

Contents

Preface	<i>page xi</i>
Part I Historical Perspective	1
1 The Forest–Climate Question	3
2 Tempering the Climate, c. 1600–1840	12
The Quandary of America	12
Forest–Climate Processes	15
The Debate Heightens	18
Divergent Science	21
3 Destroying the Rains, c. 1500–1830	26
Forests and Rainfall	26
Discovery of Oxygen	31
A Precipitation–Evapotranspiration Feedback	32
The Problem of Streamflow	33
Protecting Forests for Climate	35
4 Planting Trees for Rain, c. 1840–1900	39
India	39
Australia and New Zealand	41
South Africa	43
Russia	44
The United States	45
Rain Follows the Plow	49
5 Making a Science: Forest Meteorology, c. 1850–1880	52
France and Her Forests	52
Climates and the Influence of Wooded Soils	54
The Physical Effects of Forests on Air and Soil	57
Forests, Climate, and Water	60
CO ₂ , Water Vapor, and the Greenhouse Effect	64
6 American Meteorologists Speak Out, c. 1850–1910	67
Rational Climatology	67
Fernow’s Forest Influences	70
The Disagreement Deepens	72
	vii

viii Contents

Disciplinary Splintering	74
A Renewed Science	77
7 Views of Forests	82
In the Beginning, There Were Trees	82
What Is a Forest?	83
Visual Art	86
Literature	91
The Forest for Trees	95
Part II The Scientific Basis	99
8 Global Physical Climatology	101
Earth’s Energy Balance	101
Atmospheric General Circulation	102
Ocean Circulation	104
The Hydrologic Cycle	105
Climate Zones	105
Climate Variability	106
Mechanisms of Climate Change	108
Anthropogenic Climate Change	110
9 Forest Biometeorology	114
Principles of Environmental Physics	114
Leaf Temperature	117
Forest Canopies	120
10 Scientific Tools	127
Chamber Measurements	127
Eddy Covariance Flux Towers	128
Inventory Measurements	131
Ecosystem Experiments	132
Watershed Studies	132
Satellite Remote Sensing	134
Global Climate Models	136
11 Forest Microclimates	139
Foliage	139
Solar Radiation	142
Wind	143
Air Temperature	143
The Air above Forests	146

	Contents	ix
12 Water Yield		149
The Economy of Forest Water		149
The Hydrologic Cycle on Land		150
Paired Watershed Experiments		153
Eddy Covariance Studies		155
13 Carbon Sequestration		157
Ecosystem Carbon Fluxes		157
The Global Carbon Budget		161
The Land Carbon Sink		163
The Water Cost of Carbon Uptake		165
Forests and Oxygen		166
14 Forest Macroclimates		168
A Desert World		168
Forest–Climate Processes		170
The Climate Influences of Forests		173
The Spatial Scale Problem		175
Atmospheric Circulations		177
Droughts and Heat Waves		179
The Physiological Forcing of Climate		180
Atmospheric CO ₂		180
Atmospheric Chemistry		181
15 Case Studies		184
Amazonian Rain Forest		185
Boreal Forests		189
Temperate Forests		193
Northern Africa		196
16 Climate-Smart Forests		201
Nature-Based Climate Solutions		201
Reforestation the Planet		203
Biogeophysical Climate Influences		205
What Is a Climate-Smart Forest?		207
European Forests: Case Studies		210
17 Forests of the Future		214
Biogeography and Climate		214
Past Forests		216
Forest Succession		221
Threats to Forests		222

x	Contents	
	18 The Forests before Us	224
	Bridging Two Worlds	224
	On Narrow-Mindedness	225
	Beyond the Utilitarian Forest	227
	Natural Laws	228
	Why We Plant Trees	229
	Notes	232
	References	256
	Index	308