My NASA Data - Lesson Plans

Updated: Ocean Impacts of an El Nino Event

Grade Band

- 6-8
- 9-12

Lesson Duration

- 90 minutes

Sphere(s)

- Atmosphere
- Hydrosphere

Phenomenon

- El Nino Southern Oscillation
- Ocean Circulation Patterns
- Wind

NGSS Disciplinary Core Ideas

- ESS2A: Earth Materials and Systems
- ESS2C: The Role of Water in Earth’s Surface Processes
- ESS2D: Weather and Climate

Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Analyzing and Interpreting Data
- Engaging in Argument from Evidence

NGSS Crosscutting Concepts

- Cause and Effect
- Systems and System Models
- Stability and Change
NGSS Performance Expectation

- MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
- 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.
- HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Common Core ELA

- CC.6-8.R.ST.7 Integration of Knowledge and Ideas: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- CC.6-8.R.ST.2 Key Ideas and Details: Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
- CC.K-12.R.R.7 Integration of Knowledge and Ideas: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

Related Resources

- El Niño and Why It's So Hard To Predict the Weather
- NASA’s A 3D Look at the 2015 El Niño
- El Nino - What is it? (UK’s Meteorology Government Office)
- El Niño: Pacific Wind and Current Changes Bring Warm, Wild Weather

Student Handout(s)

- El Nino Variable Data Plots Overview & El Nino Variable Data Plots

Teacher Resource(s)

- El Nino Jigsaw Rubric

Key Vocabulary

- anomaly
- El Niño Southern Oscillation
- sea surface height
- Sea Surface Temperature
- wind vector

Purpose

Students will examine a 2014-2015 El Nino 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. In this process, students model the methods of researchers who connect their expertise with the broader community to study integrated science questions.

Learning Objectives

- analyze a sequence of plots over time for different variables for changes
- correlate changing variables that contribute to the El Nino phenomenon
- communicate arguments based on evidence

NASA Phenomenon Connection

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

1. How does a change of energy in one sphere of the Earth System affect another sphere?
2. How the energy transferred among the various spheres of the Earth System?
3. How is matter shared within the various spheres of the Earth System?
4. What other parts of the Earth System may experience the effects of El Nino and how?
5. What phenomena are associated with changes in different spheres of the Earth System? What variables appear to be correlated?
Cross-Curricular Connections

National Geography Standards:

- 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
- 8th Grade 14.3: How human actions modify the physical environment: The physical environment can both accommodate and be endangered by human activities
- 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.
- 12th Grade 14.1: How human actions modify the physical environment: Human modifications of the physical environment can have significant global impacts.

STEM Career Connections

- Physical oceanographer - This scientist researches waves, tides, currents, transmission of light and sound in the ocean, and ocean-atmosphere relationships
- Biological oceanographer - This researcher studies marine life forms and their relationships to each other and the environment
- Meteorologists - Professionals who are involved with researching, teaching, consulting, and forecasting weather, climate, and the forces that cause change in our environment.

Materials Required

Per Student:

- Earth System Graphic Organizer
- NASA Blog Post: “El Niño can do some serious trash talking” By Laura Faye Tenenbaum https://climate.nasa.gov/blog/2338/
- Sticky notes
- Student Observation Sheet
- Student Observation Table

Per Group:

Student Data Sheets:

- El Nino Variable Data Overview
- El Nino Variable Data Plots:
  - Wind Vectors
  - Sea Surface Height Anomaly
  - Sea Surface Temperature
  - Precipitation
- El Nino Jigsaw Rubric

Technology Requirements
Background Information

See NASA's El Niño: Pacific Wind and Current Changes Bring Warm, Wild Weather
https://earthobservatory.nasa.gov/features/ElNino

Procedure

Part 1: Activate Prior Knowledge

1. Distribute the Earth System Graphic Organizer or students to collect their ideas.

2. Review the sections of the graphic organizer with the students.

3. Have students jot (briefly) down ideas, processes, things that are related to El Nino that come to mind in the appropriate section. Note: Advise students to write small and do not write down whole sentences.

   1. What Do You Know about El Nino? (i.e., Trade Winds, Ocean Temperature, Upwelling, etc.)

   2. What parts of the Earth System are affected? How? (i.e., Wind push warm water, etc.)

4. Review their ideas as a class.

5. Next, the class reads aloud the NASA blog post, “El Niño can do some serious trash talking” by Laura Faye Tenenbaum, about effects of El Nino on a California community and have students look for connections to the Earth System to prime students for exploring the phenomenon of El Nino.
1. Students will briefly write their connections in the appropriate section of the sheet.

6. Read the blog aloud and have students fill in the graphic organizer.

Part 2: Explore ENSO Through Jigsaw Activity

1. Divide all students into Variable Teams (six to seven students), as well as Jigsaw Groups (four to five students) depending on class size.

   Background on The Jigsaw Teaching Strategy:

   The jigsaw activity is a cooperative learning technique wherein each student in a group becomes an expert on one particular part of a topic, El Nino in this case. The technique works by placing students into jigsaw groups. Each jigsaw group is responsible for researching and reporting back on a Driving Question related to El Nino. Each student in the group is also assigned a science variable (as part of the Variable Team) to research, therefore every member of the class is essential as the groups need each student in order to fully understand the topic. The students research their variable of the El Nino phenomenon and get together into “expert” teams composed of the students from the other Jigsaw Groups who are also responsible for the same variable. The Variable Teams share and discuss what they learn about their variable. Finally, students go back to their Jigsaw Groups and report back on what they learned about their how their variable addresses their Driving Question. In order to have a complete picture, the group must understand the contributions of each student in the group.
2. Set the stage for learning by telling students that they will first work within their Jigsaw Groups to review their Driving Question. They are responsible for taking a true systems approach to researching this question and teaching the class about the answer at the end with one PPT (or Google Slide) slide for their Driving Question. Each member is expected to communicate an aspect of their research using evidence and reasoning from their Variable Team research.

Jigsaw Groups will focus on one of the following Driving Questions:

- How does a change in the Atmosphere of the Earth System affect the Hydrosphere? Vice Versa.
- How is the energy transferred among the various spheres of the Earth System?
- How is matter shared within the various spheres of the Earth System?
- What other parts of the Earth System may experience the effects of El Nino and how?
- What phenomena are associated with changes in different spheres of the Earth System? What variables appear to be correlated?

3. Provide about 5 minutes for students to meet with their Jigsaw Group and discuss what the Driving Question means, what thoughts that they have before looking at the data, what kinds of data and changes to anticipate, additional questions, etc. It is worth noting at this point that Jigsaw groups are expected to communicate their ideas to the class using evidence and reasoning. This could be through a presentation slide, through a sketch or drawing, written summary, etc. Distribute rubric.

4. Next, divide students into their Variable Team to identify and describe the variables. (Assure that the Jigsaw Groups that there will be time at the end to come back together to prepare their product.) Together, members of the Variable Team will observe data related to the specific variable and complete the Student Observation Table and Sheet.

Variable Teams will research the following science parameters:

- Wind Vectors
- Sea Surface Height Anomaly
- Sea Surface Temperature
- Precipitation

5. Distribute Variable data to each group for 2014 & 2015.

6. Distribute (or project) the El Nino Variable Data Plots Overview and review the variables, their units, and scale with students. Draw students’ attention to the slight variations among the scales in the same variable datasets.

7. Review the Observation Table and Sheet with students and how to use the Latitude Longitude lines to guide their quantitative and qualitative observations.

8. Provide about 10-15 minutes for students to collaborate in their Variable Team to make observations and to answer questions. 9. Next, students should regroup with their Jigsaw Group and share their expertise. Students should begin addressing their Driving Question and communicate
their ideas to the class using evidence and reasoning. This could be through a presentation slide, through a sketch or drawing, written summary, etc.

9. How does a change in the Atmosphere of the Earth System affect the Hydrosphere? Vice Versa.

10. How is the energy transferred among the various spheres of the Earth System?

**Part 3: Explain their Findings**

Provide students with approximately 10 minutes to prepare their presentation and 3-5 minutes to present their information.

**Extensions**

**Part 5: Opportunities for Advanced Learners**

1. El Ninos are known to have local and global effects. Use the My NASA Data Earth System Data Explorer (ESDE) ([https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm)) to study the effects of El Nino in your region. Check out: Hydrosphere/All Data/Sea Surface Properties/ Daily Sea Surface Temperature & Sea Level (Sea Surface Height) Anomaly, Hydrosphere/All Data/Precipitation/Monthly Precipitation, as well as Atmosphere/All Data/Wind Speed & Vectors/Vectors/Monthly Near-Surface Wind Vectors. Historical ENSO events were recorded in the following years. Note: (ESDE will not feature data for all of these historic dates.)

   - 1790–93
   - 1828
   - 1876–78
   - 1891
   - 1925–26
   - 1972–73
   - 1982–83
   - 1997–98
   - 2002–03
   - 2004–05
   - 2006–07
   - 2009–10
   - 2014–16

1. La Nina is the opposite of El Nino. Check out this video on the connection between El Nino and La Nina ([https://youtu.be/wVlfyhs64IY](https://youtu.be/wVlfyhs64IY)). Use the My NASA Data Earth System Data Explorer (ESDE) ([https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm)) to study the characteristics of a La Nina. (See #1 above for recommended variables.) Historical La Nina events were recorded in the following years. Note: (ESDE will not feature data for all of these historic dates.)

   - 1904
   - 1908
3. Explore the social and economic implications of an El Niño event from a social studies perspective. Check out these resources:

- NASA Examines Global Impacts of the 2015 El Niño
- NASA Examines El Niño's Impact on Ocean’s Food Source
- El Niño Brought Drought and Fire to Indonesia