

HS-ESS2-4 Earth's Systems

California Science Test—Item Content Specifications

# HS-ESS2-4 Earth's Systems

Students who demonstrate understanding can:

Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.

[Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.] [*Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.*]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Developing and Using Models  Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).  Use a model to provide mechanistic accounts of phenomena.  Connections to Nature of Science  Scientific Knowledge is Based on Empirical Evidence  Science arguments are strengthened by multiple lines of evidence supporting a single explanation. | ESS1.B: Earth and the Solar System  1. Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. *(secondary to HS-ESS2-4)*  ESS2.A: Earth Materials and System  1. The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.  ESS2.D: Weather and Climate  1. 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. | Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

2.2 Ability to use models

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

2.2.1 Ability to use models to identify concepts and relationships represented in the models

2.2.2 Ability to use models to generate explanations and predictions about a scientific phenomenon

2.2.3 Ability to use models to test and compare the effectiveness of different design solutions

### Disciplinary Core Idea Assessment Targets

#### ESS1.B.7

* Identify that changes in the shape of Earth’s orbit and the orientation of Earth’s axis of rotation have affected Earth’s climate over time
* Identify that the climate changes on Earth due to changes in orbit and/or the orientation of its axis occur over different timescales

#### ESS2.A.8

* Identify that changes to global and regional climate are caused by interactions among different Earth systems
* Identify the relevant timescale in which astronomical, atmospheric, geologic, oceanic, and/or biologic changes in Earth systems operate

#### ESS2.D.7

* Describe the flow of energy between the Sun and Earth systems
* Identify that the input, output, storage, and redistribution of energy has an effect on climate

### Crosscutting Concept Assessment Target(s)

CCC2 Identify empirical evidence to differentiate between cause and correlation and make claims about specific causes and effects

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a model that illustrates how changes in Earth’s orbit, the orientation of its axis, and/or the Sun’s energy output affect Earth’s climate:

* Identifies or describes evidence to test a hypothesis about the effect of the changes on Earth’s climate and/or the relative time scale over which the changes take place (2.2.1, ESS1.B.7, and CCC2)
* Analyzes the model to identify evidence for relationships represented among different components of the system that affects Earth’s climate and/or the relative time scale over which the changes take place (2.2.1, ESS1.B.7, and CCC2)

Task provides a model that illustrates how astronomical, atmospheric, geologic, oceanic, and/or biologic changes in Earth systems affect Earth’s climate:

* Identifies or describes evidence to test a hypothesis about the effect of the changes on Earth’s climate and/or the relative time scale over which the changes take place (2.2.1, ESS2.A.8, and CCC2)
* Analyzes the model to identify evidence for relationships represented among different components of the system that affects Earth’s climate and/or the relative time scale over which the changes take place (2.2.1, ESS2.A.8, and CCC2)

Task provides a model that illustrates the flow of energy between components of Earth systems that affect Earth’s climate:

* Describes the flow of energy between components of the model and/or identifies the flow of energy as causal or correlational (2.2.2, ESS2.D.7, and CCC2)
* Identifies and describes the relationships between components of the model that affect the input, output, storage, and redistribution of energy, and/or the net effect on climate (2.2.2, ESS2.D.7, and CCC2)

Task provides two or more potential solutions to mediate the effect of astronomical, atmospheric, geologic, oceanic, and/or biologic changes in Earth systems on Earth’s climate with supporting data:

* Selects the most viable solution based on evidence and supports the selection using data (2.2.3, ESS2.D.7, and CCC2)

## California Environmental Principles and Concepts

* EP3: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
* EP4: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Effect of the shape of Earth’s orbit and/or the angle of Earth’s axis on changes in climate
* Relative contributions of greenhouse gas emissions or fluctuations in solar radiation to climate change
* Effect on climate change of human activity (e.g., greenhouse gas emission, deforestation) or natural activity (e.g., ice ages, plate tectonics, El Niño or La Niña events)

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Earth’s orbit and axial tilt are constant.
* Earth is always the same distance from the Sun.
* El Niño and La Niña events only affect equatorial regions.
* Removal of greenhouse gases from the atmosphere is easy to accomplish.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-ESS2-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-ESS2-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-ESS2-4%20Evidence%20Statements%20June%202015%20asterisks.pdf)

California Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

California Education and the Environment Initiative <http://californiaeei.org/>

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Appendix 2: Connections to Environmental Principles and Concepts <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

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