastic oblong container (approx. 18"x4"x4", smaller will work, food containers are ideal),
- Water,
- Mineral oil,
- Blue food coloring,
- Hair dryer
- (Red Oil-based Paint - optional)
- Paper sheet map showing the Pacific Ocean

Set-up time: Less than 5 min.

Student Misconception

Misconceptions about El Niño

- Misconception #1: All the impacts of El Niño are negative.
- Misconception #2: El Niño periods cause more disasters than normal periods.
- Misconception #3: El Niño and La Niña significantly affect the climate in most regions of the

globe.
- Misconception #4: Regions that are affected by El Niño and La Niña see impacts during the entire 8 to 12 months that the climate conditions lasts.¨
- Misconception #5: We should worry more during El Niño episodes than La Niña episodes.
- Misconception #6: The stronger the El Niño/La Niña, the stronger the impacts, and vice versa.
- Misconception #7: El Niño and La Niña events are directly responsible for specific storms or other weather events.
- Misconception #8: El Niño and La Niña are closely related to global warming.

Credit: NOAA Climate.gov

Procedure

Preparation:

- Fill the tray with water to within 1" of the top.
- Add blue food coloring to the water in until a nice "ocean blue". (Some of the food coloring will settle to the bottom which is fine because this will show the upwelling.)
- (Pour some mineral oil in a bowl and mix in some red oil-based paint until the oil is evenly colored. If you do not have oil-based paint, it does not affect the outcome - we don't use it in our demos here).
- Gently pour the oil over the surface of the water. (It's okay if it mixes a bit because it will separate out again.)
- Put the container on the paper and mark East and West at either end, Indonesia and South America.
- Plug in hair dryer, being careful to keep it away from any water spills.

Explanation of the Model: The liquids in the plastic container represent a slice across the Pacific Ocean in the vicinity of the equator. The oil (possibly colored red) represents the warm layer of surface water that has been heated by the sun. The blue water represents the colder water below the surface warm layer (Where the two layers meet is the thermocline). The hairdryer is about to represent the trade winds.

Action! (Stage 1)

1. Have a student hold the hairdryer (no heat needed) away from the top of the box to reduce risks to safety.
2. Direct student to turn on the 'trade winds' so that it blows across the surface of the oil-topped water from the East to the West.
3. Ask the class to describe what effect this has on the "warm" and "cold" water.

   Comments: Note that the "warm" water piles up in the West as it is blown by the "trade winds" (hair dryer). This is the normal condition for the equatorial Pacific Ocean. Discuss the location of the warm water on the globe. Discuss what will happen to the air above the warm water in terms of how much moisture the air can hold. (*Optional:* Have them design an experiment to test the relative moisture holding capabilities of warm and cold air). You may notice that the sediment of the blue food dye moves upwards towards the surface at the east end (this will only happen if there is a sediment). This is upwelling which, in the Pacific Ocean, brings nutrient-rich bottom waters to the surface. Plankton feed on the nutrients, and in turn fish feed on the plankton, so these areas tend to be rich in fish and other sea life.

Action! (Stage 2)

1. Direct student turn off the "trade winds" and ask the class to describe what happened when the trade winds stop. You may need to do this several times to observe the motion. The "warm" water pulses across the "ocean" from West to East, this pulse of water is the warm water effects of the El Niño phenomenon.
2. Describe that in your current model, a thick layer of warm water (oil) covers the surface in the East, this cuts off the nutrient-rich cold water from upwelling to the surface.
3. Ask students what the effect of this lack of upwelled water has on the marine ecosystem.
    - The "upwelling" (previously seen while the trade winds were blowing) is no longer present, reducing the nutrient-rich water to the ocean's surface. Upwelling brings cool, nutrient-rich water from the deep ocean up to the surface. El Niño conditions cause the local marine food web to experience loss of its usual food supply (phytoplankton). Historic observations from impacted coastal areas have shown that with less phytoplankton available, plankton have less to eat, as do the fish that feed upon plankton, and larger marine animals have a greatly reduced food supply. Past El Niños reduced fish stocks and have led to the decline of many marine animal populations.