SCIENTISTS IN THE FIELD

Where Science Meets Adventure

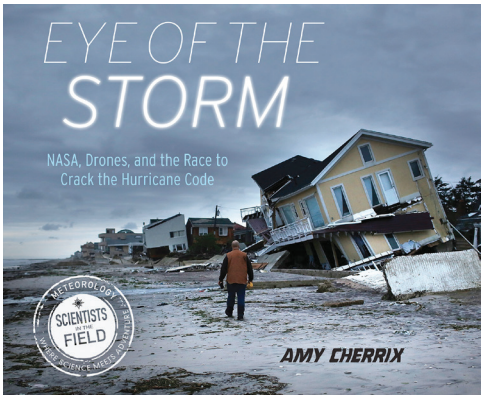
DISCUSSION AND ACTIVITY GUIDE

Eye of the Storm: NASA, Drones, and the Race to Crack the Hurricane Code

BY AMY CHERRIX

About the Series

Eye of the Storm is part of the award-winning Scientists in the Field series, which began in 1999. This distinguished and innovative series examines the work of real-life scientists doing actual research. Young readers discover what it is like to be a working scientist, investigate an intriguing research project in action, and gain a wealth of knowledge about fascinating scientific topics. Outstanding writing and stellar photography are features of every book in the series. Reading levels vary, but the books will interest a wide range of readers.



Eye of the Storm
by Amy Cherrix
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About the Book

Hurricanes whip up dangerous ocean waves and send them crashing into coastal cities, often wreaking devastation on large areas. Consequently, knowing more about how hurricanes are formed could mean saving lives and limiting damage. *Eye of the Storm* takes us to the birthplace of many North Atlantic hurricanes—the vast desert region of the Sahara. Beginning as "little more than a gasp of desert-choked air," hurricanes grow quickly! When multiple weather systems combine, they can create a super storm like Hurricane Sandy, which killed 285 people and destroyed thousands of homes. Hurricanes are great at keeping secrets, but fortunately Scott Braun, Chris Naftel, Marilyn Vasques, and a team of scientists are racing to decode these secrets before the next big one blows into town.

About the Author

Amy is no stranger to the destruction that comes with hurricanes. She has lived through six of them herself. When she isn't writing books for young readers, she works as a freelance children's book editor and children's book buyer at an independent bookstore. She has published articles in newspapers and magazines, both in print and on the Internet, about everything from celebrities for TV Guide, to venomous pet snakes for her monthly pet column, "Unleashed." She has a master's degree in children's literature from Simmons College.

Pre-Reading Activity

Make a list of risks from the weather that are more likely in your own area. If you were in charge of making sure that people in your area react appropriately to these threats, what kind of preparation, if any, would be prudent? Design a program and assess risks.

Pick a spot in the United States as far away north, south, east, and/or

west as possible from your location. Have students try to find three or more connections that link their neighborhood to these very different geographical locations.

When knowledge becomes accepted truth, people have a tendency to merely accept it without much comment or thought. Examine why the general public used to think that the world is flat. Pretend that you have been whisked back in time and it is your job to convince folks who embrace the once accepted wisdom that our Earth is flat. Some people believe that Category-1 hurricanes aren't as dangerous as stronger hurricanes. Make a list of reasons why this false assumption can cost people their lives.

Create an annotated list of all weather-related possibilities around the world. Make sure students explain what the weather event is, where it typically happens, the temperature ranges, the type of precipitation (if appropriate), potential danger, etc.

The author has firsthand experience with hurricanes and is now writing a book about them. Derrick Herndon used his own weather station to post a daily forecast for his family when he was younger, and is now a scientist. Marilyn Vasques was her sixth-grade teacher's assistant and helped write science exams in high school. Have students make a list of science projects they are interested in today that they can envision themselves still working on ten or twenty years from now. Have students make notes for how their own experiences could result in a science career.

Discussion Questions

The news today is full of claims that risks of severe weather or global warming are greatly exaggerated, despite nearly universal acceptance of these truths. What is the role of science in confronting skepticism about science exploration? What should the government response be in terms of weather science? When does science demand precise answers and when does science ask us to take bold risks? Is it harder for scientists to confront popular perceptions? What should happen when scientists confront government policy that is not supported by current scientific research?

What is the most prevalent scientific view on the status of global warning? How much influence should scientists have on formulating the government's response on decisions on environmental policy, weather, disaster preparedness, and other areas in which scientists have and continue to collect data? Is there a point at which the people's wishes should supersede the science?

Have you ever panicked in severe weather? What steps did you (or others) take to calm yourself down? Why do you think you reacted the way you did? Is there something you or others could have done to keep you from panicking?

According to this book, many North Atlantic hurricanes begin in the Sahara Desert, which contains parts of several countries. The book says on page 62 that hurricanes "have the potential to become serious political and social problems." How important is global scientific cooperation to the study of hurricanes and other inquiries? What can scientists do when, in addition to working across language and cultural, there are also political obstacles?

One of the main thrusts of this book is to make sure coastal residents like Angela Dresch and her family have the knowledge needed to be safe. The need to use information as the basis for action, however, is balanced against the harm that may caused by overstating the problem. As the book states in several places, hurricane science is also people science. What would you do to make sure that the tragedy that took Angela's life does not happen again without causing serious economic and social problems by overstating the likely risks from something as potentially dangerous as a hurricane?

Applying and Extending Our Knowledge

The book begins with a Category I hurricane colliding with another storm to become a "super storm." If you look at the infographic on page 12 it shows us how a hurricane forms, but it does not explain what happens when a hurricane runs into another storm.

- Prepare an infographic or online presentation that

explains the anatomy of a super storm, and then prepare an infographic that shows the cumulative effect of a hurricane and super storm.
- Repeat the "Fast Facts" found on page 11 with a similar set of fast facts for a super storm.
- We learn that wind span, wind speed, storm surge, air temperature, water temperature, etc., are some of the factors that contribute to the destructive power of a hurricane like Sandy. If you were designing a scenario for the most destructive hurricane possible, what elements would be in place? Where would this hurricane be? When would it happen? Make sure to do research so that you do not forget to factor in things like ocean currents and high and low tides. Write a justification to support your location, date, and other elements. Should several individuals or groups come up with very different locations and dates, debate the merits of each and determine whether or not a consensus is possible.

Common Core Connections

CCSS.ELA-Literacy.RH.6-8.7 Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
CCSS.ELA-Literacy.SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
CCSS.ELA-Literacy.W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of content.
CCSS.ELA-LITERACY.W.6.1(a-d) Write arguments to support claims with clear reasons and relevant evidence.

On page 3, we read that Hurricane Sandy affected twenty-four states.

- Show a map of all the states affected.
- Divide your students into teams to investigate the relative effects of the storm state by state. Prepare a spreadsheet or graphic that shows the effects monetarily and, when appropriate, physically (especially in ways that alter existing landforms, destroy iconic features, or inflict large-scale destruction on urban areas). Create a ranking, as close as possible, that shows the financial losses by state. Make sure to discuss the estimated long-term costs that cover things like decrease of tourist revenue.
- On page 5 we read, "Residents were trapped, surrounded by a contaminated, highly combustible flood." Prepare an animoto video or similar one that explains how a flood can catch fire.

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On page 6 we read, "Hurricane Sandy marked a technological shift in disaster survival. Social media platforms were used as a form of digital SOS."

- How did residents cope with hurricanes before smartphones, Twitter, and other social-media platforms? Prepare a chronology or a history of how our responses to disaster have shifted over the years. Prepare an addendum that speculates on what future roles technology will have in responding to disasters such as hurricanes.
- Research your school's policy on technology and social media. Does your school have a technology plan for coping with possible emergencies? How does your school's policy compare with what you read about Emily Rahimi? Adapt the list of preparations and planning shown on page 65 for your school.
- On page 7 we read, "New York and New Jersey residents were continuing to struggle with rebuilding their communities, but it was even more difficult for them to rebuild their hope. Each year they worried that disaster might strike again." The previous most destructive hurricane in the United

States was Hurricane Katrina. Research the progress or the problems in rebuilding New Orleans. How do the residents view rebuilding today? Has, for example, the Ninth Ward in New Orleans been rebuilt to its pre-hurricane condition? What does Katrina suggest for rebuilding efforts in New York and New Jersey? Or what makes the circumstances of these two hurricanes different?

Common Core Connections

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CCSS.ELA-LITERACY.W.6.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
CCSS.ELA-LITERACY.W.6.1(a-d) Write arguments to support claims with clear reasons and relevant evidence.

The second chapter has us traveling to the Sahara Desert to study the physics that underpin the formation of hurricanes.

- To see how our population may have problems understanding something like a hurricane, interview a hundred students not in your class and with no information from this book. Ask these students to point on a world map or globe to any locations they believe responsible for hurricanes starting. Record where on the map they predict (but do not show subsequent students the results of anyone else's prediction—you want students predicting independently). Keep track of any reasons behind the student's prediction(s). When one hundred students are interviewed, put pins in the map or mark an online map to show the current popular thinking about where hurricanes begin. Depending on the answers, you should have many new projects to design. For example, if very few students point to the Sahara Desert, students could create an advertising campaign to increase the awareness of our global connections.
- Spin a globe and have a student randomly stop it or toss a beach-ball globe to a student and have the student record where his right index finger is pointing. Find a connection between this location and where you live. The next person will need to find a connection with the previous location as well as their neighborhood, etc. The goal is to recognize that whether it is oxygen created in the Amazon Basin or hurricanes that might originate in the air over the Sahara or smartphones built in China, it is virtually impossible to find a place on the planet that does not depend on the natural forces or the human activity of some other place.
- To gain an appreciation of the size of the Sahara Desert, have students superimpose it over the continental United States. What happens? How many duplicates of your state would be required to equal the size of the Sahara Desert? If time permits, ask students to think about the diversity of habitats in the continental United States. The Sahara Desert is bigger than the United States. If students look only at the map on page 8 and the picture on page 9, they may not gain an appreciation for the diversity of a desert that is bigger than the continental United States. Have students prepare a poster or a report showing the diversity of plants and animals across this region. Have students prepare reports showing the similarities and differences of the Sahara in each of the different countries this desert comprises. Have students speculate on why it is getting bigger. Have students compare and contrast the Sahara with the Arctic or Antarctic.
- It is one thing to read about the Coriolis effect and quite another to see a gif or an animated video showing just exactly what this means visually. Have students prepare a demonstration for younger students showing how the Coriolis effect influences the rotation of hurricanes that happen along our coasts. Make sure this demonstration explains how the Coriolis effect works.
- We learn in this chapter that hurricane names repeat every six years unless they are retired. Fast-forward five hundred years. The world needs new names for hurricanes. Prepare a presentation that shares the history of this naming convention and then makes a case for adding new names.

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Many folks know that NASA is the organization that takes us to outer space. A smaller number may be aware that NASA is also in charge of studying severe weather.

- Create an Animoto video or iMovie casting various classmates as various storms or weather conditions to share with younger students. Using the editing tools, make the various storms/classmates bigger or smaller so that they are as close to scale as possible. Using what you know about the storms and weather, write a character introduction for each one and encourage classmates to act out their weather patterns. Have students design costumes for each storm or weather condition based on information found within the NASA website. Share this video with younger students as an introduction to various weather conditions, including the relative sizes of storms or the amount and type of precipitation, wind speed, intensity, etc. Include a nonfiction info graphic showing the various weather patterns. Students should write arguments to justify their interpretations for the various depictions. Work with your school or public librarian to document the sources used accurately.
- Record weather data for the entire term for eight different locations, including your own towns that are spaced as far apart as possible. Four of the locations should be in the Northern Hemisphere and four should be in the Southern Hemisphere. Four should be eastern and four should be western. Record high and low temperatures, type and amount of precipitation, humidity, wind speed, sunrise, sunset, and other information that would be reported locally (such as the times of high and low tide). Be sure to include notes about any atypical or noteworthy weather events. Graph the high and low temperatures, sunrise and sunset, and other information. Each month or week, summarize the weather for each of the eight areas.
- On page 17 we read, "If their high-altitude stakeout pays off, data collected by the mission could help rewrite the science of hurricane prediction. HS3 might save thousands of lives by helping meteorologists create more accurate hurricane intensity forecasts." Write an explanation for how current intensity forecasts are done and speculate on how using these drones to fly over hurricanes could lead to better forecasts. What new information would make this possible?
- Research meteorologists around the world are currently divided on the role of Saharan dust in hurricane formation. Have various teams take turns debating the significance or lack of significance dust has for a hurricane. In the debate, a casual listener should understand how the dust gets into the atmosphere and how it either does or does not affect the storm intensity. HS3 scientists hope that the drones will settle this question. How?
- Much of a meteorologist's work is looking at data. Scientists look at graphs, tables, plots, diagrams, and many more data displays to interpret any given situation, event, etc. Collect samples of many different types of data displays and remove all the identifiers. You could have a table with weights of elephants, temperatures on the moon, or numbers of calories in cereal. You could have a bar graph of stock prices, a pie graph of votes for various candidates, or the wind speeds in a hurricane over time. The point is to make sure that students do not know any of the labels or keys to the data collected. The goal is to get students to look at the data and figure out what they could potentially be describing. Students must explain why their labels make sense. There are many useful variations to this activity. For example, you could give students a table with twelve rows and two columns showing the high and low temperature each month. The students' job is to look at the data and figure out possible locations for this data. You could show only the daytime temperatures in the Sahara Desert and ask students to predict where you are. Then you could show only the nighttime temperatures and ask the same question. You could form a graph of wind speeds arrayed chronologically and have students identify where the mistake is in the graph based on what they know about hurricanes. The

point is for students to see data as a tool that can be used to solve problems as well as one that can be misleading if the information is entered poorly or out of context.
- Data entry and using data requires that scientists be skilled at recognizing when there are errors. Have students research several different ways that data can be corrupted, misleading, in error, or misinterpreted. Have students research the ways any science organization protects itself from data-entry errors and misinterpretation of data.

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CCSS.ELA-Literacy.SL.7.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-Literacy.W.7.7 Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-LITERACY.W.6.1(a-d) Write arguments to support claims with clear reasons and relevant evidence.

Scott Braun is a meteorologist and was a storm chaser. He says, "We had some fun landings just trying to keep our lunches down!" (p. 29).

- Make a chart of all hazardous weather storms. Create the criteria for rating danger from the various storms and then rank the storms from the least dangerous to the most dangerous.
- Create a poster showing what the average person should do to minimize the danger.
- What experiences does your class have with hazardous weather? Record, if possible, the class's history with various types of severe weather, keeping in mind that some students may not be willing or able to speak of storms that have caused destruction or even deaths in their own family.
- Create a poster or build models showing the differences between a drone, a turboprop plane, and other types of planes. Make sure we know why Chris Naftel thought drones would work better than turboprop planes to collect information. Do a slideshow showing the evolution of the vehicles used to study severe weather.
- The eye of a hurricane is vastly different from the outer edges. If you were selecting music to define a hurricane, which music would you choose? Play your music and then explain it in terms of the teams's storm-chasing flights into and out of the eye of a hurricane. Work with your school or public librarian to cite your music correctly and provide a brief annotation with the rationale for each piece of music selected.
- The North Atlantic hurricane season runs from June 1–November 30. Explain why we do not worry as much about hurricanes in January or the other months. Prepare an online or poster presentation explaining how the hurricane season works. Your presentation should include weather information around the globe.

Common Core Connections

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On page 33 we read, "The entire planet is divided into Flight Information Regions." Later, on page 45, we read that the Global Hawk's flight plan must be filed with the FAA twenty-four hours in advance for safety reasons.
- Do an Animoto or similar video or create a poster

or online presentation that explains what is meant by a Flight Information Region. Write a justification for elements included in your video as well as a rationale for any excluded elements.
- Show a map with a Flight Information Region for a small country like Zimbabwe. Also try a large country such as the United States, and then the Indian Ocean.
- Contact an airport in your area and speak with someone who works in a control tower. Research how flight plans are established, monitored, and adjusted. Which flights have priority? How do priorities change? Do rain, snow, and other weather events change how flight plans are created? Bring in a speaker to discuss flight plans and answer questions. Do current events influence or change how flight plans are derived? How does one become an air-traffic controller?

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CCSS.ELA-Literacy.RH.6-8.7 Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

On page 35 students are asked the activity question for this section: "How can meteorologists possibly analyze a storm that is hundreds of miles wide and thousands of miles tall?"

- Research data on hurricanes. Find the widest and tallest hurricanes. Find the skinniest and shortest hurricanes. Find the widths and heights of at least five more. Graph them.
- If a hurricane is 300 miles wide and 5,000 feet tall, how far away and where would a person need to be to see the entire thing? However, the farther away we move from an object, the less detail we can see. List the advantages of being able to see the entire hurricane and the advantages of being able to see some parts of the up close.
- When Cherrix moves us into the stratosphere in chapter 5, we are introduced to several devices the Global Hawk carries to see both the whole hurricane and the details. The first is the AVAPS, which launches dropsondes. We meet S-HIS, which scans storms from high altitudes. We read about Cloud Physics Lidar, which helps us to understand cloud structure within a hurricane. We have a GHOC computer workstation. There is a section describing how each of these work. However, if you wanted a younger student to understand, say, CPL, could you write a skit, create illustrations, make a movie, or do a presentation that would make these terms easier?
- When the Global Hawk conducts its flights, it uses either a lawn mower or a butterfly pattern. What music would be played when the Global Hawk is in a lawn-mower pattern? What music would be played in butterfly pattern? Create an annotated playlist with a justification for your choices. Create a dance for each that would interpret the differences for each pattern.

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On page 55, "The conclusion of a large field campaign is just the beginning of scientific discovery. A scientist may spend years on the same problem with little or no results. A successful scientist must be patient, curious, open-minded, and fiercely determined, no matter how long it takes to find answers."

- Nominate a classmate for the position of Successful Scientist. Rate this person based on the terms above: patient, curious, open-minded, and fiercely determined. Prioritize these terms and make a case for this person (anonymously, if that is easier).
- Looking at these same terms, which one is your biggest strength? Assuming you became a successful scientist, which of these attributes would

come closest to explaining your success? Include specific examples of things you have done that justify your answer.

- The last chapter states that science alone is not enough to protect people. The government must be prepared to keep citizens safe in a weather emergency. Find an example of when our government has done this well and when our government has not responded so well. Do not use the examples of the Bhola Cyclone, Hurricane Katrina, or Hurricane Sandy, mentioned in this book. What should governments all over the world learn from the examples you have selected? Write a persuasive essay, prepare an advertising campaign, a speech, or another creative way to convince us of how our world should proceed to keep citizens as safe as possible in the event of a severe weather emergency. Include the roles of science and government.

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Other Websites to Explore

The NASA Space Weather Action Center site is a place well worth spending a good amount of time. www.sunearthday.nasa.gov/swac/data.php

NASA has an excellent site for these interested in astronomy: www.nasa.gov

The National Oceanic and Atmospheric Administration (NOAA) has excellent information as well: www.noaa.gov

Crystal Wicker runs the Weather Wiz Kids site. This has easy-to-understand information for younger students: www.weatherwizkids.com/about-crystal.htm

National Geographic has a video about hurricanes that is worth watching, in addition to the other links and information with the *National Geographic* site: video.nationalgeographic.com/video/101-videos/hurricanes-101

Further Reading

In addition to the Seymour Simon book on hurricanes listed on page 66, Seymour Simon has several other books in this Smithsonian series that students will find useful, including books on lightning, tornadoes, weather, and storms.

Carnahan, Chris; Laura Zieger; Kimberly Crowley. *Drones in Education: Let Your Students' Imaginations Soar.* International Society for Technology in Education, 2016.

Day, John A. & Vincent J. Schaefer. *Peterson First Guide to Clouds and Weather*. 2nd. Edition. Houghton Mifflin, 1998.

Fleisher, Paul. *Doppler Radar, Satellites, and Computer Models: The Science of Weather Forecasting.* Lerner Publications, 2010.

Fleisher, Paul. *Gases, Pressure, and Wind: The Science of the Atmosphere.* Lerner Publications, 2010.

Gregory, Josh. *The Superstorm: Hurricane Sandy (A True Book).* Scholastic, 2013. Note: This series includes MANY books on all sorts of weather types.

National Audubon Society. *National Audubon Society Field Guide to Weather: North America.* Knopf, 1991.

New York Post. Sandy: A Story of Complete Devastation, Courage, and Recovery. Triumph Books, 2013.

Turton, David. *Aftermath—Images of Superstorm Sandy at the Jersey Shore, Vol. I—Ocean County.* Jersey Shore Publications, 2013.

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