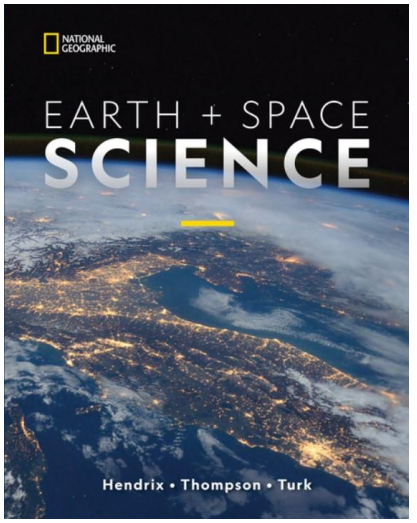

Correlation of

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to

Indiana Academic Science Standards
Earth and Space Science

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Standards	Where Addressed
High School	
Earth and Space Science	
HS-ESS1-1 Earth's Place in the Universe	
HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation.	607, 632, 729, 773, 775-779, 782-783, 789-790, 805, 813
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.A: The Universe and Its Stars	
▪ The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.	607, 632, 729, 773, 775-779, 782-783, 789-790, 805, 813
PS3.D: Energy in Chemical Processes and Everyday Life	
▪ Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary)	607, 632, 729, 773, 775-779, 782-783, 789-790, 805, 813
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	This Crosscutting Concept is addressed throughout. For example, see: 9, 39, 44-46, 124-157, 414-415, 445-446, 677-679
CC.4: 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.	12-13, 18, 34, 43-54, 58, 60-61, 63, 535, 634-635

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Standards	Where Addressed
HS-ESS1-2 Earth's Place in the Universe	
HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.	707-708, 775, 780-781, 790, 803-806, 813, 815
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	
▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812
Disciplinary Core Ideas	
ESS1.A: The Universe and Its Stars	
▪ The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	611, 614, 632, 707-708, 729, 775, 780-781, 790
▪ The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.	707-708, 775, 780-781, 790, 803-806, 813, 815

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Standards	Where Addressed
▪ Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.	611, 614, 632, 707-708, 729, 803-806, 813, 815
PS4.B: Electromagnetic Radiation	
▪ Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary)*	The opportunity to address this Disciplinary Core Idea exists. For example, see: 611, 614, 632, 729
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.	The opportunity to address this Crosscutting Concept exists. For example, see: 18, 29, 44
Connections to Engineering, Technology, and Applications of Science	
Interdependence of Science, Engineering, and Technology	
▪ Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
▪ Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806.
▪ Science assumes the universe is a vast single system in which basic laws are consistent.	800-801, 803-806, 809-811, 813, 815
HS-ESS1-3 Earth's Place in the Universe	
HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.	707-708, 715, 768-793, 799, 801, 809-810
Science and Engineering Practices	
SEP.8: Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
▪ Communicate scientific ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.A: The Universe and Its Stars	
▪ The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	707-708, 715, 768-793, 799, 801, 809-810

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Standards	Where Addressed
▪ Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.	707-708, 715, 768-793, 799, 801, 809-810
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.	This Crosscutting Concept is not directly addressed in this edition of *Earth and Space Science.*
HS-ESS1-4 Earth's Place in the Universe	
HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.	717-718, 724-725, 733, 809
Science and Engineering Practices	
SEP.5: Using Mathematical and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use mathematical or computational representations of phenomena to describe explanations.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.B: Earth and the Solar System	
▪ Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	717-718, 724-725, 733, 809

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Standards	Where Addressed
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Engineering, Technology, and Applications of Science	
Interdependence of Science, Engineering, and Technology	
▪ Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS1-5 Earth's Place in the Universe	
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.	This standard is addressed throughout. For example, see: 40, 46-47, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.B: Earth and the Solar System	
▪ Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.	717-718, 724-725, 733, 809
Crosscutting Concepts	
CC.3: Scale, Proportion, and Quantity	
▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.	This Crosscutting Concept is addressed throughout. For example, see: 9, 39, 44-46, 124-157, 414-415, 445-446, 677-679

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Standards	Where Addressed
HS-ESS1-6 Earth's Place in the Universe	
HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	This standard is addressed throughout. For example, see: 14-16, 40, 46-47, 108, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347, 359, 395, 408, 437, 713-714, 741-743, 748-750, 761-762, 765
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
• Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806.
Connections to Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	
• A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812
• Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS1.C: The History of Planet Earth	
• Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.	This Disciplinary Core Idea is addressed throughout. For example, see: 14-16, 40, 46-47, 108, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347, 359, 395, 408, 437, 713-714, 741-743, 748-750, 761-762, 765
PS1.C: Nuclear Processes	
• Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. *(secondary)*	The opportunity to address this Disciplinary Core Idea exists. For example, see: 145-147, 151,155
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Much of science deals with constructing explanations of how things change and how they remain stable.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS2-1 Earth's Systems	
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 features.	This standard is addressed throughout. For example, see: 37, 40, 46-47, 94, 132, 192-225, 232, 241-245, 259, 268-270, 274, 297-299, 301-303, 305, 335-336, 346-347
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
▪ Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.C: The History of Planet Earth	
▪ Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old.	This Disciplinary Core Idea is addressed throughout. For example, see: 40, 46-47, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347
ESS2.B: Plate Tectonics and Large-Scale System Interactions	
▪ Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. *(ESS2.B Grade 8 GBE) (secondary)*	This Disciplinary Core Idea is addressed throughout. For example, see: 40, 46-47, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347
PS1.C: Nuclear Processes	
▪ Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. *(secondary)*	The opportunity to address this Disciplinary Core Idea exists. For example, see: 145-147, 151,155

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Standards	Where Addressed
Crosscutting Concepts	
CC.1: Patterns	
▪ Empirical evidence is needed to identify patterns.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
HS-ESS2-2 Earth's Systems	
HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	This standard is addressed throughout. For example, see: 36-37, 43-50, 54-61, 353, 415, 668, 691-692, 699, 702, 741
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Connections to Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	
▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812
▪ Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS1.C: The History of Planet Earth	
▪ Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.	This Disciplinary Core Idea is addressed throughout. For example, see: 14-16, 40, 46-47, 108, 192-225, 243-245, 259, 269-270, 274, 299, 301-303, 305, 335-336, 346-347, 359, 395, 408, 437, 713-714, 741-743, 748-750, 761-762, 765
PS1.C: Nuclear Processes	
▪ Spontaneous radioactive decay follows a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. *(secondary)*	The opportunity to address this Disciplinary Core Idea exists. For example, see: 145-147, 151,155

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Standards	Where Addressed
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Much of science deals with constructing explanations of how things change and how they remain stable.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
HS-ESS2-3 Earth's Systems	
HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.	This standard is addressed throughout. For example, see: 37, 40, 46-47, 94, 132, 192-225, 232, 241-245, 259, 268-270, 274, 297-299, 301-303, 305, 335-336, 346-347
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS2.A: Earth Materials and Systems	
▪ Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.	This Disciplinary Core Idea is addressed throughout. For example, see: 33, 37-42, 44, 50, 58, 61, 101, 221, 223, 471, 574-605, 699, 702, 741

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Standards	Where Addressed
ESS2.B: Plate Tectonics and Large-Scale System Interactions	
▪ Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. *(ESS2.B Grade 8 GBE)*	This Disciplinary Core Idea is addressed throughout. For example, see: 37, 40, 46-47, 94, 132, 192-225, 232, 241-245, 259, 268-270, 274, 297-299, 301-303, 305, 335-336, 346-347
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
HS-ESS2-4 Earth's 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 changes in climate.	This standard is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Science and Engineering Practices	
SEP.4: Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze 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.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS2.A: Earth Materials and Systems	
▪ Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.	This Disciplinary Core Idea is addressed throughout. For example, see: 33, 37-42, 44, 50, 58, 61, 101, 221, 223, 471, 574-605, 699, 702, 741

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Standards	Where Addressed
ESS2.D: Weather and Climate	
▪ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	This Disciplinary Core Idea is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Feedback (negative or positive) can stabilize or destabilize a system.	This Crosscutting Concept is addressed throughout. For example, see: 36-37, 43-50, 54-61, 353, 415, 668, 691-692, 699, 702, 741
Connections to Engineering, Technology, and Applications of Science	
Influence of Engineering, Technology, and Science on Society and the Natural World	
▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS2-5 Earth's Systems	
HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	This standard is addressed throughout. For example, see: 33, 37-38, 40, 42, 44, 55-56, 101, 108, 118, 121, 165, 274, 289, 327, 360-361, 421-425, 433, 443, 471, 477-478, 618, 622-623, 632, 641-642
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Nature of Science	
Scientific Knowledge is Based on Empirical Evidence	
▪ Science knowledge is based on empirical evidence.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ Science disciplines share common rules of evidence used to evaluate explanations about natural systems.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812

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Standards	Where Addressed
▪ Science includes the process of coordinating patterns of evidence with current theory.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812
Disciplinary Core Ideas	
ESS2.A: Earth Materials and Systems	
▪ Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior.	This Disciplinary Core Idea is addressed throughout. For example, see: 37, 39-40, 46-47, 73, 80, 199-201, 203-206, 211-215, 223, 231, 234-237, 239-240, 253-257, 259, 326, 748
ESS2.B: Plate Tectonics and Large-Scale System Interactions	
▪ The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection.	This Disciplinary Core Idea is addressed throughout. For example, see: 37, 39-40, 44, 46-47, 73, 80, 199-201, 203-206, 211-215, 223, 231, 234-237, 239-240, 253-257, 259, 326, 748
Crosscutting Concepts	
CC.5: Energy and Matter	
Energy drives the cycling of matter within and between systems.	This Crosscutting Concept is addressed throughout. For example, see: 37, 39-40, 44, 46-47, 73, 80, 199-201, 203-206, 211-215, 223, 231, 234-237, 239-240, 253-257, 259, 326, 748

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Standards	Where Addressed
Connections to Engineering, Technology, and Applications of Science	
Interdependence of Science, Engineering, and Technology	
▪ Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812 Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805. Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
HS-ESS2-6 Earth's Systems	
HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	44, 56-58, 61, 63, 128, 131-133, 581, 583-584, 601, 618, 699
Science and Engineering Practices	
SEP.2: Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).	
▪ Use a model to provide mechanistic accounts of phenomena.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Connections to Nature of Science	
Scientific Knowledge is Based on Empirical Evidence	
▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812
Disciplinary Core Ideas	
ESS1.B: Earth and the Solar System	
▪ Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. *(secondary)*	39-41, 44, 51, 115, 399, 401, 409, 414-415, 520-521, 572, 601, 686-688, 691-692, 699-700
ESS2.A: Earth Materials and System	
▪ The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.	This Disciplinary Core Idea is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131-133, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
ESS2.D: Weather and Climate	
▪ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	This Disciplinary Core Idea is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705

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Standards	Where Addressed
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805. Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
CC.5: Energy and Matter	
▪ Energy drives the cycling of matter within and between systems.	This Crosscutting Concept is not directly addressed in this edition of *Earth and Space Science.*
HS-ESS2-7 Earth's Systems	
HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	This standard is addressed throughout. For example, see: 36-37, 43-50, 54-61, 353, 415, 668, 691-692, 699, 702, 741
Science and Engineering Practices	
SEP.3: Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.	
▪ Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS2.C: The Roles of Water in Earth's Surface Processes	
▪ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	This Disciplinary Core Idea is addressed throughout. For example, see: 33, 37-38, 40-42, 44, 55-56, 101, 108, 118, 121, 165, 274, 289, 327, 360-361, 421-425, 433, 443, 471, 477-478, 618, 622-623, 632, 641-642
Crosscutting Concepts	
CC.6: Structure and Function	
▪ The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798
HS-ESS2-8 Earth's Systems	
HS-ESS2-8.* Construct an explanation of how heat (energy) and water (matter) move throughout the oceans causing patterns in weather and climate.	This standard is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS2.C: The Roles of Water in Earth's Surface Processes	
▪ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	This Disciplinary Core Idea is addressed throughout. For example, see: 33, 37-38, 40-42, 44, 55-56, 101, 108, 118, 121, 165, 274, 289, 327, 360-361, 421-425, 433, 443, 471, 477-478, 618, 622-623, 632, 641-642
ESS2.D: Weather and Climate	
▪ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	This Disciplinary Core Idea is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705.
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy drives the cycling of matter within and between systems	This Crosscutting Concept is not directly addressed in this edition of *Earth and Space Science.*
HS-ESS2-9 Earth's Systems	
HS-ESS2-9.* Construct an explanation for how energy from the Sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy.	This standard is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	
▪ Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS2.C: The Roles of Water in Earth's Surface Processes	
▪ The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	This Disciplinary Core Idea is addressed throughout. For example, see: 33, 37-38, 40-42, 44, 55-56, 101, 108, 118, 121, 165, 274, 289, 327, 360-361, 421-425, 433, 443, 471, 477-478, 618, 622-623, 632, 641-642
ESS2.D: Weather and Climate	
▪ The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	This Disciplinary Core Idea is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Crosscutting Concepts	
CC.5: Energy and Matter	
▪ Energy drives the cycling of matter within and between systems.	This Crosscutting Concept is not directly addressed in this edition of *Earth and Space Science.*
HS-ESS3-1 Human Interaction with Earth's Systems	
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.	This standard is addressed throughout. For example, see: 40-41, 44, 82-83, 85-91, 153, 159-160, 162-187, 189, 354, 438-469, 471, 477, 487-491, 493, 536-571, 582-583, 620-623, 641, 690-691, 695
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.	
▪ Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS3.A: Natural Resources	
▪ Resource availability has guided the development of human society.	This Disciplinary Core Idea is addressed throughout. For example, see: 82-83, 153, 159-160, 162-164, 167, 169, 172-187, 189, 438-469, 536-571, 582-583
ESS3.B: Natural Hazards	
▪ Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.	This Disciplinary Core Idea is addressed throughout. For example, see: 47, 191, 227-291, 358, 379-380, 382, 389-390, 638-640, 656-657, 660-664, 668, 695-696, 698
Crosscutting Concepts	
CC.2: Cause and Effect	
▪ Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	
▪ Modern civilization depends on major technological systems.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS3-2 Human Interaction with Earth's Systems	
HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	This standard is addressed throughout. For example, see: 85-91, 160, 162-164, 168-185, 187, 189, 620-623, 632
Science and Engineering Practices	
SEP.7: Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
▪ Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS3.A: Natural Resources	
▪ All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	This Disciplinary Core Idea is addressed throughout. For example, see: 40-41, 44, 82-83, 85-91, 153, 159-160, 162-187, 189, 354, 438-469, 471, 477, 487-491, 493, 536-571, 582-583, 620-623, 641, 690-691, 695
ETS1.B: Developing Possible Solutions	
▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*	This Disciplinary Core Idea is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Crosscutting Concepts	
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	
▪ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ Analysis of costs and benefits is a critical aspect of decisions about technology.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Connections to Nature of Science	
Science Addresses Questions About the Natural and Material World	
▪ Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ Science knowledge indicates what can happen in natural systems — not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ Many decisions are not made using science alone but rely on social and cultural contexts to resolve issues.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS3-3 Human Interaction with Earth's Systems	
HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.	This standard is addressed throughout. For example, see: 42, 50-54, 61, 85-91, 160, 162-164, 168-185, 187, 189, 440-441, 448, 462-464, 469, 474-475, 483-484, 567, 620-623, 632, 695
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Create a computational model or simulation of a phenomenon, designed device, process, or system.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS3.C: Human Impacts on Earth Systems	
▪ The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.	This Disciplinary Core Idea is addressed throughout. For example, see: 42, 50-54, 61, 85-91, 160, 162-164, 168-185, 187, 189, 440-441, 448, 462-464, 469, 474-475, 483-484, 567, 620-623, 632, 695
Crosscutting Concepts	
CC.7:Stability and Change	
▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	This Crosscutting Concept is addressed throughout. For example, see: 18, 34, 43-54, 58, 60-61, 63, 101, 353, 532, 535, 634-635

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Standards	Where Addressed
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	
▪ Modern civilization depends on major technological systems.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ New technologies can have deep impacts on society and the environment, including some that were not anticipated.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Nature of Science	
Science is a Human Endeavor	
▪ Science is a result of human endeavors, imagination, and creativity.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS3-4 Human Interaction with Earth's Systems	
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.	This standard is addressed throughout. For example, see: 11-19, 29, 34, 40-42, 44, 50-54, 61, 68, 82-83, 85-91, 96, 126, 153,159-160, 162-187, 189, 194, 228, 264, 294, 322, 354, 356, 396, 438-469, 471, 474-475, 477, 483-484, 487-491, 493, 498, 536-571, 576, 582-583, 608, 620-623, 632, 638, 641,674, 690-691, 695, 698-699, 710, 738, 770, 796
Science and Engineering Practices	
SEP.6: Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories.	
▪ Design or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS3.C: Human Impacts on Earth Systems	
▪ Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	This Disciplinary Core Idea is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
ETS1.B: Developing Possible Solutions	
▪ When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. *(secondary)*	This Disciplinary Core Idea is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Feedback (negative or positive) can stabilize or destabilize a system.	This Crosscutting Concept is addressed throughout. For example, see: 36-37, 43-50, 54-61, 353, 415, 668, 691-692, 699, 702, 741
Connections to Engineering, Technology, and Applications of Science	
Influence of Science, Engineering, and Technology on Society and the Natural World	
▪ Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	This Connection to Engineering, Technology, and Applications of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS3-5 Human Interaction with Earth's 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 global or regional climate change and associated future impacts to Earth systems.	This standard is addressed throughout. For example, see: 34-35, 44, 50, 56-58, 60-61, 131-133, 185, 220-221, 223, 283-285, 287, 316, 327, 414-415, 444, 510, 572, 611, 614, 624-626, 628-630, 632, 672-705
Science and Engineering Practices	
SEP.4: Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
▪ Analyze data using computational models in order to make valid and reliable scientific claims.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Connections to Nature of Science	
Scientific Investigations Use a Variety of Methods	
▪ Science investigations use diverse methods and do not always use the same set of procedures to obtain data.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

Standards	Where Addressed
▪ New technologies advance scientific knowledge.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Scientific Knowledge is Based on Empirical Evidence	
▪ Science knowledge is based on empirical evidence.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation.	This Connection to Nature of Science is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
Disciplinary Core Ideas	
ESS3.D: Global Climate Change	
▪ Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.	This Disciplinary Core Idea is addressed throughout. For example, see: 12, 34-35, 50, 56, 58, 60-61, 185, 327, 334-335, 433, 500, 502-503, 510, 592, 618-619, 632, 638-640, 667, 674-676, 686-689, 692-702
Crosscutting Concepts	
CC.7: Stability and Change	
▪ Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806

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Standards	Where Addressed
HS-ESS3-6 Human Interaction with Earth's 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.	This standard is addressed throughout. For example, see: 40-42, 44, 50-54, 61, 82-83, 85-91, 153,159-160, 162-187, 189, 354, 438-469, 471, 474-475, 477, 483-484, 487-491, 493, 536-571, 582-583, 620-623, 632, 641, 690-691, 695
Science and Engineering Practices	
SEP.5: Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.	
▪ Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	This Science and Engineering Practice is addressed throughout. For example, see: 9-18. Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806
Disciplinary Core Ideas	
ESS2.D: Weather and Climate	
▪ Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary)*	This Disciplinary Core Idea is addressed throughout. For example, see: 12, 34-35, 50, 56, 58, 60-61, 185, 327, 334-335, 433, 500, 502-503, 510, 592, 618-619, 632, 638-640, 667, 674-676, 686-689, 692-702
ESS3.D: Global Climate Change	
▪ Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	This Disciplinary Core Idea is addressed throughout. For example, see: 47, 82-83, 153, 159-160, 162-164, 167, 169, 172-187, 189, 191, 227-291, 358, 379-380, 382, 389-390, 438-469, 536-571, 582-583, 638-640, 656-657, 660-664, 668, 695-696, 698

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Standards	Where Addressed
Crosscutting Concepts	
CC.4: 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.	This Crosscutting Concept is addressed throughout. For example, see: 11-19, 29, 34, 68, 96, 126, 160, 181-185, 187, 194, 228, 264, 294, 322, 356, 396, 440, 474, 498, 538, 576, 608, 638, 674, 698-699, 710, 738, 770, 796; Case Studies p. 8, 36, 70, 98, 128, 162, 196, 230, 266, 296, 324, 358, 398, 442, 476, 500, 540, 578, 610, 640, 676, 712, 740, 772, 798; Tying It All Together Activities p. 27, 60, 90, 120, 154, 186, 222, 258, 288, 316, 348, 389, 432, 466, 492, 532, 567, 600, 631, 667, 701, 732, 764, 789, 812; Data Analysis p. 12, 26, 57, 82, 118, 147, 184, 201, 239, 244, 286, 314, 327, 371, 415, 419, 448, 465, 485, 529, 542, 593, 627, 646, 666, 683, 723, 730, 743, 782, 805; Minilabs p. 14, 42, 72, 101, 146, 180, 213, 216, 238, 271, 310, 339, 364, 368, 436, 452, 460, 482, 486, 515, 563, 584, 585, 618, 621, 653, 654, 690, 724, 763, 778, 806