ORIGINAL PAPER

WRF model sensitivity to choice of PBL and microphysics parameterization for an advection fog event at Barkachha, rural site in the Indo-Gangetic basin, India

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Abstract

The present study evaluates the performance of four planetary boundary layer (PBL) parameterization schemes combined with five cloud microphysics schemes in Weather Research Forecasting (WRF) model, specifically for an advection fog event occurred during 4–6 December 2014 at Barkachha, rural site in the Indo–Gangetic plain (IGP). For this purpose, the model was configured over the IGP with 2-km horizontal resolution, and results are compared with detailed micrometeorological data (surface meteorological parameters and fluxes, radiative fluxes, and surface layer wind profiles) gathered during the Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) Integrated Ground Observational Campaign (IGOC) site located in the IGP. The meteorological conditions conducive for the fog formation have been evaluated. All of the tested PBL-microphysics combination showed substantial bias for surface temperature, radiation fluxes, and wind speed. None of the combination found to be superior in predicting the fog event; however, the local MYNN2.5 combination with the WSM3, WSM6, and Lin microphysics obtained slightly better result at the study location. In general, judging from all simulations of liquid water content (as an indicator for the fog), the above combinations were able to simulate the current fog event but the fog onset, duration, and dissipation were particularly offset.

1 Introduction

Fog is a boundary-layer weather phenomenon with very small size suspended hydrated aerosol particles or droplets that reduce visibility less than 1000 m and persist for a period of time (Stull 1988). Presence of calm wind

conditions, sufficient moisture availability, radiative cooling of ground during nighttime and formation of surface-based inversion or the advection of moist air can all produce low-level boundary-layer cloud or fog (Gultepe et al. 2009). Fog formation, its duration, intensity, and spatial extent are driven by synoptic to mesoscale behavior and non-linear interaction between local thermodynamical and microphysical processes (Croft and Ward 2015).

Occurrence of dense fog in the IGP of India is common during winter which causes severe disruption to public services such as aviation, ground transport, train services, and even day-to-day public life due to low visibility conditions (Agarwal et al. 2006; Jenamani 2007; Sawaisarje et al. 2014; Kulkarni 2016; Ghude et al. 2017). Therefore, its prediction is very important due to very high economic stake (Mohan and Payra 2009; Croft and Ward 2015). Studies on fog in India indicate that large-scale features such as Western Disturbances (WD) moving eastward during the winter season (December–February) contribute to conditions favorable for intense fog and haze (Stull 1988) in the IGP (Pasricha et al. 2003; Dimri et al. 2015). Sometimes, fog during such WD forms over a large

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Wrf Model Sensitivity To Choice Of Parameterization A

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<u>Recent Advances in Intelligent Information Systems and Applied Mathematics</u> Oscar Castillo,Dipak Kumar Jana,Debasis Giri,Arif Ahmed,2020-01-31 This book describes the latest advances in intelligent techniques such as fuzzy logic neural networks and optimization algorithms and their relevance in building intelligent information systems in combination with applied mathematics The authors also outline the applications of these systems in areas like intelligent control and robotics pattern recognition medical diagnosis time series prediction and optimization of complex problems By sharing fresh ideas and identifying new targets problems it offers young researchers and students new directions for their future research The book is intended for readers from mathematics and computer science in particular professors and students working on theory and applications of intelligent systems for real world applications *Computational Science – ICCS 2025* Michael H. Lees,Wentong Cai,Siew Ann Cheong,Yi Su,David Abramson,Jack J. Dongarra,Peter M. A. Sloot,2025-07-04 The 4 volume set LNCS constitutes the main proceedings of the 25th International Conference on Computational Science ICCS 2025 which took place in Singapore Singapore during July 7 9 2025 The 64 full papers and 52 short papers presented in these proceedings were carefully reviewed and selected from 162 submissions The ICCS 2025 main track full papers are organized in volumes 15903 15905 Parts I to III and the ICCS 2025 main track short papers are included in volume 15906 Part IV

Operational Flood Forecasting, Warning and Response for Multi-Scale Flood Risks in Developing Cities María Carolina Rogelis,2020-04-22 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 p ramo 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 p ramo area **High Performance Computing in Science and Engineering '14** Wolfgang E. Nagel,Dietmar H. Kröner,Michael M. Resch,2015-02-14 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 *Intelligence Systems for Earth, Environmental and Planetary Sciences* Hossein Bonakdari,Silvio José Gumiere,2024-07-30 Intelligence Systems for Earth Environmental and Planetary Sciences Methods Models and Applications provides cutting edge theory and applications of modern day artificial intelligence and data science in the Earth environment and planetary science fields The book is divided into three sections i Methods covering the fundamentals of intelligence systems along with an introduction to the preparation of datasets ii Models detailing model development data assimilation and techniques in each field and iii Applications presenting case studies of artificial intelligence and data science solutions to Earth environmental and planetary sciences problems as well as future perspectives Intelligence Systems for Earth Environmental and Planetary Sciences will be of interest to students academics and postgraduate professionals in the field of applied sciences Earth environmental and planetary sciences and would also serve as an excellent companion resource to courses studying artificial intelligence applications for theoretical and practical studies in Earth environmental and planetary sciences Facilitates the application of artificial intelligence and data science systems to create comprehensive methodologies for analyzing processing predicting and management strategies in the fields of Earth environment and planetary science Developed with an interdisciplinary framework with an aim to promote artificial intelligence models for real time Earth systems Includes a section on case studies of artificial intelligence and data science solutions to Earth environmental and planetary sciences problems as well as future perspectives *Issues in Global Environment: Climate and Climate Change: 2011 Edition* ,2012-01-09 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 The content of Issues in Global Environment Climate and Climate Change 2011 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at http www ScholarlyEditions com

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Environment and Humanosphere Science Sopia Lestari,Heru Santoso,Marfasran Hendrizan,Trismidianto,Ginaldi Ari Nugroho,Afif Budiyono,Sri Ekawati,2024-06-04 This book includes peer reviewed articles from INCREASE 2023 Indonesia It highlights research in the field of Radioscience Equatorial Atmospheric Science and Environment organized by the Research Center for Climate and Atmosphere PRIMA of the National Research and Innovation Agency BRIN The symposium aims to provide a scientific platform for students teachers and researchers to discuss ideas and current issues in the areas of atmosphere and ocean observation and prediction climate change urban climate and sustainable development atmospheric chemistry and air quality atmosphere ocean interaction and climate variability atmosphere and space interaction paleoclimatology cloud physics and its application and atmospheric dynamics and hydrometeorology *Machine Learning and Data Mining Approaches to Climate Science* Valliappa Lakshmanan,Eric Gilleland,Amy McGovern,Martin Tingley,2015-06-30 This book presents innovative work in Climate Informatics a new field that reflects the application of data mining methods to climate science and shows where this new and fast growing field is headed Given its interdisciplinary nature Climate Informatics offers insights tools and methods that are increasingly needed in order to understand the climate system an aspect which in turn has become crucial because of the threat of climate change There has been a veritable explosion in the amount of data produced by satellites environmental sensors and climate models that monitor measure and forecast the earth system In order to meaningfully pursue knowledge discovery on the basis of such voluminous and diverse datasets it is necessary to apply machine learning methods and Climate Informatics lies at the intersection of machine learning and climate science This book grew out of the fourth workshop on Climate Informatics held in Boulder Colorado in Sep 2014 Monitoring and Prediction of Tropical Cyclones in the Indian Ocean and Climate Change U.C. Mohanty,M. Mohapatra,O.P. Singh,B.K. Bandyopadhyay,L.S. Rathore,2013-10-12 This book deals with recent advances in our understanding and prediction of tropical cyclogenesis intensification and movement as well as landfall processes like heavy rainfall gale wind and storm surge based on the latest observational and numerical weather prediction NWP modeling platforms It also includes tropical cyclone TC management issues like early warning systems recent high impact TC events disaster preparedness assessment of risk and vulnerability including construction archiving and retrieval of the best tracking and historical data sets policy decision etc in view of recent findings on climate change aspects and their impact on TC activity The chapters are authored by leading experts both from research and operational environments This book is relevant to cyclone forecasters and researchers managers policy makers graduate and undergraduate students It intends to stimulate thinking and hence further research in the field of TCs and climate change especially over the Indian Ocean region and provides high quality reference materials for all the users mentioned above for the management of TCs over this region **Himalayan Weather and Climate and their Impact on the Environment** A.P. Dimri,B. Bookhagen,M. Stoffel,T. Yasunari,2019-11-08 This book proposes a unique and comprehensive integrated synthesis of the current understanding of

the science of Himalayan dynamics and its manifestations on physical systems and ecosystems at different spatial and temporal scales In particular this work covers relevant aspects of weather and climate paleoclimate snow glacier and hydrology ecology forestry among other topics associated with the Himalayas It highlights the role of the Himalayas in defining local to regional to global scale impact on weather and climate It includes Himalayan impact on defining physical basis of changing glacier systems permafrost melting thawing climate variability and hydrological balances As a result this volume represents an important synthesized overview both for environmental and earth science researchers and for policy makers and stakeholders interested in the physical and dynamical processes associated with the Himalayan massif

Numerical Weather Prediction: East Asian Perspectives Seon Ki Park,2023-11-20 This book describes the history development current status of numerical weather prediction NWP in both operational and research modes and various applications of NWP models which have been made by the scientists in East Asian countries In particular it introduces the major contributions to the worldwide NWP community achieved by East Asian scientists including parameterizations data assimilation techniques parameter optimizations and applications of the NWP models to improve the forecasts of high impact weather systems in East Asia This book provides both research scientists and graduate students with basic knowledge and insights on the development of NWP in East Asia **Modeling of Regional Atmospheric Pollution** Laurent Menut,2024-04-10 This book describes the main concepts used to develop and implement chemistry transport models to calculate the evolution of regional air pollution Since physico chemical principles are already widely presented in various works the perspective chosen for this book concerns the modeling of these processes As modeling can be a simplification of reality in a particular study framework we will try to show whether the processes represented are well modeled or not For each process we will discuss the simplifying assumptions that have been made the various possible ways for improvement and the impact of these simplifications on the desired results General information on pollution is presented followed by observations legislation modeling of meteorology and then chemistry transport anthropogenic and natural emissions depots validation of calculations optimization and data assimilation *Remote Sensing for Sustainability* Qihao Weng,2016-11-17 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   Perspectives on Atmospheric Sciences Theodore Karacostas,Alkiviadis Bais,Panagiotis T. Nastos,2016-09-09 This book provides the proceedings of the 13th International Conference of Meteorology Climatology and Atmospheric Physics COMECAP 2016 that is held in Thessaloniki from 19 to 21 September 2016 The Conference addresses fields of interest for researchers professionals and students related to the following topics Agricultural Meteorology and Climatology Air Quality Indoor and Outdoor Applied Meteorology and Climatology Applications of Meteorology in the Energy sector Atmospheric Physics and Chemistry Atmospheric Radiation Atmospheric Boundary layer Biometeorology and Bioclimatology Climate Dynamics Climatic Changes Cloud Physics Dynamic and Synoptic eteorology Extreme Events Hydrology and Hydrometeorology Mesoscale Meteorology Micrometeorology Urban Microclimate Remote Sensing Satellite Meteorology and Climatology Weather Analysis and Forecasting The book includes all papers that have been accepted after peer review for presentation in the conference   The Adaptation to and Mitigation of Climate-Sensitive Natural Hazards Diandong Ren,Gen Li,Mervyn Lynch,Anning Huang,Bo Lu,2022-11-29   **Numerical Optimization in Engineering and Sciences** Debashis Dutta,Biswajit Mahanty,2020-04-07 This book presents select peer reviewed papers presented at the International Conference on Numerical Optimization in Engineering and Sciences NOIEAS 2019 The book covers a wide variety of numerical optimization techniques across all major engineering disciplines like mechanical manufacturing civil electrical chemical computer and electronics engineering The major focus is on innovative ideas current methods and latest results involving advanced optimization techniques The contents provide a good balance between numerical models and analytical results obtained for different engineering problems and challenges This book will be useful for students researchers and professionals interested in engineering optimization techniques   **Advances in Numerical Model, Data Assimilation, and Observations for Hazardous Weather Prediction** Feifei Shen,Yunheng Wang,Yuefei Zeng,Dongmei Xu,2023-10-30 Accurate and timely forecasting of hazardous weather events induced by meso scale convection systems MCSs is the key to safeguarding lives and property Yet the MCS forecasting is challenging due to imperfect initial numerical conditions that lack meso scale convective information and multi scale dynamic and thermodynamic consistency Remote sensing observations are the primary source of estimating weather conditions such as moisture wind velocity and precipitation It is of fundamental pivotality to develop data assimilation technologies to enhance applications of multi source observations Performance assessments of new types of observations facilitate the network designment for regional and storm

scale numerical models This Research Topic seeks submissions underscoring the improvement of the accuracy of MCS predictions warnings and decision support for high impact weather events as well as observation network designs *Data Assimilation for Atmospheric, Oceanic and Hydrologic Applications (Vol. II)* Seon Ki Park,Liang Xu,2013-05-22 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 **Meteorological Tsunamis: The U.S. East Coast and Other Coastal Regions** Ivica Vilibić,Sebastian Monserrat,Alexander B. Rabinovich,2014-11-16 The book encompasses a set of papers on meteorological tsunamis covering various aspects on this rare but potentially destructive multiresonant phenomenon Altogether an editorial and 15 contributions are part of this book eight of the contributions deal with different aspects of meteotsunamis along the U S East Coast and in the region of the Great Lakes including one paper introducing a new methodology in meteotsunami research Seven more papers are documenting meteotsunamis in various coastal areas of the world oceans All continents except Antarctica have been covered with the authors representing 11 countries Previously Published in Natural Hazards Volume 74 No 1 2014 **Extreme Weather Forecasting** Marina Astitha,Efthymios I. Nikolopoulos,2022-10-11 Extreme Weather Forecasting reviews current knowledge about extreme weather events including key elements and less well known variables to accurately forecast them The book covers multiple temporal scales as well as components of current weather forecasting systems Sections cover case studies on successful forecasting as well as the impacts of extreme weather predictability presenting a comprehensive and model agnostic review of best practices for atmospheric scientists and others who utilize extreme weather forecasts Reviews recent developments in numerical prediction for better forecasting of extreme weather events Covers causes and mechanisms of high impact extreme events and how to account for these variables when forecasting Includes numerous case studies on successful forecasting outlining why they worked

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Wrf Model Sensitivity To Choice Of Parameterization A Introduction

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