



大气与海洋研究中的数学理论与资料同化 2023 International Workshop on Mathematical Theory and Data Assimilation in Atmospheric and Oceanic Research (2023.4.21, Online via VoovMeeting / 腾讯会议)

Program



主办单位: 南京信息工程大学 (NUIST) 江苏省工业与应用数学学会 (JSIAM)

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Announcement

2023 International Workshop on Mathematical Theory and Data Assimilation in Atmospheric and Oceanic Research

Mathematical theory and data assimilation play an important role in atmospheric and oceanic scientific research. In recent years, various models and methods have been developed and analyzed to study atmospheric and oceanic science. The Nanjing University of Information Science and Technology (NUIST) and Jiangsu Society for Industrial and Applied Mathematics (JSIAM) are proud to announce that we will host online on April 21 the 2023 International Workshop on Mathematical Theory and Data Assimilation in Atmospheric and Oceanic Research.

As one of the important activities of the Science and Technology Activity Month of NUIST, this workshop will provide an international forum for interdisciplinary experts to present their latest research findings, share innovative ideas, identify challenges and opportunities, and promote international collaborations in atmospheric and oceanic research. It will also provide an excellent opportunity for young researchers and students to interact with our top scientists and learn hands-on research experience in these fields.

Register in advance: https://meeting.tencent.com/dw/2qr4Op4IbMtE (# ID: 573-966-084)

Invited Speakers (in order of the talks):

Pierre Auger, French Academy of Sciences, France; Nanjing University of Information Science and Technology, China

Ning Ju, Oklahoma State University, USA Jinkai Li (李进开), South China Normal University, China Daiwen Huang (黄代文), Institute of Applied Physics and Computational Mathematics, China Bo You (尤波), Xi'an Jiaotong University, China Liang Yan (闫亮), Southeast University, China Shenyang Tan (谭沈阳), Nanjing University of Information Science and Technology, China Guoli Zhou (周国立), Chongqing University, China Valerio Lucarini, University of Reading, United Kingdom

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Sponsors

School of Mathematics and Statistics / Journal Center / Center for Applied Mathematics of Jiangsu Province / Jiangsu International Joint Laboratory on System Modeling and Data Analysis, Nanjing University of Information Science and Technology (NUIST), China

Jiangsu Society for Industrial and Applied Mathematics (JSIAM), China

Schedule

大气与海洋研究中的数学理论与资料同化

2023 International Workshop on Mathematical Theory and Data Assimilation in Atmospheric and Oceanic Research

(2023.4.21, Online via VoovMeeting / 腾讯会议)

April 21 th , 2023						
From 8:30 am to 12:00 am (Chinese Standard Time / CST: GMT+8)						
(Register in advance: https://meeting.tencent.com/dw/2qr4Op4IbMtE, ID: 573-966-084)						
08:30-08:40 Opening ceremony, Meeting Host: Wenjun Liu A brief introductory speech by Pierre Auger						
Invited Talks						
Time	Speaker	Institution	Title	Chair		
08:40-09:25	Ning Ju	Oklahoma State University, USA	Global Attractor for Solutions to 3D Viscous Primitive Equations	Jinkai Li		
09:25-10:10	Jinkai Li	South China Normal University, China	Primitive equations coupled with moisture dynamics and justification of hydrostatic balance	Ning Ju		
10:20-11:05	Daiwen Huang	Institute of Applied Physics and Computational Mathematics, China	On the attractors of primitive equations of the large-scale atmosphere and ocean	Bo You		
11:05-11:50	Bo You	Xi'an Jiaotong University, China	A discrete data assimilation algorithm for the three- dimensional planetary geostrophic equations of large- scale ocean circulation	Daiwen Huang		

大气与海洋研究中的数学理论与资料同化

2023 International Workshop on Mathematical Theory and Data Assimilation in Atmospheric and Oceanic Research

(2023.4.21, Online via VoovMeeting / 腾讯会议)

April 21th, 2023

From 14:30 pm to 17:30 pm (Chinese Standard Time / CST: GMT+8)

(Register in advance: https://meeting.tencent.com/dw/2qr4Op4IbMtE, ID: 573-966-084)

Invited Talks					
Time	Speaker	Institution	Title	Chair	
14:30-15:15	Liang Yan	Southeast University, China	Multi-fidelity surrogate modeling approach and its applications to data assimilation	Vuonong Wong	
15:15-16:00	Shenyang Tan	Nanjing University of Information Science and Technology, China	The strong solutions to the primitive equations coupled with multi-phase moisture atmosphere	Tuepeng wang	
16:10-16:55	Guoli Zhou	Chongqing University, China	Well-posedness of 3D stochastic Burgers equation		
16:55-17:40	Valerio Lucarini	University of Reading, United Kingdom	Fingerprinting Heatwaves and Cold Spells Using Large Deviation Theory	Guangying Lv	

Abstract and Speakers' Introduction

Global Attractor for Solutions to 3D Viscous Primitive Equations

Ning Ju

Oklahoma State University, USA

Email: ning.ju@okstate.edu

In this talk I will discuss about some previous results, mainly some obtained by myself and some along with Professor Temam, on global attractor for solutions of 3D Primitive Equations for large scale ocean flow.



Ning Ju obtained PhD in Applied Mathematics at Indiana University, USA, 1999, and now is an associate professor at Department of Mathematics in Oklahoma State University. He has published more than 20 academic papers in journals such as Comm. Math. Phys., SIAM J. Numer. Anal., Indiana Univ. Math. J., J. Differential Equations, Discrete Contin. Dyn. Syst., J. Nonlinear Sci., and so on.

Primitive equations coupled with moisture dynamics and justification of hydrostatic balance

Jinkai Li

South China Normal University, China

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In this talk we will present some recent results on the well-posedness of the coupled system of the primitive equations with the moisture system for the warm cloud. Multi-phases and phase changes are taken into consideration and both the simplified case and the thermodynamically refined case will be considered. For the simplified case, we assume that the dry air and water vaper have the same gas constants and heat capacities and ignore the heat capacity of the liquid water. Some results rigorously justifing the hydrostatic approximation from the Navier-Stokes equations to the primitive equations in both the frameworks of strong solutions and z-weak solutions will also be presented.



Jinkai Li currently is a professor at the South China Normal University. He received his PhD from the Institute of Sciences at The Chinese University of Hong Kong in December 2013 under the supervision of Professor Zhouping Xin. He was a postdoc researcher at the Weizmann Institute of Science from July 2013 to July 2016 mentored by Professor Edriss S. Titi. Before jointing the South China Normal University in July 2018, he was a research assistant professor at the Chinese University of Hong Kong from July 2016 to July 2018. He got the Second China Association of Science and Technology Outstanding Scientific Paper Award. His research interest is mainly the nonlinear partial differential equations in particular from the fluid mechanics.

On the attractors of primitive equations of the large-scale atmosphere and ocean

Daiwen Huang

Institute of Applied Physics and Computational Mathematics, China

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In this talk, we give some results on the attractors of primitive equations of the large-scale ocean. Firstly, we recall the global well-posedness and long-time dynamics for the viscous primitive equations describing the large-scale oceanic motion. Secondly, we introduce some results on the global attractors of primitive equations, such as the enhanced pullback attractors of 3D Primitive Equations.



黄代文,男,2007年获中国工程物理研究院博士学位,现为北京应用物理与计算数学研究所研究员。主持完成了两项国家基金;作为主要参加人,完成了一项国家基金重点项目和一项面上项目。在 Comm. Math. Phys., J. Func. Anal., J. Diff. Equ.等国际数学期刊上发表论文20余篇。研究领域为非线性发展方程及其无穷维动力系统,主要研究大气、海洋科学和等离子体物理中的一些重要偏微分方程。

A discrete data assimilation algorithm for the three dimensional planetary geostrophic equations of large-scale ocean circulation

Bo You

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In this talk, we consider a discrete data assimilation algorithm for the three dimensional planetary geostrophic equations of large-scale ocean circulation in the case that the observable measurements, obtained discretely in time, may be contaminated by systematic errors, which works for a general class of observable measurements, such as low Fourier modes and local spatial averages over finite volume elements. We will provide some suitable conditions to establish asymptotic in time estimates of the difference between the approximating solution and the unknown exact (reference) solution in some appropriate norms for these two different kinds of interpolant operators, which also shows that the approximation solution of the proposed discrete data assimilation algorithm will convergent to the unique unknown exact solution of the original system at an exponential rate, asymptotically in time if the observational measurements are free of error.



尤波,西安交通大学数学与统计学院教授、博士生导师,2012 年毕业于兰州大学,2014 年 9 月-2015 年 9 月曾访问美国佛罗里达州立大学。主要研究领域为非线性泛函分析与无穷维动力系统。迄今为止,已在 JDDE,AMO,NA,ZAMP,CMS,DCDS 等期刊发表学术论文 40 余篇。曾主持完成4项国家和省部级科研项目。目前,主持一项国家自然科学基金面上项目。

Multi-fidelity surrogate modeling approach and its applications to data assimilation

Liang Yan

Southeast University, China

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Surrogate modeling has a wide range of applications, including aerospace, weather forecasting, and industrial design. In this talk, we will first introduce two types of adaptive multi-fidelity surrogate model construction methods based on polynomials chaos (PC) and deep neural networks (DNNs). The application of multi-fidelity surrogate models in Bayesian inverse problems, as well as ensemble Kalman inversion, is then discussed.



闫亮,副教授、博士生导师,中国工业与应用数学学会不确定性量化专业委员会常务委员。主要从事不确定性量化、贝叶斯建模与计算的研究。2017年入选江苏省高校"青蓝工程"优秀青年骨干教师培养对象,2018年入选东南大学首批"至善青年学者"(A层次)支持计划。目前主持国家自然科学基金面上项目2项,主持完成国家自然科学基金青年项目和江苏省自然科学基金青年项目各1项。已经在 SIAM J. Sci. Comput., Inverse Problems, J. Comput. Phys.等期刊上发表学术论文30余篇。

The strong solutions to the primitive equations coupled with multi-phase moisture atmosphere

Shenyang Tan

Nanjing University of Information Science & Technology, China

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The occurrence and development of cloud and precipitation are the products of the combination of atmospheric dynamic, thermal processes and cloud microphysical processes. In order to understand the interaction between these influencing factors in more detail, in this paper we study a moisture model with multi-phase for warm clouds, which consists of the primitive equations and a set of humidity equations where water is present in the form of water vapor, rain water and cloud condensates. This model has been considered by Cao et al., where the velocity field is a given function in $L^{(0,t_{1})}((0,t_{1}))$ is more in line with the actual situation. In order to overcome the difficulty caused by the physical range requirement for the humidity, we introduce a new penalized function which is different from that introduced in (Nonlinearty, 2018 (31), 4692-4723). Then we obtain the global existence of both quasi-strong solutions and strong solutions. This talk is based on a joint work with Wenjun Liu.



Shenyang Tan, an associate professor and PhD Candidate, with a research interest in partial differential equations in large-scale atmospheric and ocean dynamics. He has published multiple academic papers in journals such as Physical D: Nonlinear Phenomena, Journal of Mathematical Analysis and Application, and Chinese Annals of Mathematics.

Well-posedness of 3D stochastic Burgers equation

Guoli Zhou

Chongqing University, China

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In this work we establish the global well-posedness and the long-time behaviour of 3D Burgers equation driven by linear multiplicative noise.



Guoli Zhou, an associate professor at Chongqing University, who has presided over 3 National Natural Science Foundation projects. He is mainly engaged in the research of stochastic partial differential equations. In recent years, he mainly considers stochastic atmospheric and ocean equations, and stochastic 3D Burgers equation. His work is published in the SIAM Journal on Mathematical Analysis, Journal of Differential Equations, Journal of Dynamics and Differential Equations, Applied Mathematics and Optimization, Physica D: Nonlinear Phenomena and other journals.

Fingerprinting Heatwaves and Cold Spells Using Large Deviation Theory

Valerio Lucarini

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The climate is a complex, chaotic system with many degrees of freedom. Attaining a deeper level of understanding of climate dynamics is an urgent scientific challenge, given the evolving climate crisis.In statistical physics, many-particle systems are studied using Large Deviation Theory (LDT). A great potential exists for applying LDT to problems in geophysical fluid dynamics and climate science. In particular, LDT allows for understanding the properties of persistent deviations of climatic fields from long-term averages and for associating them to lowfrequency, large-scale patterns. By applying LDT to a state-of-the-art Earth system model, we define the climatology of persistent heatwaves and cold spells in key target geographical regions by estimating the rate functions for the surface temperature, and we assess the impact of increasing CO2 concentration on such persistent anomalies. We propose and test an approximate formula for the return times of large and persistent temperature fluctuations from easily accessible statistical properties. Hence, we can better quantify the increasing hazard due to heatwaves in a warmer climate. We show that several high impact events - e.g the 2010 summer Russian heatwave, 2010 winter Dzud in Mongolia, the 2019 North American cold wave, and the 2021 Western North American heatwave —are associated with atmospheric patterns that are exceptional compared to the typical ones but typical compared to the climatology of extremes. Events that are sufficiently intense and persistent adhere closely to prototypes - the instantons - that are encoded in the dynamics of the climate system as part of its natural variability.

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V. M. Galfi, V. Lucarini, J. Wouters, A Large Deviation Theory-based Analysis of Heat Waves and Cold Spells in a Simplified Model of the General Circulation of the Atmosphere, J. Stat. Mech. 033404 doi: 10.1088/1742-5468/ab02e8 (2019)



Prof. Valerio Lucarini (VL) (b. 1976, Ancona, Italy, male) received a BSc and MSc in Physics at the University of Pisa and Scuola Normale Superiore in 1999. Subsequently he obtained a MSc in Climate Physics and Chemistry at MIT in 2002, and obtained a PhD in Physics at the University of Eastern Finland in 2003. After having held the chair in theoretical meteorology at the University of Hamburg between 2011-2016, since 2017 VL has been professor of statistical mechanics and director of the Centre for the Mathematics of Planet Earth at the University of Reading. He is fellow of the Royal Met. Society and of the Inst. of Math. and Applications. He has authored two books and about 140 papers in peer-reviewed journals in applied mathematics, climate science, climate modelling, statistical mechanics, extreme value theory, dynamical systems, condensed matter physics. VL has been organiser or co-organiser of more than 60 international conferences/workshops/sessions, including programmes at the I. Newton Institute and H. Poincaré Institute and advanced schools in Les Houches and Cargèse, and has given more than 70 invited presentations. He was member of the editorial board of Nonlinear Processes in Geophysics, Earth System Dynamics, Chaos. He is currently member of the editorial board of Physical Review E and Physical Review Letters. VL has supervised 15 PDRAs, 15 PhD students and more than 15 research students. He is recipient of the 2010 Arne Richter Award and of the 2020 Richardson Medal of the Eur. Geosci. Union, of the 2018 Whitehead Prize of the London Math. Society, of the 2021 Lorenz Lecture Award of the American Geophysical Union, and of the 2022 SIAM Mathematics of Planet Earth Prize. His research is currently funded by the EU through the Horizon 2020 project TiPES and the Marie Curie ITN CriticalEarth, and by EPSRC through the project EP/T018178/1. VL held an ERC Standard investigator Grant in 2010-2015 and has been directly responsible for research funds totalling over 8M Euros, obtained from national, EU, and international funders.

A Brief Introduction to the

School of Mathematics and Statistics, Nanjing University of Information Science and Technology (NUIST), China



About NUIST

NUIST, formerly named **Nanjing Institute of Meteorology**, was established in 1960 and enjoys the reputation as "the cradle of meteorological talents in China".

In 1978: Listed as one of the 88 National Key Universities in China.

In 2004: Renamed as Nanjing University of Information Science & Technology.

In 2017: Selected as National "Double-First-Class" Construction University.

Rankings: #41 in Best Global Universities in China / #511 in Best Global Universities (U.S. News);

#50-71 in Mainland China / #401-500 in World-University-Rankings-2020 (ARWU).

A⁺: Meteorology was ranked Top 1 in subject assessment by the MOE and rated A^+ in China.

About School of Mathematics and Statistics

The School of Mathematics and Statistics (SMS) in NUIST, is eligible to offer Master's and PhD programs in **Mathematics**, Professional Master's program in **Applied Statistics**, as well as postdoctoral positions of Mathematics. **Mathematics** is the key discipline of China Meteorological Administration.

The School also offers three undergraduate majors including Information and Computing Science, Applied Statistics, and Mathematics and Applied Mathematics, which are all key majors of Jiangsu Province, China. Information and Computing Science was selected as the **First-class** undergraduate major by the MOE.

Rankings: #30 in Mathematics in China / #166 in Mathematics (U.S. News);

49-75 in Mathematics in mainland China / #301-400 in Mathematics (ARWU).

Faculty: The School has personnel of highly qualified teachers with strong research capabilities. The School currently has over 110 faculty members, including 32 professors and 21 PhD supervisors, 41 associate professors / associate researchers.

Honor & Awards:

• Norbert Gerbier-Mumm International Award, World Meteorological Organization (2001)



- National Thousand Talents Program, Fok Ying-Tong Education Foundation, Distinguished Professor of Jiangsu Province, etc.
- Outstanding award in COMAP's Mathematical Contest in Modeling (MCM) / Interdisciplinary Contest in Modeling (ICM) (2012, 2018, 2019, 2022)
- The only prize of the highest rank, namely the Higher Education Press Cup, in the National Mathematical Modeling Contest for undergraduates (2011)



- The first class award for National teaching achievement by the MOE (2014)
- The first class award for teaching achievement of Jiangsu Province (2011, 2017)
- Many awards as national brand curriculum, excellent curriculum of Jiangsu Province, key textbook of Jiangsu Province, excellent textbook of China Meteorological Administration

Research in School of Mathematics and Statistics

Research Areas and Features:

- We focus on the problem-driven theoretical research, and a strong research team has been formed in the fields of fluid dynamics, scientific calculation, statistical inference, time series, algebra and number theory, etc.
- We emphasize on the intersection and integration with the atmospheric sciences, develop mathematical technology to solve key problems in interdisciplinary research, and carry out extensive and in-depth research on the application of multiple linear models to typhoon

diagnosis, the application of control theory to data assimilation, earth system model and other atmospheric mathematics, etc.

Platform: The National center for applied mathematics (jointly), the National virtual simulation experimental teaching demonstration center, the big data key laboratory of Jiangsu Province, 4 enterprise cooperative education platforms of MOE, and 5 enterprise postgraduate workstations of Jiangsu Province, which can provide excellent social resource for enhancing the students' innovation and enterprise ability.

International and Industrial Collaboration: On average, about 30 mathematicians or business experts from around the world visit the School each year for 2 to 4 weeks, conducting joint research with local mathematicians and statisticians, holding seminars, and making themselves available for consultation with students working in their area. Through teaching partnership and active cooperative research projects, the School has close ties with the industry such as Huawei and Neusoft.

Fund: In the past five years, the academic team of the School has received 55 National projects and 76 other level projects, including 973 Program, National Key Research and Development Program of China, Key Program of NSFC and so on, altogether 39.8 million (CNY).

Publications: More than 400 papers in SCI journals like **Trans. Amer. Math. Soc., Adv. Math.**, **J. Funct. Anal., Sci. China Math.**, **Arch. Ration. Mech. Anal., SIAM** journals, **IEEE** journals, etc, and more than 30 monographs and textbooks, in the past five years.

Education in School of Mathematics and Statistics

Aims: Advancing mathematical and statistical knowledge through novel and insightful research. Training experts in not only mathematics but also other academic, industrial, and applied fields.

International Joint Training Program: International cooperation with University of Reading, Florida State University, Carleton University, etc., carrying out joint enrollment and training of undergraduate, master and PhD students, as well as regular academic exchanges.

Employment and Further Education: High quality employment rate is over 98.2%, including research, teaching and technology development in the field of government agencies, research institution, education, IT, meteorology, finances and so on. The rate of studying abroad as a postgraduate is over 30%, and many graduates have been enrolled in domestic and foreign famous universities such as **Cornell University**, **University of Edinburgh**, **Columbia University**, **Imperial College London**, **Tsinghua University**, **Chinese Academy of Sciences**, etc.

Future of Our Students: The School cultivates a number of prominent alumni including "1,000 Talents Plan" and tenured professors in USA and European countries, and makes important contributions in the field of numerical prediction, climatic statistics, data assimilation and the application of differential equation, etc.

Website: https://math.nuist.edu.cn/3305/list.htm Email address: sms@nuist.edu.cn





祝您生活愉快! Wish you a happy life.