



Moon Trees GLOBE Activities and Resources

Overview: The original Moon Trees are trees that sprouted from seeds taken into lunar orbit in 1971 by astronaut Stuart Roosa aboard the Apollo 14. Around 80 Moon Trees are now growing around the world, and trees planted from seeds or cuttings have become “Second Generation” Moon Trees. In 2022, NASA’s Office of STEM Engagement and the USDA Forest Service partnered to send 1,000 seeds of five different species into lunar orbit aboard Artemis I to become the next generation of Moon Trees. The Next Generation Moon Trees have now been successfully germinated by the Forest Service; your school or organization can apply to be the home of an Artemis I Moon Tree!

The resources below outline how you can use the Global Learning and Observations to Benefit the Environment (GLOBE) program data collection protocols and activities to enhance learning around Moon Trees (and all trees!) near you. These activities and protocols can be used in your application to develop educational opportunities to connect students, schools, and communities to your Moon Tree.

GLOBE eTraining: Become a trained GLOBE educator on your own time with these free [eTraining modules](#).

Moon Trees Request for Proposals: Moon Trees opportunity opens 24 August 2023. [Learn more about how to apply here](#).

NASA Moon Trees STEM Toolkit: Find curated lesson plans, videos and hands-on activities in this [STEM toolkit](#).

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BACKGROUND INFORMATION

GLOBE

- GLOBE is a world-wide science and education program sponsored by NASA and supported by NSF, NOAA, and the Department of State. Learn more through this [GLOBE Program Overview](#).
- It's easy to join GLOBE as a trained educator or a citizen scientist. [Learn more about joining GLOBE](#).

Moon Trees

- Learn more about the original Moon Trees and the Apollo 14 mission on this [Moon Trees page](#).
- Read about the [next generation Moon Trees](#).

GLOBE DATA COLLECTION PROTOCOLS

Level	Protocol	Materials Needed	Time	NGSS Standards supported
All + Citizen Scientists	Tree Height Protocol : GLOBE Trees is an app-based tool that will help you estimate tree height. Watch the GLOBE Observer Trees Introduction Video (1 min).	GLOBE Observer App	15-20 minutes per observation	Many science practices are covered when engaging in GLOBE research.
	** Join the GLOBE Observer Moon Trees Quest 21 June to 21 September 2023 **			
All + Citizen Scientists	Land Cover Protocol : GLOBE Land Cover is an app-based tool that will help you document what is on the land (land cover). Watch the GLOBE Observer Introducing Land Cover Video (<1 min).	GLOBE Observer App	15-20 minutes per observation	Many science practices are covered when engaging in GLOBE research.

All	<p><u>Biometry Protocol:</u> Measure properties of vegetation and identify species in order to classify land cover using the MUC System.</p>	<ul style="list-style-type: none"> • Compasses • Flexible measuring tape (50 m) • Local plant field guide • MUC field guide • Small flexible measuring tapes • Tubular densiometer • Clinometer • Other materials needed depending on vegetation measured 	Variable, depending on type and number of measurements taken.	<p>3-LS4-4 5-ESS2-1 MS-LS2-4 MS-ESS3-3 HS-LS1-5 HS-LS2-1 HS-LS2-2 HS-LS4-3 HS-LS4-5 HS-ESS2-2 HS-ESS3-1 HS-ESS3-4 HS-ESS3-6</p> <p>Many science practices are also covered when engaging in GLOBE research.</p>
All	<p><u>Green-Down Protocol:</u> Monitor the change in color of selected leaves of trees, shrubs or grasses.</p>	<ul style="list-style-type: none"> • Green-down field guides • Data sheets or GLOBE Observer App • Flagging tape or ribbon • GLOBE Plant Color Guide or alternative • Fine tip permanent marker • Compass • Camera • Pencil 	15-30 minutes, twice a week through the fall	<p>2-LS4-1 5-ESS2-1 MS-LS1-1 MS-LS1-5 MS-LS1-6 MS-LS2-1 MS-LS2-4 HS-LS1-5</p> <p>Many science practices are also covered when engaging in GLOBE research.</p>

All	<p><u>Green-Up Protocol:</u> Monitor budburst and growth of leaves of selected trees, shrubs, or grasses.</p>	<ul style="list-style-type: none"> • Green-up field guides • Data sheets or GLOBE Observer App • Flagging tape or ribbon • Fine tip permanent marker • Metric ruler • Compass • Camera • Pencil 	20 minutes, twice a week through the spring	<p>2-LS4-1 5-ESS2-1 MS-LS1-1 MS-LS1-5 MS-LS1-6 MS-LS2-1 MS-LS2-4 HS-LS1-5</p> <p>Many science practices are also covered when engaging in GLOBE research.</p>
MS, HS	<p><u>Carbon Cycle Protocol:</u> Measure the biomass and carbon stored in vegetation (trees, shrubs, herbaceous). Extensive learning activities around systems thinking and the carbon cycle.</p>	<ul style="list-style-type: none"> • Compasses • Flexible measuring tape (30-50 m) • Local field guide • Small flexible measuring tapes (150-300 cm) • Other materials needed depending on vegetation measured 	Variable, depending on type and number of measurements taken.	<p>See the Carbon Cycle NGSS correlation matrix.</p>
All + Citizen Scientists	<p>Create a GLOBE Team. A GLOBE Team allows you to group all student and/or community GLOBE data together. Share your team's code with your community or on a sign at your tree so all can add to your GLOBE Moon Tree data! Learn more about setting up a GLOBE Team.</p>	NA	NA	NA

RESOURCES: PHENOLOGY

Level	Learning Activities [Source]	Materials Needed	Time	NGSS Standards supported
MS, HS	<p>Global Patterns in Green-Up and Green-Down [GLOBE] Students will analyze visualizations and graphs that show the annual cycle of plant growth and decline.</p>	<ul style="list-style-type: none"> • Worksheet • Color visualization pages • Scissors • Atlas or wall map 	Two 45-minute class periods	MS-LS1-2 MS-LS1-6 HS-LS1-2 HS-LS1-5 HS-ESS2-4
MS, HS	<p>Investigating Leaf Pigments [GLOBE] Students will conduct an experiment using paper chromatography to separate pigments present in leaves.</p>	Listed in activity	Two 45-minute class periods	MS-LS1-6 HS-LS1-2 HS-LS1-5
ELEM, MS	<p>A First Look at Phenology [GLOBE] Students will observe, compare, and classify plants during green-up or green-down and then make inferences based on the patterns they observe.</p>	<ul style="list-style-type: none"> • Hand lens • Science notebook or printed activity sheet • Flagging tape or ribbon • Plants 	2-3 class periods	2-LS4-1 MS-LS2-4

Upper ELEM/ MS	<p>Are You Red-dy to Change? [from the Natural Inquirer Investi-gator Student Science Journal] <i>Natural Inquirer</i> is a free science education journal produced by the USDA Forest Service, FIND Outdoors, and other cooperators and partners.</p> <p>**See this blog post by GLOBE guest blogger Eliza Balch on using this journal article with the “What Can We Learn About Our Seasons” activity and the Green-Down protocol.</p>	<ul style="list-style-type: none"> • Journal Article 	One class period	
All	<p>What Can We Learn About Our Seasons? [GLOBE] Students observe and record seasonal changes in their local study site.</p>	<ul style="list-style-type: none"> • Science notebooks • Markers • Glue • Large Sheets of Paper 	One class period each month	3-ESS2-1
Upper Elem, MS, HS	<p>Observing Annual Vegetation Changes [My NASA Data] Students observe monthly images of changing vegetation patterns, looking for seasonal changes occurring throughout 2017.</p>	<ul style="list-style-type: none"> • NDVI vegetation maps 	30 minutes	4-ESS2-2 MS-ESS2-1 MS-ESS2-6 MS-PS4-2 HS-ESS2-6 HS-PS4-4

RESOURCES: TREES AND LAND COVER

All	<p><u>Building Blocks A Demonstration of How Trees Grow</u>: A learning activity to explore how trees get so big and where they get the materials to grow from.</p>	<ul style="list-style-type: none"> • LEGO, Duplo, Base Ten or other blocks of equal size in three colors • Two pieces of paper or adhesive tape 	15 minutes	K-LS1-1 2-LS2-1 3-LS4-3 5-LS1-1 *Especially relevant 5-ESS2-1 MS-LS1-6 MS-LS2-3
All	<p><u>Telling Our Tree Stories</u>: A global collaborative project to share favorite trees from around planet Earth.</p>	<ul style="list-style-type: none"> • GLOBE Observer Tree Height and Land Cover Data for your area 	15 minutes	Science practice: Obtaining, evaluating, and communicating information
All	<p><u>Artemis Tree Moon Cards</u> [Natural Inquirer] This card set features information on the original Moon Trees and why they came to be, as well as information on the next generation of Artemis Moon Trees and how they came to be. Students can explore careers, tree types, NASA missions, rockets, and so much more!</p>	<p>Order a free set of cards or download content through the Natural Inquirer website linked to the left.</p>		

RESOURCES: ELEMENTARY GLOBE STORYBOOKS AND ACTIVITIES

ELEM	<u>The Scoop on Soils</u> : In the Soils module, a storybook helps students learn about the different components that make up soil, discover the basics of decomposition and understand why soil is important for plants and animals.	Listed for each activity	Varies depending on activity	2-LS4-1 Many science practices are also covered when engaging in the activities.
ELEM	<u>All About Earth - Our World on Stage</u> : In the Earth System module, a storybook helps students learn how all of Earth's processes are interconnected, and how living creatures interact with those processes.	Listed for each activity	Varies depending on activity	K-PS3-1 K-ESS2-1
ELEM	<u>The Mystery of the Missing Hummingbirds</u> : In the Seasons module, a storybook helps students learn about the environment's seasonal changes and in the module's learning activities, students observe how the local habitat's colors shift throughout the year, how to document these shifts, and describe why these changes affect local hummingbird populations.	Listed for each activity	Varies depending on activity	K-ESS2-1 2-LS4-1 3-ESS2-1 4-LS1-2