EarthComm Correlation to the Michigan Science Standards and Benchmarks

STANDARD E1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS

Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation.

Benchmark	Location/Page where Standard is found
E.1.1 Scientific Inquiry	
E1.1A Generate new questions that can be investigated in the laboratory or field.	**THROUGHOUT G37, G39-40, G84, F136, R5-8, R89-90, R97-99, R147-150, R176, R202, E46, E90-91, E127-128, E137-138, E183**
E1.1B Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.	**E28-36, E37-40, E41-46, G105-114**
E1.1C Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).	**G24, G39, G74, G86, G88, G96, G123-124, G132, G165, 168, U5, U70-72, U82, U92-94, U114, U132-133, U137, U147-148, U156, F5, F14-16, F67, F79, F116, F129-130, F136, F152, F159, F168-169, F175, F181, R5-7, R26, R34, R63, R89, R97-99, R121, R128, R137-138, R147, R157-160, R170, R176, R185-186, R197-198, R202, E15, E29, E46, E57, E59, E70, E91, E98**

E1.1D Identify patterns in data and relate them to theoretical models.	**R184-188, R189-195, E125-129, G131-137**
E1.1E Describe a reason for a given conclusion using evidence from an investigation.	**E173-181, G122-130, G131-137**
E1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.	**G38-42, G62-77**
E1.1g Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation.	**U124-126, U131-134, R169-171, R172-176, R184-188, R189-195**
E1.1h Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.	**G52-53, E128-129, G105-109, G110-117, R184-195**
E1.1i Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.	**G116-117, E128-129, E136-143, E170-171, E185-186**
E1.2 Scientific Reflection and Social Implications	
E1.2A Critique whether or not specific questions can be answered through scientific investigations.	**G116-117, E128-129, E136-143, E170-171, E185-186**
E1.2B Identify and critique arguments about personal or societal issues based on scientific evidence.	**G44, G86, G165, U70-72, 113-114, U132, U156, F67, F79, F136, F152, R5, R89, R97-99, R121, R160, R176, R185-188, R197-198, E91, E183**
E1.2C Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information.	**G105-117, G4-13, G14-22, G62-73, G147-154, E117-124**
E1.2D Evaluate scientific explanations in a peer review process or discussion format.	**R127-135, E37-44, E74-77**

E1.2E Evaluate the future career and occupational prospects of science fields.	**E80, R142, R203, F124, F62, U171, G118, E6-11, R196-202**
E1.2f Critique solutions to problems, given criteria and scientific constraints.	**G105-109, G110-117, R184-188, R189-195, F88-94, G131-137, G155-163, F113-123, E4-13, G164-171**
E1.2g Identify scientific tradeoffs in design decisions and choose among alternative solutions.	**R16-24, R25-34, R35-42, R43-52, R52-61, R62-71, R72-83, F95-102, F103-112, F113-123**
E1.2h Describe the distinctions between scientific theories, laws, hypotheses, and observations.	**G105-116, E173-181, F13-22, G155-163, G62-77, G122-130**
E1.2i Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.	**G110-115, G7-11, G26-28, G34-36, G40-41, G52, G54-56, G70-72, G92-93, G137, G144, G170-171, U53-55, U62-63, U134-136, F31-35, F43-46, F52-54, F90-93, F110, F116-122, F146, F153-155, R15, R122-124, R139-140, R173, R189-193, R199-201, E7-11, E18-20, E31, E41-42, E63-67, E99-103, E151-154, E179-180**
E1.2j Apply science principles or scientific data to anticipate effects of technological design decisions.	**R184-195, G164-172, G131-137, R43-52, F90-93, U155-162, R196-202**
E1.2k Analyze how science and society interact from a historical, political, economic, or social perspective.	**U131-137, E125-135, U122-130, R19-24, E156-164, E136-143, R77-83**

STANDARD E2: EARTH SYSTEMS

Students describe the interactions within and between Earth systems. Students will explain how both fluids (water cycle) and solids (rock cycle) move within Earth systems and how these movements form and change their environment. They will describe the relationship between physical process and human activities and use this understanding to demonstrate an ability to make wise decisions about land use.

Benchmark	Location/Page where Standard is found
E2.1 Earth Systems Overview	
E2.1A Explain why the Earth is essentially a closed system in terms of matter.	**R25-34, R156-161, E148-155, E156-164, E165-172, F56-61, R43-61, R72-83, R4-15, R146-155, E117-124, E125-135, F4-12, F13-22, F23-26, F48-55**
E2.1B Analyze the interactions between the major systems (geosphere, atmosphere, hydrosphere, biosphere) that make up the Earth.	**R146-155, R1560168, R169-176, R177-183, R184-195, R196-202, U124-130, U100-112**
E2.1C Explain, using specific examples, how a change in one system affects other Earth systems.	**E84-95, E105-116, E117-124, E125-135, E136-143**
E2.2 Energy in Earth Systems	
E2.2A Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).	**G85-94, G95-104, G105-117**
E2.2B Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.	**R16-24, R25-34, R35-42, R43-52, R52-61, R62-71, R72-83**
E2.2C Describe natural processes in which heat transfer in the Earth occurs by conduction, convection, and radiation.	**E47-57, E105-116, E117-124, E125-135, E136-143, E156-164, F4-12, F23-36, G85-94, U131-137**
E2.2D Identify the main sources of energy to the climate system.	**E47-57, E105-116, E117-124, E125-135, E136-143, E156-164, F4-12, F23-36, G85-94, U131-137**
E2.2e Explain how energy changes form through Earth systems.	**R4-15, R43-61, R72-83, F56-61, E148-155, E156-164, E165-172, U4-13, U14-22, U23-32, U33-38**
E2.2f Explain how elements exist in different compounds and states as they move from one reservoir to another.	**R4-15, R43-61, R146-155, R184-195, E125-135, U4-13, U14-22, U23-32, U33-38**

E2.3 Biogeochemical Cycles	
E2.3A Explain how carbon exists in different forms such as limestone (rock), carbon dioxide (gas), carbonic acid (water), and animals (life) within Earth systems and how those forms can be beneficial or harmful to humans.	**R25-34, R35-42, R43-52, R53-61, R62-71, G125-135**
E2.3b Explain why small amounts of some chemical forms may be beneficial for life but are poisonous in large quantities (e.g., dead zone in the Gulf of Mexico, Lake Nyos in Africa, fluoride in drinking water).	**R43-52, R136-141, R184-195, R196-202, E136-143**
E2.3c Explain how the nitrogen cycle is part of the Earth system.	**R184-195**
E2.3d Explain how carbon moves through the Earth system (including the geosphere) and how it may benefit (e.g., improve soils for agriculture) or harm (e.g., act as a pollutant) society.	**R43-52, E125-135**
E2.4 Resources and Human Impacts on Earth Systems	
E2.4A Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.	**R25-34, R35-42, R43-52, R53-61, R62-71, R72-83**
E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.	**F48-55, F95-102, F113-123, F174-179, U138-145, G23-30, G31-37, G147-154, G155-163, R43-52, F37-47, F48-55, F56-62, U163-170**
E2.4B Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.	**SAME**
E2.4d Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.	**R88-95**

STANDARD E3: THE SOLID EARTH

Students explain how scientists study and model the interior of the Earth and its dynamic nature. They use the theory of plate tectonics, the unifying theory of geology, to explain a wide variety of Earth features and processes and how hazards resulting from these processes impact society.

Benchmark	Location/Page where Standard is found
E3.p1 Landforms and Soils *(prerequisite)*	
E3.p1A Explain the origin of Michigan landforms. Describe and identify surface features using maps and satellite images. *(prerequisite)*	**U100-112, F167-173, F174-179, F149-157, F158-166, U113-119, U146-154, U70-80, U81-89, U90-99**
E3.p1B Explain how physical and chemical weathering leads to erosion and the formation of soils and sediments. *(prerequisite)*	**U155-162, U90-99**
E3.p2 Rocks and Minerals *(prerequisite)*	
E3.p2A Identify common rock-forming minerals (quartz, feldspar, biotite, calcite, hornblende). *(prerequisite)*	**U4-13, U14-22, U23-32, U33-38, U39-48**
E3.p2B Identify common igneous (granite, basalt, andesite, obsidian, pumice), metamorphic (schist, gneiss, marble, slate, quartzite), and sedimentary (sandstone, limestone, shale, conglomerate) rocks and describe the processes that change one kind of rock to another. *(prerequisite)*	**U33-38, U39-48, U49-56, U57-65**
E3.p3 Basic Plate Tectonics *(prerequisite)*	
E3.p3A Describe geologic, paleontologic, and paleoclimatalogic evidence that indicates Africa and South America were once part of a single continent.	**G105-117, G4-13, G14-22, G62-73, G147-154, E117-124**
E3.p3B Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g., continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).	**G4-13, G14-22, G62-73, G74-84, G85-94, G95-104, G105-117, G122-130, G147-154**
E3.p3B Describe the three types of plate boundaries (divergent, convergent, and transform) and geographic features associated with them (e.g., continental rifts and mid-ocean ridges, volcanic and island arcs, deep-sea trenches, transform faults).	**SAME**
E3.1 Advanced Rock Cycle	
E3.1A Discriminate between igneous, metamorphic, and sedimentary rocks and describe the processes that change one kind of rock into another.	**U4-13, U14-22, U23-32, U33-38, U39-48**
E3.1B Explain the relationship between the rock cycle and plate tectonics theory in regard to the origins of igneous, sedimentary, and metamorphic rocks.	**U4-13, U14-22, U23-32, U33-38, U39-48**

E3.1c Explain how the size and shape of grains in a sedimentary rock indicate the environment of formation (including climate) and deposition.	**U155-162, U97-99**
E3.1d Explain how the crystal sizes of igneous rocks indicate the rate of cooling and whether the rock is extrusive or intrusive.	**U14-21, U30-37, G44-49**
E3.1e Explain how the texture (foliated, nonfoliated) of metamorphic rock can indicate whether it has experienced regional or contact metamorphism.	**U23-31, U37-38**
E3.2 Interior of the Earth	
E3.2A Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.	**G62-73, G85-94, G110-117, G122-130**
E3.2B Explain how scientists infer that the Earth has interior layers with discernable properties using patterns of primary (*P*) and secondary (*S*) seismic wave arrivals.	**G122-130, G131-137G**
E3.2C Describe the differences between oceanic and continental crust (including density, age, composition).	**62-73, G78-84**
E3.2d Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.	**G85-94, G110-117**
E3.3 Plate Tectonics Theory	
E3.3A Explain how plate tectonics accounts for the features and processes (sea floor spreading, mid-ocean ridges, subduction zones, earthquakes and volcanoes, mountain ranges) that occur on or near the Earth's surface.	**G62-73, G74-84, G85-94, G95-104**
E3.3B Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that result from their increased density.	**G62-73, G74-84, G85-94**
E3.3C Describe the motion history of geologic features (e.g., plates, Hawaii) using equations relating rate, time, and distance.	**G147-154, G85-94, G95-104**
E3.3d Distinguish plate boundaries by the pattern of depth and magnitude of earthquakes.	**G74-84, G85-94**
E3.r3e Predict the temperature distribution in the lithosphere as a function of distance from the mid-ocean ridge and how it relates to ocean depth. *(recommended)*	**G85-94**

E3.r3f Describe how the direction and rate of movement for the North American plate has affected the local climate over the last 600 million years. *(recommended)*	**G95-104, G105-117, E117-124**
E3.4 Earthquakes and Volcanoes	
E3.4A Use the distribution of earthquakes and volcanoes to locate and determine the types of plate boundaries.	**G4-13, G62-73, G74-84, G95-104, G147-154**
E3.4B Describe how the sizes of earthquakes and volcanoes are measured or characterized.	**G51-57, G62-73. G131-137, G138-146**
E3.4C Describe the effects of earthquakes and volcanic eruptions on humans.	**G23-30, G31-37, G38-42, G155-163, G164-172**
E3.4d Explain how the chemical composition of magmas relates to plate tectonics and affects the geometry, structure, and explosivity of volcanoes.	**G14-22**
E3.4e Explain how volcanoes change the atmosphere, hydrosphere, and other Earth systems.	**G23-30, G31-37, G38-42**
E3.4f Explain why fences are offset after an earthquake, using the elastic rebound theory.	**G122-130, G138-146, G164-172**

STANDARD E4: THE FLUID EARTH

Students explain how the ocean and atmosphere move and transfer energy around the planet. They also explain how these movements affect climate and weather and how severe weather impacts society. Students explain how long term climatic changes (glaciers) have shaped the Michigan landscape. They also explain features and processes related to surface and ground- water and describe the sustainability of systems in terms of water quality and quantity.

Benchmark	**Location/Page where Standard is found**
E4.p1 Water Cycle *(prerequisite)*	
E4.p1A Describe that the water cycle includes evaporation, transpiration, condensation, precipitation, infiltration, surface runoff, groundwater, and absorption. *(prerequisite)*	**R146-155, R156-168**

E4.p1B Analyze the flow of water between the elements of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater. *(prerequisite)*	**R156-168, U100-112, U70-80, U81-89, U90-99**
E4.p1C Describe the river and stream types, features, and process including cycles of flooding, erosion, and deposition as they occur naturally and as they are impacted by land use decisions. *(prerequisite)*	**F95-102, U90-99, U70-80, U81-89**
E4.p1D Explain the types, process, and beneficial functions of wetlands.	**R156-168, R171-183, U81-89**
E4.p2 Weather and the Atmosphere *(prerequisite)*.	
E4.p2A Describe the composition and layers of the atmosphere. *(prerequisite)*	**F66-76, F77-87**
E4.p2B Describe the difference between weather and climate. *(prerequisite)*	**F52-54, E91-94**
E4.p2C Explain the differences between fog and dew formation and cloud formation. *(prerequisite)*	**F77-87, F66-76, R151-154, F186-187**
E4.p2D Describe relative humidity in terms of the moisture content of the air and the moisture capacity of the air and how these depend on the temperature. *(prerequisite)*	**F77-87**
E4.p2E Describe conditions associated with frontal boundaries (cold, warm, stationary, and occluded). *(prerequisite)*	**F113-123, F77-87, F88-94**
E4.p2F Describe the characteristics and movement across North America of the major air masses and the jet stream. *(prerequisite)*	**F66-76**
E4.p2G Interpret a weather map and describe present weather conditions and predict changes in weather over 24 hours. *(prerequisite)*	**F66-76, F88-94**
E4.p2H Explain the primary causes of seasons. *(prerequisite)*	**E105-116**
E4.p2I Identify major global wind belts (trade winds, prevailing westerlies, and polar easterlies) and that their vertical components control the global distribution of rainforests and deserts. *(prerequisite)*	**E84-95**
E4.p3 Glaciers *(prerequisite)*	
E4.p3A Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy. *(prerequisite)*	**F138-148, F149-157, F158-166**

E4.p3B Explain what happens to the lithosphere when an ice sheet is removed. *(prerequisite)*	**F167-173**
E4.p3C Explain the formation of the Great Lakes. *(prerequisite)*	**F174-179**
E4.1 Hydrogeology	
E4.1A Compare and contrast surface water systems (lakes, rivers, streams, wetlands) and groundwater in regard to their relative sizes as Earth's freshwater reservoirs and the dynamics of water movement (inputs and outputs, residence times, sustainability).	**R146-155**
E4.1B Explain the features and processes of groundwater systems and how the sustainability of North American aquifers has changed in recent history (e.g., the past 100 years) qualitatively using the concepts of recharge, residence time, inputs, and outputs.	**R156-168, R177-183**
E4.1C Explain how water quality in both groundwater and surface systems is impacted by land use decisions.	**R169-176, R177-183, R184-195**
E4.2 Oceans and Climate	
E4.2A Describe the major causes for the ocean's surface and deep water currents, including the prevailing winds, the Coriolis effect, unequal heating of the earth, changes in water temperature and salinity in high latitudes, and basin shape.	**F4-12, F13-22, F23-36**
E4.2B Explain how interactions between the oceans and the atmosphere influence global and regional climate. Include the major concepts of heat transfer by ocean currents, thermohaline circulation, boundary currents, evaporation, precipitation, climatic zones, and the ocean as a major CO_2 reservoir.	**F37-47, F48-55, F56-61**
E4.2c Explain the dynamics (including ocean-atmosphere interactions) of the El Niño-Southern Oscillation (ENSO) and its effect on continental climates.	**F37-47, F48-55**
E4.2d Identify factors affecting seawater density and salinity and describe how density affects oceanic layering and currents.	**F13-22**
E4.2e Explain the differences between maritime and continental climates with regard to oceanic currents.	**F48-55**
E4.2f Explain how the Coriolis effect controls oceanic circulation.	**F4-12, F23-36**
E4.r2g Explain how El Niño affects economies (e.g., in South America). *(recommended)*	**F48-55, F56-61**

E4.3 Severe Weather	
E4.3A Describe the various conditions of formation associated with severe weather (thunderstorms, tornadoes, hurricanes, floods, waves, and drought).	**F66-76, G77-87, F103-112, F113-123**
E4.3B Describe the damage resulting from, and the social impact of thunderstorms, tornadoes, hurricanes, and floods.	**F95-102, F103-112, F113-123**
E4.3C Describe severe weather and flood safety and mitigation.	**F95-102, F103-112, F113-123**
E4.3D Describe the seasonal variations in severe weather.	**F66-76, F113-123**
E4.3E Describe conditions associated with frontal boundaries that result in severe weather (thunderstorms, tornadoes, and hurricanes).	**F77-87, F66-76, F113-123**
E4.3F Describe how mountains, frontal wedging (including dry lines), convection, and convergence form clouds and precipitation.	**F66-76**
E4.3g Explain the process of adiabatic cooling and adiabatic temperature changes to the formation of clouds.	**F66-76, F77-87**

STANDARD E5: THE EARTH IN SPACE AND TIME

Students explain how the ocean and atmosphere move and transfer energy around the planet. They also explain how these movements affect climate and weather and how severe weather impacts society. Students explain how long term climatic changes (glaciers) have shaped the Michigan landscape. They also explain features and processes related to surface and ground- water and describe the sustainability of systems in terms of water quality and quantity.

Benchmark	**Location/Page where Standard is found**
E5.p1 Sky Observations *(prerequisite)*	
E5.p1A Describe the motions of various celestial bodies and some effects of those motions. *(prerequisite)*	**E4-13, E14-27, E28-36, E37-46**

EE5.p1B Explain the primary cause of seasons. *(prerequisite)*	**E105-116**
E5.p1C Explain how a light year can be used as a distance unit. *(prerequisite)*	**E4-13**
E5.p1D Describe the position and motion of our solar system in our galaxy. *(prerequisite)*	**E4-13, E69-79**
E5.1 The Earth in Space	
E5.1A Describe the position and motion of our solar system in our galaxy and the overall scale, structure, and age of the universe.	**E4-13**
E5.1b Describe how the Big Bang theory accounts for the formation of the universe.	**E4-13**
E5.1c Explain how observations of the cosmic microwave background have helped determine the age of the universe.	**E58-68**
E5.1d Differentiate between the cosmological and Doppler red shift.	**E58-68**
E5.2 The Sun	
E5.2A Identify patterns in solar activities (sunspot cycle, solar flares, solar wind).	**E47-57**
E5.2B Relate events on the Sun to phenomena such as auroras, disruption of radio and satellite communications, and power grid disturbances.	**E47-57**
E5.2C Describe how nuclear fusion produces energy in the Sun.	**E47-57**
E5.2D Describe how nuclear fusion and other processes in stars have led to the formation of all the other chemical elements.	**E47-57**
E5.2x Stellar Evolution	

E5.2e Explain how the Hertzsprung-Russell (H-R) diagram can be used to deduce other parameters (distance).	**E69-79**
E5.2f Explain how you can infer the temperature, life span, and mass of a star from its color. Use the H-R diagram to explain the life cycles of stars.	**E69-79**
E5.2g Explain how the balance between fusion and gravity controls the evolution of a star (equilibrium).	**E69-79**
E5.2h Compare the evolution paths of low-, moderate-, and high-mass stars using the H-R diagram.	**E69-79**
E5.3 Earth History and Geologic Time	
E5.3A Explain how the solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 Ga (billion years ago).	**E4-13**
E5.3B Describe the process of radioactive decay and explain how radioactive elements are used to date the rocks that contain them.	**E4-13**
E5.3C Relate major events in the history of the Earth to the geologic time scale, including formation of the Earth, formation of an oxygen atmosphere, rise of life, Cretaceous-Tertiary (K-T) and Permian extinctions, and Pleistocene ice age.	**E148-155, E173-181**
E5.3D Describe how index fossils can be used to determine time sequence.	**E148-155**
E5.3x Geologic Dating	
E5.3e Determine the approximate age of a sample, when given the half-life of a radioactive substance (in graph or tabular form) along with the ratio of daughter to parent substances present in the sample.	**E172**
E5.3f Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.	**E172**
E5.3g Identify a sequence of geologic events using relative-age dating principles.	**E173-181**

E5.4 Climate Change	
E5.4A Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).	**E125-135, G38-42, R45-50**
E5.4B Describe natural mechanisms that could result in significant changes in climate (e.g., major volcanic eruptions, changes in sunlight received by the earth, and meteorite impacts).	**E173-181**
E5.4C Analyze the empirical relationship between the emissions of carbon dioxide, atmospheric carbon dioxide levels, and the average global temperature over the past 150 years.	**E165-172, E173-181**
E5.4D Based on evidence of observable changes in recent history and climate change models, explain the consequences of warmer oceans (including the results of increased evaporation, shoreline and estuarine impacts, oceanic algae growth, and coral bleaching) and changing climatic zones (including the adaptive capacity of the biosphere).	**E165-172, E173-181, E182-188**
E5.4e Based on evidence from historical climate research (e.g. fossils, varves, ice core data) and climate change models, explain how the current melting of polar ice caps can impact the climatic system .	**E165-172, E173-181, E182-188**
E5.4f Describe geologic evidence that implies climates were significantly colder at times in the geologic record (e.g., geomorphology, striations, and fossils).	**E96-104, E136-143, E117-124**
E5.4g Compare and contrast the heat-trapping mechanisms of the major greenhouse gases resulting from emissions (carbon dioxide, methane, nitrous oxide, fluorocarbons) as well as their abundance and heat- trapping capacity.	**E125-135, E136-143**
E5.r4h Use oxygen isotope data to estimate paleotemperature. *(recommended)*	**E96-104**
E5.r4i Explain the causes of short-term climate changes such as catastrophic volcanic eruptions and impact of solar system objects. *(recommended)*	**E105-116, E117-124**
E5.r4j Predict the global temperature increase by 2100, given data on the annual trends of CO_2 concentration increase. *(recommended)*	**E125-135, E136-143**