Atmosphere Learning Progression

Grades 6-8: GLOBE Protocols Aligned with NASA Resources and NGSS Standards

NGSS Disciplinary Core Ideas Progression of Learning: Building on the concepts developed in grades 3-5 that looked at the relationship between climate and patterns of typical weather conditions over different time scales, students in grades 6-8 will take this a step further as they examine how complex interactions determine local weather patterns and influence climate, including the role of the ocean. By incorporating GLOBE and My NASA Data in the classroom educators provide students with the ability to collect data, learn how to visualize and analyze data while connecting with NASA scientists and accessing satellite data to examine a variety of interactions within the atmosphere and how these interactions affect the Earth system as a whole. Through the implementation of the learning activities and GLOBE protocols, teachers will bring authentic data collection into their classrooms. (NASA Langley GLOBE Resource Page: www.globe.gov/web/nasa-langley-research-center/home/resources)

NGSS Performance Expectations: (Note: the following Performance Expectations and 3 Dimensional Learning are aligned with GLOBE and NASA Resources and are meant to support the development of the associated content and skill development but may not lead to complete mastery)

MS-PS1-4: Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS4-2: Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

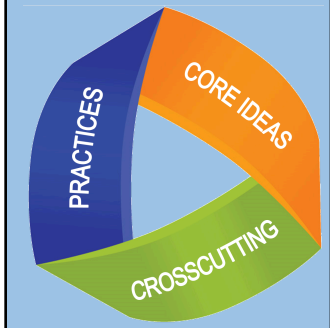
MS-ESS3-2: Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. (clarification: air pollution)

MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

NGSS Science Practices:	NGSS Disciplinary Core Idea:	NGSS Crosscutting Concepts:
Asking Questions and Defining Problems – Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5) **Planning and Carrying out Investigations** - Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.. (MS-ESS2-5) **Developing and Using Models**- Develop and use a model to predict and.or describe phenomena.	**PS1.A Structure and Properties of Matter** Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter. (MS-PS1-4) **PS1.B Chemical Reactions**: The term "heat" as used in everyday language refers both to thermal energy and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (Secondary to: MS-PS1-4) **PS4.B Electromagnetic Radiation** When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and frequency (color) of the light (MS-PS4-2) The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)	**Structure and Function** **Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. (MS-OS4-2)** **Stability and Change** Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales. (MS-ESS2-1) Stability might be disturbed either by sudden events or gradual changes that

(MS-PS1-4, MS-PS4-2, MS-ESS2-6)
Develop a model to describe unobservable mechanisms. (MS-ESS2-1, MS-ESS2-4)



ESS2.A Earth's Materials and Systems:
All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)
ESS2.C The Roles of Water in Earth's Surface Processes:
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation, and crystallization, and precipitation, as well as downhill flows on land. Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)
The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.(MS-ESS2-5)
ESS2.D Weather and Climate:
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-ESS1-5)
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)
ESS3.D Global Climate Change:
Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

accumulate over time. (MS-ESS3-5)
Cause and Effect
Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4, MS-ESS2-5)
Systems and System Models
Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)
Energy and Matter
Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

GLOBE Applications

Atmosphere Protocols:
- Air Temperature
- Clouds
- Surface Temperature
- Precipitation

Data Investigation Sheets:
- Atmosphere Investigation Integrated 1-Day
- Atmosphere Investigation Clouds 1-Day

GLOBE Learning Activities:
1. Investigating Clouds (MS-PS1-4)
2. Cloud Opacity Experiment (MS-PS4-2)
3. Observing Visibility and Sky Color (MS-ESS3-2)
4. Climate and Latitude: A GLOBE Data Exploration (MS-ESS2-5, MS-ESS2-6, MS-ESS3-5)
5. Modeling the Reason for Seasonal Change (MS-ESS2-6)
6. Seasonal Change on Land and Water (MS-PS1-4, MS-ESS2-4)
7. How do Seasonal Temperature Patterns Vary Among Different Regions of the World (MS-ESS2-6)
8. What are Some Factors That Affect Seasonal Patterns? (MS-ESS2-5, MS-ESS2-6)
9. GC1: Your Regional to Global Connection (MS-ESS2-5, MS-ESS2-6)
10. Learning to Use Visualizations (All)
11. Draw Your Own Visualization (All)
12. How do Seasonal Temperature Patterns Vary among Different Regions
13. LC3: Using Graphs to Show Connections (All)

Guiding Question(s):
1. How can satellite data combined with ground observations be used to identify trends and patterns associated with interactions that occur between the atmosphere and other Earth systems?
2. How are regional climates determined by patterns of atmospheric and oceanic circulation? What causes these patterns to occur?
3. Based on evidence that has been collected, what factors are associated with the rise in global

• Atmosphere Investigation Surface Temperature	14. **Data Entry:** After students have returned from the field with their paper data sheets, data can be shared with the GLOBE and scientific community by entering it into the GLOBE online science database (https://data.globe.gov). (All) 15. **Data Visualization Tool:** Use the GLOBE Visualization System to view and retrieve your data. (All) **Cross-Curricular Connections:** GLOBE Learning Activities · Math Connection: Calculating Relative Air Mass · Geography Connection: Making a Contour Map · Geography Connection: Weather Tourist: A GLOBE Data Exploration **GLOBE Supporting Resources:** • Air Quality and NASA Science Missions • GLOBE Weather Protocol Bundle • GLOBE Weather • UCAR SciEd Teaching Boxes • Educator Presentations • Earth System Science Posters	temperatures over the past century? Which of these factors can be attributed to human impacts? To natural hazards?

NASA ASSETS

NASA Next Gen STEM for Educators: Through authentic content students will be engaged in NASA mission activities and can provide contributions to NASA's work.

NASA Learning Activities/Resources:

- NASA Climate Change Educational Modules
- NASA Earth Observatory World Maps
- The Study of Earth as an Integrated System
- EARTHDATA: Hazards and Disasters
- Floods iQuest
- NASA's Eyes on Extreme Weather
- Graphing the Rise in Earth's Carbon Dioxide

MY NASA DATA Earth Visualization Tool

GLOBE Atmosphere Protocols and Related ESDE Datasets:
My NASA Data features resources for GLOBE protocols that provide connections to NASA datasets in the Earth System Data Explorer.

Atmosphere STEM Career Connections: My NASA Data (MND) offers resources to help students explore careers related to Earth Systems missions at NASA. Students may review

MY NASA DATA Lessons/Activities (6-8)

- Using Models in Climate Change Research (MS-ESS2-2, MS-ESS3-2)
- Comparing Temperature and Solar Radiation for Common Latitudes (MS-ESS2-5, MS-ESS2-6)
- Seasonal Science: Building Claims from Evidence (MS-ESS2-6)
- Using Precipitation and Vegetation to Study Climate Zones(MS-ESS2-4)
- Energy and Matter: Water Cycle and the Ocean's Temperature (MS-PS1-4,MS-ESS2-4, MS-ESS2-6)
- Modeling Temperature and Deep Ocean Currents (MS-ESS2-4, MS-ESS2-6)
- Energy Transfer in Earth's Atmosphere (MS-PS4-2)
- Changing Albedo Lab (MS-ESS2-1)
- MY NASA DATA-GLOBE Digital Earth System Poster (MS-ESS3-5)
- Multi-year Time Plots for Air Quality Data (MS-ESS3-3)
- Systems and System Models: Observing Our Planet on Fire (MS-ESS3-2)

• NASA Air Quality • In the Fog about Smog • Fired Up Over Math: Studying Wildfires from Space • Earth Science Data Visualizations - How to Read a Heat Map • Feel the Heat • Global Energy Budget • NASA Spotlight Interactive Lesson: Interactions of Light • NASA Spotlight Interactive Lesson: Composition of Earth's Atmosphere • NASA Spotlight Interactive Lesson: Heat and Temperature	job profiles within the four disciplines of STEM (*Science, Technology, Engineering, and Mathematics*) aligned with projects in the Atmosphere, Biosphere, Cryosphere, Geosphere, and Hydrosphere. **STEM Career Connections** • Dr. Norman Loeb, Atmospheric Scientist • Dr. Yoland Shea, Atmospheric Scientist • Jim Crawford, Project Scientist • Dr. Paul Stackhouse, Senior Research Scientist	• Systems and System Models: Observing Carbon Dioxide in the Atmosphere (MS-ESS2-1, MS-ESS3-5, MS-ESS3-3) • Pollutant Source and Transport (MS-ESS3-3) • Air Quality Story Map (MS-ESS3-3, MS-ESS3-4) • How is My Air (MS-ESS3-3, MS-ESS3-4) • Earth System Energy Travels (MS-PS4-2) **My NASA DATA Resource Pages:** • Energy and Matter Cycles (MS-PS1-4, MS-ESS2-1, MS-ESS2-4, MS-ESS3-3, MS-ESS3-5) • GLOBE Protocol Bundle: Air Quality • About the Atmosphere (All) • System Thinking About the Earth System (All) • Energy Transfer in Earth's Atmosphere (MS-ESS2-1, MS-PS4-2) • Air Temperatures (MS-PS1-4, MS-ESS2-6) • Hurricane Dynamics (MS-ESS2-5, MS-ESS2-6, MS-ESS3-2) • Electromagnetic Spectrum (MS-PS4-2)

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