Investigating El Niño Using Real Data – NGSS Alignment

This module was developed to build data literacy, engaging students in increasingly sophisticated modes of understanding and manipulation of data. It was completed prior to the release of the Next Generation Science Standards (NGSS)* and has not yet been adapted to fully incorporate the innovations described in the NGSS. However, a review has been undertaken to help teachers and educators understand if and how the activities in this module align with the new standards.

This document outlines the ways in which each level of the module provides learning experiences that engage students in the three dimensions of the NGSS Framework while building towards competency in targeted performance expectations. When reading this document, it should be noted that while Levels 1 and 2 provide students with opportunities to practice data interpretation, Levels 3, 4, and 5 *more directly* engage students in activities that blend the three dimensions of the NGSS. For this reason, Levels 1 and 2 are not included in this alignment document. Also of note, this document identifies the specific practice, core idea and concept directly associated with a performance expectation (shown in parentheses in the tables) but also includes additional practices and concepts that can help students *build toward* a standard.

Performance Expectations – Middle School

Ecosystems: Interactions, Energy, and Dynamics

> MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
Students analyze and interpret satellite data to provide evidence for the effects of disrupted upwelling on phytoplankton populations (Level 4).

> MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Using data as evidence, students construct written or oral arguments that explain how changes that occur in the tropical Pacific Ocean as a result of El Niño lead to changes in sea surface temperature, upwelling and phytoplankton populations (Level 4).

Earth's System's

> MS-ESS2-6: Develop and use a model to describe how the unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
Students use NOAA data representations (data being used as a basis for models) to identify and explain patterns of oceanographic circulation and upwelling associated with El Niño events (Levels 3, 4, and 5).

* NGSS Lead States. 2013. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press. Next Generation Science Standards is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product.

Science and Engineering Practices (SEPs)	Middle School SEP	How the SEP Is Addressed by the Module	Level				
			1	2	3	4	5
Developing and Using Models	Develop and use a model to describe phenomena. (MS-ESS2-6)	Students access and use NOAA data representations (data being used as a basis for models) to identify and explain patterns of oceanographic circulation and upwelling associated with El Niño events.			x	x	x
Planning and Carrying Out Investigations	Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. *Builds toward MS-LS2-4*	Students investigate whether there is a relationship between sea surface temperature and phytoplankton distributions by querying NOAA data and using the data as evidence.				x	
Analyzing and Interpreting Data	Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. *Builds toward MS.ESS2-6*	Students use satellite maps and graphs to identify temporal and spatial relationships associated with El Niño events.			x	x	x
	Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1)	Students analyze and interpret satellite data to provide evidence for oceanographic conditions that characterize El Niño.				x	
Using Mathematics and Computational Thinking	Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. *Builds toward MS-ESS2-6,* MS-LS2-1 & *MS.LS2-4*	Students use online data query and graphing tools to investigate relationships and trends related to El Niño.			x	x	x
Constructing Explanations and Designing Solutions	Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. *Builds toward MS-LS2-4*	Students explain the relationship between sea surface temperature and phytoplankton distribution during El Niño and non-El Niño years.				x	
Engaging in Arguments from Evidence	Construct an oral and written argument supported by empirical evidence and scientific evidence to support or refute an explanation or a model for a phenomena or a solution to a problem. (MS-LS2-4)	Using the data as evidence, students construct written arguments to support claims explaining the effect of increased sea surface temperatures on phytoplankton distributions.				x	

Disciplinary Core Ideas (DCIs)	Middle School DCI	How the DCI Is Addressed by the Module	Level				
			1	2	3	4	5
Interdependent Relationships in Ecosystems	**MS-LS2.A:** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)	Students will understand the relationships between upwelling, sea surface temperature and phytoplankton during El Niño and non-El Niño events.				x	
	MS-LS2.A: Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)	Students analyze and interpret satellite data to provide evidence for the effects of disrupted upwelling on phytoplankton populations.				x	
Ecosystem Dynamics, Functioning, and Resilience	**MS-LS2.C:** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)	Teachers could slightly modify the activities in Level 4 to better address this DCI. For example, following data investigations, students could predict how disruptions to phytoplankton blooms impact the food web during El Niño.				x	
Weather and Climate	**MS-ESS2.D:** 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)	Students will understand the changes that occur in the tropical Pacific Ocean as a result of the complex weather phenomenon, El Niño.			x	x	x

Crosscutting Concepts (CCCs)	Middle School CCC	How the CCC Is Addressed by the Module	Level				
			1	2	3	4	5
Patterns	Graphs, charts, and images can be used to identify patterns in data. *Builds toward MS-ESS2-6,* MS-LS2-1 & *MS.LS2-4*	Students use satellite maps and graphs to identify data patterns during El Niño and non-El Niño years.			x	x	x
	Patterns can be used to identify cause-and-effect relationships. *Builds toward MS-LS2-4*	Students investigate patterns between sea surface temperature and phytoplankton distribution to identify cause and effect relationships associated with El Niño.				x	
Cause and Effect	Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)	Teachers could slightly modify the questions on the student worksheet to better address this concept.				x	
System and System Models	Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-ESS2-6)	Students understand that El Niño events are a result of interactions between the ocean and atmospheric systems in the tropical Pacific.			x	x	x
Stability and Change	Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)	Students explain that changes that occur in the Pacific as a result of El Niño cause changes in upwelling systems and phytoplankton distributions.				x	