

### **5E Integrated STEM Lesson Plan**

**Lesson Title:** Introduction to Earth's Hydrosphere

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**Topic:** Earth's Hydrosphere

**Targeted Grade Level:** High School 9-12

**Time Needed:** 10-50 minute class periods.

**Subject Integration:**

- Science
- Engineering
- Math

**Justification:**

This lesson integrates Science and Engineering, Math, ELA. Students will recall the water cycle and how water is transferred throughout the Earth by looking at sea surface temperatures, by observing graphs and maps highlighting sea surface temperatures and its effects on the growth of plant life. Together this information contributes to the prediction of future El Nino Southern Oscillation (ENSO) events. Through their investigation students will be able to explain a series of events leading up to these phenomena.

**Standards:**

- **HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth's systems.**
- **HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.**
- **HS-ESS3-1 Construct an explanation based on evidence for how natural hazards have influenced human activity.**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
<p><b>Developing and Using Models</b></p> <ul style="list-style-type: none"> <li>Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.</li> <li>Develop a model using an example to describe a scientific principle. (5-ESS2-1)</li> </ul> <p><b>Using Mathematics and Computational Thinking</b></p> <ul style="list-style-type: none"> <li>Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.</li> <li>Describe and graph quantities such as area and volume to address scientific questions. (5-ESS2-2)</li> </ul>	<p><b>ESS2.A: Earth Materials and Systems</b></p> <ul style="list-style-type: none"> <li>Earth’s major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth’s surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)</li> </ul> <p><b>ESS2.C: The Roles of Water in Earth’s Surface Processes</b></p> <ul style="list-style-type: none"> <li>Nearly all of Earth’s available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>Standard units are used to measure and describe physical quantities such as weight and volume. (5-ESS2-2)</li> </ul> <p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>A system can be described in terms of its components and their interactions. (5-ESS2-1)</li> </ul>
<p style="text-align: center;"><b>Common Core State Standards</b></p> <p>ELA/Literacy -</p> <ul style="list-style-type: none"> <li>RI.5.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1),(5-ESS2-2)</li> <li>W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS2-2)</li> <li>SL.5.5: Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS2-1),(5-ESS2-2)</li> </ul>		

Mathematics -

- MP.2: Reason abstractly and quantitatively. (5-ESS2-1),(5-ESS2-2)
- MP.4: Model with mathematics. (5-ESS2-1),(5-ESS2-2)
- 5.G.A.2: Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. (5-ESS2-1)

National Geography Standards-

- 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.

**ITEEA Standards**

*(N/A)*

**Measurable Student Learning Objectives:**

- Students will be able to describe the water cycle
- Students will be able to describe how the water cycle contributes to the Atmosphere
- Students will be able to explain how the water cycle and atmosphere air temperatures affect the movement of air globally.
- Students will be able to analyze NASA data to identify the contributing factors towards global phenomena like El Nino
- Students will be able to analyze current variables to hypothesize the presence or absence of atmosphere if and hydrological phenomena like El Niño or La Niña.

**Nature of STEM:**

**Scientific Knowledge is Open to Revision in Light of New Evidence**

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-ESS2-3)

**Science is a Human Endeavor**

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-ESS3-3) Science and engineering are influenced by society and society is influenced by science and engineering. (HS-ESS3-3)

**Engaging Context/Phenomena:**

How many snow days will we have this year?!?! This is a question on every student's mind. The Hydrosphere El Nino is the phenomenon that we are focusing on here in this lesson and it also can . NASA and NOAA are interested in this phenomenon because it is the source of many weather and climate changes that occur specifically in the Pacific Ocean but also affects the contents of North and South America as well as the Central American countries. Because of the significant changes El Nino causes these countries put major efforts to track, monitor, and predict this phenomena so that they can better manage their fisheries, and agriculture can be adjusted as needed. In addition, humanitarian efforts are being made to help fishermen, farmers, and the general populations that may need assistance with food, water, and disease management; all of which result from the drastic changes ENSO events cause.

**Data Integration:**

Data from both NOAA and NASA will be used during different parts of the lesson. During the Explore lessons the students will be interpreting data that was collected and displayed for them. The activities are scaffolded to help them understand how and what data is helpful in researching El Nino as well as help them draw conclusions from the data they are presented.

During the Explain and Elaborate activities students will be using NASA and NOAA data again, this time they are searching the data for meaningful data sets and then practicing displaying the data to develop meaningful conclusions. They also get the opportunity to use the data to hypothesize and predict future ENSO events from the knowledge they have gained. During these lessons students will be able to see how the hydrosphere and the atmosphere affect each other as well as interacting and affection with many of the other spheres.

**Differentiation of Instruction:**

All of these activities can be done independently, in small groups, or even as a large group with the teacher driving the thinking process in order to help the students derive the desired conclusions. Thoughtful pairing of students should be used so that stronger students are paired with weaker students to help support them. Teachers choosing to do whole group instruction can break up some of the initial activities in the Engage and Explore sections as they are scaffolded to help the students work individually. Teachers may then do whole group discussion with the Explain, Elaborate and Evaluate as these are more complex correlations. Working as a class will allow the students more confidence to draw conclusions.

**Real-life Connection**

The hydrosphere is one of the Earth's spheres responsible for distributing water throughout the globe, onland as well as maintaining the reservoirs of lakes, rivers, and oceans. Water has the ability to transfer heat as it moves through the water cycle so it is a major contributor to an area's climate/weather pattern. With its major connection to the atmosphere the water contributes to global phenomena such as El Nino and La Nina which have been tracked and documented to cause major disruptions globally, not just in the Easter Pacific, where is originates.

Weather and what is happening day to day is something everyone is interested in, even students. Will they have their game or practice, will the competition be canceled or postponed? Will school be canceled or delayed due to snow or a possible hurricane? Some years there is more rain, some years there is less. Some years we have blizzards, other years not even a flake of snow. When these situations occur, we often wonder what is causing them especially if they cause a drought causing families to starve or flooding causes destruction to our homes. ENSO events not only cause issues here in the United States but other countries in South and Central America as well. The Peruvian fishing community struggle during El Nino events as the upwell of cold water which usually brings nutrient rich, anchovy filled waters does not occur close to shore where the fishing boats can access them. Australia's Weather and ecosystems of the Great Barrier Reef are affected by the change in water temperature. ENSO events are an international concern. The more we know, the more prepared we can be to help offset the issues both economically and environmentally.

**Possible Misconceptions:**

- The Hydrosphere is not influenced by any other sphere
- El Nino is a single event
- El Nino only affects the Pacific Ocean
- It only affects California or Peru

**Lesson Procedure:**

5E Model	5E Objectives
<p><b>Engage: 10-15 minute</b></p>	<p><b>Procedure:</b> Complete slide 2 in their <a href="#">Hydrosphere Digital Scientific Notebook</a>.</p> <ul style="list-style-type: none"><li>• Have students complete individually then discuss as a class</li><li>• Be sure to highlight:<ul style="list-style-type: none"><li>• Farmers are some of the oldest Meteorologists and we have been using their journals for centuries to help us prepare for each season.</li><li>• Farmers almanacs are based on patterns identified by using the data the farmers have collected about their growing seasons, rainfall amounts, the start of frost, and the end of freezing temperatures which signifies the start of the growing seasons again.</li></ul></li></ul> <p><b>Modifications</b></p> <ul style="list-style-type: none"><li>• review what an observation versus an inference prior to this exercise</li><li>• walk through these exercise together</li></ul> <p><b>Standards Addressed</b></p> <ul style="list-style-type: none"><li>• RI.5.7: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1),(5-ESS2-2)</li><li>• W.5.8: Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. (5-ESS2-2)</li></ul> <p><b>Formative/Summative Assessments</b></p> <ul style="list-style-type: none"><li>• Answers to the observations, see <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a> for some suggested observations.</li></ul> <p><b>Resources</b></p> <ul style="list-style-type: none"><li>• <a href="#">Hydrosphere Digital Scientific Notebook</a>.</li><li>• <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a></li><li>• Heyl, E. (2021, September 3). <i>How bad will this winter be in pa? old farmer's Almanac Weighs in. Pittsburgh, PA Patch</i>. Retrieved November 5, 2021, from <a href="https://patch.com/pennsylvania/pittsburgh/old-farmer-s-almanac-says-snowy-frigid-winter-ahead-pa-.1">https://patch.com/pennsylvania/pittsburgh/old-farmer-s-almanac-says-snowy-frigid-winter-ahead-pa-.1</a>)</li><li>• <i>Actively learn</i>. Processes of the water cycle. (n.d.). Retrieved November 5, 2021, from <a href="https://reader.activelylearn.com/grading/4115632/notes">https://reader.activelylearn.com/grading/4115632/notes</a>.</li></ul>

Explore: 30 min class

**Procedure:**

- Have the students read the UCAR article [An El Niño Fish Tale](#).
- Have them complete the Earth System Graphic Organizer from My NASA Data identifying ways El Nino is affecting each of the Earth's Spheres.- Slide 4
- Review as a class. Be sure to highlight
  - The changes in the weather patterns described off the coast of Peru are far reaching, not just centrally located. As they are filling out the organization, they ask them questions of things that are changing here could they be changing in other locations.
  - Assist with the Cryosphere and the geosphere. The article does not go into detail about these two spheres however we can assume that flooding and droughts are occurring unexpectedly. We can assume with temperature fluctuations freezing and thawing are happening unexpectedly.

**Modifications:**

- Read the article as a class fill
- in a few of the ways El Nino affects some of the more implied spheres prior to giving the hand out to the students.
- Fill out the graphic organizer together

**Standards addressed:**

- HS-ESS3-1 Construct an explanation based on evidence for how natural hazards have influenced human activity.
- ESS2.C: The Roles of Water in Earth's Surface Processes

**Formative/Summative Assessments:**

- completion of the Graphic organizer on slide 4 of the [Hydrosphere Digital Scientific Notebook](#). See [The Hydrosphere Digital Interactive Notebook-Key](#) for suggestions.

**Resources**

- [Hydrosphere Digital Scientific Notebook](#),
- [The Hydrosphere Digital Interactive Notebook-Key](#)
- *An El Niño Fish Tale*. An El Niño Fish Tale | UCAR Center for Science Education. (n.d.). Retrieved November 9, 2021, from <https://scied.ucar.edu/learning-zone/how-climate-works/el-nino-fish-tale>.
- NASA. (n.d.). *My NASA data*. NASA. Retrieved November 8, 2021, from <https://mynasadata.larc.nasa.gov/lesson-plans/ocean-impacts-el-nino-event>.

<p><u>Explain: 3 -50 min class</u></p>	<p><b>Part 1: Procedure: Atmospheric temperatures and Sea Surface temperatures -50 mins</b></p> <ul style="list-style-type: none"><li>• Students will be able to explain how atmospheric temperatures promote the water cycle</li><li>• Complete slides 5-7 of the <a href="#">Hydrosphere Digital Scientific Notebook</a>.</li></ul> <p><b>Modifications:</b></p> <ul style="list-style-type: none"><li>• work in pairs</li><li>• teacher highlights/identifies the keys used in the false color graphics</li><li>• work as a class to identify increases and decreases in data and then explain where these changes could be coming from.</li></ul> <p><b>Standards Addressed:</b></p> <ul style="list-style-type: none"><li>• HS-ESS2-3: Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.</li><li>• Developing and Using Models</li><li>• Analyzing and Interpreting Data</li></ul> <p><b>Formative/Summative Assessment:</b></p> <ul style="list-style-type: none"><li>• Slide 5-7 responses; see <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a> for answers.</li></ul> <p><b>Resources</b></p> <ul style="list-style-type: none"><li>• <a href="#">Hydrosphere Digital Scientific Notebook</a></li><li>• <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a></li><li>• NASA. (n.d.). <i>My NASA data</i>. NASA. Retrieved November 8, 2021, from <a href="https://mynasadata.larc.nasa.gov/mini-lesson/energy-and-matter-sea-surface-temperature-student-activity">https://mynasadata.larc.nasa.gov/mini-lesson/energy-and-matter-sea-surface-temperature-student-activity</a></li></ul> <p><b>Procedure: Global Wind Belts- 50 mins</b></p> <ul style="list-style-type: none"><li>• Have students complete the Actively Learn Article "<a href="#">Global Wind Belts</a>" and complete slide 8 of the <a href="#">Hydrosphere Digital Scientific Notebook</a>.</li><li>• Students will learn how changes in atmospheric temperature and pressure create global wind patterns.</li><li>• Complete slides 9-10 of the <a href="#">Hydrosphere Digital Scientific Notebook</a>.<ul style="list-style-type: none"><li>○ Discuss with class the variables of the wind vector arrows.</li><li>○ Work as a class to see the correlations between the surface ocean currents directions and the wind vector directions. This may be really challenging for students to identify if this is the first time they have seen a vector plot.</li></ul></li></ul>

**Modifications:**

- work in pairs
- teacher highlights/identifies the variables being graphed
- reduce some of the vector images in the wind plot so it is easier to see the correlation between wind pattern and surface current pattern.

**Standards Addressed:**

- HS-ESS2-1: Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- Cause and Effect
- Stability and Change

**Formative/Summative Assessment:**

- Slide 9 responses see [The Hydrosphere Digital Interactive Notebook-Key](#) Wind patterns
- Slide 10 Responses see [The Hydrosphere Digital Interactive Notebook-Key](#) Comparing Winds and Surface ocean Currents

**Resources**

- [Hydrosphere Digital Scientific Notebook](#),
- [The Hydrosphere Digital Interactive Notebook-Key](#)
- NASA. (n.d.). *My NASA data*. NASA. Retrieved November 8, 2021, from <https://mynasadata.larc.nasa.gov/mini-lesson/comparing-winds-surface-ocean-currents-student-activity>

**Part 2: Procedure: Comparing Winds and Surface Ocean currents- 50 mins**

- Students will correlate what they learned about wind and ocean surface currents by completing slides 11-12 of the [Hydrosphere Digital Scientific Notebook](#)
- Students will not be able to see the interaction of the hydrosphere and the atmosphere and the affects they have on each other.

**Modifications**

- work in pairs
- teacher highlights/identifies the variables being graphed
- reduce some of the vector images in the wind plot so it is easier to see the correlation between wind pattern and surface current pattern.

**Standards Addressed**

- HS-ESS2-1: Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- Cause and Effect
- Stability and Change

**Formative/Summative Assessments**

- Slide 12 responses See [The Hydrosphere Digital Interactive Notebook-Key](#) comparing Winds and Surface Ocean Currents

	<p><b>Resources</b></p> <ul style="list-style-type: none"><li>• <a href="#">Hydrosphere Digital Scientific Notebook</a>,</li><li>• <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a></li><li>• NASA. (n.d.). <i>My NASA data</i>. NASA. Retrieved November 8, 2021, from <a href="https://mynasadata.larc.nasa.gov/mini-lesson/comparing-winds-surface-ocean-currents-student-activity">https://mynasadata.larc.nasa.gov/mini-lesson/comparing-winds-surface-ocean-currents-student-activity</a></li></ul>
<p><b>Elaborate: 1-50 min class</b></p>	<p><b>Part 1: Procedure: What is the El Nino-Southern Oscillation (ENSO)-50 mins</b></p> <p>Students will describe and explain the science behind the El Nino-Southern Oscillation (ENSO) that contributes to changes in the atmosphere and ocean environments.</p> <ul style="list-style-type: none"><li>• Provide students reliable resources for them to use in constructing a concept map explaining the three scenarios El Nino, La Nina, and Normal conditions.</li><li>• Have them work in small groups to divide up each anomaly as they research the information for the concept map.</li><li>• Have students complete the <a href="#">UCAR Sort it out: El Nino or La Nina</a> so they can practice identifying the hydrological indicators of a normal year or a year with El Nino, La Nina.</li><li>• have students screenshot their score and post on slide 14</li></ul> <p>Suggested resources:</p> <ul style="list-style-type: none"><li>• <a href="#">ClimateBits: El Nino</a></li><li>• <a href="#">NOAA Climate Blog: ENSO</a></li><li>• <a href="#">El Nino-southern Oscillation</a></li><li>• <a href="#">Ocean Upwelling</a></li><li>• <a href="#">Teleconnections: Changes in Weather Linked Together</a></li></ul> <ul style="list-style-type: none"><li>• Have students complete the <a href="#">UCAR Sort it out: El Nino or La Nina</a> so they can practice identifying the hydrological indicators of a normal year or a year with El Nino, La Nina.</li><li>• Have students screenshot their score and post on slide 14</li></ul> <p><b>Modifications</b></p> <ul style="list-style-type: none"><li>• Teachers can create a concept map identifying normal conditions and have the students do one of the anomalies for comparison.</li><li>• Teacher can provide a partially completed concept map and have students fill in limited number of blanks</li><li>• Reduce the number of resources recommended to the students.</li></ul> <p><b>Standards Addressed:</b></p> <p>NGSS Crosscutting Concepts:</p> <ul style="list-style-type: none"><li>• Cause and Effect- cause and effect relationships may be used to predict phenomena in natural or designed systems</li><li>• Stability and Change- small changes in one part of a system might cause large changes in another part</li></ul>

- CCSS.ELA-Literacy.RST.9-10.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- CCSS.ELA-Literacy.RI.9-10.3: Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them
- CCSS.MP2: Reason abstractly and quantitatively.
- CCSS.MP7: Look for and make use of structure.

#### **Formative/Summative Assessments**

- Concept map that highlights how air pressure, wind, upwelling, ocean temperature, evaporation and overall weather change during El Nino, La Nina, and normal years.
- Results from [Sort it out: El Nino or La Nina](#) game. Students are given satellite images to drag and drop into categories; El Nino la Nina, or La Nada (normal year). Based on what they have discovered in their research for their concept map they should be able to sort the images successfully.

#### **Resources**

- *El Niño-Southern Oscillation. El Niño-Southern Oscillation | UCAR Center for Science Education. (n.d.). Retrieved November 8, 2021, from <https://scied.ucar.edu/learning-zone/how-climate-works/el-nino-southern-oscillation>.*
- *Enso blog. Blogs: ENSO | NOAA Climate.gov. (n.d.). Retrieved November 8, 2021, from <https://www.climate.gov/news-features/department/8443/all>.*
- [Hydrosphere Digital Scientific Notebook](#).
- [The Hydrosphere Digital Interactive Notebook-Key](#)
- *Ocean upwelling. Ocean Upwelling | UCAR Center for Science Education. (n.d.). Retrieved November 8, 2021, from <https://scied.ucar.edu/learning-zone/how-climate-works/ocean-upwelling>.*
- *Teleconnections: Changes in weather linked together. Teleconnections: Changes in Weather Linked Together | UCAR Center for Science Education. (n.d.). Retrieved November 8, 2021, from <https://scied.ucar.edu/learning-zone/how-climate-works/teleconnections-weather-patterns>.*
- *Sort it out: El Niño or La Niña. Sort It Out: El Niño or La Niña | UCAR Center for Science Education. (n.d.). Retrieved November 8, 2021, from <https://scied.ucar.edu/interactive/enso-sorting-game>.*
- YouTube. (2015, October 13). *Climatebits: El Niño*. YouTube. Retrieved November 8, 2021, from <https://www.youtube.com/watch?v=titsRUo4t4>.

**Part 1: Procedure: Ocean Impact of an El Nino Event-50 min**

- Students will use authentic satellite data to explore historical weather events and gain a better understanding of El Nino based on local observations
- Students will work in Jigsaw groups as well as variable groups to investigate the essential questions of the lesson .Complete slides 15-18 of the [Hydrosphere Digital Scientific Notebook](#), in variable groups

Teacher Provides:

- [JigSaw Rubric](#) and group assignments (Jigsaw group and Variable group assignments)
- [Ask NASA Climate Scientist Blog-EL Nino can do some serious trash talking](#)
- Provide each jigsaw group appropriate diagrams found in [Variables Presentation](#)
  - Wind Vectors
  - Sea Surface Height Anomaly
  - Sea Surface Temperature
  - Precipitation
- Students will return to Jigsaw groups and complete slide 19 of the [Hydrosphere Digital Scientific Notebook](#). This presentation of their interactive poster should follow the [JigSaw Rubric](#)

**Modifications**

- Thoughtful pairing of Groups as well as Jigsaw groups.
- Review the entirety of the assignment providing a key to important findings the students should have arrived at, at the end of the assignment.
- Print out the Variable graphics for ease of comparison

**Standards Addressed**

NGSS Crosscutting Concepts:

- Cause and Effect- cause and effect relationships may be used to predict phenomena in natural or designed systems
- Stability and Change- small changes in one part of a system might cause large changes in another part
- CCSS.ELA-Literacy.RST.9-10.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- CCSS.ELA-Literacy.RI.9-10.3: Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them
- CCSS.MP2: Reason abstractly and quantitatively.
- CCSS.MP7: Look for and make use of structure.
- National Geography Standard 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.
- National Geography Standard 12th Grade 14.1: How human actions modify the physical environment: Human modifications of the physical environment can have significant global impacts.

Evaluate: 3-4 50 min class

**Formative/Summative Assessments**

- Jigsaw group presentation that answers the assigned Driving Question using evidence and reasoning of the science variables collected by each individual in the group. Provide a [Jigsaw Rubric](#) to the teams to highlight expectations

**Resources**

- [Hydrosphere Digital Scientific Notebook](#).
- [The Hydrosphere Digital Interactive Notebook-Key](#)
- NASA. (n.d.). *My NASA data*. NASA. Retrieved November 8, 2021, from <https://mynasadata.larc.nasa.gov/lesson-plans/ocean-impacts-el-nino-event>.
- NASA. (2017, September 18). *El Niño can do some serious trash talking – climate change: Vital signs of the planet*. NASA. Retrieved November 8, 2021, from <https://climate.nasa.gov/blog/2338/el-nino-can-do-some-serious-trash-talking/>.

**Part 2 Procedure: Investigating El Niño Using Data in the Classroom- 100 mins**

- Completing slides 20-26 in the [Hydrosphere Digital Scientific Notebook](#).
  - Students will learn how to read and interpret sea surface temperature maps.(slides 20-21)
  - Students will explore two different ways sea surface temperature (SST) data can be represented and describe the advantages of both displays. (slide 22)
  - Students will apply map and graph skills learned in earlier levels to a real problem — identifying an El Niño event. (slides 23-24)
  - Students will examine the relationship between SST and chlorophyll to understand how El Niño affects productivity in the ocean. (slides 25-26)
- Have students duplicate their slide #2 and bring it down to the end.
- Have them edit their KWL answering any of the questions they still had remaining

**Modifications**

- This entire lesson could be done as a class or in small groups using colored map print outs or via presentation style. This would facilitate discussion to help arrive at viable conclusions
- Completing activities with the first few slides individually and then the last as a class could also help the students reach the desired conclusion while giving them the opportunity to work with the data individually. The data scaffolds starting simple and the building more critical thinking.

**Standards Addressed**

NGSS Science and Engineering Practices:

- Analyzing and Interpreting Data to provide evidence for phenomena
- Obtaining, Evaluating, and Communicating Information by constructing an explanation that includes qualitative or quantitative relationships between variables that predict and/or describe phenomena

NGSS Crosscutting Concepts:

- Cause and Effect- cause and effect relationships may be used to predict phenomena in natural or designed systems
- Stability and Change- small changes in one part of a system might cause large changes in another part

	<ul style="list-style-type: none"><li>● CCSS.MP2: Reason abstractly and quantitatively.</li><li>● CCSS.MP7: Look for and make use of structure.</li></ul> <p><b>Formative/Summative Assessments</b></p> <ul style="list-style-type: none"><li>● Slide 26-26 responses See <a href="#">The Hydrosphere Digital Interactive Notebook-Key</a> Relating Sea Surface temperatures and Chlorophyll concentrations.</li></ul> <p><b>Resources</b></p> <ul style="list-style-type: none"><li>● <a href="#">Hydrosphere Digital Scientific Notebook</a>.</li><li>● “The Birth and Death of an El Niño.” <i>YouTube</i>, 14 Feb. 2017, <a href="https://youtu.be/69N494UIIS8">https://youtu.be/69N494UIIS8</a>.</li><li>● <i>Story map series</i>. noaa.maps.arcgis.com. (n.d.). Retrieved November 5, 2021, from <a href="https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=7a6ff2dc781041bcad7f790a719a42dd">https://noaa.maps.arcgis.com/apps/MapSeries/index.html?appid=7a6ff2dc781041bcad7f790a719a42dd</a>.</li><li>● Becker, E., &amp; The meaning of an exclamation point Permalink Interesting... to you. (n.d.). <i>October 2021 ENSO update: La Niña is here!</i> October 2021 ENSO update: La Niña is here!   NOAA Climate.gov. Retrieved November 9, 2021, from <a href="https://www.climate.gov/news-features/blogs/enso/october-2021-enso-update-la-ni%C3%B1a-here">https://www.climate.gov/news-features/blogs/enso/october-2021-enso-update-la-ni%C3%B1a-here</a>.</li></ul>
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### **Teacher Background:**

This lesson is best served after an Atmosphere unit. At the high school level students will most likely be familiar with the water cycle on an elementary level but will need an understanding of how thermal energy can be transferred between substances, particularly through water cycle change water into each state of matter. Teachers then need to draw the connection between atmospheric heating and how that would contribute to promoting the water cycle on a global scale. Warm temperatures at the equator will mean lots of evaporation and low pressure while at the poles cold temperatures promote condensation and low pressure. These temperature, moisture and pressure differences contribute to wind generation. With the generation of wind, moisture, and thermal energy can be transferred globally and contribute to regional climates.

It is important that teachers convey air movement along the surface of a body of water creating surface currents which help to circulate water mixing it, like the air currents. Water is unevenly heated like air due to the insolation of sunlight. The intermingling of the Hydrosphere and the Atmosphere heavily influences one another and shows itself in major disturbances like hurricanes and tropical storms. It also becomes very apparent in the ENSO phenomenon. Teachers need to understand the basic mechanics of how the tradewinds steadily blow from an easterly direction over the southern Pacific ocean and stimulate the northern and southern Pacific gyres. The rotation of the water in a circle allows cold nutrient rich water to the surface when otherwise it would sink to the bottom of the ocean. This creates a unique ecosystem for marine organisms and humans to benefit from.

El nino is divergent from this typical Pacific pattern. For reasons unbeknownst to scientists the trade winds weaken, slowing the Pacific gyres and preventing the cold water from upwelling. The repercussions of this are felt not only in the hydrosphere, but also meteorologically. During this time weather patterns across North and South America change affecting agriculture and even affecting the spreading of diseases. Conversely La Nina phenomena occurs when the trade winds speed up causing the Pacific gyres to circulate quickly inundated the area with cold waters. This too has an effect on the climate of the region as well. Both of these phenomena are so far reaching and the changes they bring so devastating that Oceanographers and Meteorologists have been tracking their occurrences searching for ways to predict and compensate for the changes they cause.

Endeavor STEM Eyes on the Earth Earth's Spheres lesson #2  
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