Earth Systems
Science

Course Description

The Earth Systems Cherokee Teaching & Learning Standards are designed to continue student investigations that began in K-8 on the connections among Earth's systems through Earth history. These systems – the atmosphere, hydrosphere, geosphere, and biosphere – interact through time to produce the Earth's landscapes, ecology, and resources. These standards engage the students in constructing explanations of phenomena fundamental to the sciences of geology and physical geography, including the early history of the Earth, plate tectonics, landform evolution, the Earth's geologic record, weather and climate, and the history of life on Earth. Instruction should focus on development of scientific explanations, rather than mere descriptions of phenomena. Case studies, laboratory exercises, maps, and data analysis should be integrated into units as well as topics of current interest (e.g., recent earthquakes, tsunamis, global warming, price of resources) and potential careers in the geosciences.

Science standards integrate the three dimensions of **Science and Engineering Practices (SEPs)**, **Crosscutting Concepts (CCCs)**, and **Disciplinary Core Ideas (DCIs)** to provide a comprehensive framework that emphasizes active engagement, interdisciplinary connections, and core scientific principles. Together, they show how science standards engage *students* in obtaining, evaluating, and communicating information.

Science and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas
Asking Questions (Science) and Defining Problems (Engineering)	Patterns	Engineering, Technology, and the Application of Science (TLS)
Developing and Using Models	Cause and Effect: Mechanism and Explanation	
Planning and Carrying Out Investigations	Scale, Proportion, and Quantity	Physical Science (P)
Analyzing and Interpreting Data	Systems and System Models	
Mathematics and Computational Thinking	Energy and Matter: Flows, Cycles, and Conservation	Life Science (L)
Constructing Explanations (Science) and Designing Solutions (Engineering)		
Engaging in Argument from Evidence	Structure and Function	Earth and Space Science (E) Earth Systems (ES)
Obtaining, Evaluating, and Communicating Information	Stability and Change	

Science and Engineering Practices are fundamental approaches that scientists and engineers use to investigate the natural world and solve practical problems. **Crosscutting Concepts** in science are overarching themes that bridge various disciplines, helping students and researchers see connections and deepen their understanding of the natural world. **Disciplinary Core Ideas** are fundamental concepts that students need to understand to develop a deep knowledge of science across various disciplines.

Semester 1 (August – December)

Unit 0: Thinking Like a Scientist (1 week)

In this introductory unit, students will begin developing the foundational skills needed for scientific inquiry, including designing experiments, analyzing data, and communicating scientific findings. This unit will set the stage for applying these skills to understand Earth's systems throughout the course.

Overarching Standards for Unit 0

ES0: Obtain, evaluate, and communicate information to understand the interconnectedness of Earth's systems.

(Clarification statement: Students should be introduced to the four earth systems branches/spheres - hydrosphere, atmosphere, geosphere, and biosphere.)

TLS9-12: Refine scientific inquiry skills by designing and conducting investigations, applying scientific theories, critically evaluating scientific literature, and contributing to scientific discussions.

Supporting Standards for Student Mastery in Unit 0

TLS9-12.a: Use specialized scientific terms and concepts to analyze and explain scientific phenomena.

TLS9-12.b: Design and conduct independent experiments with multiple variables.

TLS9-12.c: Utilize advanced tools and statistical methods for data analysis.

TLS9-12.d: Communicate complex findings through reports and presentations.

Unit 1: The Formation of Our Solar System and the Planets (3-4 weeks)

In this unit, students will explore the formation of our solar system and the planets, focusing on the relationships between physical factors and adaptations within different biomes. They will investigate the origins of the solar system, including the nebular hypothesis, and analyze evidence related to Earth's early systems and its layered structure. Through inquiry and modeling, students will develop a deeper understanding of the composition, distribution, and motion of solar system objects, as well as the differentiation of Earth's layers, connecting these concepts to broader environmental and ecological impacts.

Overarching Standards for Unit 1

ES1: Obtain, evaluate, and communicate information to investigate the composition and formation of Earth systems, including the Earth's place in the solar system.

ES1.a: Construct an explanation of the origins of the solar system from scientific evidence including the composition, distribution, and motion of solar system objects.

(*Clarification statement*: The nebular hypothesis should be included in this element.)

Supporting Standards for Student Mastery in Unit 1

ES1.b: Ask questions to evaluate evidence for the development and composition of Earth's early systems, including the geosphere (crust, mantle, and core), hydrosphere and atmosphere.

(*Clarification statement*: The differentiation by density of Earth into crust, mantle and core should be included in this element.)

ES1.c: Develop a model of the physical composition of Earth's layers using multiple types of evidence (e.g., Earth's magnetic field, composition of meteorites and seismic waves.

(*Clarification statement*: Earth's layers should include crust, mantle, inner core, and outer core.)

Unit 2: Geologic History (7-8 weeks)

In this unit, students will study Earth's geologic history, using rock relationships and fossils to reconstruct past events such as mass extinctions, climatic shifts, and tectonic activity. They will analyze rock and fossil sequences, apply mathematical methods to determine the absolute age of rocks, and use principles of relative age to interpret geologic cross-sections. Additionally, students will explore how sedimentary rocks and their fossils reflect ancient environments, and they will construct arguments about Earth's major transitions, using spatial data and geologic evidence, with a particular focus on Georgia's geological history.

Overarching Standards for Unit 2

ES4: Obtain, evaluate, and communicate information to understand how rock relationships and fossils are used to reconstruct Earth's past.

ES4.c: Analyze and interpret data from rock and fossil succession in a rock sequence to interpret major events in Earth's history such as mass extinction, major climatic change, and tectonic events.

Supporting Standards for Student Mastery in Unit 2

ES2.d: Ask questions to compare and contrast the relationship between transformation processes of all rock types (sedimentary, igneous, and metamorphic) and specific plate tectonic settings.

(*Clarification statement*: The plate tectonic settings to be considered here are continental collision, subduction zone, mid-ocean ridge, transformation fault, hot spot, and passive zone.)

ES4.a: Use mathematics and computational thinking to calculate the absolute age of rocks using a variety of methods (e.g., radiometric dating, rates of erosion, rates of deposition, and varve count).

ES4.b: Construct an argument applying principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) to interpret a geologic cross-section and describe how unconformities form.

ES4.d: Construct an explanation applying the principle of uniformitarianism to show the relationship between sedimentary rocks and their fossils to the environments in which they were formed.

ES4.e: Construct an argument using spatial representations of Earth data that interprets major transitions in Earth's history from the fossil and rock record of geologically defined areas.

(*Clarification statement*: Students should use maps and cross-sections with a focus on Georgia.)

Unit 3: Plate Tectonics (6 weeks)

In this unit, students will explore the dynamics of plate tectonics and how they shape Earth's geologic features, landforms, materials, and hazards. They will investigate the mechanisms behind plate tectonic motion, including the role of radioactive decay in driving convection currents, and develop models of different plate tectonic settings, such as convergent, divergent, and transform boundaries. Students will also evaluate evidence supporting the theory of plate tectonics, including fossils, paleomagnetism, and seafloor age, and analyze the relationship between tectonic settings and the formation of various rock types and geologic features.

Overarching Standards for Unit 3

ES2: Obtain, evaluate, and communicate information to understand how plate tectonics creates certain geologic features, landforms, Earth materials and geologic hazards.

ES2.c: Construct an explanation that communicates the relationship of geologic features, landforms, Earth materials and geologic hazards to each plate tectonic setting.

Supporting Standards for Student Mastery in Unit 3

ES1.b: Ask questions to evaluate evidence for the development and composition of Earth's early systems, including the geosphere (crust, mantle, and core), hydrosphere and atmosphere.

(*Clarification statement*: The differentiation by density of Earth into crust, mantle and core should be included in this element.)

ES1.c: Develop a model of the physical composition of Earth's layers using multiple types of evidence (e.g., Earth's magnetic field, composition of meteorites and seismic waves).

(*Clarification statement*: Earth's layers should include crust, mantle, inner core, and outer core.)

ES2.a: Construct an explanation based on evidence that describes the mechanisms causing plate tectonic motion.

(*Clarification statement*: The role of radioactive decay as the source of energy that drives the process of convection should be studied as part of this element).

ES2.b: Develop and use models for the different types of plate tectonic settings (convergent, divergent and transform boundaries).

(*Clarification statement*: Subduction zones, continental collisions, rift zones, and ocean basins should be included.)

ES2.d: Ask questions to compare and contrast the relationship between transformation processes of all rock types (sedimentary, igneous, and metamorphic) and specific plate tectonic settings.

(*Clarification statement*: The plate tectonic settings to be considered here are continental collision, subduction zone, mid-ocean ridge, transformation fault, hot spot, and passive zone.)

ES2.e: Construct an argument using multiple forms of evidence that supports the theory of plate tectonics (e.g., fossils, paleomagnetism, seafloor age, etc.).

Semester 2 (January – May)

Unit 4: Surface Processes on Earth (5 weeks)

In this unit, students will investigate the processes that shape Earth's surface, focusing on the roles of water, wind, ice, and gravity in landscape change. They will explore how surface water and groundwater contribute to physical and chemical weathering and develop models to understand mass wasting events. Students will construct explanations that connect past and present actions of natural forces to the distribution of landforms and landscape evolution, and they will analyze the relationship between sedimentary materials and the energy responsible for their transport and deposition.

Overarching Standards for Unit 4

ES3: Obtain, evaluate, and communicate information to explore the actions of water, wind, ice and gravity as they relate to landscape change.

ES3.c: Construct an explanation that relates the past and present actions of ice, wind, and water to landform distribution and landscape change.

Supporting Standards for Student Mastery in Unit 4

ES1.b: Ask questions to evaluate evidence for the development and composition of Earth's early systems, including the geosphere (crust, mantle, and core), hydrosphere and atmosphere.

(*Clarification statement*: The differentiation by density of Earth into crust, mantle and core should be included in this element.)

ES3.a: Plan and carry out an investigation that demonstrates how surface water and groundwater act as the major agents of physical and chemical weathering.

ES3.b: Develop a model of the processes and geologic hazards that result from both sudden and gradual mass wasting.

ES3.d: Construct an argument based on evidence that relates the characteristics of the sedimentary materials to the energy by which they were transported and deposited.

Unit 5: Weather and Climate (9 weeks)

In this unit, students will explore the complex interactions between solar energy and Earth's systems that drive weather and climate. They will analyze how differences in solar heating create variations in air pressure, wind patterns, and ocean currents, and how these factors combine to influence global climate zones and weather patterns. Students will investigate the movement of air masses and use data to predict weather conditions. Additionally, they will study extreme weather events, examining the conditions that produce them and the associated hazards. Finally, students will construct arguments relating changes in global climate to variations in Earth's relationship with the sun and atmospheric composition.

Overarching Standards for Unit 5

ES5: Obtain, evaluate, and communicate information to investigate the interaction of solar energy and Earth's systems to produce weather and climate.

ES5.c: Construct an argument that predicts weather patterns based on interactions among ocean currents, air masses, and topography.

ES5.f: Construct an argument relating changes in global climate to variation to Earth/sun relationships and atmospheric composition.

Supporting Standards for Student Mastery in Unit 5

ES5.a: Develop and use models to explain how latitudinal variations in solar heating create differences in air pressure, global wind patterns, and ocean currents that redistribute heat globally.

ES5.b: Analyze and interpret data (e.g., maps, meteograms, and weather apps) that demonstrate how the interaction and movement of air masses creates weather.

ES5.d: Analyze and interpret data to show how temperature and precipitation produce the pattern of climate regions (zones) on Earth.

ES5.e: Construct an explanation that describes the conditions that generate extreme weather events (e.g., hurricanes, tornadoes, and thunderstorms) and the hazards associated with these events.

Unit 6: Resources and Our Environment (4 weeks)

In this unit, students will examine the intricate relationship between Earth's resources and the environment, focusing on how life on Earth both influences and is influenced by Earth's systems. They will explore the uneven distribution of land and water resources due to historical geological and environmental processes and investigate how human dependence on these resources shapes our world. Students will analyze how life has responded to major events in Earth's history, such as climatic and tectonic changes, through processes like extinction, migration, and adaptation. Additionally, they will evaluate how biological processes have driven significant changes in Earth's systems over geologic time and analyze data relating global climate changes to both natural and human-induced factors.

Overarching Standards for Unit 6

ES6: Obtain, evaluate, and communicate information about how life on Earth responds to and shapes Earth's systems.

ES6.c: Ask questions to investigate and communicate how humans depend on Earth's land and water resources, which are distributed unevenly around the planet as a result of past geological and environmental processes.

Supporting Standards for Student Mastery in Unit 6

ES6.a: Construct an argument from evidence that describes how life has responded to major events in Earth's history (e.g., major climatic change, tectonic events) through extinction, migration, and/or adaptation.

ES6.b: Construct an explanation that describes how biological processes have caused major changes in Earth's systems through geologic time (e.g., nutrient cycling, atmospheric composition, and soil formation).

ES6.d: Analyze and interpret data that relates changes in global climate to natural and anthropogenic modification of Earth's atmosphere and oceans.