Thinking Like A Kid

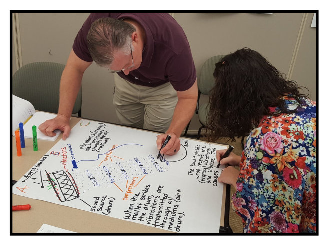
In some activities, we ask you to participate in "student hat" — engaging in the activities by thinking as your students would think. This can feel strange, and you may be wondering why we don't just describe how students do these activities and then examine classroom video and student work. Here's why.

A focus on the students' perspective: A key shift in NGSS storylines is that science work should be *coherent from the students' perspective*. Students should always see the work they are doing as a way to make progress on the questions and problems that their class has identified. Too often in science classrooms, the curriculum authors and teacher know why the next activity is coming, but students are left to figure it out after the fact, if they ever figure it out at all.

In storylines, teachers work with students to figure out *together* what the class needs to work on, and how to go about it. *Together* they reflect on progress and figure out where to go next. Of course the teacher has a guiding idea of where to go — the storyline is a planned trajectory. But by involving students as partners in reflection and planning, students see how today's data collection, analysis, or modeling will help the class make progress on the goals they have established.

How will thinking like a kid help? To do this joint navigation work, you need to work with students' ideas. Anticipating your students' ideas and questions will help you figure out what makes sense to them and how you can work with their ideas to help them develop the target science ideas. To plan your discussions, you need to put yourself in the mindset of your students.

- When your students experience a phenomenon, what ideas will they draw on to explain it? What will they wonder about?
- What kinds of experiences might they bring up to connect to the phenomena they are investigating?
- What kinds of prompts could you give to push them to dig deeper into the parts you want them to notice?
- What will they be able to figure out from investigating the phenomena in the unit so far? How would they model this?



If we jump ahead to our knowledge as adults, we might overlook steps that will be important to our students. What is a logical next step to us, since we *know* the end game already, may not seem logical to students. Put yourself in the heads of your students so you can anticipate what they will see as puzzling and what ideas they might have. Then you can orchestrate the conversations to help students develop questions and ideas that will be productive for the storyline goals.

So in these activities, we will ask you to channel your inner student. Don't worry about getting the science right at first — your group will build these ideas over time as they engage with phenomena. Resist the urge to use your college-level knowledge to explain to others. Let the group struggle with the ideas as your students might. Resist the urge to label the phenomenon with the right science words — we are trying to develop step by step explanations, not just know that the process is called photosynthesis, sublimation, or endothermic reaction. Storylines require taking the learning step by step — let's practice doing that.

By Cindy Workosky
Posted on 2018-08-14

Share Start a Discussion

Recently, my colleagues and I had an exchange with some teachers in one of our professional development programs. One teacher said, "I think I do a lot of modeling in my class. I have my kids draw pictures of the science ideas they are learning all the time."

This description of modeling is common. When we ask our colleagues, either informally or in professional development settings, about their current teaching and the practice of developing and using models, they often respond that they consider models as things like 3-D replicas or drawings. They say, "I have my kids make models of cells, the solar system, the water cycle, atoms, and so on."

This type of "modeling" activity might sound promising, but it often doesn't fully realize the potential of the modeling practice. It's not surprising, though, that this conception of modeling is so pervasive because much of the available information on modeling focuses on drawing as a way to bring kids into this practice. In our experience with modeling, we've found that a depiction—usually a drawing—focuses our attention on a surface feature of the practice and not on the deeper knowledge-building potential.
For example, teachers might typically ask students to draw a model of the pond ecosystem, or draw a model of the forces acting on a ball as it rolls down a ramp. But without a clear purpose, students might be confused about how they should interpret these tasks and can't properly judge their ideas, leaving them to appeal to the teacher or textbook as authority. "Is this right?" is what most students will inevitably ask.
In contrast, when a class can work together to examine a phenomenon or class of phenomena *and* specify questions they want to answer, the aim is clear, and students can decide if the model is effective by asking, "Does this help us answer our questions in ways that makes sense?"

We believe that viewing modeling as a means to an end is a useful way to think about the practice. Models are not the end products or learning targets in themselves, but they allow us to achieve our explanatory goals. Models help us make sense of a phenomenon in a systematic way and explain what is happening. They are used *for* an explanatory purpose.

Two of us wrote an academic paper about this idea (Gouvea & Passmore 2017). In it, we suggest a few touchpoints for educators as they consider how the modeling practice is positioned in the classroom. We ask:

- *Is there a clear phenomenon? Is there some puzzling or unknown aspect of that phenomenon to investigate? Do students understand their role as trying to understand this phenomenon better?*
- *Is there a clear question? Does the question help clarify what about the phenomenon is puzzling or unknown? Do students understand their role as attempting to answer that question?*

- *Is there a clear* *__purpose__**? Are there clear criteria for what constitutes having made progress toward answering the question? Do students understand they are responsible for generating and evaluating that knowledge? (Gouvea & Passmore 2017, p. 58)*

We call this the *models of* versus *models for* distinction. By using this simple linguistic distinction, we have found it easier to see models as explanatory tools. When planning lessons, we try to avoid saying that "students will develop a model *of* photosynthesis." Instead, we say, "Our class will develop a model *for* where the matter comes from when a seed becomes a tree." We find this slight shift in language helps us keep the modeling practice connected to an explanatory purpose. Try it out!

The next time you want to incorporate a modeling experience in the classroom, we suggest you ask yourself what the model is *for*, without using the name of the science idea or a simple label of the thing in your answer. The word "*for"* should be followed by a phenomenon and matched to a question we have about that phenomenon, something that the science ideas we are developing as a class will help us explain.
Returning to our earlier example of asking students to "draw a model of the pond ecosystem," which is rather vague, a teacher might instead want to ask students to "develop a model for why there are more mayflies than frogs in the pond." This revision centers our modeling work on the phenomenon we are trying to explain. We have found that this simple shift in how we talk about (and hopefully, in how we think about) models in the science classroom can help us engage in this practice in more powerful ways. Please post your comments below and let us know how it this approach is working for you!

Reference: Gouvea, J. & Passmore, C. Sci & Educ (2017) 26: 49. https://doi.org/10.1007/s11191-017-9884-4
As teachers and science educators we are passionate about the modeling practice and its potential to improve student learning in the science classroom. We are part of the team that developed the high school biology curriculum found at modelbasedbiology.com.

Cynthia Passmore is a professor of science education at the University of California, Davis.

Lesson 1: What is causing Mt. Everest and other mountains to move, grow, or shrink?

An interesting phenomena

Turn and talk

Turn and Talk

1. Read the headline on the slide.
2. Turn and talk with a partner about what could cause a mountain to grow.

With your class

With Your Class

3. With your class, locate Mt. Everest on the map.
4. Also as a class, find the location of your school/town and label it on the class map.

Read about Mt. Everest

In your notebook

Science Notebook

5. Make a Notice and Wonder chart in your notebook.
6. With a partner, read about Mt. Everest. Stop at the end of each paragraph and record your noticings and wonderings in your notebook.
7. Be ready to share with the class.

With your class

With Your Class

8. With your class, discuss:
    - What were some of the things you noticed about what happened to Mt. Everest?
    - What are some of your wonderings?

With a partner

With a Partner

9. Discuss the following:
    - Possible causes for the increase in elevation of Mt. Everest.
    - Possible causes for Mt. Everest moving to the northeast.

Develop an initial model

On your own

Assessment Opportunity/On Your Own

10. You will develop a model for what you think are:
    - Possible causes for the increase in elevation of Mt. Everest.
    - Possible causes for Mt. Everest moving to the northeast.

With your class

With Your Class

11. Revisit norms and set a goal of a norm to focus on as the class develops the consensus model.

Class Consensus

With your class


With Your Class

12. With a class develop a consensus model to represent:
    - Possible causes for the increase in elevation of Mt. Everest.
    - Possible causes for Mt. Everest moving to the northeast.

Considering Other Mountains

With your class


With Your Class

13. There are a lot of other mountains in the world. Discuss with the class:
    - What are some other mountains or mountain ranges you know about?
    - Do you think they are changing in similar ways too?
    - How could investigating other mountains and the range, or area they are part of, help us figure out what might be happening at Mt. Everest?

In your notebook


Science Notebook

14. With your class, develop a data table like the one on the slide to use to record data about other mountains.
15. Think about:
    - What are some types of data we would want about other mountains?

With your group

With a Group

16. With your group, analyze the *Data Cards for Other Mountains and Mt. Everest.* Each person in your group should analyze a different mountain.
17. Be ready to report to your group:
    - Are any other mountains changing either by elevation or location?
    - Why might these other mountains be changing?
    - What patterns do you notice between the different mountains?

Scientists Circle

Scientists Circle

18. Join your class in the Scientists Circle.
19. As a class, add the different locations to the map.
20. As a class, add data for each of the mountain locations that may be considered evidence of changing.
21. Look for patterns in the data with your class.

Add to initial model

With a partner

With a Partner

22. With a partner using the handout from your teacher:
    - Choose a location where the data shows that the mountain has been shrinking over time.
    - Develop a model to represent what you think is causing this to happen.

Navigation

Turn and talk

Turn and Talk

23. Talk with a partner about:
    - Why did we want to look at information about other mountains?
    - What kind of data were we looking for?

With your class

With Your Class

If all mountains aren't growing, then our initial model won't explain what is happening to every mountain.

24. As a class, revise/add to the consensus model to include ideas for what could cause a mountain to shrink.

Related Phenomena

Think back on all your experiences you've had over your life where you noticed a change in the surface of the land or landforms. Consider all scales: these changes from the very small to the very large.

On your own

Assessment Opportunity/On Your Own

25. In your notebook, on the next blank page make a T-chart with the column headings, example and causes. Think about:
    - What are other examples of where you have seen the size or shape of the land or landforms change over time?
    - What do you think caused these changes?

With a partner


With a Partner

26. Share examples of where you have seen the size or shape of the land or landforms change over time.
27. Identify any causes for these that you think might also cause the size or shape of some mountains to change over time.

With your class


With Your Class

28. With your class, share examples of where we have seen the size or shape of the land or landforms change over time AND what we think the cause for this is that might also cause some mountains to change over time.

Navigation

In your notebook


Science Notebook

29. In your notebook, write down any new questions you are thinking about after making our class consensus models.

Driving Question Board

With a partner


With a Partner

30. With a partner: Review the questions you brainstormed at the end of the last class.
31. Then write one question per sticky note. Write in marker, big and bold. Put your initials on the back in pencil. Be ready to share.

Scientists Circle

Scientists Circle

32. Gather in the Scientists Circle with your questions.
33. Be ready to share your questions.

Information and Data Needed

In your notebook

Science Notebook

34. Think about what additional sources of data we might need to figure out the answers to our questions.
35. On a new page in your notebook, record your ideas for information we need and investigations we might want to carry out.

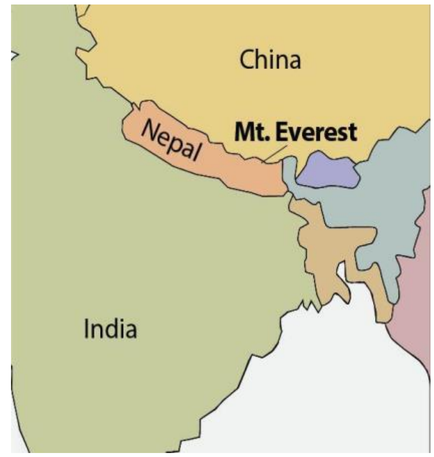
Scientists Circle

Scientists Circle

36. Take a moment to look at our questions on our DQB. Talk with your elbow partner in the Scientists Circle:
    - What potential causes did we identify as a class for Mt. Everest changing? What seems the most likely cause to you and why?

Name: ____ Date: ____________________

Reading: What is happening on Mount Everest?



Mount Everest is the tallest recorded mountain in the world. It is located on the border of two countries, China and Nepal. In the past, these two countries have collected earthquake, elevation, and location data separately on their own sides of the mountain, but had not compared the data with each other to check for accuracy. Since each country was collecting separate data and not using the other country's data to check their work, this led to a disagreement on the exact height of Mt. Everest. In 2015, a massive 7.8 magnitude earthquake occurred near Mt. Everest. Areas surrounding Mt. Everest and in both countries felt the earthquake. Scientists believed that the earthquake may have impacted the height, or elevation, of the mountain. The two countries decided to share their GPS data to figure out if there were any changes to Mt. Everest due to the earthquake.

In the years that followed, Chinese and Nepalese scientists set up Global Positional System (GPS) receivers at different places on the mountain. GPS provides the signals that our cell phones use to determine where we are located on Earth and can provide us directions to get to a new location. The GPS sensors that were used on Mt. Everest are even more sensitive than those in our phones, which enable them to detect a change in position as small as 1 millimeter.

The first official measurement of Mt. Everest was reported in 1856. At that time, it's peak was recognized to be about 29,002 feet above sea level. But since then, GPS data sharing between the two countries has allowed scientists to determine that Mt. Everest has increased in elevation by an average of 0.79 inches (2 cm) each year. In 2021, its peak was at 29,032 feet above sea level.

In addition to these changes in height, this GPS data has also provided evidence that the peak of Mt. Everest is moving at an average of 1.6 inches (or 4 cm) a year to the northeast.

Sources:

- Camero, K. (2020). The highest point on Earth just got higher. What we know about Mount Everest's growth. *Miami Herald*. Retrieved: https://www.miamiherald.com/news/nation-world/world/article247692110.html
- Wilkinson, F. (2021). How do you MEASURE Everest? It's complicated by frostbite and politics. *Science News by National Geographic*. Retrieved: www.nationalgeographic.com/science/article/remeasuring-mount-everest-the-worlds-tallest-mountain

Name: ___________________________________ Date: ___________________

Explain How Mt. Everest Moves and Grows

In the box below, draw an initial model to try to explain the following:

- What might cause Mt. Everest to increase in height 2 cm each year?
- What might cause Mt. Everest to move to the northeast 4 cm each year?

Use words, pictures, and anything else to help capture your thinking.

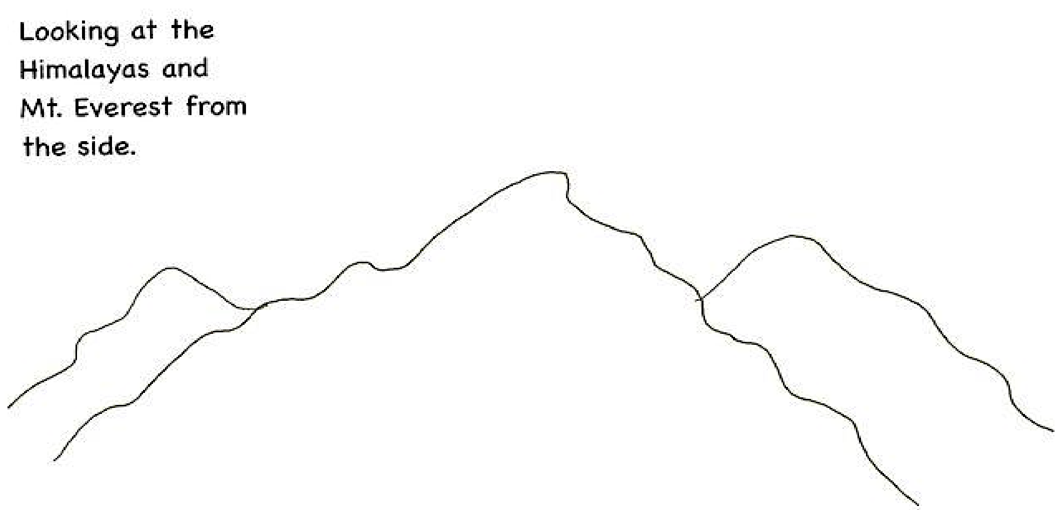
Use your model to explain:

How Mt. Everest moves 4 cm to the NE each year	How Mt. Everest grows taller by 2 cm each year

Name: ___________________________________ Date: __________________

Unit 6.4, Lesson 1 - Alternate Initial Model

Based on what you have figured out about how Mt. Everest is changing over time, use the image below to represent the changes happening to Mt. Everest.

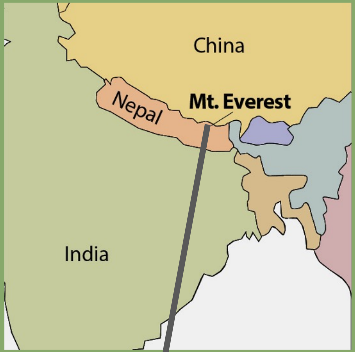


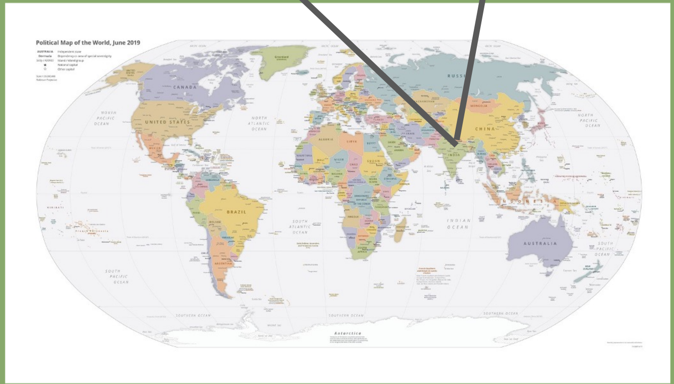
Data Cards for Other Mountains and Mt. Everest

Mount Everest in the Himalayan Mountains

Height: **29,032 feet above sea level** Movement: **4 cm northeast yearly**

Mt. Everest is located between Nepal and China in a mountain range called the Himalayas. The Himalayan range is 1,500 miles long. In addition to Nepal and China, it also covers parts of the countries of India, Pakistan, Afghanistan, China, Bhutan, and Nepal. Not only is Mt. Everest, the tallest mountain in the world located here, but so is K2, the world's second tallest mountain. The area experiences large active earthquakes.





Weather and climate

- tropical near the base of the mountains
- snow and ice near the tops of the mountains all year long
- 15,000 glaciers

Earth materials found here

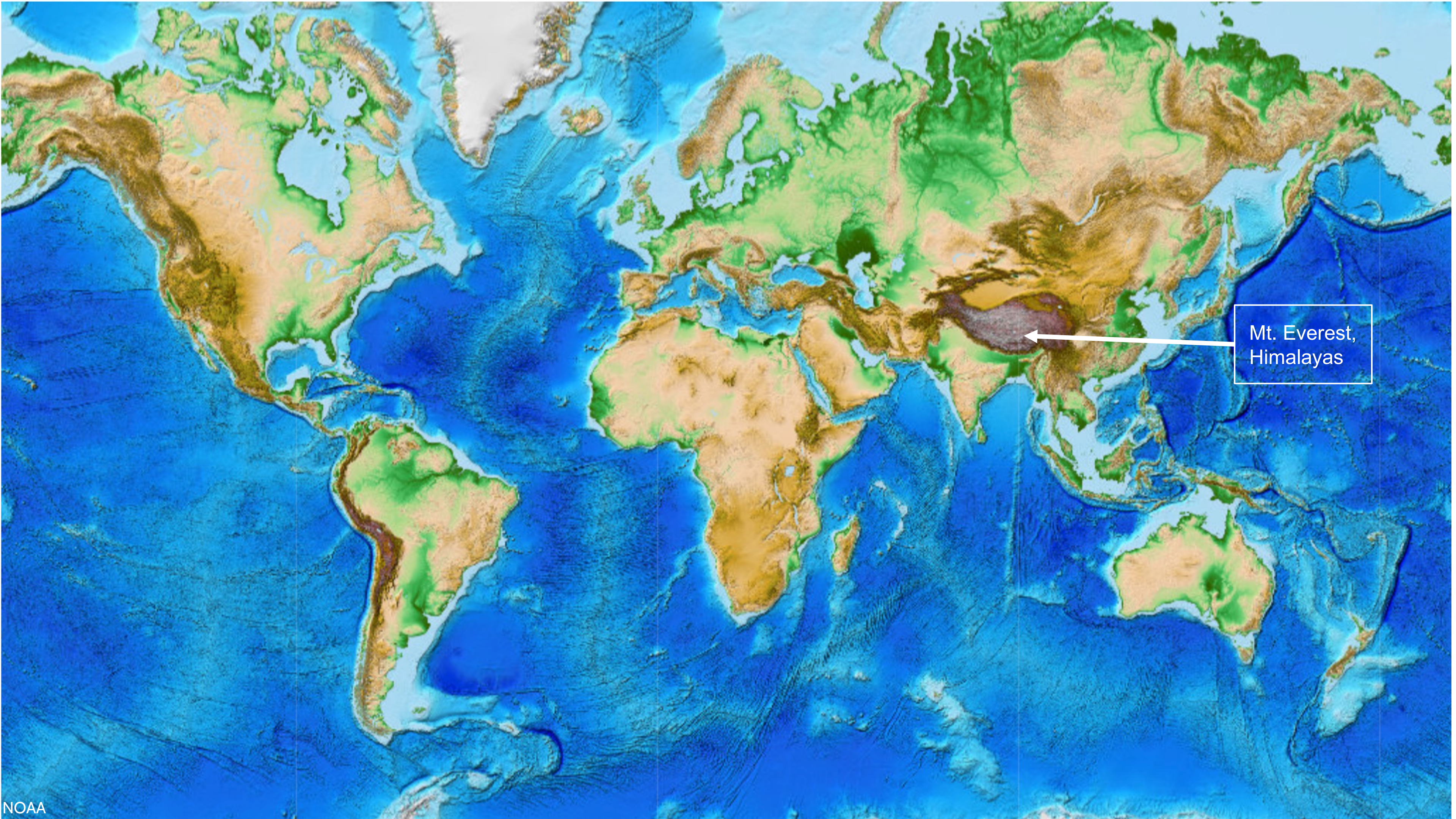
- sedimentary rock such as shale and limestone
- volcanic rock in some areas
- marine fossils on some of the peaks of the mountains

Sunset behind the Himalayas

Many pieces of fossils of crinoids (pictured above), trilobites, brachiopods (lamp shells), and ostracods (small shrimps) are found here.

The name for the Himalayas comes from Sanskrit and translates to “Abode of snow.” The Nepalese people named Mt. Everest *Sagarmatha,* which is translated as “Goddess of the Universe” or “Forehead of the Sky.” The Tibetan name for Everest is *Chomolungma*, which means “Goddess Mother of the World.” These mountains are growing in height, with Mt. Everest growing about 2 cm per year.

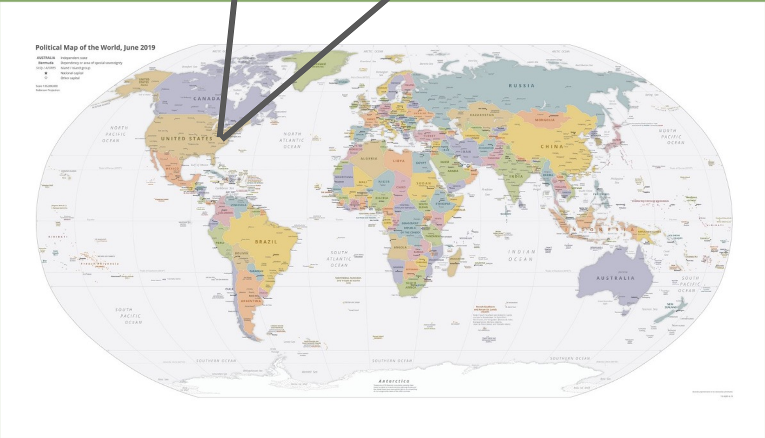
Image credits: Concord Consortium; CIA World Factbook; Erik Tanghe


Mt. Everest,
Himalayas
NOAA

Mount Mitchell in the Appalachian Mountains

Height: 6,684 ft above sea level **Movement:** 3 cm west yearly

The Appalachian Mountains are a mountain range that covers 1,500 miles in the United States, from northern Alabama to the Canadian border. The Appalachian Mountains are ancient, or very old. Scientists believe they used to be as tall as or taller than the Himalayas.



Weather and climate

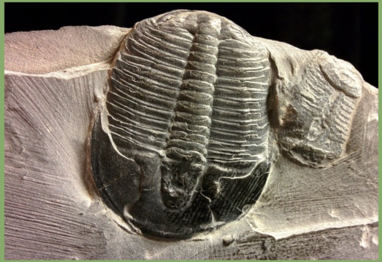
- Rain and snow are common in this mountain range
- Areas in the north can get snow all year
- Areas in the south have hot, dry summers
- Some areas get heavy, fast rains that lead to flooding

Earth materials found here

- Sedimentary rock such as sandstone and limestone
- Volcanic rock in some areas
- Forests cover most of the mountains
- Grassy meadows and valleys are in between the mountains
- Many prehistoric shells can be found in the rock layers of the mountains

Layers of sandstone above layers of coal

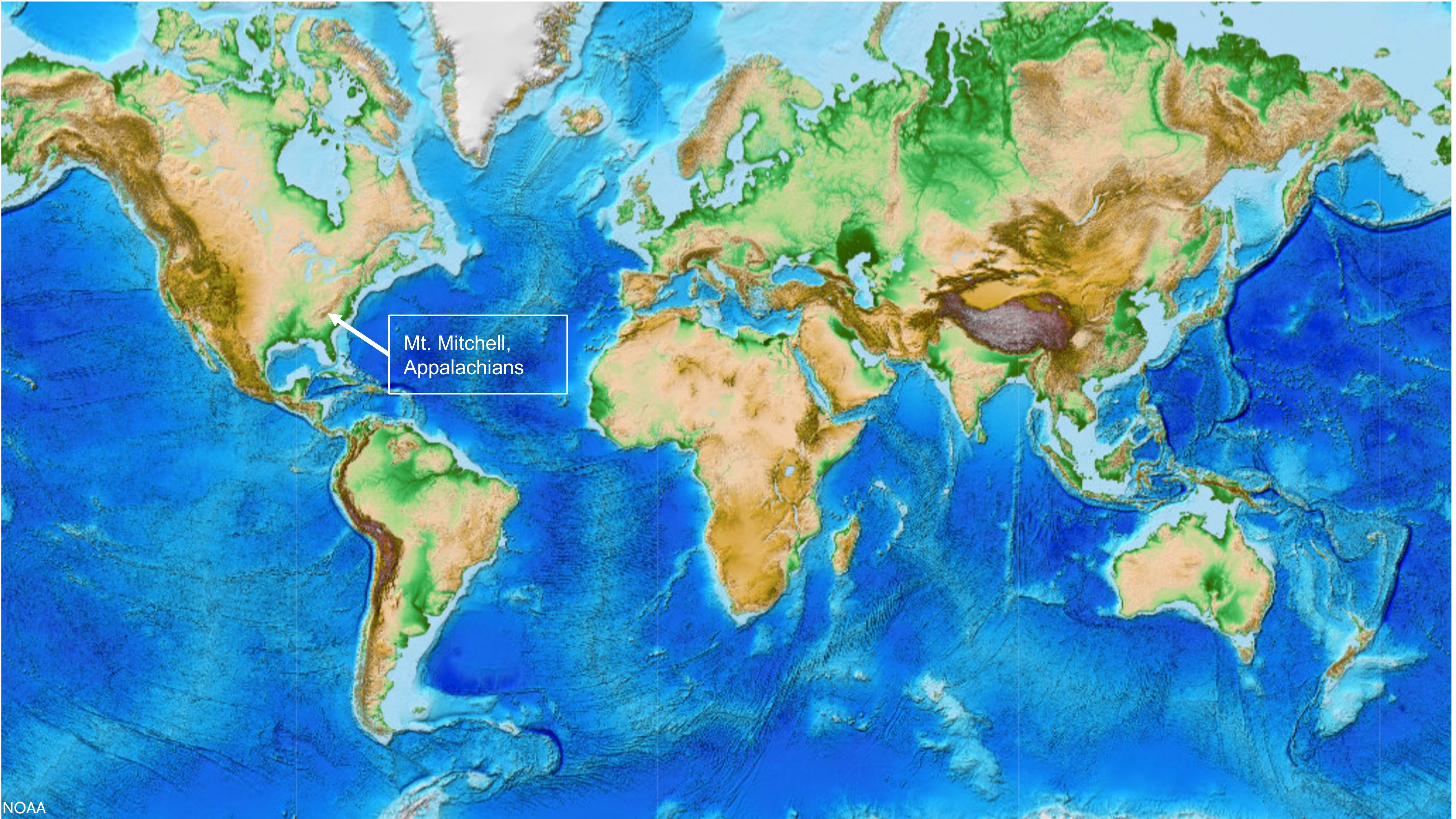
Waterfall found in the Appalachians



The oldest trilobite fossil was found here.

The peaks in the mountain range are decreasing in height. Most of the valleys in between the mountains are getting deeper. There are only a very few small earthquakes happening here.

Image credits: Concord Consortium; CIA World Factbook; C.M. Bailey; Yanny Mishchuk; Adolfo Beato


Mt. Mitchell,
Appalachians
NOAA

Name: ___________________________________ Date: ___________________

Patterns of Change for Mountains

Data for Causing Growth	Data for Causing Decrease in Height

Patterns between Mountains

Name: ___________________________________ Date: ___________________

Explaining Other Mountains That Shrink

In the spaces below, draw an initial model to explain what might be occurring with other mountains.

Explaining a shrinking mountain
• Choose a location where the data show that the mountain has been decreasing in elevation. • Develop a model to represent what you think is causing this to happen to the mountain.

Use your model to explain:

How a mountain shrinks over time