**Seasons, Weather, and Earth’s Climate** (90 minutes)

*Disciplinary Core Ideas: ESS1.B, ESS2.D*

- This model of the solar system can explain eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

**Science and Engineering Practices**

- Developing and Using Models (e.g. Model of the Earth-Sun interaction to show Earth’s tilt)
- Constructing Explanations and Designing Solutions (e.g. Explanation of seasons based on how the Earth is tilted in relation to the Sun)

**Crosscutting Concepts**

- Patterns (e.g. Climate is based on a pattern over a long period of time)
- Cause and Effect (e.g. The Earth is tilted, which explains why we experience the seasons)
- Systems and System Models (e.g. Models are used to demonstrate the orbit and tilt of the Earth around the Sun)

**Program Description**

Students’ imaginations are transported from an Earth-based perspective of seasonal variation in the Sun into a virtual spaceship for a space-eye view targeting the causes of seasons. This visual immersion into scientific information enables students to easily grasp complex 3-dimensional aspects of seasonal variation as well as Earth systems ideas targeting concepts such as the Sun’s energy is the primary driver of these systems. Highlighting distinctions between weather and climate, students virtually cruise in Earth’s orbit to explore visualizations of atmospheric and oceanic circulation patterns and their impacts on climate. This exploration includes the show Oasis in Space, which tours our solar system for liquid water – a key ingredient for climate and for life. The experience concludes with a short tour of the night sky as we turn our imaginations to what else might be out there.
Gravity and Galaxies (90 minutes)


- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2), (MSESS1-3)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)
- Forces that act at a distance (electric and magnetic) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively). (MS-PS2-5)
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

Science and Engineering Practices

- Developing and Using Models (e.g. Visual model of gravity’s influence on solar system objects)
- Constructing Explanations and Designing Solutions (e.g. Explanations using gravity for similar shapes of: Saturn system of rings and moons; solar system of planets; Milky Way galaxy system of stars)

Crosscutting Concepts

- Scale, Proportion, and Quantity (Scales explored include: Earth; Earth-Moon; inner solar system; outer solar system; galactic; extragalactic)
- Systems and System Models (modeling the solar system, its formation and subsequent development under influence of gravity)

Program Description

Students are captivated as they witness the birth of the solar system through the virtual lens of the planetarium. Immersive visualizations enable them to understand the role of gravity in forming our solar system from a disk of dust and gas. Students absorb key concepts such as how the phenomenal force called gravity is the “super glue” of the universe, holding objects in orbit from the planetary scale of the Earth, to the solar system, to the galactic scale. This exploration transports students from our little blue marble throughout the solar system, into the Milky Way, and out of our galaxy to view some of the billions of galaxies in the universe – talk about feeling insignificant! This field experience includes the show *Black Holes, which explores these voracious gravity wells and their vital role in galaxy formation. The experience concludes with a short tour of the night sky.

*BIG may substitute Black Holes to be more age appropriate for certain groups
**Moon Phases and Scale of the Solar System** *(90 minutes)*

*Disciplinary Core Ideas: ESS1.A, ESS1.B*

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. *(MS-ESS1-1)*
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. *(MS-ESS1-2)*
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. *(MS-ESS1-2), (MS-ESS1-3)*
- This model of the solar system can explain eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. *(MS-ESS1-1)*

*Science and Engineering Practices*

- Developing and Using Models (e.g. Visual model of Earth-Moon-Sun interactions)
- Constructing Explanations (e.g. Using Earth and Space-based perspective to explain the Moon’s appearance from Earth, including eclipses)

*Crosscutting Concepts*

- Patterns (e.g. Phases of Earth’s Moon and other moons, eclipses, and motion of the Sun)
- Scale, Proportion, and Quantity (e.g. Scales explored include: Earth, Earth-Moon, inner solar system, outer solar system)

*Program Description*

Beginning by exploring complex 3-dimensional interactions of the Sun, Moon, and Earth to emphasize the cause of moon phases, students experience this phenomenon both from an Earth-based perspective and a space-eye view from a virtual space ship to thoroughly internalize this celestial phenomenon. Understanding of this dynamic interplay is enriched by explorations of causes of solar eclipses (and why they are so rare). Having mastered relationships in our astronomical neighborhood, students are guided into a much larger journey to grasp the scale of our solar system and key interactions within it. From this expanded view of our place in space, minds are stretched further as our virtual spaceship transports imaginations and visual perspectives out beyond our Milky Way galaxy, placing our cozy little solar system in the larger galactic context. And then space really gets big as some of the many billions of other galaxies emerge on the dome. This exploration includes the show *Perfect Little Planet*, which features an alien family touring our solar system for the perfect vacation spot, encountering unique and interesting elements of our solar system along the way. The experience concludes with a short tour of the constellations in the night sky as we turn our imaginations outward.

*BIG or Oasis in Space may substitute Perfect Little Planet to be more age appropriate for certain groups*
**Earth’s Changing Landscape: 6-8 (90 minutes)**


- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (MS-ESS2-3)
- The planet’s systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth’s history and will determine its future. (MS-ESS2-2)
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart. (MS-ESS2-3)
- Water’s movements—both on the land and underground—cause weathering and erosion, which change the land’s surface features and create underground formations. (MS-ESS2-3)

**Science and Engineering Practices**

- **Constructing Explanations and Designing Solutions** (e.g. explanations for KY limestone deposits)
- **Developing and Using Models** (e.g. modeling plate tectonics to account for current observations)

**Crosscutting Concepts**

- **Cause and Effect** (e.g. marine organisms in a shallow ocean covering what was to become Kentucky caused the limestone deposits that we know of today)
- **Stability and Change** (e.g. continental plates move and reshape oceans and land on long time scales, whereas on shorter human time scales these actions are not directly noticeable)

**Program Description**

Our journey will begin by observing the local environment around the University of Louisville and Kentucky before taking a virtual spaceship back in time. We will fly to the outermost distances of space and time that we currently have knowledge of and discuss early events that occurred during the formation of our universe. The Milky Way galaxy and our solar system will be explored, as we then uncover how Earth came to be in its current state. As we fly back to our planet, the importance of plate tectonics and natural processes will become clear in the formation of different rock types and a very different landscape than what once existed on Earth. Over billions of years, our landscape has changed dramatically and Kentucky has experienced a booming industry thanks to the changes that have taken place. Rich deposits of limestone have contributed to the evolution of horses and as a result, Kentucky is known for producing strong, fast thoroughbred horses.

Join us in exploring the importance of our past for explaining our current success. This exploration includes our show, *Supervolcanoes*, which looks back at rare classes of eruptions that have marshaled the energy that lurks, like a sleeping dragon, beneath the surface of planet Earth. The experience concludes with a brief tour of the constellations in the night sky.
Teacher/Educator Resources:

Moon Phases and Scale of the Solar System
- Scale Models of the Solar System
- Interactive Classroom Materials
- Calendar
- Journal

Seasons, Weather and Earth’s Climate
- Interactive Classroom Materials
- Activities/Resources

Jet Propulsion Laboratory Activities and Resources
- NASA
- NOAA

Multiple Activities and Simulators: University of Nebraska – Lincoln
- Class Action
- Class Action Version 2

Astronomy.com

Kidsastronomy.com

Next Generation Science Standards