

Pascack Valley Regional High School District

**Pascack Hills High School, Montvale, New Jersey
Pascack Valley High School, Hillsdale, New Jersey**

Course Name: Earth's Natural Disasters

Born On: August, 2026
Board Approval: 8/24/26

New Jersey Curricular Mandates for Science Instruction

Disabled & LGBT:

18A:35-4.35 - History of disabled and LGBT persons included in middle and high school curriculum. A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards.

Diversity, Equity, and Inclusion (DEI):

C.18A:35-4.36a - Curriculum to include instruction on diversity and inclusion. 1. a. Beginning in the 2021-2022 school year, each school district shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards. b. The instruction shall: (1) highlight and promote diversity, including economic diversity, equity, inclusion, tolerance, and belonging in connection with gender and sexual orientation, race and ethnicity, disabilities, and religious tolerance; (2) examine the impact that unconscious bias and economic disparities have at both an individual level and on society as a whole; and (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs. c. The Commissioner of Education shall provide school districts with sample learning activities and resources designed to promote diversity and inclusion.

Amistad Law:

N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Climate Change:

2026 NJSLS-Science: Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and in many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students to understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

Dissection Law

N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Earth's Natural Disasters		
Unit Title	Approx # of weeks	Months
Energy, Water, and Weather: Impacts of Changes in Earth's Energy Budget	4 Weeks	August – September
Tropical Cyclones – Hurricanes and Coastal Flooding	4 Weeks	October
Thunderstorms, Tornadoes, and Blizzards – Rapid Onset Weather Hazards	4 Weeks	November
Earthquakes, Tsunamis, and Volcanoes – Forces That Reshape Earth	4 Weeks	December
Global Catastrophes – Asteroids, Mass Extinctions, and Diseases	4 Weeks	January

Earth's Natural Disasters		
Unit 1: Energy, Water, and Weather: Impacts of Changes in Earth's Energy Budget		
Related Phenomena: "Why Are Some Regions Flooding While Others Are Drying Out?" Communities around the world and in the U.S. are experiencing unusual water cycle patterns—reduced snowpack, rapid snowmelt, and more frequent flash floods or droughts. These changes are increasingly tied to shifts in Earth's energy balance and are intensifying extreme weather risks.		
Pacing: Approximately 4 weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-ESS2-2: Analyze geoscience data to make the claim that a change to Earth's surface or atmosphere can create feedbacks influencing other Earth systems. HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in climate changes. HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.		
Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.	ESS2.A: Earth Materials and Systems - Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. ESS2.C: The Roles of Water in Earth's Surface Processes - The abundance of liquid water on Earth's surface and its unique physical and chemical properties are central to the planet's dynamics. - Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, and precipitation. 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. - Changes in climate can result in changes to weather patterns and the frequency or intensity of extreme weather events.	Energy and Matter: Flows, Cycles, and Conservation - The total amount of energy and matter in closed systems is conserved. - Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
Analyzing and Interpreting Data Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.		Stability and Change Feedback (negative or positive) can stabilize or destabilize a system.
Developing and Using Models Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.		Cause and Effect Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
Constructing Explanations Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.		Systems and System Models When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

		ESS3.D: Global Climate Change - Though the magnitudes of human impacts are difficult to predict, current models predict that, without mitigation, Earth's systems will continue to change and impact future generations. PS3.B: Conservation of Energy and Energy Transfer - Energy cannot be created or destroyed—only moved between one place and another, between objects, or between systems.	Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- How does Earth's energy budget influence the water cycle, and why do small changes in this balance lead to extreme weather events? - What can prehistoric climates reveal about changes in today's climate? Local (New Jersey/Tri-State Area): "Why did parts of NJ experience major flash flooding in 2021–2023 after periods of drought?" Global: "How did warming in the Himalayas contribute to deadly floods in Pakistan?"	Student will be able to: Model how solar energy is absorbed, reflected, and re-radiated in Earth's systems (atmosphere, land, ocean, and cryosphere) Explain how changes in Earth's energy budget (e.g., decreased snow cover or cloud cover) affect climate and weather patterns. Analyze the role of albedo and feedback loops in amplifying warming or cooling. Describe how water moves through Earth's systems (evaporation, condensation, precipitation, infiltration, runoff) and how each process is driven by energy.	- Students will develop a model that accounts for the relative distribution of incoming solar radiation into Earth's system (My NASA Data Modeling Incoming Solar Radiation) - Students will identify and describe the different components and flows of energy of the Earth's Energy Budget diagram using My NASA Data Earth's Energy Budget Story Map - Students will compare multiple variables of the Earth System as they analyze global changes in the cryosphere in the My NASA Data Sea Ice and the Earth System Story Map - Using Vernier probeware, students investigate the relationship between the albedo of different surfaces and the temperature change due to energy absorption. - Students engage in sense-making about feedback loops using the Feedback Loop Sorting Activity. - Students investigate climate feedback loops using an online model LOOPY	Energy Flow Diagram Check Task: After learning about how solar energy is absorbed and reflected, students complete a diagram of Earth's energy budget showing where energy is reflected, absorbed, and re-radiated. Check for: Understanding of energy inputs/outputs, surface/atmosphere interactions. Method: Annotated diagram + short explanation Task: Students analyze a recent flood (e.g., Ida in NJ) and create a causal map of contributing factors (e.g., energy budget, water saturation, storm intensity). Check for: Systems thinking and ability to connect phenomena. Method: Poster, flowchart, or slide deck.

		- Students play a dice game to explore the differences between direct and indirect evidence to gain an understanding of how indirect evidence of climate change can be interpreted. - Students use the Global Climate Change Model: Making Predictions About Future Climate to explore how changing human emissions of greenhouse gases might affect the temperature. Earth's Energy Budget	Feedback Loop Exit Ticket Task: After exploring albedo and melting snow, students draw a feedback loop diagram (positive or negative) and write 2–3 sentences explaining it. Check for: Cause-effect relationships and stability/change concepts. Method: Quick sketch + written explanation. “What Would Happen If...” Scenarios Task: Given hypothetical changes (e.g., “What if Earth’s cloud cover increased by 10%?”), students predict outcomes for the energy budget and water cycle. Check for: Transfer of knowledge to new situations. Method: Scenario cards + written or spoken responses.
Interdisciplinary Connections	English Language Arts RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information. W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question or solve a problem; synthesize multiple authoritative sources while demonstrating understanding of the subject under investigation. SL.PI.11–12.4 Present information, findings, and supporting evidence clearly, concisely, and logically using appropriate organization and style. Mathematics MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics. HS.S-ID.6 Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets and interpret differences in context. Social Studies 6.3.12.GeoGI.1 Collaboratively evaluate how global environmental issues affect different regions and propose evidence-based solutions to address those challenges.		
Career Readiness, Life Literacies, and Key Skills	9.1.12.EG.5 Evaluate the economic and environmental impacts of sustainability practices at the local, national, and global levels. 9.2.12.CAP.5 Assess how knowledge, skills, ethics, and preparation contribute to career success in environmental science, meteorology, engineering, and related STEM fields. 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective.		

	● 9.4.12.IML.5 Evaluate, synthesize, and apply information while considering the ethical and legal use of technology.		
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6 Create and refine computational models to better represent relationships among different elements of data collected from a phenomenon or process. ● 8.2.12.ED.1 Apply a design thinking process to identify a real-world problem, generate possible solutions, test ideas, and refine the solution based on feedback. ● 8.2.12.ETW.2 Evaluate the positive and negative impacts of emerging technologies on society, the environment, and the global economy.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Provide illustrated vocabulary guides for weather, climate, energy transfer, and the water cycle. ● Use labeled diagrams, animations, and NASA visualizations to reinforce scientific concepts. ● Provide sentence frames for Claim-Evidence-Reasoning (CER) responses. ● Allow bilingual glossaries and translated instructional materials when appropriate. ● Use My NASA Data StoryMaps and NOAA visualizations to support language development through authentic scientific imagery.	● Break investigations into manageable steps using written checklists. ● Provide guided notes, graphic organizers, and partially completed diagrams. ● Offer extended time for laboratory investigations and data analysis. ● Allow alternative methods of demonstrating understanding (oral responses, recorded explanations, annotated diagrams). ● Use simulations before hands-on investigations to reinforce understanding.	● Connect lessons to recent weather events in New Jersey and students' lived experiences. ● Use collaborative learning groups during investigations. ● Provide frequent formative feedback through exit tickets and check-ins. ● Scaffold data analysis using partially completed graphs and guiding questions. ● Reinforce concepts through repeated exposure using NASA and NOAA interactive resources.	● GLOBE Connections: Changes in Snow and Ice Extent : Students engage in community research by collecting data using the GLOBE protocols to study changing temperatures, permafrost and freshwater ice. ● Analyze long-term climate datasets from NASA, NOAA, or GLOBE to identify regional climate trends. ● Design and conduct an independent investigation examining local changes in precipitation, flooding, or snow cover. ● Evaluate competing climate models and compare projected regional impacts. ● Develop GIS-based or computational models illustrating changes in Earth's energy budget. ● Participate in citizen science projects through GLOBE Observer, CoCoRaHS, or NASA GLOBE to contribute authentic environmental data.

Earth's Natural Disasters		
Unit 2: Tropical Cyclones – Hurricanes and Coastal Flooding		
Related Phenomena: Why was Superstorm Sandy so devastating to New Jersey's coast despite not being a major hurricane? Communities along the U.S. coast—especially in New Jersey—are increasingly vulnerable to storms that don't fit the traditional hurricane mold. Events like Superstorm Sandy reveal how rising seas, shifting storm patterns, and dense coastal development can turn even a Category 1 storm into a catastrophic disaster.		
Pacing: 4 weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, natural hazards, and climate change have influenced human activity. HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of climate change and associated impacts on Earth systems. HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.		
Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions that arise from observations, data, simulations, and models to investigate hurricane formation, storm intensity, coastal flooding, and climate impacts. Developing and Using Models - Develop, revise, and use models to explain the relationships among ocean temperature, atmospheric conditions, sea level rise, storm surge, and coastal flooding. Planning and Carrying Out Investigations - Plan and conduct investigations using real-world weather data, digital simulations, and field observations to evaluate hurricane formation and coastal vulnerability. Analyzing and Interpreting Data	ESS2.C: The Roles of Water in Earth's Surface Processes - Water continuously cycles among Earth's systems and significantly influences surface processes, coastal erosion, flooding, and storm impacts. ESS2.D: Weather and Climate - Weather results from interactions among Earth's atmosphere, oceans, and land surfaces. Variations in energy transfer influence weather systems and climate patterns. ESS3.B: Natural Hazards - Natural hazards can be predicted using scientific data and models. Human decisions influence vulnerability, preparedness, and resilience. ESS3.C: Human Impacts on Earth Systems	Patterns - Patterns observed in hurricane tracks, sea surface temperatures, precipitation, and historical storm records can be used to identify trends and improve forecasting. Cause and Effect - Changes in ocean temperature, atmospheric conditions, and coastal development influence hurricane intensity, storm surge, and flooding. Scale, Proportion, and Quantity - Hurricanes and coastal flooding operate across multiple spatial and temporal scales, from local communities to global climate systems. Systems and System Models

- Analyze geoscience data, weather maps, satellite imagery, and climate datasets to identify trends, predict storm impacts, and evaluate mitigation strategies. Using Mathematics and Computational Thinking - Apply mathematical relationships, graphical analysis, computational models, and geographic information systems (GIS) to analyze hurricane intensity, sea level rise, and flooding risk. Constructing Explanations and Designing Solutions - Construct evidence-based explanations describing hurricane formation and coastal flooding. - Design, evaluate, and refine engineering and community-based solutions that reduce the impacts of hurricanes and storm surge. Engaging in Argument from Evidence - Evaluate competing explanations and engineering solutions using scientific evidence, historical data, and climate projections. - Defend recommendations for improving coastal resilience using empirical evidence. Obtaining, Evaluating, and Communicating Information - Critically evaluate scientific information from NOAA, NASA, and peer-reviewed sources. - Communicate scientific findings through presentations, maps, infographics, and technical reports appropriate for scientific and public audiences.	- Human activities influence coastal systems through development, land-use changes, and greenhouse gas emissions. Engineering solutions can reduce risk and increase resilience. ESS3.D: Global Climate Change - Scientific evidence indicates that climate change is altering weather patterns, increasing sea level, and changing the frequency and intensity of extreme weather events. ETS1.A: Defining and Delimiting Engineering Problems - Engineering problems are defined by identifying criteria, constraints, environmental considerations, and community needs. ETS1.B: Developing Possible Solutions - Multiple engineering solutions should be developed, tested, compared, and evaluated using scientific evidence. ETS1.C: Optimizing the Design Solution - Engineering solutions are refined through iterative testing, modeling, and evaluation to improve effectiveness while balancing trade-offs.	- Atmospheric, oceanic, and coastal systems interact to produce tropical cyclones and associated hazards. Models help predict storm behavior and evaluate mitigation strategies. Energy and Matter - Energy transferred from warm ocean water drives hurricane formation, while matter cycles through atmospheric and hydrologic systems during storm events. Stability and Change - Climate variability, sea level rise, and human development influence the stability of coastal systems and the frequency and severity of natural hazards.	
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
How do tropical cyclones form, and what factors determine their strength and impact?	Student will be able to:	Students use an interactive hurricane simulator to adjust ocean temperature, humidity, and wind shear to see how storm formation is impacted.	Claim-Evidence-Reasoning write-up: “What conditions were most critical to hurricane development in your simulation and why?”

• How do physical geography and human development affect a community's vulnerability to coastal storms? • In what ways are climate change and sea level rise influencing the frequency and severity of coastal flooding? • How does urban planning influence stormwater management and flooding during extreme weather events?	• Describe the conditions necessary for tropical cyclone formation (e.g., warm ocean water, Coriolis effect, low wind shear). • Model the relationships between sea surface temperatures, atmospheric conditions, and storm development. • Identify features of coastal geography (e.g., barrier islands, elevation, proximity to water) that influence storm impacts. • Predict the future risk of storm surge under various sea level scenarios. • Compare different city plans and their effectiveness in stormwater mitigation.	• Employ My NASA Data Hurricanes as a Heat Engine Story Map to explore how hurricanes gain energy from the ocean surface. • Students access historical and real-time data from Earth Null school to investigate a computer model of the Earth that allows for visualization of conditions during current and past tropical storms. Earth Null School Hurricane Activity • Students NOAA's DATA IN THE CLASSROOM INVESTIGATING SEA LEVEL USING REAL DATA to understand the primary causes of global sea level change and the impact on sea level rise on coastal communities. • Students investigate the damage incurred from Superstorm Sandy from local resources such as the NY Times Special Edition (10/29/12); Assessing the Damage From Hurricane Sandy • Students identify specific actions, gather information and analyze a community plan to learn about hurricane resilience. (UCAR: Hurricane Resilience Lesson 10: Short and Long Term Resilience Planning) • Students use Model-my-Watershed to investigate how changes in land surface impact the potential for flooding.	• Students groups complete the Connection Circle Activity to demonstrate the movement of energy and matter. • Students gather data from individual hurricanes and groups compare one past and one current tropical storm, noting similarities and differences. • Claim-Evidence-Reasoning write-up: Supported with NOAA data showing a cause-and-effect relationship between sea level rise and local coastal impacts. • Students create a news-style report, infographic, or annotated map summarizing Sandy's impacts on different community sectors. • Students draft a resilience action plan or present recommendations in a mock town hall meeting format. • Student submit completed data table and written responses to analysis questions for Model My Watershed Lab
Interdisciplinary Connections	English Language Arts • RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to support comprehensive analysis of informational texts. • RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop evidence-based conclusions. • W.WR.11–12.5 Conduct sustained research projects using multiple authoritative sources. • SL.PI.11–12.4 Present scientific findings clearly, logically, and appropriately for varied audiences. Mathematics • MP.2 Reason abstractly and quantitatively. • MP.4 Model with mathematics. • HS.S-ID.6 Use statistics to compare data sets and interpret differences in context. Social Studies		

	● 6.3.12.GeoGI.1 Collaboratively evaluate global environmental issues and propose evidence-based solutions. Visual and Performing Arts ● 1.5.12prof.Cn10a Document the process of developing ideas from early stages to fully elaborated ideas.		
Career Readiness, Life Literacies, and Key Skills	● 9.1.12.EG.5 Evaluate the economic and environmental impacts of sustainability practices. ● 9.2.12.CAP.5 Assess careers related to meteorology, emergency management, engineering, environmental science, and climate research. ● 9.4.12.CT.2 Develop and evaluate multiple solutions to authentic problems. ● 9.4.12.IML.5 Evaluate, synthesize, and ethically apply information obtained from multiple technological sources.		
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize and communicate scientific findings. ● 8.1.12.DA.6 Develop and refine computational models representing interactions among Earth systems. ● 8.2.12.ED.1 Apply engineering design principles to develop and improve solutions to authentic problems. ● 8.2.12.ETW.2 Evaluate how emerging technologies influence society, environmental sustainability, and resilience.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Pre-teach hurricane and coastal hazard vocabulary using visuals and bilingual glossaries. ● Use NOAA animations, satellite imagery, and StoryMaps to reinforce scientific concepts. ● Provide sentence frames for CER writing and collaborative discussions. ● Allow translated resources and bilingual dictionaries as appropriate. ● Incorporate labeled diagrams and graphic organizers during data analysis.	● Provide guided notes and scaffolded data tables. ● Break investigations into manageable tasks with visual checklists. ● Offer extended time for data analysis and laboratory activities. ● Allow oral presentations, annotated diagrams, or recorded explanations as alternate assessments. ● Provide digital simulations before hands-on investigations.	● Connect learning to local events such as Superstorm Sandy and New Jersey flooding. ● Use cooperative learning and structured peer support. ● Scaffold graph interpretation and data analysis using teacher modeling. ● Monitor progress through frequent formative assessments and feedback. ● Reinforce learning with NOAA interactive activities and real-time weather data.	● Students use Hurricane Coastal Impacts Arc-GIS Story map to investigate storm surge and waves as they evolve in the nearshore environment and dissipate across natural and man-made landscapes. ● Analyze historical hurricane datasets from NOAA and NASA to investigate long-term trends. ● Develop GIS-based flood-risk maps for New Jersey communities. ● Compare engineering approaches used by different coastal communities to improve resilience. ● Evaluate climate model projections for future hurricane risk. ● Design and defend a community resilience plan using authentic scientific evidence and engineering principles.

Earth's Natural Disasters		
Unit 3: Thunderstorms, Tornadoes & Blizzards – Rapid-Onset Weather Hazards		
Related Phenomena: How did a rare EF-3 tornado strike Mullica Hill, NJ, in 2021? Communities in New Jersey don't often expect strong tornadoes, yet in 2021 an EF-3 ripped through Mullica Hill with devastating force. This rare event highlights how shifting weather patterns and atmospheric instability can bring high-intensity storms to regions unaccustomed to them.		
Pacing: 4 weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in climate changes. HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, natural hazards, and climate change have influenced human activity. HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of climate change and associated impacts on Earth systems. HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.		
Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions arising from weather observations, atmospheric data, radar imagery, and severe weather events to investigate storm formation and impacts. Developing and Using Models - Develop, revise, and use weather models to explain interactions among air masses, fronts, atmospheric instability, and severe weather systems. Planning and Carrying Out Investigations - Plan and conduct investigations using meteorological data, weather maps, and simulations to examine conditions that lead to severe weather. Analyzing and Interpreting Data - Analyze radar images, weather maps, atmospheric data, and historical storm records to identify patterns, evaluate forecasts, and assess storm impacts. Using Mathematics and Computational Thinking	ESS2.C: The Roles of Water in Earth's Surface Processes - Water cycles through Earth's systems and influences precipitation, snowfall, flooding, and severe weather events. ESS2.D: Weather and Climate - Weather results from interactions among the atmosphere, hydrosphere, and land surface. Energy transfer drives atmospheric circulation and severe weather. ESS3.B: Natural Hazards - Scientific understanding and technological advances improve the prediction of severe weather and reduce risks to human populations. ESS3.C: Human Impacts on Earth Systems - Human activities influence storm impacts through land use, urbanization, and infrastructure development. ESS3.D: Global Climate Change - Climate change influences atmospheric conditions, precipitation patterns, and the frequency and intensity of some severe weather events. ETS1.A: Defining and Delimiting Engineering Problems - Effective hazard mitigation begins by identifying criteria, constraints, and community needs.	Patterns - Patterns in atmospheric pressure, temperature, radar data, and historical storm tracks improve weather forecasting and hazard prediction. Cause and Effect - Atmospheric instability, air mass interactions, and moisture produce thunderstorms, tornadoes, blizzards, and Nor'easters through identifiable physical processes. Scale, Proportion, and Quantity - Severe weather systems develop across multiple spatial and temporal scales, from local thunderstorms to regional winter storms. Systems and System Models - Atmospheric, hydrologic, and human systems interact during severe weather events. Weather models help predict storm development and impacts. Energy and Matter

• Apply mathematical reasoning, graphical analysis, computational models, and forecasting tools to interpret severe weather data and predict storm development. Constructing Explanations and Designing Solutions • Construct evidence-based explanations describing the formation of thunderstorms, tornadoes, blizzards, and Nor'easters. • Design, evaluate, and refine preparedness and mitigation strategies that reduce the impacts of severe weather. Engaging in Argument from Evidence • Evaluate scientific evidence supporting weather forecasts, warning systems, and mitigation strategies. • Defend recommendations for community preparedness using scientific evidence and historical data. Obtaining, Evaluating, and Communicating Information • Evaluate information from NOAA, the National Weather Service, and scientific sources to communicate accurate severe weather information. • Present findings through maps, weather briefings, multimedia presentations, and scientific reports.	ETS1.B: Developing Possible Solutions • Multiple engineering and planning solutions can reduce severe weather impacts through careful evaluation and testing. ETS1.C: Optimizing the Design Solution • Preparedness plans and engineering solutions are refined through data analysis, modeling, and evaluation.	• Solar energy drives atmospheric circulation, while water continuously changes state as it moves through Earth's weather systems. Stability and Change • Weather systems constantly change as energy is transferred through the atmosphere, while long-term climate influences the frequency and severity of weather hazards.
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Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
• What atmospheric conditions cause thunderstorms, tornadoes, and Blizzards to form? • How do air masses, fronts, and atmospheric instability influence the severity of storms? • What makes a Nor'easters particularly destructive along the U.S. Northeast coast?	Student will be able to: • Explain how air masses, fronts, and atmospheric instability interact to produce thunderstorms and tornadoes. • Analyze weather maps to identify conditions favorable for severe weather. • Describe the processes that lead to tornado formation.	• Analyze a demonstration; Understanding Weather and Climate– Lesson 5: Investigating the Effects of Colliding Air Masses • Learn how to read a weather map using the NOAA SciJinks Tutorial • Weather Fronts Interactive to describe boundaries between air masses. • NOAA: Introduction to Thunderstorms	• Students complete a claim–evidence–reasoning (CER) response or labeled diagram of the demonstration. • Students annotate a sample weather map and write a short forecast summary.

• How does modern technology help us detect, track, and prepare for rapid-onset weather hazards? • In what ways do human decisions—about land use, building codes, and preparedness—affect the impacts of severe storms? • Why can tornadoes occur in unexpected places, such as New Jersey?	• Explain how Nor'easters form and why they are especially damaging in the U.S. Northeast. • Evaluate the impacts of historic Nor'easters (e.g., 1993 "Storm of the Century") on transportation, infrastructure, and coastal communities. • Construct an argument to support or deny how human decisions (zoning, building codes, emergency planning) affect vulnerability to rapid-onset weather hazards.	• Student use data to make their own weather map in the NOAA Learning Lesson: Drawing Conclusions • Investigate Data from Historical Tornadoes from NOAA • Investigate LIVE and historical Tornado tracks (Perdue Database or GIS Map) • Students group pose as a community planning board and make decisions about land use and infrastructure from the Tornado & Wind Resilience Decision-Making Chart	• Exit ticket matching front types with their associated weather conditions, supported by sketches. • Short quiz or digital concept check (multiple choice or short-answer) on thunderstorm formation. • Students submit their completed weather map with a 2–3 sentence forecast. • Students create a simple graph or map highlighting tornado trends and write a short explanation or create a Venn diagram to compare two tornado events • Groups present their decisions and complete the decision-making chart noting benefits and trade-offs.
Interdisciplinary Connections	<u>English Language Arts</u> • RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to support analysis of scientific and informational texts. • RI.MF.11–12.6 Synthesize information from multiple scientific and media sources to develop evidence-based conclusions. • W.WR.11–12.5 Conduct sustained research projects using multiple authoritative scientific sources. • SL.PI.11–12.4 Present scientific findings clearly, logically, and appropriately for varied audiences. <u>Mathematics</u> • MP.2 Reason abstractly and quantitatively. • MP.4 Model with mathematics. • HS.S-ID.6 Use statistics appropriate to the data distribution to compare weather datasets and interpret differences in context. <u>Social Studies</u> • 6.3.12.GeoGI.1 Collaboratively evaluate global environmental issues and propose evidence-based solutions. <u>Visual & Performing Arts</u> • 1.5.12prof.Cn10a Document the process of developing ideas from early stages to fully elaborated ideas.		
Career Readiness, Life Literacies, and Key Skills	• 9.1.12.EG.5 Evaluate the economic and environmental impacts of sustainability practices. • 9.2.12.CAP.5 Assess careers in meteorology, climatology, emergency management, engineering, and environmental science. • 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective. • 9.4.12.IML.5 Evaluate, synthesize, and ethically apply information from technological sources.		
Computer Science and Design Thinking	• 8.1.12.DA.5 Create data visualizations from large weather and climate datasets.		

	● 8.1.12.DA.6 Develop computational models representing atmospheric interactions and severe weather processes. ● 8.2.12.ED.1 Apply engineering design principles to improve severe weather preparedness and resilience. ● 8.2.12.ETW.2 Evaluate the impacts of emerging forecasting technologies on society and public safety.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Pre-teach severe weather vocabulary using visuals and bilingual glossaries. ● Use NOAA radar animations, satellite imagery, and labeled weather maps. ● Provide sentence frames for CER writing and forecasting activities. ● Allow translated instructional resources and bilingual dictionaries. ● Reinforce concepts through visual weather models and graphic organizers.	● Provide guided notes, scaffolded weather maps, and graphic organizers. ● Break investigations into manageable tasks with written checklists. ● Offer extended time for forecasting and data-analysis activities. ● Permit alternate assessments such as oral presentations, annotated diagrams, or recorded weather briefings. ● Use digital simulations before independent investigations.	● Connect lessons to recent New Jersey severe weather events. ● Use cooperative learning and structured peer discussions. ● Scaffold weather map interpretation and forecasting with teacher modeling. ● Reinforce concepts through frequent formative assessments and interactive NOAA resources. ● Provide clear step-by-step guidance during data analysis.	● Students use Hurricane Coastal Impacts Arc-GIS Story map to investigate storm surge and waves as they evolve in the nearshore environment and dissipate across natural and man-made landscapes. ● Analyze long-term tornado, Nor'easter, and blizzard datasets to investigate regional trends. ● Compare forecasting models and evaluate their predictive accuracy. ● Develop GIS-based severe weather risk maps for New Jersey communities. ● Design and defend community preparedness plans using historical data and engineering principles. ● Investigate emerging forecasting technologies, including Doppler radar, satellite sensing, and artificial intelligence.

Earth's Natural Disasters		
Unit 4: Earthquakes, Tsunamis, and Volcanoes – Forces That Reshape Earth		
Related Phenomena: How can Earth's internal forces—like the 2004 Indian Ocean earthquake and the 1980 eruption of Mount St. Helens—reshape landscapes, ecosystems, and even global climate. Earthquakes and volcanoes may seem like faraway disasters, but their impacts can reach across oceans—and even affect New Jersey. A quake in Japan once unleashed a tsunami that devastated entire towns, volcanoes erupt in ways that can be sudden and explosive or slow and steady, and right here in NJ we live above an ancient fault zone and the remains of old lava flows.		
Pacing: 4 weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-ESS1-5 Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor HS-ESS2-2: Analyze geoscience data to make the claim that a change to Earth's surface or atmosphere can create feedbacks influencing other Earth systems. HS-ESS3-2: Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on cost-benefit ratios and the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits. HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions that arise from observations, geologic evidence, seismic data, and models to investigate earthquakes, volcanoes, tsunamis, and plate tectonics. Developing and Using Models - Develop, revise, and use models to illustrate Earth's internal structure, mantle convection, plate interactions, seismic activity, volcanic processes, and tsunami formation. Planning and Carrying Out Investigations - Plan and conduct investigations using physical models, simulations, GIS data, and authentic geologic datasets to examine Earth's dynamic systems. Analyzing and Interpreting Data - Analyze seismic records, volcanic monitoring data, GPS measurements, geologic maps, and satellite imagery to identify patterns and evaluate geologic hazards. Using Mathematics and Computational Thinking	ESS1.C: The History of Planet Earth - Continental rocks, ocean-floor rocks, fossils, and geologic structures provide evidence for Earth's geologic history and the movement of tectonic plates over time. ESS2.A: Earth Materials and Systems - Earth's interior consists of interacting layers that drive plate tectonics through mantle convection, producing earthquakes, volcanic activity, mountain building, and seafloor spreading. ESS2.B: Plate Tectonics and Large-Scale System Interactions - Plate tectonics explains the distribution of earthquakes, volcanoes, mountain ranges, ocean basins, and other major geologic features. ESS2.C: The Roles of Water in Earth's Surface Processes - Tsunamis and coastal processes demonstrate how interactions between Earth's solid surface and water reshape landscapes and influence human populations. ESS3.B: Natural Hazards - Geologic hazards can be monitored using scientific observations and models. Hazard prediction, preparedness, engineering, and emergency planning reduce risks to human populations.	Patterns - Patterns in earthquake epicenters, volcanoes, mountain ranges, and seafloor features provide evidence for plate tectonic processes and Earth system interactions. Cause and Effect - Movement of tectonic plates causes earthquakes, volcanic eruptions, mountain building, and tsunamis. Understanding these mechanisms improves hazard prediction and mitigation. Scale, Proportion, and Quantity - Geologic processes operate across a wide range of spatial and temporal scales, from seconds during earthquakes to millions of years during continental drift. Systems and System Models

• Apply mathematical relationships, computational tools, GIS technologies, and graphical analysis to interpret seismic activity, plate motion, and volcanic hazards. Constructing Explanations and Designing Solutions • Construct evidence-based explanations describing plate tectonics, earthquakes, volcanic eruptions, and tsunami generation. • Design, evaluate, and refine engineering solutions that reduce risks associated with geologic hazards. Engaging in Argument from Evidence • Evaluate competing explanations regarding Earth's internal processes using empirical evidence. • Defend conclusions regarding geologic hazards and mitigation strategies using scientific evidence. Obtaining, Evaluating, and Communicating Information • Critically evaluate scientific information from USGS, IRIS, NASA, NOAA, and peer-reviewed research. • Communicate scientific findings using maps, models, presentations, engineering proposals, and technical reports.	ETS1.A: Defining and Delimiting Engineering Problems • Engineering problems associated with geologic hazards require balancing scientific, environmental, economic, and societal constraints. ETS1.B: Developing Possible Solutions • Multiple engineering solutions should be developed, tested, compared, and evaluated to reduce the impacts of earthquakes, tsunamis, and volcanic hazards. ETS1.C: Optimizing the Design Solution • Engineering solutions are improved through iterative testing, modeling, analysis, and refinement.	• Earth's interior, lithosphere, hydrosphere, and atmosphere function as interacting systems. Models help explain and predict geologic events and hazard impacts. Energy and Matter • Thermal energy within Earth's interior drives mantle convection and plate movement, while energy released during earthquakes and volcanic eruptions reshapes Earth's surface. Structure and Function • The structure of Earth's layers and tectonic plates determines the location, type, and magnitude of geologic hazards. Stability and Change • Earth's surface is continually changing through tectonic processes. While some changes occur gradually, others occur suddenly and dramatically, requiring ongoing monitoring and adaptation.	
Essential Questions • How does energy inside the Earth move the plates and cause earthquakes, volcanoes, and tsunamis? • What patterns in earthquakes and volcanoes help us understand how Earth’s surface is changing? • How do the causes and impacts of earthquakes, volcanic eruptions, and tsunamis compare?	Student Learning Objectives Student will be able to: • Explain how energy inside the Earth causes plate motion. • Identify patterns of seismic activity and connect them to plate boundaries. • Describe how relative plate motion are responsible for geological formations such as spreading ridges and volcanic arcs as well as seismic activity.	Suggested Tasks/Activities • Students use the IRIS Earthquake Browser to develop and organize a set of questions for a sense-making activity that supports the development of relationships between types of plate boundaries and seismic activity. Exploring Patterns of Global & Regional Seismicity	Evidence of Learning (Assessment) • Class concept map (Post-it clusters) + individual reflections to support sense-making activity. • Students develop a CER using evidence from the convection lab and density simulation to answer the question; How do convection currents and density differences inside Earth work together to drive the movement of tectonic plates?

• How are New Jersey's geologic features connected to the same forces that shape the rest of the world? • How can scientists use data and models to predict geologic hazards and help communities stay safe?	• Explain how stress and friction build up and release during an earthquake. • Analyze data and models to find earthquake epicenters. • Explain how seismic activity generates tsunamis and analyze real-world impacts. • Explain hotspot volcanism and describe the formation of the Hawaiian Island chain. • Analyze volcanic data to argue eruption impacts; connect eruptions to climate effects. • Connect NJ geology to larger volcanic and tectonic processes. • Construct an argument for how monitoring and engineering reduce hazard impacts.	• Students engage in hands-on activity about Convection Currents to discover that temperature change impacts the density of a substance, and the resulting change can cause movement inside the Earth. • Students use the Density 2.0 model to explore how tectonic plate movement is a result of differences in density. • Earthquake Machine 1—Defining an Earthquake students use a mechanical model to investigate the forces and friction that result in an earthquake • Students engage with Virtual Earthquake is an interactive Web-based activity that allows students to practice the skill of triangulation needed to find the epicenter of an earthquake. • Student engage in Hands-on exercise: Earthquakes Living Lab: Finding Epicenters & Measuring Magnitudes • Student engage with videos and animations to better understand the forces associated with the Japan's Earthquakes & Tectonic Setting • Students learn about tsunamis with a hands-on activity and test model houses to discover how different material types are impacted by the huge waves. Tsunami Attack! Giant Wave Characteristics and Causes • Students use a model to investigate the seismic and volcanic activity associated with Pacific Northwest Volcanism—55 million years to present • Students use Hawaiian Islands: Born of Fire lesson from NPS	• Students submit completed activity sheets with epicenter calculations for triangulation activities • Complete guided notes and critical thinking question/CER about Japan and the seismic activity and tsunami lab. • Class constructs a timeline of geological activity in the Pacific Northwest. • Students construct a graph model that uses slope to calculate the rate of plate movement. • Students will sort information about volcanic hazards, atmospheric effects, and eruption size into categories Cause-Effect-Response. • Students write a movie review as an Exit Ticket about the NJ Fault line video
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		to investigate types of volcanoes and the Hot Spot Theory - Students categorize causes, effects, and responses to volcanic hazards with Mt St. Helens Volcano Lesson - Students investigate Using Aerosol Data to Find Evidence of Volcanic Activity - Students analyze data from volcanic activity to make a scientific argument in Which Eruption was Larger? A Data Expedition - Students will watch videos entitled; Ramapo Fault Line: NJ & NY's Earthquake Center and 4 billion years of tectonics in 17 minutes to learn about the geological history of NJ to understand the formation of the Ramapo Fault Line.	
Interdisciplinary Connections	<u>English Language Arts</u> RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information. W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources while demonstrating understanding of the subject under investigation. SL.PI.11–12.4 Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. <u>Mathematics</u> MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics. HS.S-ID.6 Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets and interpret differences in context. <u>Social Studies</u> 6.3.12.GeoGI.1 Collaboratively evaluate how global environmental issues affect different regions and propose evidence-based solutions to address those challenges. This aligns well with evaluating the societal impacts of earthquakes, volcanic eruptions, tsunamis, and disaster mitigation. <u>Visual & Performing Arts</u>		

	● 1.5.12prof.Cn10a Document the process of developing ideas from early stages to fully elaborated ideas. ● 1.5.12prof.Pr6a Convey meaning through the presentation of artistic work, considering audience, venue, and presentation methods.		
Career Readiness, Life Literacies, and Key Skills	● 9.1.12.EG.5 Evaluate the economic and environmental impacts of sustainability practices. ● 9.2.12.CAP.5 Assess how knowledge, skills, ethics, and preparation contribute to career success in careers such as geology, seismology, volcanology, emergency management, civil engineering, environmental science, and geospatial analysis. ● 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective. ● 9.4.12.IML.5 Evaluate, synthesize, and apply information while considering the ethical and legal use of technology.		
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6 Create and refine computational models to better represent relationships among different elements of data collected from a phenomenon or process. ● 8.2.12.ED.1 Apply a design thinking process to identify a real-world problem, generate possible solutions, test ideas, and refine the solution based on feedback. ● 8.2.12.ETW.2 Evaluate the positive and negative impacts of emerging technologies on society, the environment, and the global economy.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Pre-teach key academic vocabulary (e.g., plate boundary, subduction, epicenter, hypocenter, seismic waves, mantle convection, tsunami, hotspot, fault, magnitude) using visuals, bilingual glossaries, and interactive word walls. ● Provide labeled diagrams, animations, and USGS/IRIS visualizations to reinforce geologic concepts. ● Use sentence frames and graphic organizers to support Claim-Evidence-Reasoning (CER) writing during investigations. ● Provide translated readings, captions, and bilingual dictionaries when appropriate. ● Pair students strategically during laboratory investigations and data-analysis activities to promote collaborative language development.	● Break laboratory investigations into smaller, sequential tasks using visual checklists. ● Provide guided notes, partially completed data tables, and scaffolded graphic organizers for seismic data analysis. ● Allow extended time for simulations, GIS activities, and laboratory investigations. ● Provide alternate methods of demonstrating understanding (oral explanation, annotated diagrams, digital presentations, or recorded responses). ● Allow repeated interaction with virtual earthquake and volcano simulations before completing independent analysis. ● Utilize tactile models of plate boundaries and Earth's interior to reinforce spatial concepts.	● Connect lessons to recent earthquakes, volcanic eruptions, and tsunami events that students have seen in the news. ● Use teacher-guided modeling before independent interpretation of seismic data. ● Scaffold graphing, triangulation, and map-reading activities with step-by-step examples. ● Use collaborative learning groups with assigned roles during investigations. ● Provide frequent formative feedback through exit tickets, conferencing, and small-group instruction. ● Reinforce concepts using videos, animations, and interactive USGS, IRIS, and NOAA resources before introducing more complex quantitative analysis.	● Analyze authentic USGS seismic datasets to identify regional and global earthquake patterns. ● Investigate volcanic monitoring data to evaluate eruption forecasting methods. ● Develop GIS-based hazard maps for earthquake, tsunami, or volcanic risk in selected regions. ● Design and evaluate earthquake-resistant structures or tsunami mitigation systems using engineering design principles. ● Compare competing scientific models explaining plate motion and mantle convection using peer-reviewed scientific literature.

			● Conduct an independent research investigation examining the geologic history and seismic hazards associated with the Ramapo Fault System or another tectonically active region. ● Extend learning by modeling future geologic hazards using USGS, IRIS, or NASA datasets and presenting evidence-based recommendations for hazard mitigation.
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Earth's Natural Disasters		
Unit 5: Global Catastrophes – Asteroids, Mass Extinctions & Disease		
Related Phenomena: Earth's history records at least five mass extinctions that wiped out huge numbers of species — from the dinosaurs to ancient marine life. How were these events triggered and what is the likelihood of it happening again? Investigating Earth's geological and biological past reveals the causes of previous mass extinctions and may offer critical clues that may help us recognize warning signs and reduce the risk of another global extinction today.		
Pacing: 4 weeks		
New Jersey Student Learning Standards (NJSLS)		
HS-ESS1-6: Apply scientific reasoning and evidence from ancient Earth materials to construct an account of Earth's formation and early history. HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-5: Analyze geoscience data and the results from global climate models to make an evidence-based forecast of climate change and its impacts.		
Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions arising from fossil records, geologic evidence, climate records, and disease models to investigate the causes and consequences of global catastrophes and mass extinctions. Developing and Using Models - Develop, revise, and use models to explain asteroid impacts, climate change, disease transmission, ecosystem collapse, and recovery following catastrophic events. Planning and Carrying Out Investigations - Plan and conduct investigations using sediment cores, ice core records, fossil evidence, and disease simulations to evaluate hypotheses about past and present global catastrophes. Analyzing and Interpreting Data - Analyze geologic, paleontological, climate, and epidemiological data to identify patterns, evaluate evidence, and construct explanations for extinction events and environmental change. Using Mathematics and Computational Thinking	ESS1.C: The History of Planet Earth - Rock layers, fossils, impact craters, and geologic records provide evidence of Earth's history, including catastrophic events and mass extinctions. ESS2.E: Biogeology - Biological and geologic processes interact continuously, shaping Earth's systems and influencing climate, biodiversity, and environmental change over geologic time. ESS3.B: Natural Hazards - Natural hazards such as asteroid impacts, volcanic eruptions, and pandemics can significantly alter ecosystems and human societies. Scientific observations improve prediction and preparedness. ESS3.C: Human Impacts on Earth Systems - Human activities influence biodiversity, climate, and ecosystem stability, increasing risks to species survival and environmental resilience. ESS3.D: Global Climate Change - Scientific evidence demonstrates that changes in Earth's climate influence biodiversity, ecosystem stability, and species survival over both short and long timescales. LS2.C: Ecosystem Dynamics, Functioning, and Resilience	Patterns - Patterns observed in fossils, sediment layers, biodiversity records, disease outbreaks, and climate data provide evidence of past global catastrophes and environmental change. Cause and Effect - Catastrophic events, environmental changes, and biological interactions influence extinction, adaptation, disease transmission, and ecosystem recovery. Scale, Proportion, and Quantity - Global catastrophes occur across multiple spatial and temporal scales, from sudden asteroid impacts to gradual climate change over millions of years. Systems and System Models - Earth's geosphere, atmosphere, hydrosphere, biosphere, and human systems interact to influence environmental stability and biodiversity. Energy and Matter

● Apply mathematical reasoning, statistical analysis, computational models, and graphical representations to interpret extinction rates, climate trends, biodiversity changes, and disease spread. Constructing Explanations and Designing Solutions ● Construct evidence-based explanations describing the causes and consequences of mass extinctions, asteroid impacts, and emerging diseases. ● Evaluate and propose solutions that reduce risks to biodiversity and human populations. Engaging in Argument from Evidence ● Evaluate competing scientific explanations regarding extinction events using empirical evidence. ● Defend conclusions using multiple lines of geologic, biological, and climate evidence. Obtaining, Evaluating, and Communicating Information ● Critically evaluate information from scientific literature, geologic records, climate datasets, and public health resources. ● Communicate scientific findings through presentations, scientific writing, infographics, and data visualizations.	● Ecosystems change over time in response to disturbances. Some ecosystems recover, while others undergo long-term changes in biodiversity and community structure. LS4.C: Adaptation ● Environmental changes influence natural selection, leading to adaptations that increase survival or contribute to extinction. LS4.D: Biodiversity and Humans ● Biodiversity supports ecosystem resilience and human well-being. Human activities can both threaten and conserve biodiversity.	● Catastrophic events alter the movement of energy and cycling of matter within ecosystems, affecting food webs, climate, and biodiversity. Stability and Change ● Earth's systems experience periods of relative stability interrupted by catastrophic changes that reshape ecosystems, biodiversity, and environmental conditions over time.	
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
● What do past mass extinctions teach us about how changes in Earth's environment affect which species survive or die out? ● How can scientists study rock and ice cores to discover evidence of ancient extinctions and climate changes? ● What evidence shows that an asteroid impact helped cause the extinction of the dinosaurs 65 million years ago?	Student will be able to: ● Describe the five major mass extinctions in Earth's history and the environmental changes that caused them. ● Explain how proxy data provides evidence of past climates and extinction events. ● Analyze data from simulated cores to construct a timeline of environmental change.	● Student engage in the The Making of Mass Extinctions interactive module explores the environmental factors and species involved in five major mass extinctions. ● Student explore Ocean Sediment Coring with the lesson, What is a Core? to understand how evidence of past mass extinctions are found.	● Students research a species (Extinct Species Table) that went extinct during a Mass Extinction and writes an obituary it Obituary Guidelines.

- How can modeling disease spread help us understand how pandemics begin and how they might shape future extinctions? - In what ways are today's human-driven changes to Earth's systems similar to the causes of past mass extinctions?	Examine evidence from the Cretaceous Impact Kit and construct an argument that an asteroid impact contributed to the extinction of the dinosaurs. Model how infectious diseases spread through populations and evaluate how disease can contribute to extinction events. Construct explanations and arguments about how studying Earth's past can help prevent future biodiversity loss.	- Students engage/explore the components of the Cretaceous Impact Kit to create an argument that an asteroid was the cause of the Mass Extinction 65 million years ago. - Students analyze data from classroom ice cores to develop a simulated paleo history. Create Classroom Ice Cores (Option to Make Ice core) - Student explore an interactive module to model infectious disease spread; Modeling Disease Spread. Lesson is modified for interactive group activity. - Students watch the movie, Racing Extinction (2015) to compare and contrast conditions today with previous known mass extinction events.	- Students write a short. CER (Claim–Evidence–Reasoning) essay arguing for or against the asteroid impact hypothesis using Sediment Core data as key evidence. - Students complete the Ice Core Handout with their descriptions and climate interpretations. - Student teams run a model and collect data to and collect in a group data table. Groups identify patterns and answer: Which factor had the greatest effect on disease spread?
Interdisciplinary Connections	<u>English Language Arts</u> RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information. W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple authoritative sources while demonstrating understanding of the subject under investigation. SL.PI.11–12.4 Present information, findings, and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. <u>Mathematics</u> MP.2 Reason abstractly and quantitatively. MP.4 Model with mathematics. HS.S-ID.6 Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets and interpret differences in context. <u>Social Studies</u> 6.3.12.GeoGI.1 Collaboratively evaluate how global environmental issues affect different regions and propose evidence-based solutions to address those challenges. - This aligns directly with examining the societal impacts of asteroid impacts, pandemics, climate change, biodiversity loss, and mass extinctions. <u>Visual & Performing Arts</u> 1.5.12prof.Cn10a Document the process of developing ideas from early stages to fully elaborated ideas. 1.5.12prof.Pr6a Convey meaning through the presentation of artistic work, considering audience, venue, and presentation methods.		

Career Readiness, Life Literacies, and Key Skills	● 9.1.12.EG.5 Evaluate the economic and environmental impacts of sustainability practices. ● 9.2.12.CAP.5 Assess how knowledge, skills, ethics, and preparation contribute to career success in careers such as geology, paleontology, epidemiology, environmental science, climate science, public health, and conservation biology. ● 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective. ● 9.4.12.IML.5 Evaluate, synthesize, and apply information while considering the ethical and legal use of technology.		
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6 Create and refine computational models to better represent relationships among different elements of data collected from a phenomenon or process. ● 8.2.12.ED.1 Apply a design thinking process to identify a real-world problem, generate possible solutions, test ideas, and refine the solution based on feedback. ● 8.2.12.ETW.2 Evaluate the positive and negative impacts of emerging technologies on society, the environment, and the global economy.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Pre-teach academic vocabulary (e.g., extinction, biodiversity, proxy data, sediment core, ice core, epidemiology, asteroid impact, adaptation, resilience) using visuals, bilingual glossaries, and concept maps. ● Provide illustrated timelines and diagrams showing mass extinction events, geologic time, and disease transmission. ● Use sentence frames and graphic organizers to support Claim-Evidence-Reasoning (CER) writing and scientific argumentation. ● Provide translated readings, captions, and bilingual dictionaries when appropriate. ● Pair students strategically during laboratory investigations and collaborative data-analysis activities to promote language development.	● Break laboratory investigations and data-analysis activities into smaller, sequential tasks with visual checklists. ● Provide guided notes, scaffolded graphic organizers, and partially completed data tables for sediment core, ice core, and disease-model investigations. ● Allow extended time for simulations, laboratory investigations, and written assessments. ● Provide alternate methods of demonstrating understanding (oral presentation, annotated diagrams, digital presentations, recorded responses, or visual models). ● Utilize videos, animations, and interactive simulations before independent analysis to reinforce concepts.	● Connect lessons to current events involving biodiversity loss, emerging diseases, and climate change to increase relevance and engagement. ● Use teacher-guided modeling before independent interpretation of graphs, timelines, and geologic evidence. ● Scaffold scientific writing using CER templates and structured discussion protocols. ● Incorporate cooperative learning groups with clearly defined roles during investigations. ● Provide frequent formative feedback through exit tickets, conferencing, and small-group instruction. ● Reinforce concepts using interactive simulations, videos, and authentic scientific datasets before introducing more complex analyses. ●	● Students use Google Earth and Ocean Cores to discover the concept of erosion and sediment transportation. Lesson: From the Mountains to the Ocean ● Analyze authentic paleoclimate, biodiversity, and epidemiological datasets from NASA, NOAA, CDC, USGS, or scientific journals. ● Compare multiple scientific hypotheses explaining mass extinctions using peer-reviewed literature. ● Design and conduct an independent investigation examining modern biodiversity loss and its relationship to past extinction events. ● Develop computational or GIS-based models illustrating changes in biodiversity, climate, or disease spread over time.

			• Evaluate the strengths and limitations of different proxy records (ice cores, sediment cores, fossils) for reconstructing Earth's history. • Investigate current conservation strategies and propose evidence-based solutions to reduce future biodiversity loss through scientific research and engineering design.
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Course Resources

- 2026 New Jersey Student Learning Standards for Science – <https://www.nj.gov/education/standards/science/>
- New Jersey Student Learning Standards (All Content Areas) – <https://www.nj.gov/education/standards/>
- New Jersey Department of Education Climate Change Resources – <https://www.nj.gov/education/climate/>
- My NASA Data – <https://mynasadata.larc.nasa.gov/>
- NASA Earth Observatory – <https://earthobservatory.nasa.gov/>
- NASA Earth Science – <https://science.nasa.gov/earth/>
- NASA EarthData – <https://www.earthdata.nasa.gov/>
- NOAA Data in the Classroom – <https://www.noaa.gov/office-education/data-in-the-classroom>
- NOAA SciJinks – <https://scijinks.gov/>
- NOAA National Hurricane Center – <https://www.nhc.noaa.gov/>
- NOAA National Centers for Environmental Information – <https://www.ncei.noaa.gov/>
- NOAA Climate.gov – <https://www.climate.gov/>
- Earth Nullschool – <https://earth.nullschool.net/>
- Model My Watershed – <https://modelmywatershed.org/>
- GLOBE Program – <https://www.globe.gov/>
- GLOBE Observer – <https://observer.globe.gov/>
- IRIS (EarthScope Consortium) – <https://www.earthscope.org/>
- IRIS Earthquake Browser – <https://www.iris.edu/hq/>
- USGS Earthquake Hazards Program – <https://earthquake.usgs.gov/>
- USGS Volcano Hazards Program – <https://www.usgs.gov/programs/VHP>
- USGS Natural Hazards Mission Area – <https://www.usgs.gov/natural-hazards>
- Smithsonian Learning Lab – <https://learninglab.si.edu/>
- Smithsonian Global Volcanism Program – <https://volcano.si.edu/>
- National Park Service – Hawaiian Volcanoes National Park Education – <https://www.nps.gov/havo/learn/education/curriculummaterials.htm>
- JOIDES Resolution Education Activities – <https://joidesresolution.org/activities>
- HHMI BioInteractive – <https://www.biointeractive.org/classroom-resources>

- Concord Consortium Earth & Space Interactives – <https://learn.concord.org/>
- Science Courseware – <https://www.sciencecourseware.org/>
- TeachEngineering – <https://www.teachengineering.org/>
- National Environmental Education Foundation – <https://www.neefusa.org/>
- New Visions Earth & Space Science – <https://www.newvisions.org/curriculum/science/earth-space/>
- BetterLesson – <https://teaching.betterlesson.com/>
- Oceanic Preservation Society – Racing Extinction – <https://opsociety.org/ops-productions/films/racing-extinction/>
- Google Earth – <https://earth.google.com/>
- CDC (Centers for Disease Control and Prevention) – <https://www.cdc.gov/>
- World Health Organization – <https://www.who.int/>
- National Center for Biotechnology Information (NCBI) – <https://www.ncbi.nlm.nih.gov/>
- Our World in Data – <https://ourworldindata.org/>
- National Geographic Education – <https://education.nationalgeographic.org/>
- CoCoRaHS (Community Collaborative Rain, Hail & Snow Network) – <https://www.cocorahs.org/>