Name_____

DATA Nugget

Going underground to investigate carbon locked in soils

Featured scientist: Ashley Lang from Indiana University

Research Background:

Soil is an important part of the carbon cycle because it traps carbon, keeping it out of the atmosphere and locked underground. At a global level, the amount of carbon stored by soil is more than is found in all of the plants and the atmosphere combined. Carbon trapped underground does not contribute to the rising carbon dioxide concentration in our atmosphere that leads to climate change. For decades, scientists have been researching how much carbon our soils can store to understand its role in slowing the pace of climate change.

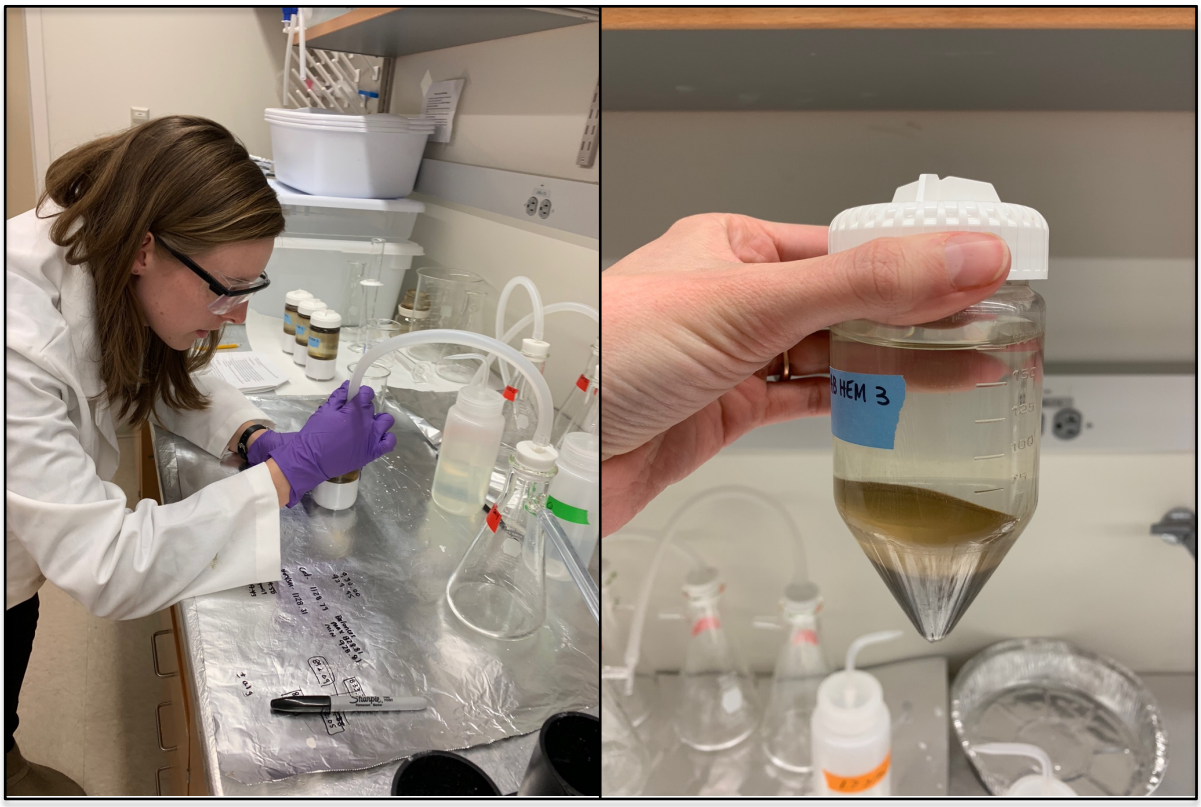
Carbon enters the soil when plants and animals die, and their organic matter is decomposed by soil bacteria and fungi. Sometimes it is broken down into very small molecules. These molecules become attached to minerals in the soil, like clay particles. We call this **mineral-associated organic matter (MAOM)**. The carbon is connected to minerals with very strong chemical bonds. Because these bonds are hard to break, the carbon stays in the soil for long periods of time and accumulates on clay minerals.

Some studies have shown that the carbon in MAOM can be trapped in soils for thousands of years! When more of the carbon in the soil is attached to minerals and locked in the soil for longer time periods, the ecosystem is serving an important role in keeping carbon out of the atmosphere.

Ashley is working to understand how much stable carbon there is in soils, and the role of climate. Microbes work faster in warmer and wetter conditions, which results in quicker decomposition. Ashley thought this rapid decomposition would cause organic matter to be broken down into smaller particles sooner. Therefore, she thought that in warmer or wetter environments, more soil carbon would attach to minerals and become stable MAOM. In colder or drier environments, she expected this process to happen more slowly, leading to a smaller amount of MAOM in the soil.

To test these ideas, Ashley used soil samples from forests with different climates throughout the Eastern United States. Soil samples were collected from New Hampshire to Alabama by teams of researchers using the same sampling protocol. The samples were mailed to Ashley's lab at Indiana University for analysis. Ashley measured the amount of MAOM in each soil sample by taking advantage of a key feature: MOAM is heavy! Ashley submerged each soil sample in a saltwater solution,

and the parts that floated were discarded, while the parts that sunk to the bottom were classified as MAOM. She then rinsed the salt off and measured the amount of carbon in the MAOM with an instrument called an elemental analyzer. She compared this number to the amount of carbon in the whole soil sample to calculate what percentage of the total soil carbon was attached to minerals.



(Left) Ashley in the lab, using a saltwater solution to isolate mineral-associated organic matter (MAOM) from soil samples. (Right) MAOM at the bottom of a test tube in a salt solution.

Scientific Question: How does an ecosystem's climate affect the percentage of soil carbon stored as mineral-associated organic matter (MAOM)?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

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Scientific Data:

Use the data below to answer the scientific question:

Site	Mean Annual Temperature (C)	Mean Annual Precipitation (mm)	Mean Percent of Carbon in MAOM	Standard Deviation (Mean Percent of Carbon in MAOM)
New Hampshire	6.2	1325	76.7	8.1
Alabama 1	17.6	1372	83.2	3.5
Alabama 2	18.1	1386	85.2	5.8
Massachusetts	7.4	1199	77.7	6.6
Tennessee	14.4	1340	77.2	9.5
Maryland	13.6	1075	84.3	7.1
Wisconsin	4.8	797	78.6	9.4

**Standard deviation (SD) tells us about the amount of variation in the data. A large SD means there is a lot of variation around the mean, while a small SD means the data points all fall very close to the mean.*

What data will you graph to answer the question?

Independent variable(s): _____

_____

Dependent variable(s): _____

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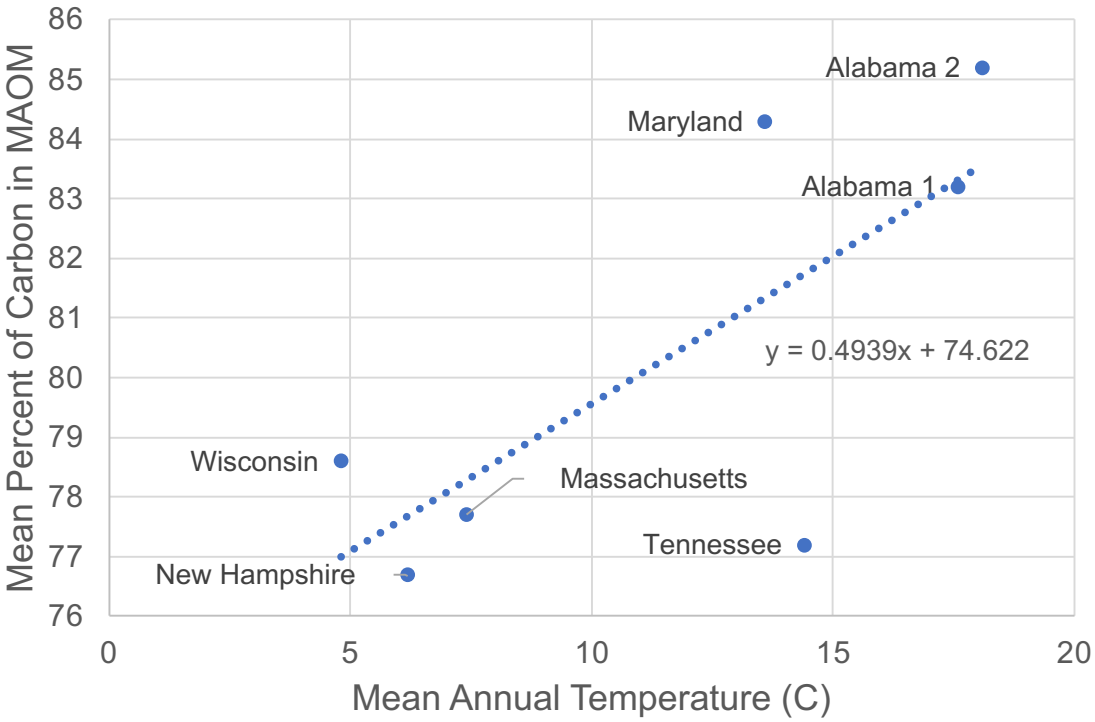
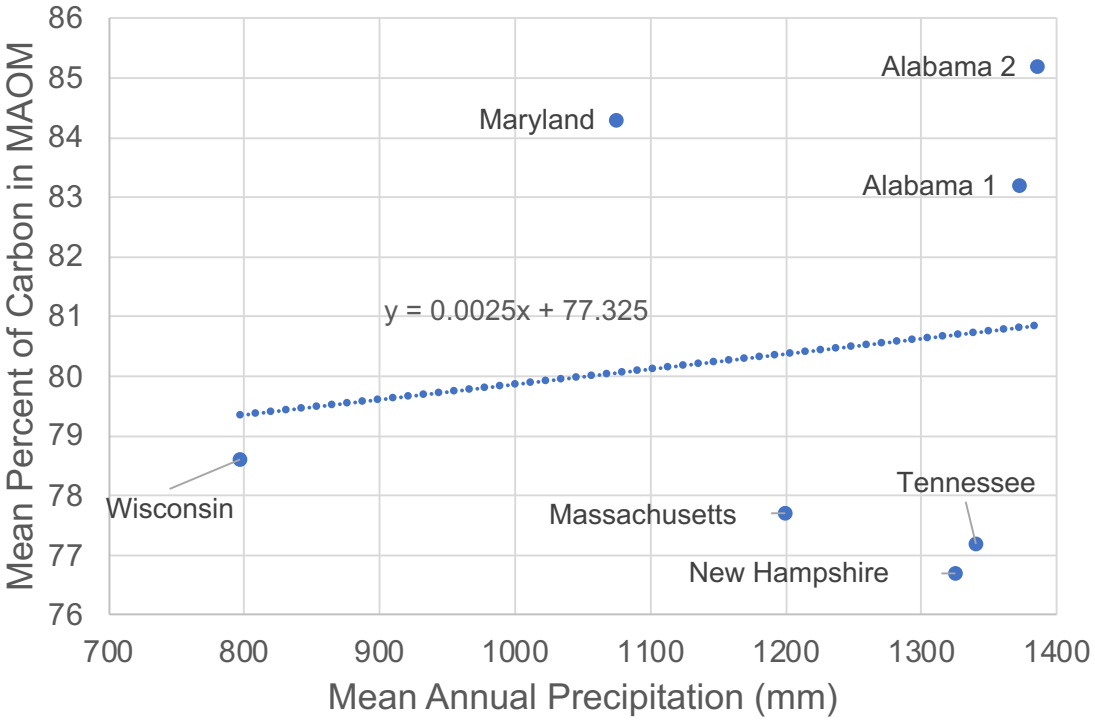
Name_____

Below are graphs of the data: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.





Name_____

Interpret the data:

Make a claim that answers the scientific question, how does an ecosystem's climate affect the proportion of the total soil carbon stored as mineral-associated organic matter (MAOM)?

What evidence was used to write your claim? Reference specific parts of the table or graph(s).

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the role of soil in the carbon cycle.

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Your next steps as a scientist:

Science is an ongoing process. What new question(s) should be investigated to build on Ashley's research? How do your questions build on the research that has already been done?

What future data should be collected to answer your question?

Independent variable(s): _____

Dependent variable(s): _____

For each variable, explain why you included it and how it could be measured.

What hypothesis are you testing in your experiment? A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.