

Contents

Earth's Rotation Measured by VLBI
H. SCHUH (With 8 Figures) 1

1 Determination of the Earth Rotation Parameters by VLBI 1

1.1 Project IRIS 1

1.2 DSN VLBI Observations at JPL 3

1.3 The GJRO Campaign 3

1.4 The VLBI Campaigns with HartRAO 3

2 Analysis of the Earth Rotation Parameters Observed by VLBI 4

2.1 Analysis of the UT1 Series 4

2.2 Analysis of the IRIS Pole Series 6

3 Relation Between the Fortnightly and Monthly Tidal Variations
and the Variations of the Pole? 9

4 Conclusions 11

References 11

Relativity and the Earth's Rotation
E. GILL, M. SOFFEL, H. RUDER, and M. SCHNEIDER 13

1 Introduction 13

2 Post-Newtonian Effects: Free Rotation of the Earth 14

3 Post-Newtonian Effects: Forced Precession and Nutation 16

4 Relativity Experiments and the Earth's Rotation 18

References 20

Astrometric Observations of Hevelius
and Derived Values of ΔT (Dynamical Time – Universal Time)
J. WÜNSCH (With 2 Figures) 21

1 Introduction 21

2 The Solar Observations 21

3 The Lunar Observations 24

References 25

Historical Chinese Astronomical Observations

LIU CIYUAN 27

1	Historical Chinese Astronomical Observations (1)	27
2	Historical Chinese Astronomical Observations (2)	30
2.1	Stars	30
2.2	Special Astronomical Phenomena	30

Application of Early Chinese Records of Lunar Occultations and Close Approaches

LIU CIYUAN and KEVIN K. C. YAU (With 5 Figures) 33

1	Introduction	33
2	Observational Criteria and Method of Analysis	33
3	Data Analysis	35
4	Discussion	37
5	Conclusions	39
	References	39

Ancient Central Eclipse Records of China and Variation of the Earth's Rotation

HAN YANBEN, LI ZHISEN, and YANG XIHONG (With 1 Figure) 40

1	Introduction	40
2	General Principle	41
3	Data Analysis and Results	42
4	Discussion	44
	References	44

Ancient Eclipse Records of East Asia and the Earth's Rotation

LI ZHISEN, HAN YANBEN, and ZENG ZHIFANG (With 1 Figure) 46

1	Introduction	46
2	Valuable Time Records of Eclipses	46
3	Importance of Central Eclipse	48
4	Use of the East Asian Series of Ancient Records	49
	References	50

Tidal Acceleration of the Moon

XX NEWHALL, J.G. WILLIAMS, and J.O. DICKEY 51

References 51

The Variation in J_2 and in the Moments of Inertia:
 Satellite Results and Consequences for the Angular Momentum Budget
 of the Earth-Moon-Sun System

M. BURŠA 52

1 Introduction 52

2 Recent Values of Quantities Needed
 for the Angular Momentum Budget 52

2.1 Secular Variation in the Moon's Mean Motion
 Due to Tidal Dissipation 52

2.2 Secular Variation in J_2 and Related Quantities 53

2.3 Secular Variations in the Orbital Elements of the Moon's
 and Earth's Orbit Due to Tidal Dissipation 53

3 Secular Tidal Variation in the Orbital Angular Momentum
 of the Earth-Moon-Sun System 54

4 Secular Tidal Variations in the Angular Velocity
 of the Earth's Rotation 55

5 Residuum in the Total Angular Momentum Budget 56

6 Conclusions 56

References 57

Celestial Mechanics of Present Tidal Friction

J. KOSTELECKÝ 58

1 Introduction 58

2 Equations of Motion 58

3 Effect of Gravitational Field 59

4 Earth's Body Tides 60

5 Ocean Tides 60

6 Effect of Tides on the Motion of Artificial Satellites,
 Solution of the Inverse Problem: Determination of Tidal Parameters 61

7 Effect of Tides on the Moon's Motion 62

8 Parameters of Ocean Tides – Satellite Solutions 63

9 Parameters of Body Tides 63

10 Secular Tidal Variation of Parameters of the Moon's Orbit 65

11 Conclusion 67

References 67

The Consideration of Solid Earth Effects in Ocean Tide Modeling

W. ZAHHEL (With 7 Figures) 69

1 Introduction 69

2 The Computation of Free and Forced Oscillations 69

3 Free and Forced Hemispherical Oscillations 71

4	Near-Resonance Semi-Diurnal Oscillation Systems	75
5	Conclusions	79
	References	80

Variations of the Angular Momentum Budget for Tides of the Present Ocean

	U. SEILER (With 7 Figures)	81
1	Introduction	81
2	Simulation of Ocean Tides	81
3	The Angular Momentum Budgets	83
4	Variations of the Earth's Rotation	87
5	Summary and Conclusions	91
	References	94

The Pole Tide and the Damping of the Earth's Free Nutation

	H. LENHARDT (With 2 Figures)	95
1	Introduction	95
2	A Glance at the History	95
2.1	At the Beginning: Klein and Sommerfeld (1910)	96
2.2	A Milestone: Bondi and Gold (1955)	97
3	A Spherical Harmonic Model of the Pole Tide	99
3.1	The Algorithm	99
3.2	The Comparison with Observed Values	102
4	Some Aspects of the Modern Theory	104
5	Conclusions	106
	References	106

The Seasonal Angular Momentum of the Thermohaline Ocean Circulation

	A. FRISCHE and J. SÜNDELMANN (With 16 Figures)	108
1	Introduction	108
2	Calculation of Thermohaline Currents	109
2.1	Basic Equations	109
2.2	Thermal Wind Equations	110
2.3	The Hydrographic Data	111
3	Oceanographic Results	111
3.1	The Global Circulation	111
3.2	Seasonal Variations	114
3.3	Transport Calculations	118
4	Angular Momentum Contained in Thermohaline Currents	120
4.1	Calculations Based on Geostrophic Currents	120

4.2 Calculations Based on a General Circulation Model 123
 4.3 Implications for Length of Day 125
 5 Conclusions 125
 References 126

Atmospheric Effects on the Earth's Rotation

H. VOLLAND 127

1 Introduction 127
 2 Outline of the Theory of Atmospheric Large-scale Motions 127
 3 Internal Friction 128
 4 Surface Friction 129
 5 Atmospheric Angular Momentum 130
 6 Polar Motion 133
 7 Solar Gravitational Tidal Torque 135
 8 Magnetospheric Friction 136
 References 140

*The Solar Torque – A Leak for the Angular Momentum
 of the Earth-Moon System*

P. BROSCHE and J. WÜNSCH 141

1 Introduction 141
 2 The Ratio 141
 2.1 The Schematic View 141
 2.2 Periodic Variations 142
 2.3 Average Torques 142
 3 The Balance 144
 References 145

*Tectonic Consequences of the Earth's Variable Rotation
 on Geological Time Scales*

C. DENIS and P. VARGA (With 8 Figures) 146

1 Introduction 146
 2 Outline of the Theory of Equilibrium Figures 147
 3 Tidal Despinning of the Earth 149
 4 Kinetic Parameters of the Earth Throughout Geological Time 152
 5 Lithospheric Stresses Caused by Tidal Despinning 155
 6 Tidal Shrinkage 158
 7 Tectonic Evolution of the Earth Due to Tidal Despinning 159
 References 161

Secular Variations of the Earth's Moment of Inertia and Related Quantities

P. VARGA and C. DENIS	163
1 Introduction	163
2 Rotational Deformation and Trace Changes of the Inertia Tensor	165
3 Variations of the Polar Moment of Inertia and Related Quantities Caused by Changes of I.o.d.	167
4 Some Causes of Secular Change of the Polar Moment of Inertia	169
5 Long-Term Variations of the Geopotential Coefficient J_2	171
6 Conclusion	174
References	174

Global Consequences of the Tidal Secular Deceleration for the Solid Earth and its Fluid Core

J. HINDERER and H. LEGROS	177
1 Introduction	177
2 Secular Deceleration of the Core-Mantle System	177
3 Geodynamic Consequences Due to the Change in the Rotational Potential	179
3.1 Radial Part	179
3.2 Zonal Part	180
4 Resonance in the Paleowobbles	181
5 Secular Deceleration and Magnetic Scaling Laws	184
6 Conclusion	185
References	186

Astronomical Frequencies in Paleoclimatic Data and the Dynamical Ellipticity of the Earth

M.F. LOUTRE, V. DEHANT, and A. BERGER (With 3 Figures)	188
1 Introduction	188
2 Climate Changes at the Astronomical Frequencies	188
2.1 Climate Variations	188
2.2 Milankovitch Astronomical Theory of Paleoclimates	190
2.3 Classical Astronomical Frequencies in Diverse Geological and Insolation Data all over the World	190
3 Earth's Orbital Parameters	192
4 Astro-Climatic Elements	193
5 Influence of the Variation of the Lunar Orbit	194
6 Impact of the Ice Sheets During the Quaternary	197
7 Conclusion	199
References	199

**Quaternary Sea-Level Changes in the North Sea,
an Analysis of Amplitudes and Velocities**

H. STREIF (With 6 Figures) 201

1 Introduction 201
 2 Geological Evidence and Processes 201
 3 Conclusions 212
 References 213

Tidal Rhythms in the Shell Secretion of Living Bivalves

C.A. RICHARDSON (With 10 Figures) 215

1 Introduction 215
 2 Experimental Approach 216
 3 Effects of Tidal Emersion 218
 4 Effects of Continuous Immersion 222
 References 225

**Implications of Some Recent Sedimentological Studies
to the History of the Earth-Moon System**

J.D.A. PIPER (With 1 Figure) 227

1 Introduction 227
 2 Sedimentary Rhythmites 228
 References 232

**Continental Configurations and Mantle Reference Frames
over Geological Time**

J.D.A. PIPER (With 12 Figures) 234

1 The Palaeomagnetic Constraint and the Dipole Assumption 234
 2 Configurations and Movements of the Continental Crust 236
 3 True Polar Wander and the Hotspot Frame 243
 4 The Geomagnetic Field Source and the Core-Mantle Boundary Zone 248
 References 253