NGSS Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	Rationale
Elementary				
2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.	**S&E Practices:** Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	**DCI:** Plants depend on water and light to grow.	**CCC:** Events have causes that generate observable patterns.	Establish the importance of water to living things, specifically plants, among young children to set the stage for more complex explanations of the role of water and living things.
3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.	**S&E Practices:** Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**DCI:** When the environment changes in ways that affects a place's physical characteristics, temperature or availability of resources, some organisms survive and reproduce, yet others move into the transformed environment, and some die.	**CCC:** A system can be described in terms of its components and their interactions.	Building upon students' notion that water is important emphasize the relationship between living things and availability of water. Comparing plants and animals to human populations, it is easy for students to realize that without water plants, animals, and human live is not likely to survive.
4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering on the rate of erosion by water.	**S&E Practices:** Make observations and/or measurements to produce data to serve as the basis for evidence of an explanation of a phenomenon.	**DCI:** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.	**CCC:** Cause and effect relationships are routinely identified, tested, and used to explain change.	Water also has the potential to cause dramatic changes to landforms and the surface of the earth through weathering in the form of liquid water and ice.
Middle School				
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.	**S&E Practices:** Develop a model to predict and/or describe phenomena.	**DCI:** Substances are made from different types of atoms, which combine with one another in various ways. **DCI:** In a liquid, the molecules are constantly in contact with others; in a gas, the molecules are widely spaces except when they happen to collide. **DCI:** The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter.	**CCC:** Cause and effect relationships may be used to predict phenomena in nature or designed systems.	Water exists as a solid, a liquid, and as a gas. The changes in the state of water are determined by variations in temperature.
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of pure substance when thermal energy is added or removed.	**S&E Practices:** Develop a model to predict and/or describe phenomena.	**DCI:** In a liquid, the molecules are constantly in contact with others; in a gas, the molecules are widely spaces except when they happen to collide. **DCI**: The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter.	**CCC:** Cause and effect relationships may be used to predict phenomena in nature or designed systems.	Students' understanding of the distinction between states of matter is important when attempting to explain the importance of water within the atmosphere. Explaining the distinction between the states of matter and kinetic energy is critical in understanding solid, liquid, and gaseous forms of water.
MS-PS3-4. Plan an investigation to determine the relationship among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	**S&E Practices:** Develop a model to predict and/or describe phenomena.	**DCI:** The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	**CCC:** Models can be used to represent systems and their intereactions - such as inputs, processes, and outputs - and energy and matter flows within systems.	As the kinetic energy of a sample of matter increases, the motion of the particles within the sample increases. An increase in the kinetic energy of water has the potential to determine the state of the water [solid, liquide, or gas].
MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	**S&E Practices:** Construct a scientific explanation based on valid and reliable evidence obtained from sources (including students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**DCI:** Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releasaes oxy6gen. These sugars can be used immediately or stored for growth or later use.	**CCC:** Within a natural system, the transfer of energy drives the motion and/or cycling of matter.	Water plays a critical role in biological processes. Photosynthesis is one of the most critical processes for continued life on earth and also the source of oxygen within the earth's atmosphere. Water is an essential component to the process of photosynthesis.
MU-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed earth's surface at varying time and spatial scales.	**S&E Practices:** Construct a scientific explanation based on valid and reliable evidence obtained from sources (including students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**DCI:** Water movements-both on land and underground-cause weathering and erosion which change the land's surface features and create underground formations.	**CCC:** Patterns can be used to identify cause and effect relationships.	Water is also an important factor in abiotic systems. The movement of water above and below the earth's surface results in dramatic changes which have the potential to impact the ecosystems of living organisms. The movement of water is one of the major components of weathering and erosion.
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.	**S&E Practices:** Develop a model to predict and/or describe observable and unobservable phenomena.	**DCI:** Water continually cycles among land, ocean, and atmosphere via transpiration, evporation, condensation and crystallization, and precipitation, as well as downhill flow on land.	**CCC:** Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.	The water cycle explains the transfer of water from large bodies of surface water to land which is far removed from oceans and seas. Understanding the water cycle is critical to understanding the cycling and movement of water from earth's oceans to the land and to the oceans.
MS-ESS2-5. Collect data to provide evidence for how the motions and complex intereactions of air masses results in changes within weather conditions.	**S&E Practices:** Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.	**DCI:** The complex patterns of the changes and the movement of water in the atmosphere determined by winds, landforms, and ocean temperatures and currents are major determinents of local weather patterns. **DCI:** Weather and climate are influenced by interactions involving sujnlight, 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.	**CCC:** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.	Water is a major factor in weather. The amount of water vapor held by the air is critical to the amount of precipitation. Data of preciptation amounts collected over time can provide important insights into weather trends and climatic changes.
MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.	**S&E Practices:** Develop a model to describe a phenomenon.	**DCI:** Humans depend on earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.	**CCC:** Cause and effect relationships may be used to predict phenomena in natural or designed systems.	Support students' understanding of the natural processes which are responsible for the placement of natural resources around the globe. Also emphasize that water can also be found in and be moving through certain rock layers beneath the earth's surface. Groundwater is a major reservoir for water on earth.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the envrironment.	**S&E Practices:** Analyze and interpret data to determine similarities and differences in findings. **S&E Practices:** Apply scientific principles to design an object tool or system.	**DCI:** Human activities have signifcantly altered the biospher, simtimes damaging or destroying natural habitats and causing the extinction of other species. But changes to the earth's environments can have different impacts (negative and positive) for different living things.	**CCC:** Relationships can be classified as causal or correlation does not nessarily imply causation.	Water quality in surface water has been impacted by human activity. Understanding of the role of water within living systems provides the rationale for examining and finding ways to minimize human impact.
High School				
HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outmost energy level of atoms.	**S&E Practices:** Use a model to predict the relationships between systems or between components of a system.	**DCI:** The periodic table orders elements horizontally by the number of protons in the atom's n ucleus and places those with similar chemical properties in a column. The repeating patterns of this table reflect the patterns of outer electron states.	**CCC:** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.	Understanding the periodic table and characteristics of elements based upon the outer electron states can provide a basis for understanding the polarity of the water molecule.
HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy	**S&E Practices:** Use a model to illustrate relationships between systems or between the components of a system.	**DCI:** The process of photosynthesis concerts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**CCC:** Changes of energy and matter in a system can bhe described in terms of energy and matter flows into and out of that system.	The process of photosynthesis emphasizes the important role of water in living things. Water is critical to the process and also the release of oxygen into the atmosphere as a photosynthetic byproduct.
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.	**S&E Practices:** Use a model to provide mechanistic accounts of phenomena.	**DCI:** Cyclical changes in the shape of earth's orbit around the sun, together with cyhanges 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 cimatic changes.	**CCC:** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	By building upon students' understanding of the water cycle, the energy from the sun is necessary for the evaporation of surface water to enter the atmosphere, condense to form clouds, and ultimately fall to earth as precipitation.
HS-ESS3-5. Analyse geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated furture impacts to earth systems.	**S&E Practices:** Analyze data using computational models in order to make valid and reliable scientific claims.	**DCI:** Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and managte current and future impacts.	**CCC:** Change and rates of change can be quantified and modeled over very short or very loong periods of time. Some system chantges are irreversible.	Climate models not only deal with temperature but also with precipitation. The rate at which water is replaced within the soil by precipitation is an important consideration and will have a dramatic impact upon soil health and productivity.
HS-ESS3-6. Use a computational representation to illustrate the relationships among earth systems and how these relationships are being modified due to human activity.	**S&E Practices:** Use a computational representation of phenomena or design solutions to describe and/or support claims and/or other explanations.	**DCI:** Through computer simjulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**CCC:** When investigation or describing a system, the boundaries and initial conditions of the system need to defined and their inputs and outputs analyzed and described using models.	The relationship between the hydrosphere, the atmosphere, and the biosphere are critical to maintaining earth systems.
HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	**S&E Practices:** Create a computational model or simulation of a phenomenon, designed devide, process or system.	**DCI:** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.	**CCC:** Modern civilization depends on major technological systems. New technologies can have deep im;pacts on societyh and the environment including some that were not anticipated.	At this level, students should be able to apply their understanding of water resources and earth's systems to address concerns of human impact upon earth's systems.

Missouri Learning Standards Grade-Level Expectations	Mathematical Practices	Rationale		
Elementary				
2.GM.B.1. Estimate and measure to determine how much longer one object is than another, expressing the length difference in terms of a standard unit of length.	**4a:** Identify relevant quantities and develop a model to describe their relationships. **4b:** Interpret mathematical models in the context of the situationn.	E.g., measuring length of plant growth at different points in time.		
2.DS.A.2. Generate measurement data by measuring lengths of several related objects (e.g. shoe lengths) to the nearest whole unit, or by making multiple measurements of the same object (e.g. the length of the room). Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.	**6a:** Express numerical answers with the degree of precision appropriate for the context of a situation. **6b**: Use appropriate units, scales, and labels.			
3.DS.A.4. Use the data shown in a line plot to generate a set of observations about the data and to answer questions about the data,(e.g., What do you notice about the data we collected? Why didn't we all get the same length when we measured our desks? What's the difference in length between the shortest and longest pencil (if data is reported to nearest whole number)? How many students have a pencil longer than 10 cm? What pencil length is most common?) (Formal terms such as 'mode', 'range', or 'maximum' are not required at this grade level.)				
5.RA.A.1. Investigate the relationship between two numerical patterns expressed as rules, tables, sets of ordered pairs, or graphs.				
Middle School				
6.RP.A.1. Understand a ratio as a comparison of two quantities and represent these comparisons in the form of ratios and as verbal statements.	**2a:** Make sense of quantities and their relationships in mathematical and real-world situations.	E.g., ratios between kinetic energy and motion of the particles, or kinetic energy and temperature.		
6.DSP.A.1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers	**3b:** Compare and discuss the validity of various reasoning strategies. **3d:** Reflect on and provide thoughtful responses to the reasoning of others.			
8.F.B.5. Describe the functional relationship between two quantities from a graph (e.g., constant, increasing/decreasing, linear/nonlinear, continuous/discontinuous) and be able to sketch a graph given a verbal description.	**4a:** Identify relevant quantities and develop a model to describe their relationships. **4b:** Interpret mathematical models in the context of the situationn. **4d:** Evaluate the reasonableness of a model and refine if necessary.	E.g., relationships between kinetic energy and the motion of the particles within the sample. Also, relationships between water and oxygen levels, or between inputs and outputs in photosynthesis.		
8.DSP.A.1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative correlation, linear association, and nonlinear association.				
High School				
A1.NQ.B.4. Define and use appropriate quantities for representing a given context or problem.	**6a:** Express numerical answers with the degree of precision appropriate for the context of a situation. **6b**: Use appropriate units, scales, and labels.	E.g., energy in and energy out from the sun's radiation, or data on human contributions (pollution) to the water system and other correlated measures.		
A1.SSE.A.1. Interpret the contextual meaning of individual terms or factors from a given situation that utilizes formulas or expressions. **A1.IF.B.6.** Interpret the parameters of a linear or exponential function in terms of the context.	**4a:** Identify relevant quantities and develop a model to describe their relationships. **4b:** Interpret mathematical models in the context of the situationn. **4c:** Make assumptions and estimates to simplify complicated situations. **4d:** Evaluate the reasonableness of a model and refine if necessary.			
A1.LQE.E.11. Distinguish between situations that can be modeled with linear or with exponential functions.	**2a:** Make sense of quantities and their relationships in mathematical and real-world situations.			
A1.DS.A.5. Given a table of data (or data in context) for two quantitative variables, represent the relationship on a scatter plot and describe how the variables are related. Identify a function that best describes the relationship and use this function to solve problems.		E.g., current water and climate data used to predict future growth based on the underlying relationships.		
A2.FM.C.5. Create functions and use them to solve simple applications of quadratic and exponential function models, e.g. price-demand-cost-revenue-profit situations, compound interest problems, and exponential growth or decay problems.				
A2.DS.A.4. Use data from a sample survey to estimate a population mean or proportion and recognize the meaning of the margin of error in these estimates				