

Contents

<i>Acknowledgements</i>	xi
<i>Preface</i>	xvii
<i>Preface to the second edition</i>	xix
<i>Preface to the third edition</i>	xx
<i>Preface to the fourth edition</i>	xxi
<i>Introduction</i>	xxiii
1 Atmospheric composition and energy	1
A Composition of the atmosphere	1
1 <i>Total atmosphere</i>	1
2 <i>Variations with height</i>	1
3 <i>Variations with latitude and season</i>	3
4 <i>Variations with time</i>	5
B Mass of the atmosphere	6
1 <i>Total pressure</i>	7
2 <i>Vapour pressure</i>	8
C Solar radiation	9
1 <i>Solar output</i>	9
2 <i>Distance from the sun</i>	11
3 <i>Altitude of the sun</i>	13
4 <i>Length of day</i>	14
D Surface receipt of solar radiation and its effects	14
1 <i>Energy transfer within the earth-atmosphere system</i>	14
2 <i>Effect of the atmosphere</i>	15
3 <i>Effect of cloud cover</i>	16
4 <i>Effect of latitude</i>	18
5 <i>Effect of land and sea</i>	22
6 <i>Effect of elevation and aspect</i>	30
E Infrared radiation from the earth	32
F Heat budget of the earth	33

G	Atmospheric energy and horizontal heat transport	37
1	<i>The horizontal transport of heat</i>	38
2	<i>Spatial pattern of the heat budget components</i>	40
H	The layering of the atmosphere	44
1	<i>Troposphere</i>	45
2	<i>Stratosphere</i>	46
3	<i>The upper atmosphere</i>	47
a	<i>Mesosphere</i>	47
b	<i>Thermosphere</i>	47
c	<i>Exosphere and magnetosphere</i>	48
I	Variation of temperature with height	48
2	Atmospheric moisture	53
A	Evaporation	54
B	Humidity	62
1	<i>Moisture content</i>	62
2	<i>Moisture transport</i>	66
C	Condensation	66
D	Adiabatic temperature changes	68
E	Air stability and instability	71
F	Cloud formation	74
1	<i>Condensation nuclei</i>	74
2	<i>Cloud types</i>	76
G	Formation of precipitation	78
1	<i>Bergeron–Findeisen theory</i>	79
2	<i>Collision theories</i>	81
3	<i>Other types of precipitation</i>	82
H	Thunderstorms	83
I	Precipitation characteristics and types	87
1	<i>Precipitation characteristics</i>	87
a	<i>Rainfall intensity</i>	88
b	<i>Areal extent of a rainstorm</i>	90
c	<i>Frequency of rainstorms</i>	90
2	<i>Precipitation types</i>	91
a	<i>'Convective type' precipitation</i>	92
b	<i>'Cyclonic type' precipitation</i>	93
c	<i>Orographic precipitation</i>	93
3	<i>Regional variations in the altitudinal maximum of precipitation</i>	94
4	<i>The world pattern of precipitation</i>	98
5	<i>Drought</i>	99

3 Atmospheric motion	103
A Laws of horizontal motion	103
1 <i>The pressure-gradient force</i>	103
2 <i>The earth's rotational deflective (Coriolis) force</i>	104
3 <i>The geostrophic wind</i>	106
4 <i>The centripetal acceleration</i>	107
5 <i>Frictional forces</i>	108
B Divergence, vertical motion and vorticity	109
1 <i>Divergence</i>	109
2 <i>Vertical motion</i>	110
3 <i>Vorticity</i>	111
C Local winds	111
1 <i>Mountain and valley winds</i>	113
2 <i>Winds due to topographic barriers</i>	114
3 <i>Land and sea breezes</i>	116
D Variation of pressure and wind velocity with height	118
1 <i>The vertical variation of pressure systems</i>	118
2 <i>Mean upper-air patterns</i>	121
3 <i>Upper winds</i>	121
4 <i>Surface pressure conditions</i>	128
E The global wind belts	131
1 <i>The trade winds</i>	131
2 <i>The equatorial westerlies</i>	133
3 <i>The mid-latitude (Ferrel) westerlies</i>	133
4 <i>The polar easterlies</i>	135
F The general circulation	136
1 <i>Circulations in the vertical and horizontal planes</i>	137
2 <i>Variations in the circulation of the northern hemisphere</i>	144
3 <i>The circulation of the ocean surface</i>	145
4 Air masses, fronts and depressions	150
A Nature of the source area	152
1 <i>Cold-air masses</i>	153
2 <i>Warm-air masses</i>	154
B Air-mass modification	157
1 <i>Mechanisms of modification</i>	158
a <i>Thermodynamic changes</i>	158
b <i>Dynamic changes</i>	160
2 <i>The results of modification: secondary air masses</i>	160
a <i>Cold air</i>	160
b <i>Warm air</i>	161
3 <i>The age of the air mass</i>	162

C	Frontogenesis	163
1	<i>Frontal waves</i>	163
2	<i>The frontal wave depression</i>	164
D	Frontal characteristics	166
1	<i>The warm front</i>	167
2	<i>The cold front</i>	168
3	<i>The occlusion</i>	170
4	<i>Frontal wave families</i>	170
E	Zones of wave development and frontogenesis	171
F	Surface/upper-air relationships and the formation of depressions	175
G	Non-frontal depressions	181
1	<i>The lee depression</i>	181
2	<i>The thermal low</i>	181
3	<i>Polar air depressions</i>	182
4	<i>The cold low</i>	182
H	Meso-scale phenomena	182
I	Forecasting	188
1	<i>Short-range forecasting</i>	188
	<i>a Synoptic methods</i>	188
	<i>b Numerical forecasting</i>	189
2	<i>Long-range forecasting</i>	190
	<i>a Statistical methods</i>	190
	<i>b Analogue methods</i>	194
5	Weather and climate in temperate latitudes	197
A	Europe	197
1	<i>Pressure and wind conditions</i>	197
2	<i>Oceanicity and continentality</i>	198
3	<i>British airflow patterns and their climatic characteristics</i>	199
4	<i>Singularities and natural seasons</i>	204
5	<i>Synoptic anomalies</i>	207
6	<i>Topographic effects</i>	209
B	North America	211
1	<i>Pressure systems</i>	212
2	<i>The temperate west coast and cordillera</i>	216
3	<i>Interior and eastern North America</i>	218
	<i>a Continental and oceanic influences</i>	219
	<i>b Warm and cold spells</i>	223
	<i>c Precipitation and the moisture balance</i>	224
C	The polar margins	230

D	The subtropical margins	231
1	<i>The Mediterranean</i>	231
2	<i>The semi-arid south-western United States</i>	237
3	<i>The interior and east coast of the United States</i>	238
6	Tropical weather and climate	242
A	The assumed simplicity of tropical weather	242
B	The intertropical confluence	243
C	Tropical disturbances	246
1	<i>Wave disturbances</i>	247
2	<i>Cyclones</i>	253
	<i>a Hurricanes</i>	253
	<i>b Other tropical depressions</i>	258
3	<i>Subsynoptic systems</i>	258
4	<i>Meso-scale systems</i>	260
D	The Asian monsoon	260
1	<i>Winter</i>	261
2	<i>Spring</i>	266
3	<i>Early summer</i>	267
4	<i>Summer</i>	271
5	<i>Autumn</i>	276
E	Other sources of climatic variations in the tropics	276
1	<i>Diurnal variations</i>	276
2	<i>Topographic effects</i>	278
3	<i>Cool ocean currents</i>	279
4	<i>Disturbances within continental subtropical high-pressure cells</i>	281
7	Small-scale climates	285
A	Surface-energy budgets	285
B	Non-vegetated natural surfaces	287
C	Vegetated surfaces	290
1	<i>Short green crops</i>	291
2	<i>Forests</i>	293
	<i>a Modification of energy transfers</i>	294
	<i>b Modification of the airflow</i>	296
	<i>c Modification of the humidity environment</i>	298
	<i>d Modification of the thermal environment</i>	302
D	Urban surfaces	302
1	<i>Modification of atmospheric composition</i>	303
	<i>a Aerosols</i>	304
	<i>b Gases</i>	308
	<i>c Pollution distribution</i>	309

2	<i>Modification of the heat budget</i>	311
	<i>a Atmospheric composition</i>	312
	<i>b Urban surfaces</i>	312
	<i>c Human heat production</i>	312
	<i>d Heat islands</i>	313
3	<i>Modification of surface characteristics</i>	315
	<i>a Airflow</i>	315
	<i>b Moisture</i>	316
8	Climatic variability, trends and fluctuations	321
A	Climatic data	321
1	<i>Averages</i>	321
2	<i>Variability</i>	323
3	<i>Trends</i>	325
B	The climatic record	325
1	<i>Evidence of climatic change</i>	325
2	<i>Post-glacial conditions</i>	326
3	<i>The last 100 years</i>	327
C	Possible causes of climatic change	332
1	<i>Long-term changes</i>	332
2	<i>Short-term fluctuations</i>	333
	<i>Bibliography</i>	337
	<i>Appendix 1 Climatic classification</i>	358
	A Generic classifications related to plant growth or vegetation	358
	B Energy and moisture budget classifications	361
	C Genetic classifications	363
	D Classifications of climatic comfort	364
	<i>Bibliography</i>	374
	<i>Appendix 2 Nomograms of height, pressure, length and temperature</i>	376
	<i>Appendix 3 Synoptic weather maps</i>	377
	<i>Appendix 4 Système International (SI) units</i>	380
	<i>Problems</i>	382
	<i>Indexes</i>	388