

Contents

Preface to the Second Edition	xiii
Preface to the First Edition	xvii
List of figures	xxi
List of tables	xxix
List of abbreviations and acronyms	xxxiii
1 Introduction: Scientific and applied rationales for the study of tropical cyclogenesis	1
1.1 International efforts on tropical cyclogenesis study	2
1.2 Present state of the art of tropical cyclogenesis study	5
1.2.1 What do we know?	6
1.2.2 What do we not know?	6
1.2.3 What tools are available to us now?	7
2 Global tropical cyclogenesis as a stochastic process	11
2.1 Information signal model: Simulation, cumulation	11
2.2 Annual single-component stochastic model of global tropical cyclogenesis	14
2.2.1 Time series and cumulative functions of global tropical cyclogenesis	14
2.2.2 Probability model and its parameters	15
2.2.3 Interannual variabilities	25
2.2.4 Poisson random model.	26
2.3 Annual two-component stochastic model of global tropical cyclogenesis.	29

2.3.1	Two-component probability model and its parameters . .	29
2.3.2	Interannual variabilities for the two-component model . .	32
2.4	Tropical cyclogenesis of the northern and southern hemispheres .	34
2.4.1	Time series and cumulative functions for hemisphere cyclogenesis	34
2.4.2	Probability model and its parameters	36
2.4.3	Intermittency coefficient and “true” intensity	40
2.4.4	Interannual variability between northern hemisphere and southern hemisphere cyclogenesis	44
2.5	Evolution of tropical cyclone initial forms as a stochastic process	49
2.5.1	Simulation of an information signal	50
2.5.2	Time series of the intensity of initial and mature forms .	51
2.5.3	Probability models of the intensity of initial and mature forms	54
2.5.4	Integral intensity of processes	57
2.5.5	Rate of hurricane formation	59
2.5.6	Regional features of Pacific cyclogenesis	62
2.5.7	Regional features of Indian Ocean cyclonic activity	65
2.5.8	Regional features of Atlantic Ocean cyclogenesis	66
2.6	Large-scale structure of global tropical cyclogenesis	67
2.6.1	Spatiotemporal variability in global cyclogenesis	67
2.6.2	Intra-annual variation of global cyclogenesis	70
2.6.3	Spatial structure of generation centers	71
2.7	Hierarchical structure of global tropical cyclogenesis	78
2.7.1	Main properties and examples of wavelet transform	78
2.7.2	Wavelet patterns of global tropical cyclogenesis	86
2.8	Hierarchical structure of popular service systems	90
2.8.1	Critical parameter of traffic services	91
2.8.2	Forming a time series for the traffic process	91
2.8.3	Wavelet patterns of disruption to traffic intensity	92
2.8.4	Possible physical models	95
2.9	Magnetosphere processes and global tropical cyclogenesis	97
3	Regional tropical cyclogenesis	103
3.1	Pacific tropical cyclogenesis as a stochastic process	103
3.1.1	Probability models of Pacific cyclogenesis intensity	104
3.1.2	Interannual variability of Pacific cyclogenesis	108
3.1.3	Intermittency coefficient and the true intensity of Pacific cyclogenesis	110
3.2	Thermal stratification of tropical atmosphere and Pacific cyclo- genesis	113
3.2.1	Initial observational data and processing methodology . .	113
3.2.2	Spatiotemporal statistics of gradient fields	117
3.2.3	Thermal stratification of the atmosphere by the action of tropical cyclones	120

3.2.4	Thermal stratification of a disturbed atmosphere (resulting from radiosonde data)	123
3.2.5	Thermal stratification of the tropical atmosphere by the action of tropical cyclone formation	126
3.3	Spatiotemporal features of atmospheric moisture and Pacific cyclogenesis	132
3.3.1	Observational data and processing procedure	133
3.3.2	Precipitable water fields in an undisturbed atmosphere	135
3.3.3	Precipitable water fields in a disturbed atmosphere	138
3.3.4	Model of precipitable water fields and their properties under various synoptic conditions	138
3.3.5	Mesoscale variability in precipitable water fields in the process of cyclogenesis	140
3.3.6	Correlation with "one-point" measurements of precipitable water content	141
3.3.7	Atmospheric water balance under pre-typhoon and typhoon conditions	143
3.4	Initial stage of tropical cyclogenesis in the Pacific: Dynamics, interactions, hierarchy	148
3.4.1	Two-stage conceptual model of tropical cyclogenesis	150
3.4.2	Dynamics and interactions of original forms of TCs	155
3.4.3	Hierarchy and clusterization of tropical convective systems	167
3.4.4	Fractal features of superconvective clusters	188
3.4.5	Spatiotemporal evolution of convective cluster mesoturbulence with high-precision Doppler radar	192
3.5	Variation in tropical cyclone activity and El Niño–Southern Oscillation	199
4	Global tropical cyclogenesis and global change	211
4.1	Universal generation constant for a stochastic mode of global tropical cyclogenesis	211
4.1.1	Statement of the problem	211
4.1.2	Modern approaches and signal formation principles	213
4.1.3	Universal constant for global and hemisphere cyclogenesis	216
4.2	Tropical cyclogenesis and sea surface temperature fields (global and regional scales)	221
4.2.1	Statement of the problem	221
4.2.2	Observational data and their processing	223
4.2.3	Statistical processing results for global cyclogenesis	225
4.2.4	Statistical properties of global cyclogenesis	229
4.2.5	Statistical features of mature form genesis in the SST field based on in situ data	232

4.2.6	Statistical features of mature form genesis in the SST field based on remote and in situ data	236
4.2.7	Features of the statistical properties of regional cyclogenesis	240
4.3	Global radiothermal fields for study of the atmosphere-ocean system	241
4.3.1	The role of microwave sounding in space monitoring. . .	242
4.3.2	Representation of the global radiothermal field as a computer animation.	244
4.3.3	Possibilities of using the radiothermal data of satellite monitoring.	247
4.3.4	Evolution of the radiothermal field of TC "Alberto" . . .	251
4.4	Global water vapor field as the energy source of tropical cyclones	261
4.4.1	Statement of the problem	261
4.4.2	Initial data of satellite-sounding and information-processing algorithms.	263
4.4.3	Entrainment effect in the evolution of TC "Gonu"	266
4.4.4	Entrainment effect in the example of TC "Hondo" evolution.	267
4.4.5	Time evolution of TC "Hondo" and TC "Ivan" and their interaction in the integral water vapor field	278
4.5	Latent heat energy transport by plural tropical cyclogenesis. . .	282
4.5.1	Statement of the problem	283
4.5.2	Plural tropical cyclogenesis evolution	284
4.5.3	Initial data for satellite sensing	289
4.5.4	Information-processing technique and algorithms.	289
4.5.5	Spatiotemporal evolution of tropical cyclogenesis in the global water vapor field	291
5	Solar activity and global tropical cyclogenesis	295
5.1	Statement of the problem: Short history of viewpoints	295
5.2	Study techniques and approaches: Processing technique.	297
5.3	Features of wavelet processing	299
5.4	Annual and interannual variabilities of solar activity and cyclogenesis.	302
5.5	Correlation of annual time series	306
5.6	Searching for 27-day periodicity in the time series of cyclogenesis	309
5.7	Features of multiyear cyclogenesis data	310
6	Ionosphere and tropical cyclone activity	315
6.1	Statement of the problem and measurement techniques for ionosphere sounding	315
6.2	Equatorial lower-ionosphere interactions with tropical cyclones studied by rocket sounding	318

6.3	Large-scale upper-ionosphere variability measurement by oblique path radiosounding	322
6.4	Tropical cyclone activity in mesospheric airglow	329
7	Physical models and simulations of global tropical cyclogenesis	337
7.1	Statistical synoptical modeling and forecasting.	338
7.1.1	Seasonal genesis parameters	338
7.1.2	North Atlantic seasonal forecasts	339
7.1.3	Development of the statistical synoptical approach	342
7.2	Global climate change models and tropical cyclone genesis	345
7.3	Kinetic diffusion approach	356
7.3.1	Principles of the formation of a signal	357
7.3.2	Correlation properties	358
7.3.3	Kinetic diffusion model	360
7.3.4	Radiophysical analogue	361
7.3.5	Ways of improving the model	362
7.4	Concept of self-organization	362
7.4.1	Elements of qualitative analysis	363
7.4.2	Helix mechanism for the formation of large-scale structures.	364
7.4.3	Effect of thermally insulated boundaries on the formation of large-scale structures	365
7.4.4	Turbulent wave dynamo.	366
7.4.5	Diagnostic problems	367
7.5	Instability genesis in a compressed and saturated moist air atmosphere.	369
7.5.1	Basic mechanisms involved in catastrophe genesis	370
7.5.2	Role played by phase passing	372
7.5.3	Physical mechanism involved in rotational instability	374
7.5.4	New requirements for remote-sensing systems.	376
8	Databases of global tropical cyclogenesis.	379
8.1	Scientific and applied philosophy of global cyclogenesis dataset design	379
8.2	Historical perspectives	382
8.3	Existing archiving procedures and current archives.	384
8.3.1	Areas of responsibility	384
8.3.2	JTWC services and products	386
8.3.3	NHC services and products.	390
8.3.4	Global tropical cyclogenesis archives.	393
8.4	The global tropical cyclogenesis dataset Global-TC	396
8.4.1	Principles of database design.	396
8.4.2	Data preparation technique.	397
8.4.3	Chronological data unit	398
8.4.4	Evolutionary data unit.	398

8.4.5	Computational architecture of dataset	399
8.5	Geoinformation dataset Pacific-TC	400
8.5.1	Principles used to develop the database	400
8.5.2	Structure of geophysical data	401
8.5.3	Computational architecture	403
8.5.4	Visualization of information	404
8.6	Combined satellite and in situ Scenario-TC database	406
8.6.1	Methodological problems of observation of atmospheric catastrophes	406
8.6.2	Scenario principles of geophysical data formation	411
8.6.3	Two experiments: the conglomerate scenario and the pursuit scenario	412
8.7	The long-standing Global-RT database for the global radio-thermal fields of the Earth	419
8.7.1	The need for global databases to provide computer animations	419
8.7.2	Principles of the design of the Global-RT database	424
8.7.3	Structure and data presentation in the Global-RT database	425
8.7.4	Basic data types generated as a result of user queries	426
8.7.5	Special software to cope with accumulated data	428
8.7.6	Future developments	430
8.8	Integrated object-related database of tropical cyclones in the global water vapor field	430
8.8.1	Considerations for the design of an integrated object-related database	431
8.8.2	EVA-00 database structure	432
8.8.3	EVA-00 database products	435
9	Remote sensing activity for cyclogenesis studies	441
9.1	Position of tropical studies in existing space programs	442
9.1.1	Ongoing missions and development trends	442
9.1.2	Future missions relevant to tropical studies	452
9.2	Missions for tropical convective system study	458
9.2.1	TRMM mission	458
9.2.2	TROPIQUES mission	461
9.3	Russian satellite systems relevant to tropical studies	463
9.3.1	Meteor-2 and Meteor-3 series	464
9.3.2	Resurs-01 and Resurs-F series	466
9.3.3	Geostationary Operational Meteorological Satellite Electro (GOMS)	469
9.3.4	<i>Priroda</i> mission	470
9.3.5	Meteor-3M system	474
9.3.6	Some aspects of the Russian remote-sensing program	474
9.4	Special Russian missions for TC study	478

9.4.1	Preliminary background to the projects	479
9.4.2	Mission Zodiak	481
9.4.3	Mission Helix.	487
9.4.4	International and practical aspects of the projects	491
A	Tables: Quantitative data on the spatiotemporal features of global and regional tropical cyclogenesis for 1983–2010	493
B	Saffir–Simpson Hurricane Scale	565
	References and bibliography.	569
	Index	597