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Sensitivity Analysis in Practice
An Introduction to Boundary Layer Meteorology
Air Pollution Modeling and its Application XXIII

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Forecasting, Monitoring, and Meeting Users' Needs John Wiley & Sons
This book contains the most recent progress in data assimilation in meteorology, oceanography and hydrology including land surface. It spans both theoretical and applicative aspects with various methodologies such as variational, Kalman filter, ensemble, Monte Carlo and artificial intelligence methods. Besides data assimilation, other important topics are also covered

including targeting observation, sensitivity analysis, and parameter estimation. The book will be useful to individual researchers as well as graduate students for a reference in the field of data assimilation.

Keys to Understanding Numerical Weather Prediction Models Springer Science & Business Media

Recent developments in air pollution modelling are explored as a series of contributions from researchers at the forefront of their field. This newest contribution on air pollution modelling and its application is focused on local, urban, regional and intercontinental modelling; data assimilation and air quality forecasting; model assessment and evaluation; aerosol transformation. Additionally, this work also examines the relationship between air quality and human health and the effects of climate change on air quality. The work derives from a series of papers presented at the 33rd International Technical Meeting on Air Pollution Modelling and its Application held in Miami, USA, August 27 - 31, 2013. The book is intended as reference material for students and professors interested in air pollution modelling at the graduate level as well as researchers and professionals involved in developing and utilizing air pollution models.

The Design and Analysis of Computer Experiments SAGE Publications India

This research monograph on circular data analysis covers some recent advances in the field, besides providing a brief introduction to, and a review of,

existing methods and models. The primary focus is on recent research into topics such as change-point problems, predictive distributions, circular correlation and regression, etc. An important feature of this work is the S-plus subroutines provided for analyzing actual data sets. Coupled with the discussion of new theoretical research, the book should benefit both the researcher and the practitioner. Parameterization Schemes CRC Press Driven by the societal needs and improvement in sensor technology and image processing techniques, remote sensing has become an essential geospatial tool for understanding the Earth and managing Human-Earth interactions. Remote Sensing for Sustainability introduces the current state of the art remote sensing knowledge integral for monitoring the world's natural resources and environments, managing exposure to natural disasters and man-made risks, and helping understand the sustainability and productivity of natural ecosystems. Bridging the gap between remote sensing and sustainability science this book examines theories and methods as well as practical applications of sustainable development for cities using remote sensing; focuses on remote sensing methods and techniques for sustainable natural resources with emphasize on forests; answers questions on how and what the remote sensing methods and techniques can do for the sustainability of environmental systems; and examines the issues of energy use

and sustainable energy sources using remote sensing technology in countries such as Germany, China, the U.S, drawing on case studies to demonstrate the applicability of remote sensing techniques. This comprehensive guide, which can serve to professors, researchers, and students alike, takes in consideration the United Nations set of sustainable development goals and intends to contribute to the GEO's Strategic Plan by addressing and exemplifying a number of societal benefit areas of remote sensing data sets, methods, and techniques for sustainable development.

Modifications to WRFs Dynamical Core to Improve the Treatment of Moisture for Large-eddy Simulations Springer

Yamaguchi and Feingold (2012) note that the cloud fields in their large-eddy simulations (LESs) of marine stratocumulus using the Weather Research and Forecasting (WRF) model exhibit a strong sensitivity to time stepping choices. In this study, we reproduce and analyze this sensitivity issue using two stratocumulus cases, one marine and one continental. Results show that (1) the sensitivity is associated with spurious motions near the moisture jump between the boundary layer and the free atmosphere, and (2) these spurious motions appear to arise from neglecting small variations in water vapor mixing ratio (qv) in the pressure gradient calculation in the acoustic sub-stepping portion of the integration procedure. We show that this issue is remedied in the WRF dynamical

core by replacing the prognostic equation for the potential temperature [theta] with one for the moist potential temperature [theta]m=[theta](1+1.61qv), which allows consistent treatment of moisture in the calculation of pressure during the acoustic sub-steps. With this modification, the spurious motions and the sensitivity to the time stepping settings (i.e., the dynamic time step length and number of acoustic sub-steps) are eliminated in both of the example stratocumulus cases. In conclusion, this modification improves the applicability of WRF for LES applications, and possibly other models using similar dynamical core formulations, and also permits the use of longer time steps than in the original code.

Impact of WRF Physics and Grid Resolution on Low-level Wind Prediction ScholarlyEditions

This book presents the state-of-the-art in supercomputer simulation. It includes the latest findings from leading researchers using systems from the High Performance Computing Center Stuttgart (HLRS). The reports cover all fields of computational science and engineering ranging from CFD to computational physics and from chemistry to computer science with a special emphasis on industrially relevant applications. Presenting findings of one of Europe’s leading systems, this volume covers a wide variety of applications that deliver a high level of sustained performance. The book covers the main methods in

high-performance computing. Its outstanding results in achieving the best performance for production codes are of particular interest for both scientists and engineers. The book comes with a wealth of color illustrations and tables of results.

High Performance Computing in Science and Engineering ‘14 Cambridge University Press

Climate change is one of the most significant challenges to global economic development. Left unchecked, continued global warming could cause worldwide social and environmental disruption. The Asia and Pacific region is more vulnerable to climate change risks than other regions due to its dependence on the natural resources and agriculture sectors. Densely populated coastal areas, weak institutions, and the poverty of a considerable proportion of its population add to the susceptibility of this region. Adaptation—making adjustments in natural or human systems in response to actual or expected climate stimuli— becomes a key strategy for sustaining economic growth. This volume examines the framework conditions for integrating climate change adaptation measures into agriculture, water, and natural resources management activities for the Asia and Pacific region. Based on the review of country experiences, the book describes key dimensions, suggests interventions for further exploration, and serves as a basis for planning and mainstreaming climate change adaptation into sectoral planning

A Guide to Assessing Scientific Models Springer Science & Business Media Mesoscale Meteorology in Mid-Latitudes presents the dynamics of mesoscale meteorological phenomena in a highly accessible, student-friendly manner. The book's clear mathematical treatments are complemented by high-quality photographs and illustrations. Comprehensive coverage of subjects including boundary layer mesoscale phenomena, orographic phenomena and deep convection is brought together with the latest developments in the field to provide an invaluable resource for mesoscale meteorology students. Mesoscale Meteorology in Mid-Latitudes functions as a comprehensive, easy-to-use undergraduate textbook while also providing a useful reference for graduate students, research scientists and weather industry professionals. Illustrated in full colour throughout Covers the latest developments and research in the field Comprehensive coverage of deep convection and its initiation Uses real life examples of phenomena taken from broad geographical areas to demonstrate the practical aspects of the science **Monthly Weather Review** Springer The U.S. Army Research Laboratory (ARL) performed numerous case studies of the Advanced Research version of the Weather Research and Forecasting (WRF) model at horizontal resolutions of 3 and 1 km to better understand weather output for military use. ARL's devised model sensitivity experiments of several WRF parameterizations including

the vertical resolution of 40, 60, and 80 levels, model time steps of 9 and 3 seconds, three different explicit microphysics, and the two planetary boundary layer options. Model output was studied for numerous different meteorological parameters, but most of the effort was aimed at analyzing surface features such as wind, temperature, moisture, and precipitation to better understand how the different parameterizations influenced the surface-based observations. Four diverse meteorological days were studied and statistical results showed little difference between each model simulation. However, significant differences in some of the meteorological variables and some model errors were discovered. These model discrepancies are discussed in detail.

Topics in Circular Statistics Springer Science & Business Media

Issues in Global Environment: Climate and Climate Change: 2011 Edition is a ScholarlyEditions™ eBook that delivers timely, authoritative, and comprehensive information about Global Environment—Climate and Climate Change. The editors have built Issues in Global Environment: Climate and Climate Change: 2011 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Global Environment—Climate and Climate Change in this eBook to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant.

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Quantitative Precipitation Forecast Sensitivity to Microphysics Parameterization and Sea Surface Temperature Source Over North Carolina During Two Cold Season Events Nova Publishers

The aim of this book is to contribute to understanding risk knowledge and to forecasting components of early flood warning, particularly in the environment of tropical high mountains in developing cities. This research covers a challenge, taking into account the persistent lack of data, limited resources and often complex climatic, hydrologic and hydraulic conditions. In this research, a regional method is proposed for assessing flash flood susceptibility and for identifying debris flow predisposition at the watershed scale. An indication of hazard is obtained from the flash flood susceptibility analysis and continually, the vulnerability and an indication of flood risk at watershed scale was obtained. Based on risk analyses, the

research follows the modelling steps for flood forecasting development. Input precipitation is addressed in the environment of complex topography commonly found in mountainous tropical areas. A distributed model, a semi-distributed model and a lumped model were all used to simulate the discharges of a tropical high mountain basin with a páramo upper basin. Performance analysis and diagnostics were carried out in order to identify the most appropriate model for the study area for flood early warning. Finally, the Weather Research and Forecasting (WRF) model was used to explore the added value of numerical weather models for flood early warning in a páramo area.

Recent Progress and Current Challenges CRC Press

The Weather Research and Forecast (WRF) model is used in short-range simulations to explore the sensitivity of model physics and horizontal grid resolution. We choose five events with the clear-sky conditions to study the impact of different planetary boundary layer (PBL), surface and soil-layer physics on low-level wind forecast for two wind farms; one in California (CA) and the other in Texas (TX). Short-range simulations are validated with field measurements. Results indicate that the forecast error of the CA case decreases with increasing grid resolution due to the improved representation of valley winds. Besides, the model physics configuration has a significant impact on the forecast error at this location. In contrast, the forecast error of the TX case exhibits

little dependence on grid resolution and is relatively independent of physics configuration. Therefore, the occurrence frequency of lowest root mean square errors (RMSEs) at this location is used to determine an optimal model configuration for subsequent decade-scale regional climate model (RCM) simulations. In this study, we perform two sets of 20-year RCM simulations using the data from the NCAR Global Climate Model (GCM) simulations; one set models the present climate and the other simulates the future climate. These RCM simulations will be used to assess the impact of climate change on future wind energy.

Recent Advances in Intelligent Information Systems and Applied Mathematics World Scientific

Every year weather events cause billions of dollars property damage and take many lives globally. Preventing as much damage as possible is crucial, and one way to help is through having the most accurate advance warning of extreme weather events. Therefore, this thesis investigates the sensitivity of precipitation, temperatures, and surface energy fluxes (i.e., sensible heat flux (SHF), latent heat flux (LHF), and ground heat flux (GHF) in four cumulus cloud (CU), five cloud microphysics (MP), and four planetary boundary layer (PBL) parameterization schemes; over five years (2002, 2007, 2008, 2014, and 2015) with significantly different climatological atmospheric conditions; horizontal grid spacing; two seasons: winter and summer; and feedback

between the nest and its parent domain, using the dynamical downscaling technique of the Weather Research and Forecasting (WRF) model. The main objectives are 1) to identify a combination of physics schemes that realistically reproduce observed atmospheric conditions, and 2) to improve current understanding of factors influencing the micro climate of southern Ontario, a region of complex land-water-atmosphere interactions. Ontario is also the most populous province and the largest manufacturing hub of Canada. WRF-simulated precipitation and temperature agree well with DAYMET model gridded observations, with correlation coefficients of nearly 0.3 to 0.8 and >0.9, respectively. Precipitation showed an average systematic bias for July of -50 to +30 mm and for January of -10 to +30 mm. The simulated precipitation was more sensitive to CU and PBL schemes. WRF-simulated temperatures showed good reproducing skill, with biases within the range of -1.0°C to +1.0° C in most parts of the domain. Model-predicted temperature was quite sensitive to PBL and MP schemes. Model-simulated precipitation variability increased when the horizontal grid resolution was refined from 8.0 to 2.67 km. However, simulated temperature variability decreased. Overall, the model performed better in the 2.67 km resolution simulation than in the highest resolution simulations (with grid spacing of 0.888 km), an unexpected finding that suggests the need for carefully designed high-

resolution dynamical downscaling experiments. WRF's limitation to capture all variation that may occur at a resolution of 1 km, particularly of precipitation in mountainous areas may result from uncertainties in our understanding of the climate and our inability to parameterize sub-grid scale processes realistically. WRF reproduced the diurnal variability of the SHF very well but systematically overestimated LHF compared to eddy covariance (EC) tower measurements for June of 2007 and 2008. For the interior of all three domains in July 2002, spatial distribution was overestimated for SHF and underestimated for LHF, with biases ranging from -30 to +30 W/m2 over most of the area when compared to the North America Land Data Assimilation System (NLDAS) model gridded analysis. WRF showed little sensitivity to the choice of PBL scheme, except for January 2002's LHF, the hottest January of the five studied. If forced with distinctively different annual climatological boundary conditions, such as extreme cold in January 2014 and below average temperatures in January 2015, the model's simulated spatial distribution of energy flux bias indicates behavior that clearly differs from NLDAS analysis. A large energy flux bias occurs over the smaller shallow northern lakes, perhaps due to incorrect representation of their water temperatures. Overall, the Kain-Fritsch (KF) CU, Yonsei University (YSU) PBL, and WRF Single-Moment 6-class (WSM6) microphysics parameterization schemes exhibit superior results over

the domain studied. The WRF model shows a high skill score over southern Ontario while reproducing observed climate means and statistics. Nevertheless, the model's performance depends on the meteorological variables, season, and synoptic conditions. The Great Lakes strongly influence atmospheric conditions in southern Ontario, by affecting precipitation and surface temperatures, ranging from the diurnal to the seasonal timescales. These results affirm the need for extensive sensitivity analysis, for both research, and operational applications. However, the findings are limited by the shorter spin-up time and by having only one-month simulation, although WRF ran for a month in both the winter and summer over multiple years.

Physical Processes in Clouds and Cloud Modeling John Wiley & Sons

This book describes methods for designing and analyzing experiments that are conducted using a computer code, a computer experiment, and, when possible, a physical experiment. Computer experiments continue to increase in popularity as surrogates for and adjuncts to physical experiments. Since the publication of the first edition, there have been many methodological advances and software developments to implement these new methodologies. The computer experiments literature has emphasized the construction of algorithms for various data analysis tasks (design construction, prediction, sensitivity analysis, calibration among

others), and the development of web-based repositories of designs for immediate application. While it is written at a level that is accessible to readers with Masters-level training in Statistics, the book is written in sufficient detail to be useful for practitioners and researchers. New to this revised and expanded edition: • An expanded presentation of basic material on computer experiments and Gaussian processes with additional simulations and examples • A new comparison of plug-in prediction methodologies for real-valued simulator output • An enlarged discussion of space-filling designs including Latin Hypercube designs (LHDs), near-orthogonal designs, and nonrectangular regions • A chapter length description of process-based designs for optimization, to improve good overall fit, quantile estimation, and Pareto optimization • A new chapter describing graphical and numerical sensitivity analysis tools • Substantial new material on calibration-based prediction and inference for calibration parameters • Lists of software that can be used to fit models discussed in the book to aid practitioners

The Sensitivity of Tropical Cyclone Simulations in the WRF Model to Surface Layer and Planetary Boundary Layer Parameterization Springer

Numerical weather prediction models play an increasingly important role in meteorology, both in short- and medium-range forecasting and global climate change studies. The most important components of any numerical weather

prediction model are the subgrid-scale parameterization schemes, and the analysis and understanding of these schemes is a key aspect of numerical weather prediction. This book provides in-depth explorations of the most commonly used types of parameterization schemes that influence both short-range weather forecasts and global climate models. Several parameterizations are summarised and compared, followed by a discussion of their limitations. Review questions at the end of each chapter enable readers to monitor their understanding of the topics covered, and solutions are available to instructors at www.cambridge.org/9780521865401. This will be an essential reference for academic researchers, meteorologists, weather forecasters, and graduate students interested in numerical weather prediction and its use in weather forecasting.

The Representation of Cumulus Convection in Numerical Models Springer Science & Business Media

Although the technology of observation and prediction of atmospheric systems draws upon many common fields, until now the interrelatedness and interdisciplinary nature of these research fields have scarcely been discussed in one volume containing fundamental theories, numerical methods, and operational application results. This is a book to provide in-depth explorations of the numerical methods developed to better understand atmospheric systems, which are introduced in eight chapters.

Chapter 1 presents an efficient algorithm for tropical cyclone center determination by using satellite imagery. Chapter 2 aims to identify atmospheric systems with a new polarization remote sensing method. Chapters 3-8 place emphasis on enhancing the performance of numerical models in the prediction of atmospheric systems that should be valuable for researchers and forecasters.

Machine Learning and Data Mining Approaches to Climate Science BoD – Books on Demand

A state-of-the-art overview of the influence of terrestrial vegetation and soils within the Earth system. The text deals especially with interactions between the terrestrial biosphere and the atmosphere via the hydrological cycle and their interlinkage with anthropogenic activities. Measurements gathered in integrated field experiments in the Sahel, the Amazon, North America and South-east Asia confirm the importance of these interactions. Observations are complemented by modelling studies, including regional models that simulate flows and transport in river catchments, coupled land-cover and regional climate systems, and Earth-system and global circulation models. Water, nutrient and sediment fluxes in river basins are also discussed and are shown to be highly impacted and regulated by humans through land use, pollution and river engineering. Finally, the book discusses environmental vulnerability and methodologies for assessing the risks associated with regional and global climatic and

environmental variability and change. The results reported in this book are based on the research work of many individual scientists and teams around the world associated with the objectives of the IGBP-BAHC and WCRP-GEWEX international research programmes.

Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change Springer Nature

Statistical mechanics is the application of probability theory, which includes mathematical tools for dealing with large populations, to the field of mechanics, which is concerned with the motion of particles or objects when subjected to a force. It provides a framework for relating the microscopic properties of individual atoms and molecules to the macroscopic or bulk properties of materials that can be observed in everyday life, therefore explaining thermodynamics as a natural result of statistics and mechanics (classical and quantum) at the microscopic level. In particular, it can be used to calculate the thermodynamic properties of bulk materials from the spectroscopic data of individual molecules. This ability to make macroscopic predictions based on microscopic properties is the main asset of statistical mechanics over thermodynamics. Both theories are governed by the second law of thermodynamics through the medium of entropy.

Research and Forecast Springer Science & Business Media

Statistical Methods in the Atmospheric

Sciences, Third Edition, explains the latest statistical methods used to describe, analyze, test, and forecast atmospheric data. This revised and expanded text is intended to help students understand and communicate what their data sets have to say, or to make sense of the scientific literature in meteorology, climatology, and related disciplines. In this new edition, what was a single chapter on multivariate statistics has been expanded to a full six chapters on this important topic. Other chapters have also been revised and cover exploratory data analysis, probability distributions, hypothesis testing, statistical weather forecasting, forecast verification, and time series analysis. There is now an expanded treatment of resampling tests and key analysis techniques, an updated discussion on ensemble forecasting, and a detailed chapter on forecast verification. In addition, the book includes new sections on maximum likelihood and on statistical simulation and contains current references to original research. Students will benefit from pedagogical features including worked examples, end-of-chapter exercises with separate solutions, and numerous illustrations and equations. This book will be of interest to researchers and students in the atmospheric sciences, including meteorology, climatology, and other geophysical disciplines. Accessible presentation and explanation of techniques for atmospheric data summarization, analysis, testing and

forecasting Many worked examples End-of-chapter exercises, with answers provided

Perspectives on Atmospheric Sciences John Wiley & Sons

This book presents a current review of the science of monsoon research and forecasting. The contents are based on the invited reviews presented at the World Meteorological Organization''s Fourth International Workshop on Monsoons in late 2008, with subsequent manuscripts revised from 2009 to early 2010. The book builds on the concept that the monsoons in various parts of the globe can be viewed as components of an integrated global monsoon system, while emphasizing that significant region-specific characteristics are present in individual monsoon regions. The topics covered include all major monsoon regions and time scales (mesoscale, synoptic, intraseasonal, interannual, decadal, and climate change). It is intended to provide an updated comprehensive review of the current status of knowledge, modeling capability, and future directions in the research of monsoon systems around the world.

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