

Environmental Earth Sciences

Vladimir F. Krapivin  
Costas A. Varotsos  
Vladimir Yu. Soldatov

# New Ecoinformatics Tools in Environmental Science

Applications and Decision-making

 Springer

# **Environmental Earth Sciences**

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Vladimir F. Krapivin  
Informatics  
Kotelnikov Institute of Radioengineering  
Fryazino  
Russia

Vladimir Yu. Soldatov  
Informatics  
Kotelnikov Institute of Radioengineering  
Fryazino  
Russia

Costas A. Varotsos  
Environmental Physics and Meteorology  
University of Athens  
Athens  
Greece

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# Preface

The design problem of geoinformation monitoring systems needs the solution of a wide spectrum of tasks incoming to the competence of many areas of knowledge. The complex character of this problem is stipulated by the assembly of heterogeneous and differently systematic and applied research that is realized in many countries in the framework of national and international environmental programs. The basic goal of all similar researches consists in the attempt to answer the unique basic question: What structure and working regime of the observation system are to be in order to guarantee the reliable assessments of its current state and the prognosis of its evolution in the nearest and perspective future? Unfortunately, present science does not give an affirmative reply to this question. Ecoinformatics tries to answer this question by developing new informational technologies and producing a theoretical base for a new stage of the environmental science developing.

Ecoinformatics is the science of information in ecology and environmental science that integrates environmental and information sciences. Ecoinformatics tries to create the tools for the assessment and analysis of natural systems that exist under different conditions. In this context, ecoinformatics develops computer technologies relevant to the management of ecological data and information delivered existing and planned geoinformational systems. As a result ecoinformatics proposes new tools based on the coupled use of ecological, geophysical, and mathematical knowledge to integrate information, data, methods, algorithms, and computer technologies for providing ecological data to scientific or policy making processes.

Ecoinformatics is studying the problems that arise due to use of informatics methods for solution of environment control tasks. It is developed areas such as elaboration of new informational technologies for monitoring data processing, making and development of algorithms for spatial–temporal interpolation, analysis of correlation functions in the nature–anthropogenic systems taking into account hierarchy of spatial and temporal scales, and search for the most efficient methods for the synthesis of monitoring system structures.

Ecoinformatics devotes priority to technologies in the framework in which the informatics methods are used for research of dynamic characteristics of environmental systems, assessment of large-scale consequences of anthropogenic activity,

and prognosis of biogeochemical processes from local to global scales. This field of study also includes a creation and application of mathematical models for natural and anthropogenic processes, search of criteria for reliable assessment of human living condition quality, and detection of causes stimulating the disturbances of sanitary epidemiological conditions in the environment.

Ecoinformatics studies theoretical and applied tasks that are aimed at understanding the role of mathematical modeling methods, theory of complex systems, nonlinear programming, computer cartography, remote sensing technology, and expert systems in the study of processes happening in the environment.

Ecoinformatics joins knowledge from such areas as physics, mathematics, biology, chemistry, sociology, ecology, economics, and law that solve environmental problems. It helps to find answers to many questions on the conflicts between nature and human society. Most experts suggest that an efficient way to resolve these conflicts would be creation of a unified planetary-scale adaptive geoinformation monitoring system, which should be based on knowledge bases and global datasets that are constantly updated. The adaptive nature of such a system should be provided by continuously correcting the data acquisition mode and by varying the parameters and structure of the global model.

This book develops ideas and technologies that could help solve many environmental problems and describes a simulation system based on sets of computer algorithms that process data from global and regional monitoring. The book has ten chapters that consider various aspects of the environmental problems and develops information-modeling technologies for operational diagnostics of environmental processes including stressful natural phenomena. In particular, the book discusses the following topics:

- Natural catastrophes as a dynamic category of environmental phenomena;
- Remote sensing and mathematical modeling for effective forecast of large-scale land territories and water areas behavior;
- Practical applications of microwave radiometric technologies along with other remote sensing technologies in different situations in hydrology for underground water mapping and for fire hazard determination in forested and peat bog environments;
- Decision making in complicated conditions;
- Evolution modeling in ecology and hydrometeorology;
- Arctic Basin pollution dynamics under intensive anthropogenic forcing due to a variety of industrial activities;
- Target-oriented models that may be effective in socioeconomic areas; and
- Regional and global ecological monitoring functioning based on the fundamentals of the noosphere paradigm.

The book discusses the global implications of environmental degradation—a model for predicting anthropogenic influences on global environmental change and for incorporating monitoring data into the predictions. Global problems of the nature–society system dynamics are considered and the key problems of ensuring

its sustainable development are studied. Emphasis is placed on global geoinformation monitoring, which could provide a reliable control for the development of environmental processes by obtaining prognostic estimates of the consequences of the realization of anthropogenic projects. Ecoinformatics tools developed in this book offer a new approach to the study of global environmental changes, focusing on it as an area of study involving many scientific disciplines. These tools provide a unique insight into the social context of global changes in biogeochemical cycles, and is a timely contribution to the current debate into global warming and sustainable development of the nature–society system.

The book is aimed at specialists dealing with the development of information-modeling technologies to protect the natural world. Global modeling, climate change, problems inherent in relationships between society and nature, geopolitics, international relations, and methodology of interdisciplinary studies are studied in-depth. It is of special interest to designers and users of information-modeling technologies in the field of population protection from natural disasters.



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# About the Authors



**Vladimir F. Krapivin** was educated at the Moscow State University as mathematician in 1959. He received his Ph.D. in Radiophysics from the Kotelnikov Institute of Radioengineering and Electronics (KIRE) of Russian Academy of Sciences (RAS) in 1966. The Doctoral Dissertation in Geophysics was defended by him at the Moscow Institute of Oceanology of RAS in 1973. He is leader of Informatics Department in KIRE RAS. His responsibilities include all environmental and research activities of the Institute, including the design and construction of monitoring systems. He became Full Professor of Radiophysics in 1987 at KIRE RAS.

The title “Honoured Worker of Science” was given to him in 1999 by the Russian Government.

He was appointed Grand Professor in 2003 at the World University for Development of Science, Education and Society, and in 2012 at the Nguyen Tat Thanh University (Ho Chi Minh City, Vietnam). Vladimir Krapivin is a full member of the Russian Academy of Natural Sciences and Balkan Academy of Sciences, New Culture and Sustainable Development. He has published 32 books and 450 papers in the field of ecoinformatics, remote sensing, and global modeling. He has specialized in investigating global environmental change by the application of modeling technology.





**Costas A. Varotsos** received his B.Sc. in Physics at the Athens University in 1980 and his Ph.D. in Atmospheric Physics in 1984. He is Full Professor in Atmospheric Physics at the Department of Environmental Physics and Meteorology of the Faculty of Physics and Dean of the School of Sciences of the National and Kapodistrian University of Athens. Since 1989 he teaches Atmospheric and Environmental Physics and Chemistry, which are also the main topics of his research interests. He is Honorary Professor of the Russian Academy of Natural Sciences, Fellow (elected) of the Royal Meteorological Society (Oxford, UK), and Full Member (elected) of the European Academy of Natural Sciences (Hanover, Germany).

He is a member of several scientific societies including the American Meteorological Society, the American Geophysical Union, and the EGU. He has been appointed as Specialty Chief Editor of “Frontiers in Environmental Science” of the NATURE Publishing Group, Editor of the “International Journal of Remote Sensing” of T&F, Editor of the “Remote Sensing Letters” of T&F, Editor of “The Scientific World Journal” of Hindawi Publ. Co., Advisor of the “Environmental Science and Pollution Research”, Guest Editor of a number of Journals, and member of the Editorial board in several International Journals indexed in WoS. He is also serving as reviewer of various Journals, EU, UN, and US Scientific Proposals and Reports. He has published more than 250 papers and 20 books in the fields of atmospheric physics, atmospheric chemistry, and environmental change.



**Vladimir Yu. Soldatov** was born on April 17, 1986 in Fryazino of Moscow Region, Russian Federation. He educated as an Engineer in Applied Mathematics at the Moscow Technological University “Stankin.” He received his Ph.D. in Experimental Physics from the Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences in 2011. He has edited monographs and has authored over 120 scientific articles, reports, and book chapters in the field of experimental hydrophysics, decision making, prognosis theory, and mathematical ecology. At present, Vladimir Soldatov is studying the problem of prognosis and control of hydrophysical, hydrological, and hydrochemical processes. His major research interests include a creation of new information-modeling technologies for environmental monitoring systems.

Vladimir Soldatov took part in many scientific projects funded by Russian Fund for Basic Research, Russian Academy of Sciences, and International Science and Technology Center. He proposed a new technology for diagnosis of tropical hurricanes beginning in oceans with remote sensing methods and mathematical modeling.

# Summary

The greatly enhanced awareness today of environmental problems has led to a resurgence of interest in all aspects of global environmental monitoring. The need to reduce pollution of the hydrosphere and to reduce the risk of damage from extreme environmental processes has led to a large increase in the number of theoretical and applied investigations in the field of global ecoinformatics. The growth of needs in practically all spheres of remote environmental monitoring has resulted in numerous problems arising from the many unsolved tasks including the assessment of important characteristics of the soil–plant formations and oceans. It has become a priority to develop new concepts and approaches for assessing and dealing with natural and man-made system dynamics. A major priority is global problems connected with creation of effective information technologies to data processing within the environment studies.

The complexity, importance, and interdisciplinary nature of ecoinformatics allow the solution of many environmental problems by means of combined use of environmental monitoring systems and mathematical models. The main objective of the book lies in the working information technology for the combined use of modeling technology and remote sensing measurements in the assessment of environmental system states as well as to illustrate this technology with computer calculations for various environmental problems. Different tasks related to the assessment and prognosis of natural systems' dynamics are solved based on the remote sensing measurements using mobile platforms. New information-modeling technology is proposed to be used for optimization of remote sensing monitoring systems. This technology is based on sets of computer algorithms for comprehensive analysis of data from global and regional monitoring systems.

The chapters in the theoretical part of the book contain descriptions of rigorous algorithms and environmental models. The applied part considers specific problems of environmental dynamics in areas of different countries where *on-site* experiments were realized to test new information-modeling technology that enhances the GIS to GIMS.

This book is the result of a detailed study of the environment by means of computer algorithms and simulation models. It describes the sets of algorithms and models for comprehensive analysis of data from global and regional monitoring systems. The main purpose of this book is to develop a universal information-modeling technology to estimate the characteristics of environmental subsystems both at global and regional scales. Applied mathematicians, hydrologists, geophysicists, radiophysicists, and other researchers of the environment will find a wealth of information in this book.

This book should prove useful to students in a variety of disciplines since it provides basic information in an interdisciplinary area and encourages students, through the references supplied, to seek out and to read the original monographs and articles cited. It should also be of interest to professionals in academia, in consulting offices, and government agencies, and to others responsible for the investigation, evaluation, and solution of complicated environmental issues.

# Abbreviations and Acronyms

AAMU	Alabama Agricultural and Mechanical University
AARS	Asian Association on Remote Sensing
ABL	Atmospheric Boundary Layer
ABPCV	Archive of Biometric and Production Characteristics of Vegetation
ACCSV	Arctic Climate Change, Substrate, and Vegetation
ACES	Aral–Caspian Expert System
ACIA	Arctic Climate Impact Assessment
ACRS	Asian Conference on Remote Sensing
ACSYS	Arctic Climate SYstem Study
ADEOS	ADvanced Earth Observation Satellite
AEPS	Arctic Environmental Protection Strategy
AGCM	Atmosphere Global Climate Model
AGIR	Asociatia Generala a Inginerilor din Romania
AIMES	Analysis, Integration, and Modeling of the Earth System
AIMS	Adaptive Information-Modeling System
AIP	American Institute of Physics
AMAP	Arctic Monitoring and Assessment Programme
AMMA	African Monsoon Multidisciplinary Analysis
AMSR	Advanced Microwave Scanning Radiometer
ANWAP	Arctic Nuclear Waste Assessment Programme
AO	Arctic Oscillations
APDA	Arctic Precipitation Data Archive
APS	Atmosphere–Plant–Soil
ARCSS	ARCtic System Science Programme
ARCUS	Arctic Research Consortium of United States
ARDB	Arctic Run-off Data Base
ARF	Aerosol Radiative Forcing
ARISTI	All-Russian Institute for Scientific and Technical Information
ARM	Atmosphere Radiation Measurement
ASI	Advanced Science Institutes

ASP	Arctic Studies Program
ASPC	Atlantic Storm Prediction Center
ASTER	Advanced Spaceborne Thermal Emission and reflection Radiometer
ATLAS	Arctic Transitions in the Land–Atmosphere System
AVHRR	Advanced Very High Resolution Radiometer
AVSS	Atmosphere–Vegetation–Soil System
AYRS	Angara–Yenisei River System
AYRSSM	AYRS Simulation Model
BARC	Burned Area Reflectance Classification
BC	Black Carbon
BCSS	Biosphere/Climate/Society System
BDMS	Base of the Decision Making System
BEXCO	Busan EXhibition and CONvention center
BSAP	Baltic Sea Action Plan
BSS	Biosphere/Society System
CA	Climate Agenda
CAD	Computer-Aided Design
CALRS	Cluster Analysis focused on the account of Local Reading of Sensors
CANO	Central Administration of Navigation and Oceanography
CART	Cloud And Radiation Testbed
CASRS	Cluster Analysis focused on sings Space of Remote Sensors
CATCH	Computer And Technology Crime High
CBS	Climate–Biosphere–Society
CCM	Community Climate Model
CCN	Cloud Concentration Nucleii
CCSS	Common Core State Standards
CDR	Climate Data Record
CEAI	Control Engineering and Applied Informatics
CEOP	Coordinated Enhanced Observing Period
CF	Cloud Feedback
CFL	Circumpolar Flaw Lead
CHAMP	CHAllenging Minisatellite Payload
CG	Cloud–Ground
CGCM	Canadian Global Climate Model
CHC	Canadian Hurricane Center
CIESIN	Center for International Earth Science Information Network
ClIC	Climate and Criosphere
CLIVAR	CLImate VARIability and predictability
CLRTAP	Convention on Long-Range Transboundary Air Pollution
CM	Climate Model
CMAQ	Congestion Mitigation and Air Quality model
CMIP	Coupled Model Intercomparison Project
CNES	Centre National d’Etudes Spatiales (Space Agency of France)

COADS	Comprehensive Ocean–Atmosphere Data Set
COLA	Center for Ocean–Land–Atmosphere studies
COP	Conference Of the Parties
COPEs	Coordinated Observations and Prediction of the Earth System
COST	Cooperation in Science and Technology
CRED	Centre for Research on the Epidemiology of Disasters
CRC	Chemical Rubber Company
CSCS	Control Systems and Computer Science
CSI	Canopy Structure Index
CSIRO	Commonwealth Scientific and IndustRial Organization
CSL	Climatic Snow Line
DDC	Data Distribution Center
DEKLIM	DEutsches KLIMaforschung’s program
DIC	Dissolved Inorganic Carbon
DLR	Deutsches zentrum für Luft- und Raumfahrte.V. (German Aerospace Center)
DMS	DiMethylSulfide
DMSp	Decision Making Sequent Procedure
DNA	DeoxyriboNucleic Acid
DO	Dansgaard–Oeschger
DOC	Dissolved Organic Carbon
DPIR	Drivers, Pressures, Impact, Response
EASE	Equal-Area Scalable Earth
ECHAM	European Center HAMBurg
ECMWF	European Center for Medium-range Weather Forecast
EDB	Extendable Data Base
EES	Ecologo-Economic System
EIA	Environmental Impact Assessment
EIER	Engineering Institute for the Electronics and Radiotechnics
ELA	Equilibrium Line Altitude
ENSO	El Niño–Southern Oscillation
ENVISAT	ENVironmental SATellite
EMW	ElectroMagnetic Waves
EOF	Empirical Orthogonal Function
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
EPA	Environmental Protection Agency
ERB	Earth’s Radiation Balance
ESA	European Space Agency
ESA	Environmental Systems Analysis
ESAIEP	Expert System for an Adaptive Identification of the Environmental Parameters
ESDIS	Earth Science Data and Information System
ESECEZ	Expert System for Ecological Control of Estuary Zone
ESM	Earth System Model

ESPAP	Expert System for Physics of Atmospheric Pollution
ESTAR	Electronically Scanned Thin Array Radiometer
ETM+	Enhanced Thematic Mapper Plus
EUP	Enterprise Unified Process
EUSAR	EUropean conference on Synthetic Aperture Radar
EVI	Enhanced Vegetation Index
EWT	Equivalent Water Thickness
FAO	Food and Agriculture Organization
FASIR	Fourier-Adjusted, Solar zenith angle-corrected, Interpolated, and Reconstructed data
FCCC	Framework Climate Change Convention
FGGE	First GARP Global Experiment
FMC	Fuel Moisture Content
FPAR	Fraction of PAR
FRA	Forest Resources Assessment
FTP	File Transfer Protocol
GARP	Global Atmospheric Research Program
GATOR	Gas-Aerosol-TranspOrt-Radiation-chemistry model
GCCM	Global Carbon Cycle Model
GCM	Global Climate Model
GCMC	General Circulation and Mesoscale Meteorological model
GCN	Global Core Network
GCOM	Global Change Observation Mission
GCOS	Global Climate Observation System
GCP	Global Carbon Project
GDP	Gross Domestic Product
GEF	Global Ecological Fund
GEO	Group on Earth Observations
GEOS	Global Earth Observation System
GEOS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water cycle Experiment
GFDL	Geophysical Fluid Dynamics model
GHG	GreenHouse Gas
GHOST	Global HOlocene Spatial and Temporal climate variability
GIGAS	<u>G</u> EOS, <u>I</u> NSPIRE, and <u>G</u> MES an Action in Support
GIMS	Global Information-Modeling System
GIMSAP	GeoInformation Monitoring System of Agricultural Function
GIS	Geographical Information System
GISP2	Greenland Ice Sheet Project Two
GISS	Goddard Institute for Space Studies
GLOBEC	GLOBAL ocean ECosystem dynamics
GLOSS	Global Sea Level Observing System
GMES	Global Monitoring for Environment and Security
GMSS	Global Model of the NSS
GNSS	Global Navigation Satellite System



GOES	Geostationary Operational Environmental Satellite
GOOS	Global Ocean Observing System
GPM	Global Precipitation Measurement
GPS	Global Positioning System
GSM	Global Simulation Model
GST	Global Surface Temperature
GTOS	Global Terrestrial Observation System
GWEM	Global Wildland fire Emission Model
GWP	Global Warming Potential
HARC	Human Dimensions of the Arctic System
HCN	Hydrogen Cyanide
HDI	Human Development Index
HELCOM	HELSINKI COMMISSION
HSCaRS	Hydrology, Soil Climatology and Remote Sensing
IA	Integral Assessment
IACCA	Inter-Agency Committee on the Climate Agenda
IASC	International Arctic Science Committee
IASTED	International Association of Science and Technology for Development
IBCAO	International Bathymetric Chart of the Arctic Ocean
IBP	International Biological Program
ICGGM	International Center on the Global Geoinformation Monitoring
ICID	International Commission on Irrigation and Drainage
ICLIPS	Integrated assessment of CLimate Protection Strategies
ICLRT	International Center for Lightning Research and Testing
ICSU	International Council of Scientific Unions
IE	Interactive Ensemble
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IFG	International Forum on Globalization
IGAC	International Global Atmospheric Chemistry
IGARSS	International Geoscience And Remote Sensing Symposium
IGBP	International Geosphere–Biosphere Program
IGCM	Intermediate General Circulation Model
IGOS	Integrated Global Observing Strategy
IHDP	International Human Dimensions Program
IIASA	International Institute for Applied Systems Analysis
IIC	Information Interface with Computer
IISGGM	International Integrated System for Global Geoinformation Monitoring
IMAGE	Integrated Model to Assess the Greenhouse Effect
IMARC	Intelligent Multifrequency Airborne polarimetric Radar Complex
IMS	Ice Mapping System
IMTEM	Information-Modeling Technology for the Environmental Monitoring

INSPIRE	INfrastructure for SPatial InfoRmation in the European community
IPAB	International Program for Antarctic Buoys
IPCC	Intergovernmental Panel on Climate Change
IPSL	Institute Pierre Simon Laplace
IPY	International Polar Year
IR	InfraRed
ISAC	International Study of Arctic Change
ISGGM	Integrated System for Global Geoinformation Monitoring
ISPRS	International Society for Photogrammetry and Remote Sensing
ISRS	International Symposium on Remote Sensing
ITBL	Internal Thermal Boundary Layer
ITCZ	Inter-Tropical Convergence Zone
ITEX	International Tundra EXperiment
ITHEA	Institute if information THEories and Applications
JASL	Joint Archive for Sea Level
JERS	Japanese Earth Resources Satellite
JGOFS	Joint Global Ocean Flux Study
KIREE	Kotelnikov Institute of RadioEngineering and Electronics
KIT	Karlsruher Instituts für Technologie
KP	Kyoto Protocol
LAI	Leaf Area Index
LAII	Land–Atmosphere–Ice Interactions
LLGHG	Long-Lived GreenHouse Gas
LMDZ	Laboratoire de Météorologie Dynamique Zoom
LOSAC	L-band Ocean Salinity Airborne Campaign
LPJ-DGVM	Lund–Potsdam–Jena Dynamic Global Vegetation Model
LRTAP	Long-Range Transport of Air Pollution
LSAT	Land Surface Air Temperature
LUT	LookUp Table
LWRF	LongWave Radiative Forcings
MACS	Microwave Autonomous Copter System
MAT	Moist Acidic Tundra
MCBS	Magnetosphere–Climate–Biosphere–Society
MCRM	Markov Chain Reflectance Model
MDA	Model-Driven Architecture
MEA	Millennium Ecosystems Assessment
MEM	Microwave Emission Model
MGBC	Model of the Global Biogeochemical Cycle
MGC	Minor Gas Components
MGCDC	Model of Global Carbon Dioxide Cycle
MGSC	Model of Global Sulfur Cycle
MIROC	Model for Interdisciplinary Research On Climate
MISR	Multiangle Imaging SpectroRadiometer
MMTS	Maximum–Minimum Temperature System
MNT	Moist Nonacidic Tundra

MODIS	MODerate resolution Imaging Spectroradiometer
MR	Microwave Radiometer
MSAVI	Modified Soil-adjusted Vegetation Index
MSD	Mean Squared Displacement
MSP	Multichannel SpectroPolarimeter
MSSA	Multichannel Singular Spectral Analysis
MTLE	Model of Transmission Line with Exponential current decay
MTVZA	Module of Temperature and Vlazhnost (humidity) Zonding of the Atmosphere
MUE	Model of the Upwelling Ecosystem
MVI	Microwave Vegetation Index
NAM	Northern hemisphere Annular Mode
NAO	North Atlantic Oscillation
NASA	National Aeronautical and Space Administration
NASDA	National Space Development Agency (Japan)
NATO	North Atlantic Treaty Organization
NAWQA	National Water-Quality Assessment Program
NBR	Normalized Burn Ratio
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NDBC	National Data Buoy Center NOAA
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NEE	Net Ecosystem Exchange
NEW	North-East Water
NGDC	National Geophysical Data Center
NH	Northern Hemisphere
NHC	National Hurricane Center
NMAT	Nocturnal Marine Air Temperature
NMD	Normalized Mean Difference
NME	Normalized Mean Error
NMHC	Non-Methane HydroCarbons
NN	Neural Network
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Center
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NPP	Net Primary Productivity
NSIDC	National Snow and Ice Data Center
NSS	Nature–Society System
NTU	Nephelometric Turbidity Units
NVR	Nadir Viewing Rada
OAI	Ocean/Atmosphere/Ice Interactions
OAS	Ocean–Atmosphere System
OC	Organic Carbon

OECD	Organization for Economic Cooperation and Development
OGCM	Oceanic General Circulation Model
OM	Organic Matter
ONR	Office of Naval Research
OSE	Okhotsk Sea Environment
PAGES	Pilot Analysis of the Global EcoSystems
PALE	Paleoclimates of Arctic Lakes and Estuaries
PALS	Passive and Active L and S band system
PAR	Photosynthetically Active Radiation
PARCS	Paleoenvironmental ARctic Sciences
PBL	Planetary Boundary Layer
PCE	Peruvian Current Ecosystem
PCEM	Peruvian Current Ecosystem Model
PCP	Packet of Computer Programs
PEHP	Production of Electric power and Heat for the Population
PEL	Petroleum Economics Limited
PGT	Pasquill-Gifford-Turner
PIRA	Petroleum Industry Research Associates
PIRATA	Pilot Research moored Array in the Tropical Atlantic
PLC	Pollution Load Compilation
PMR	Passive Microwave Radar
PNAS	Proceedings of the National Academy of Sciences
POC	Particulate Organic Carbon
POLDER	POLarization and Directionality of Earth's Reflectances
PORSEC	Pan Ocean Remote Sensing Conference
PSC	Polar Stratospheric Clouds
PWI	Plant Water Indexes
QSAR	Quantitative Structure–Activity Relationships
RAISE	Russian–American Initiative on Shelf–land Environments
RAS	Russian Academy of Sciences
RCA	Russian Custom Academy
RF	Radiative Forcing
RGGI	Regional Greenhouse Gas Initiative
RIBAMOD	River BASin MODeling
RIMS	Regional Information-Modeling System
RNA	River BASin MODeling
RSMC	Regional Specialized Meteorological Center
RT	Radiative Transfer
SAC-C	Satélite de Aplicaciones Científicas-C
SALLJEX	South American Low-Level Jet Experiment
SASS	Subsonic ASSessment program
SAM	Southern hemisphere Annual Mode
SAR	Synthetic Aperture Radar
SAS	Surface Active Substance
SAT	Surface Air Temperature

SATVI	Soil-adjusted Total Vegetation Index
SAVI	Soil-adjusted Vegetation Index
SBI	Shelf–Basin Interactions
SCE	Snow Cover Extent
SCOPE	Scientific Committee On Problems of the Environment
SDS	Scott Data System
SEA	Strategic Environmental Assessment
SEATCH	Study of Environmental ArcTic CHange
SEDAAR	Strategic Environmental Distributed Active Archive Resource
SGM	Spatial Global Model
SGPE	Southern Great Plains Experiment
SH	Southern Hemisphere
SHEBA	Surface HEat Budget of the Arctic
SHF	Super High Frequency
SHIPS	Statistical Hurricane Intensity Prediction Scheme
SIMS	Synthesis, Integration, and Modelling Studies
SLAR	Side-Looking Airborne Radar
SMEX	Soil Moisture Experiments
SMMR	Scanning Multichannel Microwave Radiometer
SMOS	Soil Moisture and Ocean Salinity
SMOSE	Simulation Model of the Okhotsk Sea Environment
SONEX	SAAS Ozone and Nitrogen oxide Experiment
SPARC	Stratospheric Processes And their Role in Climate
SPF	Soil–Plant Formation
SPM	Summary for Policy Makers
SPOT	Système Probatoire d’Observation de la Terre
SPREP	Secretariat of the Pacific Regional Environment Programme
SPRINTARS	SPEctral RadlatioN-Transport model for AeRosol Species
SR	Simple Ratio
SRB	Surface Radiation Budget
SRVI	Simple Ratio Vegetation Index
SSAPP	Simulation System for the Atmosphere Pollution Physics
SSHHI	Simulation System for Hydrophysical and Hydrochemical Investigations
SSM/I	Spatial Sensor Microwave/Imager
SSMAE	Spatial Simulation Model of the Arctic Ecosystem
SSMIS	Special Sensor Microwave Imager/Sounder
SST	Sea Surface Temperature
STOCHEM	UK Meteorological Office Global Three-Dimensional Lagrangian Chemistry model
SVI	Spectral Vegetation Index
SWR	Short-Wave Radiation
SWRF	Short-Wave Radiative Forcings
TAO	Tropical Atmosphere Ocean
TAR	Third Assessment Report

TCWC	Tropical Cyclone Warning Center
TERC	Terrestrial Environment Research Center
THORPEX	THE Observing system Research and Predictability EXperiment
TIR	Thermal Infrared Radiometer
TL	Transmission Line
TM	Thematic Mapper
TOA	Top-Of-Atmosphere
TOGA	Tropical Ocean Global Atmosphere
TOMS	Total Ozone Mapping Spectrometer
TORRO	TORnado and storm Research Organization
TRITON	TRIangle Trans-Ocean buoy Network
TRMM	Tropical Rainfall Measuring Mission
TTP	Technology Transfer and Promotion
TVDI	Temperature Vegetation Dryness Index
UHI	Urban Heat Island
UHSLC	University of Hawaii Sea Level Center
UML	Unified Modeling Language
UNCSD	United Nations Conference on Sustainable Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UQHL	Upper Quasi-Homogeneous Layer
USA	United States of America
USCRN	U.S. Climate Reference Network
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USSR	Union of Soviet Socialistic Republics
UV	UltraViolet
VAMOS	Variability of the American Monsoon Systems
VDI	Vegetation Dryness Index
VHF	Very High Frequency
VI	Vegetation Indices
VWC	Vegetation Water Content
WAM	West African Monsoon
WB	World Bank
WCP	World Climate Programme
WCRP	World Climate Research Programme
WCSDG	World Commission on the Social Dimension of Globalization
WDI	Water Deficit Index
WEO	World Energy Outlook
WHO	World Health Organization
WISE	Web-based Inquiry Science Environment
WIT	Wessex Institute Transactions
WMO	World Meteorological Organization