

CONTENTS

CONTRIBUTORS	vii
--------------------	-----

Dynamics of the Ice Age Earth

RICHARD PELTIER

1. Introduction	2
2. Mantle Rheology: A Uniformly Valid Linear Viscoelastic Model	12
3. The Impulse Response of a Maxwell Earth	34
4. Postglacial Variations of Relative Sea Level	59
5. Deglaciation-Induced Perturbations of the Gravitational Field	75
6. Deglaciation-Induced Perturbations of Planetary Rotation	90
7. Glacial Isostasy and Climatic Change: A Theory of the Ice Age Cycle	119
8. Conclusions	133
References	139

Planetary Solitary Waves in Geophysical Flows

P. MALANOTTE RIZZOLI

1. Introduction: Why Solitary Waves May Be Important in Large-Scale Geophysical Motions	147
2. Solitary Waves in One Dimension: A Short Synopsis	154
3. The Existing Models for Large-Scale Permanent Structures	160
4. Evolution of Coherent Structures: The Initial Value Problem	173
5. Stability	191
6. Further Investigations on Coherent Structures	206
7. Conclusions	215
References	221

Organization and Structure of Precipitating Cloud Systems

ROBERT A. HOUZE, JR. AND PETER V. HOBBS

1. Introduction	225
2. Extratropical Cyclones	229
3. Midlatitude Convective Systems	247
4. Tropical Cloud Systems	287
5. Conclusions	303
References	305

INDEX	317
-------------	-----

DYNAMICS OF THE ICE AGE EARTH

RICHARD PELTIER

Department of Physics

University of Toronto

Toronto, Ontario, Canada

1. Introduction	2
2. Mantle Rheology: A Uniformly Valid Linear Viscoelastic Model	12
2.1 The Generalized Burgers Body	14
2.2 Free Oscillations of a Homogeneous Spherical Burgers Body	19
2.3 Viscous Gravitational Relaxation of a Homogeneous, Incompressible, and Spherical Burgers Body	28
2.4 The Phenomenological Utility of the Generalized Burgers Body	32
3. The Impulse Response of a Maxwell Earth	34
3.1 The Observed Elastic Structure of the Planet and Its Physical Interpretation	35
3.2 Formulation of the Viscoelastic Problem for Models with Radial Heterogeneity	38
3.3 Normal Modes of Viscous Gravitational Relaxation	41
3.4 Love Number Spectra for Impulsive Forcing	46
3.5 Elastic and Isostatic Asymptotes of the Love Number Spectra	52
3.6 Green's Functions for the Surface Mass Load Boundary Value Problem	53
3.7 Response to Simple Disk Load Deglaciation Histories	55
4. Postglacial Variations of Relative Sea Level	59
4.1 An Integral Equation for Relative Sea Level	60
4.2 Inputs to the RSL Calculation: The Deglaciation Chronology and Mantle Viscosity Profile	62
4.3 Output from the RSL Calculation: Global Sea Level Histories	65
4.4 RSL Constraints on the Mantle Viscosity Profile When Initial Isostatic Equilibrium Is Assumed	68
5. Deglaciation-Induced Perturbations of the Gravitational Field	75
5.1 Satellite and Surface Observations of the Gravity Field over Deglaciation Centers	76
5.2 Disk Load Approximations and the Effect of Initial Isostatic Disequilibrium	79
5.3 Free-Air Anomalies from the Self-consistent Model	88
5.4 Gravity Field Constraints on the Mantle Viscosity Profile	89
6. Deglaciation-Induced Perturbations of Planetary Rotation	90
6.1 The Historical Records of Polar Motion and I.o.d. Variation	90
6.2 The Theory of Deglaciation-Forced Rotational Effects	93
6.3 Polar Motion and I.o.d. Constraints on the Earth's Viscoelastic Stratification	114
6.4 Secular Instability of the Rotation Pole	115
7. Glacial Isostasy and Climatic Change: A Theory of the Ice Age Cycle	119
7.1 Oxygen Isotope Stratigraphy and the Observed Spectrum of Climate Fluctuations on the Time Scale 10^4 - 10^6 Years: The Milankovitch Hypothesis	119
7.2 A Preliminary Model of the Pleistocene Climatic Oscillation	123
7.3 A Spectral Model with Isostatic Adjustment: The Feedback between Accumulation Rate and Ice Sheet Topographic Height	128
7.4 An Analysis of the Properties of a Reduced Form of the Spectral Model	130
8. Conclusions	133
References	139

PLANETARY SOLITARY WAVES IN GEOPHYSICAL FLOWS

P. MALANOTTE RIZZOLI

*Department of Meteorology and Physical Oceanography
Massachusetts Institute of Technology
Cambridge, Massachusetts*

1. Introduction: Why Solitary Waves May Be Important in Large-Scale Geophysical Motions	147
2. Solitary Waves in One Dimension: A Short Synopsis	154
3. The Existing Models for Large-Scale Permanent Structures	160
3.1 A Unified Approach: Length Scales of the Order of the External Deformation Radius	164
3.2 Length Scales Smaller Than the External Deformation Radius	168
4. Evolution of Coherent Structures: The Initial Value Problem	173
4.1 The Single Solitary Eddy in the Weak- and Strong-Wave Limits	175
4.2 Collision Experiments	182
5. Stability	191
5.1 Perturbations in the Initial Conditions: Numerical Experiments	195
5.2 Overlapping Resonances	200
6. Further Investigations on Coherent Structures	206
6.1 Numerical Accuracy	206
6.2 Dissipation	207
7. Conclusions	215
References	221

ORGANIZATION AND STRUCTURE OF PRECIPITATING CLOUD SYSTEMS

ROBERT A. HOUZE, JR. AND PETER V. HOBBS

*Department of Atmospheric Sciences
University of Washington
Seattle, Washington*

1.	Introduction	225
2.	Extratropical Cyclones	229
2.1	Introductory Comments and Historical Perspective	229
2.2	Classification of Rainbands in Cyclones	232
2.3	Warm-Frontal Rainbands	234
2.4	Warm-Sector Rainbands	237
2.5	Wide Cold-Frontal Rainbands	238
2.6	The Narrow Cold-Frontal Rainband	239
2.7	Prefrontal Cold Surge	243
2.8	Postfrontal Rainbands	243
2.9	Some Interactions between Rainbands	244
2.10	Orographic Effects	246
2.11	Vortices in Polar Air Masses	247
3.	Midlatitude Convective Systems	247
3.1	Thunderstorms	247
3.2	Multicell Storms	249
3.3	Supercell Storms	256
3.4	Midlatitude Mesoscale Convective Complexes	275
3.5	Midlatitude Squall Lines	278
3.6	Effects of Downdraft Spreading	284
4.	Tropical Cloud Systems	287
4.1	The Spectrum of Clouds in the Tropics	287
4.2	Types of Cloud Clusters	289
4.3	Squall-Line Cloud Clusters	290
4.4	Nonsquall Cloud Clusters	293
4.5	Generalized Cloud Cluster Structure	296
4.6	Hurricanes	300
5.	Conclusions	303
	References	305