Climate Change & Next Generation Science Standards

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PS – Physical Sciences
ESS – Earth and Space Sciences
LS – Life Sciences

Information from https://www.nextgenscience.org/.
Definitions paraphrased for brevity's sake.

Part I: Disciplinary Core Ideas (DCI)

Kindergarten:

K-PS3.B: Conservation of Energy and Energy Transfer. Sunlight warms Earth's surface.

K-ESS2.D: Weather and Climate. People measure sunlight, wind, snow or rain, and temperature to describe and record the weather and to notice patterns over time.

K-ESS3.C: Human Impacts on Earth Systems. Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things.

K-ETS1.A: Defining and Delimiting an Engineering Problem. A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

K-ETS1.A: Defining and Delimiting an Engineering Problem. Asking questions, making observations, and gathering information are helpful in thinking about problems.

K-ETS1.B: Developing Possible Solutions. Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

First Grade:

1-LS1.D: Information Processing. Plants and animals respond to the environment with behaviors that help them survive.

2nd Grade:

2-PS1.A: Structure and Properties of Matter. Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.

2-LS2.A: Interdependent Relationships in Ecosystems. Plants depend on water and light to grow. Plants depend on animals for pollination or to move their seeds around.

2-ETS1.B: Developing Possible Solutions. Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

2-ETS1.C: Optimizing the Design Solution. Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

3rd Grade:

3-LS2.C: Ecosystem Dynamics, Functioning, and Resilience. When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

3-LS4.C: Adaptation. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

3-LS4.D: Biodiversity and Humans. Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

3-ESS2.D: Weather and Climate. Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

4th Grade:

4-PS3.B: Conservation of Energy and Energy Transfer. Light and motion can create electrical energy. Energy can be transferred to produce motion, sound, heat or light.

4-ESS3.A: Natural Resources. Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

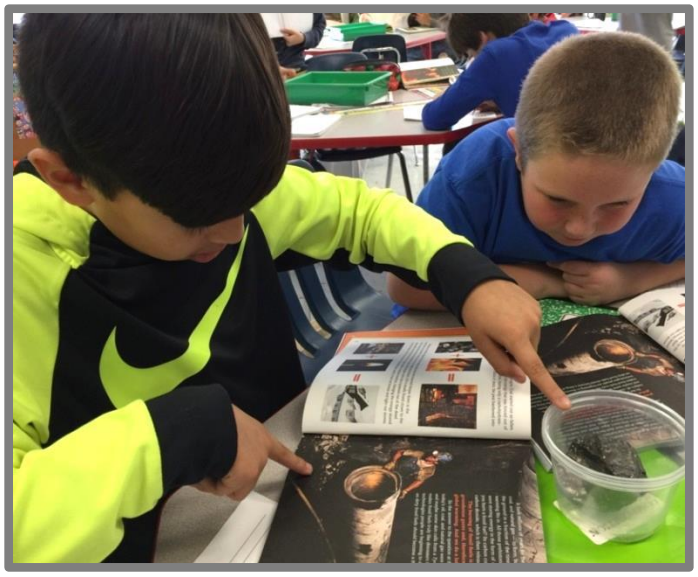
5th Grade:

5-LS2.A: Interdependent Relationships in Ecosystems. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.

5-ESS2.A: Earth Materials and Systems. Earth's major systems, the atmosphere, geosphere, hydrosphere, and biosphere, interact in multiple ways to affect Earth's surface materials and processes.

5-ESS2.A: Earth Materials and Systems. The ocean influences climate.

5-ESS3.C: Human Impacts on Earth Systems. Human activities have had major effects on land, ocean, and air. But individuals and communities are doing things to help protect Earth's resources and environments.



Middle School (6-8)

MS-PS3.D: Energy in Chemical Processes and Everyday Life. Cellular respiration in plants and animals involves chemical reactions with oxygen to produce carbon dioxide and other materials.

MS-PS4.B: Electromagnetic Radiation. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.
MS-LS1.B: Growth and Development of Organisms. Local conditions affect the growth of plants.

MS-LS1.C: Organization for Matter and Energy Flow in Organisms. Plants, algae and microorganisms make food from water and atmospheric carbon dioxide. They release oxygen.

MS-LS2.A: Interdependent Relationships in Ecosystems. Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with non-living factors.

MS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience. 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-LS4.C: Adaptation. Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.

MS-LS4.D: Biodiversity and Humans. Changes in biodiversity can influence humans' resources, such as food, energy, and medicines.

MS-ESS2.A: Earth's Materials and Systems. The planet's systems interact. These interactions have shaped Earth's history and will determine its future.

MS-ESS2.C: The Roles of Water in Earth's Surface Processes. Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation.

MS-ESS2.C: The Roles of Water in Earth's Surface Processes. 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 determinants of local weather patterns.

MS-ESS2.C: The Roles of Water in Earth's Surface Processes. Global movements of water and its changes in form are propelled by sunlight and gravity.

MS-ESS2.C: The Roles of Water in Earth's Surface Processes. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

MS-ESS2.D: Weather and Climate. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.

MS-ESS2.D: Weather and Climate. 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.

MS-ESS3.A: Natural Resources. Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Resources are limited, and many are not renewable or replaceable over human lifetimes.

MS-ESS3.C: Human Impacts on Earth Systems. Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species.

MS-ESS3.C: Human Impacts on Earth Systems. Changes to Earth's environments can have negative or positive impacts to living things.

MS-ESS3.C: Human Impacts on Earth Systems. 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.

MS-ESS3.D: Global Climate Change. 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).

MS-ESS3.D: Global Climate Change. 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 human behavior and applying that knowledge wisely in decisions and activities.

MS-ETS1.B: Developing Possible Solutions. Models of all kinds are important for testing solutions.

High School (9-12)

HS-PS1.B: Chemical Reactions. The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

HS-PS3.D: Energy in Chemical Processes. Solar Cells are human-made devices that likewise capture the sun's energy and produce electrical energy.

HS-PS4.B: Electromagnetic Radiation. When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat).

HS-LS1.C: Organization for Matter and Energy Flow in Organisms. Photosynthesis converts light energy to stored chemical energy by converting carbon dioxide and water into sugars plus released oxygen.

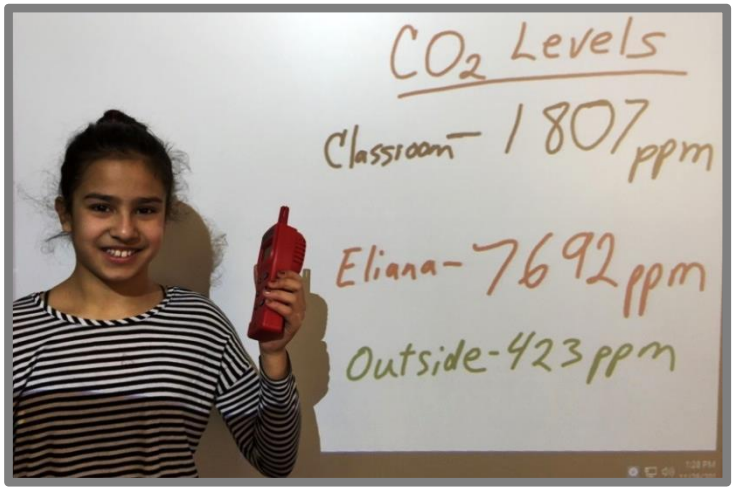
HS-LS2.A: Interdependent Relationships in Ecosystems. Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and non-living resources and from such challenges as predation, competition, and disease. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

HS-LS2.B: Cycles of Matter and Energy Transfer in Ecosystems. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience. A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. Extreme fluctuations in conditions or the size of an population, however, can challenge the function of ecosystems in terms of resources and habitat availability.

HS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience. Anthropogenic changes (induced by human activity) in the environment – including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change – can disrupt an ecosystem and threaten the survival of some species.

HS-LS4.C: Adaptation. Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment.



HS-LS4.C: Adaptation. Adaptation also means that the distribution of traits in a population can change when conditions change.

HS-LS4.C: Adaptation. Changes in the physical environment, whether naturally occurring or human induced, have contributed to the expansion of some species, the emergence of new and distinct species as population diverge under different conditions, and the decline – and sometimes the extinction – of some species.

HS-LS4.C: Adaptation. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.

HS-LS4.D: Biodiversity and Humans. Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem function and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

HS-ESS1.B: Earth and the Solar System. 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 Earth. These phenomena cause a cycle of ice ages and other gradual climate changes.

HS-ESS2.A: Earth Materials and Systems. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

HS-ESS2.A: Earth Materials and Systems. The geologic 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 timescales.

HS-ESS2.C: The Roles of Water in Earth's Surface Processes. The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, and dissolve and transport materials.

HS-ESS2.D: Weather and Climate. 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.

HS-ESS2.D: Weather and Climate. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

HS-ESS2.D: Weather and Climate. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.

HS-ESS2.D: Weather and Climate. Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.

HS-ESS2.E: Biogeology. The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.

HS-ESS3.A: Natural Resources. Resource availability has guided the development of human society.

HS-ESS3.B: Natural Hazards. Natural hazards (e.g., hurricanes, torrential downpours, droughts) have shaped the course of human history; they have significantly altered the sizes of human populations and have driven human migrations.

HS-ESS3.C: Human Impacts on Earth Systems. The sustainability of human societies and the biodiversity that supports them require responsible management of natural resources.

HS-ESS3.C: Human Impacts on Earth Systems. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

HS-ESS3.D: Global Climate Change. Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

HS-ESS3.D: Global Climate Change. Through computer simulations and other studies, important discoveries are still being made about how the ocean, atmosphere, and biosphere interact and are modified in response to human activities.

HS-ETS1.A: Defining and Delimiting Engineering Problems. Humanity faces major global challenges today, such as the need for supplies of clean water and food, or for energy sources that minimize pollution, which can be addressed through engineering.

HS-ETS1.B: Developing Possible Solutions. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical.

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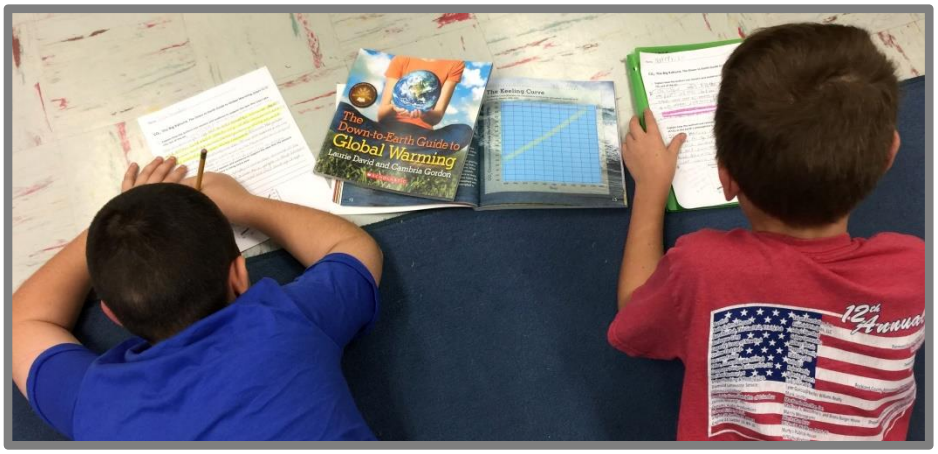
Part II: Crosscutting Concepts (CC)

- **Patterns**
- **Cause and Effect**
- **Scale, Proportion, and Quantity**
- **Systems and System Models**
- **Energy and Matter in Systems**
- **Structure and Function**
- **Stability and Change of Systems**

Part III: Science and Engineering Practices (SEP)

- **Asking questions and defining problems.**
- **Developing and using models.**
- **Planning and carrying out investigations.**
- **Analyzing and interpreting data.**
- **Using mathematics and computational thinking.**
- **Constructing explanations and designing solutions.**
- **Engaging in argument from evidence.**
- **Obtaining, evaluating, and communicating information.**



Part IV: Connections to Engineering, Technology, and Applications of Science

- **Interdependence of Science, Engineering, and Technology**:

  - ✓ Science and engineering complement each other in the cycle known as research and development.

  - ✓ Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

- **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.

  - ✓ The use 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.

  - ✓ Modern civilization depends on major technological systems.

  - ✓ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Part V: Science is a Human Endeavor

- **Science is a Human Endeavor:**

  - ✓ Scientists and engineers are guided by habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

  - ✓ Science and engineering are influenced by society, and society is influenced by science and engineering.

  - ✓ Technological advances have influenced the progress of science, and science has influenced advances in technology.

- **Scientific Knowledge Assumes an Order and Consistency in Natural Systems:**

  - ✓ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

  - ✓ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future.

- **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.