



# The Physics and Parameterization of Moist Atmospheric Convection

Edited by

Roger K. Smith

NATO ASI Series

Series C: Mathematical and Physical Sciences – Vol. 505

D III 248

DK 551.511.33

# The Physics and Parameterization of Moist Atmospheric Convection

edited by

Roger K. Smith

University of Munich, Germany

322/3968      INSTITUT  
FÜR METEOROLOGIE U. KLIMATOLOGIE  
UNIVERSITÄT HANNOVER  
HERKENHAUSER STR. 2 - 30419 HANNOVER



**Kluwer Academic Publishers**

Dordrecht / Boston / London

Published in cooperation with NATO Scientific Affairs Division

## CONTENTS

Preface	R.K. Smith	vii
---------	------------	-----

### (a) MOIST CONVECTION

Chapter 1:	Overview of atmospheric convection (K.A. Emanuel)	1
Chapter 2:	Thermodynamics of moist and cloudy air (R.K. Smith)	29
Chapter 3:	The mesoscale organization of deep convection (J-L. Redelsperger)	59
Chapter 4:	Trade cumulus: observations and modelling (A.K. Betts)	99
Chapter 5:	Convection in stratocumulus-topped atmospheric boundary layers (C.S. Bretherton)	127
Chapter 6:	Discrete dry convective entities: I Review (B.R. Morton)	143
Chapter 7:	Discrete dry convective entities: II Thermals and deflected jets (B.R. Morton)	175
Chapter 8:	Entrainment, detrainment and mixing in atmospheric convection (C.S. Bretherton)	211
Chapter 9:	Momentum transport by organized convection (M.W. Moncrieff)	231

### (b) PARAMETERIZATION OF MOIST CONVECTION

Chapter 10:	The Parameterization of deep convection (A.K. Betts)	255
Chapter 11:	The Arakawa-Schubert parameterization (D.A. Randall, P. Ding and D.-M. Pan)	281
Chapter 12:	The mass flux approach to the parameterization of deep convection (D. Gregory)	297

### (c) IMPLICATIONS OF CONVECTION FOR THE LARGE-SCALE FLOW

Chapter 13:	Equilibrium vs. activation control of large scale variations of tropical deep convection (B.E. Mapes)	321
Chapter 14:	Quasi-equilibrium (D.A. Randall, D.-M. Pan P. Ding and D.G. Cripe)	359
Chapter 15:	Boundary layer quasi-equilibrium (BLQ) (D.J. Raymond)	387
Chapter 16:	Mutual adjustment of mass flux and stratification profiles (B.E. Mapes)	399

Chapter 17: Implications of convective quasi-equilibrium for the large scale flow (J.D. Neelin)	413
Chapter 18: The problem of convective moistening (K.A. Emanuel)	447
Chapter 19: Sensitivity of General Circulation Model performance to convective parameterization (D. Gregory)	463
(d) SOME OBSERVATIONAL CONSIDERATIONS	
Chapter 20: Critical observations of convection - State of the art and a proposal (D.J. Raymond)	483