## MS-ESS2-4    Earth's Systems

Students who demonstrate understanding can:

**MS-ESS2-4.** **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.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
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| **Developing and Using Models**<br>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.<br><br>• Develop a model to describe unobservable mechanisms. | **ESS2.C: The Roles of Water in Earth's Surface Processes**<br>• Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.<br>• Global movements of water and its changes in form are propelled by sunlight and gravity. | **Energy and Matter**<br>• Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. |

| | Observable features of the student performance by the end of the course: | |
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| 1 | Components of the model | |
| | a | To make sense of a phenomenon, students develop a model in which they identify the relevant components: |
| | | i.    Water (liquid, solid, and in the atmosphere). |
| | | ii.   Energy in the form of sunlight. |
| | | iii.  Gravity. |
| | | iv.   Atmosphere. |
| | | v.    Landforms. |
| | | vi.   Plants and other living things. |
| 2 | Relationships | |
| | a | In their model, students describe the relevant relationships between components, including: |
| | | i.    Energy transfer from the sun warms water on Earth, which can evaporate into the atmosphere. |
| | | ii.   Water vapor in the atmosphere forms clouds, which can cool and condense to produce precipitation that falls to the surface of Earth. |
| | | iii.  Gravity causes water on land to move downhill (e.g., rivers and glaciers) and much of it eventually flows into oceans. |
| | | iv.   Some liquid and solid water remains on land in the form of bodies of water and ice sheets. |
| | | v.    Some water remains in the tissues of plants and other living organisms, and this water is released when the tissues decompose. |
| 3 | Connections | |
| | a | Students use the model to account for both energy from light and the force of gravity driving water cycling between oceans, the atmosphere, and land, including that: |
| | | i.    Energy from the sun drives the movement of water from the Earth (e.g., oceans, landforms, plants) into the atmosphere through transpiration and evaporation. |
| | | ii.   Water vapor in the atmosphere can cool and condense to form rain or crystallize to form snow or ice, which returns to Earth when pulled down by gravity. |
| | | iii.  Some rain falls back into the ocean, and some rain falls on land. Water that falls on land can: |

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| | | 1. | Be pulled down by gravity to form surface waters such as rivers, which join together and generally flow back into the ocean. |
| | | 2. | Evaporate back into the atmosphere. |
| | | 3. | Be taken up by plants, which release it through transpiration and also eventually through decomposition. |
| | | 4. | Be taken up by animals, which release it through respiration and also eventually through decomposition. |
| | | 5. | Freeze (crystallize) and/or collect in frozen form, in some cases forming glaciers or ice sheets. |
| | | 6. | Be stored on land in bodies of water or below ground in aquifers. |
| | b | Students use the model to describe that the transfer of energy between water and its environment drives the phase changes that drive water cycling through evaporation, transpiration, condensation, crystallization, and precipitation. | |
| | c | Students use the model to describe how gravity interacts with water in different phases and locations to drive water cycling between the Earth's surface and the atmosphere. | |