

Contents

Introduction	1
Chapter 1 Optical-Physical Models of Atmospheric Aerosol	7
1.1 Complex Optical Models of Atmospheric Aerosol	7
1.2 Application of Mie Theory in Determining the Optical Parameters of Atmospheric Aerosol	22
1.3 Closed Modeling of the Optical Characteristics of Atmospheric Aerosol	37
Chapter 2 The Radiation-Environment Interaction	43
2.1 Basic Definitions in Photometry	44
2.2 Equations of Interaction Between Radiation and Randomly Inhomogeneous Media	46
2.3 The Filtering Role of the Optical Radiation Sensors	50
2.4 Coherence Functions	55
2.5 The Structure of the Brightness Field and the Structuring of Computation Programs	59
2.6 Partially Coherent Waves Coherence Matrices	61
Chapter 3 Theoretical Models of the Non-Polarized Optical Radiation in the Atmosphere-Surface System	69
3.1 Justification of the Necessity to Consider the Distorting Effect of the Atmosphere when Surveying the Earth from Space	69
3.2 Calculating Facilities of the Analytical and Numerical Methods of the Radiation Transfer Theory ...	74
3.3 Setting the Problem of Theoretical Determination of Scalar Asymptotic Transfer Functions of the Atmosphere ..	77
3.4 An Accurate Solution for the Problem of Diffused Reflection and Transmission of Light by the Terrestrial Atmosphere for Model Phase Functions	82

3.5	Algorithm to Determine the Azimuthal Harmonics of q^m and σ^m Brightness Coefficients	90
3.6	Linear Integral Equations for Basic Functions	97
3.7	Application of the Specular Reflection Principle in the Theory of Radiation Transfer	103
3.8	The Meaning in Probability Terms of Basic Ω_i^m and θ_i^m Functions	113
3.9	Accurate Expressions for the Azimuthal Harmonics of Brightness Coefficients q^m and σ^m for an Approximating Three-Term Phase Function ($m = 0, 1, 2$)	116
3.10	Atmospheric Albedo, Spherical Albedo and Irradiance of the Planetary Surface	123
3.11	Approximate Expressions for the Coefficients of Diffused Reflection and Transmission with an Arbitrary Phase Function	127
3.12	Determination of the Parameters of the Radiation Field with the Use of an Advanced Method of Spherical Harmonics	131
 Chapter 4 A One-Dimensional Scalar Transfer Function of the Atmosphere		 141
4.1	Theoretical Assessment of the Spectral Transfer Function for the Brightnesses of a Horizontally Homogeneous Surface	141
4.2	On the Solution of Inverse Problems of Space-Based Atmospheric Optics for Model Phase Functions	146
4.3	Tabulating Basic Constituents of the Scalar Transfer Function of an Aerosol Atmosphere	151
4.4	The Effect of the Non-Orthotropic Surface on the Radiation Field	155
4.5	Results of Numerical Modeling of the Background Spectral Transfer Functions	161
4.6	Diagrams of an Optimization of the Transforming Effect of the Atmosphere when Surveying the Earth from Space	165
4.7	The Geographical and Seasonal Distribution of the Transfer Function Monochromatic Values	166
4.8	The Effect of Atmospheric Haze on the Colour of Natural Formations	170
4.9	An Assessment of the Polarization Transfer Function of the Atmosphere	171
4.10	The Effect of the Atmosphere on the Spectral Albedo of Natural Formations	179
4.11	The Geographical and Seasonal Change of the Transfer Function for Albedo	183

Chapter 5	The Effect of Horizontal Inhomogeneities of the Underlying Surface on the Scalar Transfer Function of the Atmospheric	187
5.1	Setting the Problem of Theoretical Estimation of a 2-Dimensional (2-D) Atmospheric Transfer Function	187
5.2	The Effect of the Atmospheric Optical Parameters and of the Conditions of Survey on a 2-D Transfer Function	189
5.3	The Effect of the Horizontally Inhomogeneous Constituent of the Scattered Radiation	195
5.4	An Assessment of the Effect of Horizontal Diffusion of Photons on the Spectral Transfer Function	199
5.5	An Approximate Assessment of the Transfer Function for a Surface Formed by Two Horizontally Homogeneous Half-Planes	210
5.6	A Comparison of Experimental and Theoretical Estimates of the Spectral Transfer Functions	215
5.7	The Effect of the Atmospheric Radiative Factors on the Detection of the Small-Sized Optical Inhomogeneities of the Terrestrial Surface	219
5.8	The Formation of Reflection Spectra Near the Interface Between Two Horizontally Homogeneous Media	223
Chapter 6	Radiative Correction of the Space-Derived Images of the Earth Surface	229
6.1	Setting the Problem of Atmospheric Radiative Correction	229
6.2	The Status of the Problem of Radiative Correction of Multispectral Space-Derived Images	233
6.3	An Approximation of the Dependences of Outgoing Radiation Intensities by Orthogonal Polynomials	255
6.4	Sensitivity of the Calculation Scheme Considering the Atmospheric Haze Brightness to Variations in the Initial Data	263
6.5	Atmospheric Filter for Spatial Frequencies	271
6.6	Retrieving the Spatial Structure of an Ideal Image	275
6.7	A Regularized Solution for Inverse Problem	281
6.8	Results of Radiative Correction of the Digitized Photographic and Scanner Information	285
6.9	Comparison of Results of Surface Albedo Estimation from Satellites and Aircraft	290
6.10	Thematic Interpretation of Air- and Space-Derived Digitized Video Information	294
6.10.1	Improving the Properties of Images	295
6.10.2	Principles of Recognition of Images	298
6.10.3	Features of the Applied Method for Classification	304

6.10.4	Classification of Images Before and After Their Radiative Correction	306
6.11	Atmospheric Correction as One of the Stages of Thematic Interpretation of Video Information	316
6.11.1	A Comparative Analysis of Space Images and Spectra	317
6.11.2	The Stages of Atmospheric Correction of Video Information ..	326
6.11.3	The Morphological and Structural Analysis of Images	333
6.11.4	The Technology of Atmospheric Correction of Video Information	340
6.12	An Assessment of the State of Natural Objects from Remote Sensing Data	343
6.12.1	Models of Multifactor Regression	344
6.12.2	Interactive Classification of Soils and Vegetation from Mid-Resolution Images	350
6.13	The Structure and Principal Elements of the Automated System of Processing Digital Aerospace Video Information ...	357
 Chapter 7 Models of Interaction of the Shortwave and Longwave Components of the Radiation Budget with the Atmosphere and the Earth Surface		 361
7.1	The Boundary Problems of Shortwave Radiation Transfer	361
7.2	Cross-Sections of Interaction and Phase Functions	363
7.3	The Solution of the Boundary Problem for Shortwave Radiation	370
7.4	Possibilities of Reducing Computer Time	374
7.5	Consideration of Non-Orthotropicity and Horizontal Inhomogeneity of the Earth-Surface	382
7.6	The Longwave Radiation Transfer	388
7.7	Radiation Fluxes and Heat Flux Divergences in Radiation-Balance Models	393
 Chapter 8 Observations of the Earth Radiation Budget from Space		 397
8.1	The Status of the Problem of Retrieving the Heat and Radiation Budgets of the Earth's Surface	397
8.2	Empirical Analysis of the Earth's Radiation Budget Components	411
8.3	The Variability of the ERB Components from Satellite Measurements	411
8.4	The Retrieval of the Radiation and Heat Budgets of the Earth's Surface	416
8.5	The Interannual Variability of Radiation Budget at the Upper and Lower Boundaries of the Atmosphere	421

8.6	Cloudiness as a Factor of Interannual Variability of the Radiation Budget	426
8.7	Statistical Characteristics of Anomalies of the 2-D Fields of the Radiation Budget of the North Atlantic	430
8.8	Anomalies of the Radiation Budget and the EAZO Problem .	437
8.9	Teleconnections Between the ERB Anomalies in Tropical and Mid-Latitudes	445
8.10	Prospects for Using Satellite Measurements in Climate Studies	453
Conclusion		459
References		463
Subject Index		475