**Pedosphere**

**Grades K-2:** Soils are one of the Earth System’s essential natural resources, yet they are often taken for granted. In these activities, K**-**2 students will learn about the characteristics of the soil and how they interact with one another to support the Biosphere. Through participating in a series of GLOBE and NASA learning activities and protocols, students have the opportunity to engage in authentic science learning experiences with the Pedosphere.

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| **Performance Expectations Support:*** K-LS1-1, K-ESS2-2 Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.
* K-ESS3-1 Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live.
* 2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
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| **Science Practices:*** Asking Questions and Defining Problems:
* Developing and Using Models:
* Analyzing and Interpreting Data:
* Engaging in Argument from Evidence
* Obtaining, Evaluating, and Communicating Information:
 | **Disciplinary Core Idea:*** LS1.C: Organization for Matter and Energy Flow in Organisms
* ESS2.E: Biogeology
* ESS3.A: Natural Resources
* ESS3.C: Human Impacts on Earth Systems
 | **Crosscutting Concepts:*** Patterns
* Cause and Effect
* Systems and System Models
* Energy and Matter:
 |
| **GLOBE Application** |
| Pedosphere Protocols: [E-Training](https://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867724/12276)* Protocols begin for grades 3-5
* [Soil Protocols Introduction](https://www.globe.gov/documents/352961/8de1fc2a-dc4e-41c5-a5d9-985865b0d67f)

Data Investigation Sheets:* Data sheets associated with protocols begin for grades 3-5. Available through [Soil Protocols Introduction](https://www.globe.gov/documents/352961/8de1fc2a-dc4e-41c5-a5d9-985865b0d67f)

Elementary GLOBE Storybooks:* [It’s All About Earth](https://www.globe.gov/documents/348830/350113/ElementaryGLOBE_EarthSystems_en.pdf)
* [The Scoop on Soils](https://www.globe.gov/documents/348830/35487706/Soil%2BBook_FINAL2017.pdf/6b84e020-6215-41a5-82c7-dd9155efcdbf)
 | GLOBE Learning Activities: (Learning activities can be used to support concepts associated with the NGSS Performance Expectations.)* [Soil and My Backyard](https://www.globe.gov/documents/352961/5c5f7bfe-f98f-4aec-b554-539809a98725) (2-PS1-1)
* [Soil Treasure Hunt](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity2_en.pdf/af7f6b29-6fdb-4b08-a9ba-d6f9ea5bcbe5) (2-PS1-)
* [We All Need Soil!](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity3_en.pdf/3041408c-15e9-4274-a27a-63368afd320c) (K-LS1-1, K-ESS2-2)
* [From Mud Pies to Bricks](https://www.globe.gov/documents/352961/a542e33d-e06e-4baf-9b83-dd84df9bae9e) (2-PS1-1, K-LS1-A, K-ESS2-2, K-ESS3-1)
* [Earth System Play](https://www.globe.gov/documents/348830/350113/ElementaryGLOBE_EarthSystemsActivity3_en.pdf) (K-PS2-1)
* [Why do We Study Soil?](https://www.globe.gov/documents/352961/2392e756-b89f-48ed-90ce-5f1440ab2d75) (K-ESS3-1, 2-PS1-1)
* [Getting to Know the Soil](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity1_en.pdf/97fdde91-e41a-4f31-9116-cbb049c6e743) (2-PS1-1)

 [We All Need Soil](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity3_en.pdf/3041408c-15e9-4274-a27a-63368afd320c) (K-LS1-1, K-ESS2-2, K-ESS3-1, 2-PS1-1) | **Guiding Question(s):**1. What is soil? What is it made of?
2. How does Earth’s surface change from place to place?
3. Why is soil important?
4. What role does soil play in our big Earth?

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| **NASA Resources** |
| **Extension Learning Activities:*** [**Earth Systems Connections:** Compost Bucket](https://www.americangeosciences.org/sites/default/files/education-nasatriad-CompostBucketk-2.pdf)
* [**Earth Systems Connections**: Hold On Tight, K2](https://www.americangeosciences.org/sites/default/files/education-nasatriad-HoldonTightK-2.pdf)
* [**Earth Systems Connections:** Playground Pounding](https://www.americangeosciences.org/sites/default/files/education-nasatriad-PlaygroundPoundingK-4.pdf)
* [**ESSEA K-4 Climate: Land:** The Dirt on Dirt and Climate](https://esseacourses.strategies.org/dirt_climate.pdf)
* **[NASA Moon Munchies:](https://www.nasa.gov/pdf/326862main_Moon_Munchies_Lesson_1.pdf)** [Natural Resources on Earth](https://www.nasa.gov/pdf/326862main_Moon_Munchies_Lesson_1.pdf)
 | **My NASA Data Visualization Tool:*** [Earth System Data Explorer](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* [Tutorials](https://mynasadata.larc.nasa.gov/basic-page/tutorials)

**My NASA Data Science Variable Suggestions:****Soil Moisture:** [Monthly Mean Soil Moisture (millimeters)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)**Soil Temperature:*** [Daytime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_A-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)
* [Nighttime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_D-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)

**Land Cover Classification:**Surface Scene Type/[Soil Characterization](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=A0DB27025C92201EE0CF405A32D63119;xDSID=soil_char;varid=SCENE_TYPE-id-5a5ba6b6a6;imageSize=auto;over=x;compute=Nonetoken;tlo=01-Feb-2006%2000:00;thi=01-Feb-2006%2000:00;catid=A0DB27025C9220) | **My NASA Data Lessons/Activities:***Not supported at this grade level band.***Multimedia Links:*** [NASA's Earth Minute: Dishing the Dirt](https://www.youtube.com/watch?v=hgsIFyITvJE&feature=youtu.be)
* [NASA eClips Our World: What is Soil?](https://nasaeclips.arc.nasa.gov/video/ourworld/our-world-what-is-soil)
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**Pedosphere**

**Grades 3-5:** Building on concepts developed in grades K-2 that focused on general soil characteristics and their relationship to the Biosphere, students in grades 3-5 examine these characteristics and make inferences about how the interactions among the spheres of the Earth System affect each other. By incorporating GLOBE and My NASA Data in the classroom, educators provide students with the ability to collect data and access satellite data to answer their own questions related to Earth System interactions that affect the soil where they live.

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| **Performance Expectations Support:*** 5-LS1-1 From Molecules to Organisms: Structures and Processes Support an argument that plants get the materials they need for growth chiefly from air and water.
* 5-LS2-1 Ecosystems: Interactions, Energy, and Dynamics Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
* 5-ESS2-1 Earth's Systems Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
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| **Science Practices:*** Asking Questions and Defining Problems
* Developing and Using Models
* Analyzing and Interpreting Data
* Engaging in Argument from Evidence
* Obtaining, Evaluating, and Communicating Information
 | **Disciplinary Core Idea:*** LS2.A Independent Relationships in Ecosystems
* LS2.B Cycles of Matter and Energy Transfer in EcosystemsESS2.A Earth Materials and Systems
 | **Crosscutting Concepts:*** Patterns
* Cause and Effect
* Systems and System Models
* Energy and Matter
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| **GLOBE Application** |
| **Pedosphere Protocols**: [Introduction](https://www.globe.gov/documents/352961/8de1fc2a-dc4e-41c5-a5d9-985865b0d67f) and [E-Training](https://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867724/12276)* [Soil Temperature](https://www.globe.gov/documents/352961/87a3491a-25af-4123-9e0c-08f341bfc004)
* [Soil Moisture - SMAP Block Pattern](https://www.globe.gov/documents/352961/bd487244-d864-41bd-965a-61743033c29b)
* [Soil pH](https://www.globe.gov/documents/352961/782a668b-cecb-4801-ad80-db32a701eb58)
* [Frost Tube](https://www.globe.gov/documents/352961/5c9a552a-0677-48f0-ae4b-4cc0f8ba8f12)
* [Soil Characterization](https://www.globe.gov/documents/352961/e5d46e27-2ac0-4a34-8fbf-7a871c66a4be)

**Data Investigation Sheets:*** [Soil Temperature Data Sheet](https://www.globe.gov/documents/352961/d17e6192-3631-4f2b-94d8-fcff6b96f308)
* [Soil Moisture - SMAP Block Pattern Data Sheet](https://www.globe.gov/documents/352961/e6f48ee9-1ede-4227-a115-7df9ab8d8aa4)
* [Frost Tube - Data Sheet](https://www.globe.gov/documents/352961/353271/Frost%2BTube%2BData%2BSheet/1dd8f14f-1d9c-4236-924b-d949276ebc67)
* [Soil pH Data Sheet](https://www.globe.gov/documents/352961/674e3c9a-7f05-4fcd-96f9-96d030cc8f85)

**Elementary GLOBE Storybooks:*** [It’s All About Earth](https://www.globe.gov/documents/348830/350113/ElementaryGLOBE_EarthSystems_en.pdf)
* [The Scoop on Soils](https://www.globe.gov/documents/348830/35487706/Soil%2BBook_FINAL2017.pdf/6b84e020-6215-41a5-82c7-dd9155efcdbf)
 | **GLOBE Learning Activities**: (Activities can be used to support the development of the NGSS performance expectations.)* [Why do We Study Soil?](https://www.globe.gov/documents/352961/2392e756-b89f-48ed-90ce-5f1440ab2d75) (5-ESS2-1)
* [Soil: The Great Decomposer](https://www.globe.gov/documents/352961/821adf05-2b82-4548-92e2-9469b6b7b76b) (5-LS2-1)
* [Getting to Know the Soil](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity1_en.pdf/97fdde91-e41a-4f31-9116-cbb049c6e743) (5-LS2-1, 5-ESS2-1)
* [Just Passing Through Beginner Version](https://www.globe.gov/documents/352961/c5712e79-6e0b-4f71-9aa8-5b9a075775ef) (5-ESS2-1)
* [Earth System in a Bottle](https://www.globe.gov/documents/348830/350113/ElementaryGLOBE_EarthSystemsActivity1_en.pdf) (5-ESS2-1)
* [We All Need Soil](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity3_en.pdf/3041408c-15e9-4274-a27a-63368afd320c) (5-LS1-1, 5-LS2-1, 5-ESS2-1)
* [Soil and My Backyard](https://www.globe.gov/documents/352961/5c5f7bfe-f98f-4aec-b554-539809a98725) (5-ESS2-1)
* [Soil Treasure Hunt](https://www.globe.gov/documents/348830/351088/ElementaryGLOBE_SoilActivity2_en.pdf/af7f6b29-6fdb-4b08-a9ba-d6f9ea5bcbe5) (5-ESS2-1)
* [From Mud Pies to Bricks](https://www.globe.gov/documents/352961/a542e33d-e06e-4baf-9b83-dd84df9bae9e) (5-ESS2-1)
 | **Guiding Question(s):**1. What is soil’s role in decomposition?
2. What role does soil play in the Earth system?
3. How is matter moved in and out of soil?
4. How do living things rely on soil?
 |
| **NASA Resources** |
| **NASA Learning Activities:*** [Earth Systems Connections: Plants to Soil](https://www.americangeosciences.org/sites/default/files/education-nasatriad-PlantstoSoil2-4.pdf)
* [Earth Systems Connections: Hold on Tight, 2-4](https://www.americangeosciences.org/sites/default/files/education-nasatriad-HoldonTight2-4.pdf)
* [Earth Systems Connections:](https://www.americangeosciences.org/sites/default/files/education-nasatriad-PlaygroundPoundingK-4.pdf) [Playground Pounding](https://www.americangeosciences.org/sites/default/files/education-nasatriad-PlaygroundPoundingK-4.pdf)
* [ESSEA K-4 Climate: Land: The Dirt on Dirt and Climate](https://esseacourses.strategies.org/dirt_climate.pdf)
* [NASA Moon Munchies: Natural Resources on Earth](https://www.nasa.gov/pdf/326862main_Moon_Munchies_Lesson_1.pdf)
* [Create Your Own Soil Profile Activity](https://mynasadata.larc.nasa.gov/lesson-plans/create-your-own-soil-profile-activity) Grades​​​​​​​ 3-8​​​​​​​
* [NASA’s Our World: Dirt](https://nasaeclips.arc.nasa.gov/teachertoolbox/download/58)
 | **My NASA Data Visualization Tool:*** [Earth System Data Explorer](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* [Tutorials](https://mynasadata.larc.nasa.gov/basic-page/tutorials)

**My NASA Data Science Variable Suggestions:*** Soil Moisture: [Monthly Mean Soil Moisture (millimeters)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* Soil Temperature:
* [Daytime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_A-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)
* [Nighttime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_D-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)
* Land Cover Classification:
* Surface Scene Type/[Soil Characterization](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=A0DB27025C92201EE0CF405A32D63119;xDSID=soil_char;varid=SCENE_TYPE-id-5a5ba6b6a6;imageSize=auto;over=x;compute=Nonetoken;tlo=01-Feb-2006%2000:00;thi=01-Feb-2006%2000:00;catid=A0DB27025C9220)
 | **My NASA Data Lessons/Activities:** * [Data Literacy Cube: Intermediate Graph Data using Soil Moisture Data](https://mynasadata.larc.nasa.gov/lesson-plans/data-literacy-cube-intermediate-graph-data-using-soil-moisture-data), Grades 3-8

**Multimedia Links:*** [NASA's Earth Minute: Dishing the Dirt](https://youtu.be/hgsIFyITvJE)
* [NASA eClips Our World: What is Soil?](https://youtu.be/5TIebXYgQ80)
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**Pedosphere**

**Grades 6-8:** Building on concepts developed in grades 3-5 that examined soil characteristics and its interactions among the spheres of the Earth System, students will explore the role of soil in the transfer of matter and energy in the Earth system and its effects over time. By incorporating GLOBE and My NASA Data, educators provide students with the ability to collect data and access satellite data to answer their own questions related to Earth System interactions that affect soil in their communities.

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| **Performance Expectations Supported:*** MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
* MS-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at various time and spatial scales.
* MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distribution of Earth's’ mineral, energy, and groundwater resources are the result of past and current geoscience processes.
* MS-PS3-4: Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.
 |
| **Science Practices:*** Asking Questions and Defining Problems
* Developing and Using Models
* Analyzing and Interpreting Data
 | **Disciplinary Core Idea:*** LS2.B Cycles of Matter and Energy Transfer in Ecosystems
* ESS2.A Earth’s Materials and Systems
* ESS3.A Earth’s Materials and Systems
* PS3.B Conservation of Energy and Energy Transfer
 | **Crosscutting Concepts:*** Patterns
* Cause and Effect
* Systems and System Models
 |
| **GLOBE Application** |
| **Pedosphere Protocols**: [Introduction](https://www.globe.gov/documents/352961/8de1fc2a-dc4e-41c5-a5d9-985865b0d67f) and [E-Training](https://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867724/12276)* [Bulk Density](https://www.globe.gov/documents/352961/5b9110c4-e026-4ad1-914d-237e1219fb40)
* [Soil Moisture - SMAP Block Pattern](https://www.globe.gov/documents/352961/bd487244-d864-41bd-965a-61743033c29b)
* [Soil Infiltration](https://www.globe.gov/documents/352961/41672784-81d0-4189-81f4-280acaa3364d)
* [Frost Tube](https://www.globe.gov/documents/352961/5c9a552a-0677-48f0-ae4b-4cc0f8ba8f12)
* [Soil Characterization](https://www.globe.gov/documents/352961/e5d46e27-2ac0-4a34-8fbf-7a871c66a4be)

**Data Investigation Sheets:*** [Bulk Density Data Sheet](https://www.globe.gov/documents/352961/d759b444-cdfa-4123-a78f-b92b82dfa4ab)
* [Soil Moisture - SMAP Block Pattern Data Sheet](https://www.globe.gov/documents/352961/e6f48ee9-1ede-4227-a115-7df9ab8d8aa4)
* [Soil Infiltration Data Sheet](https://www.globe.gov/documents/352961/d55ccdb4-3c6d-40bc-803a-9c855ba064e6)
 | **GLOBE Learning Activities:** (Learning activities can be used to support performance expectations * [A Field View of Soil - Digging Around](https://www.globe.gov/documents/352961/a744ce39-0be0-4e30-999b-ad2fb8b0be94) (MS-ESS3-1)
* [Making a Contour Map](https://www.globe.gov/documents/348614/7becec5e-4638-4cd7-b76f-8deb9290bbf3) (MS-ESS3-1)
* [Soil Makers](https://www.globe.gov/documents/352961/c801c8d8-e4a8-4b0d-ae83-4b650349dae6) (MS-ESS2-2, MS-ESS3-A)
* [Soils as Sponges: How Much Water Does Soil Hold?](https://www.globe.gov/documents/352961/e4a90c9f-2a5a-43ef-b7b6-108ec4a06e76) (MS-ESS2-2, MS-ESS3-1)
* [Just Passing Through](https://www.globe.gov/documents/352961/353899/Just%2BPassing%2BThrough/06f90bc2-1e4e-4830-b36d-dba1e170914e) (MS-ESS2-2)
* [Land, Water, and Air](https://www.globe.gov/documents/348614/15c96d8c-507c-4097-98d7-73d8f555dd03) (MS-PS3-4)
* [Soil: The Great Decomposer](https://www.globe.gov/documents/352961/821adf05-2b82-4548-92e2-9469b6b7b76b) (MS-LS2-3)
 | Guiding Question(s): How does soil change over space and time?1. How is matter moved in and out of soil?
2. What role does soil play in the Earth system?
3. How are soil and decomposition?
4. How do living things rely on soil?
 |
| **NASA Resources** |
| **NASA Learning Activities:*** [Soil Moisture - Dirt to Dinner](https://smap.jpl.nasa.gov/system/internal_resources/details/original/250_Soil_Moisture_Dirt_to_Dinner_3.5.14.pdf), Grades 6-8
* [Water in the Geosphere](http://pmm.nasa.gov/education/lesson-plans/water-earths-geosphere), Grades 6-8
* [Freeze/Thaw - The Breathing Boreal Forest](http://smap.jpl.nasa.gov/files/smap2/Freeze-Thaw-The-Breathing-Boreal-Forest-201403051.pdf), Grades 6-8
* [Draw Your Own Visualization Learning Activity](http://www.globe.gov/documents/348614/ea1af5aa-1082-4014-a287-f44ddea270e7)

**My NASA Data: STEM Career Connections*** [SCIENCE: Soil Scientist](https://mynasadata.larc.nasa.gov/stem-career-connections/science-soil-scientist)
* [TECHNOLOGY: Soil Conservation Technician](https://mynasadata.larc.nasa.gov/stem-career-connections/technology-soil-conservation-technician)
* [ENGINEERING: Geotechnical Engineer](https://mynasadata.larc.nasa.gov/stem-career-connections/engineering-geotechnical-engineer)
* [MATHEMATICS: Mathematical Modeler](https://mynasadata.larc.nasa.gov/stem-career-connections/mathematics-mathematical-modeler)
 | **My NASA Data Visualization Tool:*** [Earth System Data Explorer](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* [Tutorials](https://mynasadata.larc.nasa.gov/basic-page/tutorials)

**My NASA Data Science Variable Suggestions:*** Soil Moisture: [Monthly Mean Soil Moisture (millimeters)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* Soil Temperature:
* [Daytime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_A-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)
* [Nighttime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_D-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)
* Land Cover Classification: Surface Scene Type/[Soil Characterization](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=A0DB27025C92201EE0CF405A32D63119;xDSID=soil_char;varid=SCENE_TYPE-id-5a5ba6b6a6;imageSize=auto;over=x;compute=Nonetoken;tlo=01-Feb-2006%2000:00;thi=01-Feb-2006%2000:00;catid=A0DB27025C9220)
 | **My NASA Data Lessons/Activities:** * [Data Literacy Cube: Intermediate Graph Data using Soil Moisture Data](https://mynasadata.larc.nasa.gov/lesson-plans/data-literacy-cube-intermediate-graph-data-using-soil-moisture-data), Grades 3-8
* [Behavior Over Time: Analyzing Seasonal Soil and Air Properties](https://mynasadata.larc.nasa.gov/lesson-plans/behavior-over-time-analyzing-seasonal-soil-and-air-properties), Grades 6-12

**Multimedia Links:*** [NASA's Earth Minute: Dishing the Dirt](https://youtu.be/hgsIFyITvJE)
* [NASA’s eClips Real World: What Is Soil Moisture?](https://youtu.be/aJ3KaDJ9chM)
 |

**Pedosphere**

**Grades 9-12**: Building on concepts developed in grades 6-8 that explored the role of soil in the transfer of matter and energy in the Earth system and its short and long-term effects, students will explain the role of soil in the carbon cycle and use evidence to support conclusions. By incorporating GLOBE and My NASA Data, educators provide students with the ability to collect data and access satellite data to answer their own questions related to Earth System interactions that affect local soils.

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| **Performance Expectations Supported:*** 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.
* HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
 |
| **Science Practices:*** Asking Questions and Defining Problems
* Developing and Using Models
* Analyzing and Interpreting Data
 | **Disciplinary Core Idea:*** ESS2.A Earth Materials and Systems
* ESS2.D Weather and Climate
* ESS2.D Weather and Climate
 | **Crosscutting Concepts:*** Patterns
* Cause and Effect
* Systems and System Models
 |
| GLOBE Application |
| **Pedosphere Protocols**: [Introduction](https://www.globe.gov/documents/352961/8de1fc2a-dc4e-41c5-a5d9-985865b0d67f) and [E-Training](https://www.globe.gov/get-trained/protocol-etraining/etraining-modules/16867724/12276)* [Soil Moisture - SMAP Block Pattern](https://www.globe.gov/documents/352961/bd487244-d864-41bd-965a-61743033c29b)
* [Soil Characterization](https://www.globe.gov/documents/352961/e5d46e27-2ac0-4a34-8fbf-7a871c66a4be)
* [Soil Fertility](https://www.globe.gov/documents/352961/5d7d7dab-3bc5-4424-9354-f395b928d151)
* [Soil Particle Density](https://www.globe.gov/documents/352961/08b00ef4-5344-4c7c-85ff-b840b291e309)
* [Soil Particle Size Distribution](https://www.globe.gov/documents/352961/1a98284f-d4f0-4827-a746-4c4162e680d6)

**Data Investigation Sheets:*** [Soil Moisture - SMAP Block Pattern Data Sheet](https://www.globe.gov/documents/352961/e6f48ee9-1ede-4227-a115-7df9ab8d8aa4)
* [Soil Fertility Data Sheet](https://www.globe.gov/documents/352961/561e69a5-70f9-41af-804a-d07bf86dd895)
* [Soil Particle Density Data Sheet](https://www.globe.gov/documents/352961/6588fef2-7084-46a7-9531-2031f3cc193c)
* [Soil Particle Size and Distribution Data Sheet](https://www.globe.gov/documents/352961/f71f3439-9f48-4c49-bd5a-9c367639177c)
 | **GLOBE Learning Activities**: (Learning activities can be used to support the NGSS Performance Expectations.)* [Using Graphs to Show Connections](https://www.globe.gov/documents/356823/bd27e34c-cbd9-48a9-b4c9-d72cd8b93e64) (HS-ESS2-2)
* [GLOBE Carbon Cycle Introductory Activities Flowchart](https://www.globe.gov/documents/355050/b9afed93-44b6-4692-869f-a061b75c5a25) (HS-ESS2-6)
* [Paper Clip Simulation A Simple System](https://www.globe.gov/documents/355050/7da1ef2a-28eb-43e6-b6ee-e6af26a401f3) (HS-ESS2-6)
* [Carbon Cycle Adventure Story](https://www.globe.gov/documents/355050/8cf263cb-436c-4e29-851f-678a6cfb6b2d) (HS-ESS2-6)
* [Getting to Know Global Carbon](https://www.globe.gov/documents/355050/e4d3c5de-f6d3-43eb-af48-095c32009ad6) (HS-ESS2-6)
* [Land, Water, and Air](https://www.globe.gov/documents/348614/15c96d8c-507c-4097-98d7-73d8f555dd03) (HS-ESS2-2)
 | **Guiding Question(s):**1. What role does soil play in the carbon cycle?
2. What effect does soil have on Earth’s energy budget?
3. How are soils and humans inextricably interconnected?
 |
| **NASA Resources** |
| **NASA Learning Activities:*** [GLOBE Learning Activity: The Data Game](https://www.globe.gov/documents/352961/353899/The%2BData%2BGame/5a184b04-9ac0-4284-be86-f5938bd43a6f)
* [GLOBE Learning Activity: Land, Water, and Air](https://www.globe.gov/documents/348614/15c96d8c-507c-4097-98d7-73d8f555dd03)
* [NASA’s Soil Moisture Quiz](https://mynasadata.larc.nasa.gov/lesson-plans/soil-moisture-quiz)

**My NASA Data: STEM Career Connections*** [SCIENCE: Soil Scientist](https://mynasadata.larc.nasa.gov/stem-career-connections/science-soil-scientist)
* [TECHNOLOGY: Soil Conservation Technician](https://mynasadata.larc.nasa.gov/stem-career-connections/technology-soil-conservation-technician)
* [ENGINEERING: Geotechnical Engineer](https://mynasadata.larc.nasa.gov/stem-career-connections/engineering-geotechnical-engineer)
* [MATHEMATICS: Mathematical Modeler](https://mynasadata.larc.nasa.gov/stem-career-connections/mathematics-mathematical-modeler)
 | **My NASA Data Visualization Tool:*** [Earth System Data Explorer](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;globalMin=0;globalMax=750.4146;xCATID=06ECF098DFA28B37C38B9EA28DCB9B88;xDSID=soil_moisture;varid=soilw-id-70637cbe91;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Jan-2018%2000:00;thi=01-Jan-20)
* [Tutorials](https://mynasadata.larc.nasa.gov/basic-page/tutorials)

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* [Nighttime Skin Temperature (degrees Celsius)](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=0A456C6EE1BEE5AC8A2D7BD0386C1A1F;xDSID=skinTemp;varid=SurfSkinTemp_D-id-4c24211c9a;imageSize=auto;over=xy;compute=Nonetoken;tlo=01-Sep-2002%2000:00;thi=01-Sep-2002%2000:00;catid=0A456C6EE1)

Atmospheric Chemistry: * [Monthly Air Column Concentration of CO](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=5B8A29C97BEF6F08F2DA85F2361ABBD5;xDSID=atmospheric_chem;varid=CO_Total_Column_Day-id-4d7187485c;imageSize=auto;over=xy;compute=Nonetoken;tlo=15-Mar-2000%2000:00;thi=15-Mar-2000%2000:00;catid=5B8A29C97BEF6F08F2DA85F2361ABBD5;dsid=atmospheric_chem;varid=CO_Total_Column_Day-id-4d7187485c;avarcount=0;xlo=-180;xhi=180;ylo=-90;yhi=90;operation_id=Plot_2D_XY_zoom;view=xy)
* [Monthly Concentration of CO2 in Troposphere](https://mynasadata-las.larc.nasa.gov/EarthSystemLAS/UI.vm#panelHeaderHidden=false;differences=false;autoContour=false;xCATID=5B8A29C97BEF6F08F2DA85F2361ABBD5;xDSID=atmospheric_chem;varid=carbon_dioxide_in_free_troposphere;imageSize=auto;over=xy;compute=Nonetoken;tlo=15-Sep-2002%2000:00;thi=15-Sep-2002%2000:00;catid=5B8A29C97BEF6F08F2DA85F2361ABBD5;dsid=atmospheric_chem;varid=carbon_dioxide_in_free_troposphere;avarcount=0;xlo=-181.25;xhi=178.75;ylo=-90;yhi=90;operation_id=Plot_2D_XY_zoom;view=xy)
 | **My NASA Data Lessons/Activities:** * [Data Literacy Cube: Intermediate Graph Data using Soil Moisture Data](https://mynasadata.larc.nasa.gov/lesson-plans/data-literacy-cube-intermediate-graph-data-using-soil-moisture-data)
* [Behavior Over Time: Analyzing Seasonal Soil and Air Properties](https://mynasadata.larc.nasa.gov/lesson-plans/behavior-over-time-analyzing-seasonal-soil-and-air-properties)

**Multimedia Links:*** [NASA The Carbon Cycle](http://svs.gsfc.nasa.gov/10494)
* [Climate Time Machine - NASA Climate Change](https://climate.nasa.gov/interactives/climate-time-machine)
* [NASA’s eClips Launchpad: What is Soil Moisture?](https://nasaeclips.arc.nasa.gov/video/realworld/real-world-what-is-soil-moisture)
* [NASA's Earth Minute: Dishing the Dirt](https://youtu.be/hgsIFyITvJE)
* [NASA's SMAP: Mapping the Water Under Our Feet](https://www.youtube.com/watch?v=GCBBEbKVwm4)
* [NASA’s Eyes on the Earth: Vital Signs of the Planet](https://pmm.nasa.gov/education/interactive/eyes-earth-vital-signs-planet)
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