Datums and Map Projections
CONTENTS

Preface ix

Chapter 1: Introduction 1
  1.1 The context 1
  1.2 Introduction to the concepts and the structure of this book 2

Chapter 2: Coordinates and reference systems 8
  2.1 The Earth – geoid and ellipsoid 8
    2.1.1 The geoid 8
    2.1.2 Models of the shape of the Earth – the ellipsoid 8
  2.2 Coordinate systems 11
    2.2.1 Coordinate system attributes 11
    2.2.2 Coordinate systems for the sphere and ellipsoid 12
    2.2.3 Geocentric Cartesian coordinates 14
    2.2.4 Conversion between ellipsoidal and geocentric Cartesian coordinates 15
    2.2.5 Map projection coordinates 16
    2.2.6 Cartesian coordinates for engineering applications 17
    2.2.7 Gravity-related systems (height and depth) 18
    2.2.8 Miscellaneous coordinate systems 19
  2.3 Datums and coordinate reference systems 20
    2.3.1 Datum overview and classification 20
    2.3.2 Geodetic datums and coordinate reference systems 20
    2.3.3 Projected coordinate reference systems 28
    2.3.4 Vertical systems 29
    2.3.5 Engineering datums and coordinate reference systems 35
    2.3.6 Image datums and coordinate reference systems 35
  2.4 Compound coordinate reference systems 36
  2.5 Coordinate reference system identification 36
    2.5.1 CRS description 36
    2.5.2 Registers of coordinate reference systems 38

Chapter 3: Map Projections 39
  3.1 Introduction 39
  3.2 Map projections: fundamental concepts 40
    3.2.1 Grids and graticules 40
    3.2.2 Scale factor 40
    3.2.3 Developable surfaces 42
    3.2.4 Preserved features 44
    3.2.5 Spheres and ellipsoids 46
Appendix A: Terminology 176
Appendix B: Computations with spherical coordinates 181
Appendix C: Basic geometry of the ellipsoid 182
  C.1 Introduction 182
  C.2 Radii of curvature of the ellipsoid 182
  C.3 Normal sections and geodesics 182
  C.4 Forward computation of coordinates 184
  C.5 Reverse computation of azimuth 184
  C.6 Determination of points on the geodesic 185
Appendix D: The Molodensky equations 186
Appendix E: Determination of transformation parameter values by least squares 187
  E.1 Introduction and least squares terminology 187
  E.2 Two dimensional transformations of Cartesian coordinates 189
    E.2.1 The Similarity transformation 189
    E.2.2 The affine transformation 192
    E.2.3 Second order polynomials 193
  E.3 Three-dimensional transformations of Cartesian coordinates 194
    E.3.1 The seven-parameter transformation 194
    E.3.2 The ten-parameter geocentric transformation 196
    E.3.3 Subsets of the seven-parameter geocentric transformation 196
  E.4 Worked example 197

References & Further Reading 200

Index 203