MS-ESS2-4 Earth's Systems

Students who demonstrate understanding can:

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] *[Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to describe unobservable mechanisms.	**ESS2.C: The Roles of Water in Earth's Surface Processes** 3. Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. 4. Global movements of water and its changes in form are propelled by sunlight and gravity.	**Energy and Matter** • Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

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.

2.1 Ability to develop 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.

2.1.1 Ability to determine the components as well as relationships among multiple components, to include or omit, of a scientific event, system, or design solution

2.1.2 Ability to determine scope, scale, and grain-size of the model, as appropriate to its intended use

2.1.3 Ability to represent mechanisms, relationships, and connections to illustrate, explain or predict a scientific event

Disciplinary Core Idea Assessment Targets

ESS2.C.3a Identify the components of the water cycle including water, energy, gravity, the atmosphere, landforms, and organisms

ESS2.C.3b Identify the processes of the water cycle such as transpiration, evaporation, condensation, crystallization, precipitation, and runoff

ESS2.C.3c Describe the relationships between the components of the water cycle (e.g., the transfer of energy from the Sun drives the evaporation of water)

ESS2.C.4a Describe that the transfer of energy between water and the environment during phase changes drives the cycling of water

ESS2.C.4b Describe that gravity acting on water in different phases and locations drives the cycling of water

ESS2.C.4c Develop and use models of the water cycle that include both energy from light and the force of gravity driving water cycling between the oceans, the atmosphere, and land

Crosscutting Concept Assessment Target(s)

CCC5 Identify that within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a phenomenon involving the water cycle and a list of relevant and irrelevant components and processes to model the phenomenon:

- Selects the relevant components and/or labels the components (2.1.1, ESS2.C.3, and CCC5)
- Selects the processes operating between components and/or labels those processes (2.1.1, ESS2.C.3, and CCC5)

Task provides an incomplete model representing a relevant weather event such as a map showing sea surface temperatures that lead to hurricane formation:

- Completes the model to illustrate or predict the event (2.1.1, ESS2.C.4, and CCC5)

Task provides a diagram of the water cycle with all components the same size:

- Selects the relative scale and size of the components appropriate to their relative importance (e.g., oceans have more influence on the cycle than lakes) (2.1.2, ESS2.C.3, and CCC5)

Task provides representations such as text descriptions, labels, or arrows to model phase changes and other processes in the water cycle:

- Selects the representations that best illustrates the phase change or process (2.1.3, ESS2.C.4, and CCC5)

Environmental Principles and Concepts

- EP3: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- The movement of water from the atmosphere to plants and from plants to the atmosphere
- The movement of water over landmasses
- Energy transfers to and from the environment during phase changes such as evaporation and condensation.

- The roles of solar energy and gravity on the movement of water, leading to cloud formation, precipitation, and other weather processes
- The relationship between energy in the atmosphere and oceans and the volume of glacial ice on Earth’s surface
- The movement of water through aquifers

Common Misconceptions

Note that the list in this section is not exhaustive.

- All processes in the water cycle are linear.
- Living things are not part of the water cycle.

Additional Assessment Boundaries

None listed at this time.

Additional References

MS-ESS2-4 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS2-4%20Evidence%20Statements%20June%202015%20asterisks.pdf

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

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

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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

MS-ESS2-6 Earth's Systems

Students who demonstrate understanding can:

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.

[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] *[Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena.	**ESS2.C: The Roles of Water in Earth's Surface Processes** 6. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. **ESS2.D: Weather and Climate** 4. 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. 6. 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.	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

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.

2.1 Ability to develop models

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.

2.1.1 Ability to determine the components as well as relationships among multiple components, to include or omit, of a scientific event, system, or design solution

2.1.3 Ability to represent mechanisms, relationships, and connections to illustrate, explain or predict a scientific event

2.2.1 Ability to use the model to collect evidence to reason qualitatively or quantitatively about concepts and relationships represented in the model

2.2.2 Ability to use the model to generate explanations and predictions about the behavior of a scientific phenomenon

Disciplinary Core Idea Assessment Targets

ESS2.C6a Identify and describe how variations in temperature and salinity affect the density of fluids, driving convection currents that can act both vertically and horizontally

ESS2.D4a Identify the components that affect climate including the rotating Earth, the atmosphere, the ocean, energy, and the distribution of continents, landforms, ice, and living things

ESS2.D4b	Identify and describe relationships between components affecting climate including differences in the distribution of solar energy and temperature changes, the motion of ocean waters and air masses, factors affecting the motion of winds and currents, and thermal energy transfer
ESS2.D4c	Describe the differing climate patterns due to changes in latitude and altitude
ESS2.D6a	Describe the differing climate patterns in the center of continents versus marine coasts due to water being able to absorb more solar energy for every degree change in temperature than land can

Crosscutting Concept Assessment Target(s)

CCC4	Use a model to represent a system and its interactions—such as inputs, processes and outputs—and energy, matter, and information flows within the system

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides an incomplete model for the mixing of air cells from Mexico and Canada as they interact on the plains of Tornado Alley:

- Adds labels to the model such as Earth's rotation, the temperature of the interacting air cells, and the topology of the region (2.1.1, ESS2.D4, and CCC4)
- Completes the model to explain why tornados have their characteristic strength, why tornados rotate, and/or why tornados are more likely in the plains rather than in mountainous or coastal regions (2.1.1, ESS2.D4, and CCC4)

Task provides a scenario in which air over the sea is cooler in daytime than the air on the coast, with the pattern reversing at night:

- Uses a representation to illustrate the flow of air during daytime and nighttime (2.1.3, ESS2.D4, and CCC4)

Task provides an interactive model that details coastal temperatures along the Atlantic and Mediterranean coasts of North America and Europe:

- Identifies evidence needed to support (or refute) that oceanic water temperatures have an impact on the climate of city pairs like Montreal-London or New York-Madrid, accounting for the milder temperatures/climates of the European cities over the American ones (2.2.1, ESS2.D6, and CCC4)

Task provides several maps showing the path and strength (in wind speed and diameter) of several large hurricanes:

- Identifies the role of the Coriolis effect in hurricane rotation (2.2.1, ESS2.D4, and CCC4)
- Identifies that hurricanes increase in strength as they pass over large, warm bodies of water and taper off as they pass over landmasses (2.2.1, ESS2.D4, and CCC4)

Task provides two models for oceanic circulation currents, one which reflects modern cycles with ice caps intact, and another in which the circulation is diminished due to the influx of freshwater after the ice caps melt:

- Identifies the source of the freshwater and salinity-based convection currents as the mechanism which has been altered due to climate change (2.2.2, ESS2.C6, and CCC4)

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- Changes in ocean salinity due to the influx of freshwater from melting ice caps
- Sea breeze created from temperature and pressure differentials between land and bodies of water near the coastline
- The rotation and strength of hurricanes as a function of pressure, the solar energy stored in the ocean, and the rotation of Earth
- The different climates of New York and Madrid despite the two being on approximately the same latitude (40°N)
- The difference in albedo of oceans and ice caps
- Prevailing winds and their effects on climate systems

Common Misconceptions

Note that the list in this section is not exhaustive.

- Solar energy absorbed by water in the ocean is trapped there permanently.
- Weather and climate are synonymous.
- Small climate changes can only have small impacts.
- Human activity only has small impacts on surface features and, therefore, cannot have a meaningful effect on climate patterns.

Additional Assessment Boundaries

None listed at this time.

Additional References

MS-ESS2-6 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS2-6%20Evidence%20Statements%20June%202015%20asterisks.pdf

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> *https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf*

MS-ESS3-2 Earth and Human Activity

Students who demonstrate understanding can:

> **Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**
>
> [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings.	**ESS3.B: Natural Hazards** 4. Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**Patterns** • Graphs, charts, and images can be used to identify patterns in data. ------------------------------------ ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

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.

4.2 Ability to analyze data to identify relationships

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.

4.2.1 Ability to use observational and/or empirical data to describe patterns and relationships

4.2.2 Ability to identify patterns (qualitative or quantitative) among variables represented in data

4.2.3 Ability to apply concepts of statistics and probability to data

4.2.4 Ability to consider limitations of data analysis

Disciplinary Core Idea Assessment Targets

ESS3.B.4a Identify and describe patterns of location and timing of natural hazard events relative to geographic/geologic features of the impacted region

ESS3.B.4b Identify and describe patterns of frequency and severity of natural hazard events and their associated types of damage

ESS3.B.4c Describe the risk of a prospective natural hazard event based on geographic/geologic features

ESS3.B.4d Describe different types of impacts, including the type of damage (e.g., wind, flooding, etc.) associated with different natural hazard events

ESS3.B.4e Describe the susceptibility of a region to different types of hazard impacts

ESS3.B.4f Describe patterns in different indicators that can be used to predict the likelihood of future hazard events

ESS3.B.4g Describe steps humans can take to mitigate the impacts of natural hazard events

Crosscutting Concept Assessment Target(s)

CCC1 Use graphs, charts, and images to identify patterns in data

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides two (or more) data sets from the same natural disaster:

- Compares the information provided in each and describes a pattern between the location and/or frequency and/or severity of a natural disaster and the geologic features of the impacted region (4.2.1, ESS3.B.4, and CCC1)

Task provides a map showing the location and severity of a class of natural disasters:

- Identifies a pattern that a geographic feature of a region makes it more susceptible to that class of disaster than regions that do not have that geographic feature (4.2.2, ESS3.B.4, and CCC1)

Task provides data on the frequency and severity of a certain class of natural disasters:

- Applies concepts in probability and averages to demonstrate that a “one-in-a-hundred year” event means that the probability that an event of that magnitude will occur in a given year is 1%, but not that the event will occur exactly once per hundred years (4.2.3, ESS3.B.4, and CCC1)

- Uses probability to determine if a proposed structure (rated to some level of severity event) is well suited to a region (4.2.3, ESS3.B.4, and CCC1)

Task provides information from many natural disasters about the severity of the event and the time difference between when an alert about an impending disaster event was made to the citizens of a region and the time when the event actually occurred (if at all):

- Identifies the limitations of using the relationship between severity and lead time to predict the event in advance (4.2.4, ESS3.B.4, and CCC1)

Environmental Principles and Concepts

- EP1: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

- EP2: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- Different types of volcanoes, their causes, and the types of eruptions that they can emit
- Patterns in hurricane landfall (or intensity)
- Structural features of buildings in different regions where different natural disasters are more likely
- Established safety mechanisms based on the predictability of both primary and secondary effects of natural disasters
- Patterns in tornado formation
- Plate tectonic data to predict seismic changes and other activity
- Patterns in seismic data to study earthquakes, volcanic eruptions, and tsunamis
- Remote sensing data such as satellite images to determine risks of changes over time (such as measuring the distribution and health of vegetation as part of predicting a region's susceptibility to wildfires, droughts, and other events)

Common Misconceptions

Note that the list in this section is not exhaustive.

- Natural disasters are chaotic events that cannot be predicted.
- Human activity does not affect the susceptibility of a region to the impacts of a natural catastrophe.

Additional Assessment Boundaries

None listed at this time.

Additional References

MS-ESS3-2 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS3-2%20Evidence%20Statements%20June%202015%20asterisks.pdf

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MS-ESS3-4 Earth and Human Activity

Students who demonstrate understanding can:

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

[Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

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
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**ESS3.C: Human Impacts on Earth Systems** 4. 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.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. -------------------------- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. -------------------------- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

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.

7.1 Ability to construct scientific arguments

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.

7.1.1 Ability to develop scientific arguments that are supported by evidence/data

7.1.2 Ability to identify evidence/data that supports a claim

7.1.3 Ability to use reasoning to explain how relevant evidence/data supports or refute the claim; the reasoning should reflect application of scientific concepts, principles, ideas

Disciplinary Core Idea Assessment Targets

ESS3.C.4a Identify changes in human population over various timespans within and between different geographic regions

ESS3.C.4b Identify changes in the availability of natural resources of a region and relate those changes to the needs of human populations

ESS3.C.4c Describe how changes in the availability of natural resources of a region will impact the ecology of the region

ESS3.C.4d Explain how humans can cause a change in one region to impact other Earth systems (e.g., the conversion of arable land for farming impacts erosion)

ESS3.C.4e Describe potential design solutions in terms of their effect on limiting resource use

ESS3.C.4f Describe potential design solutions in terms of the needs of a changing human population

Crosscutting Concept Assessment Target(s)

CCC2 Use cause and effect relationships to predict phenomena in natural or designed systems

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides data regarding the availability of a resource, current rates of consumption by a relevant human population, and details regarding a proposed engineering project designed to limit future use of that resource:

- Constructs an argument in support/opposition of the proposal using the data provided as evidence with reasoning that considers nonscientific factors (7.1.1, ESS3.C.4, and CCC2)

Task provides a claim with evidence regarding the potential impact of projected increases in human population based on a particular data set:

- Evaluates (with reasoning) whether the provided evidence/data are sufficient to defend the claim (7.1.2, ESS3.C.4, and CCC2)

Task provides an incomplete argument regarding a potential negative consequence for humans based on overconsumption of a particular resource that includes both a claim and reasoning but no evidence:

- Identifies a potential source of evidence/data that could be used to support the claim (7.1.2, ESS3.C.4, and CCC2)

- Evaluates the impact of the proposed project using relevant scientific principles (7.1.3, ESS3.C.4, and CCC2)

- Explains the role that society plays in determining the viability of a design solution (7.1.3, ESS3.C.4, and CCC2)

Task provides contrasting arguments about the magnitude of a potential negative impact based on current rates of resource consumption:

- Selects the best argument on the basis of the quantity and appropriateness of evidence (7.1.2, ESS3.C.4, and CCC2)

- Indicates the argument best supported by reasoning that considers both scientific and societal factors (7.1.2, ESS3.C.4, and CCC2)

Environmental Principles and Concepts

- EP1: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.
- EP2: The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- Per capita consumption of natural resources in different populations
- Consumption issues such as:
  - poor farming practices
  - overfishing
  - use of fossil fuels
- The merits of a potential engineering project designed to limit impacts of resource use in light of resource needs (e.g., changing from fossil fuels to solar power for electricity generation)
- The quality/quantity of evidence used to support an argument that current rates of consumption of a given natural resource are (or are not) sustainable
- Potential sources of evidence that students could use to support/refute a claim regarding a population’s natural resource needs
- Comparison of the amount of available resource (such as water, forest, petroleum) to the amount consumed over time
- Extinction rates and human population growth
- Impact on an environment after recovering natural resources (e.g., open-pit mining, offshore oil drilling)
- Possible negative environmental effects of design solutions intended to reduce resource consumption (e.g., windmills may cause noise and loss of wildlife habitat, dams may cause loss of wildlife habitat and coastal erosion)

Common Misconceptions

Note that the list in this section is not exhaustive.

- Solutions to mitigating human resource needs should only consider relevant scientific principles.
- Natural resources are abundant and will last forever.
- Features of Earth systems are always in flux; therefore, no steps need to be taken to mitigate the impacts of human resource consumption.

Additional Assessment Boundaries

None listed at this time.

Additional References

MS-ESS3-4 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS3-4%20Evidence%20Statements%20June%202015%20asterisks.pdf

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https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf

MS-ESS3-5 Earth and Human Activity

Students who demonstrate understanding can:

> **Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.**
>
> [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. • Ask questions to identify and clarify evidence of an argument.	**ESS3.D: Global Climate Change** 1. Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	**Stability and Change** • Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

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.

1.2 Ability to ask and evaluate scientific questions arising from examining models, explanations, arguments to specify relationships between variables

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.

1.2.1 Ability to ask questions that clarify and refine a model, or provide an explanation

1.2.3 Ability to ask and/or evaluate questions that challenge the premise(s) of an argument, or provide interpretation of a data set

Disciplinary Core Idea Assessment Targets

ESS3.D.1a Identify patterns in data about carbon dioxide emissions (and other greenhouse gases) from human activities and global temperature and describe the relationship between them over the past century

ESS3.D.1b Describe the effectiveness of possible climate-change-mitigating activities (e.g., reductions in emissions or making changes in fuel usage) based on knowledge about past human behaviors and considerations of resource costs (including time, human capital, and material cost)

ESS3.D.1c Identify the effect of natural processes (e.g., volcanism, natural carbon dioxide cycling in plant life, and variations in solar radiation) on global temperature and distinguish it from the effect of human activities

ESS3.D.1d Identify potential outcomes of climate change (including changes to weather patterns and changes to ecosystems) and classify them in terms of their effects

ESS3.D.1e Identify patterns in data regarding carbon dioxide released from human activities and global temperatures and describe the relationship between them over the past century

ESS3.D.1f Identify patterns in data that connect natural processes and human activities to changes in global temperatures and carbon dioxide and other greenhouse gases over the past century

Crosscutting Concept Assessment Target(s)

CCC7 Identify sources of change as being either sudden events or gradual changes that accumulate over time

Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a graph predicting both future emission rates and future surface temperatures:

- Asks questions to correctly clarify why surface temperatures continue to rise even if emissions have decreased (1.2.1, ESS3.D.1, and CCC7)

- Predicts changes due to varying emission rates (1.2.1, ESS3.D.1, and CCC7)

Task provides a series of graphs, tables, and/or maps displaying different climate predictions for the next several decades:

- Asks questions about improvements in methodology, decreases in uncertainty or error, and the difference between refinements in models to understand the ongoing debate regarding the role of human activities in climate change (1.2.1, ESS3.D.1, and CCC7)

Task provides an explanation for the differential role of short-term and long-term climate impacts due to various factors:

- Asks a testable question that could be used to evaluate differential impacts (1.2.1, ESS3.D.1, and CCC7)

Task provides an argument regarding evidence for human-driven climate change:

- Identifies questions which best challenge the scientific reasoning of the argument (1.2.3, ESS3.D.1, and CCC7)

Task provides an argument in favor of a policy position regarding potential steps a local/national/or global initiative could implement to mitigate climate change:

- Identifies questions which best evaluate the resource cost of the initiative (including human capital, material cost, and time) and best challenge the viability of the proposed initiative (1.2.3, ESS3.D.1, and CCC7)

Task provides a series of photos, graphs, and/or maps showing the melting of glacial ice:

- Identifies questions about the rates of change in ice caps which are empirically testable (1.2.3, ESS3.D.1, and CCC7)

Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

- A comparison of the short-term impacts of volcanic eruptions to carbon dioxide emissions released from human activities
- Claims made at the local, national, or global level about the impacts of increases in mean surface temperature
- A comparison of the climate of the past ice age to today
- The relative impacts of various human activities
- The influence of social dynamics on decisions about policies designed to mitigate climate change issues
- Data predicting the effects of climate change (e.g., rate of sea surface water temperature change)
- Patterns and relationships in climate change data
- The potential outcomes of climate change
- The cost–benefit relationship of climate change mitigation strategies

Common Misconceptions

Note that the list in this section is not exhaustive.

- The terms climate and weather are interchangeable.
- Humans are the only driver of climate change.

Additional Assessment Boundaries

None listed at this time.

Additional References

MS-ESS3-5 Evidence Statement https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-ESS3-5%20Evidence%20Statements%20June%202015%20asterisks.pdf

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*