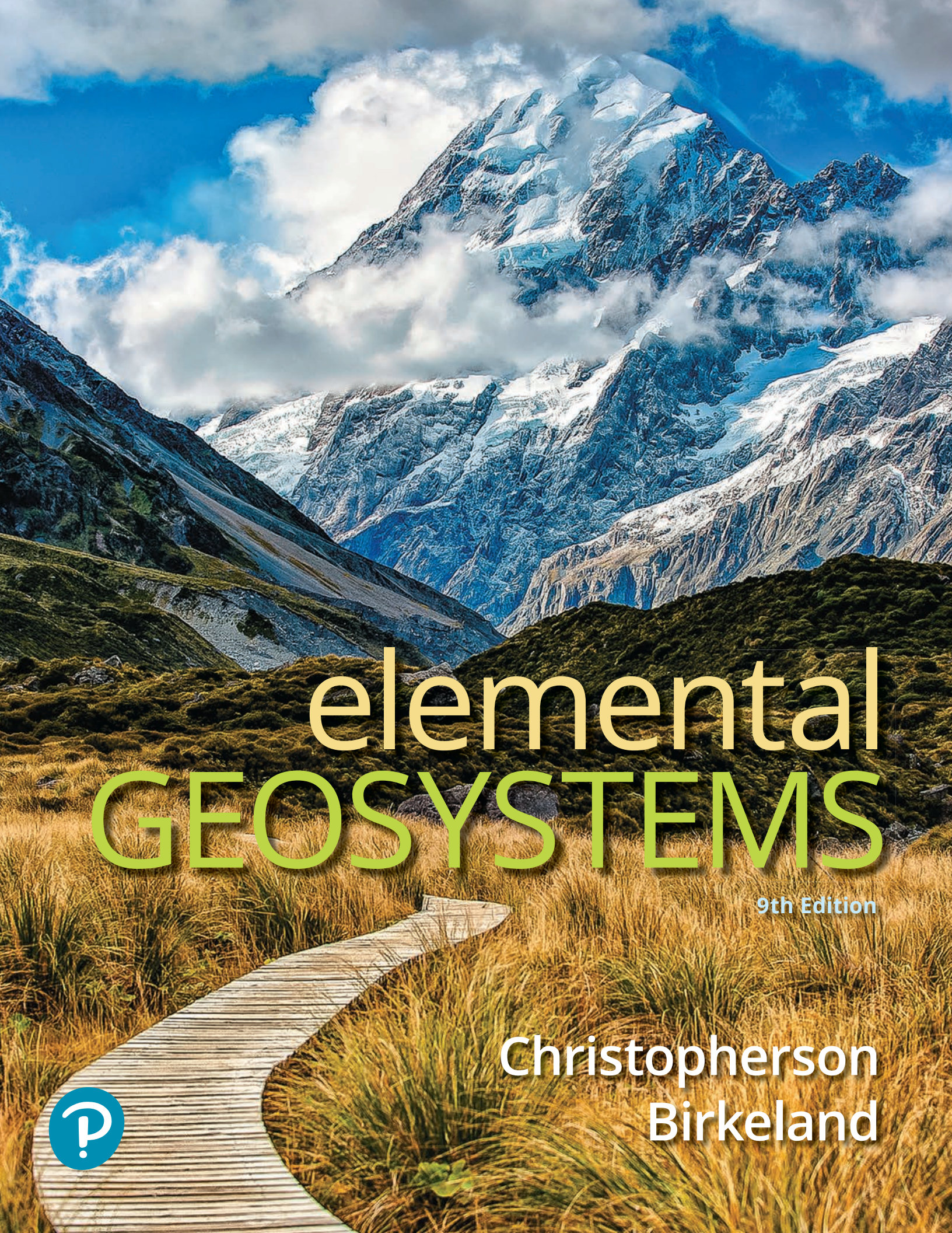

elemental GEOSYSTEMS

9th Edition

Christopherson
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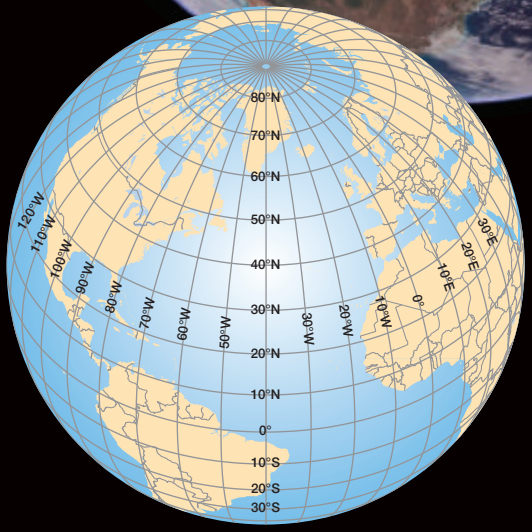
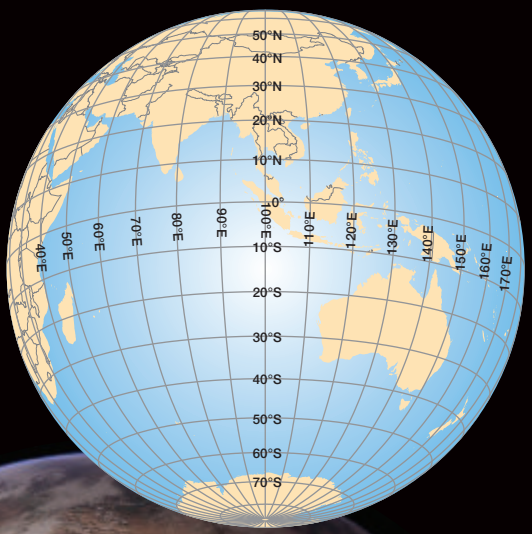
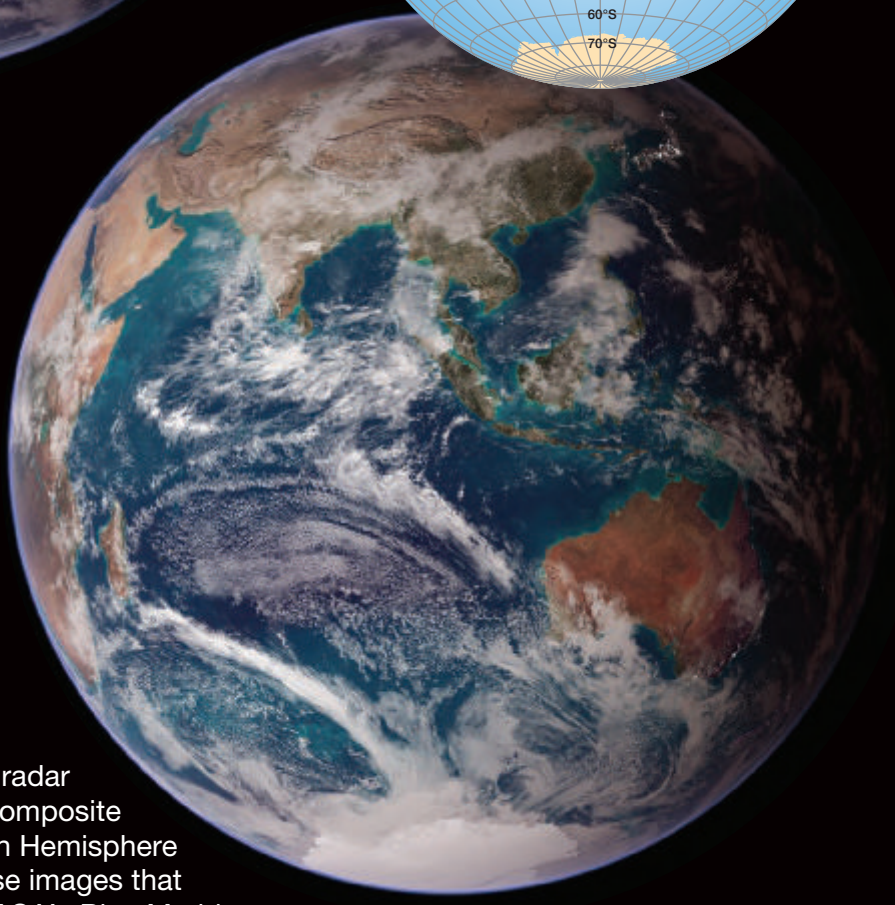
Western Hemisphere



Eastern Hemisphere





Multiple images from satellites *Terra*, *Aqua*, *Radarsat*, and *Defense Meteorological Satellite*, and from Space Shuttle *Endeavor's* radar data of topography, all merge in a dramatic composite to show the Western Hemisphere and Eastern Hemisphere of Earth. What indications do you see on these images that tell you the time of year? These are part of NASA's Blue Marble Next Generation image collection.

[NASA images by Reto Stöckli, based on data from NASA and NOAA.]

Elemental Geosystems explores Earth systems and human–Earth connections.

PART I
Energy–Atmosphere System

Gases and particulates make up the air we breathe and filter the Sun's harmful radiation. Energy from the Sun drives atmospheric circulation.

Montezuma Hills, California

Solar and wind resources provide power for human societies.

PART II
Water, Weather, and Climate Systems

Water in the atmosphere and on Earth's surface affects weather and climate. Water availability is critical for humans and other organisms.

Plitvice Lakes, Croatia

Earth's changing climate alters precipitation patterns and increases periods of drought, making human water supplies less dependable.

PART III
Earth–Atmosphere Interface

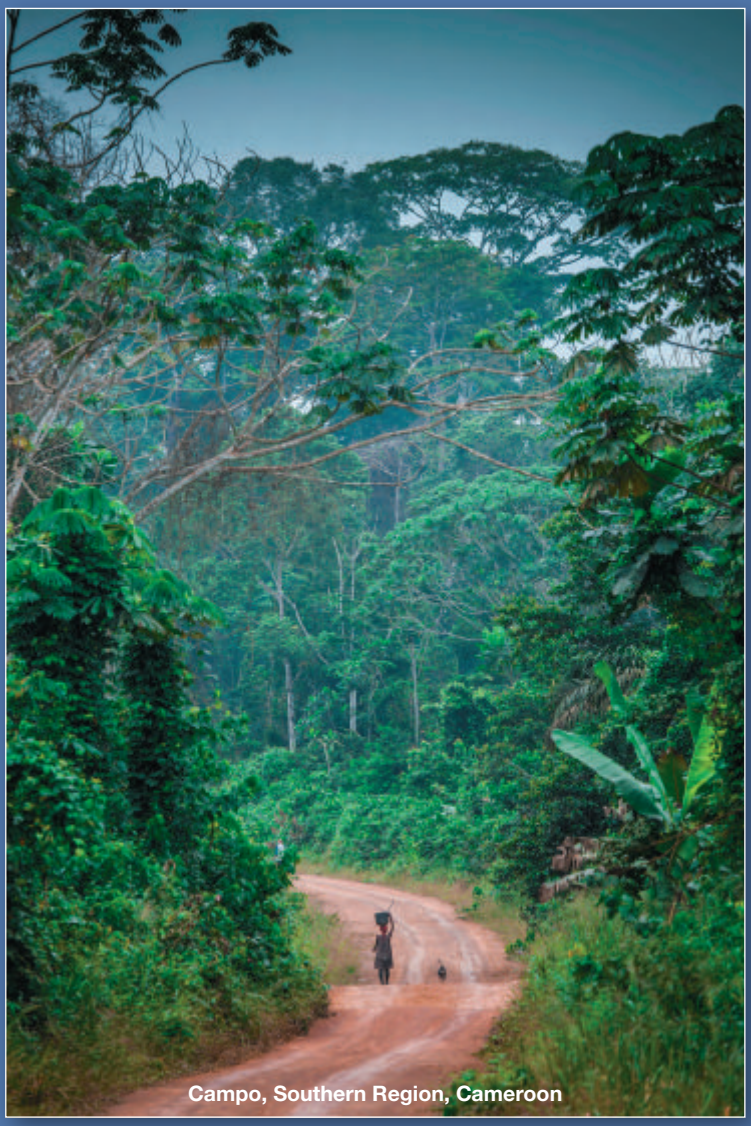
Forces within Earth build and warp crustal landforms at the same time that processes on Earth's surface wear landforms away.

Valley of the Moon, Atacama Desert, Chile

Earth's desert landscapes are changing with ongoing development, poor land use practices, and drought related to climate change.

PART IV
Soils, Ecosystems, and Biomes

Solar energy powers the biosphere as plants and algae convert sunlight into food. Soils are the medium for plant growth.



Campo, Southern Region, Cameroon

Tropical rain forest removal for development, ranching, palm oil, and forest products is ongoing, putting rainforest species at risk.

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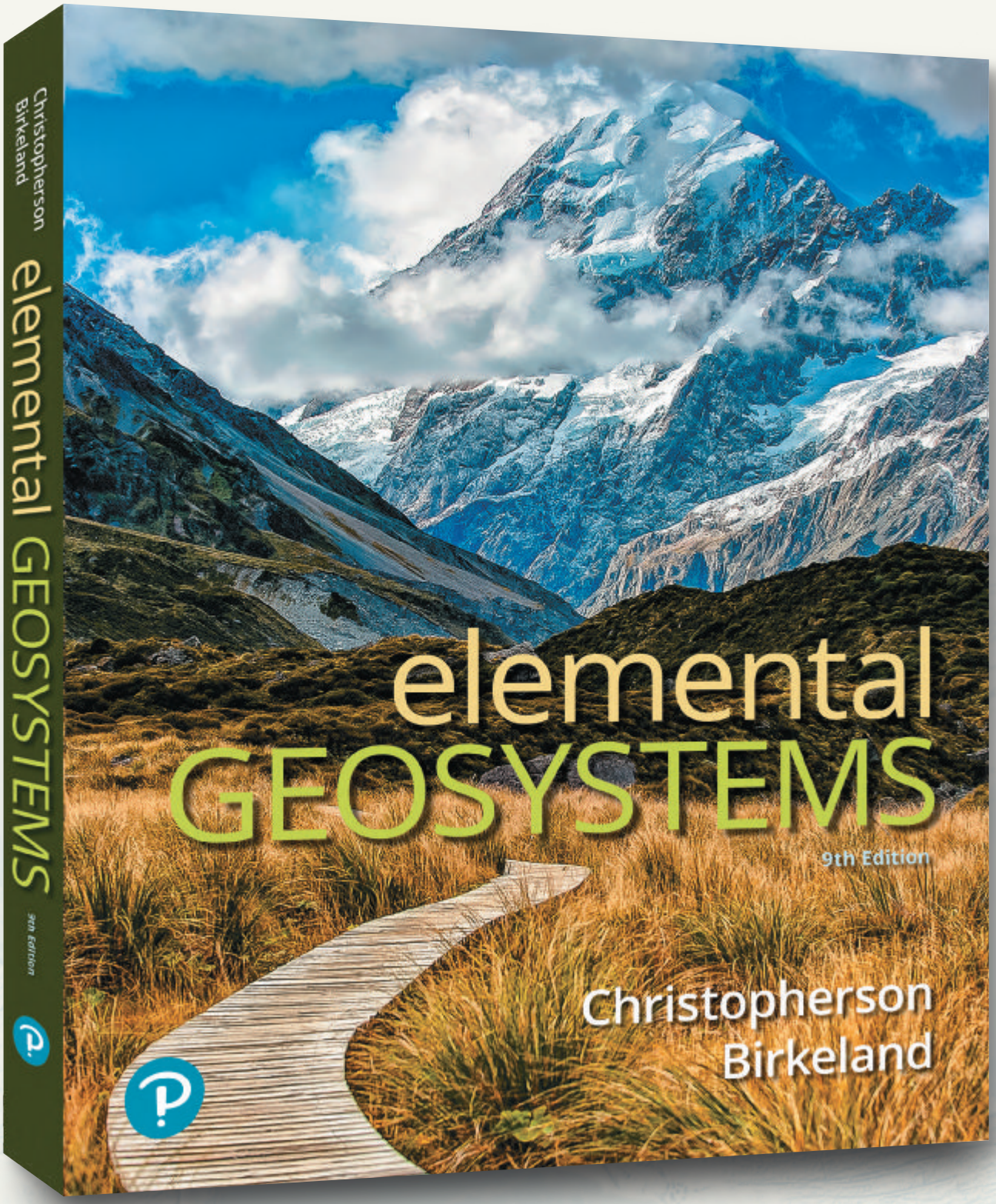
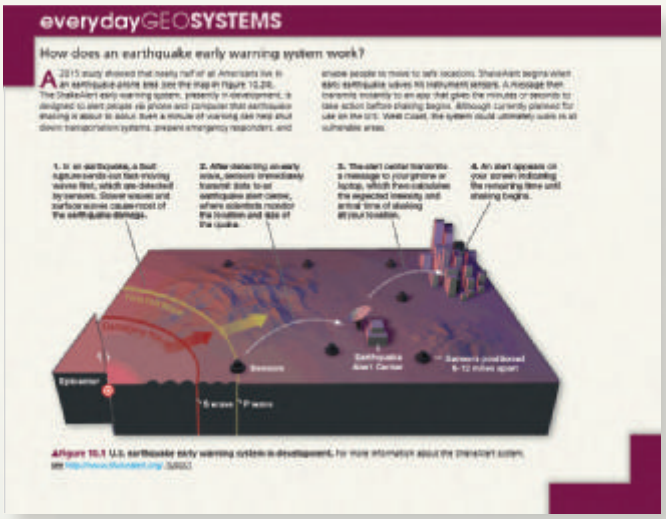
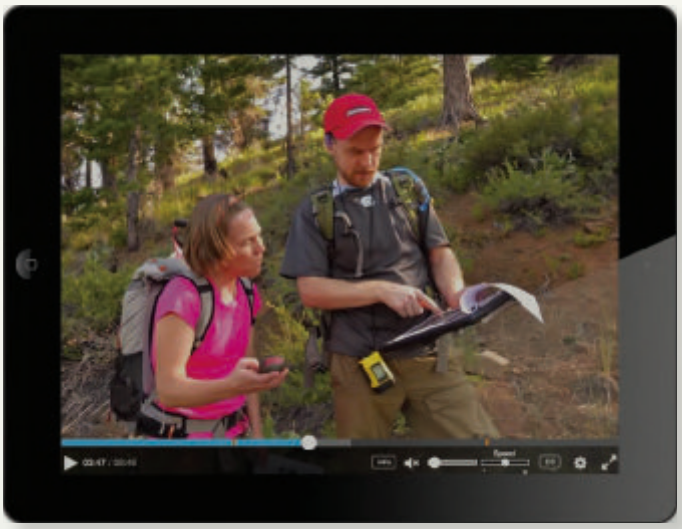
Explore Earth's Dynamic Systems



Real-World Physical Geography

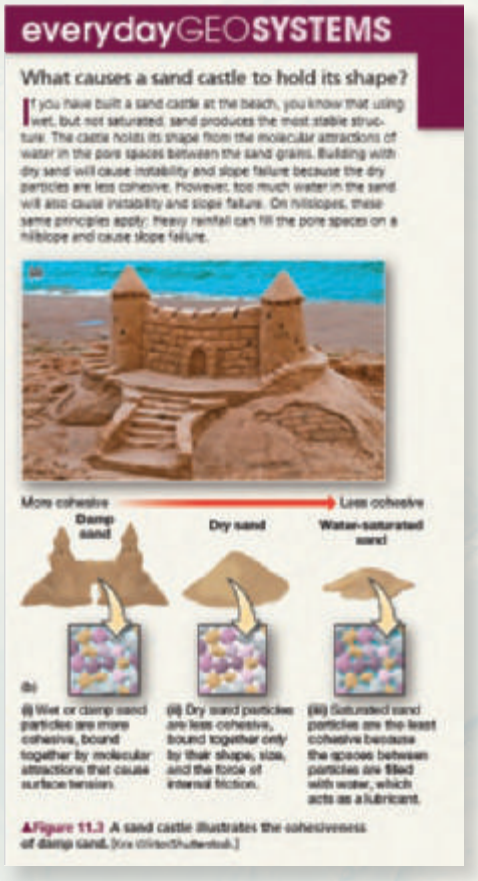

everydayGEOSYSTEMS

How does an earthquake early warning system work?



NEW! Everyday Geosystems features at the beginning of each chapter invite the reader to explore the "why" and "how" application of physical geography concepts to everyday phenomena.

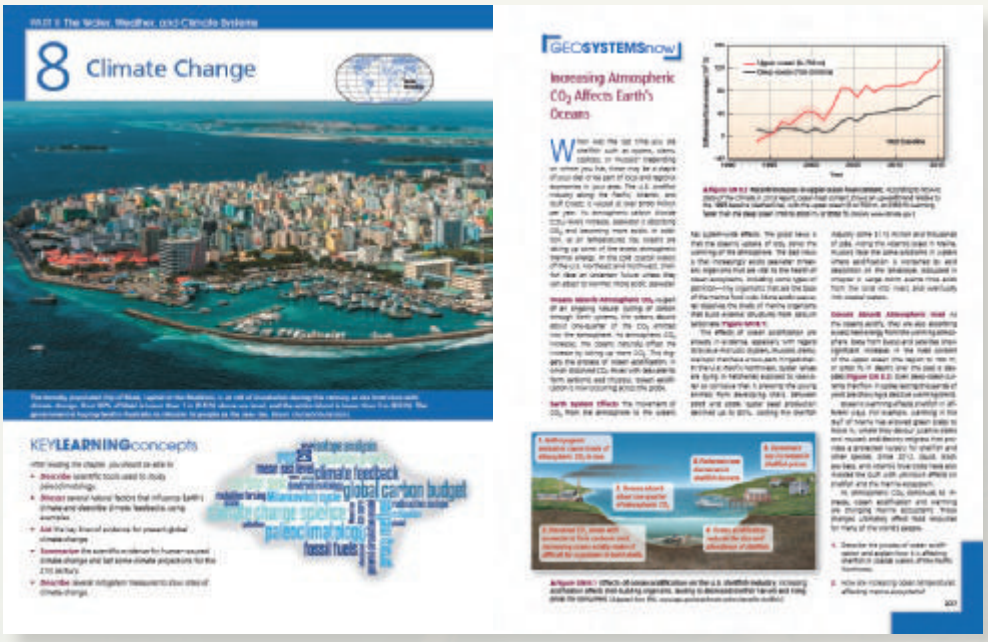
NEW! Mobile Field Trips by acclaimed geoscientist, photographer, and pilot Michael Collier transport students out into the field to explore the patterns and processes of North America's physical geography.


everydayGEOSYSTEMS

What causes a sand castle to hold its shape?

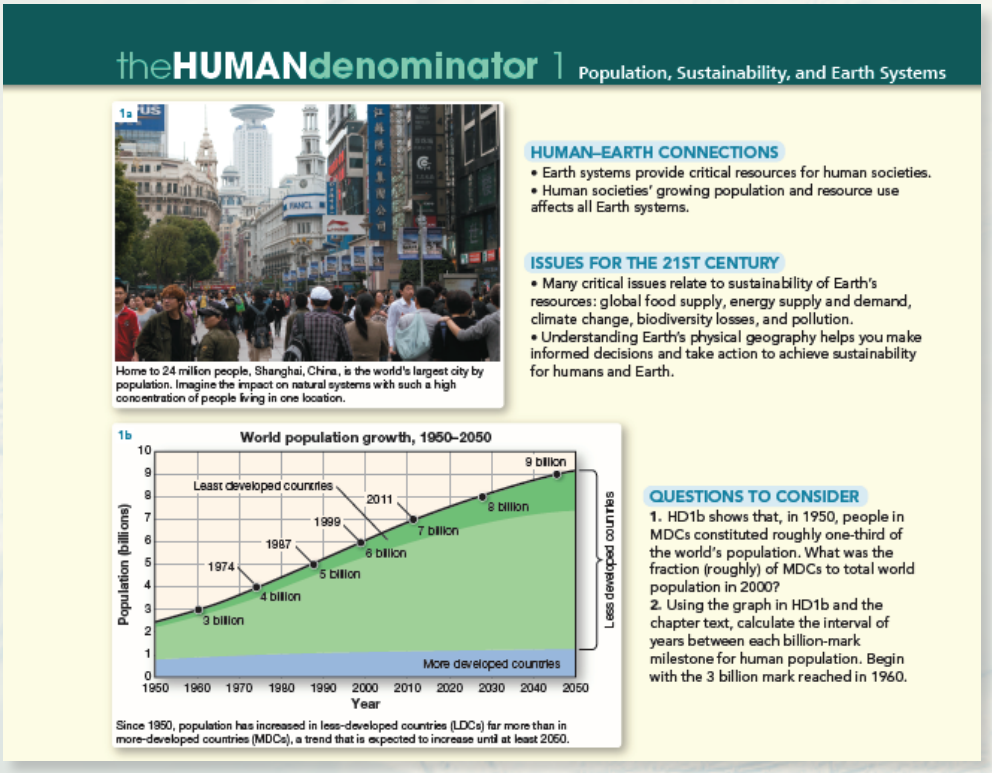
NEW! Project Condor Quadcopter Videos capture stunning footage of the Mountain West region with a quadcopter and a GoPro™ camera. Annotation, sketching, and narrations help students learn about monoclines, streams, terraces, and much more.

Our Fast-Changing Earth Systems



UPDATED! Unique to *Elemental Geosystems*, Chapter 8: *Climate Change* presents a comprehensive overview of climate change science, exploring paleoclimatology, climate feedback, evidence and causes of present climate change, climate models and projections, and steps we can take to moderate Earth's changing climate.

UPDATED! The Human Denominator at the end of most chapters helps students explore the connections between humans and Earth's physical environment and the critical issues facing us in the 21st century. New *Questions to Consider* ask students to interpret graphs and maps in the feature and connect information to topics within the chapter.

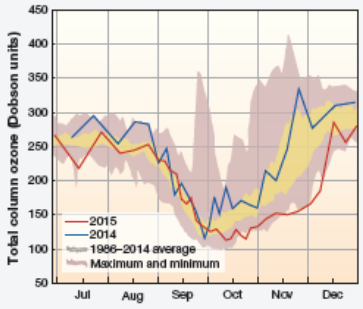


Integrated Active Learning Tools

WORKITOUT 2.5
Antarctic Ozone Depletion

The graph in **Figure WIO 2.1** shows that seasonal ozone depletion at the South Pole still occurs despite decreases in ozone-depleting chemicals.

1. What months showed the greatest ozone depletion in 2015 and 2016?
2. Which of these 2 years recorded lower total ozone in October? Which year recorded higher ozone in December?
3. Based on the chapter discussion, explain the difference in December versus September Antarctic ozone levels.



▲**Figure WIO 2.1 South Pole Ozone.** [NOAA.]

NEW! Work It Out activities integrated throughout each chapter give students a chance to practice basic conceptual or quantitative reasoning as they read.

WORKITOUT 9.1
Digging a Hole Through Earth

Suppose you could drill a hole straight down through the center of Earth to the other side? What conditions would you encounter?

1. Would your drilling project pass through solid rock or molten magma or both? Describe the order of solid or plastic materials you would encounter.
2. At what point would you encounter the highest temperatures? The highest pressure?
3. If you jumped into the hole, would you fly out the other end at maximum velocity? What force would control your speed?

Go to http://indianapublicmedia.org/amomentofscience/hole-in-the-earth/ for answers and more information.

NEW! Apply Concepts features, part of the text's hallmark *Focus Studies,* are active learning tasks and short activities that compel students to reflect on the information they have learned from these rich case studies.

APPLYconcepts Part 1. List advantages and disadvantages of geothermal energy.

Advantages	Disadvantages
a.	a.
b.	
c.	b.
d.	

Part 2. Is geothermal energy a renewable or nonrenewable resource? Explain.

APPLYconcepts Referring to Figure 11.1.3, determine the largest rockfall that has occurred in each season, and check the appropriate box in the table. Then, taking into consideration the rockfall data and the factors that influence mass movements, write a hypothesis that might explain the seasonal distribution of rockfalls in Yosemite.

Volume of Rockfall	Winter	Spring	Summer	Fall
200,000 m^3 or above				
Between 20,000 m^3 and 200,000 m^3				
20,000 m^3 or below				

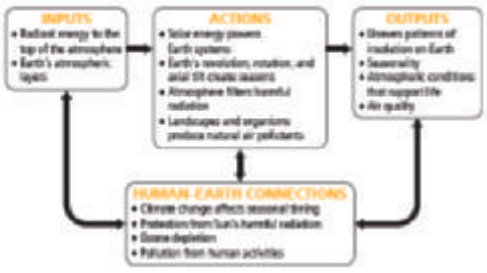
EARTH SYSTEMS CONNECTIONS

Seasons and the Atmosphere

Review the topics of Chapter 2 organized in a systems flow diagram.

Summarize the System

1. Explain the "action" related to the atmosphere and radiation. Which layer of the atmosphere filters ultraviolet radiation? How have humans affected that layer?
2. Explain the "inputs" and "actions" that cause seasonality? How has human-caused climate change impacted the timing of the seasons? Give an example.



NEW! Earth Systems Connections features ask students to explore the cascading system operations that are the basis for chapter organization, emphasizing the inputs, actions, outputs, and human–Earth connections relevant to each chapter.

Mapping Earth's Dynamic Geography

INTERACTIVE **Mapping** 8

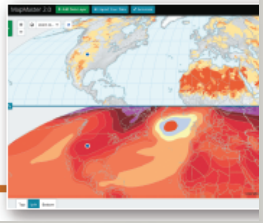
Worst-Case Projections for Surface Warming

Open MapMaster 2.0™ in the Mastering Geography Study Area and add the **Global Surface Warming, Worst-Case Projections** data layer.

1. As part of the worst-case projection, which world regions will see the highest temperature rise? What phenomenon explains the pattern you see? (Hint: Look back to the section *Global Temperature Increase* in Chapter 3, page 98.)

Add **Drought Risk** as a second data layer in split screen. Probe the two world maps.

2. What correlations, if any, do you find between high or extremely high drought risk and worst-case temperatures greater than 4°C? Describe the spatial patterns. How will higher temperatures affect drought risk?
3. What is the worst-case projection for warming at your home or school? What is the drought risk?



INTERACTIVE **Mapping** 10

Recent M 4.5+ Earthquakes

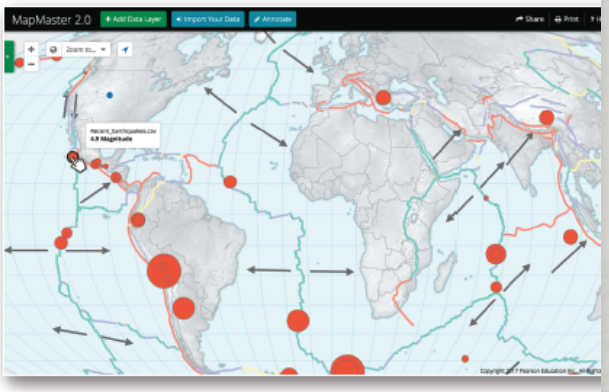
Navigate to the USGS Earthquake Hazards Program page by typing "USGS earthquakes of the day spreadsheet" in a web browser. Under the tab **Data and Tools**, click on **Spreadsheet Applications**. In the **Past 30 Days** column at right, click on **M4.5+Earthquakes** to download data.

Open MapMaster 2.0™ in the Mastering Geography Study Area, choose **Import Your Data**, and *Browse* to the USGS file *4.5_month.csv*. Choose to display *Locations with numbers* and select the column *mag*. Probe the world map.

1. How many M4.5+ earthquakes occurred in the United States in the past 30 days, and where were they located?

Add the **Plate Tectonics** data layer; choose *Ring of Fire* among the group data layers on the map.

2. Describe the distribution of earthquakes in relation to the Pacific Ring of Fire. In which country or world region did the largest magnitude quakes occur?
3. Activate *Geolocation*. Using the *Measure distance* tool, determine your distance to the nearest earthquake. What was the magnitude? Did the quake occur on land or on the ocean floor?



NEW! Interactive Mapping exercises at the end of each chapter direct students to GIS-inspired MapMaster 2.0™ interactive maps in Mastering™ Geography, where they can access, manipulate, analyze, and create maps related to each chapter's topics.

GEO**SPATIAL** ANALYSIS

Mapping Wildfire Danger

Wildfire occurrences are increasing with climate change, which has caused increased spring and summer temperatures, earlier spring snowmelt, drought, and dry soil conditions. Warming temperatures have also encouraged the spread of insects and disease that damage and kill trees, adding to dry forest fuels that help wildfire spread.

Activities

Go to the National Interagency Fire Center (NIFC) fire potential map at http://osgeodata.fs.fed.us/forecast/#/outlooks?state=map. Examine the National 7-Day Significant Fire Potential map for the present date.

1. What is the fire potential in your area?
2. In which U.S. regions, if any, do you see low or moderate fire risk?
3. Click on a region on the map that has low or moderate wildfire risk. Move your cursor over the High Risk Triggers on the legend in the upper right. What are the potential triggers in this region?

Weather plays a role in determining where fires occur. Click on a region with low or moderate wildfire risk, and then click on "Forecast" in the lower left.

4. How will weather conditions be changing and how will this affect the fire potential?
5. In general, what weather conditions tend to raise fire potential? Describe the optimum environmental conditions for wildfires.

In a different window, open the U.S. Drought Monitor map at http://droughtmonitor.unl.edu/.

6. Compare the Fire Potential map to the Drought Monitor map. How do areas of low-to-moderate fire potential compare to areas experiencing drought? Describe what you find.

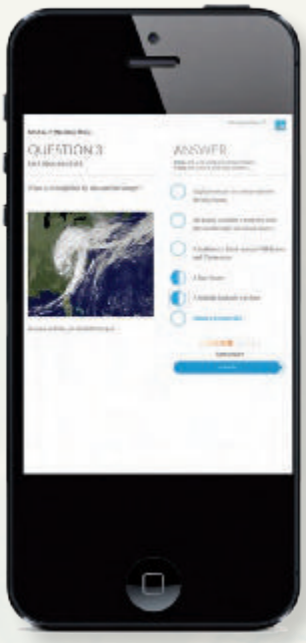
Go to the Active Fire Mapping Program's Current Large Incidents map at https://fsapps.nwcg.gov/afm/index.php.

7. How many large fires are currently active?
8. Where are the fires located in relation to low-to-moderate fire potential regions and drought regions?
9. Click on a fire currently displayed on the map. Record this fire's name, location, burned area, cause, and containment status.

NEW! Geospatial Analysis exercises at the end of each chapter are mini-lab activities, sending students outside of the book to access and explore online science tools and data sets from sources such as NASA, USGS, and NOAA, performing critical geospatial data analysis.

Continuous Learning Before, During, and After Class

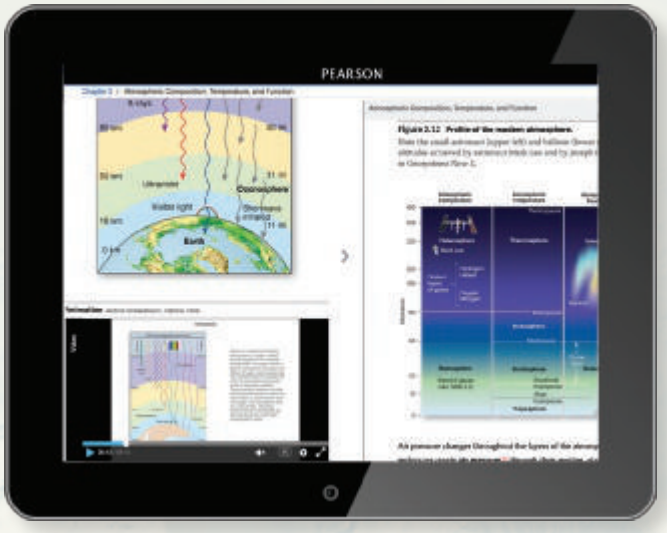
Mobile Media and Reading Assignments Ensure Students Come to Class Prepared



UPDATED! Dynamic Study Modules help students study more effectively by continuously assessing student performance and providing practice in areas where students struggle the most. Each Dynamic Study Module, accessed by computer, smartphone, or tablet, promotes fast learning and long-term retention.

NEW! Interactive eText gives students access to the text whenever they can access the Internet. eText features include:

- Available on smartphones and tablets.
- Seamlessly integrated videos and animations.
- Accessible (screen-reader ready).
- Configurable reading settings, including resizable type and night reading mode.
- Instructor and student note taking, highlighting, bookmarking, and searching.



Pre-Lecture Reading Quizzes are easy to customize and assign

UPDATED! Reading Quiz Questions ensure that students complete the assigned reading before class and stay on track with reading assignments. Reading Questions are 100% mobile ready and can be completed by students on mobile devices.

Optional eText upgrades for accompanying books

- *Dire Predictions: Understanding Climate Change,* 2nd Edition, by Michael Mann and Lee Kump
- *Goode's World Atlas*, 23rd Edition by Rand McNally

. . . with Mastering Geography

Engage Students with Learning Catalytics™

What has teachers and students excited? Learning Cataltyics, a "bring your own device" student engagement, assessment, and classroom intelligence system, allows students to use their smartphone, tablet, or laptop to respond to questions in class. With Learning Catalytics, you can:

- Assess students in real time using open-ended question formats, such as word clouds, sketching, and image upload, to uncover student misconceptions and adjust lectures accordingly.
- Automatically create groups for peer instruction based on student response patterns to optimize discussion.

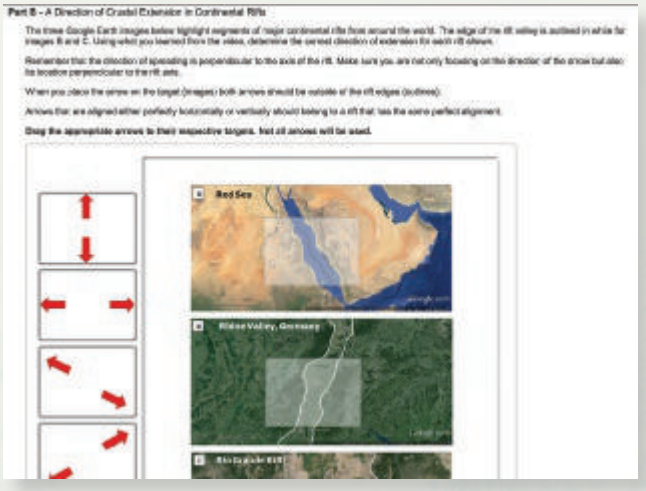
"My students are so busy and engaged answering Learning Catalytics questions during the lecture that they don't have time for Facebook."

Declan De Paor, Old Dominion University

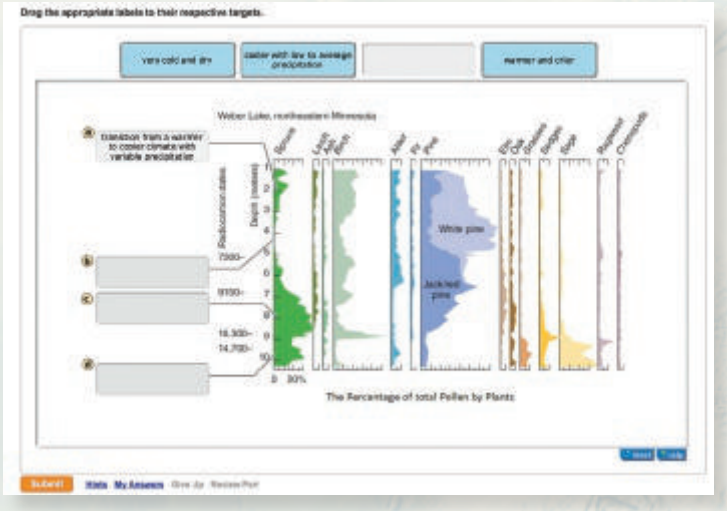
Continuous Learning Before, During, and After Class

Easy to Assign, Customizable, Media-Rich, and Automatically Graded Assignments

NEW! Mobile Field Trips by acclaimed geoscientist, photographer, and pilot Michael Collier transport students out into the field to explore the patterns and processes of North America's physical geography. Teachers can assign the videos with quizzes in Mastering Geography to assess student understanding.



NEW! Project Condor Quadcopter Video Activities include stunning footage of the Mountain West region captured with a quadcopter and a GoPro camera. Annotation, sketching, and narrations help students learn about monoclines, streams, terraces, and so much more. Teachers can assign students the videos with quizzes in Mastering Geography.

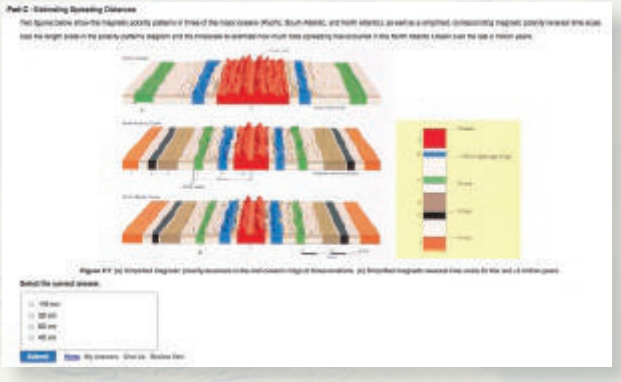


HALLMARK! GeoTutor Activities help students master the most challenging physical geoscience concepts with highly visual, kinesthetic, and data-rich activities focused on critical thinking and the application of core geoscience concepts.

www.masteringgeography.com

NEW! MapMaster 2.0 Interactive Map Activities are inspired by GIS, allowing students to layer various thematic maps to analyze spatial patterns and data at regional and global scales. The maps are now fully mobile, with enhanced analysis tools, such as split screen, allowing students to geolocate themselves in the data and upload their own data for advanced mapmaking. This tool includes zoom and annotation functionality, with hundreds of map layers leveraging recent data from sources such as NOAA, NASA, USGS, United Nations, the CIA, the PRB, the World Bank, and more.

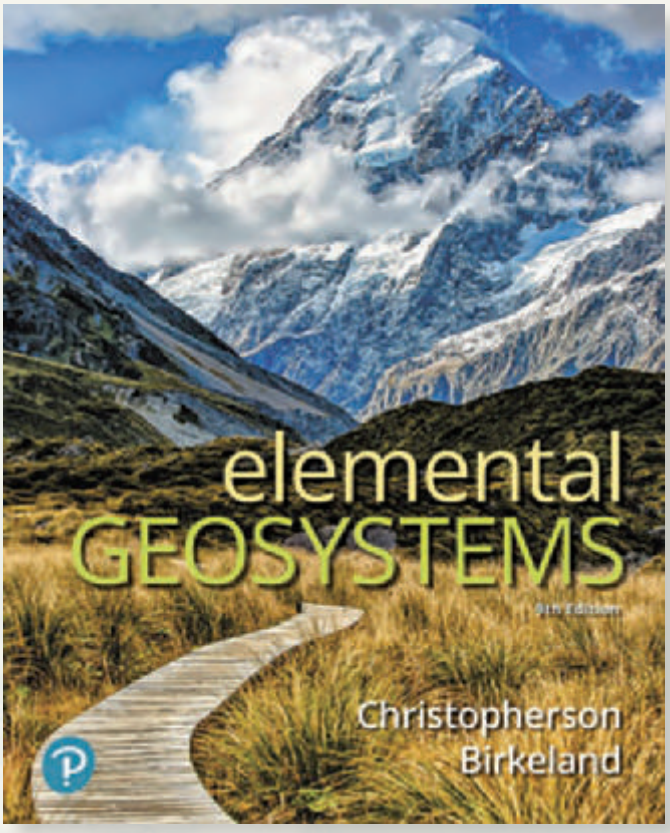
NEW! GeoLab Activities augment the chapters with online, automatically graded, and data-rich applied lab activities.



NEW! Video Activities from sources such as the BBC, Financial Times, and Television for the Environment's ***Life*** and ***Earth Report*** series provide students with applied real-world examples of physical geography in action, giving a sense of place, and allowing students to explore a range of locations and topics.

Resources for YOU, the Instructor

Mastering Geography provides you with everything you need to prep for your course and deliver a dynamic lecture, in one convenient place. Resources include:



LECTURE PRESENTATION ASSETS FOR EACH CHAPTER

- PowerPoint Lecture Outlines
- PowerPoint Clicker Questions
- Files for all illustrations, tables, and photos from the text

TEST BANK

- The *Test Bank* in Microsoft Word format
- TestGen Computerized Test Bank, which includes all the questions from the printed test bank in a format that allows you to easily and intuitively build exams and quizzes

TEACHING RESOURCES

- *Instructor Resource Manual* in Microsoft Word and PDF formats
- Pearson Community Website (https://communities.pearson.com/northamerica/s/)
- *Goode's World Atlas*, 23rd Edition
- Mann/Kump, *Dire Predictions: Understanding Climate Change*, 2nd Edition
- *Applied Physical Geography: Geosystems in the Laboratory*, 10th Edition

Measuring Student Learning Outcomes

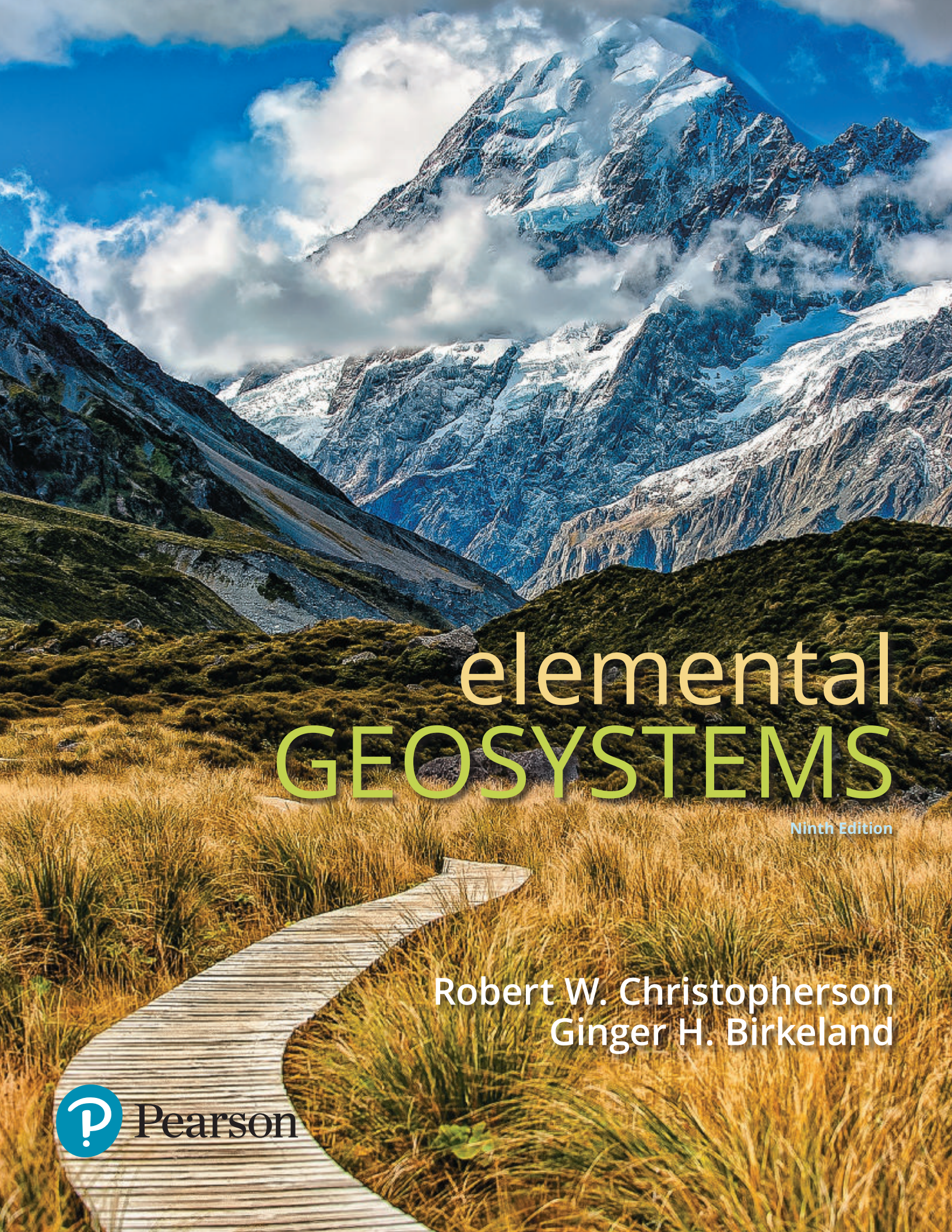
All of the Mastering Geography assignable content is tagged to key learning concepts from the book, the National Geography Standards, and Bloom's Taxonomy. You also have the ability to add your own learning outcomes, helping you track student performance against your course goals. You can view class performance against the specified learning outcomes and share those results quickly and easily by exporting to a spreadsheet.

elemental GEOSYSTEMS

Ninth Edition

about our **sustainability initiatives**

Pearson recognizes the environmental challenges facing this planet, as well as acknowledges our responsibility in making a difference. This book is carefully crafted to minimize environmental impact. The binding, cover, and paper come from facilities that minimize waste, energy consumption, and the use of harmful chemicals. Pearson closes the loop by recycling every out-of-date text returned to our warehouse. Along with developing and exploring digital solutions to our market's needs, Pearson has a strong commitment to achieving carbon-neutrality. As of 2009, Pearson became the first carbon- and climate-neutral publishing company, having reduced our absolute carbon footprint by 22% since then. Pearson has protected over 1,000 hectares of land in Columbia, Costa Rica, the United States, the UK, and Canada. In 2015, Pearson formally adopted The Global Goals for Sustainable Development, sponsoring an event at the United Nations General Assembly and other ongoing initiatives. Pearson sources 100% of the electricity we use from green power and invests in renewable energy resources in multiple cities where we have operations, helping make them more sustainable and limiting our environmental impact for local communities. The future holds great promise for reducing our impact on Earth's environment, and Pearson is proud to be leading the way. We strive to publish the best books with the most up-to-date and accurate content, and to do so in ways that minimize our impact on Earth. To learn more about our initiatives, please visit **https://www.pearson.com/sustainability.html**.



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Robert W. Christopherson
Ginger H. Birkeland

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Content Producer: Lauren Bakker
Managing Producer: Mike Early
Courseware Director, Content Development: Ginnie Simione Jutson
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DEDICATION

To the students and teachers of Earth and to applied geospatial sciences, as the discipline shows the way toward a sustainable future.

The land still provides our genesis, however we might like to forget that our food comes from dank, muddy Earth, that the oxygen in our lungs was recently inside a leaf, and that every newspaper or book we may pick up is made from the hearts of trees that died for the sake of our imagined lives. What you hold in your hands right now, beneath these words, is consecrated air and time and sunlight.

—Barbara Kingsolver

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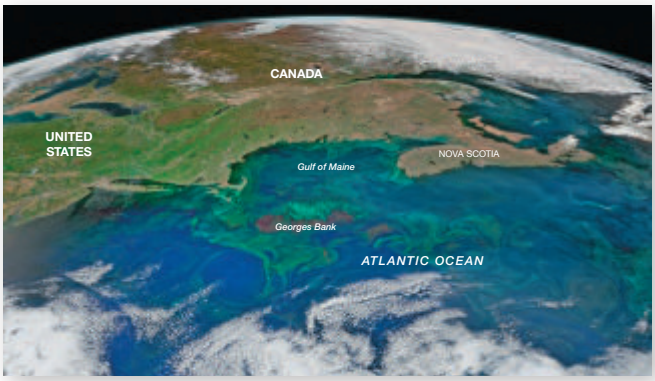

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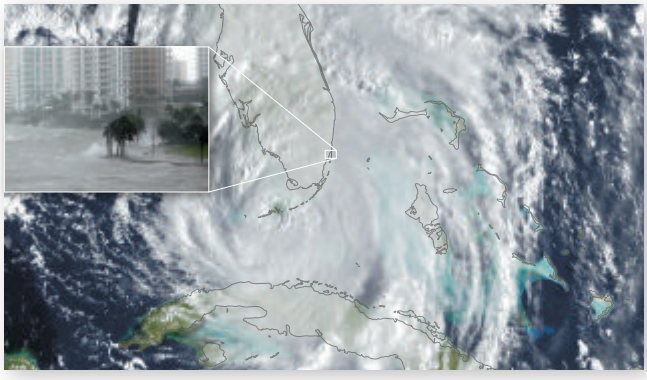

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