

# ScienceNews

IN HIGH SCHOOLS | EDUCATOR GUIDE



# WhiteOUT



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# SN whiteOUT

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## About the article

The *Science News* article “White out” shares what scientists have learned about the physics of avalanches and how improvements in computer modeling can help keep people safe.

“White out” can be used across a wide range of curricula, with a focus on **earth science** and **engineering design**. The activities, questions and discussions in this educator guide can be used to support the following education standards:

### Next Generation Science

Motion and Stability: Forces and Interactions: [HS-PS2-3](#)

Earth's Systems: [HS-ESS2-1](#), [HS-ESS2-2](#), [HS-ESS2-5](#)

Earth and Human Activity: [HS-ESS3-5](#)

Engineering and Design: [HS-ETS1-3](#), [HS-ETS1-4](#)

### Common Core

ELA Standards: [Reading Informational Text \(RI\)](#): 5

ELA Standards: [Writing \(W\)](#): 3, 4, 7, 9

ELA Standards: [Speaking and Listening \(SL\)](#): 1, 2, 4, 6

ELA Standards: [Language \(L\)](#): 1, 2, 6

ELA Standards: [Reading for Literacy in History/Social Studies \(RH\)](#): 2, 3, 6, 7, 9

ELA Standards: [Reading for Literacy in Science and Technical Subjects \(RST\)](#): 2, 3, 4, 5, 6, 8, 9

ELA Standards: [Writing Literacy in History/Social Studies and Science and Technical Subjects \(WHST\)](#): 2, 4, 6, 7, 8, 9

## Prior to reading

Guide student reading by pointing out connections between this article and what students are learning in class. Here, find ideas for standard-aligned paths to follow while reading:

- Ask students to share what they know about avalanches. Prompt them to brainstorm what causes avalanches and why they are so dangerous. Show students the chart on [Blackline Master 1](#), depicting fatalities due to avalanches in the United States, and ask students what might be causing the increase in fatalities. (*Answers will vary, but hypotheses include: increasing interest in winter sports, increased accessibility to mountains, changing weather patterns.*) Encourage students to examine additional data sources (<http://avalanche.state.co.us/accidents/statistics-and-reporting/>) that show fatalities by activity, state and month. You can form additional questions or ask students to form their own questions and answers based on the trends seen in the charts and maps.
- What does it feel like to be caught in an avalanche? Encourage students to research firsthand accounts from avalanche survivors (some examples include: [a skier trapped in an avalanche in the Swiss Alps](#), [an Australian climber trapped on Mount Everest after an earthquake](#), [a skier trapped under an avalanche in Colorado](#)). How do these modern accounts differ from the more romanticized, historical account from John Muir's *The Yosemite* (1912), provided in [Blackline Master 2](#)? Ask students to brainstorm reasons for the differences in style and tone. You might prompt them by explaining that many environmentalists in the United States were promoting wilderness preservation and the protection of lands as national parks during the early 20th century. (For more discussions and activities related to John Muir, visit the [Sierra Club's John Muir Study Guide](#).)
- How do scientists study avalanches and other natural disasters? What data can researchers collect before an event? What about afterward? How can they use that data to better understand the science behind an event? And how might that understanding help predict or prevent future events, damaged and deaths?

## After reading: Comprehend

You can adapt and print these questions ([Blackline Master 3](#)) to check for comprehension and analysis before or after discussion:

1. **What is the main topic of the article?** (*Scientists are studying the physics of snow and the causes of avalanches to better understand these potentially lethal events.*)
2. **What causes an avalanche?** (*Snow piles up and its weight is greater than what the underlying snowpack can support, so a slab detaches and slides downhill.*)
3. **What is the difference between a “wet” and a “dry” avalanche?** (*They typically occur in different weather conditions; wet avalanches travel slower than dry ones; wet avalanches tend to occur naturally when the snowpack is weakened by liquid water, while dry avalanches are often triggered by human activity after loading of new snow; wet avalanches cause damage because of their weight, while dry avalanches kill more people because of their speed.*)

4. **What variables do scientists measure to better understand avalanches?** (*Air pressure, impact pressure, flow speed, density, temperature, particle motion, clumping, turbulence, among others.*)
5. **How are computer simulations saving lives?** (*They evaluate avalanche risk at specific locations so that people know what areas or structures are at risk and can take preventative measures, such as removing loose snow.*)

## After reading: Analyze

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1. **Based on the chart “Snow risk,” what activities put people at the greatest risk of fatality from an avalanche? Why do you think this is so? Can you think of ways people can minimize their risk?**
2. **Use the figure “Simulating slides” to analyze the difference between direct measurements of an avalanche and the simulation by RAMMS. How are the two different? Why do you think they are different? Despite these differences, why are simulations valuable tools for predicting the location and scale of avalanches?** (*In the simulation, the snow covers a greater area and is less patchy in its distribution. The simulation roughly captures the depth of the snow correctly, but it doesn’t predict with exactness where the deepest snow will be. Still, the simulations give researchers a general idea of how the snow might flow and where, and accuracy increases as data collection and technology improves.*)
3. **Based on the text, how might climate change affect avalanche risk over time?** (*A changing climate might make avalanches more likely in some places and less likely in others. Unpredictable temperature swings might make avalanches harder to anticipate. Severe storms could pile on snow quickly and rain in mountainous areas could weaken the snowpack, making avalanches more likely.*)

## Discuss and Assess

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After students read the article independently, return as a group to the concepts outlined prior to reading. Invite students to share their answers and observations from the article and lead a class discussion that further underscores your current curriculum. The discussion can serve as an informal assessment. Ideas for further reading discussion or writing prompts include:

- Ask students to think about the natural disasters that occur where they live. Are avalanches common, or is another natural disaster more likely? Have students consider whether there are any places in the country, or across the globe, that are safer to live than others. (*There are hurricanes in the Southeast, blizzards in the Northeast, tornadoes in the Midwest, earthquakes on the West Coast. Globally, areas that are prone to drought and water conflict are sometimes rich in natural resources.*) To what extent do these risks shape where people decide to live? To what extent should these risks shape people’s decisions? How can these risks be minimized or managed?
- How do writers turn scientific and data-heavy accounts of phenomena into a high-interest piece of writing? Examine the techniques and stylistic choices used in “White out.” How does the writer increase interest in the science of avalanches? (*The writer starts with an anecdote to hook the reader; the writer uses comparisons to put the data in context — “the force of up to 100 onrushing cars,” for example; the writer references current events, such as the April 2015 avalanche on Mount Everest.*) Provide students with an example or two and encourage them to identify more.
- Visit the RAMMS website and view [case study simulations](#) of wet and dry avalanches. Discuss the information these simulations can provide. Why do scientists use models? How are they useful? What are the limits of models? Ask students to think of other scenarios where models are helpful to scientists (*weather modeling, model airplanes, animal models in medicine, toy models in physics, even maps are a form of model*). Ask students to consider how the strength of a model depends on the availability of data.

## Extend

Offer students other ways to explore the content of the article as it relates to your curriculum, such as:

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### WRITING THE AVALANCHE

After researching firsthand accounts from avalanche survivors, have students write their own short story taking the point of view of the avalanche. Encourage students to incorporate the scientific information they have learned from “White out.” Students should consider where their stories will be set, what type of avalanche will take place and how disastrous it will be. In all cases, ask students to personify the avalanche. What would an avalanche see, hear and experience as it runs down a slope? What would the event look like to an individual snowflake or a tree caught in the action? Encourage students to use colorful adjectives, figurative language and other writing techniques.

### SURVIVAL TECHNOLOGY

Have students select a winter activity that might put a person at risk from an avalanche. Then ask them to imagine and draw a prototype of a futuristic avalanche survival gadget that could be used by an athlete. Students should consider how fast the gadget needs to deploy (avalanches often occur with little warning), how much snow will tumble under different circumstances and how fast the snow will be moving, along with the weight

and ease of use of the device. Currently, physicists are creating smart clothing with sensors to monitor human health and activity. What might technology bring in 25, 50 or 100 years? Students can be fanciful in their designs, but they should ground the designs in real scientific ideas. To inspire creativity, consider showing a [clip from the film \*The World is Not Enough\*](#), in which James Bond survives an avalanche using a very special device.

## AVALANCHE AWAY

- **Purpose:** Students will examine various materials (proxies for snow crystals) and model avalanches across different landscapes to determine the characteristics most likely to cause an avalanche in their simulated environments. This activity will help students think about what factors scientists consider when studying avalanches, as well as the ways using models helps scientists understand natural phenomena.
- **Activity overview:** Snow accumulates in layers with each precipitation event. These layers vary in strength because of differences in temperature and humidity in the air and across the snowpack, and because of the shape of the snow crystals and how they interact. In the activities that follow, students will explore how different materials create stable versus unstable layers in a simulated snowpack. Though actual snow crystals might behave differently from the proxy materials, the process mimics the ways scientists think about and study snow and avalanches. As students work through this modeling activity, they will begin to understand the variables involved in avalanche prediction (snow type, terrain, slope, chance events, weather conditions).

Students will test their snowpacks by increasing the incline of a board (their landscape), and thus increasing the stress on the snowpack. In nature, avalanches tend to occur on slopes with angles between 25 and 40 degrees. (Snowpacks don't get deep enough to form avalanches on slopes with larger angles.) In addition to slope angle, friction plays a role in the likelihood of an avalanche. Though weaker layers often slide first, a strong layer doesn't always stay put. Slab avalanches occur when a relatively strong layer sits atop a weaker layer, breaking off in a single plate.

The following activity is divided into three stages. First, students examine the characteristics of various materials (Examine the substances activity). Then students test how the characteristics of each material influence stability on an inclined surface ("Snow" stability activity). The third activity (Avalanche!) encourages students to use what they've learned to create an environment resistant to avalanches. Some of these activities and tests can be performed by students independently, using class time for discussion and analysis.

### ■ Materials:

#### Examine the substances activity (for each pair or team)

- microscope
- microscope slide
- substances for observation: flour, sugar, borax, potato flakes, Epsom salt, other salts as available
- small spoon
- tissue
- [Blackline Master 4](#)
- [Blackline Master 5](#)

#### "Snow" stability activity

- board (about 11 x 17 inches)
- 1 sheet of printer paper (8½ x 11 inches)
- 1 sheet of sandpaper (8½ x 11 inches)
- 1 sheet of wax paper (8½ x 11 inches)
- tape
- protractor
- ruler
- 2 cups of each substance used above
- [Blackline Master 6](#)

#### Avalanche! activity

- the same board used above
- the same protractor used above
- the same 2 cups of each substance used above
- material with various textures (printer paper, sandpaper, wax paper used above, but also newspaper, burlap, cheesecloth, plastic wrap)
- masking tape
- miniature trees and buildings or other structures
- [Blackline Master 7](#)

### ■ Directions:

#### Examine the substances activity

1. Explain that as snow falls from clouds to the ground, each snowflake travels through different temperature and humidity conditions, changing the way the flake develops. Ask, "Why would temperature and humidity play an important role in the formation of a snowflake?" (*Answers will vary, but students should mention that the amount of water vapor will affect how fast the snowflake can grow and temperatures will influence the flake's three-dimensional shape.*)
2. Show students [Blackline Master 4](#) and discuss the different shapes of snowflake crystals and the affect of shape on snowpack stability.
3. Explain that in order to model an avalanche, scientists study snowflake types to determine how they differ and how each might act under various conditions. Form working pairs or teams. Have students analyze each of the materials available under the microscope (using

[Blackline Master 5](#)) to determine how their structures are similar to specific types of snow crystals.

4. Optional: If you live where there is snow, students can freeze slides, gather snowflakes and observe them under a microscope. Or, students can capture a snowflake on a black, slick surface and view it using a hand lens.

#### **“Snow” stability activity**

1. Based on what students found in the previous activity, have them predict which substances will be most and least stable under avalanche conditions.
2. Remind students that scientists test variables in isolation before examining how they interact. In this activity, students will test both substance type and surface type independently.
3. Give each team a set of materials and [Blackline Master 6](#).
4. Have students begin testing. If you'd like to consolidate time and materials, you can divide up the substances among the teams. In this case, it is recommended that each substance be tested by two different teams to verify findings and reduce experimental error.
5. Once teams have completed their tests, discuss their findings and make predictions on how materials will interact. Ask students to consider how these materials are different from snow crystals and how those differences might affect performance during the simulated avalanche.

#### **Avalanche! activity**

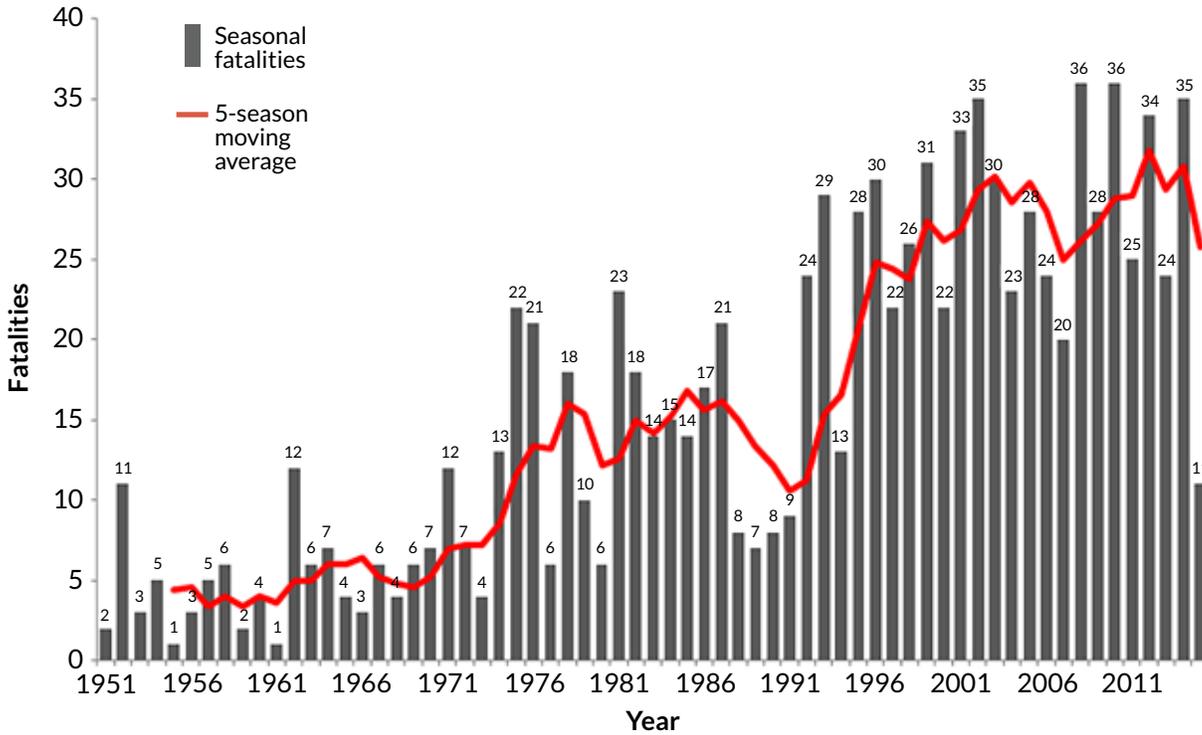
1. Using the board from the previous activity, have students design their own landscape, considering what landscape types might be most resistant to avalanches. Students might want to add crumpled paper, pebbles or other textures under an outer layer of paper to create a surface that resembles a mountain.
2. Next, students will design and add their snowpack to the landscape, selecting two to four substances to make snow layers. Each layer represents a different snowstorm with different characteristics. Remind students that the type of substance affects how it will pack and its stability, so they should use their findings from the previous activities to inform their decisions. Teams can record their plans and results using [Blackline Master 7](#).
3. Give teams time to run their tests.
4. Discuss and compare each team's results. Whose landscape and snowpack combination was most resistant to avalanches? Why was this so? Were the findings in the final activity consistent with findings from previous activities? Why or why not?

“Avalanche away” was inspired by the [Sierra Club's John Muir Study Guide](#), the [U.S. Forest Service's Science of Snow pdf](#), NOVA's [Avalanche! classroom activity](#) and the [Avalanche Modeling Project from Arizona State University](#).

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## U.S. Avalanche Fatalities by Year, 1950-51 to 2014-15



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## Excerpt from *The Yosemite*, by John Muir

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Few Yosemite visitors ever see snow avalanches and fewer still know the exhilaration of riding on them. In all my mountaineering I have enjoyed only one avalanche ride, and the start was so sudden and the end came so soon I had but little time to think of the danger that attends this sort of travel, though at such times one thinks fast. One fine Yosemite morning after a heavy snowfall, being eager to see as many avalanches as possible and wide views of the forest and summit peaks in their new white robes before the sunshine had time to change them, I set out early to climb by a side cañon to the top of a commanding ridge a little over three thousand feet above the Valley. On account of the looseness of the snow that blocked the cañon I knew the climb would require a long time, some three or four hours as I estimated; but it proved far more difficult than I had anticipated. Most of the way I sank waist deep, almost out of sight in some places. After spending the whole day to within half an hour or so of sundown, I was still several hundred feet below the summit. Then my hopes were reduced to getting up in time to see the sunset. But I was not to get summit views of any sort that day, for deep trampling near the cañon head, where the snow was strained, started an avalanche, and I was swished down to the foot of the cañon as if by enchantment. The wallowing ascent had taken nearly all day, the descent only about a minute. When the avalanche started I threw myself on my back and spread my arms to try to keep from sinking. Fortunately, though the grade of the cañon is very steep, it is not interrupted by precipices large enough to cause outbounding or free plunging. On no part of the rush was I buried. I was only moderately imbedded on the surface or at times a little below it, and covered with a veil of back-streaming dust particles; and as the whole mass beneath and about me joined in the flight there was no friction, though I was tossed here and there and lurched from side to side. When the avalanche came to rest I found myself on top of the crumpled pile without bruise or scar. This was a fine experience. Hawthorne says somewhere that steam has spiritualized travel; though unspiritual smells, smoke, etc., still attend steam travel. This flight in what might be called a milky way of snow-stars was the most spiritual and exhilarating of all the modes of motion I have ever experienced. Elijah's flight in a chariot of fire could hardly have been more gloriously exciting.

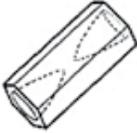
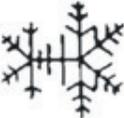
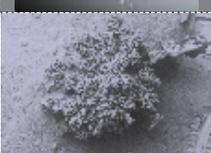
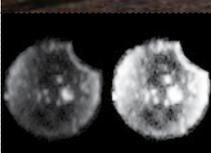
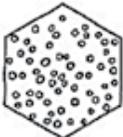




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## Snowflake crystals

Shape	Name	How They Are Formed	Effect on Snowpack	Actual Image
	Columns (hollow or solid)	At 14–21 degrees Fahrenheit (°F)	unstable	
	Needles (simple, cluster or crossed)	At 25–21 °F	unstable	
	Stellar Plates	At 14–10 °F	stable	
	Stellar Dendrites	At 14–10 °F	stable	
	Irregular	At 3–10 °F	stable	
	Graupel	When snow crystals fall through very moist air	unstable	
	Hail	When precipitation becomes coated with a layer of ice	unstable	
	Ice pellets	When rain falls through very cold air	unstable	
	Rime	When extremely cold water droplets freeze almost instantly on a cold surface	unstable	

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## Examine the substances activity

**Materials:**

- microscope
- microscope slide
- substances for observation: flour, sugar, borax, potato flakes, Epsom salt, other salts as available
- small spoon
- tissue
- Blackline Master 4

**Directions:**

1. Researchers know that the size and shape of snow crystals affect how they interact and this is an important characteristic in understanding avalanches. To simulate the way scientists study snowflakes, examine the substances provided and analyze the characteristics of each.
2. Make a slide of one substance and focus it under the microscope.
3. Draw one particle of the substance on the chart below (or if using a digital scope, take a screenshot).
4. Measure the diameter of an average-sized particle (in micrometers) in three locations and average the measurements. Record the information on the chart below.
5. With the help of Blackline Master 4, classify the substance as if it were a snow crystal.
6. Clean off your slide and repeat with each of the remaining substances assigned to you.
7. Within your team or as a class, rank your particles from smallest to largest.

Substance	Drawing	Particle size				Snow classification	Size rank
		D1	D2	D3	Avg.		

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## “Snow” stability activity

### Materials:

- board (about 11 x 17 inches)
- 1 sheet of printer paper (8½ x 11 inches)
- 1 sheet of sandpaper (8½ x 11 inches)
- 1 sheet of wax paper (8½ x 11 inches)
- tape
- protractor
- ruler
- 2 cups of each substance used previously

### Directions:

1. Tape the sheet of printer paper to the board.
2. Distribute one of the substances evenly on the paper.
3. Slowly raise one end of the board, using the protractor to track the angle of the board. Mark the angle at which the avalanche begins and record other observations.
4. Repeat with the sandpaper and wax paper, and then with the other substances assigned to you.

Substance	Surface	Angle of the board at avalanche	Other observations
	Printer paper		
	Sandpaper		
	Wax paper		
	Printer paper		
	Sandpaper		
	Wax paper		
	Printer paper		
	Sandpaper		
	Wax paper		
	Printer paper		
	Sandpaper		
	Wax paper		
	Printer paper		
	Sandpaper		
	Wax paper		
	Printer paper		
	Sandpaper		
	Wax paper		

## Avalanche! activity

### Materials:

- the same board used in the previous activity
- protractor used previously
- 2 cups of each substance used previously
- material with various textures (printer paper, sandpaper, wax paper used previously, as well as newspaper, burlap, cheesecloth, plastic wrap)
- masking tape
- miniature trees and buildings or other structures

### Directions:

1. Design your landscape: Create a realistic mountainside by crumpling and positioning paper and taping it in place on your board. Your landscape might have smooth areas, valleys, groves of trees, buildings and other structural elements. Use the information gained from the previous activities to make choices that will decrease the likelihood of an avalanche.
2. Design your snowpack: Use what you've learned in the previous activities to select substances for your snowpack. You will build two to five layers of simulated snow, each representing a different snowstorm. Remember that the size and shape of the snowflake determines its stability in the snowpack. What combination do you think will make the most stable snowpack? Record your layers in the chart below.

Layer	Substance selected
Top layer	
Bottom layer	

3. Build your snowpack, placing the substances to form your bottom layer first, ending with the top layer.
4. You will be conducting your experiment once. Read through the following questions and be prepared before you run your test:
  - i. What was the slope when your avalanche occurred?
  - ii. Which type of terrain avalanched first (rocky, smooth, etc.)?
  - iii. Which parts of the snowpack avalanched? Which layers gave way?
  - iv. Which snow layer was the weakest? What was it made of?
  - v. Did this follow your predictions?
  - vi. If you could change anything about your experiment in order to make your landscape more stable, what would it be?
5. Test your landscape: Slowly raise the board on one end to create a slope. Stop as soon as the snowpack starts to slide. Use the protractor to measure the slope and gather observations about your avalanche.
6. Compare the landscapes across the classroom. Whose landscapes were most resistant to avalanches? Why? Did the results match your predictions? Why or why not?