Extreme Environmental Events
Complexity in Forecasting and Early Warning
Extreme Environmental Events

Complexity in Forecasting and Early Warning

With 661 Figures and 51 Tables
Extreme Environmental Events is an authoritative single source for understanding and applying the basic tenets of complexity and systems theory as well as the tools and measures for analyzing complex systems in understanding, predicting, monitoring and evaluating major phenomena and natural disasters affecting life on earth. These phenomena are earthquakes, tsunamis, volcanoes, climate change and weather. Early warning, damage, and the immediate response of human populations to these phenomena are also covered from a complexity (nonlinear) viewpoint. The content is presented in 61 articles and 1250 pages written by 110 of the world’s experts in each field.

Extreme Environmental Events is written for an audience of advanced university undergraduate and graduate students, professors, and professionals in a wide range of fields including earth sciences, climatology, sociology, mathematics, physics and engineering. Each article was selected and peer reviewed by one of our Section Editors with advice and consultation provided by our Board Members and Editor-in-Chief. This level of coordination assures that the reader can have a level of confidence in the relevance and accuracy of the information far exceeding that generally found on the World Wide Web or any print publication. Accessibility is also a priority and for this reason each article includes a glossary of important terms and a concise definition of the subject. A list of the 61 articles and authors is presented on pages XV through XVII and a listing of the articles by section is shown on pages VII to VIII. A summary, perspective and roadmap for the articles on earthquakes, tsunamis and volcanoes is presented on pages 68 to 78. Also, a summary, perspective and roadmap for the articles on climate modeling, global warming and weather prediction is presented on pages 66 to 67.

Complex systems are systems that comprise many interacting parts with the ability to generate a new quality of collective behavior through self-organization, e.g. the spontaneous formation of temporal, spatial or functional structures. They are therefore adaptive as they evolve and may contain self-driving feedback loops. Thus, complex systems are much more than a sum of their parts. Complex systems are often characterized as having extreme sensitivity to initial conditions as well as emergent behavior that are not readily predictable or even completely deterministic. The conclusion is that a reductionist (bottom-up) approach is often an incomplete description of a phenomenon. This recognition, that the collective behavior of the whole system cannot be simply inferred from the understanding of the behavior of the individual components, has led to many new concepts and sophisticated mathematical and modeling tools for application to extreme environmental phenomena. These tools include fractals, cellular automata, solitons game theory, network theory and statistical physics.

Acknowledgments

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Robert A. Meyers
Editor in Chief
Larkspur, California
August 2010
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**Climate Modeling, Global Warming and Weather Prediction,**
*Section Editors: Hartmut Grassl, Brian Dangerfield, and Marilda Sotomayor*

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- System Dynamics Models of Environment, Energy and Climate Change

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Biography
Dr. Meyers has worked with more than 25 Nobel laureates during his career.

Research
Dr. Meyers was Manager of Chemical Technology at TRW (now Northrop Grumman) in Redondo Beach, CA and is now President of RAMTECH Limited. He is co-inventor of the Gravimelt process for desulfurization and demineralization of coal for air pollution and water pollution control. Dr. Meyers is the inventor of and was project manager for the DOE-sponsored Magnetohydrodynamics Seed Regeneration Project which has resulted in the construction and successful operation of a pilot plant for production of potassium formate, a chemical utilized for plasma electricity generation and air pollution control. Dr. Meyers managed the pilot-scale DoE project for determining the hydrodynamics of synthetic fuels. He is a co-inventor of several thermo-oxidative stable polymers which have achieved commercial success as the GE PEI, Upjohn Polymides and Rhone-Polenc bismaleimide resins. He has also managed projects for photochemistry, chemical lasers, flue gas scrubbing, oil shale analysis and refining, petroleum analysis and refining, global change measurement from space satellites, analysis and mitigation (carbon dioxide and ozone), hydrometallurgical refining, soil and hazardous waste remediation, novel polymers synthesis, modeling of the economics of space transportation systems, space rigidizable structures and chemiluminescence-based devices.

He is a senior member of the American Institute of Chemical Engineers, member of the American Physical Society, member of the American Chemical Society and serves on the UCLA Chemistry Department Advisory Board. He was a member of the joint USA-Russia working group on air pollution control and the EPA-sponsored Waste Reduction Institute for Scientists and Engineers.
Dr. Meyers has more than 20 patents and 50 technical papers. He has published in primary literature journals including Science and the Journal of the American Chemical Society, and is listed in Who’s Who in America and Who’s Who in the World. Dr. Meyers’ scientific achievements have been reviewed in feature articles in the popular press in publications such as The New York Times Science Supplement and The Wall Street Journal as well as more specialized publications such as Chemical Engineering and Coal Age. A public service film was produced by the Environmental Protection Agency of Dr. Meyers’ chemical desulfurization invention for air pollution control.

**Scientific Books**

Dr. Meyers is the author or Editor-in-Chief of 12 technical books one of which won the Association of American Publishers Award as the best book in technology and engineering.

**Encyclopedias**

Dr. Meyers conceived and has served as Editor-in-Chief of the Academic Press (now Elsevier) Encyclopedia of Physical Science and Technology. This is an 18-volume publication of 780 twenty-page articles written to an audience of university students and practicing professionals. This encyclopedia, first published in 1987, was very successful, and because of this, was revised and reissued in 1992 as a second edition. The Third Edition was published in 2001 and is now online. Dr. Meyers has completed two editions of the Encyclopedia of Molecular Cell Biology and Molecular Medicine for Wiley VCH publishers (1995 and 2004). These cover molecular and cellular level genetics, biochemistry, pharmacology, diseases and structure determination as well as cell biology. His eight-volume Encyclopedia of Environmental Analysis and Remediation was published in 1998 by John Wiley & Sons and his 15-volume Encyclopedia of Analytical Chemistry was published in 2000, also by John Wiley & Sons, all of which are available on-line.
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