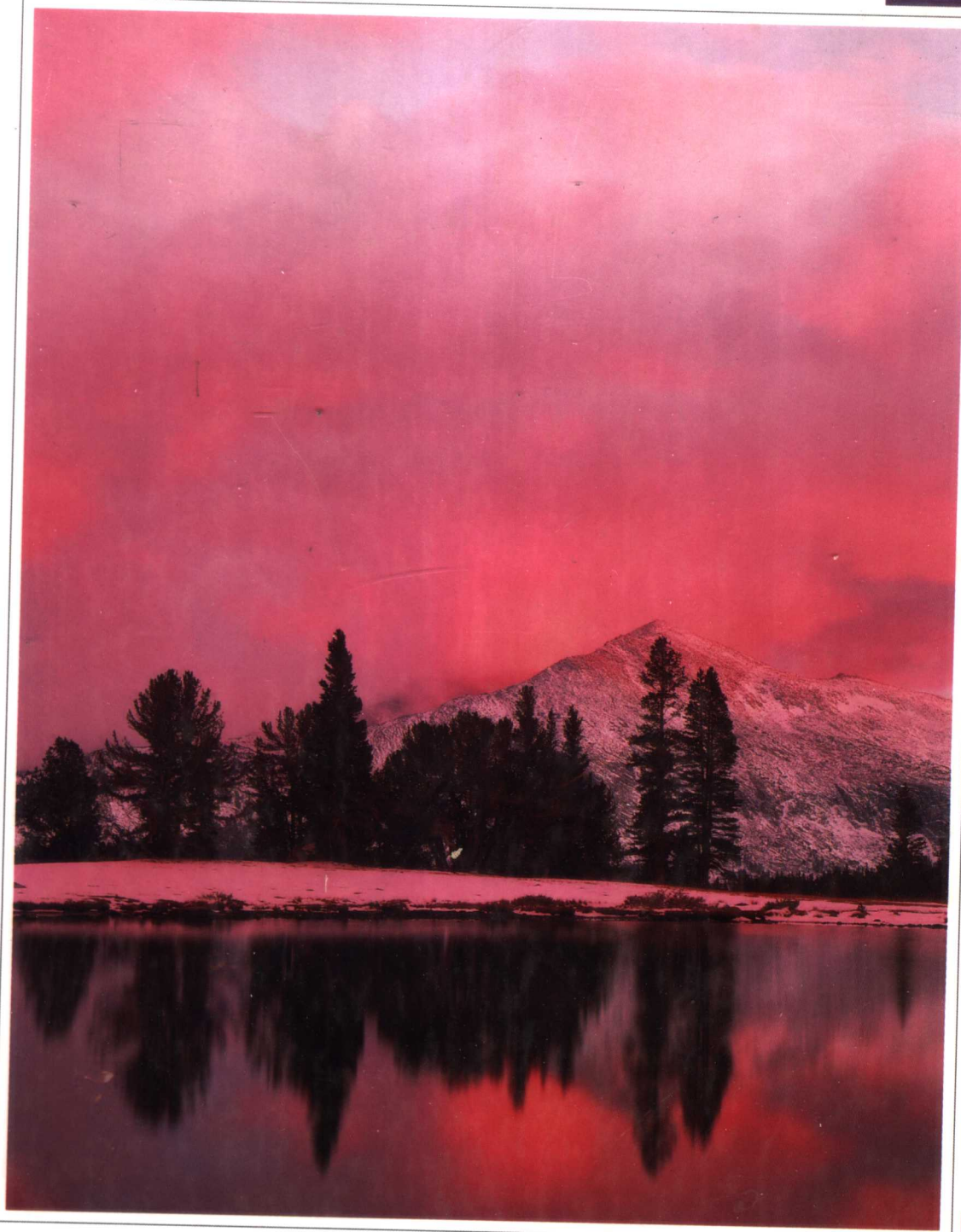


Meteorology Today

AN INTRODUCTION TO WEATHER, CLIMATE, AND THE ENVIRONMENT

FIFTH EDITION



C. Donald Ahrens

F I F T H E D I T I O N

Meteorology Today

An Introduction to Weather, Climate, and the Environment

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C. Donald Ahrens

Modesto Junior College

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(continued following Index)

Preface

The world is an ever-changing picture of naturally occurring events. From drought and famine to devastating floods, some of the greatest challenges we face come in the form of natural disasters created by weather. Yet, dealing with weather and climate is an inevitable part of our lives. Sometimes it is as small as deciding what to wear for the day or how to plan a vacation. But it can also have life-shattering consequences, as witnessed by those who are victim to a hurricane or tornado.

In recent years, weather and climate have become front page news—from global warming to the cooling brought on by the eruption of Mt. Pinatubo. The dynamic nature of the atmosphere seems to demand our attention and understanding more these days than ever before. Almost daily, there are newspaper articles describing some weather event or impending climate change. For this reason, and the fact that weather influences our lives in so many ways, interest in meteorology (the study of the atmosphere) has been growing. This rapidly developing and popular science is giving us more information about the workings of the atmosphere than ever before. Although the atmosphere will always provide challenges for us, as research and technology advance, our ability to understand our atmosphere improves, as well. The information available to you in this book, therefore, is intended to aid in your own personal understanding and appreciation of our earth's dynamic atmosphere.

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About This Book

Meteorology Today is written for college-level students taking an introductory course on the atmospheric environment. The main purpose of the text is to convey

meteorological concepts in a visual and practical manner, while simultaneously providing students with a comprehensive background in basic meteorology. This fifth edition includes up-to-date information on important topics, such as ozone depletion, global warming, and the climatic influence brought on by the eruption of Mt. Pinatubo. Discussions of recent weather events, such as the destruction wrought by hurricanes Andrew and Iniki and the great United States flood of 1993 in the upper Midwest, are also included. As with the other editions, no special science prerequisites are necessary.

Written with the student in mind, this book covers topics directly related to our everyday experiences with weather and stresses the understanding and application of meteorological principles. The text emphasizes watching the weather so that it becomes “alive,” allowing readers to immediately apply textbook material to the world around them. To assist with this endeavor, a color cloud chart appears toward the back of the text. The cloud chart can be separated from the book and used as a learning tool when observing the sky. To strengthen points and clarify concepts, illustrations are rendered in full color throughout. Color photographs were carefully selected to illustrate features, stimulate interest, and show how exciting the study of weather can be.

This edition, organized into nineteen chapters, is designed to provide maximum flexibility to instructors of atmospheric science courses. Thus, chapters can be covered in any desired order. For example, Chapter 4, “Atmospheric Optics,” is self-contained and can be covered later if so desired. Instructors, then, are able to tailor this text to their particular needs.

This book basically follows a traditional approach. After an introductory chapter on the composition, origin, and structure of the atmosphere, it then covers energy,

temperature, moisture, precipitation, and winds. Then come chapters that deal with air masses and middle-latitude cyclones. Weather prediction and severe storms are next. A new chapter on air pollution is followed by a chapter on climate change. The final chapter deals with global climate.

Each chapter contains at least two Focus sections, which expand on material in the text or explore a subject closely related to what is being covered. Focus sections fall into one of six distinct categories: observations, applications, issues, instruments, special topics, and advanced topics. Some include material that is not always found in introductory meteorology textbooks, subjects such as aviation weather, wind power, cloud seeding, polar lows, and the ozone hole. Others help bridge theory and practice. Focus sections new to this edition include "Can It Be a Rainbow If It Is Not Raining?" and "The Pineapple Connection." Quantitative discussions of important equations, such as the geostrophic wind equation and the hydrostatic equation, are found in the Focus sections on advanced topics.

Each chapter incorporates other effective learning aids:

- 】 A major topic outline begins each chapter
- 】 Interesting introductory pieces draw the reader naturally into the main text
- 】 Important terms are boldfaced with their definitions appearing in the glossary or in the text
- 】 Key phrases are italicized
- 】 English equivalents of metric units are immediately provided in parenthesis
- 】 Summaries at the end of each chapter review the chapter's main ideas
- 】 A list of key terms following each chapter allow students to review and reinforce their knowledge of the chief concepts they encountered
- 】 Questions for Review act to check how well students assimilate the material
- 】 Questions for Thought require students to synthesize learned concepts for deeper understanding
- 】 Problems and Exercises require mathematical calculations that provide a technical challenge to the student

Ten appendices conclude the book including two that are new to this edition—the Hurricane Tracking Chart and the Beaufort Wind Scale. The instant weather forecast chart, Appendix E, should especially interest students. In addition, at the end of the book, a compilation of supplementary reading material is presented, as is an extensive glossary.

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Fifth Edition Changes

Initially, the most apparent change in this fifth edition is the use of color. To strengthen points and clarify more involved concepts, all of the illustrations are rendered in full color. To help visualize how exciting meteorology can be over 70 new color photographs and many new illustrations have been added to this edition.

To complement the new art and photographs, the fifth edition of *Meteorology Today* has been thoroughly revised and updated. Chapter 1 still serves as a broad overview of the atmosphere, but it now contains information on the origin, composition, and vertical structure of the atmosphere. Layers of the atmosphere are also now discussed in this chapter, as is an updated discussion on stratospheric ozone, and a new Focus section—"The Atmospheres of Other Planets."

Chapter 2 from the fourth edition has been carefully woven into other chapters. For example, the section on water in the atmosphere, including the hydrologic cycle, now appears in Chapter 5, "Atmospheric Moisture." Additionally, the topic of atmospheric pressure, including the section on barometers and the section on the gas law, now appear in Chapter 9, "The Atmosphere in Motion—Air Pressure, Forces, and Winds."

Chapter 2 in the fifth edition, "Energy: Warming the Earth and the Atmosphere," now contains information on UVB radiation in the Focus section—"Wave Energy, Sun Burning, and UVB Radiation." A new Focus section, "Characteristics of the Sun" is also found in this chapter. Chapter 4 on atmospheric optics describes the formation of the circumzenithal arc in the Focus section, "Can It Be a Rainbow If It Is Not Raining?" Moreover, Chapter 8, "Precipitation," has been substantially revised.

The chapter on small-scale and local winds (Chapter 10) now contains information on the strong northeaster that hit the East Coast during December, 1992, and the devastating fires that roared through southern California during the fall of 1993. Chapter 11, "Wind: Global Systems," contains information on the most recent ENSO event. The new Focus section, "The Pineapple Connection," describes the weather pattern and associated heavy rains that drenched southern California during the winter of 1993. The chapter on middle latitude storms (Chapter 13) has been rewritten and restructured. It is now strengthened with new material on developing wave cyclones and a new section on vorticity. It also contains an examination of the March, 1993, "Storm of the Century," and discusses a new topic: Polar lows.

For clarity, all of the surface and upper-air maps were redrawn in Chapter 14, "Weather Forecasting." Adding to

this chapter is a new Focus section—"Watches, Warnings, and Advisories." Many sections of Chapter 15, "Thunderstorms and Tornadoes," have been rewritten. Moreover, this chapter now contains information on algorithms from the new Doppler radar as well as a section on the devastating floods that struck the upper Midwest during the summer of 1993. Also, new to this chapter is information describing the stages of a developing tornado. Chapter 16 contains new material on the formation of hurricanes, along with the latest information on the destruction wrought by Hurricane Andrew, including the subject of "mini-swirls."

Chapter 17 is a new chapter that deals with air pollution. It contains material on the formation of photochemical smog and other pollutants found in the urban environment. Acid rain is discussed in this chapter. Indoor pollutants, including radon, formaldehyde, and asbestos are covered as well. The chapter on climate change (Chapter 18) has been thoroughly revised to include the latest material on global warming. Among the additions to this chapter is a section that covers sulfate aerosols in the lower atmosphere and one that deals with the eruption of Mt. Pinatubo and its effect on global surface air temperatures. Moreover, this chapter includes new material on feedback mechanisms, radiative forcing agents, and ice cores extracted from Greenland.

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To the Student

Learning about the atmosphere can be an enjoyable experience, especially if you become involved. This book is intended to give you some insight into the workings of the atmosphere, but for a real appreciation of your atmospheric environment, you must go outside and observe. Mountains take millions of years to form, while a cumulus cloud can develop into a raging thunderstorm in less than an hour. To help with your observations, a color cloud chart is bound toward the back of the book for easy reference. Remove it, and keep it with you. And remember, all of the information in this book is out there—please, take the time to look.

C. Donald Ahrens



Supplemental Materials

Available with this edition is an instructor's manual with test bank by Charles Weidman of the University of Arizona, a slide package, overhead transparencies, Sunpath, Climograph, and Wind software by Micro-Innovations (for demonstration and laboratory purposes) and meteorology videos. A computerized test bank is available as WESTEST for IBM and compatible and Macintosh microcomputers. Multimedia presentations using ASTOUND™ software have been developed to present key topics in an exciting new format. ASTOUND™ will also enable you to create your own displays. For courses that emphasize quantitative aspects of meteorology a *Companion Book for Scientists and Engineers* has been written by Roland Stull of the University of Wisconsin—Madison. Also available is a student workbook/study guide prepared by the author. For additional information on this package, contact your West sales representative.

Contents



Chapter 1

The Earth and Its Atmosphere 1

- Overview of the Earth's Atmosphere 2
 - Composition of the Atmosphere 2
 - Focus on a Special Topic: A Breath of Fresh Air* 4
 - The Early Atmosphere 7
- Vertical Structure of the Atmosphere 8
 - A Brief Look at Air Pressure and Air Density 8
 - Layers of the Atmosphere 9
 - Focus on a Special Topic: The Atmospheres of Other Planets* 10
 - Focus on Instruments: The Radiosonde* 13
 - The Ionosphere 14
 - The Ozone Dilemma in the Stratosphere 15
- Weather and Climate 17
 - Meteorology—A Brief History 17
 - Focus on a Special Topic: The Ozone Hole* 18
 - A Satellite's View of the Weather 20
 - Storms of All Sizes* 20
 - A Look at a Weather Map* 20
 - Weather and Climate in Our Lives 21
- Summary 25
- Key Terms 26
- Questions for Review 26
- Questions for Thought 27
- Problems and Exercises 27



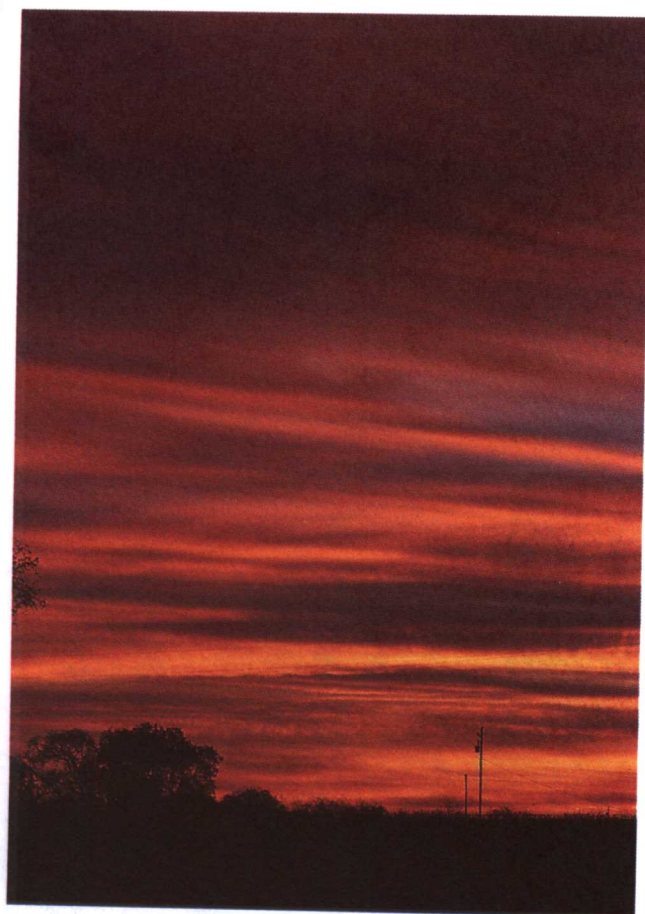
Chapter 2

Energy: Warming the Earth and the Atmosphere 28

- Energy, Temperature, and Heat 30
 - Focus on Instruments: Temperature Scales* 31



- Specific Heat 32
- Latent Heat—The Hidden Warmth 32
- Heat Transfer in the Atmosphere 34
 - Conduction 34



<i>Focus on a Special Topic: The Fate of a Sunbeam</i>	35
Convection	35
Radiation	36
<i>Focus on a Special Topic: Rising Air Cools and Sinking Air Warms</i>	37
Radiation and Temperature	37
Radiation of the Sun and Earth	38
Balancing Act—Absorption, Emission, and Equilibrium	40
Selective Absorbers and the Atmospheric Greenhouse Effect	40
<i>Focus on a Special Topic: Wave Energy, Sun Burning, and UVB Radiation</i>	41
Enhancement of the Greenhouse Effect	43
Warming the Air from Below	45
Incoming Solar Energy	46
Scattered and Reflected Light	46
The Earth's Annual Energy Balance	47
Solar Particles and the Aurora	48
<i>Focus on a Special Topic: Characteristics of the Sun</i>	50
Summary	52

Key Terms	53
Questions for Review	53
Questions for Thought	54
Problems and Exercises	54



Chapter 3

Seasonal and Daily Temperatures 56

Why the Earth Has Seasons	58
Seasons in the Northern Hemisphere	59
<i>Focus on an Issue: Is December 21 Really the First Day of Winter?</i>	60
<i>Focus on a Special Topic: Does the First Frost Cause the Leaves to Change Color in Autumn?</i>	62
Seasons in the Southern Hemisphere	63
<i>Focus on a Special Topic: The Tilted Earth and Its Energy Balance</i>	64
Local Seasonal Variations	65
Daily Temperature Variations	66
Daytime Warming	66
<i>Focus on an Application: Solar Heating and the Noonday Sun</i>	68
Nighttime Cooling	68
Radiation Inversions	69
<i>Protecting Crops from the Cold</i>	71
The Controls of Temperature	72
Air Temperature Data	74
Daily, Monthly, and Yearly Temperatures	74
The Use of Temperature Data	75
Air Temperature and Human Comfort	76
<i>Focus on an Observation: A Thousand Degrees and Freezing to Death</i>	78
Measuring Air Temperature	78
<i>Focus on Instruments: Thermometers Should Be Read in the Shade</i>	80
Summary	82
Key Terms	82
Questions for Review	82
Questions for Thought	83
Problems and Exercises	84



Chapter 4

Light, Color, and Atmospheric Optics 86

White and Colors	88
White Clouds and Scattered Light	88
Blue Skies and Hazy Days	89
Red Suns and Blue Moons	91
Twinkling, Twilight, and the Green Flash	92

The Mirage: Seeing Is Not Believing	96
<i>Focus on an Observation: The Fata Morgana</i>	98
Halos, Sundogs, and Sun Pillars	98
Rainbows	100
<i>Focus on an Observation: Can It Be a Rainbow</i>	
If It Is Not Raining?	104
Coronas, Glories, and <i>Heiligenschein</i>	104
Summary	107
Key Terms	107
Questions for Review	108
Questions for Thought	108
Problems and Exercises	108



Chapter 5

Atmospheric Moisture 110

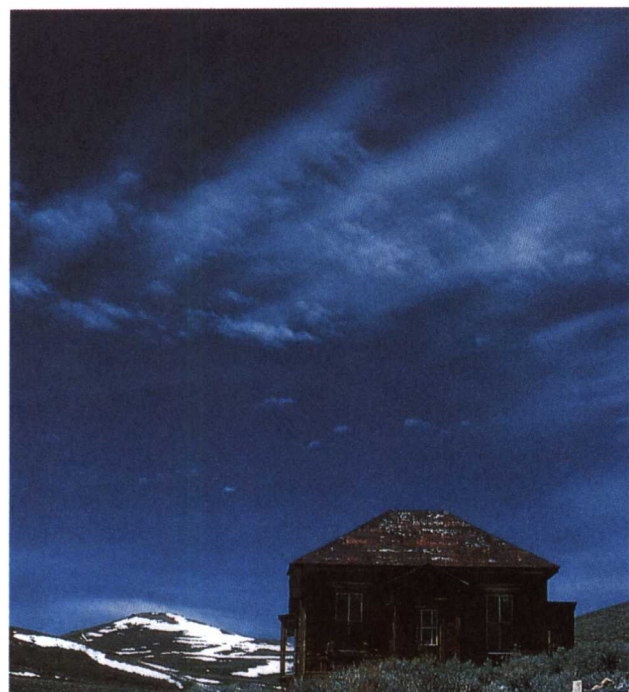
Water in the Atmosphere	112
The Many Phases of Water	112
Circulation of Water in the Atmosphere	113
Absolute Humidity	114
Specific Humidity and Mixing Ratio	115
Vapor Pressure	116
Relative Humidity	118
<i>Focus on a Special Topic: Vapor Pressure and</i>	
Boiling—The Higher You Go, the Longer	
Cooking Takes	119
Relative Humidity in the Home	120
Relative Humidity and Human Discomfort	121
Dew Point	122
<i>Focus on a Special Topic: Is Humid Air or Dry Air</i>	
More Dense?	123
Comparing Humidities	124
Measuring Humidity	125
<i>Focus on a Special Topic: Computing Relative</i>	
Humidity and Dew Point	126
Summary	127
Key Terms	128
Questions for Review	128
Questions for Thought	129
Problems and Exercises	129



Chapter 6

Condensation: Dew, Fog, and Clouds 130

The Formation of Dew and Frost	132
Condensation Nuclei	133
Haze	134
Fog	134
Radiation Fog	135



Advection Fog	136
<i>Focus on an Observation: Why Are Headlands</i>	
Usually Foggier than Beaches?	138
Upslope Fog	139
Evaporation (Mixing) Fog	139
Foggy Weather	140
<i>Focus on a Special Topic: Fog that Forms by</i>	
Mixing	140
Clouds	142
Classification of Clouds	143
Cloud Identification	143
High Clouds	143
<i>Focus on a Special Topic: Fog Dispersal</i>	144
Middle Clouds	144
Low Clouds	145
Clouds with Vertical Development	148
Some Unusual Clouds	152
Cloud Observations	156
Determining Sky Conditions	156
Satellite Observations	156
<i>Focus on Instruments: Measuring Cloud</i>	
Ceilings	158
<i>Focus on a Special Topic: Satellites Do More than</i>	
Observe Clouds	160
Summary	162
Key Terms	163
Questions for Review	163
Questions for Thought	164
Problems and Exercises	164



Chapter 7 Stability and Cloud Development 166

- Atmospheric Stability 168
- Determining Stability 169
 - Stable Air 169
 - A Stable Atmosphere 170
 - Unstable Air 171
 - Causes of Instability 172
- Cloud Development 175
 - Convection and Clouds 175
 - Topography and Clouds 178
 - Focus on an Observation: Determining Convective Cloud Bases* 180
 - Focus on an Advanced Topic: Adiabatic Charts* 182
 - Widespread Ascent and Clouds 184
 - Changing Cloud Forms 184
 - Mixing and Stratocumulus 185
- Summary 187
- Key Terms 187
- Questions for Review 187
- Questions for Thought 188
- Problems and Exercises 188



Chapter 8 Precipitation 190

- Precipitation Processes 192
 - How Do Cloud Droplets Grow Larger? 192
 - Collision and Coalescence Process 194
 - Ice-Crystal Process 195
 - Cloud Seeding 198

- Precipitation in Clouds 199
- Precipitation Types 199
 - Rain 199
 - Focus on an Issue: Does Cloud Seeding Enhance Precipitation?* 200
 - Snow 201
 - Focus on a Special Topic: Are Raindrops Tear-Shaped?* 202
 - Snowflakes and Snowfall* 202
 - Focus on a Special Topic: When Is It Too Warm to Snow?* 204
 - A Blanket of Snow* 205
 - Sleet and Freezing Rain 205
 - Focus on a Special Topic: Sounds of Silence* 206
 - Snow Grains and Snow Pellets 207
 - Focus on an Application: Aircraft Icing* 208
 - Hail 209
- Measuring Precipitation 211
 - Instruments 211
 - Weather Radar and Precipitation 212
- Summary 213
- Key Terms 213
- Questions for Review 213
- Questions for Thought 214
- Problems and Exercises 214



Chapter 9 The Atmosphere in Motion: Air Pressure, Forces, and Wind 216

- Atmospheric Pressure 218
 - Pressure Measurements 219
 - Focus on a Special Topic: The Atmosphere Obeys the Gas Law* 220
 - Pressure Readings 223
- Surface and Upper-Level Charts 225
- Newton's Laws of Motion 228
- Forces that Influence the Winds Aloft 229
 - Focus on an Application: Flying on a Constant Pressure Surface—High to Low, Look Out Below* 230
- Pressure Gradient Force 230
- Coriolis Force 231
- Wind Flow Aloft 234
 - Geostrophic Wind 234
 - Winds Around Lows and Highs 234
 - Focus on an Advanced Topic: A Mathematical Look at the Geostrophic Wind* 235
 - Focus on an Observation: Estimating Wind Direction and Pressure Patterns Aloft* 237
 - Winds on Upper-Level Charts 238
- Surface Winds 239

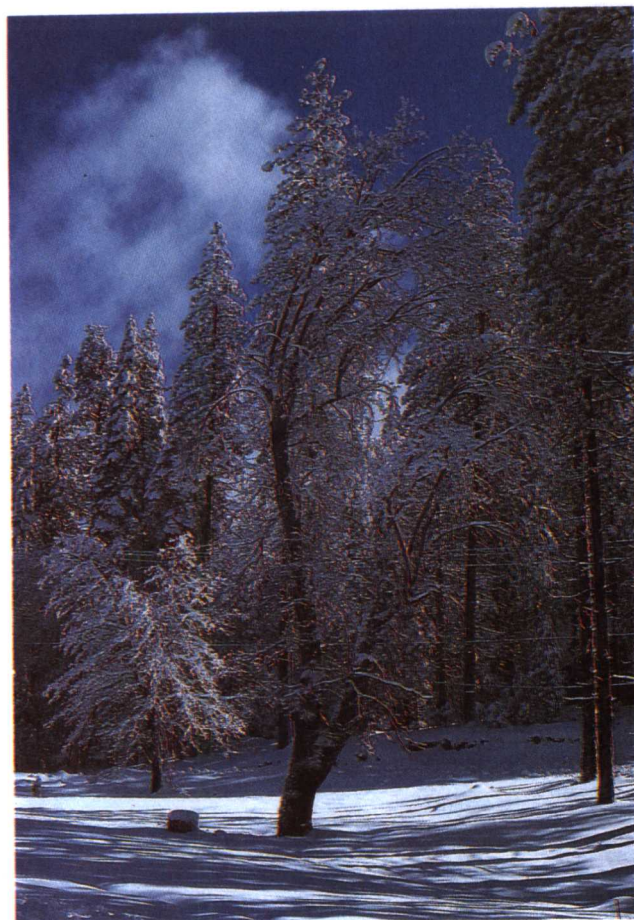
- Focus on a Special Topic: Winds Aloft in the Southern Hemisphere* 240
- Winds and Vertical Air Motions 240
- Focus on an Advanced Topic: The Hydrostatic Equation* 242
- Summary 243
- Key Terms 243
- Questions for Review 243
- Questions for Thought 244
- Problems and Exercises 245



Chapter 10

Wind: Small-Scale and Local Systems 246

- Small-Scale Winds Interacting with the Environment 248
 - Scales of Motion 248
 - Friction and Turbulence in the Boundary Layer 248
 - Eddies—Big and Small 251
 - The Force of the Wind 252
 - Microscale Winds Blowing over the Earth's Surface 253
 - Wind and Exposed Soil* 253
 - Focus on an Application: Eddies and "Air Pockets"* 254
 - Wind and Snow Surfaces* 254
 - Wind and Vegetation* 256
 - Wind and Waves* 257
 - Focus on a Special Topic: Pedaling into the Wind* 258
- Determining Wind Direction and Speed 258
 - The Influence of Prevailing Winds 258
 - Wind Instruments 260
 - Focus on an Issue: Wind Power* 262
- Local Wind Systems 263
 - Thermal Circulations 263
 - Sea and Land Breezes 264
 - Local Winds and Water 267
 - Seasonally Changing Winds—The Monsoon 268
 - Mountain and Valley Breezes 269
 - Katabatic Winds 270
 - Chinook (Foehn) Winds 271
 - Focus on a Special Topic: Snow Eaters and Rapid Temperature Changes* 272
 - Santa Ana Winds 272
 - Desert Winds 274
 - Other Local Winds of Interest 275
- Summary 277



- Key Terms 278
- Questions for Review 279
- Questions for Thought 279
- Problems and Exercises 280



Chapter 11

Wind: Global Systems 282

- General Circulation of the Atmosphere 284
 - Single-cell Model 284
 - Three-cell Model 284
 - Focus on a Special Topic: Dynamic General Circulation Models* 287
 - Average Surface Winds and Pressure: The Real World 287
 - The General Circulation and Precipitation Patterns 289
 - Average Wind Flow and Pressure Patterns Aloft 290
- Jet Streams 292



The Formation of the Polar Front Jet and the Subtropical Jet	294
<i>Focus on an Observation: The "Dishpan" Experiment</i>	295
<i>Focus on an Advanced Topic: Momentum—A Case of Give and Take</i>	296
Other Jet Streams	298
Atmosphere-Ocean Interactions	299
Global Wind Patterns and Surface Ocean Currents	299
Upwelling	300
Global Wind Patterns and Surface Ocean Temperatures	302
El Niño and the Southern Oscillation	303
<i>Focus on a Special Topic: The Pineapple Connection</i>	305
Summary	307
Key Terms	307
Questions for Review	307
Questions for Thought	308
Problems and Exercises	308



Chapter 12

Air Masses and Fronts 310

Air Masses	312
Source Regions	312
Classification	312
Air Masses of North America	313
<i>cP (Continental Polar) and cA (Continental Arctic) Air Masses</i>	313
<i>Focus on a Special Topic: Lake-Effect Snows</i>	316
<i>mP (Maritime Polar) Air Masses</i>	317
<i>Focus on a Special Topic: The Return of the Siberian Express</i>	318
<i>mT (Maritime Tropical) Air Masses</i>	320
<i>cT (Continental Tropical) Air Masses</i>	322
Fronts	322
Stationary Fronts	323
Cold Fronts	323
Warm Fronts	328
Occluded Fronts	330
Summary	331
Key Terms	332
Questions for Review	332
Questions for Thought	333
Problems and Exercises	333



Chapter 13

Middle Latitude Cyclones 334

Polar Front Theory	336
Developing Middle Latitude Storms—Cyclogenesis	337
Vertical Structure of Deep Pressure Systems	338
<i>Focus on a Special Topic: A Closer Look at Convergence and Divergence</i>	340
Upper-Level Waves and Surface Storms	341
The Necessary Ingredients for a Developing Wave Cyclone	343
Upper-Air Support	343
A Developing Wave Cyclone Becomes "The Storm of the Century"	345
The Conveyor Belt Model of Rising and Descending Air	347
The Role of the Jet Stream	348
<i>Focus on a Special Topic: Jet Streaks and Storms</i>	349
Vorticity, Divergence, and Developing Storm Systems	351
<i>Focus on a Special Topic: Vorticity and Longwaves</i>	353

- Polar Lows 356
 - Focus on a Special Topic: The Development of Lee-Side Lows* 357
- Summary 359
- Key Terms 359
- Questions for Review 359
- Questions for Thought 360
- Problems and Exercises 360



Chapter 14

Weather Forecasting 362

- Acquisition of Weather Information 364
- Methods of Weather Forecasting 365
 - Focus on a Special Topic: Watches, Warnings, and Advisories* 366
 - Accuracy and Skill in Forecasting 368
 - The Computer and Weather Forecasts: Numerical Weather Prediction 369
- Problems in Weather Prediction 370
- Improving Weather Forecasts 371
- Predicting the Weather from Local Signs 373
- Weather Forecasting Using Surface Charts 373
 - Determining the Movement of Weather Systems 374
 - Focus on an Observation: Forecasting Temperature Advection by Watching the Clouds* 376
 - A Forecast for Six Cities 376
 - Weather Forecast for Augusta, Georgia* 379
 - Rain or Snow for Washington, D.C.?* 379
 - Big Snowstorm for Chicago* 380
 - Mixed Bag of Weather for Memphis* 380
 - Cold Wave for Dallas* 381
 - Clear but Cold for Denver* 381
- A Meteorologist Makes a Prediction 381
 - Help from the 500-mb Chart 382
 - The Computer Provides Assistance 383
 - A Valid Forecast 386
 - Assistance from the Satellite 386
 - A Day of Rain and Wind 387
- Summary 389
- Key Terms 389
- Questions for Review 390
- Questions for Thought 390
- Problems and Exercises 391



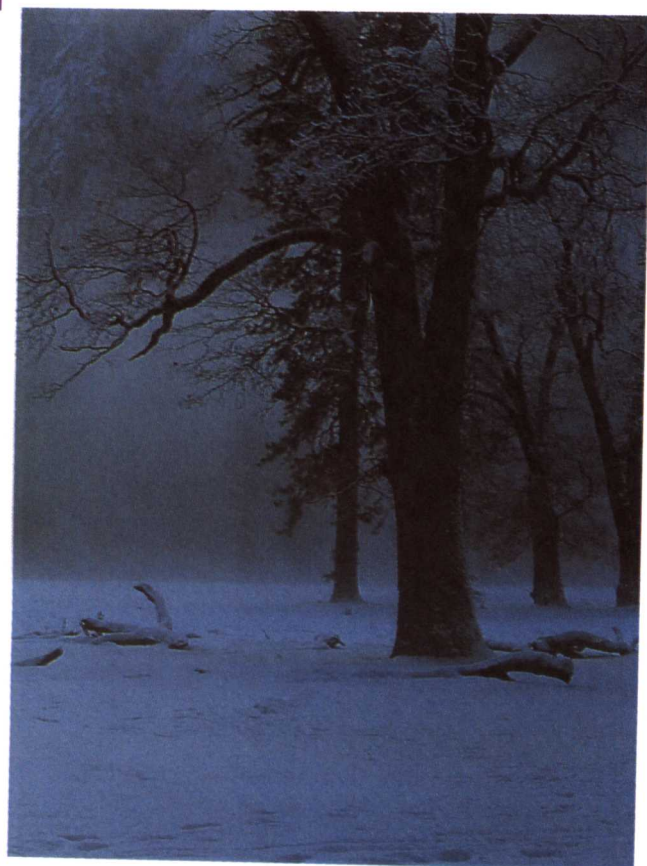
Chapter 15

Thunderstorms and Tornadoes 392

- What Are Thunderstorms? 394
- Air-Mass (Ordinary) Thunderstorms 394



- Severe Thunderstorms 396
 - The Gust Front and Microburst 397
 - Supercell and Squall-line Thunderstorms 400
 - The Dryline 402
 - Floods and Flash Floods 403
 - Focus on a Special Topic: The Terrifying Flash Flood in the Big Thompson Canyon* 404
 - Mesoscale Convective Complexes 405
 - Thunderstorm Movement 405
- Distribution of Thunderstorms 406
- Lightning and Thunder 407
 - Electrification of Clouds 408
 - The Lightning Stroke 409
 - Lightning Detection and Suppression 411
- Tornadoes 412
 - Focus on an Application: Don't Sit Under the Apple Tree* 413
 - Tornado Occurrence 415
 - Focus on an Observation: Viewing the Inside of a Tornado* 416
 - Tornado Winds 416
 - Tornado Formation 418
 - Observing Tornadoes 420
- Doppler Radar 421
 - Focus on a Special Topic: Thunderstorm Rotation* 423
- Waterspouts 425
- Summary 425
- Key Terms 426
- Questions for Review 426



Questions for Thought 427
Problems and Exercises 427



Chapter 16 Hurricanes 428

Tropical Weather 430
Anatomy of a Hurricane 430
Hurricane Formation and Dissipation 432
Hurricane Stages of Development 434
Hurricane Movement 435
Focus on a Special Topic: How Do Hurricanes Compare with Middle Latitude Storms? 437
Destruction and Warning 438
Naming Hurricanes 444
Focus on a Special Topic: Modifying Hurricanes 445
Summary 445
Key Terms 446
Questions for Review 446
Questions for Thought 447
Problems and Exercises 447



Chapter 17 Air Pollution 448

A Brief History of Air Pollution 450
Types and Sources of Air Pollutants 451
Principal Air Pollutants 452
Focus on a Special Topic: Indoor Air Pollution 456
Air Pollution: Trends and Patterns 456
Factors that Affect Air Pollution 461
The Role of the Wind 461
The Role of Stability and Inversions 461
The Role of Topography 463
Focus on an Observation: Smoke Stack Plumes 464
Severe Air Pollution Potential 466
Air Pollution and the Urban Environment 466
Focus on an Observation: Five Days in Donora—An Air Pollution Episode 468
Acid Deposition 469
Summary 473
Key Terms 473
Questions for Review 473
Questions for Thought 474
Problems and Exercises 474



Chapter 18 Climate Change 476

The Earth's Changing Climate 478
Determining Past Climates 478
Climate through the Ages 480
Climate during the Last 1000 Years 481
Possible Causes of Climatic Change 483
Climate Change and Feedback Mechanisms 483
Climate Change, Plate Tectonics, and Mountain Building 483
Climate Change and Variations in the Earth's Orbit 485
Climate Change and Atmospheric Particles 487
Aerosols in the Troposphere 488
Volcanic Eruptions and Aerosols in the Stratosphere 488
Focus on an Issue: Nuclear Winter—Climate Change Induced by Nuclear War 490
Climate Change and Variations in Solar Output 491
Carbon Dioxide, the Greenhouse Effect, and Recent Global Warming 492
Oceans, Clouds, and Global Warming 493
Possible Consequences of Global Warming 495
Is the Warming Real? 496

*Focus on a Special Topic: The Sahel—An Example
of Climatic Variability and Human*

Existence 498

In Perspective 499

Summary 499

Key Terms 499

Questions for Review 500

Questions for Thought 500

Problems and Exercises 501



Chapter 19

Global Climate 502

A World with Many Climates 504

Global Temperatures 504

The Hottest and Coldest Places on Earth 505

Global Precipitation 506

Climate Classification 510

The Ancient Greeks 510

The Köppen System 510

Thornthwaite's System 511

Focus on a Special Topic: Precipitation Extremes 512

The Global Pattern of Climate 513

Tropical Moist Climates (Group A) 513

Dry Climates (Group B) 519

Moist Subtropical Mid-latitude Climates
(Group C) 522

*Focus on a Special Topic: A Desert with Clouds
and Drizzle* 524

Moist Continental Climates (Group D) 527

Polar Climates (Group E) 529

Highland Climates (Group H) 531

Summary 531

Key Terms 532

Questions for Review 533

Questions for Thought 533

Problems and Exercises 534

Appendix A

Units, Conversions, Abbreviations, and Equations 535

Appendix B

Weather Symbols and the Station Model 539

Appendix C

Beaufort Wind Scale 541

Appendix D

Humidity and Dew-Point Tables 542

Appendix E

Instant Weather Forecast Chart 546



Appendix F

Changing GMT and UTC to Local Time 547

Appendix G

Heat Index (HI) Table 548

Appendix H

Standard Atmosphere 549

Appendix I

Hurricane Tracking Chart 550

Appendix J

Climatic Data for Cities Throughout the World 551

Additional Reading Material 561

Glossary 565

Index 581

The Earth and Its Atmosphere

Contents

Overview of the Earth's Atmosphere	
Composition of the Atmosphere	
<i>Focus on a Special Topic: A Breath of Fresh Air</i>	
The Early Atmosphere	
Vertical Structure of the Atmosphere	
A Brief Look at Air Pressure and Air Density	
Layers of the Atmosphere	
<i>Focus on a Special Topic: The Atmospheres of Other Planets</i>	
<i>Focus on Instruments: The Radiosonde</i>	
The Ionosphere	
The Ozone Dilemma in the Stratosphere	
Weather and Climate	
Meteorology—A Brief History	
<i>Focus on a Special Topic: The Ozone Hole</i>	
A Satellite's View of the Weather	
<i>Storms of All Sizes</i>	
<i>A Look at a Weather Map</i>	
Weather and Climate in Our Lives	
Summary	
Key Terms	
Questions for Review	
Questions for Thought	
Problems and Exercises	

»»»» I well remember a brilliant red balloon which kept me completely happy for a whole afternoon, until, while I was playing, a clumsy movement allowed it to escape. Spellbound, I gazed after it as it drifted silently away, gently swaying, growing smaller and smaller until it was only a red point in a blue sky. At that moment I realized, for the first time, the vastness above us: a huge space without visible limits. It was an apparent void, full of secrets, exerting an inexplicable power over all the earth's inhabitants. I believe that many people, consciously or unconsciously, have been filled with awe by the immensity of the atmosphere. All our knowledge about the air, gathered over hundreds of years, has not diminished this feeling.

Theo Loeb sack, *Our Atmosphere*