

Table of Contents

<i>List of Figures and Tables</i>	ix	<i>CD-ROM</i>	25
<i>Preface</i>	xv	<i>Television broadcasts</i>	25
<i>Acknowledgments</i>	xvii		
CHAPTER 1			
<i>Foundations of Remote Sensing</i>	1	CHAPTER 3	<i>The Basics of Image Interpretation</i> 26
Introduction to remote sensing	2	Introduction to image interpretation	27
Electromagnetic radiation	2	Image composition	27
<i>Emission of electromagnetic radiation</i>	3	Characteristics of visible imagery	28
<i>Radiation that strikes the Earth</i>	4	Characteristics of infrared imagery	33
<i>Radiation in the atmosphere</i>	7	<i>Enhancement of IR imagery</i>	36
Transmissivity of the atmosphere	7	Water vapor imagery	36
Sensing radiation in the atmosphere	8	Errors in satellite imagery	39
		<i>Cloud displacement</i>	39
		<i>Limb darkening</i>	40
		<i>Instrument response delay time</i>	41
CHAPTER 2			
<i>The Satellites</i>	9	CHAPTER 4	<i>Geographical Applications of Satellite Imagery</i> 43
Introduction to meteorological satellites	10	Locating geographical features	44
Polar orbiting satellites	10	<i>Coastal features</i>	44
<i>The Direct Readout System</i>	13	<i>Inland water features</i>	44
Geostationary satellites	16	<i>Terrain features</i>	46
<i>GOES history</i>	17	Urban heat islands	49
<i>Early GOES satellites: GOES 1–7</i>	17	Detecting snow cover	50
<i>Future GOES satellites: GOES 8 and GOES J–M</i>	20		
<i>GOES data broadcasting</i>	21	CHAPTER 5	<i>The Atmosphere</i> 55
Satellites operated by other countries	22	Introduction to the atmosphere	56
<i>Russian polar orbiters</i>	22	Atmospheric composition	57
<i>Other non-U.S. polar orbiting satellites</i>	22	The water cycle	57
<i>Non-U.S. geostationary satellites</i>	22	Heating of the atmosphere	58
Methods of obtaining satellite imagery	23		
<i>Ground stations</i>	24		
<i>Telecommunications</i>	25		

Seasonal variations in atmospheric heating	58
Structure of the atmosphere	62
Atmospheric pressure	64

CHAPTER 6

Identifying Cloud Types in Satellite Imagery 66

Introduction to cloud identification	67
Cloud formation	67
Large-scale cloud patterns	68
Features that aid in cloud identification	70
Stratiform clouds	70
Fog identification	71
Cumuliform clouds	73
Stratocumulus clouds	73
Towering cumulus and cumulonimbus clouds	74
Middle-level (alto) clouds	76
High-level (cirro) clouds	76
Examples of cloud identification	77
Detection of small and thin clouds	82

CHAPTER 7

Determining Wind Direction from Satellite Imagery 84

Introduction to winds	85
Convective features indicating low-level wind direction	85
Cloud streets and lines	85
Sea and lake breezes	89
Land breezes	91
The lake effect	92
Mountain upslope winds	92
Katabatic (mountain downslope) winds	94
Open-cell convection	94
Thunderstorm outflow boundaries	94
Flow around and over mountains	96
Island barrier effects	97
Island eddies	98
Island lee lines	100

CHAPTER 8

Global Circulation 101

Simple thermal circulation in the atmosphere	102
The Coriolis effect	102

A dynamic model of atmospheric circulation	103
The Intertropical Convergence Zone (ITCZ)	105

CHAPTER 9

Jet Streams 108

Characteristics of jet streams	109
Wave motion of jet streams	110
Zonal vs. meridional flow	111
Locating jet streams	111
Locating ridges	118
Locating troughs	120
Using water vapor imagery to locate jet streams	122

CHAPTER 10

Synoptic-Scale Storm Development 124

Introduction to synoptic forecasting	125
Air masses	126
Fronts	126
Cold fronts	126
Warm fronts	128
Occluded fronts	130
Stationary fronts	130
Cyclogenesis: Development of storm systems	130
Leaf stage	132
Open comma stage	132
Mature (occluded) stage	134
Shearing stage	134
Synoptic forecasting in Atlantic winter storm monitoring	136
Estimating central pressure	139
Example of Atlantic storm monitoring	142

CHAPTER 11

Thunderstorm and Severe Weather Forecasting 145

Introduction to thunderstorm forecasting	146
Thunderstorm formation	146
Identifying thunderstorms in satellite imagery	147
Enhanced IR imagery	150
Locating regions of possible thunderstorm development (synoptic scale)	152

<i>Frontal boundaries</i>	152
<i>Jet streams</i>	153
<i>Mid-latitude cyclones</i>	155
<i>The Intertropical Convergence Zone (ITCZ)</i>	155
Locating local areas of thunderstorm development (mesoscale)	157
<i>Arc-cloud lines</i>	157
<i>Squall lines</i>	158
<i>Land and sea breezes</i>	159
<i>Early morning cloud cover</i>	162
<i>Ocean currents</i>	162
<i>Mountain convection</i>	162
Identifying areas of heavy precipitation	162
<i>Merging thunderstorms</i>	167
<i>Moisture plumes from the tropics</i>	167
Damaging winds and tornadoes	167
<i>Windstorms</i>	172
<i>Downbursts</i>	172
<i>Tornadoes</i>	172
Case Study: Thunderstorm development	179

CHAPTER 12

Tropical Cyclones 183

Characteristics of tropical cyclones	184
<i>Hurricane season</i>	184
<i>The structure of a hurricane</i>	185
<i>The life cycle of a hurricane</i>	186
Observing hurricane development and estimating intensity	187
Movement and tracking of hurricanes	188
Case study: Hurricane Andrew	190

CHAPTER 13

Monitoring Air Quality 195

Introduction to air quality monitoring	196
Haze and pollution	196
Smoke	196
Blowing sand and dust	198
Volcanic activity	199

CHAPTER 14

Oceanography 203

Oceanography from space	204
Sea surface temperature	204
Oceanic circulation	204
<i>Oceanic fronts</i>	207
<i>The Gulf Stream</i>	207
<i>The Gulf of Mexico Loop Current</i>	210
<i>The California Current</i>	211
Upwelling	211
<i>Causes of upwelling</i>	212
El Niño	214
Ice detection and forecasting	216
Ice on inland bodies of water	216
Sea ice	217
<i>Sea ice formation</i>	218
<i>Sea ice distribution</i>	218
<i>Sea ice movement</i>	219
Icebergs	222
<i>Appendix A: Conversions and Constants</i>	225
<i>Appendix B: Internet Resources for Satellite Imagery</i>	226
<i>Glossary</i>	228
<i>References</i>	239