

# Contents

<b>1</b>	<b>Computation of Green's Functions for Ocean Tide Loading</b> . . . . .	<b>1</b>
1	Introduction. . . . .	1
2	Equations of Motions and Rheology. . . . .	3
3	Spheroidal and Toroidal Motions. . . . .	6
4	Fluid Core. . . . .	12
5	Resonance Effects . . . . .	16
6	Boundary Conditions . . . . .	17
7	Simple Earth Models and Love Numbers . . . . .	21
8	Degree-1 Response and Translational Invariance . . . . .	26
9	Numerical Methods . . . . .	28
10	Rheology: Viscosity and Anelasticity . . . . .	32
11	Green's Functions . . . . .	35
12	Final Remarks . . . . .	40
	Appendix 1: Lyapunov-Transformed Matrices . . . . .	41
	Appendix 2: Analytical Solution for a Homogeneous Earth . . . . .	42
	Appendix 3: Analytical Solution for a Homogeneous Fluid Inner Sphere . . . . .	47
	Appendix 4: Tiny Fluid Sphere . . . . .	49
	Appendix 5: Gravity Green's Function and Kummer Transform. . . . .	50
	References . . . . .	50
<b>2</b>	<b>General Relativity and Space Geodesy</b> . . . . .	<b>53</b>
1	Background. . . . .	53
	1.1 Introduction. . . . .	54
	1.2 Basic Implications of GRT for Space Geodesy Techniques . . . . .	56
2	Satellite Laser Ranging. . . . .	56
	2.1 Shapiro Delay . . . . .	59
	2.2 GRT Accelerations . . . . .	60
	2.3 SLR Tests of General Relativity Theory . . . . .	69
3	Global Positioning System . . . . .	76
	3.1 Reference Frame Issues. . . . .	76

- 3.2 Clock and Frequency Effects . . . . . 76
- 3.3 General Relativistic Accelerations . . . . . 84
- 3.4 Spatial Curvature Effect on Geodetic Distance. . . . . 85
- 4 Very Long Baseline Interferometry . . . . . 85
  - 4.1 Gravitational Delay . . . . . 85
  - 4.2 General Relativistic Tests Using VLBI . . . . . 86
- 5 Concluding Remarks . . . . . 89
- References . . . . . 90
  
- 3 Global Terrestrial Reference Systems and Their Realizations . . . . . 97**
  - 1 Introduction. . . . . 97
  - 2 Basic Concepts and Fundamentals . . . . . 100
  - 3 International Terrestrial Reference System . . . . . 101
    - 3.1 ITRS Definition . . . . . 101
    - 3.2 Positions and Displacements of Reference Points. . . . . 103
  - 4 International Terrestrial Reference Frame . . . . . 106
    - 4.1 IERS Network . . . . . 106
    - 4.2 History of ITRS Realizations. . . . . 110
  - 5 The Latest Realization, the ITRF2008 . . . . . 112
    - 5.1 ITRF2008 Input Data . . . . . 112
    - 5.2 ITRF2008 Data Analysis. . . . . 114
    - 5.3 ITRF2008 Results . . . . . 119
    - 5.4 Comparison of ITRF2008 and DTRF2008. . . . . 120
    - 5.5 Transformation Parameters from ITRF2008 to Past ITRF Realizations . . . . . 122
  - 6 Discussion and Challenges for the Future . . . . . 124
    - 6.1 IERS Network, Co-Location Sites and Local Tie Vectors . . . . . 125
    - 6.2 Input Data for the ITRF Computations . . . . . 125
    - 6.3 Nonlinear Station Motions. . . . . 126
    - 6.4 Effect of Large Earthquakes . . . . . 127
    - 6.5 Combination Methodology and Datum Definition . . . . . 128
- References . . . . . 129
  
- 4 Photogrammetry . . . . . 133**
  - 1 Introduction. . . . . 133
    - 1.1 Definition and Short History . . . . . 133
    - 1.2 Applications and Limitations . . . . . 136
  - 2 Image Acquisition . . . . . 137
    - 2.1 Aerial Cameras . . . . . 137
    - 2.2 Planning the Photo Flight . . . . . 149
  - 3 Image Georeferencing. . . . . 155
    - 3.1 Coordinate Systems in Photogrammetry . . . . . 155
    - 3.2 Indirect Georeferencing. . . . . 158
    - 3.3 Semi-Direct Georeferencing. . . . . 165

3.4	Direct Georeferencing . . . . .	167
4	Image Processing . . . . .	171
4.1	Stereoplotting . . . . .	172
4.2	Three-Dimensional Modelling . . . . .	172
4.3	Orthorectification . . . . .	178
	References . . . . .	182
<b>5</b>	<b>Regional Gravity Field Modeling: Theory and Practical Results . . . . .</b>	<b>185</b>
1	Introduction . . . . .	185
2	Fundamentals of Physical Geodesy . . . . .	187
2.1	Reference Systems . . . . .	187
2.2	Newton’s Law of Gravitation and Potential . . . . .	192
2.3	The Earth’s Gravity Field . . . . .	198
2.4	The Geoid and Heights . . . . .	201
2.5	The Normal Gravity Field . . . . .	208
2.6	Temporal Gravity Field Variations and the Atmosphere . . . . .	212
3	Gravity Field Modeling . . . . .	217
3.1	Geodetic Boundary Value Problems . . . . .	217
3.2	Linearization of the Boundary Conditions . . . . .	218
3.3	The Constant Radius Approximation . . . . .	228
3.4	Solutions to Molodensky’s Boundary Value Problem . . . . .	232
3.5	Solutions to Stokes’s Boundary Value Problem . . . . .	235
3.6	The Spectral Combination Technique . . . . .	237
3.7	Least-Squares Collocation . . . . .	241
3.8	Astronomical Leveling . . . . .	244
3.9	The Remove-Compute-Restore Technique and Topographic Effects . . . . .	247
4	Practical Results . . . . .	251
4.1	Data Requirements . . . . .	251
4.2	The European Gravity and Geoid Project . . . . .	255
4.3	The European Gravity and Terrain Data . . . . .	256
4.4	Development of the European Quasigeoid Model EGG2008 . . . . .	261
4.5	Evaluation of the European Quasigeoid Model EGG2008 . . . . .	272
4.6	Summary and Outlook . . . . .	281
	References . . . . .	282
<b>6</b>	<b>Regularization and Adjustment . . . . .</b>	<b>293</b>
	Part I: Regularized Solution to Ill-Posed Problems . . . . .	293
1	Introduction . . . . .	293
2	Unstable Analysis of Least Squares Solution to Ill-Posed Observation Equation . . . . .	294
3	Regularized Solution to Ill-Posed Observation Equations . . . . .	297
3.1	Solution to Rank-Deficient Observation Equations . . . . .	297
3.2	Regularized Solution to Ill-Posed Observation Equations . . . . .	298

- 4 Determination of the Regularization Parameter . . . . . 302
- 5 Numerical Cases . . . . . 306
- 6 Summary . . . . . 309
  - Part II: Adjustment . . . . . 310
- 7 Introduction. . . . . 310
- 8 Least Squares Adjustment. . . . . 310
  - 8.1 Least Squares Adjustment with Sequential
    - Observation Groups . . . . . 312
- 9 Sequential Least Squares Adjustment . . . . . 314
- 10 Conditional Least Squares Adjustment . . . . . 315
  - 10.1 Sequential Application of Conditional Least
    - Squares Adjustment . . . . . 317
- 11 Block-Wise Least Squares Adjustment . . . . . 319
  - 11.1 Sequential Solution of Block-Wise Least
    - Squares Adjustment . . . . . 321
- 12 Equivalently Eliminated Observation Equation System. . . . . 323
  - 12.1 Diagonalized Normal Equation and the Equivalent
    - Observation Equation . . . . . 326
- 13 A Priori Constrained Least Squares Adjustment. . . . . 327
  - 13.1 A Priori Parameter Constraints. . . . . 328
  - 13.2 A Priori Datum . . . . . 329
  - 13.3 Quasi-Stable Datum . . . . . 331
- 14 Summary . . . . . 333
- Bibliography . . . . . 334
  
- 7 Very Long Baseline Interferometry for Geodesy and Astrometry. . . . . 339**
  - 1 Introduction. . . . . 340
    - 1.1 Geometric Principle . . . . . 340
    - 1.2 History and Technological Developments . . . . . 341
    - 1.3 Data Acquisition . . . . . 343
    - 1.4 Data Analysis . . . . . 347
  - 2 Theoretical Delays . . . . . 348
    - 2.1 Station Coordinates at the Time of Observation. . . . . 348
    - 2.2 Earth Orientation . . . . . 349
    - 2.3 General Relativistic Model for the VLBI Time Delay. . . . . 351
    - 2.4 Troposphere Delay Modeling. . . . . 355
    - 2.5 Antenna Deformation . . . . . 358
    - 2.6 Axis Offsets . . . . . 359
    - 2.7 Source Structure. . . . . 360
    - 2.8 A Few Examples of Constituents of the Delay. . . . . 360
  - 3 Least-Squares Adjustment in VLBI . . . . . 361
    - 3.1 The Concept of Piecewise Linear Offsets . . . . . 362
    - 3.2 Global VLBI Solutions . . . . . 363
  - 4 Results from Geodetic VLBI and the IVS. . . . . 365

5	The Next Generation VLBI System, VLBI2010. . . . .	369
6	Concluding Remarks . . . . .	371
	References . . . . .	371
	<b>Index</b> . . . . .	<b>377</b>



<http://www.springer.com/978-3-642-27999-7>

Sciences of Geodesy – II

Innovations and Future Developments

(Ed.) G. Xu

2013, XIX, 391 p. 95 illus., 12 in color., Hardcover

ISBN: 978-3-642-27999-7