# VEGETATION AND THE ATMOSPHERE

Volume

J. L. MONTEITH

# Vegetation and the Atmosphere

# Volume 1 Principles

#### EDITED BY

## J. L. MONTEITH

Department of Physiology and Environmental Studies, University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, England

1975

### ACADEMIC PRESS London · New York · San Francisco

A Subsidiary of Harcourt Brace Jovanovich, Publishers

## Contents

CONTRIBU	TO	RS							•	v
PREFACE						w •				vii
SYMBOLS				,		·	·	•	•	Х

#### 1. Micrometeorology and Ecology

J. ELSTON and J. L. MONTEITH

١.	History .									1
11.	Micrometeoro	ology								3
III.	Physiology									4
IV.	Ecology.						4			6
V.	Achievement	and c	halle	enge						7
Refe	rences .				,				• _	11

#### 2. Radiative Transfer in Plant Communities

J. ROSS

<u>с</u> І.	Introduction .							13
	Incident radiation							16
1								16
	B. Spectral distribu							18
ш	Optical properties o							21
	Plant community ar							24
	Penetration of the d		liffuse					29
	Total solar radiation							35
	Reflected radiation							40
	Radiation regime in							43
•	A. Spectral compos							43
	B. Angular distribu							46
	C. Variability.							46
IX	Long-wave radiation					<u>,</u>		50
	Net radiation in pla		cum us				2	52
-	rences		÷					52

#### 3. Momentum, Mass and Heat Exchange of Plant Communities

A. S. THOM						
I. The aerodynamic approach: momentum	transf	er as t	he pr	imary	proce	ess.
A. The logarithmic wind profile equation	ι.				•	
B. Transfer coefficients and resistances						
C. Eddy diffusivity	heat t	ransfe	r.			
A. Fully forced convection						
<ul><li>A. Fully forced convection</li><li>B. Effects of vertical temperature gradien</li></ul>	nts					
C. Relationships involving surface condi	tions					
<ul> <li>C. Relationships involving surface condi</li> <li>III. The energy balance approach .</li> <li>A. Total heat and available energy .</li> <li>B. Energy partition</li></ul>					۰.	
A. Total heat and available energy .						
B. Energy partition.						
<ul><li>B. Energy partition.</li><li>C. The Penman combination equation</li></ul>						
eferences						
The Undrological Cuale in Vegetatic						
. The Hydrological Cycle in Vegetation						
A. J. RUTTER						
I. Introduction	1					
<ul> <li>Introduction</li></ul>	1				÷	
A. The process described					÷	
B. Magnitude of interception loss			÷		÷	
C. Factors affecting interception loss			·		i.	÷
D. Is interception a 'loss'?			·			·
E Interception of fog and mist occult n	recini	tation	•	•	•	
II Dew	reeipi	cation	•	•		•
<ul><li>III. Dew</li><li>IV. Absorption and guttation of water by lea</li></ul>	ves					
V The soil_plant_atmosphere continuum						
VI. Magnitude and variability of the water co	ntent	of ve	retatio	on.		
II Transpiration			Juni		2	
<ul><li>/II. Transpiration</li></ul>		•	•			•
B The behaviour of stomata	10	•	•	•	•	
<ul><li>B. The behaviour of stomata .</li><li>C. Resistance to transpiration; stomatal</li></ul>	diffue	ion	•	•	•	·
D. Magnitude of diffusive resistances and	theiri	nterac	tions i	n tran	spirat	ion
II. Soil water and its effects on transpiration	inen 1	aterac		ai ci all	spirat	
A. Available water		·		•		
B. Further discussion of the soil-plant-a		here (				-
C Experimental evidence and practical r	redic	tion	Jonn	uum	•	·
C. Experimental evidence and practical providence and providence and practical providence and pr	n eure	, ion	•	•		•
		•	•	•	·	•
oforeneos						

١.	Introduction .							155
11.	Particle physics							156
	A. Forces on partic	les	,					156

#### xvi

#### CONTENTS

<ul> <li>B. Stoppi</li> <li>C. Impac</li> <li>III. Particles in</li> <li>A. Airbor</li> <li>B. Splash</li> <li>C. Disper</li> <li>IV. Deposition</li> </ul>	ng distance				•					159
C. Impac	tion on surface	es								160
III. Particles in	n the atmosphe	ere .								164
A. Airbor	ne dispersal of	f spores and	pollen							164
B. Splash	dispersal.									166
C. Disper	sal of inorgani	ic particles								167
IV. Deposition A. Depos B. Depos	n of particles									170
A. Depos	ition on leaves	and stems								170
B. Depos	ition to canop	ies in wind to	unnels							175
V Travel and	deposition in	the field								180
A. Theore	etical .									181
A. Theore B. Field e VI. Effects of A. Variat	experiments									187
VI. Effects of	deposition on	airborne cor	centra	tion						194
A. Variat	ion of concent	ration with o	listanc	e						194
B. Vertica	al gradients									197
B. Vertica VII. Implicatio	ns of turbulen	t deposition	of par	ticles				8		199
References .			. 1							201
6. Micromet	eorological	Models								
		modelo								
P. E. WAC										
I. Introducti	on									205
II. Heat and	water .									207
A. Single	water . leaf									207
B. Air an	d foliage abov	e soil that e	xchang	ges a s	pecifi	ed flu	x of h	eat an	d	
water	with the air	·			÷ (					209
C. Strata	of air and fol	iage above l	nown	temp	eratur	e and	l humi	dity o	or	
known	fluxes of heat liage and the s	and water								210
D. Air, fo	liage and the s	soil beneath								215
E. Advec	tion	•					1.			216
F. Relation	on of microme	teorological	model	s to e	vapora	ation	formu	lae		217
G. Some III. Photosynt	uses and unres	olved proble	ms			•				218
III. Photosynt	hesis and carb	on dioxide								219
A. Single	leaf									219
B. Canop	y of foliage									220
C. Relation	on of micron	neteorologica	al pho	otosyn	thesis	mod	lels to	othe	er	
measu	rements and m uses and unres	odels .		•						221
D. Some	uses and unres	olved proble	ms				*			221
IV. Exchange	of other gases	• × •								223
A. Ozone										223
B. Sulphu	ır dioxide .				•				•	224
V. Plant disea	ases .							÷		224
IV. Exchange A. Ozone B. Sulphu V. Plant dise References	· · · ~									227
7. Instrumen	ts and their	Exposure								
G. SZEICZ		3.	<b>c</b> ·							220
	anneamanta an	A AVIO AUTO	at inct.	ATT THAT CHA	to					1 741

xvii

١.	General requirements and exposure	of in	istrum	ents			229
	A. Robustness and waterproofing		•				230

xviii

#### CONTENTS

B. Experimental s	ite ar	nd exp	osure	of ins	strume	ents					231
II. Instruments .				14							233
A. Radiation .											234
B. Airflow .											243
C. Temperature							•	,			246
D. Humidity .										÷	254
E. Carbon dioxide	e con	tent		•							258
											261
G. Other instrume	ents										268
III. Recording .											269
A. Recorders.				•	•			<u>,</u> 1		•	270
B. Data loggers					•		•			•	270
References	·		•	•	•	·	•		•		272
CUDIECT INDEV											275
SUBJECT INDEX	•	•	·	•	•	•	•	•	•	•	275