



Introducing PHYSICAL GEOGRAPHY

Alan Strahler / Arthur Strahler



THIRD EDITION

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PREFACE

It is with great pleasure that we present the Third Edition of *Introducing Physical Geography*. Our new edition builds on the considerable strengths of our prior editions, but also adds much that is new. In topical coverage, we have added two new chapters to our text:

- ***Introducing Physical Geography***, a new chapter that introduces geography as a discipline and identifies the realm of physical geography within geography as a whole. After briefly introducing key geographer's tools, the chapter continues with the conceptual themes of spheres, scales, systems, and cycles as they will appear in the remainder of the book. It concludes by motivating the study of physical geography with the global change topics of climate change, carbon cycle, biodiversity, pollution, and extreme events.
- ***Biogeographic Processes***, a new chapter that adds key concepts from historical biogeography as well as additional depth to our previous coverage of ecological biogeography. Positioned between our surveys of global climate (Chapter 7) and global vegetation (Chapter 9), the new chapter better ties the concepts that explain the geographical distribution of plants and animals to the global biogeographic patterns we see today.

The remaining parts of our text have also seen some significant revisions. Especially noteworthy are major changes in:

- ***The Earth's Global Energy Balance (Chapter 2)***, revised for flow and content and updated with new values for the solar constant and new flux rates for the global energy balance.

- ***Winds and Global Circulation (Chapter 5)***, extensively revised to provide better flow and more detail in relating surface winds to upper atmosphere circulation. The chapter includes new figures and text on global air pressure gradients, the geostrophic wind, and upper air wind motion and pressure.
- ***Global Climates (Chapter 7)***, revised to provide a better introduction to global temperature and rainfall regimes with accompanying new figures.
- ***Earth Materials and Plate Tectonics (Chapters 12 and 13)***, revised for a clearer description of the rock cycle and better flow of topics across the two chapters.
- ***Weathering and Mass Wasting (Chapter 14)***, restructured for better topical flow, including a new separate section on processes and landforms of alpine tundra.

Also updated are many references to ***environmental events and global change***, including ozone layer coverage, earthquakes, hurricanes, and landslides. New data appear in our air pollution feature (Chapter 4). We also provide new information on greenhouse gases and their impact on global warming, as well as updated coverage of environmental treaties (Buenos Aires, Kyoto) and new climate change projections from the International Panel on Climate Change (Chapter 3).

Another new development is ***much more extensive use of remotely sensed images***. Our senior author, Alan Strahler, has used his expertise in this field to select many new images from the latest sources, including abundant coverage from NASA's Earth Observing System. The new images are used extensively as text figures and also appear in special boxed features entitled *Focus on Remote Sensing*. To support

these new uses of remotely sensed images, we have expanded our appendix coverage of the basic principles of remote sensing and placed it as a special boxed feature within the text, *Geographer's Tools 2.1 • Remote Sensing for Physical Geography*, which appears in Chapter 2. Our previous appendix on Geographic Information Systems has also been moved to the text as *Geographer's Tools 1.3 • Geographic Information Systems* in Chapter 1, where it is accompanied by *Geographer's Tools 1.2 • Focus on Maps*.

Our Third Edition also includes important improvements to the learning environment. These include:

- **Restyled art for enhanced comprehension.** Labels on drawings and sketch maps have been enlarged and feature a new typeface that enhances legibility. Colors have been enhanced as well.
- **New “showcase” art pieces.** These full- or double-page spreads use multiple photos and drawings to supplement a particular text topic.
- **New *Eye on Global Change* features.** Alternating with our *Eye on the Environment* features are now *Eye on Global Change* features that better emphasize the changing nature of our planet as influenced by human activity.
- ***Eye on the Landscape*.** This feature helps students preview what they will learn about our environment by taking selected photographs and identifying the prominent features that a physical geographer would recognize and understand.
- **New *GeoDiscoveries CD-ROM and website*.** This new supplement enhances student learning on many levels and is described more fully in a special section below.

THE LEARNING ENVIRONMENT

In developing and revising *Introducing Physical Geography*, we paid special attention to the learning environment for students. This includes an emphasis on clearly communicating the structure of the text. The first few paragraphs of each chapter are especially written to provide an orientation to the material to come, and transitional paragraphs continue within the text whenever an important new subject begins. To enhance the forward linkages, we provide a brief final section, *A Look Ahead*, that puts the present chapter in perspective and leads into the next.

Another important part of the learning environment is our series of *Putting You in the Picture* features that open each chapter. The first such feature, in our *Introducing Physical Geography* chapter, puts the student in the place of an astronaut stationed on the Moon who embarks on a journey home to Earth. By following this journey, the student sees the planet at ever-increasing scales, first as a whole, then as a realm of the four great spheres, then as regions differentiated by climate, vegetation, and soils, and finally as a collection of individual landscape features as the return spacecraft proceeds to a touchdown. The journey is both a metaphor and model for the learning to come.

Other *Putting You in the Picture* features continue the involvement of the student, personalizing the chapter with an experience or topic relevant to the chapter's main themes. For example, in Chapter 6 the student reads an account of experiencing Hurricane Andrew as it devastated the South Florida coast in 1992. In Chapter 16, the student is introduced to the erosive power of rivers by riding a raft down the Colorado River through the Grand Canyon. Most of these essays are written in the second person to draw the student in more directly.

Students enjoy learning that their new knowledge is important and useful. Our *Eye on the Environment* and *Eye on Global Change* features help reinforce text material and provide relevance. These essays focus the concepts of the chapter on specific topics in environmental and global change, ranging from the ozone layer to ice sheets and global warming.

The book concludes with an *Epilogue* that raises the environmental implications of the physical geography that the student has learned. In an extended script for a news broadcast from the mid-twenty-first century, students picture how life might change in the future as human impacts continue to reshape our planet. The news broadcast leads into a discussion of the most serious environmental issues facing the human species and the prognosis for the Earth's immediate future.

Learning Tools

To help students master text material, we provide a number of learning tools. To help build the necessary vocabulary, we have identified the dozen or so key terms that are most important in each chapter with the use of **boldface**. Less important terms are identified in *italics*. All terms are defined in our *Glossary*, which contains over 1000 individual entries and includes many terms that are part of a basic science vocabulary.

As another aid to learning, we have embedded brief *key statements* in the text that summarize important concepts in one or two sentences. They are set as type blocks between text columns.

Our suite of end-of-chapter materials is also designed to reinforce key concepts and ideas of the chapter. A summary, *In Review*, covers all the major concepts of the chapter. The list of *Key Terms* gathers together the critical vocabulary of the chapter. *Review Questions* are designed as oral or written exercises that require description or explanation of important ideas and concepts. They are provided both for text and *Eye on the Environment/Global Change* boxes. *Visualizing Exercises* are review questions that utilize sketching or graphing as a way of focusing attention on key illustrations. Also provided are *Essay Questions* that require more synthesis or the reorganization of knowledge in a new context.

Users of our second edition will recognize in our third edition the key elements of our visualization strategy to learning, which focuses on helping students form lasting visual images of the processes of physical geography. The

strategy involves three components: illustrations, word pictures, and the GeoDiscoveries CD-ROM. As noted earlier in this preface, each line art illustration in our third edition has been restyled with a larger, more readable typeface for labels and enhanced colors for better clarity and more visual appeal. Building word pictures that stay in students' minds is another aspect of visualization, and our *Putting You in the Picture* features and the *Epilogue* are key parts of that effort.

GEODISCOVERIES

Serving not only our visualization strategy but also our goals of presenting clear learning structures and enhanced comprehension is our new CD-ROM with coupled website, *GeoDiscoveries*, created by S. Mary P. Benbow of the University of Manitoba. Organized on topics oriented to specific chapters, it reviews and strengthens the understanding of the key concepts of each chapter in a dynamic, interactive fashion. Of particular importance are the many graphic animations of key processes, coupled with video clips that expand their key ideas to the real world. Exploration modules, such as a simulation of climate in response to variations in the Earth's albedo or solar output, put the concepts of the chapter and visualizations to work in a way that enhances logical thinking and comprehension. Each topical segment concludes with a self-evaluation that reinforces mastery while also pointing out areas of difficulty. To link *GeoDiscoveries* with the text, small icons with attached navigation information are placed with the running text and illustration captions in the book. For example, the following refers to an animation of the Coriolis effect: **GEODISCOVERIES** animation/Coriolis effect_animation.

SUPPLEMENTS

INSTRUCTOR'S WEB RESOURCE. Instructors adopting *Introducing Physical Geography* will be issued a password that will provide access to a wide range of instructional resources on a protected Wiley website. These include test banks, chapter outlines, and a Supplements Integrator, a guide to using the Web for active learning in the physical geography course, with a chapter-by-chapter list of well-maintained URLs hot-linked to websites. The dynamic nature of this site allows the publisher to post current events, maps, and other news and developments related to physical geography, from Wiley and the authors. The address of the book companion site is: <http://www.wiley.com/college/strahler>.

ON-LINE STUDY COMPANION. Students will be able to interact over the Internet with a study guide at any time during the term with the On-line Study Companion. Each chapter includes practice quizzes; tutorials for selected topics; hot links to current World Wide Web sites; and other Internet services, all designed to make the On-line Study Companion both a solid study resource and a perfect component of any distance learning or Web-delivered course. The address of

the book companion site is: <http://www.wiley.com/college/strahler>.

THE BOOK COMPANION SITE. Be sure to visit the book's companion website at <http://www.wiley.com/college/strahler> to access materials to supplement your physical geography course.

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Alan Strahler
Arthur Strahler
Cambridge, Massachusetts
February 1, 2002

ABOUT THE AUTHORS

Alan Strahler received his B.A. degree in 1964 and his Ph.D degree in 1969 from The Johns Hopkins University, Department of Geography and Environmental Engineering. He has held academic positions at the University of Virginia, the University of California at Santa Barbara, and Hunter College of the City University of New York, and is now Professor of Geography at Boston University. With Arthur Strahler, he is a coauthor of seven textbook titles with nine revised editions on physical geography and environmental science. He has published over 250 articles in the refereed scientific literature, largely on the theory of remote sensing of vegetation, and has also contributed to the fields of plant geography, forest ecology, and quantitative methods. His work has been supported by over \$6 million in grant and contract funds, primarily from NASA. In 1993, he was awarded the Association of American Geographers/Remote Sensing Specialty Group Medal for Outstanding Contributions to Remote Sensing. In 2000, he received the honorary degree *Doctorem Scientiarum Honoris Causa* (D.S.H.C.)

from the Université Catholique de Louvain, Belgium, for his academic accomplishments in teaching and research.

Arthur Strahler received his B.A. degree in 1938 from the College of Wooster, Ohio, and his Ph.D. degree in geology from Columbia University in 1944. He was appointed to the Columbia University faculty in 1941, serving as Professor of Geomorphology from 1958 to 1967 and as Chairman of the Department of Geology from 1959 to 1962. He was elected as a Fellow of both the Geological Society of America and the Association of American Geographers for his pioneering contributions to quantitative and dynamic geomorphology, contained in over 30 major papers in leading scientific journals. He is the author or coauthor with Alan Strahler of 16 textbook titles with 15 revised editions in physical geography, environmental science, the Earth sciences, and geology. His most recent new title, *Plate Tectonics* (GeoBooks Publishing, Cambridge, Massachusetts), has received critical praise as an upper-level college text on plate tectonics as the grand paradigm in Earth science.

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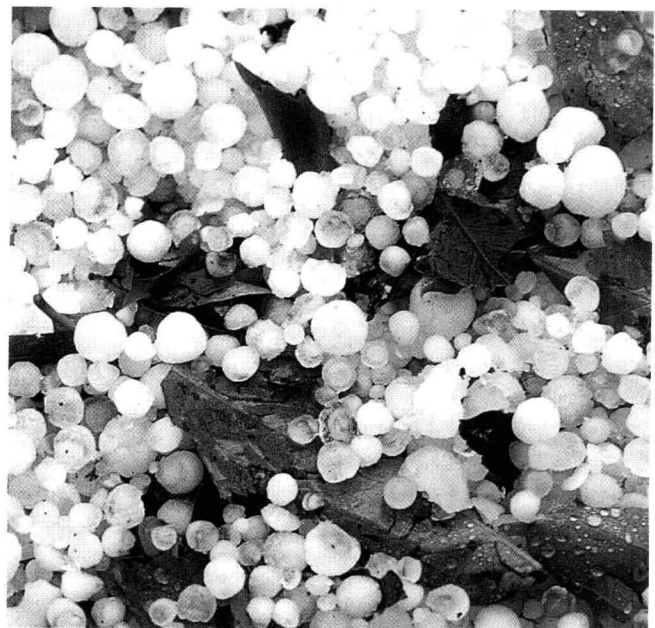
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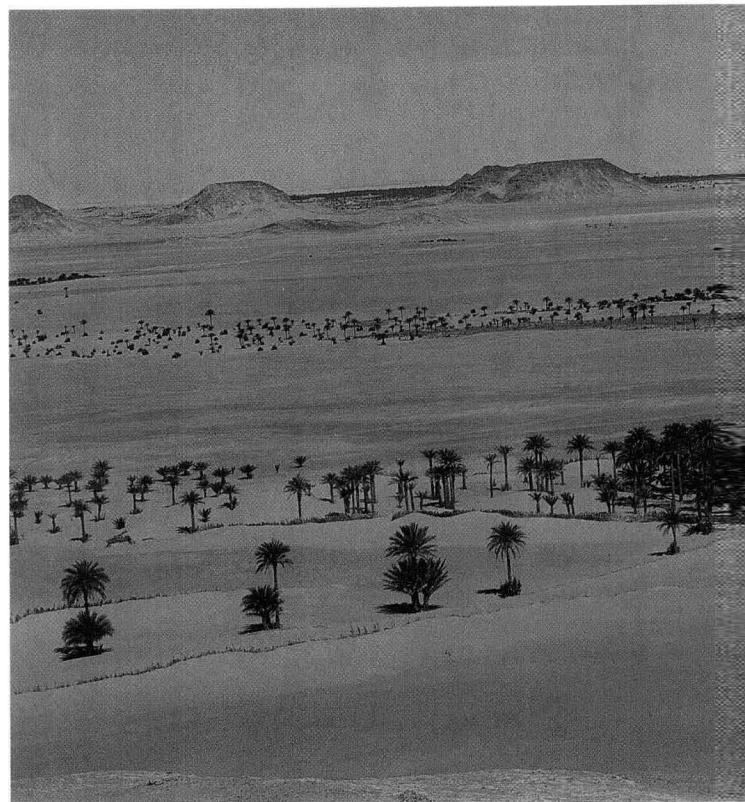
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Third Edition

INTRODUCING PHYSICAL GEOGRAPHY

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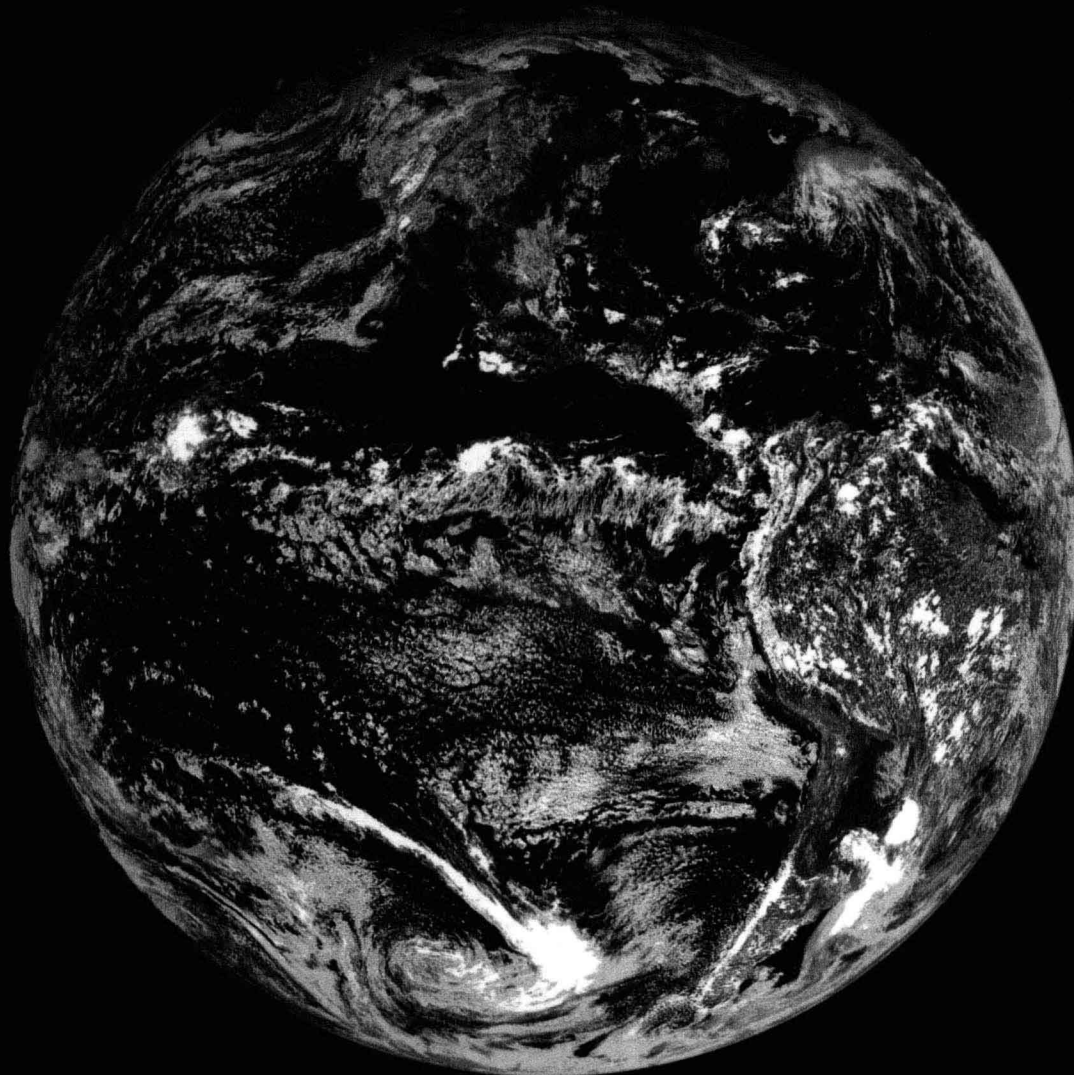
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John Wiley & Sons, Inc.

An astronaut on the Moon would see the Earth suspended in space in a similar perspective to this Meteosat photo, which records clouds, water vapor patterns, and land masses as seen from a geostationary orbit.



INTRODUCING PHYSICAL GEOGRAPHY

CHAPTER **Introducing Geography**

OUTLINE Realms of Geography
Tools in Geography
Understanding Physical Geography
Spheres, Scales, Systems, and Cycles
The Spheres—Four Great Earth Realms
Scales in Physical Geography
Systems in Physical Geography

Time Cycles

Physical Geography, Environment, and Global Change

Global Climate Change

The Carbon Cycle

Biodiversity

Pollution

Extreme Events

..... **PUTTING YOU IN THE PICTURE**

Physical geography is the study of the surface of our home planet, Earth. It is not just a catalog of mountains and rivers, but rather a branch of science that investigates how and why the surface changes from day to day, from year to year, and over millions of years.

Perhaps the easiest way to introduce physical geography is to examine the features of our planet—first as a whole and then by zooming in on continents, regions, and, finally, local areas. But to make it more interesting, imagine that the year is 2050 and that you are an astronaut ending a tour of duty on a lunar base station. Relax and follow along as you move from the lunar base to a space station orbiting the Earth and finally to the descent and landing of a space shuttle carrying you safely home.

It's eight hundred hours, on December 17, Houston time, and your duty watch is just beginning. Taking your place at the lab's environmental control desk, you check the oxygen and carbon dioxide balances and review the pressure and water vapor concentration log from the previous watch. All is well. You rise from your desk and turn. A small push on your right foot produces a giant but graceful step. You are standing in front of the viewport, looking out across the moonscape. Not much scenery here at Lunar Base Alpha, at least not when you're in the middle of the long lunar night. But in the black sky above, there is a truly majestic sight—a huge blue, green, and brown disk veiled by swirls and films of white. It is Earth, your home.

From your lunar viewpoint, the Earth's environmental realms are easily identified by their colors. The blue of the world oceans—the hydrosphere—dominates the area of the disk. Rich browns characterize the lithosphere—the solid rocky portion of the planet—where it rises above the seas. Vast white cloud expanses form and fade in the gaseous portion of the planet—the atmosphere. The lush greens of plants are the visible portion of the biosphere, the realm of life on