



El Niño Implementation Sequence		
Phenomenon: El Niño	Guiding Question: How do Earth System variables interact when there is an El Niño event?	Contact: Reach out to the My NASA Data Team if you have questions.
Grade Level: 6-8		
Further Investigation: My NASA Data El Niño main website and the My NASA Data main website		
Revision Date: 2-16-2024		
Note to Teachers: The El Niño Implementation Sequence provides a series of lessons and activities for students to learn about a condition that sometimes occurs in the Pacific Ocean, but it is so big that it affects weather all over the world.		

Standards - These standards are supported by the activities in this guide but not completely covered.

<p>Performance Expectations:</p> <ul style="list-style-type: none"> MS- ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. 	<p>Disciplinary Core Ideas:</p> <ul style="list-style-type: none"> <i>DCIs are aligned to each activity below. Please note that the aligned activity may not fully address all components of the DCI.</i>
<p>Science and Engineering Practices:</p> <ul style="list-style-type: none"> Analyzing and Interpreting Data Developing and Using Models Engaging in Argument from Evidence 	<p>Crosscutting Concepts:</p> <ul style="list-style-type: none"> Cause and Effect Systems and System Models Energy and Matter Stability and Change



Background Information and NASA Connection

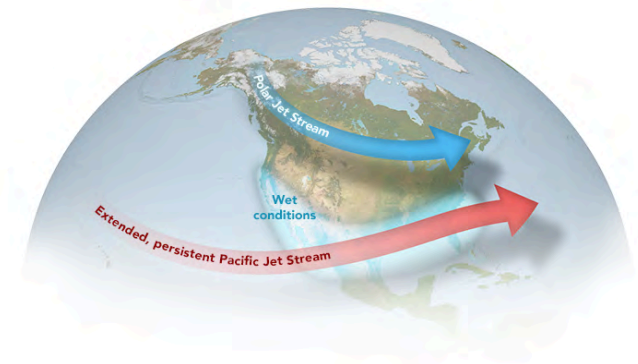
Every two to seven years, an El Niño event occurs typically between November and January. During El Niño events, strong winds along the equator shift towards the west coast of the Americas, pushing warm ocean water to this region. With warmer air and sea surface water reaching Central and South America, more clouds develop leading to increased precipitation. El Niño is one of the best phenomena to show students the interconnectedness of Earth Systems and even how these systems impact ecology.

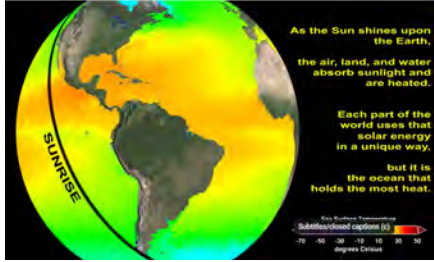
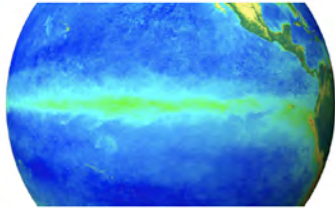
The scientific community has not yet uncovered what triggers El Niño. What we do know is that in normal years Easterly trade winds blow from the Americas toward Asia and Australia but during an El Niño year, these strong winds die down or reverse course becoming westerlies. In the “Make Your Own El Niño in the Classroom” lesson in this instructional sequence, students use a hair dryer to model the trade winds that drive the movement of sea surface water under neutral conditions and during an El Niño year.

Under normal conditions, warm surface water travels towards Australia and Southeast Asia which allows the upwelling of cold water along the Americas. The colder water is nutrient-rich and important to fish populations along the coasts of Peru and Ecuador. Warmer water in the East Pacific not only disrupts fisheries, it also raises sea surface height because it expands much more than cold, dense water.

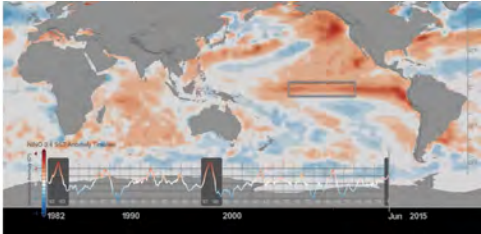
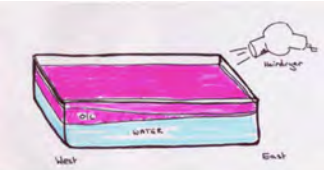
NASA is committed to collecting data on variables related to El Niño, including sea surface height, salinity, temperature, wind direction, and precipitation, because a larger time span of data allows scientists to make more accurate predictions of what to expect during future El Niño events.

Image Source: NASA Earth Observatory | [El Niño Pacific Wind and Current Changes Bring Warm, Wild Weather](#)

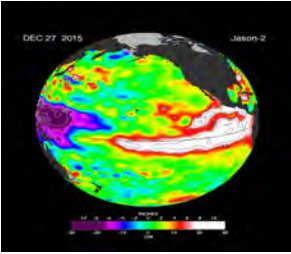


Day 1			
Time	NGSS Disciplinary Core Ideas	Learning Objective	Activity / Assessment
30 min	<p>ESS2.C: The Roles of Water in Earth's Surface Processes Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)</p>	<p>I can interpret a model to explain what happens to the temperature of the land and ocean over the course of the day and night.</p> 	<p>Mini Lesson: Energy and Matter: Water Cycle & The Ocean's Temperature Students review a video showing how the ocean is warmed by solar energy. This is the first video of a four-part series on the water cycle, which follows the journey of water from the ocean to the atmosphere, to the land, and back again to the ocean.</p>
Day 2			
Time	NGSS Disciplinary Core Idea	Learning Objective	Activity / Assessment
50 min	<p>ESS2.C: The Roles of Water in Earth's Surface Processes The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)</p>	<p>I can develop an argument, using data to justify how a variable is related to El Niño.</p> 	<p>Lesson Plan: Ocean Impacts of an El Niño Event Students will examine a 2014-2015 El Niño Southern Oscillation (ENSO) event to identify relationships among sea surface height, sea surface temperature, precipitation, and wind vectors. This activity employs a Jigsaw strategy where students analyze a single variable and then compare all four variables to analyze Earth System Essential Questions.</p>

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Day 3			
Time	NGSS Disciplinary Core Idea	Learning Objective	Activity / Assessment
30 min	<p>ESS2.D: Weather and Climate Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)</p>	<p>I can synthesize information from a video, maps, and my own research to determine how environmental changes caused by El Niño relate to the spread of disease.</p> 	<p>Mini Lesson: El Niño & Spread of Human Disease Students will review a NASA article and watch the associated video to use as a tool to compare with maps related to 2015-2016 rainfall and elevated disease risk, and answer the questions.</p>
Day 4			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
30 min	<p>ESS2.C: The Roles of Water in Earth's Surface Processes Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)</p>	<p>I can explain the movement of cold and warm water when trade winds weaken during El Niño.</p> 	<p>Lesson Plan: Make Your Own El Niño in the Classroom Students will develop a model that is a hands-on demonstration of the El Niño Effect, trade winds, and upwelling provided by NASA's Jet Propulsion Lab.</p>

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Day 5			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
30 min	<p>ESS2.D: Weather and Climate The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)</p>	<p>I can compare similarities and differences between two El Niño events.</p> 	<p>Mini Lesson: Creating an El Niño Poster Model Students will use coloring sheets to create a color coded model of El Niño, then make comparisons using the actual model by answering questions. If the Data Literacy Map Cube is used with this, students will color their models first.</p>
Additional Resources (Page 1 of 5)			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
15 min	<p>ESS2.C: The Roles of Water in Earth's Surface Processes Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.(MS-ESS2-4)</p>	<p>I can explain why salinity is important in the water cycle and in ocean circulation.</p>	<p>Mini Lesson: Energy and Matter: Exploring Ocean Salinity This NASA visualization shows sea surface salinity observations (September 2011-September 2014). Students review the video and answer questions.</p>

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Additional Resources (Page 2 of 5)			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
30 min	<p>ESS2.C: The Roles of Water in Earth's Surface Processes Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)</p>	<p>I can analyze patterns in a line plot to describe the average sea levels from across the globe.</p>	<p>Mini Lesson: Sea Level Rise By Decade: Student Activity For over 20 years, satellite instruments have measured the sea surface height of our ever-changing oceans. This video of images shows the complicated patterns of rising and falling ocean levels across the globe from 1993 to 2015.</p>
30 min	<p>ESS2.A: Earth's Materials and Systems All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)</p>	<p>I can give examples of the kinds of ways energy is used once it enters the Earth system.</p>	<p>Mini Lesson: Earth System Energy Travels Students will analyze a pie chart (circle graph) showing the distribution of different parts of the Earth system absorption and reflection of energy.</p>

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Additional Resources (Page 3 of 5)			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
15 min	<p>PS4.C: Information Technologies and Instrumentation Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)</p>	I can create a false color image by using a color key and a data table.	<p>Interactive: Creating Images from Numbers Scientific data are often represented by assigning ranges of numbers to specific colors. The colors are then used to make false color images which allow us to see patterns more easily. Students will make a false-color image using a set of numbers.</p>
30 min	<p>PS4.C: Information Technologies and Instrumentation Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)</p>	I can create an array table and determine the color of a pixel in a grid.	<p>Interactive: Creating and Interpreting Images as Models Information from satellites is often used to display information about objects. This information can include how things appear, as well as their contents. Explore how pixel data sequences can be used to create an image and interpret it.</p>
90 min	<p>ESS2.A: Earth's Materials and Systems All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)</p>	I can model changes in the Pacific Ocean during the El Niño event.	<p>Lesson Plan: Creating an El Niño Model In this activity, students will analyze a NASA sea surface height model of El Niño for December 27, 2015, and answer questions. Then they will be instructed to create a model of their own made from pudding to reflect the layers of El Niño.</p>

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Additional Resources (Page 4 of 5)			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
1 Week	<p>ESS2.D: Weather and Climate The foundation for Earth’s global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. (HS-ESS2-2)</p>	I can explain how, when, and where ENSO events occur.	<p>Lesson Plan: What are the causes and effects of ENSO? This investigation is part of the NASA: Mission Geography Module "What are the causes and consequences of climate change?" that guides students through explorations in climatic variability and evidence for global climate change.</p>
50 min	<p>ESS2.D: Weather and Climate The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)</p>	I can assess maps, graphs and data tables about sea surface temperature and sea level rise.	<p>Lesson Plan: El Niño Southern Oscillation: Maps, Graphs, and Data In this differentiated lesson, students analyze maps, graphs, and data related to sea surface temperature and sea level rise. They roll a die to determine the question that they will respond to in the question set.</p>
15 min	<p>ESS3.D: Global Climate Change Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)</p>	I can give examples of how models can be used in climate research.	<p>Lesson Plan: Using Models in Climate Change Research Explore how climate models are used in climate change research.</p>

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Additional Resources (Page 5 of 5)			
Time	NGSS Disciplinary Core Idea	Learning Target	Activity / Assessment
90 min	<p>ESS3.C: Human Impacts on Earth Systems Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4)</p>	<p>I can explain how scientists use false color images to help solve real-world problems.</p>	<p>Lesson Plan: Exploring Satellite Imagery and False Color Images</p> <p>Explore characteristics of Landsat's false-color images</p>